The Crib
NORTH MANITOU
LIGHT KEEPERS

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MANAGEMENT SUMMARY

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Executive Summary

Located off the coasts of Lake Michigan's South Manitou and North Manitou Islands in the Manitou Passage, the North Manitou Shoal Light Station is situated approximately two and one-quarter nautical miles south of the southeastern tip of North Manitou Island and seven and one-quarter miles northeast of Glen Arbor on Michigan's western shore. (Latitude 45^0 01'12.0"N, Longitude 87^0 57'21.6"W).

The North Manitou Shoal Light Station has served as an active aid to navigation for 85 years. Initially run by the U.S. Lighthouse Service (USLS) and later by the U.S. Coast Guard (USCG), the station was operated by lighthouse keepers and USCG personnel for 45 years. The station is a multi-level steel structure that rises over 80 feet above the surface of Lake Michigan. It is constructed on a massive concrete base, known as a "crib", that measures approximately 67 feet square at the main deck level. This concrete structure is supported by a submerged timber crib filled with both concrete and stone that rests on the Lake Michigan bottomland. The station was automated in 1980 and the Coast Guard crew were reassigned.

North Manitou Light Keepers (NMLK) is a team of stewards who are dedicated to rehabilitating, maintaining, and appreciating the North Manitou Shoal Light in Leelanau County, Michigan. Recognizing that the structure has been "lightly maintained" since its automation by the US Coast Guard in 1980, the NMLK states that a meaningful restoration of the lighthouse structure is necessary to stop its further deterioration, make it "pretty" again, and make it available to the public for viewing and appreciation.

The State Historic Preservation Office (SHPO) has worked closely with Michigan lighthouse stewards through federal and state preservation programs since the passage of the National Historic Lighthouse Preservation Act (NHLPA). Through this experience, the SHPO has recognized the need for planning documents and educational efforts for Michigan's offshore maritime resources. Since these offshore resources are often difficult to visit and are not easily visible to the general public, their stewards face additional challenges relative to educating the public about their significance and fundraising for their rehabilitation. Therefore, development of comprehensive planning documents and subsequent public outreach is essential in maintaining these historic sites. This HSR is one such comprehensive document. It is funded through a Michigan Lighthouse Assistance Program (MLAP) grant from the SHPO.

Background and History

The Manitou Islands are the two southern islands of an archipelago in northeastern Lake Michigan. Approximately 16 miles long and varying from 7 to 12 miles wide, the Manitou Passage extends between the islands and the western shore of Michigan. Travel on Lake Michigan steadily increased following the opening of the Erie Canal, and by the 1830s there was considerable steamboat traffic on the lake. The treacherous Manitou Passage was situated along one of Lake Michigan's heaviest travelled shipping routes. The United States Lighthouse Establishment (USLHE) sought Congressional funding to establish a lighthouse along the passage in 1838. This first lighthouse was completed in 1840 and was located on the southeast corner of South Manitou Island, at the southern edge of its natural harbor. The lighthouse was later replaced in 1858 and improved again in 1871 with the addition of new light tower. By the early 1890s, the USLHE acknowledged the need for an additional aid to navigation in the region along one of the main navigational routes between Green Bay and the Straits of Mackinac. Congress subsequently authorized funding, and a light station was built on North Manitou Island in 1896-1898.

In the early twentieth century, the route through the Manitou Passage continued to be one of the most heavily traveled shipping lanes along Lake Michigan. During this time a shoal had developed in the passage southeast of North Manitou Island, warranting the need for another aid to navigation. In its 1908 Annual Report, the Lighthouse Board requested funding to place a lightship on the easterly end of the shoal. Lightship No. 56 (LV-56), the first of three lightships to serve the shoal, was put into service in 1910. This lightship was equipped with both a light and a steam whistle fog signal. Lightship LV-89 replaced LV-56 in the spring of 1927. The third, and last, lightship to serve at the station, LV-103, was assigned to the shoal for the 1934 navigational season. In addition to the light, LV-103 was also equipped with a TYFON steam-powered fog horn and radio beacon. All three lightships had "MANITOU" painted on the sides of their hulls.

Design and Construction

The history of the design, funding, procurement and construction of the North Manitou Island Light Station extended several years and is quite complex. The U.S. Lighthouse Service conducted an extensive project in the 1920s and 1930s to replace all lightships in the upper Great Lakes region with permanent aids to navigation. The Assistant Superintendent of the Twelfth Lighthouse District (in which the North Manitou Shoal was located) visited the recently completed DeTour Reef Light, and possibly other nearby offshore lights, in 1932 to obtain data for construction of a permanent station at the North Manitou Shoal. By November of that year, the Twelfth District had prepared preliminary drawings and construction cost estimates, and a survey of the shoal topography was underway to assist in determining the best location for the permanent station. The District submitted a formal request for Congressional funding of $175,000, with the intention to obtain funding from the Emergency Relief & Construction Act (ERCA) of 1932. The ERCA, signed by President Hoover on July 27, 1932, appropriated funds for federal relief loans to the states and new public works construction.

The early design of the station included a two-story building and tower to be built on an 80-foot diameter steel caisson foundation. The design proposed omitting a traditional enclosed lantern, and instead installing an airway beacon placed on an open deck at the top of the tower. The Bureau of Lighthouses in Washington, D.C. did not respond favorably to this design put forth by the Twelfth District, nor the District's proposed recommended location on the shoal. The Bureau's concern with the design was that it wasn't similar to DeTour Reef and other offshore Great Lakes light stations, as the Bureau had originally recommended. The Bureau informed the Twelfth District to reach out to the Lake Carriers' Association and the Lake Survey for their viewpoints on the most suitable location for the station. The Bureau also required the District to provide two cost estimates for the station in two different locations along the shoal. The District prepared two estimates, but not for two different locations, but for two different types of foundation. One estimate was for a revised circular caisson foundation at a reduced depth and the other was for a square crib foundation with steel sheet piles. The Bureau subsequently required the District administration to attend a meeting with the Bureau in late December to review both the design and location of the station.

The Twelfth District Assistant Superintendent N.M. Works and 11th District Superintendent C.A. Park attended the December 28th conference in Washington, DC along with the Deputy Commissioner, General Superintendent and the Chief Constructing Engineer from the Bureau. It was determined that the most suitable location for the station would be near the location of the lightship, with the exact location pending further detailed survey. The outcome of the discussion relative to the design of the structure was not so favorable. Although both the original caisson design and revised design with square foundation were "given careful consideration," they were not acceptable to the Bureau. Again, it was preferred to follow previously completed offshore lights, which neither design did so much. A couple of days after the meeting, the Bureau formally sent written correspondence to the District on December 30th, informing them that the design was not approved.

Although the design was not approved, within days of his return to Milwaukee, the superintendent started working on securing timber for a square crib. Superintendent Hubbard coordinated with the 17th District in Seattle and the Bureau on the procurement of timber from a

Pacific Coast mill. By the end of January, Hubbard wrote to the Lighthouse Commissioner telling him that revised plans for an approved type of structure similar to DeTour Reef Light were well underway. He also requested immediate funding of $175,000 to secure contracts for materials and construction as soon as possible. The Commissioner wrote back to Superintendent Hubbard stating that an $155,000 allotment was approved and explained that his cost reduction reflected elimination of the telephone cable from the project and reduction of the amount of riprap by fifty percent. The Twelfth District then prepared specifications for steel sheet piling and timber and plank for the crib. Bids were solicited for both in February. Inland Steel Company and Daugherty Lumber Company were the low bidders for the steel and timber, respectively. The Bureau also sent the District standard drawings for a third order lantern in February, for the District to incorporate into the station design (rather than the previous lantern-less design).

While bids were being solicited for materials, Superintendent Hubbard was also working on an alternate construction method for the pier construction. It appears he was considering an alternate method of grouting rock fill in the crib instead of the more traditional concrete method used at the time. He solicited the advice of the Dravo Contracting Company in Pittsburgh, who responded favorably to his idea, providing details on how to undertake the construction using this method, amounts of material needed, estimated unit costs, and that Dravo was interested in doing the work.

The Twelfth District submitted their preliminary plans for the revised structure on March 11, 1933 and they were less than favorably received by the Bureau. Correspondence from the Bureau includes criticisms of several aspects of the design and states that the design was decidedly inferior both architecturally and structurally to that of DeTour Reef Light Station. The District had advertised for bids for the general contract for construction the same day they sent the preliminary plans off to the Bureau, and a bid opening date was set for April 10th. Then, unfortunately, on March 24th, the project stalled due to an Executive Order to freeze funding from the Emergency Relief & Construction Act. The Bureau sent a telegram to the 12th District "directing that the creation of further obligations against public works appropriations be discontinued until further notice." Superintendent Hubbard responded with a letter to the Commissioner indicating that he telegraphed the Superintendent in Oregon to stop production on the timber and then pleaded to not stop the project.

Despite the stop order from Washington, work on the project seemed to continue per usual in Milwaukee. It appears that the 12th District kept full steam on the project, preparing construction drawings for the station (possibly incorporating the critiqued comments from the Bureau). The National Archives has over a dozen drawings of the station dated March 31, 1933.

Some unique features of the final design that was ultimately constructed include its configuration of the light tower being turned 45-degrees off axis to the foundation; sea doors for entering the structure at the water/basement level within the foundation structure; and a large boatroom built within the structure that has large doors at both ends. North Manitou Shoal Light Station was the only offshore light in the upper Great Lakes designed with the unique 45-degree turn. The convenient provision of seadoors at the water level appears to have only been included in four offshore lighthouses. Only one other offshore light (Lansing Shoal) also originally had boat bay doors at both ends of the boatroom, but they have been infilled with concrete block.

The bids for the cast iron lantern were opened on March 31st, with Johnson City Foundry of Johnson City, Tennessee being the low bidder. Superintendent Hubbard wrote back to the Dravo Contracting Company on April 10th, thanking them for their assistance and telling Dravo that their suggestions were incorporated into the design and potential bidders were informed of Dravo's interest in the work to fill the crib.

Superintendent Hubbard also wrote to the Commissioner informing him that the District was still working on completing the drawings and specifications, so the general contractor bid due date was being extended. Bids were opened on April 25, 1933, with Lyons Construction Company of Grand Rapids, Michigan being the low bidder. Hubbard sent the Commissioner a plea to lift the Stop Order on funding, as they were ready to place orders for the timber, sheet piling and lantern; and they were close behind being ready to do the same on the radio beacon, lens and fog signal. Hubbard also explained and requested to use his alternate grouting method for the crib, a quicker method than traditional concrete, to keep the project moving quickly. The Bureau notified the Twelfth District via letter and telegram at the beginning of May that the bids were rejected and to suspend all further action on this project.

The region's congressman, Mr. Harry W. Musselwhite got involved and sent a letter to the Commissioner referencing a new public works bill and asking to proceed with the contract with the Lyons Construction Company as soon as the new funding was available. In the meantime, the Bureau had reviewed the updated drawings and specifications for the station, and still had several criticisms. With a new economic recovery bill in the works for funding, there wasn't time for much redesign. Therefore, the Bureau gave a qualified approval to proceed once funding was available and the Stop Work order was lifted.

The new bill, the National Industrial Recovery Act (NIRA), was enacted by Congress on June 16, 1933. It apparently took some time between the enactment of the NIRA and when funding was approved for projects to commence. With no word on approval for the North Manitou Shoal Light Station construction to proceed, Congressman Musselwhite again got involved, writing to the Commissioner on June 30th. By this time, the timber for the crib had already arrived in the nearby port of Frankfort. Musselwhite's colleague in the Senate, Senator A.H. Vandenberg also sent a telegram to the Commissioner on July 15th. Commissioner Putnam promptly responded to both men that the project could not proceed until funds were made available by public works administrator and that allotment for lighthouse construction was not yet available due to legal complications in awarding contracts that were previously bid before the enactment of the NIRA.

Finally, on July 17th, Commissioner Putnam informed Superintendent Hubbard that all contracts would have to be re-bid, and to solicit new bids only from the same contractors who had previously bid. Realizing that time was of the essence, he said to obtain bids by telegraph if necessary. The contracts were rebid accordingly. On July 29, 1933, the project was approved to proceed, with the low bidder again Lyons Construction Company for general construction contract, and using the traditional tremie concrete construction for the foundation and not alternate grouting method. The steel sheet piling was re-bid in early August and Inland Steel Company was again the low bidder.

Construction of the crib began in Frankfort on August 7th. Later in the month, Lyons Construction stated that it was now too late in the season to use the traditional concrete method to fill the crib, and that they would need

to use the much quicker alternate grouting method to get the foundation in a safe condition to weather through the winter. The Lighthouse Bureau gave conditional approval to proceed with the alternate method at no additional cost to the project. The contract for cast iron lantern was also re-bid in late August, with Johnson City Foundry again the low bidder. The third order lens was delivered to the Twelfth District Depot in Milwaukee on August 25, 1933.

The timber crib was taken out and sunk on the shoal on September 9th, and filled with a mixture of stone and gravel the following day. In mid-September, the Hansell Elcock Company was approved to provide steel for the lighthouse building and tower. Correspondence ensued throughout October between the Twelfth District who was recommending to increase the amount of stone rip rap around the crib and the Lighthouse Bureau who was not seeing a warranted need for it, and thus not approving. The Bureau's Chief Engineer visited the station in November to review construction progress and construction stopped for the winter in December of 1933.

The contract for engine generators for the station was bid in December 1933, with the Fairbanks Morse Company being the low bidder. Extensive debate followed in January through April 1934 over several aspects of the generators to install and use at station. Discussions between the Twelfth District and the Bureau included the type of equipment, fuel type, manual versus automatic operation, and whether they would be supplying alternating current (AC) or direct current (DC). Factors that were considered included economical generation for loads needed; that the radio beacon will run hourly; safety of the fuel type (diesel vs. gasoline vs. oil) at the remote location; and that there wasn't a possibility of obtaining commercial electricity from the mainland. The debate led to the specifications being revised in May and the contract being rebid in June. Fairbanks Morse Company was again the low bidder and awarded the contract.

Construction resumed in the spring of 1934 and a temporary navigational light was installed on the main deck of the station. The light vessel also remained in operation through the 1934 navigational season. As construction was underway, revisions and additions continued to be made to the design of the station. One significant design change in the summer of 1934 was relocating the placement of the boat derricks from the north and west corners of the main lighthouse structure to the centers of the northeast and southwest sides of the building. Construction drawings were prepared for the heating system boiler and layout of steam piping and radiators, and for the sea doors and hardware for them. Drawings were also prepared for placement of the air diaphone equipment and the radio beacon antennae. Through collaboration between the USLHS and the USCG, the USCG provided and installed a telephone cable out to the station from North Manitou Island. Construction of the station continued through the end of November. At that time, construction was nearly complete. Spare parts for the lens and motors were acquired in January 1934. Interior finishes and exterior painting of the station were completed in 1935.

Operational Years

The North Manitou Shoal Light Station was officially put into service on May 1, 1935. The 1935 *Light List* states that its fourth-order lens had 240,000 candlepower and provided a red flashing light. It flashed in 15-second intervals (flashed for 0.5 second with a 14.5 second eclipse) and could be seen twelve miles away. The TYFON diaphragm air horns blasted

for two-seconds between 18 second intervals of silence. The Class C radio beacon installed at North Manitou Shoal Light Station consisted of an antenna atop the lantern with a transmitter, signal timer, electric generator, primary clock, radio receiver, and warning device installed inside the light station. The radio signal's reliable average range was 20 miles. The radio signal was synchronized with the lighthouse's fog signal to serve as a distance-finding station.

The *Lighthousefriends.com* website indicates that the first head keeper was John A. Reneham, who served in that role until at least 1940. He was joined at the station by First Assistant Keeper John C. McDonald. and later in 1939, Second Assistant Keeper Jerry P. Conley. In July 1939, the Lighthouse Service was abolished as a separate federal agency and its duties subsumed by the U.S. Coast Guard. Lighthouse keepers and assistants employed by the Lighthouse Service were eventually phased out and replaced by U.S. Coast Guard personnel. The crew serving at the station increased to three in about 1939, each of whom served two weeks at the station followed by a week off. To pass time, the men watched television, read books and magazines, played board games, and chatted with passing ship captains by radio. One coastguardsman perfected his rappelling skills by using ropes to descend from the gallery outside the lantern room to the concrete deck below.

The USLHS often used a private dock in nearby Glen Haven for launching and returning from the station. Owned by the Day family of Glen Haven, the dock was often referred to as "Day's Dock." In 1937, there was extensive correspondence between the Day Estate and the USHLS regarding the USLHS taking ownership of the dock for one dollar. However, the dock was found to be in very poor condition. Due to the anticipated cost of its rehabilitation, combined with concerns of the fire hazard of the wood dock, the USLHS did not proceed with acquiring it.

Very limited historic documentation regarding the station during the 1940s and 1950s has been located. Review of the logbooks reveal that in addition to documentating the weather and shipping traffic, the entries were mainly related to everyday task the keepers had completed. These included cleaning, painting, and changing out machinery parts. The logs also note when there were problems with the aids to navigation, resulting in either the fog signal or radio beacon being temporarily out of service. A 1945 drawing, with as-built notes added in 1954, indicates that the diesel generators and associated electrical panels were replaced between 1945 and 1954. The boat derrick booms were replaced in 1952 and the heating system was changed in 1957.

Review of keepers' logbooks from April 1960 and December 1961 reflect entries for seasonal tasks related to opening and closing the station in the spring and fall respectively. Spring tasks included reinstalling the boat derrick booms; removing storm windows; and testing and inspecting all equipment. Year-end tasks included securing the sea doors; closing vents in the lantern; covering the lens; putting the winter light into operation; and shutting down the fog signal and radio beacon equipment. The fog signal was replaced in 1966, and an emergency version was also added. New generators were installed in conjunction with replacement of the fog signal equipment. The Tyfon air horns were removed from the sides of tower and a new fog signal emitter was installed on a new steel bracket constructed off the side of the lantern deck. Deadbolts were added to and the sea doors were permanently secured closed in June 1969.

Review of photos from the late 1960s - early 1970s indicate that the some of the exterior paint colors had been changed by this time. The lantern roof and radiobeacon antennae were now red instead of black; and the railings at the perimeter of the three decks were now gray instead of the former black. The red, white and blue USCG emblem had also been painted on the east face of the concrete pier and a large USCG sign was mounted to the southeast side of the tower.

By 1980 North Manitou Shoal Light Station was the last offshore light station in the Great Lakes manned by Coast Guard resident keepers. Its automation that year ended the era of keeper-occupied offshore light stations in the region. A key component of the automation, the original lens was removed from the lantern and replaced with a DCB-224 beacon powered by an underwater cable from the mainland. A photo accompanying a period newspaper article about the unmanning of the station shows that everything was apparently removed from the interior, including furniture and appliances. During the 1980s, steel plates were installed over the concrete at the pier deck and watch deck and a submarine electrical cable was installed out to the station from the mainland.

Recent History

The light's power source was replaced in 2000 with a battery system recharged by a solar array mounted on the light tower. This power system also powers the lighthouse's automated modem fog signal and the RACON radar beacon. The USCG prepared a nomination in 2004 and the station was then listed in the National Register of Historic Places in 2005. The nomination stated that the modern Vega Industries VRB-25 marine beacon in place at the time signaled a flash every 15 seconds and had 23-mile range. The automated fog signal sounded two 2-second blasts every 20 seconds year-round. A RACON radar beacon was also mounted on the lantern deck.

After sitting vacant and minimally maintained for 35 years, in May 2015, North Manitou Shoal Lighthouse was declared excess to the needs of the United States Coast Guard and made available to eligible organizations under the provisions of the National Historic Lighthouse Preservation Act of 2000. Qualified entities were given sixty days to submit a letter of interest and were required to obtain a conveyance from the State of Michigan for the bottomlands on which the lighthouse stands. When a new custodian was not found, the General Services Administration initiated an online auction for the lighthouse on July 15, 2016. The non-profit North Manitou Lightkeepers (NMLK) was the winning bidder. In June 2017, NMLK completed its acquisition upon receiving approval from the Michigan Department of Environmental Quality to occupy the "bottomlands" (at the bottom of Lake Michigan) on which The Crib sits.

Currently uninhabited, visitation to the station is limited to the NMLK and contractors undertaking restoration efforts. The NMLK has undertaken several stabilization and restoration projects since acquiring the station. Work completed to date includes removal of hazardous materials (lead-based paint, asbestos and bird guano) and general cleanup; installation of temporary boat/equipment hoists; extensive exterior painting; interior painting of the lantern; and restoration of the windows. NMLK has a membership program inviting those who share the passion, dream and commitment to care for this piece of history to join in on the mission. They have also launched their "Campaign for the Crib" capital fundraising effort to cover the rehabilitation costs of the coming years. Further, NMKL has committed

matching funds to the Michigan Lighthouse Assistance Program grant they received to develop this Historic Structure report. In July 2019, the LED lens was replaced, and a smaller solar panel was installed. The NMLK also completed an underwater evaluation of structure in 2020.

Period of Significance and Period of Interpretation

The North Manitou Shoal Light Station is listed on the National Register of Historic Places. The Period of Significance is listed as 1935 to 1955 with Maritime History, Transportation, Architecture, and Engineering stated as the areas of significance. It is recommended, however, that the Period of Significance be extended from 1955 through 1980 to include the entire time period that the North Manitou Shoal Light Station was a manned aid to navigation and includes the automation of the station.

Period of Interpretation is utilized in this Historic Structure Report to inform the appearance of the station as it undergoes rehabilitation rather than the period used to guide educational or interpretive programming. The Period of Interpretation, based on the station's history, existing conditions and the recommended rehabilitation treatment strategy, has been established as 1935 through 1966. The Period of Interpretation provides an appropriate, specific period of time within the station's evolution that should be recognized as a guide for specific rehabilitation treatments. It does not diminish the importance of the Period of Significance and the recommendation that the station's full history (especially including the recent and on-going rehabilitation) be included in future interpretive programming.

Since its construction, the North Manitou Shoal Light Station has served only one purpose—to serve as an aid to navigation. As such, alterations were mainly limited to technological upgrades and subsequent modifications have been related to these upgrades. Alterations over the last twenty years have been mainly deterioration of elements (rather than purposeful alterations) and the subsequent, recent stabilization and rehabilitation efforts undertaken by the North Manitou Light Keepers.

Current Conditions

The present day conditions of the North Manitou Shoal Light Station are very similar to when it was originally constructed. Although the offshore location typically makes maintenance and repair work more difficult, it often serves to protect the original structure from alterations and changes. Few alterations have occurred over time with major changes being the removal of the metal chimneys that once projected above the Lantern deck and the two derricks that were once located on the Pier Deck. Relatively minor changes have been made to the interior spaces.

The North Manitou Light Keepers have already embarked upon a major restoration of the exterior of the tower including the Lantern. Exterior windows and doors, metal walls and railings have been restored and painted. The Pier Deck, the main surface around the perimeter of the tower, including the perimeter railing system is in poor condition and in need of restoration. Significant water leaks on the upper deck level, which is also the roof of the living quarters, have resulted in deterioration of interior finishes and elements of the steel structure, requiring further evaluation and repair.

Little maintenance was undertaken at the interior of the structure for many years, presumably since the station was automated. All interior floor, wall and ceiling surfaces are in poor condition.

Ultimate Treatment and Use

NMLK has undertaken several stabilization and restoration projects since acquiring the station. Additionally, they maintain a membership program and have also launched a "Campaign for the Crib" capital fundraising effort to cover the rehabilitation costs of the coming years.

The only access to the North Manitou Shoal Light Station is via boat. NMLK members and restoration contractors currently reach the station via private and chartered boats and climb the ladders inset into the concrete pier to access the structure. The recently installed boat/equipment hoists are used for loading and unloading construction materials and equipment, as well as lifting boats onto the main deck when people are on the crib for an extended period.

NMLK's goal is to open the station to public tours and viewing on July 4, 2021. Intended public access is via the to-be-restored sea door located at the water/basement level. Long-term aspirations include holding special events and hosting overnight guests. The NMLK recognizes the important balance of respecting and sharing the history of the station and strategically incorporating contemporary elements to allow visitors to safely enjoy the station.

Treatment Recommendations and Budgetary Cost Estimates

The Secretary of Interior's Standards are divided into four distinct, yet interrelated approaches to the treatment of historic properties: preservation, rehabilitation, restoration, and reconstruction. Preservation focuses on the maintenance and repair of existing historic materials and retention of a property's form as it has evolved over time. Rehabilitation acknowledges the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character. Restoration depicts a property at a particular period of time in its history, while removing evidence of other periods. Reconstruction re-creates vanished or non-surviving portions of a property for interpretive purposes.

The selection of an appropriate treatment(s) depends on a variety of factors, including the property's historical significance, physical condition, proposed use, and intended interpretation. These factors have been considered in determining the appropriate treatment approach for the North Manitou Shoal Light Station. Based on this analysis, the recommended treatment approach is rehabilitation with recognition of the Period of Interpretation of 1935 – 1966.

Specific treatment recommendations have been developed to follow the *U.S. Secretary of the Interior's Standards for Rehabilitation*. These recommendations are prioritized into phases based on condition and relation to the overall recommended Ultimate Treatment and Use. The following is a summary of the treatment recommendations and associated costs.

Phase 1: Continued Rehabilitation and Limited Visitor Access $415,800

Phase 1 work is the highest priority and includes further structural investigation and repairs; exterior repairs and drainage improvements to ensure the structure is watertight; exterior and limited interior rehabilitation treatments; and restoration of the sea door to improve access. These recommendations continue the stabilization and rehabilitation efforts already completed by North Manitou Light Keepers, Inc. Rehabilitation treatments take into account the appearance and configuration of features during the Period of Interpretation where feasible.

Work recommended in later phases may be able to be completed in this first phase to maximize efficiency of construction mobility, schedule and cost.

Phase 2: Rehabilitation and Enhanced Visitor Access $638,500

This phase includes a continuation of interior work, with a focus on returning the interior to its appearance and configuration during the Period of Interpretation. This includes removal of features added after the Period of Interpretation, including the poured concrete containment walls; interior walls added in the Equipment Room area; brackets extending from the lantern deck that supported later fog signal equipment; and elimination of a later wall opening into the Boat Room.

Phase 2 includes restoration and replacement of interior floor, wall and ceiling finishes; as well as exterior and interior doors and hardware, and kitchen cabinets and sink. Additional restoration recommendations include the interior floor deck lights at Level L-1 and interior stairs, guardrails and handrails. Replacement of missing porthole-style windows in the tower is recommended in this phase. Phase 2 also includes installation of new plumbing, heating and electrical systems.

Phase 3: Continued Rehabilitation $139,600

Phase 3 includes additional work to supplement enhanced use of the light station by visitors for longer time periods, as well as non-structural repairs of the vertical faces of the concrete crib. Specific recommendations include construction of a new bathroom in the basement and restoration of damaged concrete surfaces at the vertical face of the crib.

Phase 4: Reconstruction of Missing Features $138,600

This phase includes restoration (if presently concealed) or reconstruction of missing features from the Period of Interpretation, including the boat derricks, replica air horns, metal chimneys coal chutes, boat tracks and other items.

Total Estimated Project Cost All Phases $1,332,500

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Administrative Data

Property Identification Information

Located off the coasts of Lake Michigan's South Manitou and North Manitou Islands in the Manitou Passage, the North Manitou Shoal Light Station is situated approximately two and one-quarter nautical miles south of the southeastern tip of North Manitou Island and seven and one-quarter miles northeast of Glen Arbor on Michigan's western shore. (Latitude 45^0 01'12.0"N, Longitude 87^0 57'21.6"W).

North Manitou Shoal Light Station is listed on the National Register of Historic Places. The station is identified as reference number 5000981 and located in Leelanau County in the National Register Database/Research searchable table on the National Register of Historic Places website.

Investigation Methodology

Physical investigation of the station was undertaken for this HSR on August 23, 2019. All investigative techniques were undertaken with respect for the material and historical sensitivity of the structures. Investigations were made using visual observation techniques and were non-destructive with the exception of the lab

analysis. On the exterior, the assessment was completed from the decks; lifts, scaffolding or other equipment were not used in this field evaluation. Consequently, some elements could not be fully evaluated due to inaccessible or concealed conditions.

Research Sources

Several published, archival, and online resources were reviewed and analyzed for preparation of this HSR. Significant sources included textual, cartographic and photographic archival materials included in the U.S. Coast Guard (USCG) files at the National Archives and Records Administration in Washington, D.C. and College Park, Maryland; archival materials located at the USCG Historian's Office in Washington, D.C., and information and materials provided by members of the North Manitou Lightkeepers, Inc. (NMLK) A full listing of all resources is included in the bibliography. A spreadsheet listing each of the resources with notes and digital file names is also included in the appendices. The project team will provide NMLK and SHPO a digital copy of all digital resources that were gathered.

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Michigan State Historic Preservation Office

Michigan Lighthouse Assistance Program (MLAP), Secretary of the Interior Standards and National Historic Lighthouse Preservation Act (NHLPA) Compliance Review

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Archival Storage of HSR

Hard and electronic copies of this HSR will be kept at the offices of Sanders & Czapski Associates, Smay Trombley Architecture, the State Historic Preservation Office, and NMLK. A copy will also be provided to the Library of Michigan.

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PART I: DEVELOPMENTAL HISTORY

This section of the HSR documents the evolution of the North Manitou Shoal Light Station, its current condition, and the causes of its deterioration. Documentary research for this section includes review of historical information (written, cartographic and pictorial documentation) obtained from the North Manitou Light Keepers, the National Archives and Records Administration, and other sources as noted in the bibliography. Analysis of current conditions is based on physical examination of the station undertaken on August 23, 2019.

Part 1 includes the following:

1A - Historical Background and Context

This section provides an historical context for the North Manitou Shoal Light Station, including a brief history of the United States Lighthouse Service and Coast Guard; general lighthouse types; and the historical development of lighthouse equipment.

1B – Historical Overview

This section provides an historical overview of the station, including a summary of other navigational aids in the vicinity (former light stations at the Manitou Islands and former North Manitou Shoal lightships) and how these relate within the national and Great Lakes' maritime context. This section includes a summary of the construction, evolution, people and events associated with the current structure; and a detailed history of the station, including associated structures such as the dock in Glen Haven.

This section also includes discussion of the Period of Significance at the station and the recommended Period of Interpretation that should be recognized as the station is rehabilitated. The recommended Period of Significance and recommended Period of Interpretation are based on both the history and the existing conditions at the North Manitou Shoal Light Station as well as the North Manitou Light Keepers' goals for use and interpretation of the station.

1C - Chronology of Development and Use

This section provides a summary of the construction, modifications, and use of the station. This section was developed through analysis and coordination of the historical information obtained with the physical evidence observed during on-site physical investigation. This information is organized into two parts:

- A written and photographic analysis of the construction, modifications, use, historical evolution and development of the existing structure.
- A summary chronological timeline divided into distinct episodes of time that is based on significant events, activities, and/or physical changes at the station.

1D - Physical Description

This section includes a physical description, observations and analysis of the existing conditions at the North Manitou Shoal Light Station. This content is based on field investigation undertaken by the project team on August 23, 2019, in conjunction with review of historical documentation, code criteria, and the project team's experience.

1A Historical Background + Context

THE UNITED STATES LIGHTHOUSE ESTABLISHMENT AND COAST GUARD

The first North American lighthouse was constructed in 1716 on Little Brewster Island in Boston Harbor. Several more lighthouses were subsequently built along the Atlantic Seaboard during the next several years. These lighthouses, as well as others built in the eighteenth century, were built and maintained by individual colonial governments and private organizations affiliated with maritime commerce. In 1789, with passage of the Lighthouse Act, Congress provided for the transfer of all twelve existing lights, and future lighthouses, to the Federal Government through the formation of the United States Lighthouse Establishment (USLHE). Once transferred, all maintenance and repairs were the responsibility of the Federal Government. It is important to note that it took several years for some of the lights to transfer—not all were immediately transferred to the U.S. government in 1789.

In its early years, the growth and administration of the USLHE was slow and full of political corruption. Much of this inefficiency has often been attributed to Stephen Pleasonton, Fifth Auditor of the U.S. Treasury Department. Pleasonton was appointed to the position by President James Monroe in 1817 and in that capacity served as the administrative head of the USLHE for over thirty years. Pleasonton, who had no engineering or maritime experience, also oversaw accounts for the U.S. State Department and U.S. Patent Office and was generally more concerned about budget and expenses than the quality of lighthouse construction, maintenance and repairs. For example, during his tenure, there was no on-site supervision of contractors during the building of Great Lakes lights.[1] As a result, many of these early lights were substandard and had to be extensively repaired, rebuilt or replaced.

To alleviate the corruption and expedite growth and efficiency, Congress appointed a nine-member board in 1852 to replace Pleasonton. The new Lighthouse Board of the United States was comprised of naval and army engineers and maritime professionals. Although Pleasonton became the ex-officio president of the Lighthouse Board, the management of the USLHE and its facilities rested in the hands of the nine board members.

Each U.S. lighthouse belonged to a lighthouse district whose numbers, extent and associated geographic areas varied over time. In 1838, the president, with the authority of Congress, created six lighthouse districts to oversee lights on the Atlantic Coast and two districts on the Great Lakes. One of the first responsibilities of the newly formed 1852 Lighthouse Board was to expand the number of districts, although not to exceed twelve. Although the number of districts increased to twelve, the number of lighthouses in each district was lowered, making the districts easier to manage.

The lighthouse districts were individually governed by a regional district administration that consisted of a superintendent, inspector, and engineer.

- *District Superintendent*—Oversaw the workings of the entire district. The Superintendent answered directly to the Lighthouse Board (and later the Commissioner of Lighthouses) on all matters relating to his district.
- *District Inspector*—Responsible for the personnel, inspections, and general administration of each of the individual light stations within the district. The inspector was the direct supervisor of the lighthouse keepers and enforced the rules and regulations of the Federal lighthouse authority, i.e., USLHE.
- *District Engineer*—Responsible for all construction and repairs of the light stations within the district; was typically a member of the U.S. Army Corps of Engineers.

Each lighthouse district maintained a headquarters and main depot within the district that served as the administrative and supply center. Several secondary depots were also located throughout the district. Each district had a small fleet of tenders to transport supplies, work crews and the engineer and inspector to the light stations. Work crews for each district would travel throughout the district to undertake construction and larger maintenance and repair projects. Smaller projects and maintenance were undertaken by individual light keepers.

In 1852, the lighthouses of Lakes Huron, Michigan and Superior were assigned to the Eleventh District.

In 1874, Lake Michigan became the Twelfth District, while Lakes Huron and Superior remained in the Eleventh. In 1886, another lighthouse district reorganization took place, at which time the total number of districts increased to sixteen. Lake Michigan lights were assigned to the Ninth District as part of this reorganization; light stations on Lakes Erie and Ontario joined the Tenth District and lights on Lakes Superior and Huron remained in the Eleventh District.

On July 1, 1903, the USLHE and Lighthouse Board were transferred out of the Treasury Department and into the U.S. Department of Commerce and Labor. In 1910, Congress abolished the Lighthouse Board (36 Stat. L., 534) and created the Bureau of Lighthouses. At that same time, the operating name of the USLHE changed to the United States Lighthouse Service (USLHS). Unlike the USLHE's Lighthouse Board, civilians, rather than military personnel, were now assigned to manage the USLHS. That same year, the total number of lighthouse districts expanded to eighteen to establish districts for Puerto Rico, Hawaii and Alaska. Existing districts were also reorganized at this time and Lake Michigan was reassigned to the Twelfth District.

George Putnam, who had a long and distinguished career with the U.S. Coast & Geodetic Survey, was appointed the first Commissioner of the new bureau. He would reign until May 31, 1935 when he was forced to retire due to age. Prior to assuming control over the Lighthouse Service, Putman was director of the coastal surveys of the Philippines. Once appointed to the new bureau, he took firm control and instituted, not only the new administration, but implementation of many technological advances including radiobeacons. At his retirement luncheon, the Secretary of Treasury Daniel Roper congratulated Mr. Putnam on his distinguished career of 45 years and noted that while aids to navigation had increased from around 12,000 to 24,000 during his tenure, the number of employees dropped from 5,832 to 4,980. Putnam was replaced by H.D. King who headed up the bureau until the Coast Guard assumed control in 1939.[2]

In 1913, when the U.S. Department of Commerce and Labor was separated into two departments, the Bureau of Lighthouses was assigned to the Department of Commerce. On July 1, 1939, the USLHS merged with the USCG within the Department of Treasury and the Bureau of Lighthouses was abolished. With this transition, the Great Lakes light stations became part of the Ninth Coast Guard District. In 1967, the USCG was transferred out of the Treasury Department and into the U.S. Department of Transportation. This governance jurisdiction continues today with the North Manitou Shoal Light Station operating as an active aid to navigation within the USCG's Ninth District. See Figure 1A-01 for a summary of the USLHE/USLHS/USCG organization and management.

LIGHT STATION STRUCTURES

A light station typically consisted of a complex of interdependent structures designed for utilitarian purposes. The light required a keeper for both daily operation and on-going maintenance. At stations that also had a fog signal, which was the majority, at least one additional keeper was needed for its operation and maintenance. Due to these time-consuming responsibilities, as well as the typically remote location of the station, the keeper(s) needed a place to live on site as well as transportation to and from the site. Thus, in addition to the light tower and a building to house the fog signal, the stations typically had at least one dwelling and privy, storage buildings for fuel and other materials and some form of transportation

Date	Federal Parent Agency	Federal Lighthouse Authority	Managing Agent/Agency	Executive
1789	U.S. Department of the Treasury	United States Lighthouse Establishment USLHE	5th Auditor	
1852	U.S. Department of the Treasury	United States Lighthouse Establishment USLHE	Lighthouse Board	
1903	U.S. Department of Commerce & Labor	United States Lighthouse Establishment USLHE	Lighthouse Board	
1910	U.S. Department of Commerce & Labor	United States Lighthouse Service USLHS	Bureau of Lighthouses	Commissioner of Lighthouses
1913	U.S. Department of Commerce	United States Lighthouse Service USLHS	Bureau of Lighthouses	Commissioner of Lighthouses
1939	U.S. Department of Treasury	United States Coast Guard USCG		
1967	U.S. Department of Transportation	United States Coast Guard USCG		

Figure 1A-01: Summary table of the Federal Government organizational and management structure of U.S. lighthouses.

storage, which was usually a boathouse, stable or garage depending on the location of the light station. At the very minimum, a station would have a tower containing both the light and living quarters for the keeper. As technology progressed relative to maritime navigation, additional structures were often added to light stations, e.g., radiobeacons, while other existing structures were adaptively re-used for new purposes.

LIGHTHOUSE TYPES

Most lighthouses can be categorized by their construction method, shape, building material or foundation type. In addition to the specific location's need (e.g., guiding mariners around dangerous shoals or into safe harbors), location, geography, available materials, cost, politics, current technology and popular architectural styles of the period influenced lighthouse designs. The United States has more lighthouses and diverse architectural engineering types than any other country in the world.[3]

Lighthouses in the United States built prior to 1850 typically consisted of towers and separate/detached dwellings built of local, readily available materials, mainly stone and brick and later wood. Due to the previously mentioned lack of supervision of these early structures, they were often of substandard quality. Technological developments and congressional mandates for professional management of lighthouse construction in the latter half of the nineteenth century led to more diverse construction types of better quality. Figure 1A-02 is a table showing the chronology of lighthouse types.

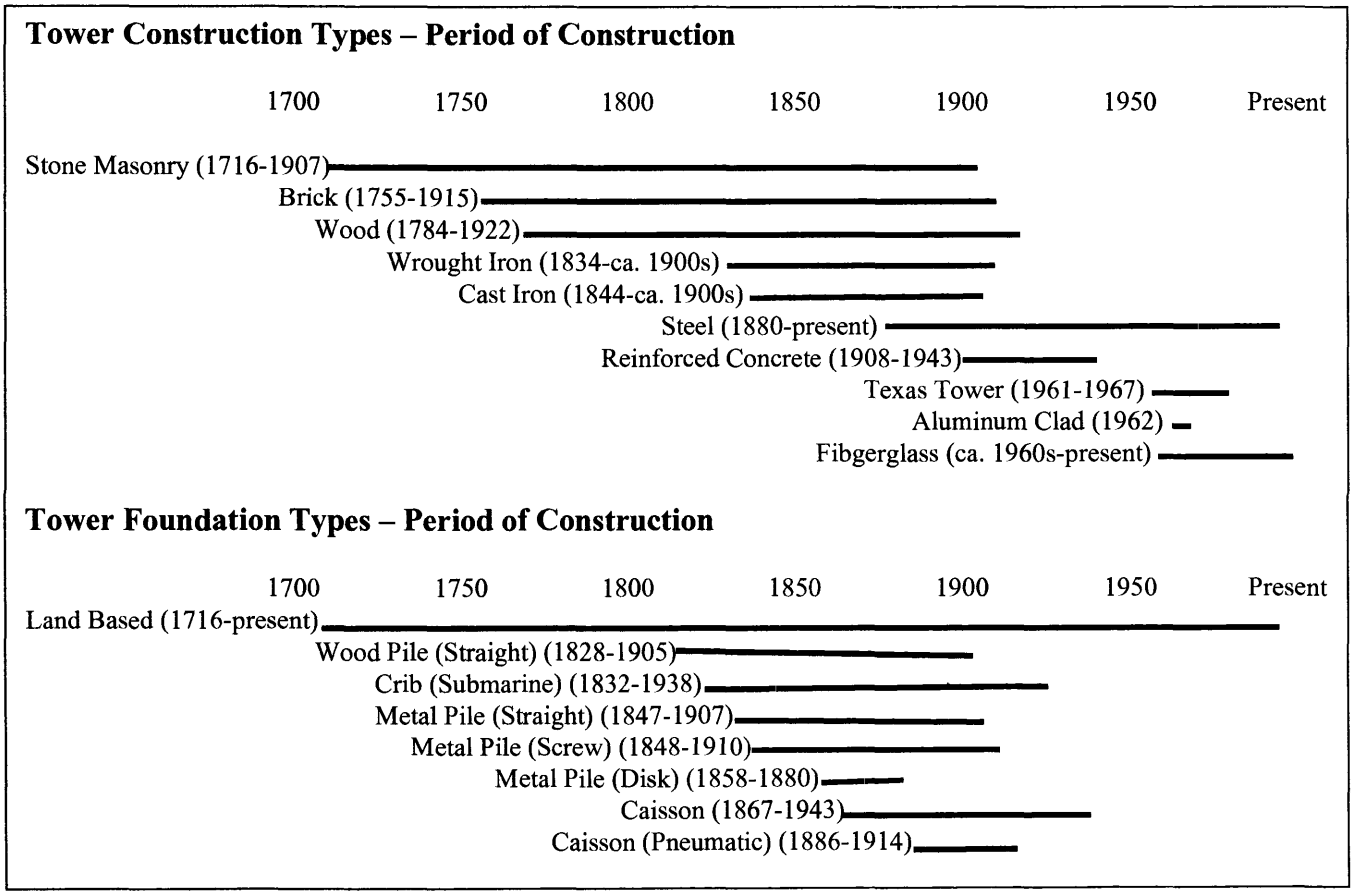

Figure 1A-02: This is a timeline is of U.S. lighthouse typologies. The dates are meant only to give relative time, not absolute first and last use of construction type.

Due to the increasing number of light stations being established in the Great Lakes during the second half of the nineteenth century, the district engineers (and their Canadian counterparts) often produced and utilized standard designs for the construction of lighthouses and related outbuildings at the stations. The rapid increase in lighthouse construction was making it difficult to develop unique designs for the structures at each station. Nearly identical buildings such as light towers, fog signal buildings, keeper's dwellings and other outbuildings, can be found at several light stations around the Great Lakes. While the goal of these standardized designs was efficiency, slightly modified details such as window type and location were incorporated to provide a semblance of individuality.

The efficient use of standardized designs resulted in ten basic styles and numerous other individual or modified styles of light towers on the Great Lakes:[4]

- *Conical*—Tower usually made of stone or brick; utilized at Stannard Rock (Lake Superior).
- *Skeletal*—Tower made of wood, iron or steel; utilized at Manitou Island (Lake Superior).
- *Pyramidal*—Tower made of wood or iron plate; Frankfort (Lake Michigan) is an example.
- *Pyramidal Style*—Tower with attached dwelling made of wood. This was a Canadian style utilized because they were inexpensive

to erect and could be moved if necessary. An extant example is at Salmon Point (Lake Ontario).

- *Schoolhouse Style*—Made of wood or brick, it is basically a rectangular building (dwelling) with a square tower up the middle at one end on the outside of the building; utilized at Gull Rock and Copper Harbor (Lake Superior).
- *Octagonal*—Brick, stone or wooden tower; some were affixed to a corner of the dwelling such as at Eagle Harbor (Lake Superior).
- *Round or Cylindrical*—Tower made of brick or stone; Beaver Island Harbor Lighthouse in St. James (Lake Michigan) is an example.
- *Square*—Tower, often brick with a circular brick liner; Forty Mile Point (Lake Huron) is an example or steel as at North Manitou Shoal (Lake Michigan).
- *Square Integral*—Tower made of wood or steel , it is basically a building (dwelling) with a square tower going up from the inside of it; utilized at Fairport Harbor West Breakwater (Lake Erie).
- *Flying Buttress*—Canadian style tower; utilized at Caribou Island in eastern Lake Superior.

LIGHTSHIPS

Lightships were also a fixture of the maritime landscape for years, installed by the USLHE, USLHS, and USCG for many years to mark dangerous shoals, moving sandbars, low water, harbor entrances, a river's mouth or other locations where it was difficult to build a lighthouse. The first lightship was a small wooden schooner moored on Chesapeake Bay. From this pioneer, the lightship developed through the 19th century from sail to steam, from wood to iron to steel hulls, and to more powerful optics. Further evolution of the lightship was marked by changes in hull design, the introduction of direct diesel and diesel-electric propulsion, changes in sound (fog) signals and the development of radiobeacons in the 1920s which revolutionized the navigational potential of lightships by providing a non-visual long range electronic bearing to the lightship station. In total, 179 lightships were built between 1820 and 1952. In 1915, the heyday of U.S. lightships, there were 54 stations in the United States; 36 off the East Coast, 2 in the Gulf, 5 on the West Coast and 11 in the Great Lakes. [5]

Lightships were initially named according to the location they marked. However, this naming convention became problematic when older ships were replaced with new ones or transferred to a new location or their service changed to be a relief lightship to be used temporarily at locations where the lightship there was in need of repair. Keeping track of these vessels by name was difficult and the USLHE thus began assigning them a letter designation in 1867.[6] The letters went from "A" to "XX" for the older ships and as new ones were built, they were numbered, with the acronym "LV" (for light vessel) preceding the number (i.e., LV-56). Active lightships retained their lighthouse service numbers until 1947, when the USCG designated some of them WAL and assigned a new number (such as WAL-534). After 1965, all lightships were re-designated WLV (such as WLV-534).[7]

OFFSHORE CRIB LIGHTS

Many lightships were eventually replaced by a permanent, fixed structure, utilizing different types of foundations to secure them to the ocean or lakebed. Wooden crib foundations, constructed onshore, towed to the site, and then filled with stone

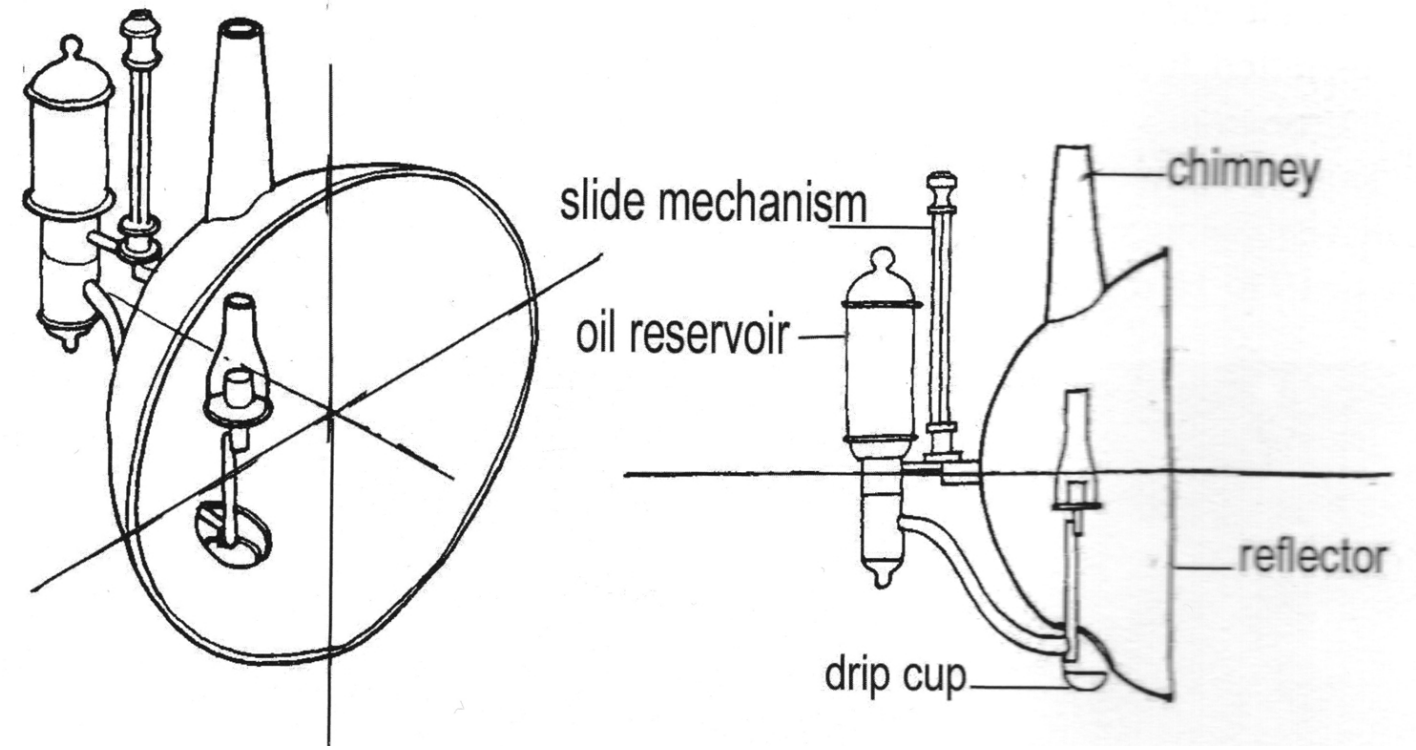

Figure 1A-03: Drawing of the Argand/Lewis lamp system with parabolic reflector used in U.S. lighthouses prior to the introduction of the Fresnel lens.

to sink them in place were used extensively in the Great Lakes.[8] Once settled and leveled, the cribs were capped with concrete or some other masonry upon which the lighthouse structure was constructed.

ILLUMINATION - LANTERN AND LENS DEVELOPMENT

As described by Francis Ross Holland, Jr., in *America's Lighthouses: An Illustrated History*, "Over the centuries the light tower has supported a variety of lights, but until the most recent years, when electricity came into use, the light has been a flame in one form or another. The history of the development of the lighthouse light is the story of the refinement and adaptation of the flame. It was so refined through the years that by the time of the introduction of electricity, the flame was virtually no longer a flame—it was a glowing ball."[9]

Argand Lamp

Until the introduction of enclosed lamps in the 1700s, lighthouses used wood, coal and candles to fuel these flames. Although they had been used in U.S. lighthouses for many years, these lamps were problematic because they produced a significant amount of smoke, which dimmed the light, and gave off acrid fumes. The fumes burned the nostrils and eyes of keepers so much so that they couldn't remain in the lantern very long to service them.

The first successful solution to this problem was the invention of a lamp with a hollow circular wick by Swiss physicist and chemist Aimé Argand in 1781. Because oxygen passed along the inside and outside of the wick, the flame burned intensely and brightly and, more importantly, smokelessly.[10] Argand patented this lamp in England where it was soon commonly

Figure 1A-04: Visual comparison of the six orders (sizes) of Fresnel lenses.

used in both public buildings and private homes. There is some disagreement as to who was the first to place parabolic reflectors behind Argand's lamp to further boost and concentrate the output (Figure 1A-03). H L. Reynaud, Director of the French Lighthouse Service, credited Aimé Argand himself with the first proposal for an apparatus using an Argand lamp and a reflector. This combination represented a considerable improvement over illumination systems used at the time and quickly came into widespread use in European lighthouses. However, the incorporation of Argand's lamp technology with parabolic reflectors in U.S. lighthouses is attributed to Winslow Lewis.[11] Lewis had patented a reflecting and magnifying lantern in the United States that was essentially a modified version of Argand's lamp. Although Lewis's version was inferior in quality, Fifth Auditor Stephen Pleasonton adopted them as the U.S. standard and they were subsequently installed in all U.S. lighthouses prior to 1852.

Fresnel Lens

One of the significant changes implemented by the Lighthouse Board shortly following its 1852 inception was a mandate for the installation Fresnel lenses in all lighthouses throughout the United States. The Fresnel lens, which had been invented by the French engineer Augustin Fresnel in 1822, had long been used in Europe and was known to provide much better illumination than the Lewis/Argand system used in the United States. The invention of this lens was a significant technical improvement in the history of lighthouses. The Fresnel lens system projected light from a single source through a set of rigid lenses that were set at a focal plane of light. The design of this lens system caused all the light rays that were emitted to bend parallel to the horizon sending greater light out to sea. Fresnel lenses were typically manufactured in France, with some also made in Great Britain. These lenses were dismantled for shipping across the Atlantic and reassembled once inside a U.S. lighthouse lantern room. One American company, Macbeth-Evans, produced a limited quantity of smaller fourth and fifth order Fresnel lenses for the USLHS from 1910 to 1932.[12] These lenses were used in range lights and lightships.

Figure 1A-05: Photo of a BBT Corp. of America (successor company of the French company Barbier, Bernard and Turenne that fabricated lighthouse Fresnel lenses) airport lens on display at the National Museum of the US Air Force Museum, Dayton, Ohio. This lens was used in the 1930s at a government Air Mail emergency airfield in Illinois.

There are six sizes of Fresnel lenses, referred to as orders (Figure 1A-04). The orders range from one to six, with a first order being the largest (6′ diameter, 12′ tall) and providing the most illumination and a sixth order being the smallest (1′ diameter, 18″ tall). District engineers were responsible for determining the order of the lens that would be installed at each lighthouse. This decision was based on location of the light station and subsequent intensity and distance projection required by the light. Traditional beehive and barrel-shaped Fresnel lenses were installed in U.S. Lighthouses through the early twentieth century.

Figure 1A-06: Photo of a BBT Corp. of America Aviation Lens that gives a vertical shaft of light for aircraft navigation.

Aviation-Style Lens

In May 1918, the United States Government developed an Air Mail Service. The US Department of Commerce created an Aeronautics Branch and daytime only flights began. By the early 1920s the Department of Commerce decided that the best way to establish nighttime air routes across the country was through the use of lighted airway beacons.[13] The American Air Route System, and the similar French Air Route System that had been developed by the French Aerial Navigation Service, used airway beacons that utilized Fresnel lens technology. Many of these beacons were equipped with lenses fabricated by Sautter-Harle and Barbier, Bernard and Turenne; fabricators who had fabricated many Fresnel lenses for use in both Europe and the United States. These airway lenses came in several shapes and sizes. Some resembled a straighter, vertical version of the traditional beehive-shaped lens used in lighthouses (Figure 1A-05) while others were more spherical (Figure 1A-06). Based on limited available information, the USLHS began installing aviation lenses,

Figure 1A-07: Photo of the 4-sided airway-beacon lens originally installed in the North Manitou Shoal Light Station in 1935. This lens was removed in 1980 and is currently on display at the Cannery Boat Museum in historic Glen Haven within the Sleeping Bear Dunes National Lakeshore.

Figure 1A-08: Photo of the single DCB-24 aero beacon installed in the New Dungeness Lighthouse in Sequim, Washington in 1976.

similar to those used as airway beacons, in new lighthouses and as replacement lenses in existing lighthouses in the 1930s. During this time, Westinghouse Electric and Manufacturing Company and other US companies were producing what were referred to as "airway beacon" Fresnel lenses for use in lighthouses. These were four-sided with the glass in a bulls-eye pattern (Figure 1A-07).

Directionally Coded Beacons & Automation

The USCG began installing directionally coded beacons (DCBs), which were also originally designed for airport applications, in lighthouses throughout the country in the mid-twentieth century. According to the June 1931 Lighthouse Service Bulletin:

> A new type of revolving beacon, having two 36-inch lenses, is now available for marine work, this beacon has been developed in the airways division. Among the advantages which this beacon offers over previous types is that of two lenses. This amounts to a doubling of the light period and makes it possible to double the number of flashes without speeding up the beacon.[14]

DCBs were installed to replace Fresnel lenses from the 1940s through the 1980s. There were several models of the DCB series, with the DCB-224, DCB-24 and DCB-36 being the most widely used in lighthouses.[15] These DCBs were installed in both single and double configurations (Figures 1A-08 and 1A-09). DCBs were often installed in conjunction

Figure 1A-09: Photo of the twin DCB-224 aero beacons with automatic bulb changers installed in the Pointe Aux Barques Lighthouse in the 1950s.

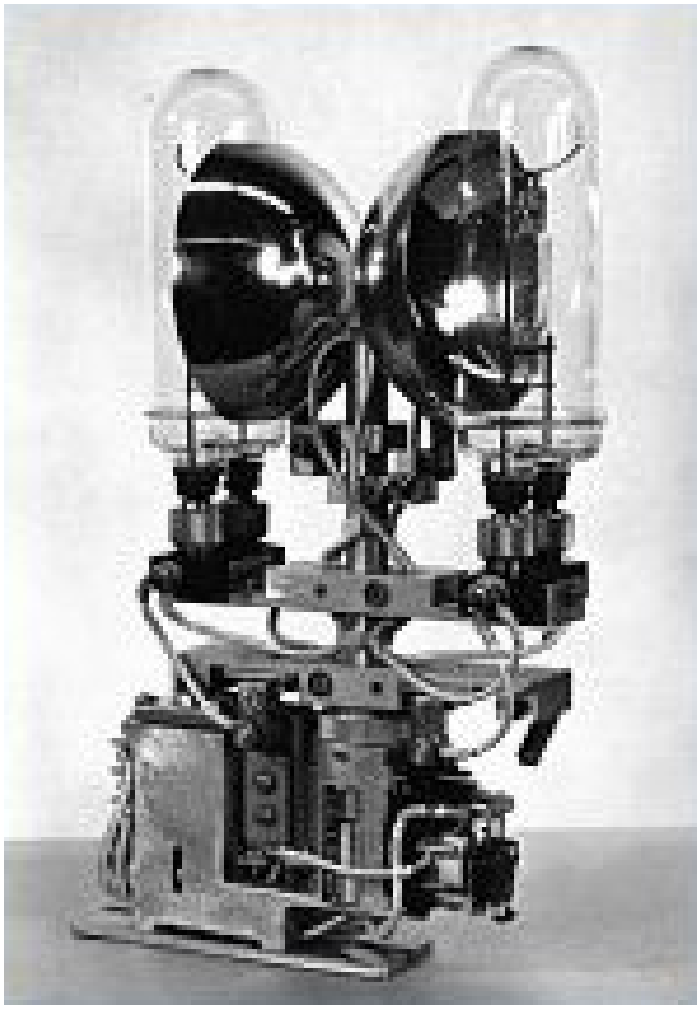

Figure 1A-11: Photo of a twin DCB aero beacon with automatic bulb changer.

Figure 1A-10: Photo of a sun valve used in the earlier automation of lights. These flow control valves were used with acetylene illumination systems prior to electricity. The valve is controlled by four metal rods enclosed in a glass tube. The central rod that is blackened is surrounded by the three polished rods. As sunlight falls onto all of the rods, the absorbed heat of the sun allows the unequally expanding dark rod to cut the acetylene gas supply. After sunset, the central rod cools down, becoming the same length as the polished rods and opening the gas supply.

with automation of a light. Although there had been experimentation as early as the 1880s, the use of automated equipment at light stations accelerated with the widespread installation of electricity in the 1930s and 1940s. Automation equipment consisted of varying types of timing mechanisms to turn the light on and off without the need of a keeper (Figures 1A-10 and 1A-11). Automation continued through the 1980s and all lighthouses currently in operation are automated.

Modern Lenses

Beginning in the 1980s and continuing through today, the USCG began installing modern lenses fabricated of acrylic or plastic (Figure 1A-12). One of the more common types in use is a variable rotating beacon (VRB).

> The VRB-25 is a lighthouse optical system designed and built by Vega Industries Ltd. in Porirua, New Zealand. It was originally designed in 1993-95 with the assistance of the United States Coast Guard to meet USCG requirements for a robust mechanism requiring minimum maintenance. It has become the Coast Guard's standard 12 volt rotating beacon.[16]

Figure 1A-13 is a photo of a six-sided VRB-25 previously installed in the DeTour Reef Light. More recently, the USCG has been installing Vega LED Beacons (VLBs). These lenses are much smaller, provide intense light, and require minimal maintenance (Figure 1A-14). While virtually all of the maritime illumination manufacturers now offer LED lighting systems, the Coast Guard appears to have narrowed its focus on two major manufacturers of LED lights, conducting extensive field testing of units produced by Vega Industries and Carmanah Technologies.[17]

Figure 1A-12: 2003 photo of Coastguardsmen holding the replacement optic for the St. Joseph Outer Light.

Figure 1A-13: : Photo of the six-sided VRB-25 previously installed at DeTour Reef Lighthouse.

Figure 1A-14: Photo of the VLB44R-2.5-2T light by Vega Industries currently installed in the North Manitou Shoal Light Station.

Light and Beacon Characteristics

Lighthouses were, and continue to be, assigned unique characteristics to distinguish them from one another to mariners. Different characteristics included fixed, revolving, pulsating and colored lights. These characteristics were created through several means, including rotating the lens between opaque panels, referred to as flash panels, colored chimneys around the flame, and colored screens. There is a standard abbreviation system for light characteristics that are utilized in Broadcast Notices to Mariners, Local Notices to Mariners, on charts and in the Light Lists.[18]

FOG SIGNAL DEVELOPMENT

Audio warnings to aid mariners were developed concurrently with advances in lighthouse technology. In cases of fog and smoke, both of which were common throughout the Great Lakes, audio signals took over from the lights as the guiding instrument for mariners. The first fog signals in the United States were cannons (or fog guns) utilized at a few light stations on the east and west coasts, including the country's first station in Boston.[19] The use of these guns was short-lived due to the danger of operating them, the length of intervals between successive explosions and the brief duration of the sound.

The next type of signal consistently used in this country was large bells. These bells were initially manually struck. Later signals were actuated by mechanically operated bell strikers that were powered by descending weights, compressed gas or electricity. Due to their reliability, fog bells with automated bell strikers were used well into the twentieth century often times as a backup signal to later devices.

Several versions of fog whistles and trumpets were developed in the nineteenth century. These utilized locomotive whistles or reed trumpets (similar to a vibrating clarinet reed on a larger scale) that produced sound by compressed air or steam emitted through a circumferential slot in a cylindrical bell chamber. The compressed air versions were powered by hand, horsepower or steam.

Another sound signal that arose during this period of experimentation was the siren. It was first tested in 1867 and installed at New Jersey's Sandy Hook East Beacon in 1868. Originally this signal consisted of a large cast-iron trumpet. In the mouthpiece of the trumpet, a slotted revolving disc, or plate, was placed on a fixed slotted disc (seat). A slotted disc valve was placed on the back of the seated disc, which produced the characteristic. The chamber containing the discs was directly affixed to the steam dome of the boiler. About seventy pounds of steam was forced through the fixed and rotating discs and the interruptions of the jets of steam produced the note. Eventually, the disc type of siren was replaced by a rotation cylinder with peripheral slots (called the rotor) placed inside a casing, also with slots (termed the stator).[20]

By 1870, the trumpet, whistle, bell and siren had become standard fog signals. Because the bell had poor resonance and carrying power, it was not effective at coastal locations where wind would dampen the signal. Coastal stations received the steam whistle or siren; the reed horn trumpet was installed at less exposed locations and bells were used in areas with bays, estuaries and along rivers.[21] By 1900, there were 377 fog signals, exclusive of those on buoys, around the country with steam-powered whistles being the most common in use on the Great Lakes.

By the 1930s, many of these whistles were replaced with air diaphone systems. Air diaphone systems produced sound by means of a slotted reciprocating piston actuated by compressed air. The two most common diaphones used at light stations were the standard diaphone (gave a full steady upper tone that terminated in a heavy "grunt" tone) and the classic two-tone diaphone (produced an upper tone followed by a full steady low tone of equal or greater duration than the upper tone).[22]

Diaphones ranged in size and function from the tiny single tone Type "A" to the "Standard" units (Types "C-C" through the huge Type "L"), which produced a high tone that terminated in a heavy descending "grunt" tone, to the classic two-tone Type "F-2-T" foghorn.[23] Air diaphone systems were recognizable by the large resonators (commonly referred to as horns) that protruded out of the fog signal building or lighthouse tower and emitted the sound. Long, flared horns oriented horizontally were more commonly used as they provided maximum audibility in a specific direction (typically the direction of the most used shipping lane). Vertically mounted mushroom resonators were also used in some locations. These provided sound in all directions of the compass.[24]

As was the case with the light at each station, each fog signal had its own particular characteristic that distinguished it from other fog signals. Throughout the evolution of the systems, each was set up to sound-out a pattern of blasts and silence unique to that station. This enabled mariners to help pinpoint their location in thick weather from the unique sounds around them. It was also common to install duplicate fog signal equipment at each location. If one piece of machinery failed or was under repair, the duplicate system could be put into operation to keep the audio warning functioning.

RADIO EQUIPMENT

Another technological advance in aids to navigation was the radio beacon, which first came into use in 1921. Radio beacons were, in essence, a combination of noiseless fog signals and lightless navigational aids. Directional signals were broadcast by radio transmitters from a light station, enabling mariners to plot their course accurately, even when they were too far away to see a light or hear a foghorn.[25] Further, with several beacons operating at the same time, ships could easily determine their position by taking bearings on the various signals. The first set of stations consisted of the Ambrose and Fire Island lightships and the Sea Girt, NJ lighthouse.[26] Lighthouse Commissioner George Putnam was a champion of radio beacons, and at his urging, as many as 200 transmitters were placed at light stations on US coasts and lakeshores.[27]

The 1949 *Light List* stated that "radiobeacons are the most valuable fog signals [at that time], and are also available for navigation in clear weather."[28] Radio beacons had three levels of transmitting power. Class B beacons had an average reliable range of 100 miles (50 to 150). The average reliable range for class C radio beacons was 20 miles (15 to 25) and for class

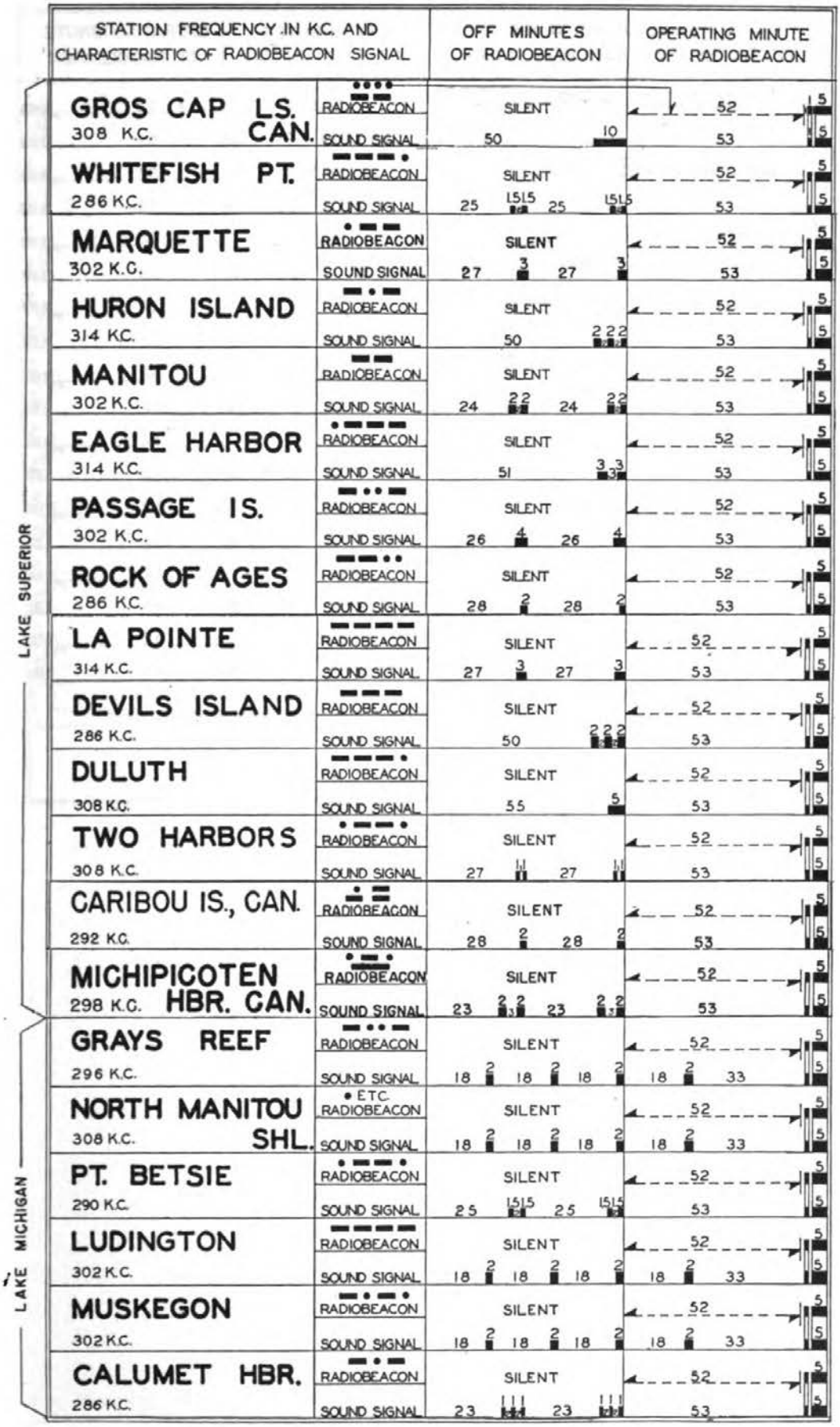

Figure 1A-15: Excerpt page from the 1949 Great Lakes *Light List* showing chart of the Lake Superior and Lake Huron stations designated as Distance Finding Stations, showing the radiobeacon and fog signal characteristics and the time relation of their synchronization.

D was 10 miles (5 to 15). This classification principally indicated the relative power of the station, since the actual useful range could vary considerably from that indicated with some types of radio direction finders.[29]

Similar to lights and fog signals, each station's radio beacon had a designated characteristic for station identification. The characteristic consisted of combinations of dots and dashes. They were not transmitted as code letters and were not referenced as such. The simple combinations and the length of the dots, dashes, and spaces were chosen for ease of identification when heard by a ship's navigating officer, who was not expected to be skilled in radiotelegraphy.

While all radio beacons operated during fog or low visibility, several stations equipped with them were designated distance-finding stations (including North Manitou Shoal) and also operated in clear weather. At these stations, the radio beacon and fog signal sounds were synchronized for distance finding.

The annual *Light Lists* included a chart of each station's radio beacon and fog signal characteristics and the time relation of their synchronization (Figure 1A-15). An example of how to use these synchronized signals was provided in the 1949 Light List: "In the case of Lansing Shoal Light Station, if the interval between hearing the end of the long radio dash marking the end of the radiobeacon minute and the end of the long (5-second) blast of the diaphone is 30 seconds the observer is 30 -/- 5 = 6 miles from the station."[30] The USCG provided these charts for posting in the pilot house of vessels or another onboard location near the radio direction finder.

Radio beacon equipment consisted of antennae, radio equipment, and batteries. Land-based light stations typically had two antennae spaced a couple hundred feet apart with transmitting wires extending between them (Figure 1A-16). In the case of offshore lights, a single antenna was attached to the top of the lantern and the transmitting wire extended out to outriggers and poles (Figures 1B-32 and 1B-33). The transmitter, related radio equipment and batteries were typically located in the fog signal building at land-based stations, and within a designated room at offshore lights.

Made obsolete by radar and global positioning, all US radio beacons have been taken out of service by the US Coast Guard.[31]

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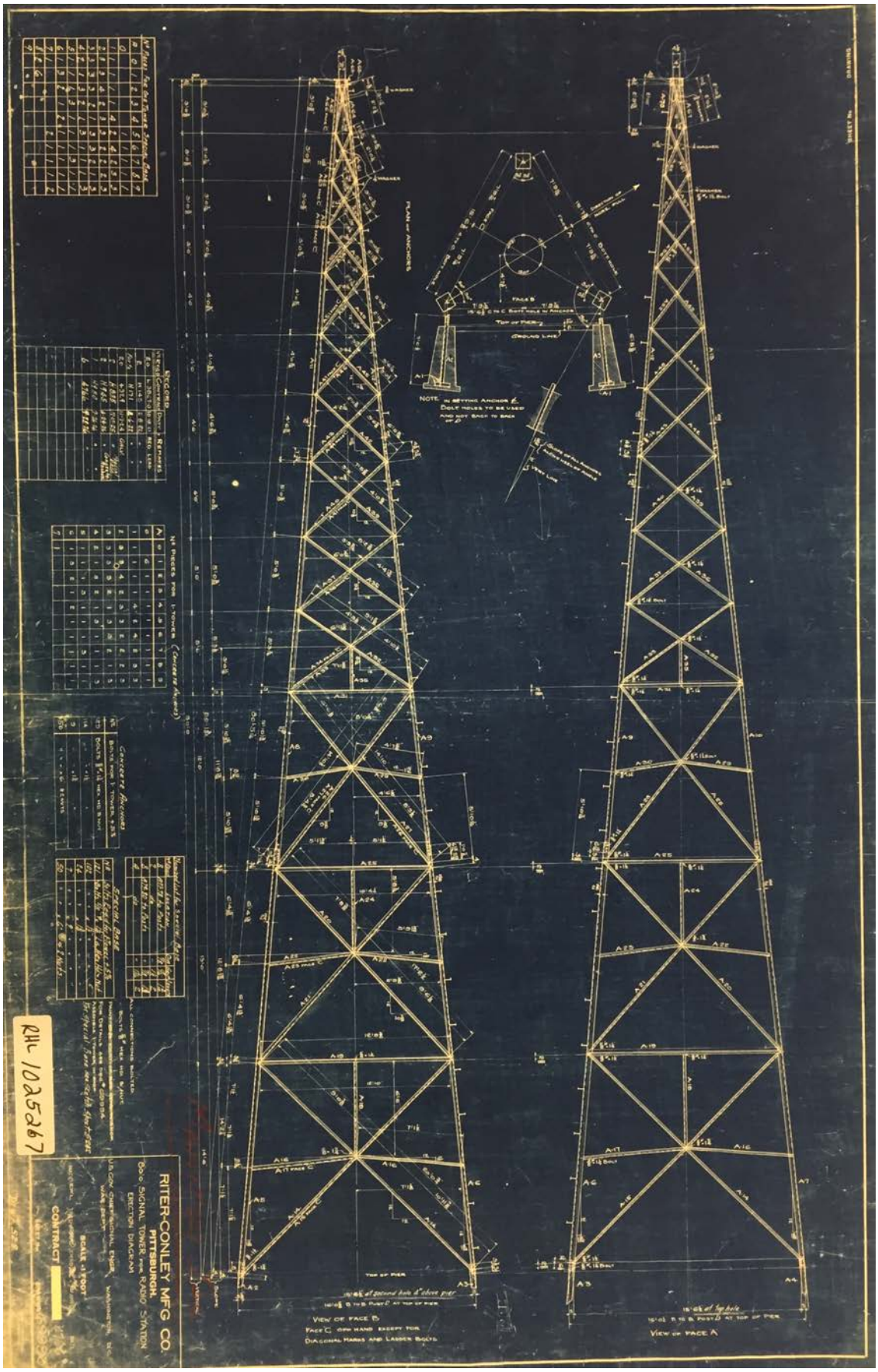

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The Crib
NORTH MANITOU
LIGHT KEEPERS

1B Historical Overview

This section provides an historical overview of the station, including a summary of other navigational aids in the vicinity (former light stations at the Manitou Islands and former North Manitou Shoal lightships) and how these relate within the national and Great Lakes' maritime context. This section includes a summary of the construction, evolution, people and events associated with the current structure; and a detailed history of the station, including associated structures such as the dock in Glen Haven.

GREAT LAKES AND LAKE MICHIGAN SHIPPING

Sailing craft have navigated the Great Lakes since the 17th century. The first steamships to offer service on the Great Lakes were the Frontenac, launched in 1816, and the Ontario in 1817. Both were offering regular service in 1817. The Erie Canal, which opened in 1825, provided access to the Atlantic seaboard via the Hudson River for both sailing and steam-powered vessels. This led to an explosive growth in commercial and passenger service on the lakes. With the Soo Locks opening in 1855, the Great Lakes systems became a significantly vital part of the American economy. Linking the Midwest's natural resources and agriculture to the industrialized East Coast, the value of products on the Great Lakes in 1856 was approximately $600 million—more than the total value of American foreign trade.[1] Large numbers of settlers also moved to the Great Lakes region, many settling on islands and the mainland near harbors along the shipping routes.

THE MANITOU PASSAGE

The Manitou Islands are the two southern islands of an archipelago in northeastern Lake Michigan. Approximately 16 miles long and varying from 7 to 12 miles wide, the Manitou Passage extends between the islands and the western shore of Michigan (Figure 1B-01). Being a much quicker route than traveling west of the islands, along with South Manitou offering the only natural harbor along the 300-mile journey between the Straits of Mackinac and Chicago that could admit large ships, the Manitou Passage quickly became (and continues to be) a frequently traveled channel (Figure 1B-02). However, the lake bottom mirrors the typography of the imposing points and bluffs of the land that rises alongside it and is marked by sharp depth changes from 100 feet to twice that and more.[2] The navigable portion of the passage is only approximately one mile across in areas and it has often been noted as the most dangerous passage on the Great Lakes.[3]

SOUTH MANITOU ISLAND LIGHT STATION

Travel on Lake Michigan steadily increased following the opening of the Erie Canal, and by the 1830s there was considerable steamboat traffic on the lake. Because the ships consumed vast amounts of wood for fuel on their journeys, frequent stops for refueling were a necessity. Ships plying Lake Michigan began stopping at South Manitou Island for this very purpose. The island was situated on Lake Michigan's heaviest shipping route and had dense forests of hardwood trees. Further, South Manitou had a natural deep harbor which could admit large ships. The harbor and forests made the island a logical place for a cordwood stopping point and a village soon was established.

Due to the presence of its natural harbor and the lack of any lights in the region to guide ships through the treacherous Manitou Passage, Congress appropriated funding in 1838 to build a lighthouse on the southeast corner of South Manitou Island at the southern edge of the harbor.[4] Construction was complete and the lighthouse was operational in 1840. A new lighthouse was later built in the same location in 1858. There are no records as to why it was rebuilt, but some speculated that the original lighthouse was struck by lightning and burnt down. The 1858 brick lighthouse was the schoolhouse style with a lantern projecting from the roof of the dwelling. By 1869, the Lighthouse Board noted the need to improve the lighthouse at this location:

> Through the channel between South Manitou Island and the mainland the principal commerce of the lakes passes, guided by this light, which should have a lens of a higher order, with greater elevation and a characteristic distinction not readily mistaken. It is also a guide to a harbor of refuge, which is probably more used than any other on the chain of lakes, and it is frequently impossible to distinguish the present light from those on board vessels at anchor.[5]

A new brick lighthouse tower with a third order Fresnel lens was completed in 1871 (Figure 1B-03). The lantern was removed from the roof of the dwelling and a long, brick passageway was built

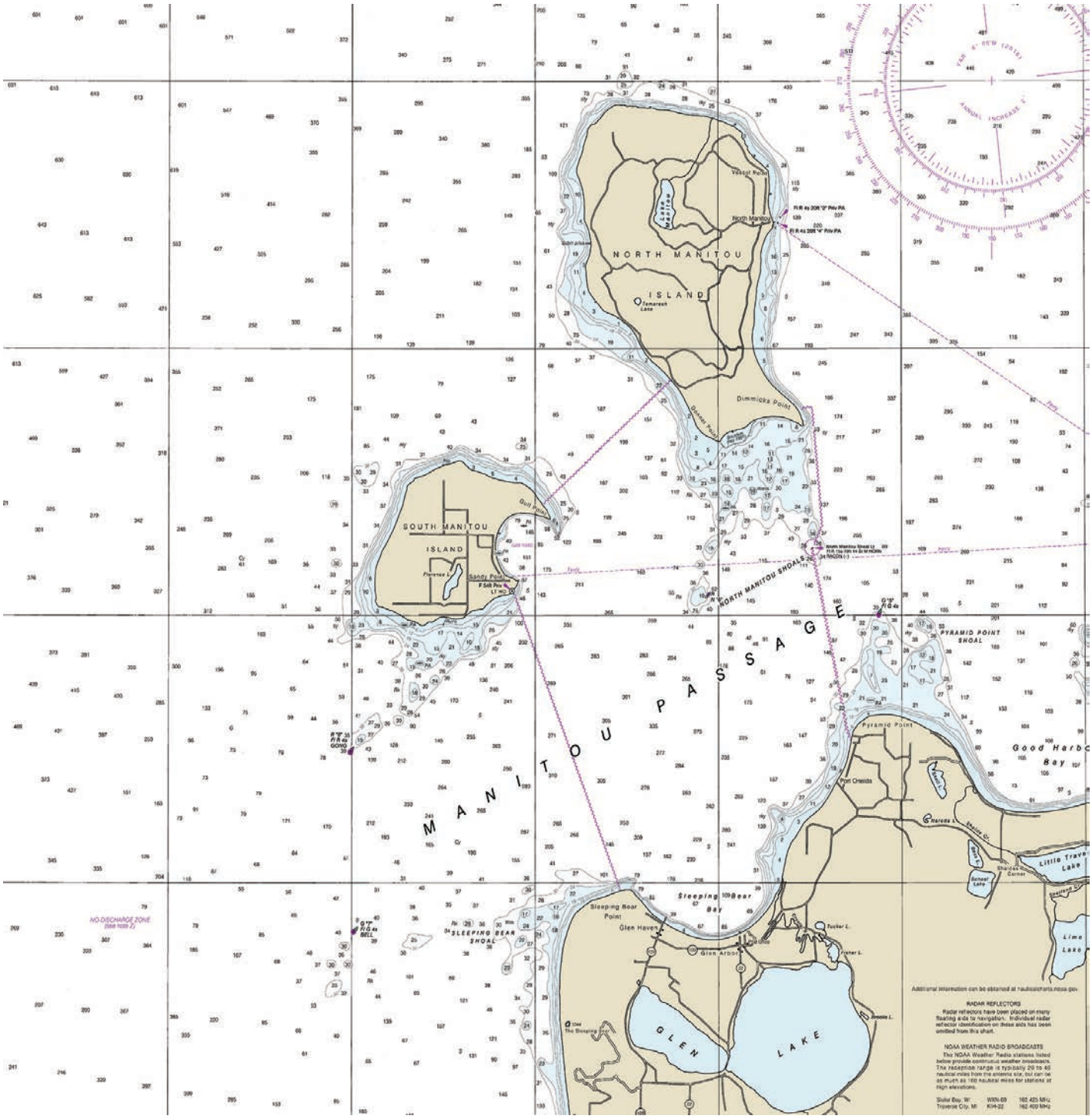


Figure 1B-01: Nautical map of the Manitou Passage

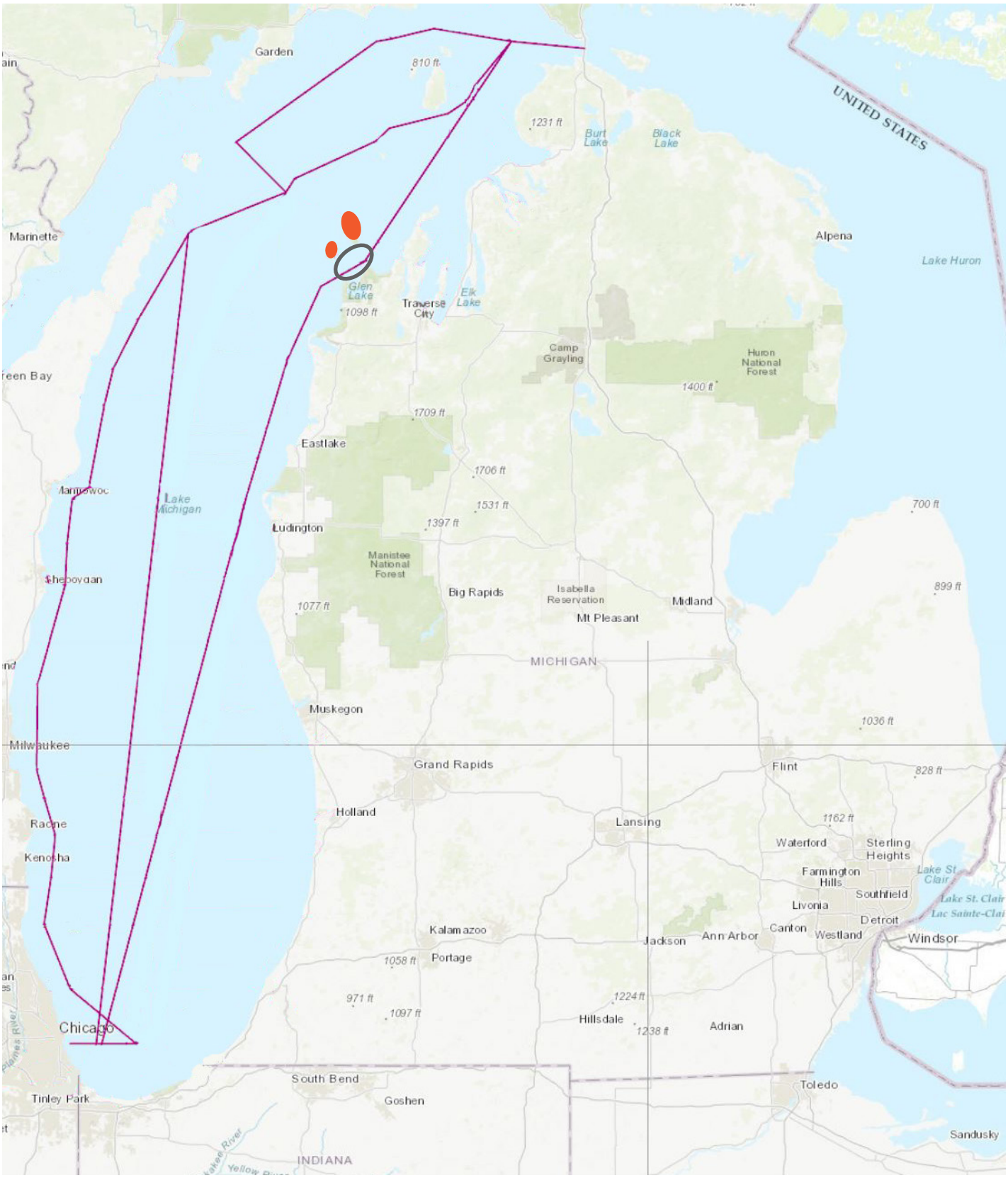


Figure 1B-02: Lake Michigan shipping lanes. Lighting of the Manitou Passage, which first occurred in 1838, began to make navigating it a safer and viable shipping route, which ultimately saved time and money.

connecting the dwelling to the new 100-feet tall tower. With its completion, South Manitou Island had one of the tallest light towers on the Great Lakes.[6]

The first fog signal at South Manitou Island Light Station was a 1,000-pound bell struck by clockwork machinery. Two fog signal buildings with steam-powered whistles replaced the fog bell in 1874. In 1934, the fog signal was changed to an air diaphone system powered by steam generators and air compressors. These air diaphones were mounted on the light tower and connected by hoses to the air compressor tanks on the ground.

Although the aids to navigation remained in operation, there were no longer keepers living at the station following the reorganization of the USLHS into the Coast Guard in 1939. Coastguardsmen from the nearby Coast Guard station maintained the light and fog signal. A wood frame Coast Guard lookout tower was built near the fog signal building in 1940. The fog signal at the station ceased operation in 1954. The South Manitou Island Light Station was discontinued in 1958, and its function replaced by a lighted gong buoy installed on South Manitou Shoal.

Figure 1B-03: Ca. 1994 photograph of the South Manitou Island Light Station.

Figure 1B-04: 1914 photograph of the dwelling at the North Manitou Island Light Station.

NORTH MANITOU ISLAND LIGHT STATION

By the early 1890s, the need for an additional aid to navigation in the region was noted:

> In 1892, the Lighthouse Board noted that there were three different passages linking Green Bay and the Straits of Mackinac:
>
> 1. The North Passage, protected by a lightship at White Shoal and lighthouses on Squaw Island and Seul Choix Pointe.
> 2. The passage between North Fox Island and Beaver Island, marked by Beaver Head Lighthouse and South Fox Island Lighthouse.
> 3. The seventeen-mile-wide passage between South Fox Island and North Manitou Island, marked only on the north by South Fox Island Lighthouse.

Figure 1B-05: 1930 photograph of the light tower, fog signal building and oil house at the North Manitou Island Light Station.

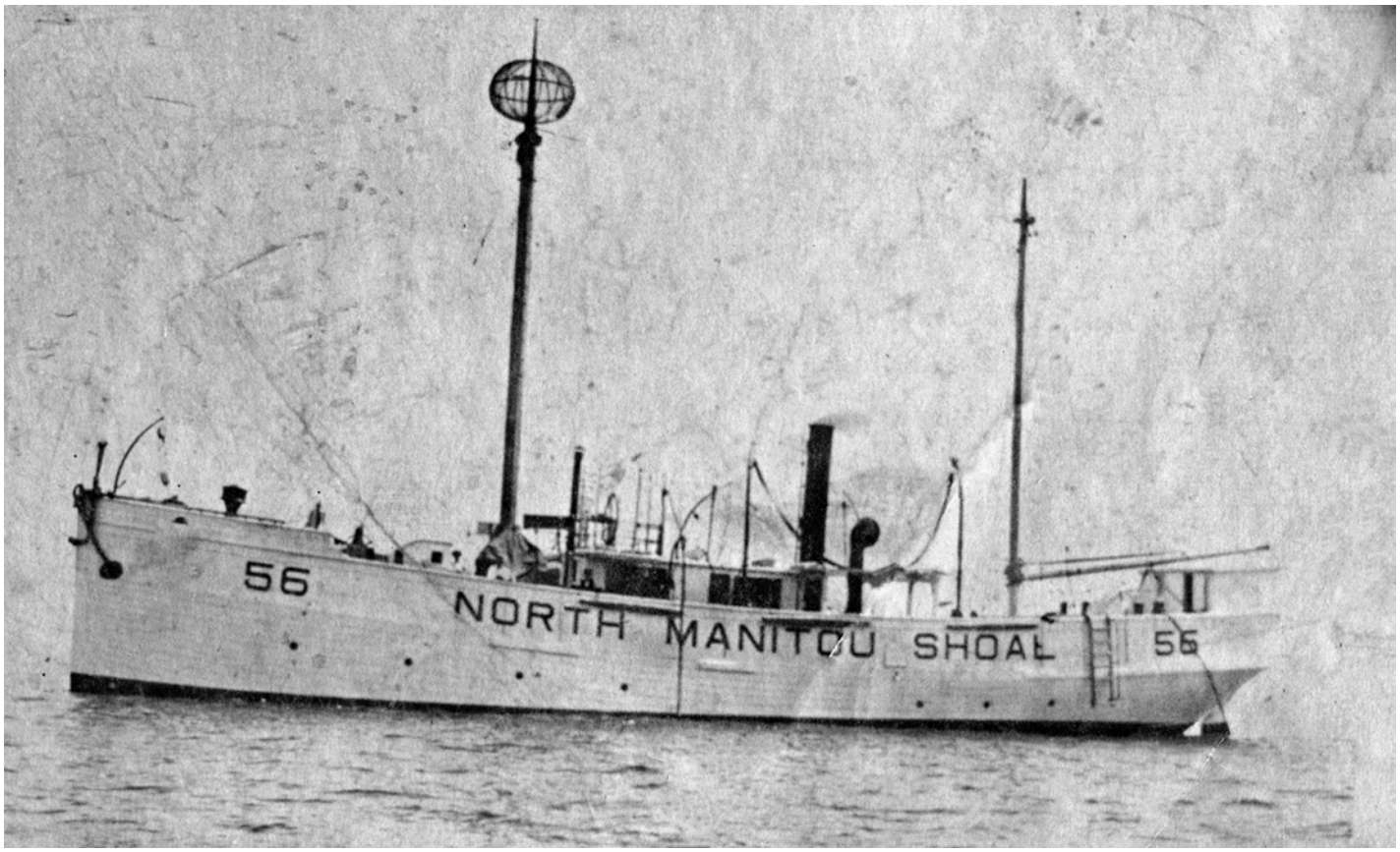


Figure 1B-06: Undated photograph of Lightship No.56 (LV-56).

As the passage mariners used depended on weather conditions, it was imperative that each be well lighted. To better mark the third passage, the Lighthouse Board requested $20,000 for a light and fog signal on the north end of North Manitou Island.[7]

Congress authorized funding for a light station on North Manitou Island in 1895 and construction began in 1896. A fog signal building and keepers' dwelling were built that year and the light tower was completed in 1898 (Figures 1B-04 and 1B-05). While the initial request by the Lighthouse Board called for the station to be built on the northern end of the island, it was built on the island's southeast point, known as Dimmick's Point, so it could also guide mariners between the island and the mainland[8] (i.e., through the Manitou Passage). Review of the 1930 *Light List* indicates that an unattended winter light, with a flashing white characteristic) had been added to the station by that time.

As noted later in this section, the USCG installed a telephone line between the North Manitou Island Light Station and the new North Manitou Shoal Light Station in 1934. According to the Lighthouse Friends website, an automatic light had been installed at the station in 1932 and the fog signal was discontinued that same year. This was likely due to a lesser need for the island station with the construction of the shoal station. According the lighthousefriends.com, following the departure of resident keepers at the station, it soon fell into disrepair:

> William R. Angell, who would later become president of Continental Motors, joined two Chicago businessmen to form Manitou Island Syndicate, which started buying up land on North Manitou Island. Angell later bought out the other members of the syndicate and renamed it the Manitou Island Association. In 1938, Angell purchased the North Manitou Island Lighthouse property at auction and added it to his island land holdings, which were being used as a deer hunting preserve. The wooden tower, fog signal building,

and keeper's dwelling were neglected and eventually lost to erosion. The lighthouse crashed to the ground in October 1942, after being undermined by the lake.

LIGHTSHIPS IN THE MANITOU PASSAGE

In the early twentieth century, the route through the Manitou Passage continued to be one of the most heavily traveled shipping lanes along Lake Michigan (Figures 1B-06 and 1B-07). During this time a shoal had developed in the passage southeast of North Manitou Island, warranting the need for another aid to navigation. In its 1908 Annual Report, the Lighthouse Board noted:

> *North Manitou light-vessel, Lake Michigan.* -- In recent years a shoal has developed to the southeastward of North Manitou Island. With the exception of this shoal this is the safest passage through Lake Michigan, and is largely used. Owing to the proximity of Pyramid Point to the eastward, it is impracticable for masters to accurately locate the position of their vessels in thick or foggy weather, and a light-vessel on the easterly end of the southeast shoal would aid them in passing through this narrow channel. The Board therefore recommends that an appropriation of $50,000 be made for the establishment of this vessel.[9]

Congress subsequently appropriated the funding, and 1910 the first of three lightships to serve at the shoal was put into service. This first lightship was Lightship No. 56 (LV-56). It had been built in 1891 by the Craig Shipbuilding Company of Toledo, Ohio, at a cost of $14,225.[10] According to the *Lighthousefriends.com* web page about North Manitou Shoal Light Station, LV-56 had previously served further east in Lake Michigan at White Shoal, located approximately twenty miles west of the Mackinac Bridge.

Review of the 1924 Light List indicates that LV-56 was located in 21 feet of water on the south end of the shoals. It had a 320-candlepower fixed white light that was approximately thirty feet above the high-water line and could be seen up to twelve miles away. The *Light List* noted

Figure 1B-07: Undated photograph of Lightship No.56 (LV-56).*

Figure 1B-08: Undated photograph of Lightship No.89 (LV-89).*

Figure 1B-09: Undated photograph of Lightship No. 103 (LV-103).*

* It is unknown why the North Manitou Shoal lightships retained the location naming convention of "Manitou" rather than the standard alpha numeric naming system."

that the vessel had a white hull with "MANITOU" painted on the sides and a black oval daymark at the foremast head (Figure 1B-07). The vessel was also equipped with a 6-inch steam whistle. There was also a white station buoy located about 0.1 mile northwesterly from the lightship that was equipped with a submarine bell. Lightship LV-56 served at the shoal through the 1926 navigational season, was reassigned to Grays Reef in 1927, and then retired from duty in 1928. [11]

A replacement lightship, LV-89, was assigned to North Manitou Shoal in the spring of 1927. This 88-foot long vessel was built in 1908 by Racine-Truscott-Shell Lake Boat Company at a cost of $37,500. [12] Review of the 1930 *Light List* indicates that LV-89 was located in the same spot as LV-56 had been. Its light was approximately 44 feet above the high-water line, but like its predecessor, could be seen up to twelve miles away. Also like its predecessor, LV-89 was fitted with a 6-inch steam whistle and the station buoy remained nearby. The *Light List* noted that the vessel's hull was painted red with "MANITOU" painted on the sides, and that it had a tubular mast and lantern gallery and a white house (Figure 1B-08).

The LV-89 was on station each shipping season until the end of 1933. Lightship LV-103 was then assigned to the shoal for the 1934 season (Figure 1B-09). LV-103 was built by Consolidated Shipbuilding Company in Morris Heights, New York at a cost of $147,428 and launched in 1920. [13] The vessel served at Grays Reef prior to North Manitou Shoal. Like LV-89, LV-103 had a red hull with "MANITOU" painted on the sides. In addition to the light, LV-103 was also equipped with a TYFON steam-powered fog horn and radiobeacon. The 1934 *Light List* indicates that the lightship was also a Distance Finding Station. The *Light List* Stated that "radiobeacon signals are sent continuously during fog or low visibility, and at certain scheduled times in clear weather. They are the most valuable fog signals, and are also available for navigation in clear weather."[14] It also defines a Distance Finding Station: "At certain stations the sound and radio signals are synchronized for the purpose of distance finding."[15]

No longer needed at North Manitou Shoal in 1935, LV-103 was transferred to Corsica Shoals in Lake Huron:

> She was later re-designated U.S. Coast Guard WAL-526, then WLV-526. From 1935 until 1970 she served at Corsica Shoals, at the southern end of Lake Huron, approximately six miles north of the Blue Water Bridge and three miles east of the Michigan shoreline. When she was withdrawn in 1970 she was the last of twenty-two lightships on the Great Lakes and the only lightship to keep her station throughout World War II. In 1972, she was enshrined on the banks of St. Clair River at Pine Grove Park in Port Huron as a tribute to her vigilance and in memory of a by-gone era. In 1989, the lightship was designated a National Historic Landmark. [16]

The lightship is now owned by the City of Port Huron, maintained by Volunteers of the Huron Lightship Museum and supported financially by the Lake Huron Lore Marine Society.

CONSTRUCTION OF THE PERMANENT LIGHT STATION

The history of the design, funding, procurement and construction of the North Manitou Island Light Station is detailed on the following several pages. As this history is quite complex, two summaries are also included. A summary through July 1933 is included on pages 54 and 55. A summary from August 1933 through construction completion is included on page 68.

The U.S. Lighthouse Service conducted an extensive project in the 1920s and 1930s to replace all lightships in the upper Great Lakes region (Lakes Huron and Michigan, including the Straights of Mackinac) with permanent aids to navigation. Some of those built in the 1920s

Figure 1B-10: 1932 photo of Poe Reef Light.

include Lansing Shoal Light in the East Straits and Martin Reef and Poe Reef (Figure 1B-10) Lights in Lake Michigan. The 1930s construction began with completion of the DeTour Reef Light (Figure 1B-11) in 1930-1931. The Twelfth District Assistant Superintendent, N.M. Works, who oversaw lights in Lake Michigan, wrote to the Commissioner of Lighthouses in January 1932 requesting permission to visit DeTour Reef Light "for the purpose of obtaining data for use in connection with the construction of the North Manitou Light Station," and "to visit any other light stations in general vicinity of Detour and northerly end of Huron."[17]

Figure 1B-11: 1947 photo of DeTour Reef Light

In November 1932, the official Form 80 "Recommendation as to Aids to Navigation" was completed by the 12th District Superintendent and submitted to the Commissioner of Lighthouses to request a Congressional funding appropriation. The form stated the proposed action: Established fixed light, fog signal and radiobeacon station on crib or caisson structure, on submarine site, to replace North Manitou Lightship No. 103, and its necessity: To provide better aids to navigation along this important heavy traffic route; which will be in position 12 months per year[18] instead of 8 months as now for lightship. To reduce materially the cost of maintenance for aids in this locality.[19]The annual maintenance cost was estimated at $7,300.00.

The estimated cost for construction of the station was $175,000, with the intention to obtain funding appropriation from the Emergency Relief & Construction Act (ERCA) of 1932. The ERCA, signed by President Hoover on July 27, 1932, appropriated funds for federal relief loans to the states and new public works construction. In his statement about signing the act, Hoover stated the following regarding the public works component, "through the provision for $1,500 million of loans by the Reconstruction Corporation for reproductive construction work of public character on terms which will be repaid,

SUMMARY OF DESIGN, FUNDING AND PROCUREMENT THROUGH JULY 29, 1933

January 1932	Asst Supt Works requests approval to visit DeTour and other offshore lights to obtain data for use in constructing NMSL
July 1932	Emergency Relief & Construction Act (ERCA)
Fall 1932	Preliminary drawings made – key items to note: round caisson foundation and no lantern with airways beacon
Oct – Nov 1932	Survey of the shoal to determine location for the structure
November 1932	Official "Recommendation as to Aids to Navigation" form completed by 12th Supt and submitted to Commissioner, with intent to build light station with fog signal and radiobeacon with ERCA funds (estimated cost of $175,000)
November 1932	Four options presented for location of the structure on the shoal, with recommended location (location #4)
Nov – Dec 1932	Commissioner not in favor of design and recommended revisions to follow DeTour Reef design (most notably square caisson)
December 1932	Commissioner not in favor of recommended site location, prefers location of lightship (location #2)
December 1932	Lake Carriers' Association and Lake Survey opinions sought for suitable site
December 1932	Twelfth District prepares cost estimates for structure with round caisson foundation and square crib foundation; both are $175,000.
Dec. 28, 1932	Conference held at Bureau in Washington, D.C. to review site location, foundation type, and structure design • Site near the lightship (location #2) confirmed, pending further detailed survey • Neither of the foundation types nor design of the lighthouse acceptable to the Bureau and the Twelfth District Administration informed to redesign following the designs of recently completed Poe Reef and DeTour Reef Light Stations.
January 1933	Correspondence relative to Twelfth District working with Seattle District to purchase West Coast timber for the foundation crib
January 1933	Revised design underway (as reported by Twelfth District)
Jan. 26, 1933	Bureau funding request to Secretary of Commerce of reduced amount of $155,000 (reduction due to elimination of telephone cable and less rip rap)
January 1933	Twelfth Superintendent working with Dravo Contracting Company exploring alternative construction method for the pier construction – grouting rock fill in the fill instead of the more traditional Tremie concrete method in use at the time
Jan. 31, 1933	Approval to advertise for bids for steel sheet piling, timber for crib, and third order lantern
Jan - Feb 1933	Specifications prepared for steel sheet piling and timber and plank for crib
February 1933	Bureau sent Twelfth District standard drawings for third order lantern to incorporate into the design
February 1933	Bids solicited for steel sheet piling (with options for 5" and 6" steel) and timber and plank for crib
February 1933	Bureau recommendation to award steel sheet piling to low bidder Inland Steel Company, with higher priced 6" steel with option to change to 5" if available funding requires
March 1, 1933	Daugherty Lumber Company low bidder for crib timber
March 11, 1933	Twelfth District submits revised drawings to Bureau – Bureau responds unfavorably, critiquing many aspects of the design and noting considerable differences from the recommended DeTour Reef design

March 11, 1933	General construction contract advertised for bids
March 24, 1933	Presidential Executive Order to freeze all funding from the Emergency Relief & Construction Act; Bureau sends telegram to Twelfth District to halt work
Mar – May 1933	(despite stop work order) Twelfth District continues with design (drawings and specs), including alternate grouting method as option
March 31, 1933	(despite stop work order) Twelfth District obtains bids for the cast iron lantern
April 6, 1933	(despite stop work order) Twelfth District requests authority and funds to purchase lantern from low bidder Johnson City Foundry
April 1933	(despite stop work order) General construction contract bids due date extended from April 10 to April 25 because drawings and specs not complete
April 29, 1933	(despite stop work order) Twelfth District requests authority and funds to award construction contract to low bidder Lyons Construction Company
May 2, 1933	Bureau rejects funding requests and sends telegram to cancel all work on project
May 1933	Local Congressman writes to Commissioner asking to authorize work to proceed, referencing a new forthcoming public works bill
May 31, 1933	Bureau reluctantly provides a qualified approval of the revised drawings and specifications, noting they do not conform to the agreement made at the December 1932 conference to follow the design of DeTour Reef but that since the new funding bill will likely pass soon, there wouldn't be enough time to revise and proceed with construction in timely manner
June 16, 1933	National Industrial Recovery Act enacted
June 30, 1933	With no word from Bureau to proceed with project, local Congressman writes the Commissioner asking for project to re-commence, timber for crib had arrived; Commissioner responds that funding not yet made available
July 15, 1933	With still no authorization to proceed, Senator write to Commissioner; response is that legal complications with proceeding with projects bid before NIRA
July 17, 1933	Notification that projects must be re-bid
July 18, 1933	General construction contract re-bid
July 21, 1933	General construction contract bids opened, Lyons Construction Company again low bidder
July 1933	Great Lakes River and Harbor Association (GLRHA) lobbying for mandated minimum wage rates be incorporated in NIRA; these were included in requirements for bidders but Lyons did not state they would comply; GLRHA states they will protest awarding to Lyons
July 22–26, 1933	Correspondence between Senator and Commissioner, former urging to award and notify contract to Lyons, latter stating waiting on release of funds
July 28, 1933	Commissioner recommends awarding to Lyons per bid, not increased funds per GLRHA recommendations to increase wages in NIRA, as they were not incorporated
July 29, 1933	Project approved to proceed, with low bidder Lyons Construction Company for general construction contract using traditional tremie concrete construction for foundation and not alternate grouting method; and using bid amount (not increase per GLRHA recommended wage increase/minimum as not incorporated into NIRA)

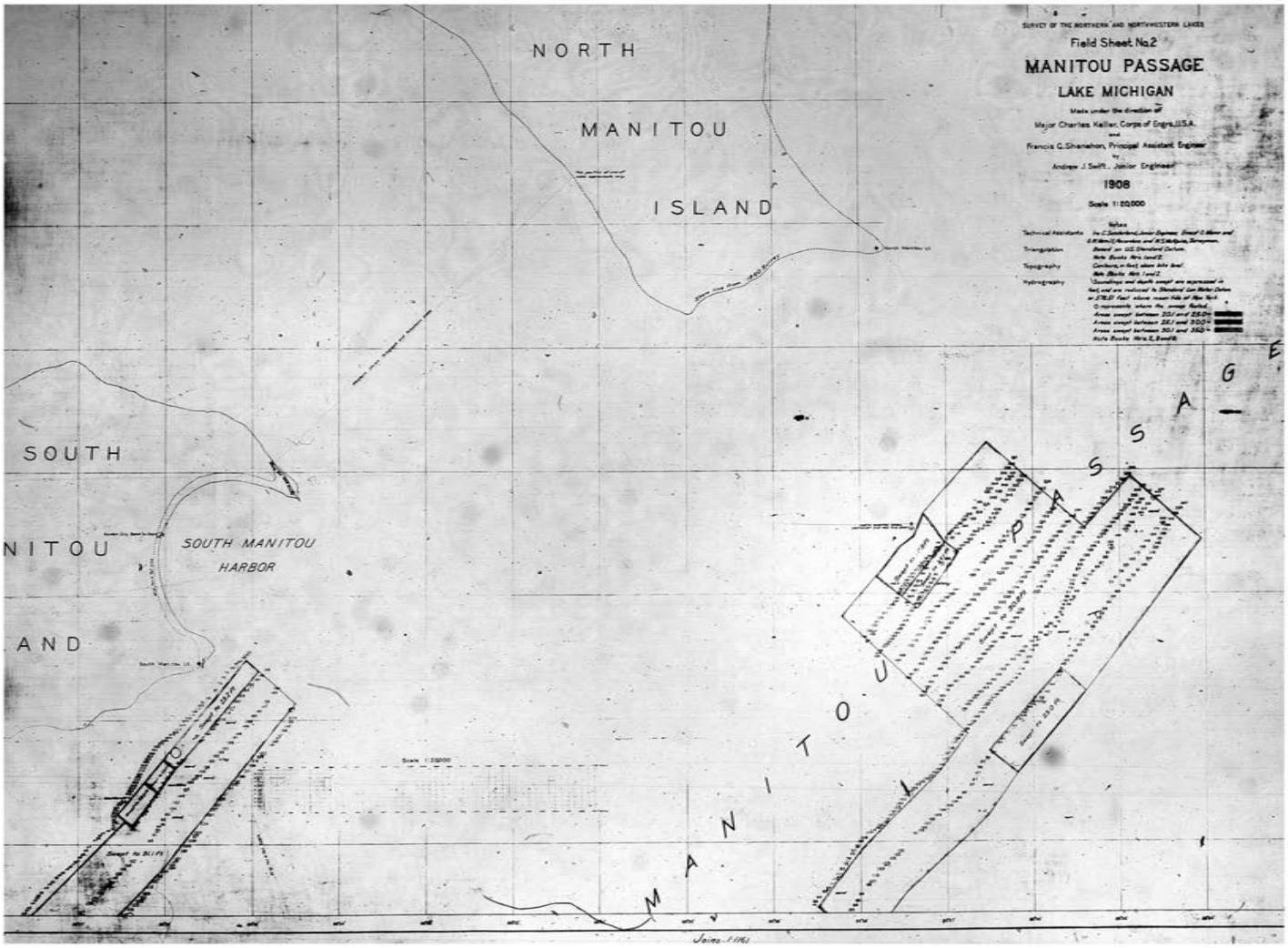


Figure 1B-12: 1908 survey drawing of soundings taken in the Manitou Passage at North Manitou Shoal and along South Manitou Island.

we should ultimately be able to find employment for hundreds of thousands of people without drain on the taxpayer." [20]

The form indicated that $150,000 of the estimated $175,000 cost would be paid to a general contractor, $15,000 would be used for materials, and $10,000 for "depot forces," further stating, "[The] Entire project to be executed by contract, except minor portions, such as installing the fog signal machinery, illuminating equipment and radio equipment, etc., which can most advantageously be so installed by competent district force available." Form 83 was also attached, which provided a further breakdown of the $175,000 proposed cost.

A survey of the shoal was underway at the time the form was prepared, and noted regarding the site: "It is proposed if survey so determines to locate structure on the "25 1/2 ft" spot shown on the chart, about 1500 feet S 25 degrees E (Azmith 155 deg.) from the position occupied by the Lightship, or in that general vicinity." The form further stated:

> The Tender "HYACINTH" is now at North Manitou Shoal with party making a survey and examination of bottom to determine proper location for structure. Reports already received from survey indicate that a 24 ft. depth of water is available, ... and that material at proposed location is heavy gravel with some sand. Further definite report will be made within about a week regarding site, after full data has been received from survey. [21]

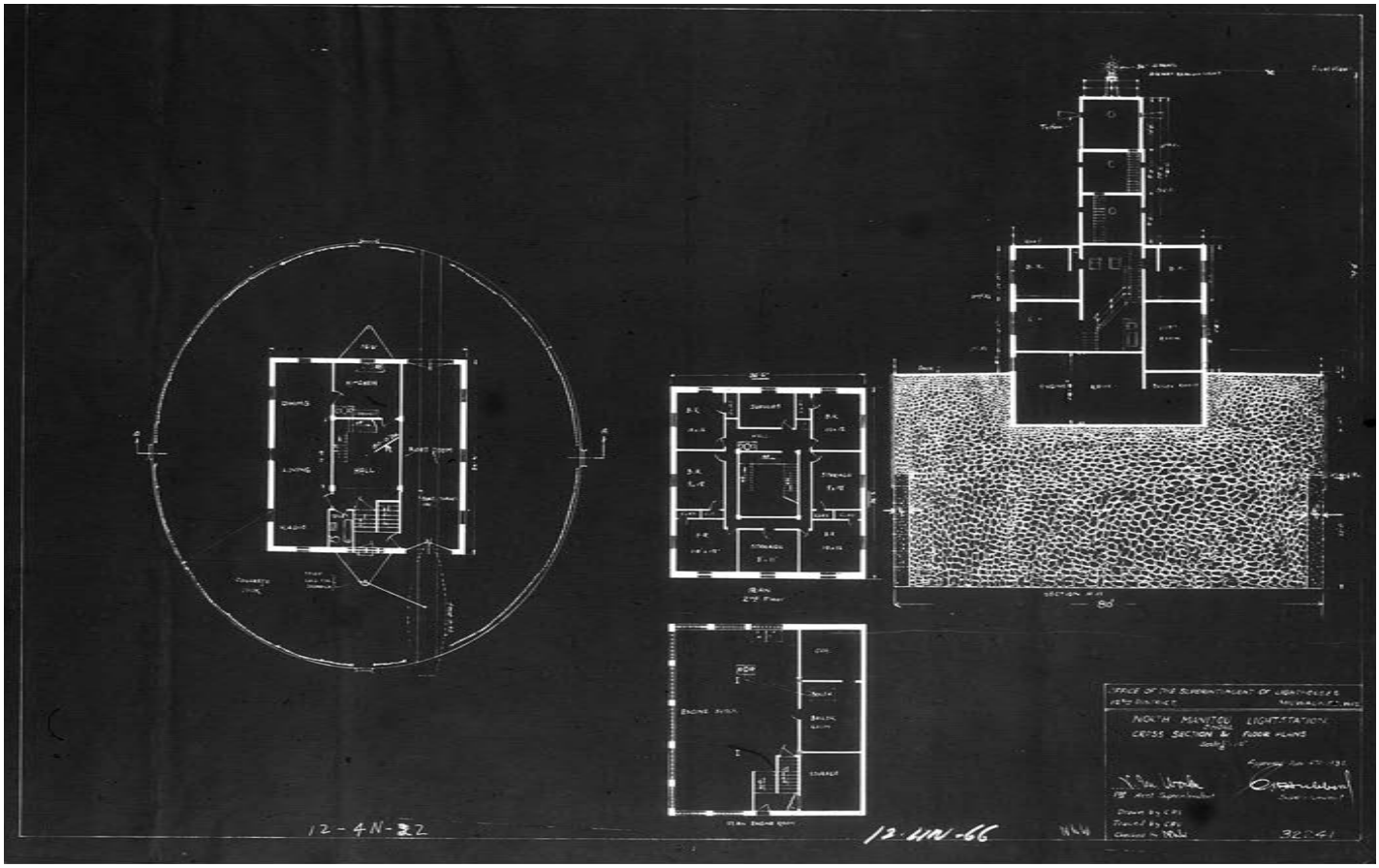


Figure 1B-13: 1932 preliminary drawing for the North Manitou Shoal Light Station.

An attached letter written by Assistant Superintendent N.M. Works gave details of the completed survey, and noted that it appeared the location and boundary of the shoal hadn't changed in several years:

> A survey was made by Master Steamer Hyacinth Captain H.W. Maynard and Foreman Lou H. Comfort, on Oct. 19 to Nov 14, 1932, recorded in Note Book No. 204 and platted on the following maps…
>
> While the survey was in progress, it was noted that passing ships follow exactly course laid down on the L.S. charts, which takes them exactly over the shoal spot 25.6 at No. 8…
>
> A comparison of L.S. Chart No. 784 and the two blue prints above, with the present survey seems to indicate that there has been no great material change in the contours at the outer end of the Shoal, in the last 24 years or more.[22]

Figure 1B-12 is a 1908 survey drawing of those soundings/contours taken twenty-fours years prior. The letter went on to describe several locations and surveyed and commentary on those as potential locations for the new light station structure:

> A light station located at No.4---(Light Ship Location) would be justifiable, however. we feel that in view of the revised project of the U.S. Engineers for Great Lakes Connecting Channels, calling for depth of 25 or 27 ft., this new fixed light station should be located further out on the reef, as near to the dangerous 25.6 ft spot, at No.2 location (24 ft. depth at present gage) as may be practicable, in order to give ample protection against grounding on this shoal spot. This shoal spot is located 1700 ft. outside of the Light Ship.
>
> "THE SHOAL SPOT "No. 2" would be the ideal spot to locate the structure and could be used, but for the fact that the bottom is sand with about 40% gravel. This location is too close to the adjacent deep water. Lake bottom at this site is hard and solid on the slope down to deep water and shows no signs of movement or disturbance...

Figure 1B-14: 1932 preliminary drawing for the North Manitou Shoal Light Station.

> "THE NO.3 LOCATION WAS SELECTED by Survey Party, as being the best site available, located 170 ft., 340 deg. -19min. from the No. 2 location. This location is practically absolutely level, over the required foundation area, 80 ft. in diameter. At this place bottom is of sand, sharp, with about 40% gravel, bottom surface hard and no indication of sand movement... IT IS NOW RECOMMENDED THAT THE STRUCTURE TO BE BUILT on this proposed site as recommended by Form 80, dated Nov. 12th., now at the Bureau."[23]

Assistant Superintendent Works ended the letter with a comment, "Personally I believe that as a matter of insurance, the structure should be located about 320 ft. further back."

Drawings of the proposed structure were attached to the Form 80 (Figures 1B-13 and 1B-14). A written description of the proposed structure provided additional details:

> …it is proposed to construct a cylindrical steel caisson, 80 ft. outside diameter and 21 ft. deep; made up of an outside cylinder 80 ft. diameter and an inside cylinder 72 ft. diameter, the two cylinders assembled in concentric position…
>
> …The two concentric steel cylinders to be constructed of 12"—20.7 lb. steel channels, each piece of channel being about 30 ft. long, (half of the length ordinarily rolled in steel mills), bent cold in rolls to the required radius and riveted together through flanges. NOTE--Several large mills and fabricators have been consulted and have advised that such bending is entirely easy and practicable….[24]

The description noted that the cylinders would be braced apart and tied together with steel rods and a two-foot concrete seal poured at the bottom of the cavity between them. The circular caisson structure would then be braced and stiffened with lower and upper beam systems. The following was stated regarding assembly:

Preferably assemble the caisson, as described in a dry dock and float out.

NOTE--We have consulted the Manitowoc Shipbuilding Corporation, and they have advised that their dock will accommodate the size caisson described, and they find the scheme of construction entirely practicable.

The scheme of using steel channels for the construction of a floating structure is a well established practice in the construction of scows and dredge hulls, and in such use has demonstrated extreme strength and stiffness.

Instead of assembly in a dry dock, the caisson could be assembled supported above water by temporary piles in a harbor, and lowered by screw rods into the water, and then pull the pipes. This scheme was used very successfully by the City of Chicago in the assembly of the very heavy and elaborate steel plate caisson for the new Carter Harrison Waterworks Crib.

Or the caisson could be assembled on launching ways at South Manitou Island, or at Frankfort, and slid into the water in accordance with ordinary ship launching procedure.

However, the dry dock assembly seems entirely the best procedure, especially in view of the fact that the channel construction insures quick assembly, and at this time it is particularly to be considered in view of the fact that ship yards are practically without work.

The Caisson would be towed to the site and sunk by opening the sea cocks in the bottom… and would be immediately filled with seven inch "Furnace Stone" from large conveyor ship… Concrete mixer could then fill the annular space in the caisson…[25]

The description then gave details on the two-story building and tower to be built on the caisson; the main deck; and the advantages of both using a round caisson and providing a large boat room:

The two story building and the tower, both square in plan, and both of steel channel construction, channels set vertical, would then be erected, and lined with 4" concrete [sic?] or pyrobar blocks, and provided with waterproof roof deck of concrete, and with floors and lantern deck of concrete.

It is to be noted that the walls of the building, 36 ft. square and the walls of tower will be thin, providing maximum amount of room. Also that the space provided in the building and basement is sufficient for the purpose required, but at the same time is the minimum amount necessary to meet the necessary uses.

A proper boat room is provided with floor 1 ft. above main deck, and with store rooms and boiler room 10 ft. high in the basement beneath.

A convenient living room, kitchen, dining room and space for radio apparatus, is provided in the first story, with floor up 4 ft. above main deck, with engine room space in the basement beneath, 14 ft. high.

The engine room space will be lighted by an ample continuous area of glass near the top of room. This glass area will be made of very thick glass, 1" or more thick, in small panes, all fixed, and with provision to protect same on the more exposed sides, with plank covers in late fall and winter. Ventilation for engine will be thru roof.

The Main Deck to be surfaced with thin, 4", concrete slab, over the stone fill, which can easily be replaced, if in course of time the fill settles materially.

It is believed that the round form of caisson is of particular merit in that the sea and ice action on same will be greatly lessened in violence, and that the amount of water which will board the main deck in time of very heavy sea will be small. No doubt the round form will not be so favorable for landing at crib from a boat, however, we are inclined to think that the merits of this form outweigh this objection. It is to be noted that this station is located relatively near to land.

The provision of an adequate and convenient boat room is considered a matter of major importance to the safety of the men in charge of a station of this type.[26]

Based on a handwritten note on the form, it is assumed that the Commissioner did not necessarily agree with some aspects of the proposed design. The notes reads: "Rec[ommend] study 11th Design for Detour as an example of excellent work, pleasing appearance and economical constr[uction]. In deep water, square caisson. See Supt. Genrl Duty inspection report to 11th & 12th D 11/15."

The form included the following regarding the proposed navigational aids for the station:

> FOG SIGNAL -- It is proposed to install Oil Engines in duplicate with air compressors, and two TYFON instruments, one pointing north easterly and one pointing south westerly, with a simultaneous blast from both: CHARACTERISTIC -- 2 seconds blast, 18 seconds silent.
>
> RADIO BEACON -- Apparatus of power similar to that now in service on North Manitou Light Ship No. 103 to be installed:-- Class C low power with CHARACTERISTIC same as now maintained on Light Ship. Continuous dots for 60 seconds, Silent for 120 seconds NOTE --- The RADIO BEACON and Sound Fog Signal to be coordinated for Distance Finding purposes.
>
> ILLUMINATING APPARATUS: -- It is proposed to omit the Lantern House [house circled with question mark], third order, usually placed on structures of this type, and to install the four panel, 36x Airways type apparatus, recently developed by the bureau, using such size incandescent lamp and such characteristic as the Bureau may consider best for this situation.[27]

A December 12, 1932 cost estimate indicated an estimated cost of $700.00 [although there is a handwritten note next to the amount that says "1435 bid, over twice the estimate amount] and provided more detailed information regarding the proposed lighting equipment:

> ITEMS, QUANTITIES AND UNIT PRICES: 1 - 36" Diameter revolving lens, see Bureau drawing No. 1-A 438 consisting of four pressed glass lenses 36" diameter airway beacon using either 500 or 1000 watt type T incandescent lamp producing 800,000 candlepower with 500 watt lamp. The apparatus to be complete as shown on drawing and if possible the worm and the worm gear to run in bath of oil. The motor to be direct current 110 volts and lens to make a revolution in 60 seconds to be mounted outside and without any housing.[28]

The drawings (Figures 1B-13 and 1B-14) indeed show a lantern-less light tower.

Review of December 1932 correspondence reveals that the Bureau of Lighthouses did not necessarily agree with the Twelfth District's proposed site nor lighthouse design. On December 16th, writing on behalf of the Commissioner, Deputy Commissioner H.D. King wrote to Superintendent C.H. Hubbard:

> Referring to your Form 80 of November 12, 1932 and letter of November 19, 1932, in reference to the above-named project:
>
> The Bureau considers, after a careful examination of the proposed site and plans as recommended by you, that a conference should be held at the Bureau in the near future in order to discuss the proper location of the lighthouse and its method of construction and erection, at which it is proposed to have the Superintendent of the 11th Lighthouse District present.
>
> With this end in view it is desired that you and Mr. Works [12th District Assistant Superintendent] visit the Bureau on Wednesday December 28, 1932, and bring with you an estimate of the cost of your proposed design if placed at Site #4, the location occupied by the anchor of the lightship, and if placed on the 17 foot shoal about 3/8 mile north of Site #4.
>
> If it is practicable for you to do so, you can make arrangements to meet Mr. Park [11th District Superintendent who was based in Detroit and oversaw lights on Lake Huron] on the way down and discuss the matter together so that on arrival he may be advised in some detail as to what is proposed. In case the work of the district is such that it is not advisable for you to

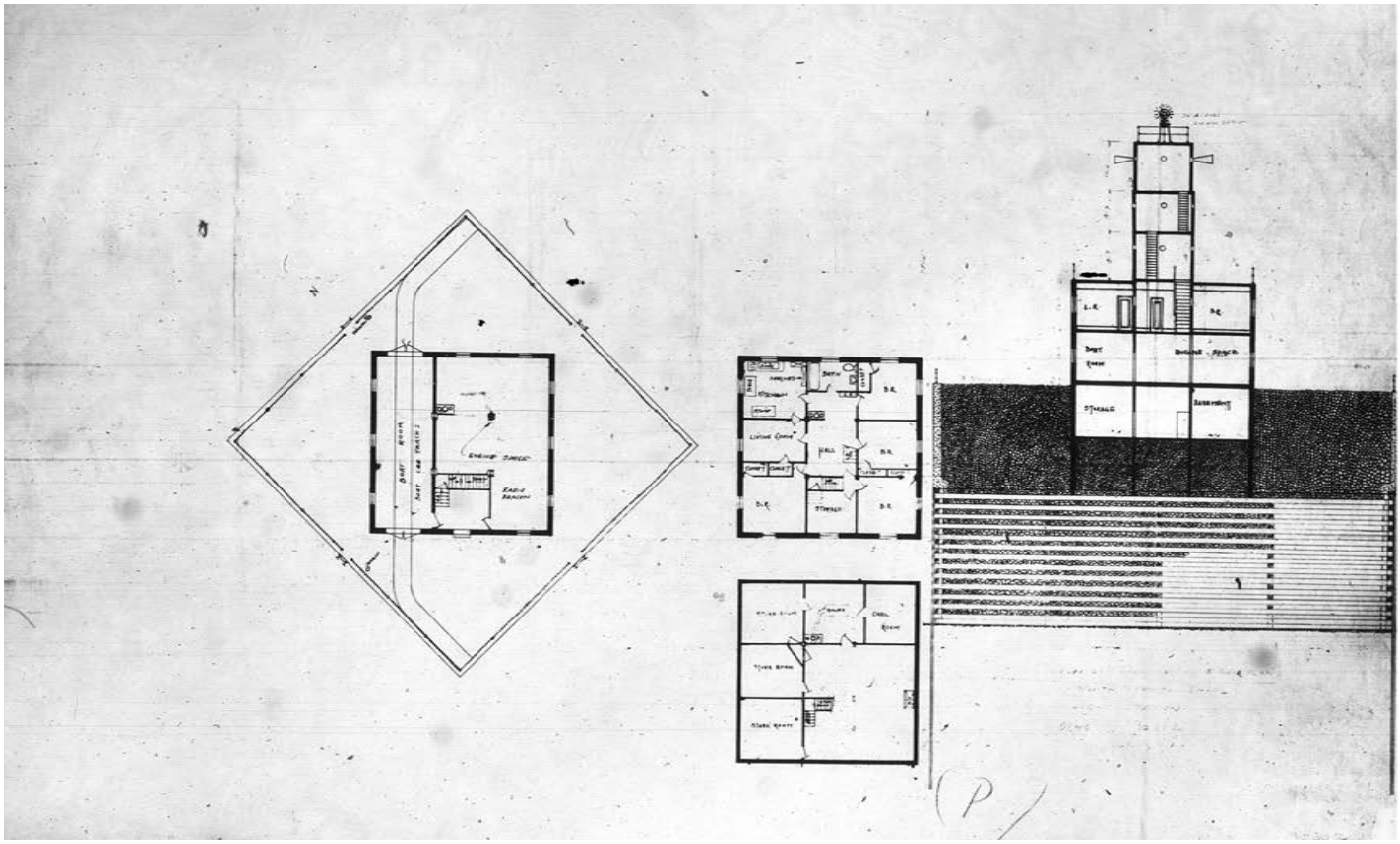


Figure 1B-15: 1932 preliminary drawing for the North Manitou Shoal Light Station

come, you can give Mr. Works such instructions as may be deemed proper as to the relative desirability of all sites proposed.[29]

It is apparent that the concern with the design was that it wasn't similar to DeTour Reef, as had been originally recommended. A copy of the letter was forwarded to 11th District Superintendent Park with an additional note: "This information is given you in advance in case you meet and accompany the Superintendent and Mr. Works to Washington, and in view of the methods of construction employed at Martin Reef, Poe Reef, Fourteen Foot Shoal and Detour, which the Bureau believes may be suitable for the North Manitou project and about which you can reserve judgment until the matter is discussed here."[30]

The Commissioner also wrote another, separate letter to the 11th District Superintendent seeking his assistance regarding the proposed sites for the North Manitou Shoal Light. He wrote:

1. The Bureau requests you to obtain informally by telephone the views of the Lake Carriers' Association (Shore Captains Committee) and the Lake Survey as to a suitable site for the light station proposed to take the place of North Manitou Lightship, particularly as to the preferable site among the following:

   (a) Approximate present location of the lightship.

   (b) A site about 1700 feet directly south of the lightship as shown on Chart 784, and between soundings 30 and 31, just northward of the line of traffic, as shown on this chart.

   (c) A site on the 17-foot shoal about 1500 feet north of the lightship.

2. Your early attention is requested.[31]

Mr. L.C. Sabin of the Lake Carrier's Association responded directly to the Lighthouse Bureau's Chief Engineer Park later in December via telegram: "PREFERABLE LOCATION NORTH MANITOU LIGHTHOUSE CONSIDERED TWENTY FIVE FOOT SPOT LATITUDE FORTY FIVE NAUGHT ONE SHOWN ON CHART INDEX SEVEN EIGHTY FOUR [STOP] IF GREAT DIFFERENCE IN COST OR

DIFFERENCE IN FOUNDATION CONDITIONS THE CHARTED LOCATION OF LIGHT VESSEL WOULD BE FAIRLY SATISFACTORY WITH BUOY ON SPOT FIRST MENTIONED."[32]

In somewhat following the Commissioner's request to prepare and bring cost estimates for the structure at two locations on the shoal, the Twelfth District prepared two estimates. However, these were for two different types of foundation, rather than two locations. The first was a revised estimate for a round steel caisson on the "17 ft. Spot, N. of Original Assumed Location."[33] The estimate indicated that the cost for the caisson at this reduced depth of 17 feet would be $73,921.00, a savings of $29,574.00 from the original estimate for a 25-foot depth at the location of the lightship. It was noted that there was change for the rest of the structure from the estimate previously presented in November.

The second estimate was based on revising the foundation from a round caisson to a square crib surrounded by steel sheet piles. An accompanying letter from Superintendent Hubbard to the Commissioner described the reason for the change of foundation, as well as other changes to the structure:

> …further consideration has been given to another type of foundation involving the use of 60 ft. steel sheet piling, which type lends itself to use for a foundation on sand such as we have at this location. We have changed the shape to square and reduced the size to 66 x 66. We hand the Bureau herewith drawings Nos. 32299, 32300, 32301 and 32302 (Figure 1B-15) which are forwarded at this time in the belief that possibly the Bureau may desire to consider same before the conference to be held with regard to this structure on Dec 28, 1932.
>
> The scheme of construction would involve the sinking of a cheap square open-work timber crib about 66x66x27' deep, top at water surface, then driving 60 ft. steel arch web sheet piles into the sand to a depth of 33 feet leaving the top of the pile a little above water surface entirely enclosing the square timber crib with such piling. The outside wall from water surface to 21 ft. elevation would then be constructed of 12" steel channels secured to an interior frame work, the crib and the pier superstructure as described above to be filled with 7" furnace stone delivered by a self-unloading boat. The building and tower would be quite similar to those shown in our previous design, however, we have now placed the engine room in the first story above the main deck and have placed the kitchen, living room and sleeping room all together in the second story. It will also be noted that the building has been placed with sides at 45 degree angle with the sides of main crib. This arrangement is justified in order to secure a sufficient width of deck room for landing the motor boat before rolling into boat room also we secure by this placement at an angle the following advantages.
>
> The crib itself being placed square with the points of the compass insures that a great storm from the Southwest or Northeast will split on the corners of the crib and the house being placed at 45 degrees with the points of the compass insures that the windows in the sides of the building will look out onto the ship channel and in the direction of the ship channel both ways owing to the fact that the ship channel runs in a direction about Southwest and Northeast.[34]

Although the commentary above refers to a "cheap square open-work timber work crib," the cost estimate for this revised, square foundation was $107,613. However, the total cost of the revised estimate remained $175,000 as previously presented.[35]

12th District Assistant Superintendent N.M. Works and 11th District Superintendent C.A. Park attended the December 28th conference in Washington, DC along with the Deputy Commissioner, General Superintendent and the Chief Constructing Engineer from the Bureau. The memo summarizing the conference noted that in regard to the site location, the positions indicated on the Form 80 and subsequent

letter from the 12th District were carefully reviewed, along with input that the 11th District Superintendent had obtained from the Lake Carriers' Association and the Lake Survey Office. "As a result of the discussion it appeared that a site near the present lightship would be the most suitable location, dependent upon further detailed survey of the locality by the Superintendent of the 12th Lighthouse District before selecting the actual site in 23 to 24 feet if found."[36]

The outcome of the discussion relative to the design of the structure was not so favorable. Although both the original caisson design and revised design with square foundation were "given careful consideration," they were not acceptable to the Bureau. Again, it was preferred to follow previously completed offshore lights, which neither design did so much. The memo stated:

> As both of these designs appeared to be unusual in their main features though no doubt susceptible of practical erection, it was thought best to adhere in the main method of construction recently carried out in the 11th Lighthouse District at Poe Reef and Detour Light Station, and that the plans for these structures be obtained and followed in the redesign.
>
> The new design to include a timber crib placed on the bottom, on a light apron of riprap if the resurvey shows that it is desirable, with the outer pockets filled with concrete and the inner ones with stone, the wooden crib to be surrounded with interlocking steel sheet piles driven as closely as possible to the crib about 20 feet below bottom with their tops about 5 or 6 feet above datum of lake level. A concrete pier is to be erected on the timber crib with its deck about 21 feet above datum and will contain the basement of the tower all as shown on the plans to be obtained from the 11th District. The superstructure will follow the 12th District design, but will support a standard helical bar lantern of sufficient size to take the newly designed 36" revolving lens, details of which will be furnished later by the Bureau.[37]

Following the conference, the Deputy Commissioner subsequently returned the Form 80 and attachments to the 12th District with a December 30, 1932 statement that they were not approved. Although those plans were not approved, within days of his return to Milwaukee, Superintendent Hubbard started working on securing timber for the crib. On January 4th he wrote to the Commissioner:

> Request is made that authority be secured from the Chief of Engineers, permitting this office to request the U.S. District Engineers at Seattle, Washington to purchase for account this office the necessary 12"x12" fir timbers for construction of the timber crib, about 60"x60"x26ft. deep, requiring 200,000 f.b.m more or less. We are advised by the U.S. District Engineer Office at Milwaukee that such method of purchase and shipment under Govt. bill of lading over land grant railroads results in a very material economy. The Seattle Engineer Office is in touch with the large mills of the Pacific Coast and will be able to secure the lowest competitive prices and can arrange for proper inspection.[38]

There was considerable subsequent correspondence regarding the details of acquiring the timber from a Pacific Coast mill with the assistance of the 17th Lighthouse District in Seattle. Procurement details discussed included confirming with the 17th District that it was feasible for them to assist with the purchase and inspection; which district would solicit the bids and award the contract (the 11th district had done so previously in a similar arrangement for timber for their cribs); and whether the freight cost would be included in the bids from mills or the Lighthouse Bureau would purchase at the mill and assume the cost of shipping.

Both the District and the Bureau recognized the short construction season on the Lakes and the urgency to gets things moving quickly. On January 24th, Superintendent Hubbard wrote to the Commissioner telling him that revised plans for an approved type of structure similar to DeTour Reef Light were well underway. He

also wrote that contracts should be made as soon as possible for the crib timbers and sheet piling as well as the general contract for the entire structure so that work could commence as soon as the weather allowed. He concluded his letter with a request for the immediate allotment of funds from the Emergency Relief and Construction Act of 1932 appropriation. A detailed estimate was attached to his letter with the total amount requested still $175,000.

Hubbard noted that this estimate was based on the following parameters:

> To be located at site now occupied by North Manitou Light Ship #89 in a depth of about 22 feet of water. (See inclosed blueprint drawing) on which are plotted the soundings taken at this location in November 1932. The timber crib to be 60 feet square, the center portion filled with stone and outer pockets filled with concrete and the entire crib surrounded by steel arch with sheet piles 50 feet above water. A concrete super-structure 20 feet high with a 2 feet overhang on all sides will inclose a basement to be occupied by machinery. A super-structure building two stories high surrounded tower three stories high all of steel channel construction with a cast iron third order lantern house at the top.[39]

An interesting handwritten note on the letter references that the Superintendent "sticks to his estimate of $175,000 as compared with [the] lower costs incurred at Poe Reef of $143,000 and DeTour of $145,970." The Commissioner may have written this note, as the official funding request to the Secretary of Commerce was for $155,000. His request noted his amendment of the cost:

> Object: Construct and equip North Manitou Shoal Light Station, Michigan, to replace North Manitou Shoal Lightship. There are enclosed letter of January 24, 1933 and itemized estimate of cost as amended by the Bureau, from the Superintendent of Lighthouses, Milwaukee, Wis. The approximate annual maintenance cost of the Lightship is $13,300 whereas it is estimated that the annual maintenance cost of the proposed light station will approximate $7300, resulting in an annual saving of about $6,000, which saving is necessary in order that the maintenance expenses of the Service may be reduced, in view of the prospective cuts in next year's appropriations and for improving the economical operation of the District and Service in general. In addition to this direct saving of $6,000, tender service to the extent of about $1,000 will also be eliminated by the establishment of a light station at this point. It should also be stated that while there are four lightship stations in the 12th District, no relief is available, as the previous relief ship has been placed out of commission as a part of this year's economy program. The establishment of a light station in lieu of the lightship is also considered to effect better service to the shipping along this important heavy traffic route as the light station will be in commission 12 months in the year while the lightship can only be maintained for 8 months on account of winter storms and ice.[40]

The Commissioner wrote to Superintendent Hubbard that the $155,000 allotment was approved and explained that his cost reduction reflected elimination of the telephone cable from the project and reduction of the amount of riprap by fifty percent. The Chief Clerk for the Bureau subsequently approved advertisements for bid for the steel sheet piling, timber for the crib and a third order lantern. The Twelfth District then prepared specifications for arch webb steel sheet piling and timber and plank for the crib. Bids were solicited for both in February.

The steel sheet piling specifications called for six-inch deep steel, weighing 32 pounds per square foot, with a minimum thickness of ½ inch. The specifications also included an alternate for five-inch steel weighing 25 pounds per square foot with a minimum thickness of 5/16". The steel sheet piling bids were opened on February 27th and seven bids were received. Superintendent Hubbard wrote to the Commissioner on March 7th regarding the low bidders based on the different size steel and the cost for transport:

> The bids cover prices f.o.b. mill and f.o.b. Frankfort, Michigan. As the shipment can

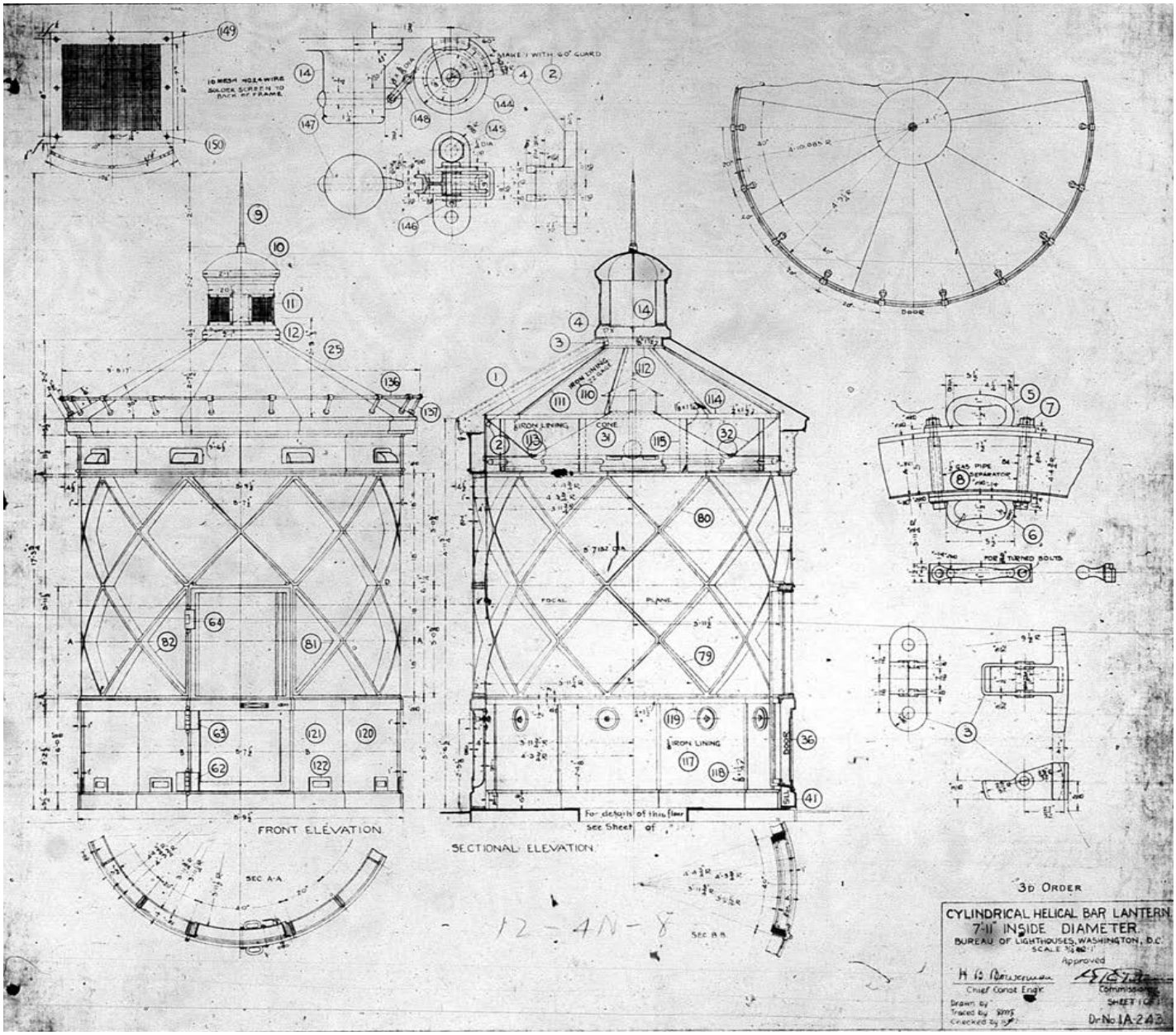


Figure 1B-16: Undated drawing for a third order cast iron lantern.

be routed over land grant railroads for a considerable distance, giving the Government a 50 per cent rate, it will no doubt prove most advantageous to accept bids f.o.b. mill and ship under government bill of lading to Frankfort, Michigan.

We have shown the weight to be shipped on the abstract. The Bureau is requested to insert the amount of freight under govt bill of lading and the total cost delivered Frankfort under such govt bill of lading.

It appears that Jones and Laughlin Steel Corporation is low bidder in case 5" depth arch web 25 pound steel sheet piling is accepted, and that the Carnegie Steel Company is low in case 6" 32 pound piling is accepted. However, from such data as we have available with regard to land grant railroads, it appears quite possible that the Inland Steel Company of Indiana Harbor, Indiana, may be low bidder on both 5" and 6" piling.

From an engineering standpoint we believe that the 6" depth (32 pounds per square foot of wall) sheet piling should be used in view of the fact that it has much greater stiffness and strength to resist the impact of steel hammer in driving and its thickness of 1/2" will insure much longer life than the 3/8" thickness of the 5" depth 25 pound piling.

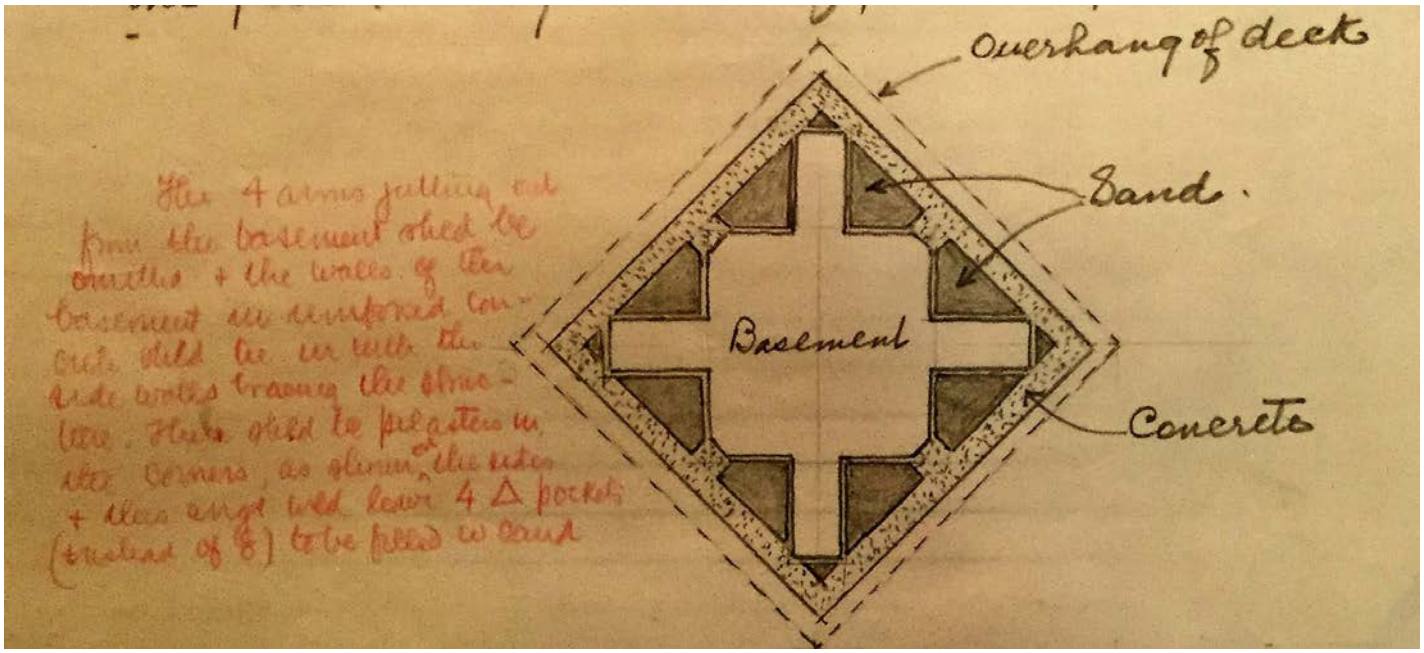


Figure 1B-17: March 1933 sketch showing the proposed configuration of the basement and pier.

> In this connection it is to be noted that piling will be driven about 23' depth into sand bottom, the sand carrying about 25 to 40 per cent of moderate sized gravel.
>
> From the standpoint of cost the 5" depth 25 pound piling appears of advantage in view of the fact that its cost will be about $2,036.00 less than the cost for the 6" 32 pound piling.[41]

Hubbard also noted that while the cost for the six-inch steel was higher, based on bids received for the timber, the timber costs were lower than estimated and cost offset the higher steel cost. He concluded his letter requesting that the Lighthouse Bureau make the decision as to which size steel and confirm the route and cost for delivery. In its request to the Secretary of Commerce to purchase the steel, the Bureau recommended awarding the contract to the Inland Steel Company, as they were the low bidder taking the delivery costs into consideration. The request was for six-inch steel piling, with a note that it may be necessary to purchase the lower cost five-inch steel dependent on available funding if costs for the other materials was higher than anticipated.

The timber request for bids specifically pointed out that lumber should be No. 1 Common Douglas Fir and that shipping costs would be at the expense of US government for delivery to the lightkeeper at the nearby Frankfort Light Station. The timber bids were opened on March 1st and seven bids were received. Daughtery Lumber Company was the low bidder and Superintendent Hubbard recommending awarding the contract to them with a note that the recommendation may be "subject to change in case the Bureau should find some one of the other bidders low when the item of freight under Govt Bill of Lading is considered in connection with the bid prices, F.O.B. Mill."[42]

The Lighthouse Bureau sent the 12th District plans (Figure 1B-16) and specifications for the lantern in mid February. The transmittal letter stated, "A set of plans and specifications issued by the Bureau are inclosed in order that you may lay out tentatively the installation of the apparatus in the lens and determine the character of its subpedestal. As the contractor must furnish the Bureau a set of his shop detail plans based on those of the Bureau, they will also be sent to you at the proper time in order that you may finally fix the dimensions of the subpedestal."[43]

While bids were being solicited for materials, Superintendent Hubbard was also working on an alternate construction method for the pier construction. It appears he was considering an alternate method of grouting rock fill in the crib instead of the more traditional concrete method used at the time. He solicited the advice of the Dravo Contracting Company in Pittsburgh, who responded favorably to his idea:

> We have your letter of January 27th with reference to the possible application of grouting in the construction of a timber crib light house foundation.
>
> The grouting of the rock fill in the twenty outside pockets as you describe is entirely feasible and would result in a concrete equally as good as that placed through a tremie. The effect of grouting under water does not affect the procedure or results and, in fact, most of our work under this heading consists of dealing with water in mines. Whilst we cannot quote you any actually similar applications in this country, we would refer you to the brief descriptions given in the enclosed bulletin on shaft plugs and underground dams as constructed by Francois methods to stop inflow of water in certain cases.[44]

Dravo's letter provided details on how the grouting would be accomplished, including quantities of stone and cement grout that would be required; that an anticipated 40% (air) voidage would be expected; and that better penetration of the grout would be achieved by using a perforated grout pipe and leaving it in place permanently. Dravo also provided estimated unit costs and indicated they were interested in doing this work.

The Twelfth District submitted their preliminary plans for the revised structure on March 11, 1933 and they were less than favorably received by the Bureau. A three-page, handwritten memo presumably written by an engineer with the Bureau comments on several issues with the design. He started by saying:

> According to my understanding of the conference at the Bu. when 11th & 12th Supts were here which is confirmed by Bu. Files, design for N. Manitou was to follow closely design for Detour. This preliminary design cannot be said to follow Detour except perhaps that both utilize a timber crib for submarine structure. Complete plans have already been worked out for Detour which are quite satisfactory and could be used without expense & delay of preparing new plans.[45]

Other issues noted were a concern that the only lighting of the basement would be indirect lighting from deck lights (essentially thick glass set within the concrete slab above) and that the only ventilation would be via the stairway. He again referenced the DeTour Reef design, which provided better light and ventilation by eliminating the solid floor entirely and utilizing open grating. He went on to express dislike for the large boatroom:

> The space assigned as a boat house is unnecessary. The other lake districts apparently do not consider it imperative to incorporate a boat-room within the house structure. This is a feature used solely in the 12th Dist, I believe, & is one of the reasons why 12th Dist structures are so much more expensive than other lake dist. structures. This boatroom is equal in area to 3 good sized rooms & the house must therefore be that much larger.[45]

Figure 1B-17 is a sketch of the basement and pier that he included in his memo with the notes:

> I see no objection to setting pier at angle of 45° to prevailing current & ice shown but setting axis of house 45° to axis of pier accomplishes no important purpose but increases construction costs and provides awkward framing problems such as at the corridor leading from the basement entrance doors in the pier to the basement which must enter the basement at the 45° angle.[46]

He also noted in red that the four arms jutting out from the basement should be omitted and the walls made of reinforced concrete. His

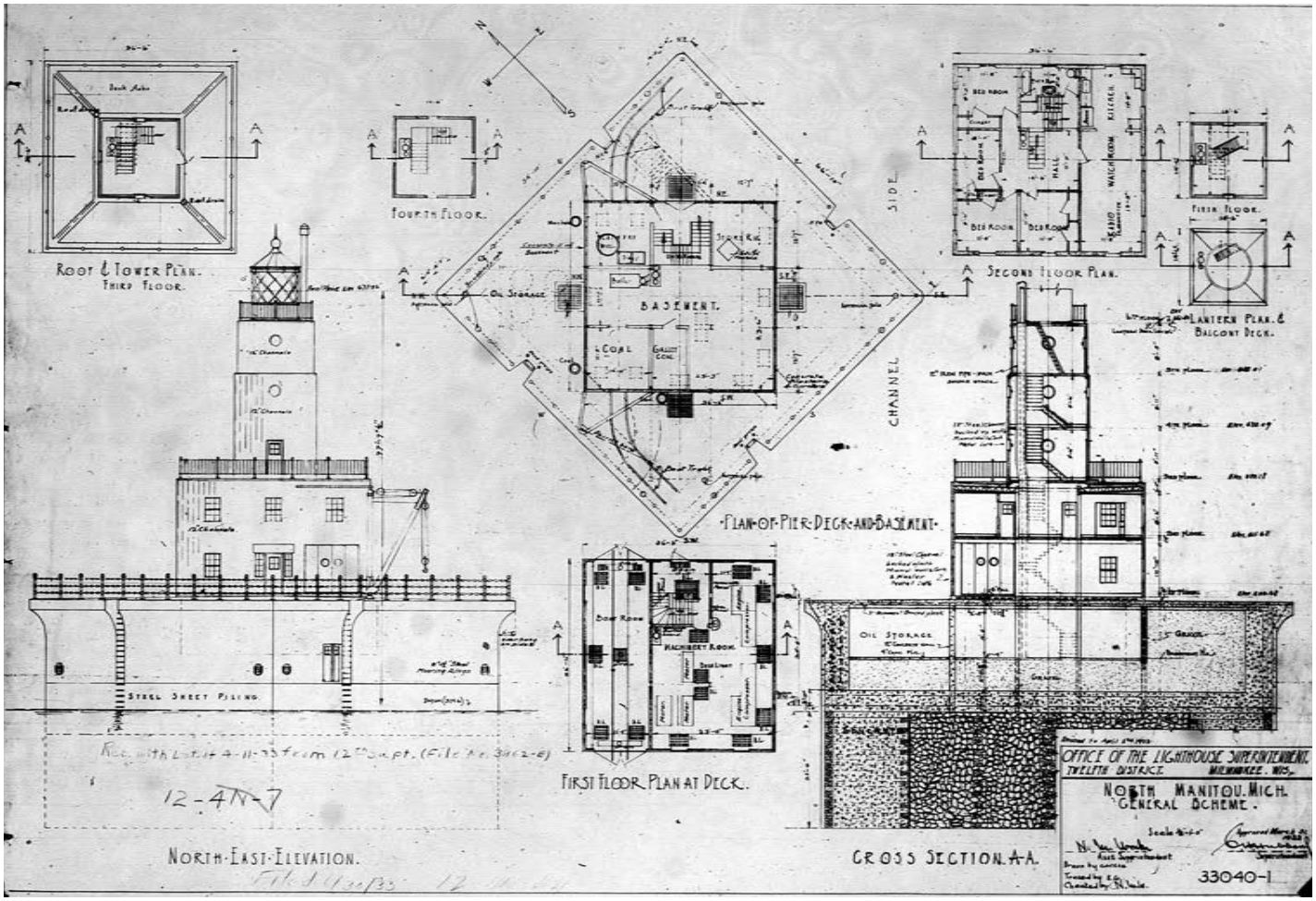


Figure 1B-18: First sheet of construction drawings for the station.

memo went on to note that while the four-feet thick outside walls of the pier may be sufficient against wave action, it was unusual, given that those walls were designed as six-feet thick at DeTour Reef Light and five-feet thick at the Buffalo Breakwater Light. After several more criticisms of the design, he concluded by stating, "I consider this design decidedly inferior both architecturally & structurally to that for Detour. Recomm. disapprove design & request 12th Supt. to follow Detour as directed at time of Conference at Bu." It is important to note a handwritten note added next to this final statement in red pencil by someone else: "concur, but at conf decided to let 12th use their own design for the super-structure." Although the drawings he reviewed and was writing about have not been located, the descriptions sound very close to the series of drawings dated March 31, 1933, to which for the most part, the structure was built according to. It is quite likely the March 31 drawings are revised versions of those referenced.

The advertisement for bids for the general construction contract were published on March 11, 1933 with a bid opening date set for April 10th. Then, unfortunately, on March 24th, the project stalled due to an Executive Order to freeze funding from the Emergency Relief & Construction Act. The Bureau sent a telegram to the 12th District "directing that the creation of further obligations against public works appropriations be discontinued until further notice."[47] Superintendent Hubbard responded with a letter to the Commissioner indicating that he telegraphed the Superintendent in Oregon to stop production on the timber and then pleaded to not stop the project:

> Request is made that careful consideration be given to clearing the North Manitou job for execution, in view of the fact that we have the plans and arrangements for starting construction at a very early date well lined up.

The timber for the crib can be delivered within twenty days and the steel sheet piling which will surround the crib can be delivered in even less time. Bids are to be opened on March 31, for the Third Order Cast Iron Lantern House, the design of the steel building is such that we will be able to obtain delivery of same by end of May. The plans and specification for the general construction contract are well advanced and part of them are already in the hands of bidders so that they may have preliminary advice and can make the field inspection of conditions at the site and can investigate with regard to locations for base of operation in order that when they receive the final and complete plans and specs they will be able to submit bid quickly. The date for opening bids under the general construction contract which was originally set for April 10, has been changed to April 17, at 11 am. We have a large list of prospective bidders who are very urgent to submit a proposal and we have every reason for expecting a very low price for the construction of this station, in view of the fact that its design is such that it facilitates quick construction of standard materials using ordinary construction plant.

It would be of great advantage if the Bureau could advise us as to the possibilities or probabilities with regard to clearance on this North Manitou project.

We have every reason to believe that the North Manitou Station will be sufficiently advanced by August 31, to permit removal of the first-class Lightship #103 which will give ample time for the ship to reach the Atlantic Coast before the close of the navigation season, and the entire North Manitou project will be completed by November 30.

Advice is also requested with regard to the possibilities or probabilities of securing clearance on the project for replacing ten steam fog signals with new machinery to take the place of the very old and worn out boilers. A large quantity of the machinery has already been purchased, a total of $22,300 having already been obligated for the fog signal replacement project.

Our balance of funds under "General Expenses Appropriation" is very limited and unless we are able to go ahead with the above-mentioned work on the fog signals, the lack of available work will involve the laying off of a number of our men who have been with us for years.[48]

Despite the stop order from Washington, work on the project seemed to continue per usual in Milwaukee. It appears that the 12th District kept full steam preparing construction drawings for the station (possibly incorporating the critiqued comments from the Bureau). Figures 1B-18 and 1B-19 are two of a dozen drawings dated as approved by Superintendent C.H. Hubbard on March 31, 1933. These were later updated and additional drawings completed in April and May. (These drawings are included in the appendix.) The bids for the cast iron lantern were opened on March 31st and seven bids were received. They ranged in cost from the low bid of $2,800 to the high bid of $6,942. On April 6th, the district prepared a Form 97 requesting authority and funds to purchase the lantern from the low bidder, Johnson City Foundry in Johnson City, Tennessee. Superintendent Hubbard wrote back to the Dravo Contracting Company on April 10th, thanking them for their assistance:

> Gentlemen: We thank you for your very kind letter of January 30, which gives us just the information we desire with regard to the possibility of using a cementation or grouting process forfilling the 20 pockets of our North Manitou Crib.
>
> We have incorporated your suggestions in our specifications issued to people who will bid for the general contract for the construction of the station and we have addressed to each bidder a letter advising them that your firm is in a position to carry out the grouting operation.
>
> We hand you with this a complete set of plans and specifications for your information.[49]

Superintendent Hubbard then wrote to the Commissioner informing him that although they had advertised for general contractor bids to be due on April 10, the plans and specifications weren't yet ready, so he was extending the bid date to April 25 and assumed he'd be ready to award contract to the low bidder by the 1st of May. He further stated that "arrangements were complete" and they were ready to place orders

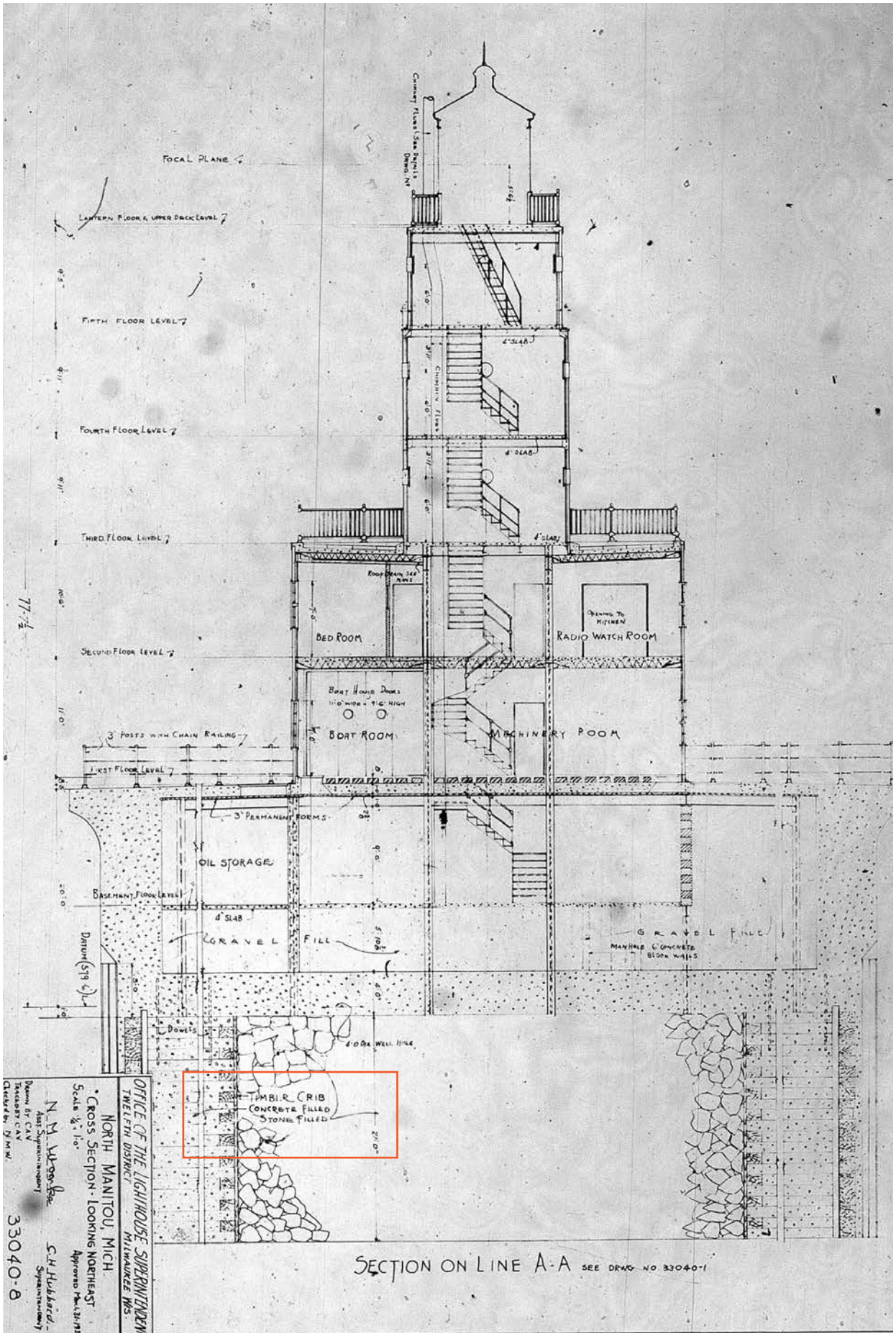


Figure 1B-19: Sheet 8 of the construction drawings showing a full cross section of the structure. The drawing indicates large stone fill in the inner portion of the crib and concrete fill in the outer portion.

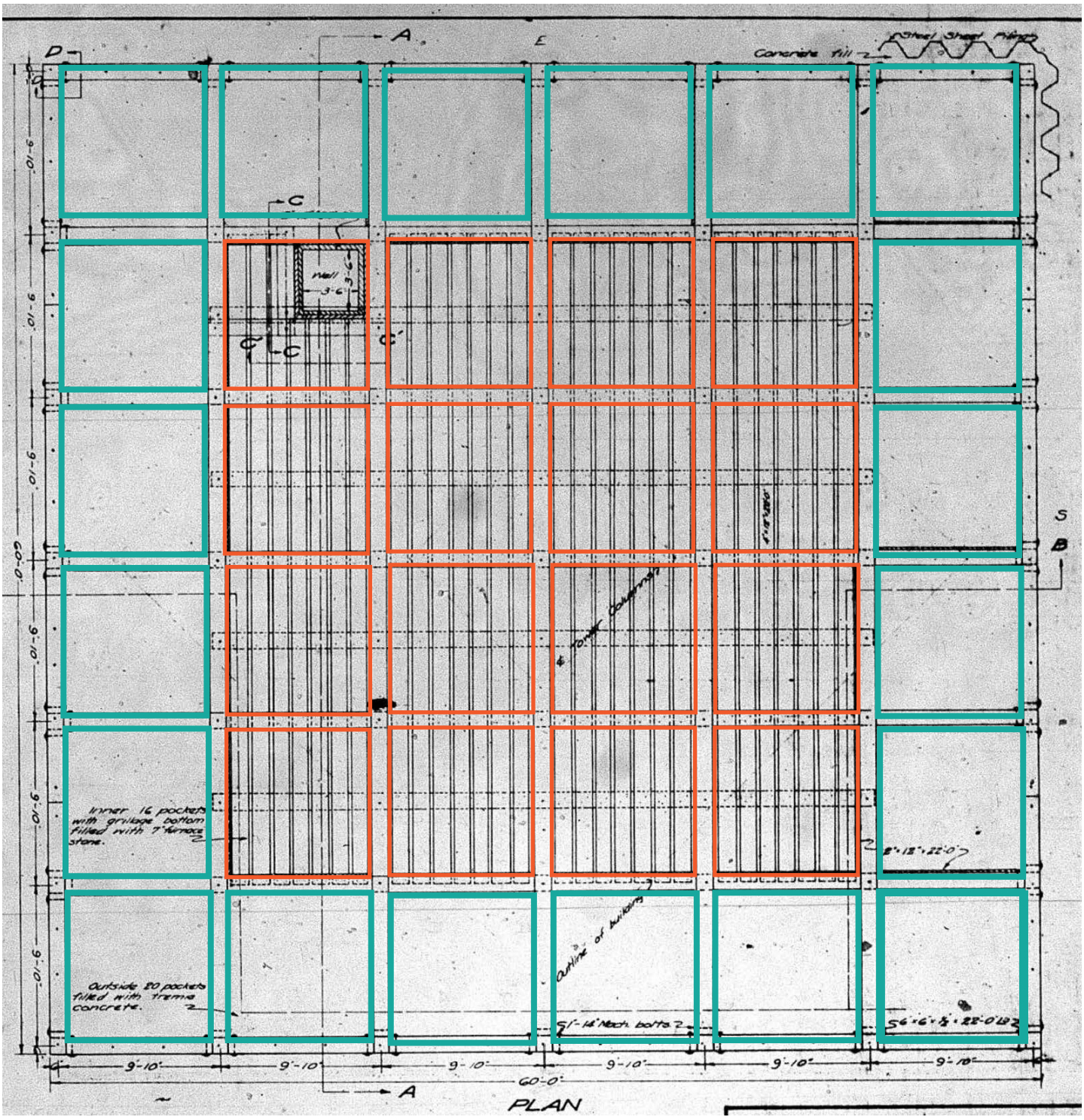


Figure 1B-20: Original construction drawing for the timber crib. The sixteen inner pockets have been highlighted in orange - these were noted to be filled with 7" furnace stone. The twenty outer pockets have been highlighted in light blue - these were noted to be filled with tremie concrete (these twenty pockets were instead filled using an alternate grouting method). The note at the top right of the drawing indicates that the space between the outer edge of the timber crib and the steel sheet piling was to be filled with concrete.

for the timber, sheet piling and lantern; and they were close behind being ready to do the same on the radio beacon, lens and fog signal. He then asked if he could proceed with the Emergency Construction Act Funds.

The bids for the general construction contract were opened on April 25, 1933 and seven bids were received from firms in Michigan, Wisconsin and Illinois. They ranged in cost from the low bid of $64,908.18 to the high bid of $128,884.78. On April 29th, the district prepared a Form 97 requesting authority and funds to proceed with the low bidder, Lyons Construction Company of Grand Rapids, Michigan. Hubbard attached a letter to the form with information about Lyons, request to proceed with his alternate grouting method in lieu of tremie concrete, and essentially a plea to keep the project going:

> The Lyons Construction Company is a reliable concern with offices in Grand Rapids, Michigan. Mr. Ira J. Lyons is associated with Captain Rohn of Sturgeon Bay who operates the Steamer "GREEN" and other marine equipment under the name Northwestern Dredge Co. We understand that they may have certain derrick equipment from Ray Durocher of Detour, Michigan.
>
> The plans provide that the sixteen inner pockets [see Figures 1B-19 and 1B-20] of the timber crib be filled with 7" "furnace conveyor stone" to which a percentage of gravel has been added, reducing the voids to as near 20% as may be practicable.
>
> The twenty outer pockets to be filled with tremie placed concrete.
>
> As the above method leaves the crib only 44% loaded, exposed to possible storm displacement until such time as the filling of the twenty outer pockets with concrete has been accomplished, it is proposed to accept the alternative bid which contemplates filling the twenty outer pockets with 7" "furnace stone" mixed with gravel having as near 20% voids as practicable at the same time that the sixteen inner pockets are filled, so that the crib will be completely loaded at once on the day the crib is sunk.
>
> Then pump in neat cement grout into the twenty pockets through pipes previously provided in crib completely filling the voids in the stone and producing what might be called cement grout penetration concrete.
>
> See in this connection Specification, pages 26, 27, 28, paragraph 36, also see Schedule A, page 4, Items AX-11, AX-12, AX-13, also original letter from the Dravo Contracting Company dated January 30, 1933 in reply to our letter of January 27, 1933.
>
> We would make urgent request that the "STOP ORDER" of March 25, 1933 be lifted and this North Manitou project permitted to go ahead. The following materials are already covered by proposals and shipment can be accomplished very quickly after the stop order is raised. - Timber for crib from Oregon, 5" steel sheet piling from Indiana Hbr., Ind., Third Order lantern house from Johnson City, Tenn.
>
> If the work is to be done this year it is absolutely necessary to place the crib during the month of June and drive the steel sheet piles promptly. Such work in the upper lake is possible on only a very few days during the year.
>
> The price quoted by Lyons Const Co is very low and the total cost for the project will be well under the estimate of Jan. 25, 1933. The present situation with regard to possible raise in price level is also to be considered, in fact this matter is of very great importance due to the fact that the Lyons people have quoted a very low price and will have to use the highest efficiency to come out on the right side of the ledger.[50]

The form was promptly returned on May 2nd with the response: "Returned to the Superintendent with request that bids be rejected and that your office suspend all further action on this project."[51] The request form that had also been submitted on April 29th for the sheet piling, was returned with the same exact response. Apparently, Commissioner Putnam wanted to get the point across and followed up with a telegram on May 3rd saying to "CANCEL ALL NORTH MANITOU PROJECTS."[52] The region's congressman, Mr. Harry W. Musselwhite got involved and sent a

letter to the Commissioner referencing a new public works bill and asking to proceed with the contract with the Lyons Construction Company as soon as the new funding was available:

> My dear Commissioner:
>
> It is my understanding that the work which has been proposed for Manitou Island [sic] lighthouse during the present navigation season has been suspended under a recent executive order. My information is that nothing will be done on this job unless and until the President's new public works program is put into effect.
>
> The Lyons Construction Company was the low bidder by about $9,000 and on the strength of this Lyons bought about $20,000 worth of additional marine equipment in anticipation of beginning the job at once.
>
> I believe it would be unfair to Lyons if new bids were asked, and I hope when the project is authorized you will consider his bid of $65,000 without requiring him to compete again.[53]

Commissioner Putnam and Superintendent Hubbard exchanged subsequent telegrams confirming that the bids were rejected, and that Lyons was notified of the situation. In the meantime, it appears that the Bureau was still reviewing the drawings and specifications that had been sent to them. A May 11, 1933 handwritten memo indicated continued dissatisfaction with them:

> 1) Regarding the detail plans & specs for North Manitou [---] which bids were recently taken, this Division has taken a number of bites at them as will be noted by the 3 attached memos.
>
> 2) These detail criticisms are not as full as they might be - it seems that endless objections can be made to the plans & I do not believe they are overstated.
>
> 3) I can hardly expect you to go thru them all in detail. You have suggested that in case a hurried order to go ahead is received that they could be accepted with reservation, but in case construction is put off until spring of 1934, that a redesign could be ordered.[54]

Since the likelihood that President Roosevelt's new public works bill for economic recovery would be passed and funding soon available, redesign was likely not an option. The Deputy Commissioner subsequently sent Superintendent Hubbard a letter on May 31st stating that "An unqualified approval can not be given of these plans for the crib and pier as it does not appear that the agreement at the conference held on Dec 28, 1932, as covered by paragraphs 5 and 6 of the memo of that date has been strictly carried out. However, it is proposed to proceed along the lines of the design as submitted when further orders to do so are received." He also noted that in the same vein, Daugherty's proposal for timber would be accepted once funding approved.

The new bill, the National Industrial Recovery Act (NIRA), was enacted by Congress on June 16, 1933. The NIRA intended "to encourage national industrial recovery to foster fair competition and to provide for the construction of certain useful public works, and for other purposes." As this bill was to improve the American economy, it was important that funded projects did so. In anticipation of that, the Lighthouse Bureau reached out to the Twelfth District requesting that they confirm all of the materials to be used in the construction of the lighthouse be "of domestic production manufacture and production." Superintendent Hubbard confirmed that both the steel and lumber were indeed such, and included this regarding the lumber, "This fact can hardly be disputed in view of the timber growing in the State of Oregon."[55]

It apparently took some time between the enactment of the NIRA and when funding was approved for projects to commence. With no word on approval for the North Manitou Shoal Light Station construction to proceed, Congressman Musselwhite again telegrammed the Commissioner on June 30th, informing him that the timber had arrived in Frankfort, Lyons was under contract and ready to go, and that

during this season of the year, time is of the essence. Commissioner Putnam responded the next day informing the congressman that Lyons was not yet under contract and that they could not proceed until funds were made available by public works administrator. With still no word on funding, Musselwhite's colleague in the Senate, Senator A.H. Vandenberg sent another telegram to the Commissioner on July 15th, reiterating Musselwhite's requesting authority to proceed immediately and that "time is of the essence of this contract because of heavy fog after October."[56] Putnam responded to him that same day, informing the Senator that allotment for lighthouse construction was not yet available due to legal complications in awarding contracts that were previously bid before the enactment of the NIRA. He said that this matter was being carefully reviewed and he would update him promptly once a conclusion was reached. Putnam followed up two days later with a telegram to Superintendent Hubbard informing him that all contracts would have to be re-bid, and to solicit new bids only from the same contractors who had previously bid. Realizing that time was of the essence, he said to obtain bids by telegraph if necessary.

The general contract for construction was advertised for bids on July 18, 1933 with bids to be due on July 21st. In the meantime, the Great Lakes River and Harbor Association had been working on getting a code filed that all projects funded under the NIRA mandate strict minimum wage rates. The pending requirement was to pay fifty cents per hour for employees working on land and sixty-five cents for those working on a floating plant. The association's president stated via a telegram to Commissioner Putnam that they would protest awarding a contract to any contractor that did not provide these rates. Putnam informed Superintendent Hubbard on the 19th that although the Bureau felt it did not have authority to impose the pending rates, all bidders need to state their wage rates in their bids.

The same seven bidders submitted bids and Lyons Construction Company was again the low bidder, with just a slightly higher quote than their former one. The Twelfth District immediately completed a new Form 80 to proceed with the project. This included Lyon's cost at $69,950, and the quotes for timber, steel and lantern per previous proposals. On July 29, 1933, the Bureau approved the project to proceed, but with reference back to the Commissioner's May 31st letter that the Bureau was dissatisfied with the design because it did not follow the requirements established at the December conference but could proceed. The description of the project that was attached to the Form 80 did include some modifications to the design from what had been proposed in March:

> The Structure Proposed, is shown completely by the drawings which accompany this recommendation. A timber Crib, 60#ft[sic] x 60ft.x22ft. Deep to be sunk on the sand bottom of the Lake at the location of the Lightship as occupied for many years, about 1700 ft. from the outer 25 1.2 ft. spot on the outer end of the point. The 16 center pockets of the crib to be filled with 7" "furnace conveyor" stone mixed with gravel, and the 20 outer pockets to be filled with concrete placed in the water thru tremie (or by cement grout method). The entire crib then to be surrounded with 5" x 16" ---3/8" thick---25 lbs. per sq ft., Arch Web Steel Sheet piling, 50 ft. long, leaving the tops of sheet piles at 5 ft. above water, 22 ft. of the piles being in the water, and 23 ft. of the length of the sheet piles penetrating the sand bottom. The sheet piles to be anchored to the concrete slab by a lower layer of 1 1/2" bolts (with 2" upset ends in every other sheet pile, (this lower layer being at top of crib). Also an upper similar layer of rods 3 ft above the lower layer. These two layers of anchor rods to be extended clear across the crib, in two layers, and to constitute the reinforcing of the FOUR FOOT THICK Concrete Slab, which is to be poured on top of the crib, inside of the tops of the steel sheet piling.
>
> Outside walls, four feet thick to be raised on the margins of the 4 ft. base slab, and a main deck of concrete poured at 20 ft. elevation.

Before carrying out the above operation, the steel columns and beam system at main deck level would be erected and plank working platform placed at 1 ft. below main deck level. This platform will serve as a working platform and also later as the forms for the underside of the 12" thick reinforced main deck. The steel columns and beam system also serve to support the concrete forms for the outside walls.

The "basement" to be filled with gravel or sand up to the floor of the basement proper under the building, and above that level basement to be filled in two corners, and the other two corners to be occupied, one for OIL STORAGE and one for Basement Entrance.

The Steel Building and Tower then to be erected, two stories high, with three story tower, Building and Tower to be constructed of 12" 20.7 steel channels, set vertically, and bolted together thru the flanges. These steel walls to be lined with 2"x4" studding bolts to the inside of the channels, horizontal metal lath and plaster placed, with rock wool insulation filling in the space between the back of the plaster and the inside of the steel.

Floors and roof to be of reinforced concrete, on bar joists, with the second story, occupied as living quarters, surfaced with Bruce [sic?], cellized [?] oak flooring, set in mastic on the concrete.

Roof to be waterproofed with two layers of asphalt saturated cotton fabric, with three moppings of soft waterproofing asphalt.

The lantern house to be third order, on a concrete deck.

The Basement, proper, under the 36'-6" sq. building, to be occupied for heating plant and laundry and storage.

The First Story to be occupied by Boat Room and Machinery Room.

The Second Story to be occupied by Living Quarters, which provide a long room on channel side, for WATCH ROOM--KITCHEN--RADIO ROOM, and four Small Rooms, for individual use of the four keepers.

The building to be provided with bath room and steam heat.[57]

A copy of the construction drawings on file at the National Archives [presumably those that accompanied the Form 80] are included in the appendix. As discussed below, some of the earlier March 1933 drawings were revised later in the year, and additional drawings were added to the set through the spring of 1934. The drawings include overall plans, elevations and sections, as well as several sheets for many of the details of the station from windows and doors (Figure 1B-21) to the boat track to be built on the main deck (Figure 1B-22).

A description of the planned lens, fog signal, and radiobeacon equipment was also attached to the Form 80, as was a letter from Assistant Superintendent N.M. Works that stated, "The season is late now, and only by the most efficient handling can the Lyons Const Co. accomplish the placement of the crib this season, and the bringing of it to a safe point with the steel sheet piling in place and with the four foot concrete main slab in place." Essentially the only work that would be completed in 1933 would be getting the crib in and complete enough to make it through the winter. He noted that the timber for the crib had arrived in Frankfort and Inland Steel was ready to deliver the steel per their previous proposal. However, he wasn't so sure about Johnson City Foundry and Machine Company delivering the lantern per their proposal, "due to the advancing market."

Form 97 relative specifically to the general contract for construction included an update on Lyons Construction company and a request to use the alternate grouting method for the crib given how late it was in the season:

The Lyons Construction Company is a reliable concern, with offices at 41 Oxford St., S.W. Grand Rapids, Mich. This concern completed a large addition to the State Ferry Dock at

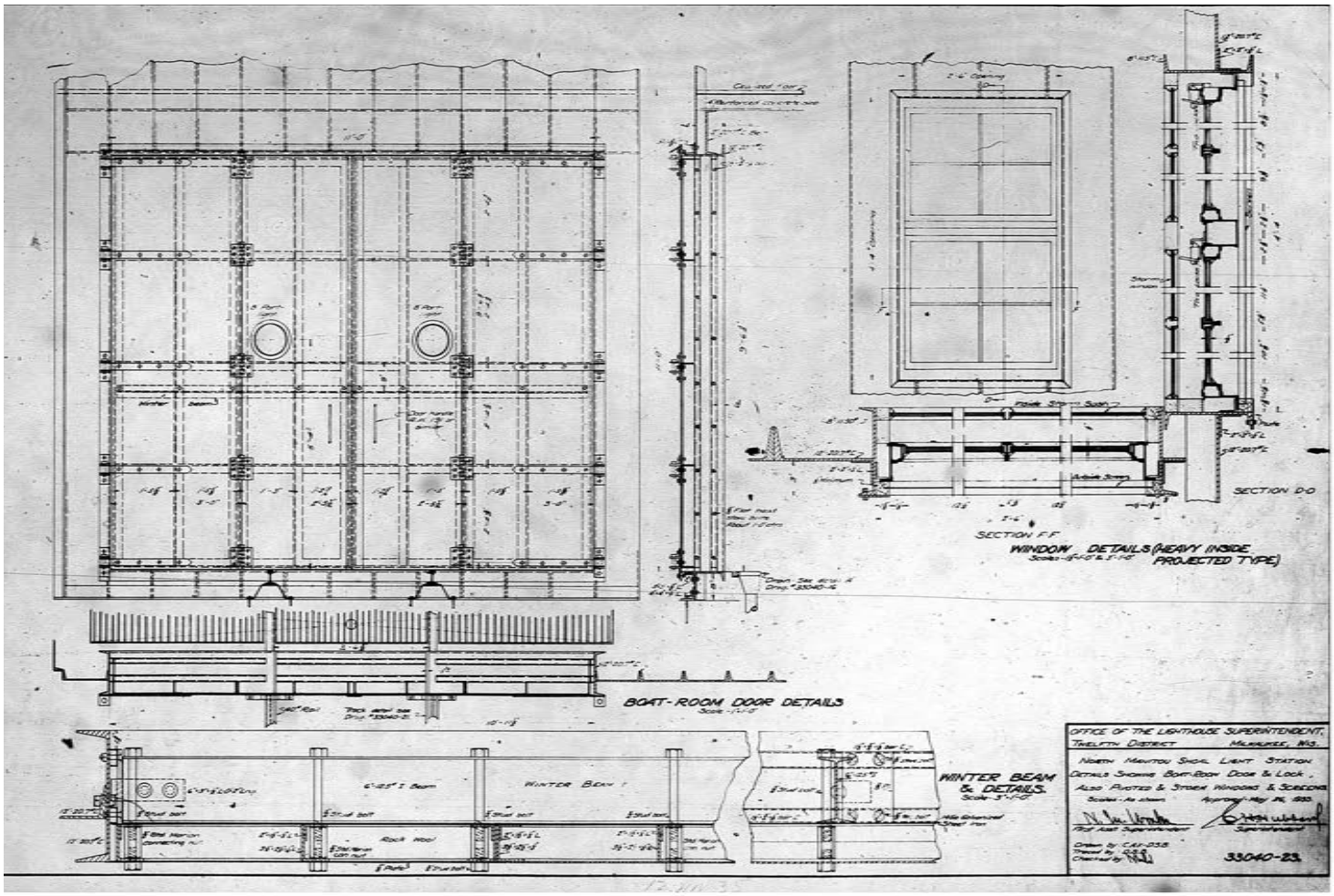


Figure 1B-21: Original construction drawing for the windows and boat room door.

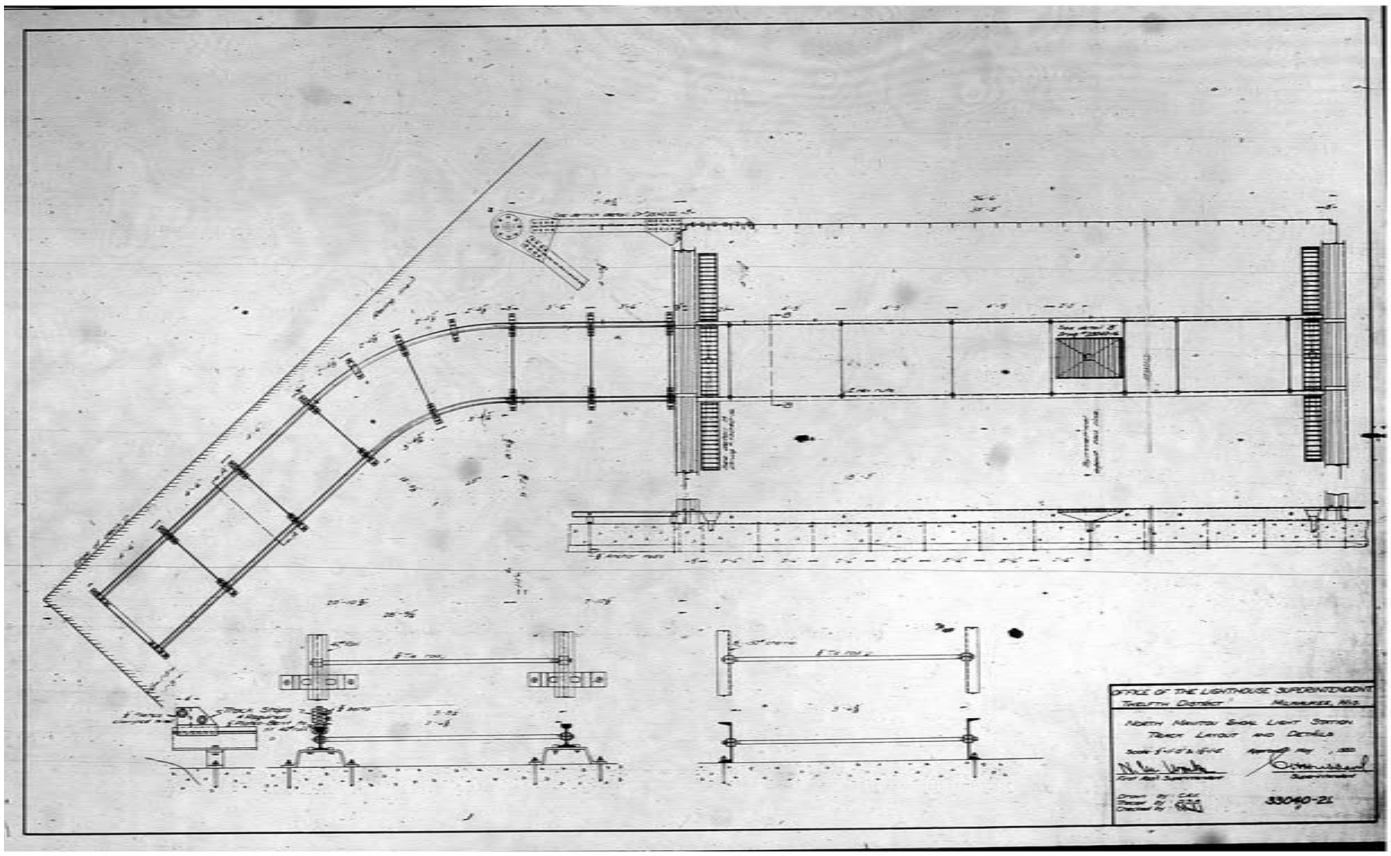


Figure 1B-22: Original construction drawing for the boat track.

> Mackinaw City, Michigan within the past year or two. Mr. Ira J. Lyons is also interested in the Northwestern Dredging Co. of Sturgeon Bay, Wisconsin, (with Capt. Rohn of Steamer "GREEN") which makes their plant available as required. We also understand that Lyons is interested in certain heavy derrick equipment with Roy Durocher of Detour, Michigan.
>
> The plans provide that the sixteen inner pockets of the timber crib be filled with 7" "furnace conveyor stone" to which a percentage of gravel has been added, reducing the voids to as near 20% as may be practicable. The twenty outer pockets to be filled with tremie placed concrete.
>
> As the above method leaves the crib only 44% loaded, exposed to possible storm displacement until such time as the filling of the twenty outer pockets with concrete has been accomplished, it is proposed to accept the alternative bid which contemplates filling the twenty outer pockets with 7" "furnace stone" mixed with gravel having as near 20% voids as practicable at the same time that the sixteen inner pockets are filled, so that the crib will be completely loaded at once on the day the crib is sunk. Then pump in neat cement grout into the twenty pockets through pipes previously provided in crib completely filling the voids in the stone and producing what might be called cement grout penetration concrete.
>
> See in this connection Specification, pages 26, 27, 28, paragraph 36, also see Schedule A, page 4, Items AX-11, AX-12, AX-13, also original letter from the Dravo Contracting Company dated January 30, 1933 in reply to our letter of January 27, 1933.
>
> As the Lyons bid gives a price ($1192.50 [$1300 crossed out]) higher for the alternative grouting method, we have recommended the acceptance of the Tremie placed concrete fill in 20 outer pockets of crib. This recommendation also made because it is in accordance with ordinary practice and will be probably approved without question.[58]

Although this letter indicates a proposal to use the alternate grouting method, because Lyons' cost for that was higher, the District recommended proceeding with the tremie concrete method given that it was a more traditional construction practice and would be approved quickly. Another letter attached to the form provides more detail from Lyons regarding the alternate grouting method and why it was preferred to use to ensure the crib would be completed before winter:

> Attention of Bureau is invited to attached letter of July 18, of Lyons in which he expresses a preference to use the cement grouted concrete method.
>
> The personal preference of the writer would also agree with Lyons in this matter, as we are well convinced that the cement grouting method is entirely practicable and that it gives an insurance at this late season of the year against a possible loss of the crib in fall storms.
>
> Bureau will note that we have changed the "TIME" requirements of the specifications, allowing two months, 60 days, August and September in 1933 and two months, May and June in spring 1934. October 1933 will not be available for work in view of the fact that bad sea conditions prevail then and structure will not be advanced sufficiently for inside work, as but 60 days are available this year and as it is absolutely necessary to accomplish the following work in this 1933 season.
>
> Sink Crib. Surround with steel sheet piling. Riprap. Erect steel columns and beams up to 20 ft. to main deck. Pour four foot thick main concrete slab on top of crib.
>
> This is necessary to make structure safe for the winter season. We would urge the immediate approval of contract and authorization to proceed with the work. Two weeks delay at this time would involve a great risk.[59]

The letter also reiterated that Lyon's bid was low:

> The price quoted by the Lyons Company is very low and it will require very efficient handling of the job if they are to come out on the right side of the ledger.[60]

The letter concluded with indication that they were ready to start construction, noting again that the Daugherty Lumber Company had already delivered timber for the crib to Frankfort and the Inland Steel Company was standing ready to deliver the steel sheet piling.

Concurrent with the debate on how best to fill the crib, the Great Lakes River and Harbor Association continued to argue to the Bureau regarding Lyon's proposed wages for its workers. While Lyon's bid was again the lowest of the bidders, the company did not explicitly state in their bid (as the others had) rates from 50 cents to 65 cents hour. Association President J.F. Cushing sent another telegram, this time to the Secretary of Commerce, stating that the Lyons Construction Company was not complying with pending wages to be set forth in the National Industrial Recovery Act; was not a member of the Association; and was in violation of the code of fair competition. He wrote:

> THERE IS EVERY INDICATION TO BELIEVE THAT A CONTRACT ENTERED INTO UPON THE BASIS OF HIS BID CAN ONLY BE CONSTRUED AS BEING DELIBERATE TO DEFEAT THE PURPOSE OF SUCH A CODE OF FAIR COMPETITION SUCH ACTION IS CLEARLY TYPICAL OF THOSE CONDITIONS WHICH ENACTMENT OF THE NATIONAL INDUSTRIAL RECOVERY ACT WAS INTENDED TO PREVENT
>
> THIS ASSOCIATION REQUESTS THEREFORE THAT THIS LOW BID BE SUMMARILY REJECTED AND THE WORK AWARDED TO THE LOWEST COMPETENT BIDDER WHO HAS INDICATED IN HIS BID THAT HE IS WILLING TO COMPLY WITH THE PROVISIONS OF A CODE OF FAIR COMPETITION AND OF THE NATIONAL INDUSTRIAL RECOVERY ACT[61]

Regardless of their stated wages, approval to award to Lyons had still not been granted as it grew to be late July. Senator Vandenberg sent the Commissioner a another telegram on July 22nd, referring to this matter. He noted that Lyons Construction Company has already moved their equipment to Frankfort and thus "I ASSUME THERE IS NO DOUBT ABOUT THE AWARD [STOP] WILL APPRECIATE FURTHER INFORMATION FROM YOU BY WIRE."[62] Having not received a prompt reply, Vandenberg sent another telegram the next day seeking a response. Commissioner Putnam did then respond via telegram on the 26th noting that both of Vandenberg's telegrams were "receiving careful attention." He said that approval was pending release of funds and prescribing of conditions of the work, and that he would advise on status as soon as feasible.

Commissioner Putnam wrote to the Secretary of Commerce on July 28th recommending award of the contract to Lyons Construction Company as the low bidder. In his letter, he referenced that although Lyons had not included a statement of the designated wages in their bid, they did subsequently submit a letter indicating that they would comply with those rates for an additional $2,000.00 if they were required.

> The Lyons Construction Company, by letter of July 21, which apparently was written after the opening of bids, states that if it was decided at Washington that 50 cents per hour should be the minimum wage pay, they would assume all responsibility for this increase in case it is wanted for an additional $2,000 for the entire job. The Supt has prepared contract with the $69,950.68, based on the rate of wages specified in the bid, and recommends its acceptance.[63]

Putnam further wrote that "The Bureau has informal information from the Industrial Relief Administration that no code has been adopted or as yet scheduled for hearings, as to the construction industry that would affect the award of this contract." It is assumed that he was referring to the impending protest from the Great Lakes River and Harbor Association and so no need or requirement to increase the contract amount by the $2,000.00 proposed by Lyons. A memo written by H.D. King in the Department of Commerce provided written acknowledgment of the circumstances, King wrote:

> Saw Mr. Strauss of the N.R.A. in regard to protest telegram from River and Harbor Improvement Association, relative to0.2994 in award on North Manitou contract. He advised that as things stood at present we would have to proceed on our own judgment. That no code had been promulgated on building construction and no hearings yet scheduled. That it appeared that they might likely be promulgated to cover specific lines of construction, such as steel-work, brick-work, etc., rather than general construction. That their present set-up of information would not indicate whether any particular contractor or concern was "playing-ball" or not.[64]

A July 28th newspaper clipping filed with the above memo from Mr. King refers to inclusions in the NIRA, including 35-hour work week for the automotive industry and minimum wages of 40 to 43 cents per hour in factories. A handwritten note on the clipping puts these into perspective with the wage issue contemplated with Lyons: "Mr. Kerlin [Administrative Assistant to the Secretary of Commerce]: This clipping (from Star July 28) indicates that 40 cents an hour, as offered by Lyons Co., low bidder on the North Manitou project, is being considered in an important code as a reasonable wage under certain circumstances."[65]

Finally, on July 29th, Commissioner Putnam sent telegrams to both Superintendent Hubbard and Senator Vandenberg that the project was authorized to proceed. While Putnam wrote to both of them that he regretted the delay, he also included in his telegram to Hubbard, "DELAY IN CLOSING CONTRACT REGRETTED BUT GOVERNMENT ASSUMES NO RESPONSIBILITY FOR RISKS DUE TO LATENESS OF SEASON IN COMMENCING WORK. SO NOTIFY CONTRACTOR." The commissioner also wrote to the President of the Great Lakes River & Harbor Association informing him that the Bureau was proceeding with awarding the contract to Lyons Construction. He wrote:

> Your telegram of July 22, addressed to Secretary Roper, has been referred to this office. This telegram was carefully considered in connection with a determination of action on the bids for the construction of a lighthouse at North Manitou, in Lake Michigan. In view of all the circumstances of this case, and the information which we have received that no code has been adopted as repects such construction work, and that no code on this subject is as yet under definite consideration by the National Recovery Administration, and also the further information had as to reasonable rates of wages, it was concluded that the only action feasible if this work was to be undertaken at this late season and not allowed to go over until next year, was to award the contract to the lowest bidder. I have to advise you, therefore, that this action has now been taken.[66]

Due to the NIRA requirement to rebid work previously bid before the act, the contract to provide steel sheet piling was also rebid with a new bid date of August 7th. The bid documents included specific contractual requirements set forth by the NIRA. The specifications were revised to only include the lesser 5" depth steel from outside surface to the center of interlock. The original specifications had included 6" depth steel with an alternate option of 5" depth. The schedule included in the specifications was updated to indicate that it was anticipated that the crib would now be sunk about August 25th, rather than the earlier projected June 1st. They called for delivery of the steel within 10 days, rather than the earlier 60 days with a statement that "time is considered as of the essence of the contract." Upon review of the revised specifications, Commissioner Putnam informed Superintendent Hubbard to update them and the bid form to include a provision that the steel provided must be domestic.

Lyons Construction began assembly of the crib in Frankfort on August 7, 1933. Inland Steel Company was again the low bidder for steel sheet piling with a bid $6,451.74. Telegram correspondence on August 11th reflects the urgency to get them under contract given that

SUMMARY OF PROCUREMENT AND CONSTRUCTION AUGUST 1933 THROUGH MAY 1935

August 2, 1933	Steel sheet piling specifications revised to only include 5" deep steel (not options of both 5" and 6")
August 2, 1933	Contract for steel sheet piling re-bid
August 7, 1933	Steel sheet piling contract bids opened, Inland Steel Company again low bidder
August 7, 1933	Construction of crib (on mainland) begins
August 19, 1933	Lyons states that it is too late in season use tremie concrete in crib, need to use much quicker alternate grouting method
August 21, 1933	Lighthouse Bureau gives conditional approval to proceed with the alternate method at no additional cost
August 22, 1933	Contract for cast iron lantern re-bid
August 25, 1933	Lens delivered to Twelfth District Depot in Milwaukee
August 30, 1933	Lantern bids opened, John City Foundry again low bidder
Septemer 9, 1933	Timber crib sunk on the shoal
September 10, 1933	Crib filled with mixture of stone and gravel
September 15, 1933	Hansell Elcock Company approved to provide steel for lighthouse building and tower (no documentation whether this was a bid contract)
October 1933	Correspondence from Twelfth District recommending to increase amount of stone rip rap
October 25, 1933	Lighthouse Bureau does not approve increase in amount of rip rap stone
November 1933	Bureau Chief Engineer visits the station to review construction progress
December 1933	Construction stops for the winter
December 1933	Contract for engine generators bid, Fairbanks Morse Company low bidder
January - April 1934	Extensive debate over several aspects of generators to install and use at station
March 1934	Collaboration with USCG to install telephone line to station
May 1934	Temporary light installed on main deck
May 1934	Specifications for generators revised
June 1934	Generator contract re-bid, Fairbanks Morse Company again low bidder
June 1934	Purchase order to Fairbanks Morse Company for generators
July 1934	Design revision to locate boat derricks at center of northeast and southwest sides of station
November 30, 1934	Construction stops for the winter
January 1935	Spare parts for lens and motors acquired
April - May 1935	Construction completed
Summer 1935	Exterior painting completed

construction of the crib was already underway. The Bureau followed up with formal approval of the contract and performance bond via air mail so that the rolling could be scheduled at the mill for the following week. A final, detailed survey and soundings to confirm location of the crib were also undertaken in August, although they took longer than expected due to bad sea conditions.

Assistant Superintendent Works wrote to the Commissioner on August 20th, informing him of the progress and stating that the Twelfth District had just received a telegram from Lyons stating that it was too dangerous to wait for tremie concrete to be placed in the outer pockets of the crib steel sheet piling. Lyons stated in their telegram that they would use the alternate rock fill grouting method for no change in cost (their previous bid back in April had included a $1,200 increase for the alternate method). Works went into detail regarding the Twelfth District's agreement with changing the construction method, given the late season and it being a quicker method to get the foundation in a safe condition to weather through the winter:

> Request is made that the Bureau authorize the filling of the twenty outside pockets of the crib, by the "cement grouted concrete method", rather than by the "concrete poured thru a tremie pipe method" covered by the contract as placed.
>
> The crib will be sunk early in September, when wind and sea conditions are constantly getting worse. If the 20 outside pockets are filled with tremie concrete, the crib must necessarily stand for a good many days while the filling process is going on, with only 16 pockets filled with stone, out of the 36 pockets in the crib, or 44% loaded; and this 44% load, is located near the center of the crib, where the load would be most effective in resisting disturbance of the crib by sea action.
>
> If filled by grouted concrete in the 20 outer pockets, the entire 36 pockets of the crib will be filled with "conveyor furnace stone", 100%, on the day the crib is sunk, and the cement grouting of the 20 outside pockets can proceed at once from grout pumps mounted on the construction platform, supported by steel columns, 20 ft. above the water; and at the same time the driving of the steel sheet piling can proceed from floating pile driver equipment:--- and the pouring of the 4 ft. reinforced concrete main slab, over the entire crib area, inside the projecting tops of the steel sheet piles, will immediately follow the driving of sheet piles.
>
> We feel strongly convinced that this grouted concrete method offers tremendous advantages, especially under the conditions of wind and weather which must be met at this season of the year. It gives an element of insurance which is important to the Government as well as the contractor.[67]

To minimize any further delay of the work, Assistant Superintendent Works requested Bureau approval via telegraph by the following day. He also requested "in all fairness to the Lyons Co." that the Bureau consider increasing Lyons' contract amount by $1,200 to cover the additional expense, stating:

> The Lyons Co. has been put to large expense due to their bidding first on April 25th., and being subjected to cancellation, and bidding again on July 21st. The work has been pushed into the hard end of the season thru no fault of theirs. In fact the Lyons People showed fine spirit in that they moved their plant to Frankfort after the first bidding, in preparation to push the work into the early spring.
>
> The contract price with the Lyons Co. is very low, and they face advancing prices all the time until completion of the contract.[68]

The Bureau did send a reply telegram the following day, giving conditional approval to proceed with the alternate method at no additional cost. The telegram stated:

> Your letter twentieth North Manitou. You are authorized permit use of grouting method with clear written understanding no claim to arise against United States account this action

> and with further agreement that one or more cores as directed by contracting officer shall be taken from finished work to show condition of material and that such further grouting as indicated to be necessary to insure the satisfactory filling of all voids in stone may be required, all without expense to the United States. Also require furnishing of clean hard stone for filling material free from sludge or disintegrated material.[69]

A letter from Commissioner Putnam to Superintendent Hubbard dated August 25th indicated that the lens for the station had been delivered to the Twelfth District in Milwaukee. The letter indicates that drawings will be sent "comprising the essential details of this outfit as furnished by the contractor." The letter also states that the lens had been inspected prior to shipment and requests that the Twelfth District undertake additional tests of the beam from the lens using various types of electric lamps while still at the depot. The letter concludes that it is advisable to have spare parts on-hand for those parts that are most susceptible to damage, and that the Bureau was in the process of purchasing them.

As with other contracts for the project, the contract for fabrication of the cast iron lantern was rebid on August 22nd. Bids were opened on August 30th, and Johnson City Foundry was again the low bidder. Correspondence indicates that fabrication of the lantern was well underway by early October and the Twelfth District sent a representative to Johnson City, Tennessee to inspect it.

A telegram from Assistant Superintendent Works to Commissioner Putnam had stated that 48 men had already been employed on the project by early August. He also noted that the project would provide 58,000 man hours of direct labor. The 60 feet by 60 feet square, 22 feet deep, crib was taken out to the shoal, sunk and leveled on September 9, 1933 and was filled with a mixture of stone and gravel on the 10th.

The Hansell Elcock Company of Chicago was approved on September 15th to fabricate and provide the steel for the lighthouse building and tower. Although Hansell Elcock had nearly finished fabrication of the steel by the end of September, correspondence from early October indicates that their contract was not officially approved due to issues with their performance bond. A letter from Superintendent Hubbard to Commissioner Putnam on October 12th states that Hansell Elcock had completed and delivered the steel ahead of schedule despite resolution of their contract:

> The Bureau is advised that the Hansell-Elcock Company has furnished us an exceptionally fine piece of fabricated steel and took particular pains in the fabrication of this and in the devotion of their entire force and facilities in order to complete the contract, which was accomplished three days ahead of the contract period. In their letter dated October 11 transmitting the bills they state "we trust you will find it convenient to favor us with a check for at least part of the above amount at an early date." The Bureau is advised that this large firm has extensive shops having a large amount of work "hung up" on which they have not been able to collect, and that it is a matter of importance that we pay them at the earliest practicable date."[70]

It appears that the contract was not resolved and therefore Hansell Elcock had still not been paid by mid-November. The company's president, E.G. Elcock sent Commissioner Putnam a telegram on November 13th urgently seeking payment for the steel his company had already delivered. Correspondence has not been located as to when Hansell Elcock was (presumably) paid.

Assistant Superintendent Works wrote to the Commissioner on October 7th regarding the rip rap stone that was to be placed around the base of the structure. The amount of rip rap specified to be placed had been cut back earlier as one of the measures to maintain the project budget within the funding allotment. Lyons Construction and the Twelfth District administration felt that the

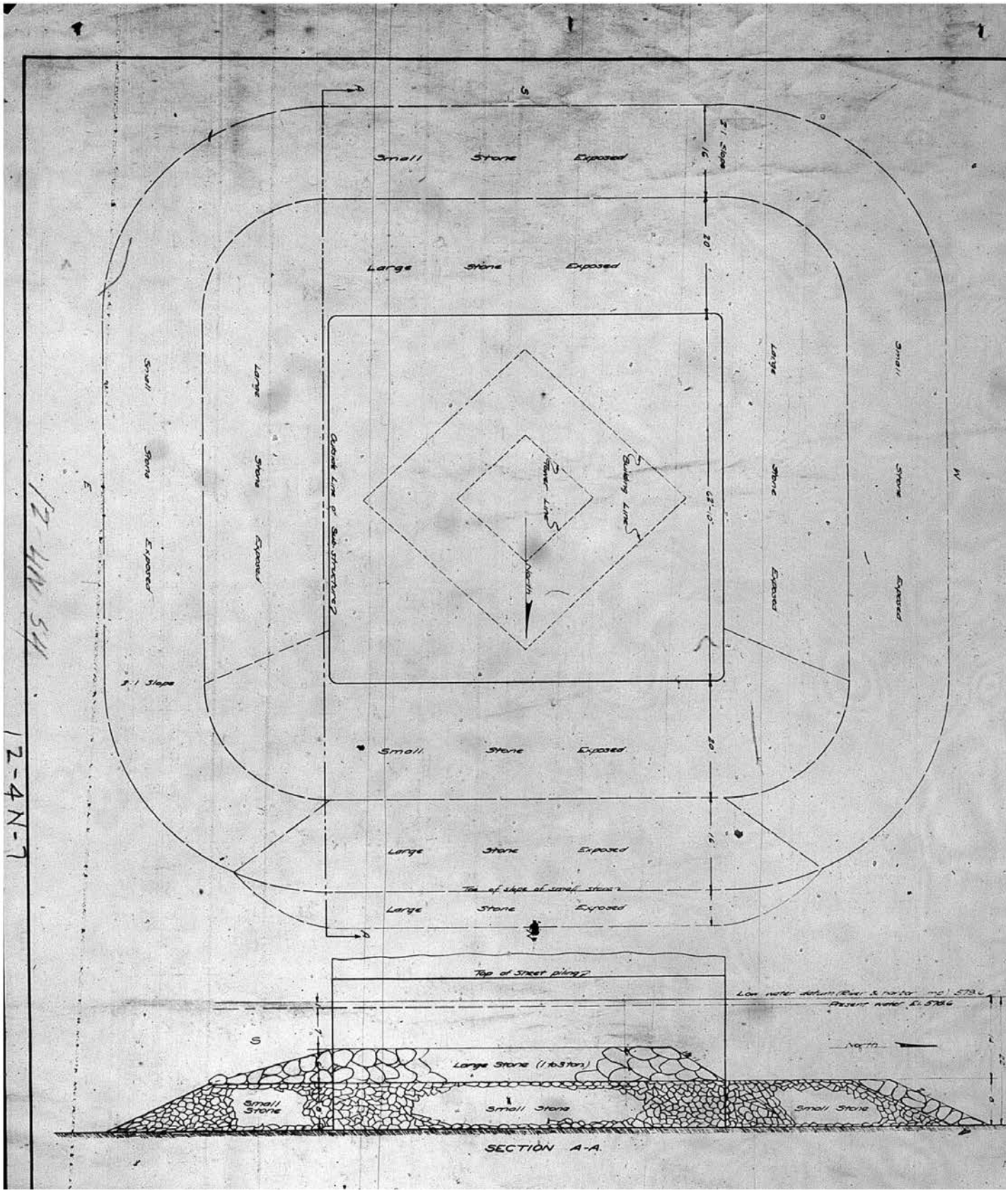


Figure 1B-23: Original construction drawing for placement of the stone rip rap around the crib.

reduced amount of 3,000 tons of small stone rip rap and 900 tons of large stone was not adequate. Assistant Superintendent Works requested authorization to increase the amount of large rip rap by 2,000 tons. Although the specifications had stated "Contractor shall be prepared to deliver additional quantities of stone both large size and small size, at same price, in case found necessary or desirable,"[71] Works recommended paying Lyons the additional cost of $5,000 for them to obtain the stone from a quarry located on Drummond Island. He included this increased amount in an updated project cost estimate (which remained at $155,000) attached to his letter.

Handwritten notes on Assistant Superintendent Works' letter (presumably made by the Commissioner) indicate that he did not agree with the need for additional stone. His notes included: "It appears to me that the amt as shown on est 33040 is sufficient to hold the structure which in itself is loaded w stone & concrete & by the interlockg steel sheet piles, & that no addl riprap is needed unless subsequent experience shows to contrary; such as erosion" and "Finally from experience w riprap at Atlantic pier or Caisson towers, the peer loaded w riprap & concrete & held by water, steel sheet piles wld only require at this time a light amt of riprap abt 3 or 4' thick: as shown on 33040-11 (Figure 1B-23) it seems ample." The Commissioner followed up with a letter to Superintendent Hubbard stating that if not already placed, to modify the quantities of large and small rip rap, with direction on how to place it around the structure. He also included a sketch graphically showing what he had written (Figure 1B-24). If this was not feasible, the Bureau would then consider approving the requested additional 2,000 tons of large rip rap, but only at no additional cost to the overall project budget.

Assistant Superintendent Works responded to the Commissioner via telegram on October 14th saying that the rip rap would be placed after completion of the sheet piles, anticipated to be around the 21st. He stated that the District did not agree with Putnam's proposed modification, as it would reduce the amount of rip rap by 600 tons. He then said, "RENEW RECOMMENDATION PLACE THREE THOUSAND TONS SMALL AND TWENTY NINE HUNDRED TONS LARGE WILL COMPLETE STATION WITHIN FUNDS ALLOTTED." Works also sent a lengthy letter the same day, providing more detail justifying the quantity and types of rip rap he recommended. The following are some excerpts from his letter, including references to rip rap at other stations in the district:

> We would urge that the maximum amount of RIPRAP (consistent with completing the station within the funds allotted) be placed about any crib station. To figure exactly how much is necessary is a pretty difficult matter, especially in view of the fact that the forces to which such a structure will be subjected, in its life, say 100 years, are almost impossible to evaluate.
>
> The only permanent natural features around the Lake are shoals and most of the artifical features tend to become of the form of shoals if given a fairly long exposure to the natural forces which exist around Lake Michigan. The hearer we can make our lighthouse structures conform to the shape of shoals, the more permanent they will be.
>
> While the conditions in the several cases mentioned below are very different, we would mention them just as a comparison and to "visualize" the quantities under consideration:--
>
> - at Racine Reef: In the last twenty years additional quantities of stone riprap have been placed on three occasions, the last amount, placed this summer of 1933, was 2500 tons. It placed the station in just fine condition, but there is none too much.
>
> In 1930 we placed 5000 tons at the outer end lake side of the East Pier at Michigan City, Ind. It made a reasonably good job, but there is not a stone too much. The storm of fall 1929 pushed off about 800 ft. of concrete caissons at the Milwaukee Breakwater, which cost some $300,000 to replace, just for lack of sufficient riprap.

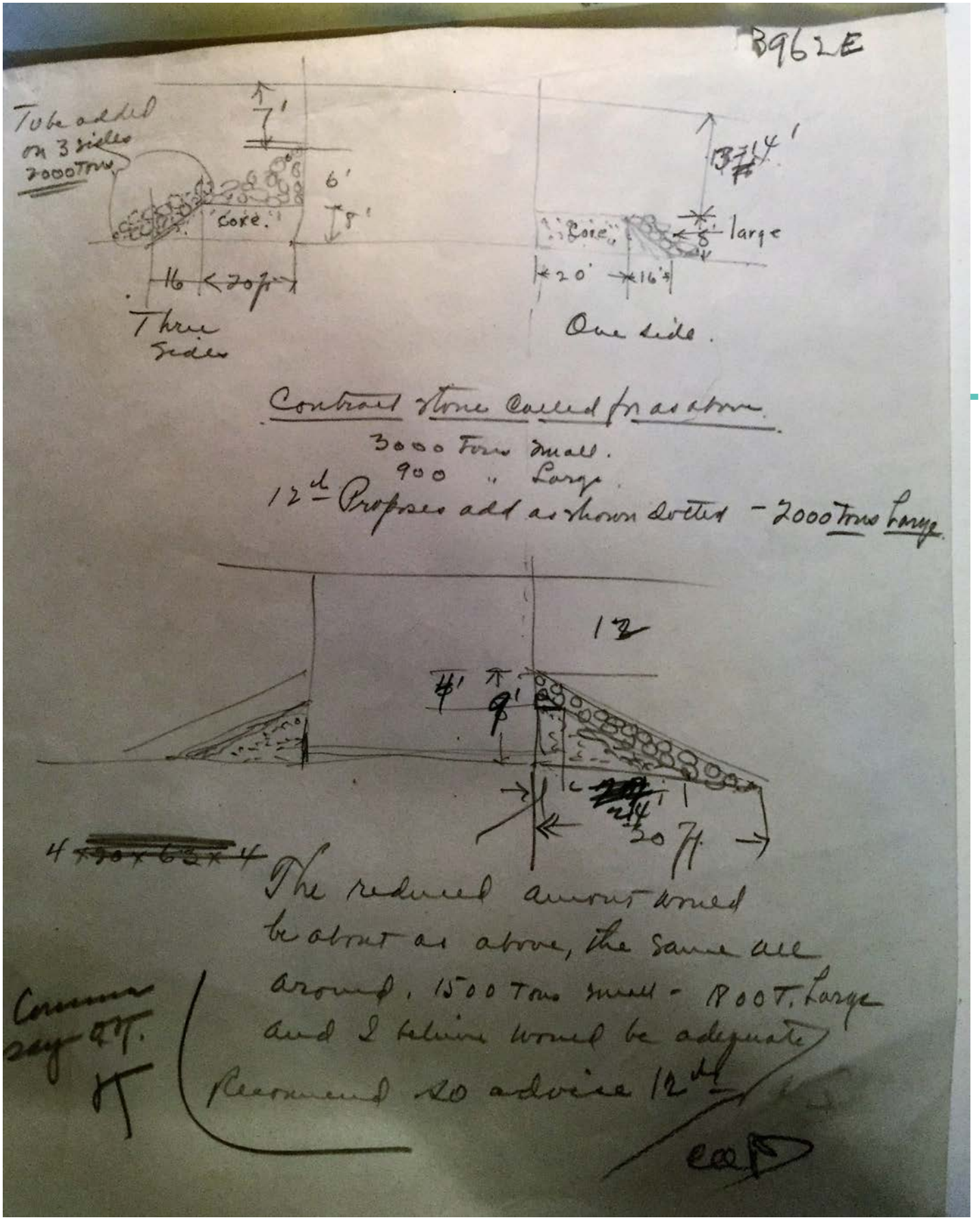


Figure 1B-24: Sketch by Commissioner Putnam graphically showing options for placement of the stone rip rip. This sketch accompanied his October 14th letter to the Twelfth District.

> In this case we believe that consideration should be given to the fact that these prices for small rip rap, $1.50 and for large rip rap, $2.50 ton are very low, lower than they will probably be for years to come. Also on a sand bottom there is much to be said for placing an ample quantity of small stone in contact with the sand, or perhaps a mixture of small and large. With large stone in contact with sand, there is a tendency for the large stones to bury themselves. The late Mr. Tompkins, Prin. Asst. Engr. in the Milwaukee Engineerr Office, maintained this fact very strongly.
>
> At $1.50 per ton, each dollar purchases a much larger yardage of small stone than the higher priced large stone. The funds available will permit of placing the quantities recommended, and complete the station within the allotment.[72]

The Bureau responded to the Twelfth District on October 25th to proceed with placement of the stone rip rap as had originally been designed, saying that it should be ample considering the mass of the structure and the sheet pile protection. The letter asked for the District to monitor its adequacy over the winter and then write if additional stone may need to be added:

> It is considered desirable that the section of this riprap be carefully observed, and you are requested, before the close of navigation this year, to take a series of accurate soundings of the entire riprapped area and extending out some little distance beyond it. A similar set of soundings covering the same points should be taken at the first opportunity next year and a comparison made to see what action has taken place in the way of settlement, erosion, etc. Submit the result of your soundings at both of these periods to the Bureau when complete with recommendation as to any action considered advisable in view of the results.[73]

Review of correspondence in late October reveals that progress on installation of the steel sheet piling and filling it with the stone and grout was very slow, mainly due to poor weather conditions. On October 26th, Superintendent Hubbard wrote to the Bureau's Chief Engineer Park detailing the erection and grouting process:

> The period from September 10 to the present date has been a continuous succession of storms with heavy sea so that contractor had had very few days on which he could work at the crib, and the fact that all pockets of crib were filled with stone and gravel has been an important element in insuring the structure against damage or movement by sea action as compared with the situation which would have existed had only the 16 center pockets been filled with stone at the time that crib was filled, which would be only about 50% of the stone capacity of crib. In this connection it is to be noted that on at least two occasions during these heavy storms the North Manitou Lightship No. 103 has dragged her anchor.
>
> The contractor undertook to try to drive steel sheet piling on September 18th and placed the first three on Sept 22, since which time the contractor has been able, by using every possible moment of calm weather day or night, to drive about two-thirds of the total of 184 piles required.
>
> Previous to starting to drive the piles, contractor erected the 20 ft. columns and beam system at main deck level and placed the heavy creosoted plank for working platform and forms and on Sept 23rd unloaded 375 barrels onto platform. The grouting machine was placed on Sept 16 on a temporary platform about 10 ft. above the top of crib supported by the four central steel columns.[74]

Hubbard's letter went on in detail on the grouting process, from number of men working at each stage to how many bags of cement could be mixed at one time. He concluded that although they had only completed but a small section, the work was satisfactory:

> We have delayed answering Bureau letter on account of the fact that we were waiting for an opportunity to get to North Manitou and actually observe the procedure in carrying out this grouting work. The contractor worked but one day last week, and we were able to watch the operation on Friday, October 20.

At the time of our visit last Friday but one pocket had been completely filled and from what we could see we judged it to be entirely satisfactory. Some additional pockets had been about half filled and we understand that on the morning following such a half filling they are able to sound through the grout pipe and determine the depth to which the pocket had been filled.

From what we were able to learn it appeared that the cement grout, when placed in the gravel and stone filled pocket which is completely saturated with water, acts in the same manner as one would expect mercury to act if poured into a gravel fill; that is, the cement grout sinks out of sight rapidly and apparently goes clear to the bottom of the pocket and finds its level and builds up from the bottom toward the top, maintaining a certain increasing level height during the entire time.

We believe that the method is working out satisfactorily. We expect to visit the station within about 10 days and will at that time make a further report to the Bureau with regard to the matter.[75]

Chief Engineer C.A. Park responded to the Superintendent on November 1st, stating that the Bureau was very interested in the progress report, especially the adequacy of the alternate grouting method employed:

Your report of operations so far in the grouting of pockets in the pier at North Manitou as conveyed in indorsement of October 26th has been noted with much interest.

Your further report will be awaited. The Bureau will be particularly interested in being fully advised as to the characteristic of the material in these pockets as will be revealed by cores taken with diamond drill after the work has been completed. In taking such cores, it is assumed that you will select the points most remote from the grouting pipe and thus the least likely to show complete filling of voids. If the method proves to have been fully satisfactory as well as economical, it may have an important application in the construction work of the Service at places where the immediate filling of an exposed crib is desirable for safety.[76]

Apparently Mr. Park was interested in seeing the work in progress himself and ventured a visit later in November. He wrote to the Commissioner on the 29th, summarizing his trip and the status of the project, and commenting on the poor weather at this late time of the season:

At the time of my visit Mr. Works was at South Manitou Island endeavoring to reach North Manitou Station which had been impossible for some time because of unfavorable weather. Wishing to see the construction to date, particularly in view of its unfinished condition before winter, I endeavored to reach the station expecting to meet Mr. Works at Glenhaven and proceed with him. I arrived at Glenhaven and met Mr. Works, but the temperature had fallen to zero and the storm was continuing so that there was no possibility of reaching the pier and even so observations would not have been feasible because of iced-up conditions. Mr. Works returned with me to Milwaukee where opportunity was had to go over fully the entire construction program of the district in regard to which another memorandum will be submitted.

As the North Manitou job now stands, the pier is placed and entirely filled. Steel sheet piling has been driven around the entire periphery and cross-bolted just above the top of the crib timbers. These bolts draw the sheet piling firmly against a steel ring girder which is in turn secured to the top timber of the crib. The inner pockets of the crib are filled with furnace stone and the outer pockets have been filled with stone and grouted to form a concrete. Eighteen hundred barrels of cement have been pumped into these pockets as grout, that work being practically completed. The cores which the Bureau required be drilled from the grouted material in the pockets in case this method were adopted and considered necessary to demonstrate a satisfactory filling, have not yet been obtained. It had been the expectation that the slab of concrete about 4 feet thick on top of the crib could be placed before the work was left for the winter. This would have included the placing of another set of cross-anchor bolts. It was decided that the placing of this concrete would be entirely impracticable owing to the advanced season and that it would be necessary to let the pier stand in its present condition. It is not believed that it will suffer due to the anchors and the fact that the inner part will undoubtedly

> freeze solid with ice and remain so, forming considerable protection.
>
> The material encountered in driving the piles is such that much scour is not anticipated. The riprap had not been placed at the time of my visit but was on a barge at the location ready to be placed when weather permits. Both the Superintendent and the Assistant Superintendent are now of the opinion that the amount of riprap covered by the contract will prove adequate.
>
> There is a feeling that the contractor may be losing money under present conditions. I would estimate that the work can be finished in about three months after the opening of navigation next year.[77]

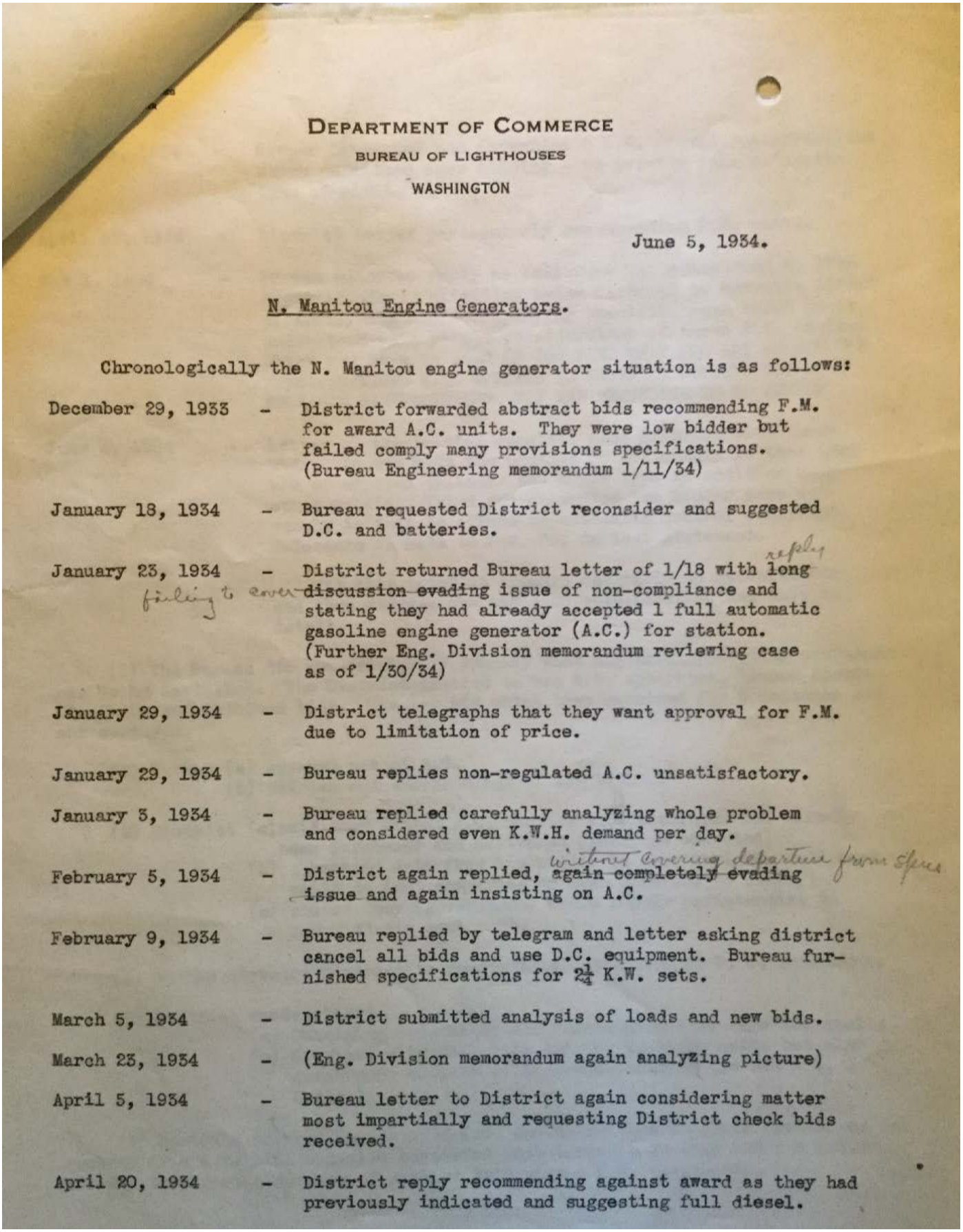
Although documentation was not located confirming it, it is assumed that the rip rap was installed around the structure before construction operations stopped for the winter. Although construction was temporarily suspended, continued planning and discussions regarding completion of the station continued in early 1934.

The contract to provide three engine generators to supply electricity for the light, fog signal and radio beacon equipment at the station was bid in December 1933. Fairbanks Morse Company was the low bidder and the Twelfth District recommended awarding the contract to them for installation of alternating current (AC) generators.

Extensive correspondence between the Bureau and the Twelfth District administrations followed from January through April of 1934. There was continued debate over the type of equipment, fuel type, manual versus automatic operation, and whether they would be supplying alternating current (AC) or direct current (DC). Factors that were considered included economical generation for loads needed; that the radiobeacon will run hourly; safety of the fuel type (diesel vs. gasoline vs. oil) at the remote location; and that there wasn't a possibility of obtaining commercial electricity from the mainland. The debate led to the specifications being revised in May and the contract being rebid in June. Upon receipt of the three bids, the Bureau noted that two of the bidders did not comply with the specifications, essentially accusing the Twelfth District of steering the bids to the Fairbanks Morse Company by writing the specifications so restrictive that they were the only company that could comply. The Lighthouse Bureau's Assistant Radio Engineer, F.I. Phippeny, summarized the lengthy debate and status as of early June in a four-page summary included on the following pages (Figures 1B-25 through 1B-28). As noted by the North Manitou Lighthouse Keepers, the handwritten edits on the first page, used to soften the language, add a unique and personal touch to this document.

While the electrical generation debate ensued, Engineer Park also wrote to Superintendent Hubbard in January 1934 reminding him that cores would still need to be taken from the grouted concrete pockets of the pier to demonstrate the satisfactory quality of concrete obtained. He included in his letter that he had been in contact with Sullivan Machinery Company in Michigan City, Indiana and that they had the required core drilling equipment if needed and was available for hire. Hubbard presumably passed this information on to Lyons Construction, as Lyons wrote to the Commissioner and Engineer Park in mid-March with concerns regarding this requirement, and the equipment required and associated costs:

> Gentlemen:- Att: Mr C.A.Park. C.E. We are writing you regarding our Lighthouse Contract at North Manitou Shoal.
>
> We have had instructions from the Milwaukee office to make core drill tests of the grouted stone in the outer pockets of the crib, and were notified that we would have to stand the expense of same. This is not only a hardship on us, but is unjust as we are in no way responsible for any type of construction designed by your



DEPARTMENT OF COMMERCE

BUREAU OF LIGHTHOUSES

WASHINGTON

June 5, 1934.

N. Manitou Engine Generators.

Chronologically the N. Manitou engine generator situation is as follows:

December 29, 1933 - District forwarded abstract bids recommending F.M. for award A.C. units. They were low bidder but failed comply many provisions specifications. (Bureau Engineering memorandum 1/11/34)

January 18, 1934 - Bureau requested District reconsider and suggested D.C. and batteries.

January 23, 1934 - District returned Bureau letter of 1/18 with long discussion evading issue of non-compliance and stating they had already accepted 1 full automatic gasoline engine generator (A.C.) for station. (Further Eng. Division memorandum reviewing case as of 1/30/34)

January 29, 1934 - District telegraphs that they want approval for F.M. due to limitation of price.

January 29, 1934 - Bureau replies non-regulated A.C. unsatisfactory.

January 3, 1934 - Bureau replied carefully analyzing whole problem and considered even K.W.H. demand per day.

February 5, 1934 - District again replied, again completely evading issue and again insisting on A.C.

February 9, 1934 - Bureau replied by telegram and letter asking district cancel all bids and use D.C. equipment. Bureau furnished specifications for 2¼ K.W. sets.

March 5, 1934 - District submitted analysis of loads and new bids.

March 23, 1934 - (Eng. Division memorandum again analyzing picture)

April 5, 1934 - Bureau letter to District again considering matter most impartially and requesting District check bids received.

April 20, 1934 - District reply recommending against award as they had previously indicated and suggesting full diesel.

Figure 1B-25: Page 1 of summary of the "engine generator situation."

28, 1934 - Bureau concurred and forwarded 5 K.W. diesel specifications which permitted open bidding - to provide full automatic type of plant.

April 27, 1934 - District letter particularly recommending F.M. units.

May 1, 1934 - Bureau endorsed reply as follows:- Quote Returned to 12th Superintendent, attention being directed to Bureau's letter of April 28th and accompanying specifications which it is understood will permit consideration of these F.M. engines which you have in mind IF YOU FIND THAT FOR ANY REASON THE SPECIFICATIONS WILL OPERATE TO RESTRICT COMPETITION FROM RELIABLE MANUFACTURERS, YOU ARE REQUESTED TO SO ADVISE

June 4, 1934 - Letter of transmittal received from District with three bids. In two bids the engines do not comply in that they are of opposed cylinder two cycle type in addition many other points. Third and otherwise low bidder does not comply in that he offers no automatic control equipment. Reference is made to F.M. Co. in last statement.

At this point it appears desirable to recapitulate and then discuss the attached specification and bids in detail.

(1) The Bureau did not originally specify what electric generating equipment was to be installed. The District decided to use A.C. apparatus, issued specifications and obtained bids. The low bid which they received for acceptance did not comply.

(2) Bureau (a) opposed use of A.C.
(b) pointed out shortcomings of low bidder.

(3) District (a) said they wanted A.C. because A.C. apparatus had already been purchased and delivered (gasoline operated).
(b) submitted data from low bidder to show what his equipment would do (not complying or even offering to comply)
(c) stated they (government) would supply deficiencies in low bidder's equipment.

(4) Bureau directed District to readvertise, obtaining 2¼ D. C. equipment.

(5) District readvertised
(a) Obtaining bids on 2¼ but maintaining they were too small.
(b) Obtained alternate bids 4 K. W. kerosene units but also questioned quality of apparatus offered (Le Roi & U. S. Motors).

(6) Bureau concurred in use of 4 K.W. and asked them to check further as to quality of 4 K.W. bids and also suggested that inasmuch as they had a 5 K.W. already they reconsider use of smaller sets with 5 K.W. as standby.

Figure 1B-26: Page 2 of summary of the "engine generator situation."

(7) District replied disagreeing entirely, submitted data to show both Le Roi & U. S. Motors unsatisfactory and suggested use of full diesel apparatus.

(8) Bureau concurred and attached a 5 K.W. diesel specification which had approval of 5 companies and requested District use same unless it was restrictive, in which case they were to advise.

(9) District revised specification, making it almost completely proprietary. The following points would shut out practically all bidders:

(a) Rating too low for diesel forcing other bidders to bid larger more expensive less economical units.

(b) Removable liner, machined, etc.

(c) No drop cover on crank case permitted.

(d) Combustion arrangement of pre-chamber type.

(e) Built-in governor - compound type to permit idling operation Speed reduction from 1,200 to 300 to be possible with speed control lever.

(f) Valves and valve assembly including method of carrying rocker arms on needle bearings.

(g) Fuel injection paragraph verbatim copy from F.M. This paragraph cuts everybody.

(h) Type nozzles.

(i) Relief of compression for hand starting (not serious).

(j) Number of rings required on piston.

(k) Crankshaft - requiring 3" on 8 to 10 H.P. engine.

(l) Reciprocating plunger type water pump.

(10) Ambiguity in items.

Item 5 Remote starting and manual stop features. States government will furnish and arrange all starting, and other relays, thus describes what these are to do and states the contractors will quote on this separately. Two bidders quoted - the low bidder did not. It is my opinion that assembled apparatus as specified arranged by District personnel would prove troublesome. Commercial apparatus supplied as a unit by Cutler Hammer or others will cost several hundred dollars per unit.

Figure 1B-27: Page 3 of summary of the "engine generator situation."

(11) Three bids were received. Two did not and could not comply due to numerous engine features. The third does not include any control apparatus which brings the whole project back to its original status of months ago.

(a) A preferred single bidder who does not furnish complete automatic equipment as specified.

(b) The District recommending award to this bidder and offering to supply all accessory electrical equipment at government expense (except picture has changed from A.C. to D.C. cycled battery operation)

(12) The whole project is not in the interest of the government in that:

(a) Specifications were highly restrictive.

(b) Recommended bidder does not supply a complete and workable automatic engine-generator set whereas with proper specifications several concerns could and have supplied such equipment.

(c) The price intrinsically is not low. We have purchased Hill Diesel two cylinder 5 K.W. plants at approximately $700.00 each. Hill and Cummins were not asked to bid.

(13) There can be no objection offered to the purchase of the particular apparatus offered if it is offered in fair competition with similar equipment.

(14) The District now proposes to use the old method of cycle charging in which the battery is to operate the radiobeacon, lights, water supply during the day and be "floated" at night. This cannot be successfully done with 4 K.W. without the use of battery charging resistors to hold the current down during the initial portion of the charge. The Districts letter of transmittal indicates they so intend to operate.

(15) It is recommended that the District be requested to reject all bids as either not complying or being incomplete.

2nd - that they issue the specification as furnished by the Bureau, without modification.

3rd - that they proceed with plans to use a full float battery and automatic engines as directed.

4th - that Cummins, Hill, F.M., Winton, and Buda be included in list of bidders. (Note Atlas Imperial declined before)

F. I. PHIPPENY,
Asst. Radio Engineer.

FIP/EJD

Figure 1B-28: Page 4 of summary of the "engine generator situation."

department. There is nothing in our contract regarding Core Drilling but grouted stone is taken care of.

As you know this Contract was delayed in Washington so we missed the summer months to work in the lake. This crib was ready to sink in September, just prior to the storm period, and it would have been suicide to run chances on the crib staying in position with just the center pockets filled with stone, as we would have to have good weather to pour tremmie concrete, and it so happened that on the second day after the crib was sunk we had a terrible Northwester.

The contract price for tremmie concrete was $12,807.50 and the contract price for Grouted concrete was $14,000.00, we agreed to put in the Grouted stone for the same price just to make the job safer, the reason for the higher price on the Grouted method is that it takes more cement, while the specs call for 1800 bbls. of cement we figured that it would take at least 2200 bbls. we have over 1800 bbls. in the work now but it will take considerable more to complete the work as the weather was so bad we did not dare to bring the grout near the surface on account of the sea washing over the top of the stone. We have some pockets that are finished and we have some Air Drilling Equipment on the job that could sink any number of holes in these pockets as the concrete has had a chance to get some age, but the pockets that are not finished will have to be completed and then aged for at least 10 days before we can do any drilling, and there is only a small amount of work that we could do while waiting for the unfinished pockets to harden. Our overhead, payrolls and equipment is just about $500.00 per day.

We have looked up core drilling equipment and their charges are high. If this job wa ashore where there would be no lost time we could get out of it for about $600.00, but our conditions would run this cost up over $1,000.00.

We have every conceivable kind of equipment with us except core drilling outfit, and the writer knows that you have personally battled with enough jobs out in unprotected water to know what we are up against.

We can drill 1 1 /2" holes down to 20' then with aid of hook rods the Inspector can determine if there are any loose stone or pockets. As this work cannot be started until May 1st, we wish that you would take a little time and think this matter over, and see if there is some way we can satisfy you with our present equipment.

We are positive that you are going to get a first class job in every way. The estimated cost of core drilling and the lost time on our own equipment will cost us better than $3,000.00.[78]

The Deputy Commissioner responded to Lyon's letter with a letter of its own to Superintendent Hubbard on March 24th. He wrote that the alternate stone and grouting method was conditionally approved in lieu of tremmie-placed concrete with the requirement that cores would be taken to confirm that the completed work was of suitable quality. The Bureau stated that cores were required because this method of filling sheet piling had not been used before in the Lighthouse Service and that, "there appears to be no adequate background of common experience or uniform method of procedure to insure that the results are all that may be anticipated." He further stated that the smaller size cores Lyons had proposed would give some indication of the character of the fill, but would not be adequate to confirm the overall satisfaction with the end result. He ended his letter requesting Hubbard's views on the matter before he responded to Lyons.

Superintendent Hubbard wrote Commissioner Putnam a lengthy, seven-page letter in response. He first outlined that the original specifications had included four alternatives for filling the outer pockets of the crib, one of which was later determined to not be practical for this project and one which was very similar to that completed by Lyons. He then reminded the Commissioner of the previous year's schedule issues, stating that although bids were received in April, due to the Executive Order to halt work and eventual cancellation of the Emergency Relief & Construction Act, contract award was

held up all summer and eventually all bids were cancelled. He noted that "Lyons, however, during this hold up period, on his own initiative, showed his faith by moving a good share of his construction plant to the "base" at Frankfort so as to be ready to proceed without delay whenever he should get the word."[79] He further noted that once Lyons was authorized to proceed, they immediately began taking the crib out to the site (apparently they had already constructed it) and sunk and filled it in just two days, on September 9th and 10th. Calling favorable attention to Lyons' dedication to the project, he wrote:

> Lyons worked a double 6-hour shift, 12 hours, while building the crib, employing a large crew and the assembly of the crib was accomplished in a very short period.
>
> Failure to have sunk the crib the day that they actually did sink it would probably have resulted in not sinking the crib at all in 1933, and in any event, would have resulted in not completing the sheet piling and making the crib safe in fall of 1933.
>
> The attention of the Bureau is called to the following letter dated July 21, 1933, which Lyons submitted with his bid, and which letter was attached to the bid when forwarded to Washington with Form 97dated July 22, 1933: "Regarding the North Manitou Lighthouse, which bids were opened today and we were the low bidders, it is really important that you let us know by wire as soon as possible when to proceed on account of running into bad weather and material prices going up. We suggest in the award that you use the grouting method as this permits us to load the entire crib the first day that it is sunk, giving us about 60% more load in case of storms. Instead of the crib being sunk the first part of June as planned, it will now be some time in August. Hoping that the above meets with your approval -".[80]

Hubbard went on at length restating the correspondence of the past year regarding using the alternate grouting method rather than the tremie concrete, including citing Lyons' August telegram stating that it was too late in the season and dangerous to use the tremie method and the Twelfth District subsequent letter to the Bureau recommending use of the grouting method. He continued that while Lyons was contractually bound to their original contract amount, he felt they should be compensated fairly for the work they performed plus the additional cost of coring, which was he felt in-line with the intent of NIRA:

> There can be no question but that Lyons is legally bound by this understanding. However, a re-examination of all the facts in the case indicates that EQUITY should dictate such relief as may now be practicable.
>
> Our specs cover two alternative methods for accomplishing this work; both were presented in complete detail and so far as our relations with the contractor are concerned, the two methods were on an equality. Tremie method ...$12,650.00; Grouting method...$14,000.00
>
> There was good precedent in the Lighthouse Service for the use of the tremie method, however, it is particularly adapted for use in good summer weather. The grouting method as specified was based on the extensive practice of Dravo Contracting Company of Pittsburgh; however, the use of grouting has been very extensive in all sorts of work, and it would not be difficult to find good precedent.
>
> The contractor and this office favor the use of the grouting method; however, we made the mistake of recommending the acceptance of the tremie method at a time of year when that method was not practicable to use, basing our recommendation only on the fact that the tremie method was scheduled to cost less and that it might be considered more conservative.
>
> We stated in Form 97 that but two months were available for construction work in fall of 1933, however, as a matter of fact August is often windy and September always has considerable wind and sea.
>
> As a legal matter, this is all very well; however, it is to be remembered that the only reason that the NIRA funds were provided for this work was in order to make work in the industry. Had

Lyons accepted the dictates of good, sound, conservative judgment he would have coiled up and gone into hibernation for the winter and sunk the crib in May or June, 1934.

Lyons did not do that, however. He went at the job with energy, worked a double crew on the crib and sunk the crib Sept 9, and then he stuck to the job through the worst weather as to wind and sea that we have had on Lake Michigan in 20 or 30 years, and kept a large force of men on board his floating equipment ready to go out and do work whenever sea and wind conditions permitted. Lyons stuck to the job until the sheet piles were all driven, but had to give up without pouring the 4 ft. main slab. His men recognized by their attitude their respect for Lyons in his fight with weather and sea. He finally quit and left for Frankfort, winter quarters, on November 18.

During this long period of hard weather conditions week and after week the outfit had to lie at anchor and move about from place to place, sometimes twice in a night, to find shelter from changing wind and sea, as there is no good harbor in the vicinity. Sometimes he would get out to the crib and drive a pile or two and then be driven away, and it should be remarked in this condition that driving 50 ft. steel sheet piling hanging on the end of a derrick boom is a very risky matter under such conditions.

Foreman Guest, who inspected the work, was in constant attendance and is fully convinced that the grouting accomplished what was intended. Lyons, in making his proposition to use the grouting method, was not proposing any scheme of his own; it was all in the specs as an alternative, with the price stated, and the use of that method insured that the job was practicable in 1933.

Lyons was in a position where he had to agree to anything to insure the safety of the work or run the risk of a big loss. We would recommend that Lyons be paid for the grouting job at the bid price of $14,000.00

The specs did not require the cutting out of test cores. It would be very valuable to the Lighthouse Service to have such cores taken, however, if they are to be cut we believe that they should be paid for, as a definite asset to the Lighthouse Service, either as an extra to the contractor or that the United States arrange direct for the cutting of such cores.

We are convinced that the crib concrete is solid and entirely suitable and that sufficient demonstration of this fact could be secured by drilling 1 1/2" holes as suggested by Contractor Lyons.

As seismographic readings could be taken on the crib with the pockets filled with grouted concrete, and such readings compare with similar readings on a stone filled crib, the comparison would no doubt prove that concreting by the grouting method gives sufficient solidity to such a crib.[81]

A handwritten memo dated a few days later than Hubbard's response, presumably written by Commissioner Putnam, indicates that Putnam did not agree with Hubbard. The memo indicates that an increase in Lyons' contract would not be approved and that the cores would still be required. The memo states:

I do not think under the circumstances the Govt should take the responsibility of acceptance without the evidence which will be supplied by cores taken from the work to show that the material is good.

The Govt authorized a change in method at the contractor's request. The change was in his direct interest. It might also have been in the interest of the Govt but this point remains to be proven. The contractor was apparently saved much time by the change. A condition of the change has not yet been fulfilled. I cannot see how this condition can be avoided or the cost of same assumed by the U.S. in view of the agreement.

The only thing to do is to require adherence to the contract and agreement in connection with this change.[82]

A more positive item of collaboration between the USLHS and USCG to note took place back in late March 1934. On March 26th, Superintendent

Hubbard wrote to the Commissioner regarding the USCG's offer to provide, install and maintain telephone cable out to the station from North Manitou Island:

> It gives this office considerable satisfaction to be able to advise you that the Coast Guard Service has furnished some 15,000 feet of submarine telephone cable at no cost to this Service for the purpose of connecting their telephone line at North Manitou Island with our new North Manitou Light Station. It is understood that the Coast Guard Service will furnish all instruments and maintain the line. It will bring the important North Manitou Island Station in telephone communication with North and South Manitou Islands and all land stations and no doubt will be valuable to marine interests, the Coast Guard, and the Lighthouse Service.
>
> Obtaining the cable has been brought about by the fine spirit of cooperation existing between this office and the Coast Guard Service, particularly with Mr. Geiss, their official located at Green Bay in charge of Coast Guard Communication Service. Advice has been received that this 15,000 feet of cable is on reels stored at their dock at "The Soo". I have assured Mr. Geiss we would be glad to lay the cable in question, using one of our Lighthouse tenders for that purpose, if the Commissioner would approve of said action.
>
> Am now requesting the Commissioner's approval to send a tender to the Soo at the most advantageous time this season to load the cable from the reels into the vessel's hold. Then lay same between North Manitou Island and North Manitou Light Station. By sending the tender to "The Soo" will avoid double handling of reels and cable, also having a good dock at "The Soo" to load and make the necessary splices in the cable, which work is performed by the Coast Guard expert splicers.[83]

In June, Chief Engineer Park sent a letter to Superintendent Hubbard following up on the rip rap:

> 1. In letter of October 25, 1933 it was requested that observations as to the condition of the rip rapped area at North Manitou Shoal Light Station be taken before the close of the season and again this spring to determine whether or not erosive action or tendency to misplacement of the stone rip rap was in evidence.
>
> 2. You are requested to advise as to the conditions advised.[84]

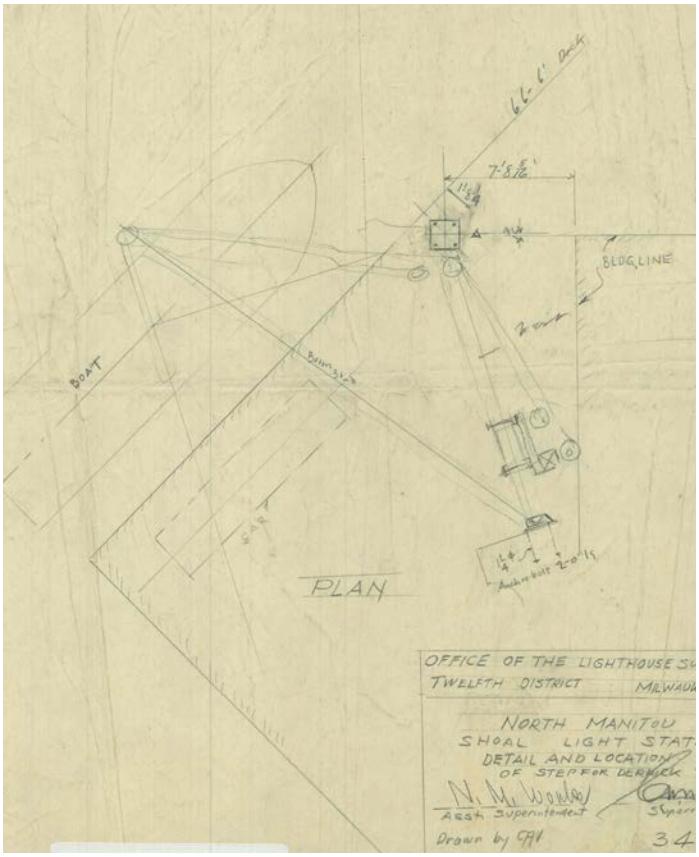


Figure 1B-29: Sketch showing one of the boat derricks.

Apparently not having received a reply, Park again wrote to Hubbard in September requesting that the rip rap observations be sent to the Bureau.

As construction was underway and the generator debate ensued in 1934, revisions and additions continued to be made to the design of the station. One significant design change in the summer of 1934 was relocating the placement of the boat derricks from the north and west corners of the main lighthouse structure to the centers of the northeast and southwest sides of the building (Figures 1B-29 and 1B-30). Construction drawings were prepared for the heating system boiler and layout of steam piping and radiators, and for the sea doors and hardware for them.

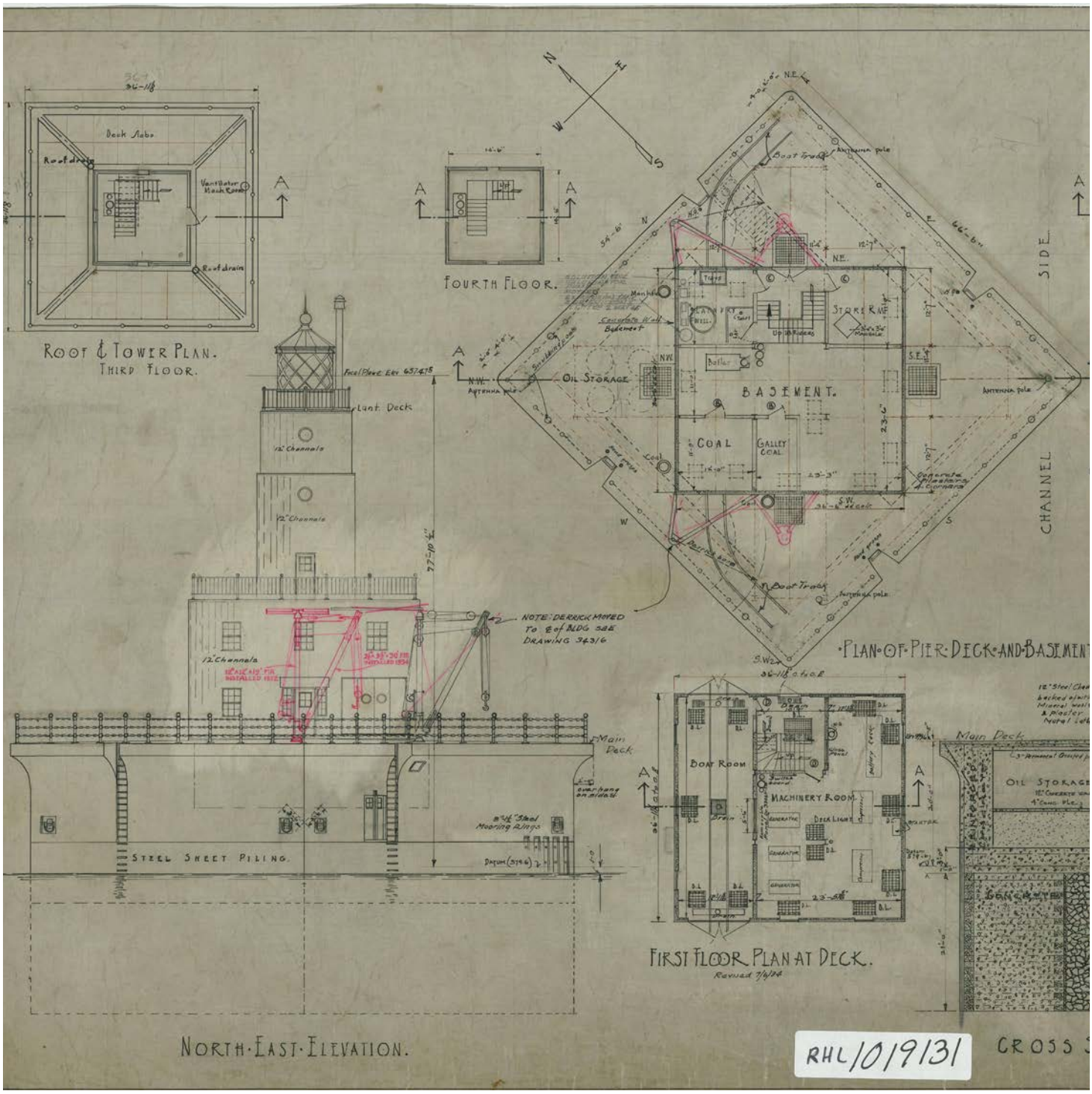


Figure 1B-30: Construction drawing showing the revised locations of the boat derricks.

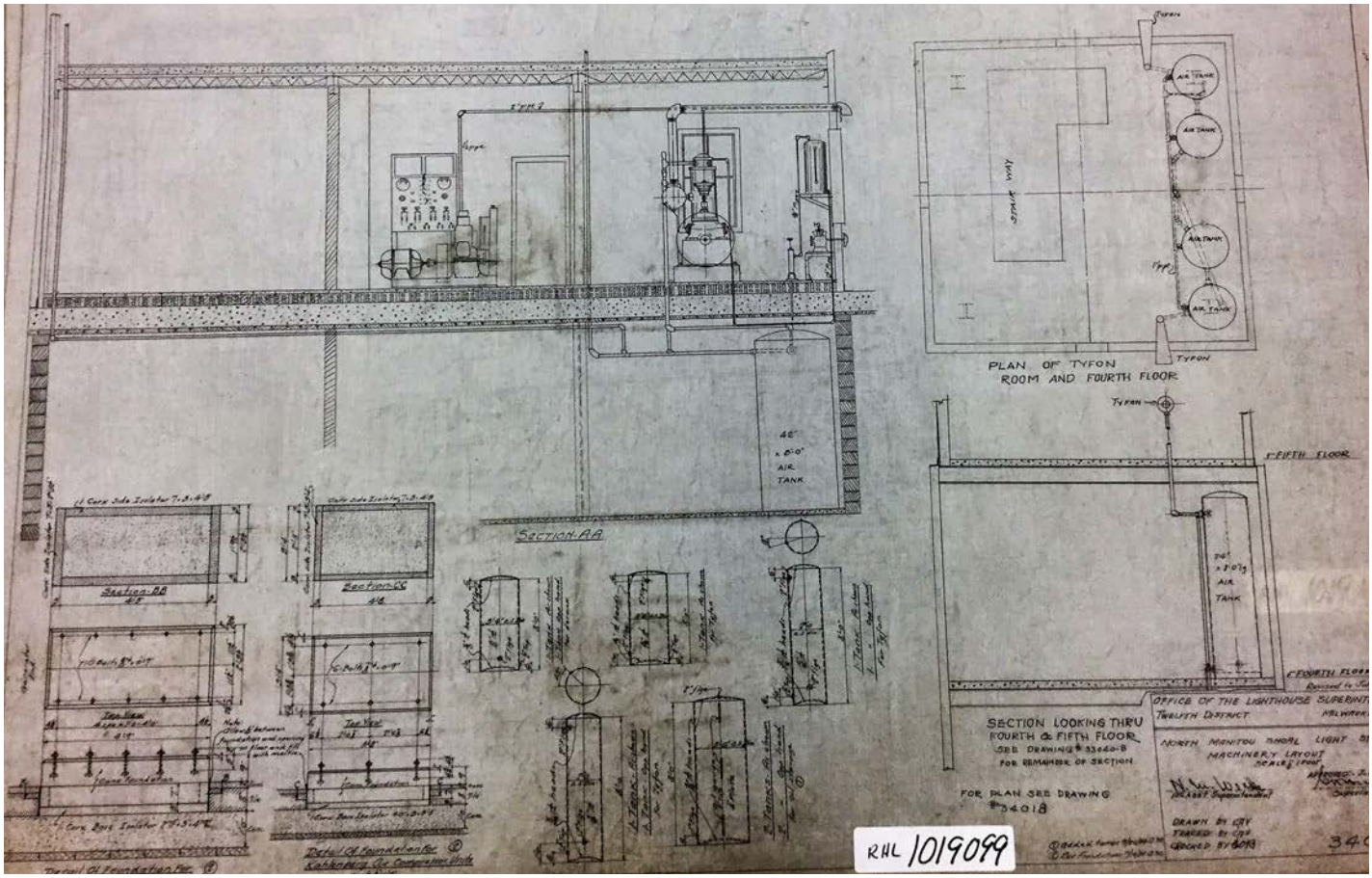


Figure 1B-31: Drawing showing the locations for the air diaphone equipment and foundations for the generators and compressors.

Drawings were also prepared for placement of the air diaphone equipment (Figure 1B-31) and the radiobeacon antennae.

The drawing for the air diaphone machinery include raised, reinforced concrete foundations for the generator and compressor units in the equipment room on the first floor; air tanks in the basement and fourth floors; and placement of the two Tyfon air horns projecting from the sides of the fifth floor.

One of the radiobeacon drawings include construction details for the antennae itself including sections and elevations and the access ladder that extends up one side (Figures 1B-32). The other drawing shows the placement of the antennae pole at the main deck; the outrigger extending from the lantern deck; and the cast bronze swivel pulley hanger at the top of the antennae (Figures 1B-33). The radiobeacon wires were extended between these elements.

The generator debate concluded in June with a purchase order made to Fairbanks Morse Company for 4 KW diesel engine generators. On July 3rd, the Bureau approved the Twelfth District to seek proposals for automatic controls for the units from Fairbanks Morse Co., Westinghouse Co., Cutler Hammer Co. and Monitor Controller Co.

Review of the 1934 *Light List* indicates that while the light vessel remained the main aid to navigation at the shoal during the 1934 shipping season, a temporary light had also been placed on the permanent structure. The *Light List* notes that the temporary light was a flashing red light that flashed for 5 seconds. It also states that the light was 34' above water, indicating that it was placed on the pier deck. A copy of correspondence between the Twelfth District and Lighthouse Bureau in October and November reveals that the district had been leasing storage space from the Glen Haven

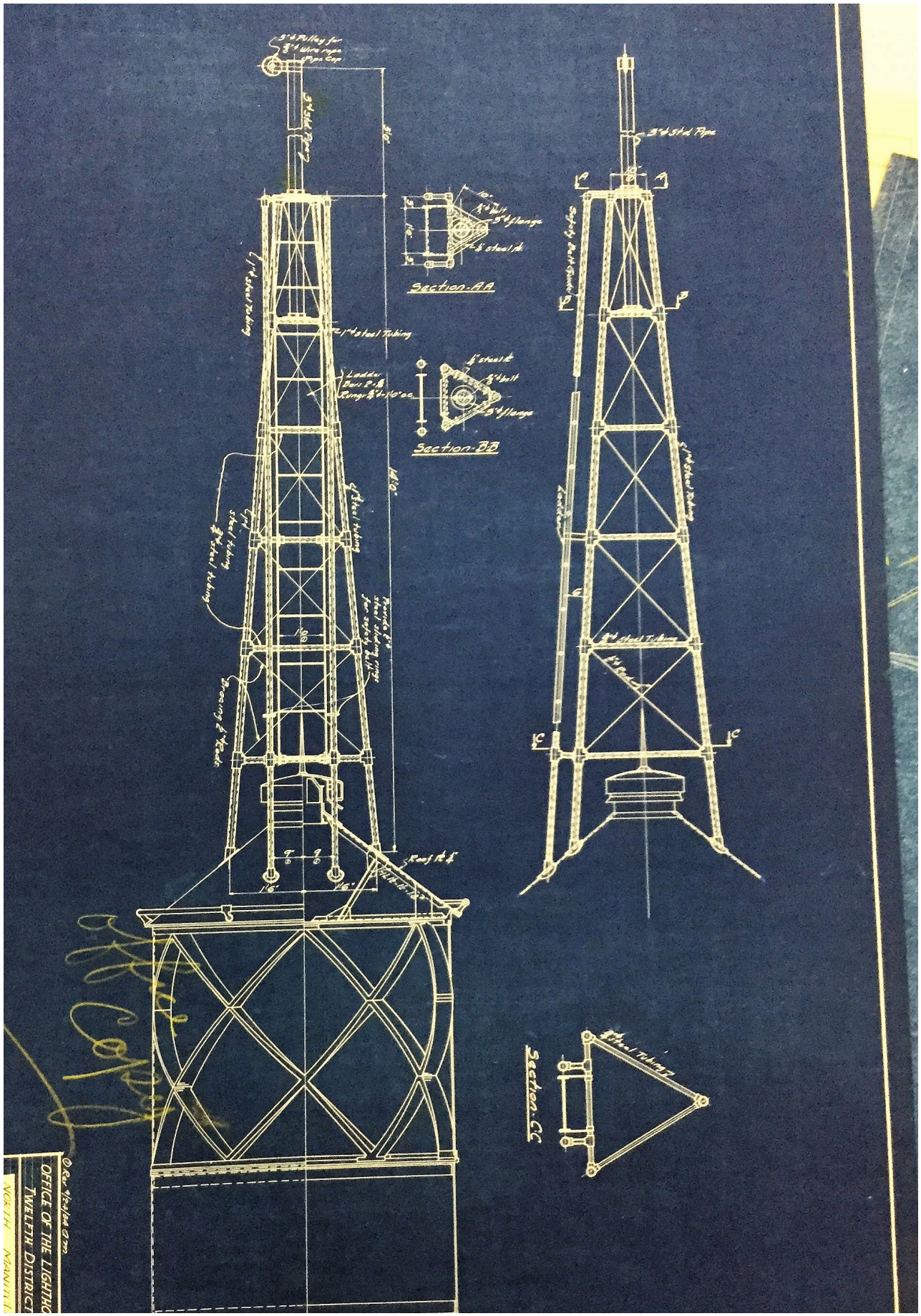


Figure 1B-32: Drawing for the radiobeacon antennae.

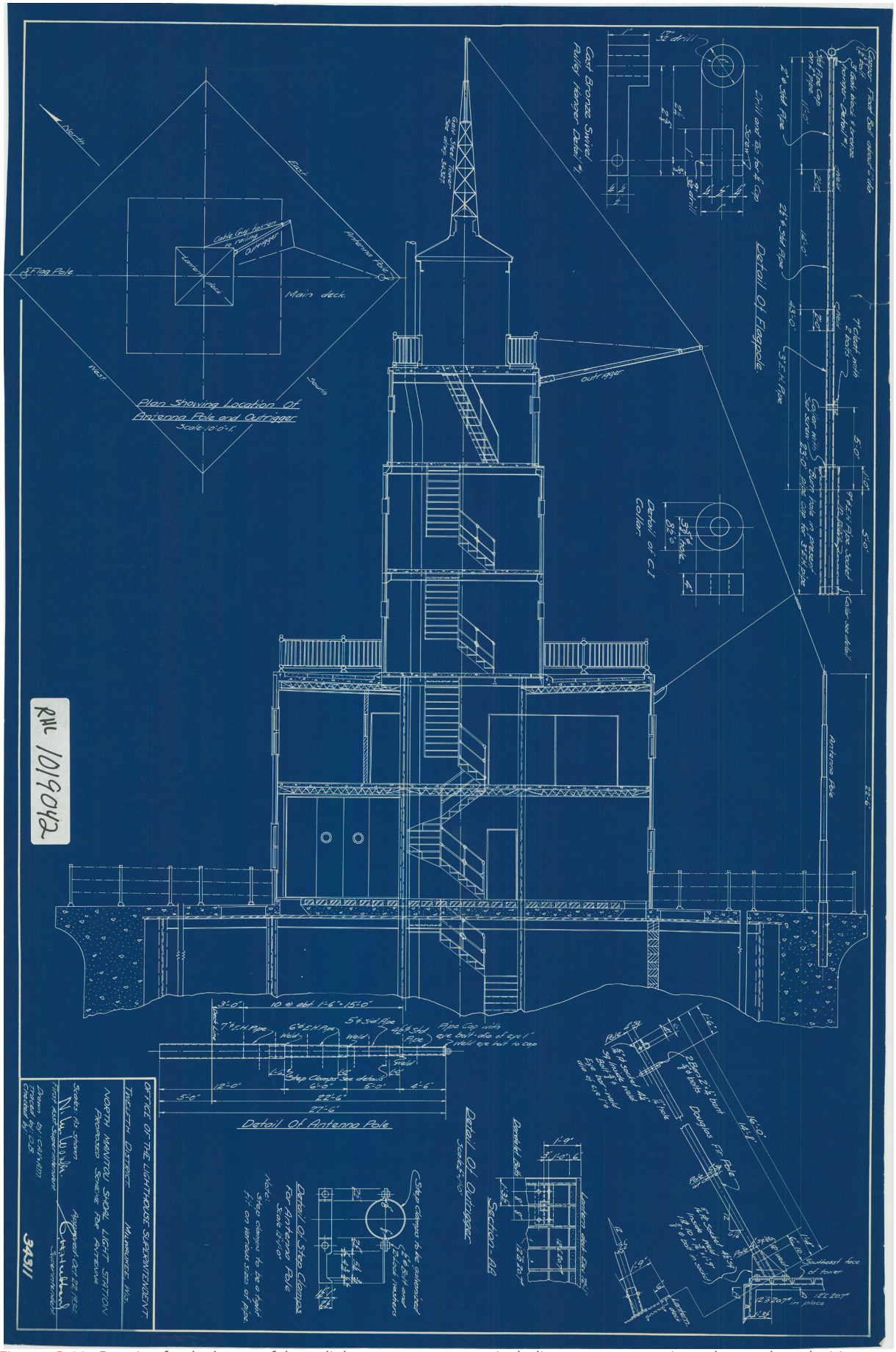


Figure 1B-33: Drawing for the layout of the radiobeacon components, including antennae, outrigger, base pole and wiring extending between them.

Canning Company in Glen Haven and from the Chicago and Northwestern Railway Company in Escanaba for storage of materials during the project.

On November 18th, the Twelfth District reported to the Lighthouse Bureau on the status of the project at the end of the 1934 season:

> The Lyons Construction Co., General Contractor, practically completed the structure, except the interior finish, and plastering, by the end of September, Tender landed plaster materials and finish October 12th and 13th., Camp established and work of installing Heating Plant, by Heating Contractor, placing interior insulation, lath, plaster, wiring, installing machinery, boat derrick, lens, etc. by L.H. Force, actively in progress since and well advanced. We expect to stop work at the station on Nov. 30th account of weather conditions, and the danger in attempting to keep up communications with station after Dec 1st.
>
> By the end of November the interior plastering and finish will be about 75% completed, if not all done, and the installation of the machinery will be so far advanced that a weeks work in the spring, just before the opening of navigation, will place the station in commission, on the opening of navigation:-- and there will be no necessity for the return of Lightship No.103 to the North Manitou Station.
>
> The General Construction, by Lyons Constr. Co., was completed in a highly satisfactory manner.[85]

Figure 1B-34 is a November 20, 1934 photo of the station when construction was nearing completion but not yet to be painted. The air horns and radiobeacon have not yet been installed either.

Correspondence between the Twelfth District and Lighthouse Bureau resumed in January 1935. Correspondence from January and February discussed purchase of spare lens and motor parts, as well as stating that the inner lens of the 4-panel 36" revolving marine Lighthouse lens made by Westinghouse Electric & Mfg. Co., Cleveland, Ohio will be red instead of clear.

Figure 1B-34: November 1934 photo of the station. Note that it is nearly complete but not yet painted. The radiobeacon and fog signal horns have not yet been installed.

Some of the spare parts were purchased from Westinghouse and other were transferred from the lighthouse district in San Juan, Puerto Rico, which had extra parts on hand that were not needed there.

Construction was completed in the spring of 1935. Two historic photographs show the progress of the exterior painting (Figures 1B-35 and 1B-36). An undated colored sketch (Figure 1B-37) shows the steel structure painted a yellow color, with the bottom three feet of the main deck level painted gray and the lantern painted black. Review of annual *Light Lists* through 1959 state the lighthouse color as "cream." Although historic photos of the station from the 1930s and 1940s are in black and white, the paint colors appears white, indicating that it was likely a very light cream color, rather than the more yellow-cream shown in Figure 1B-37.

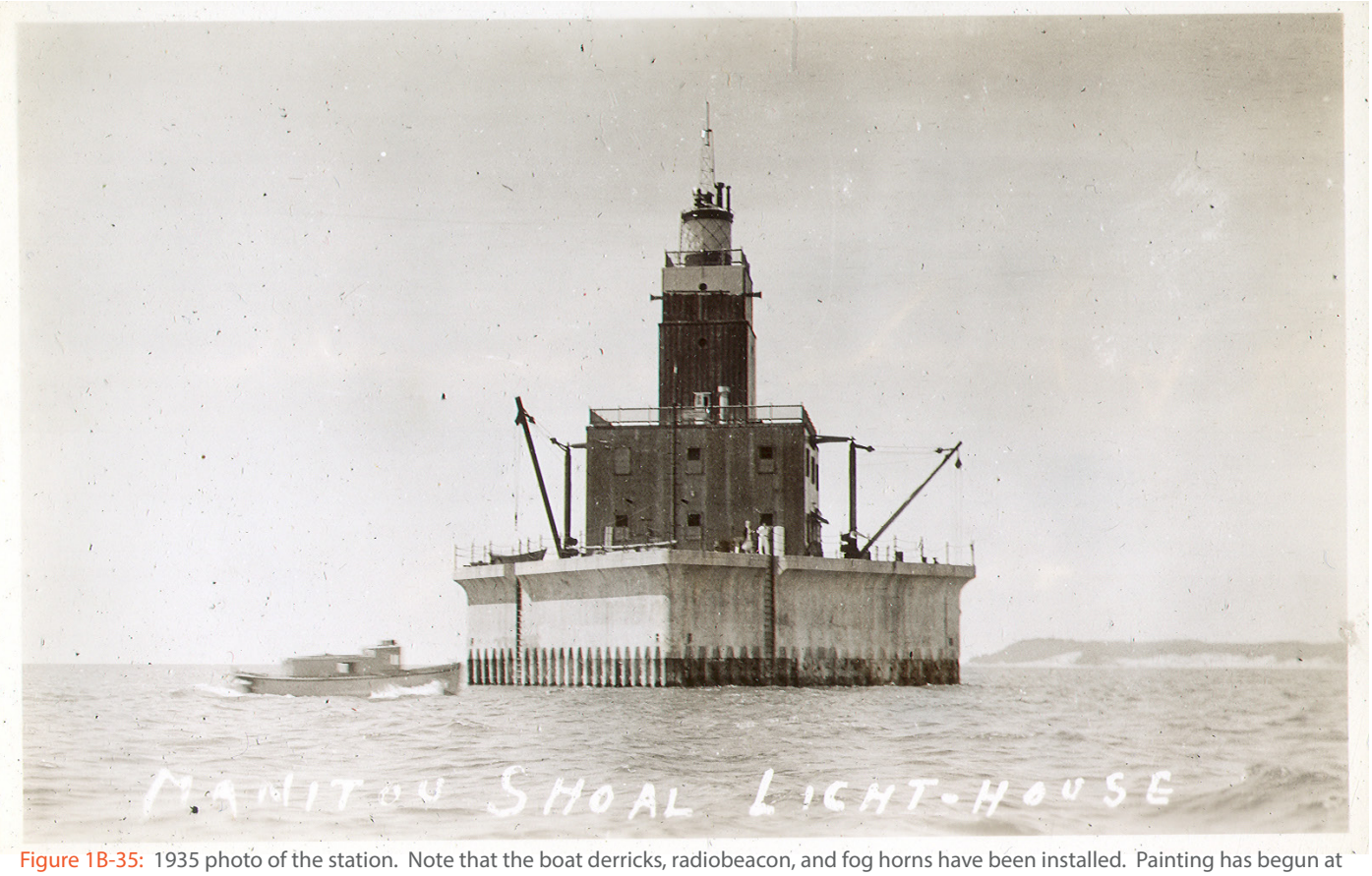


Figure 1B-35: 1935 photo of the station. Note that the boat derricks, radiobeacon, and fog horns have been installed. Painting has begun at the top of the tower.

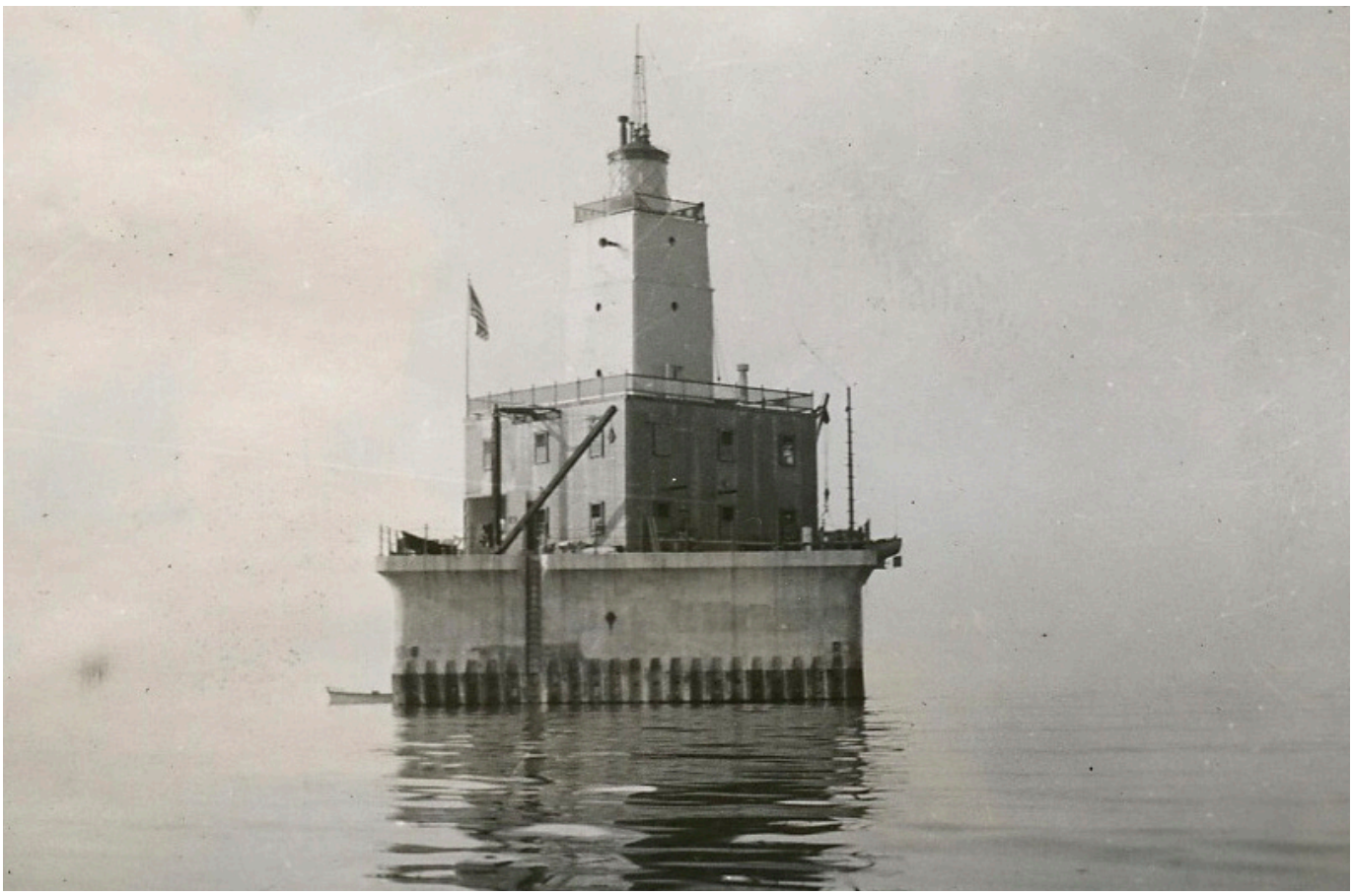


Figure 1B-36: 1935 photo of the station showing that the tower has been painted but the lower two floor have not yet been painted. The flagpole is installed on the corner of the watch deck and the lantern curtains have been drawn to protect the lens.

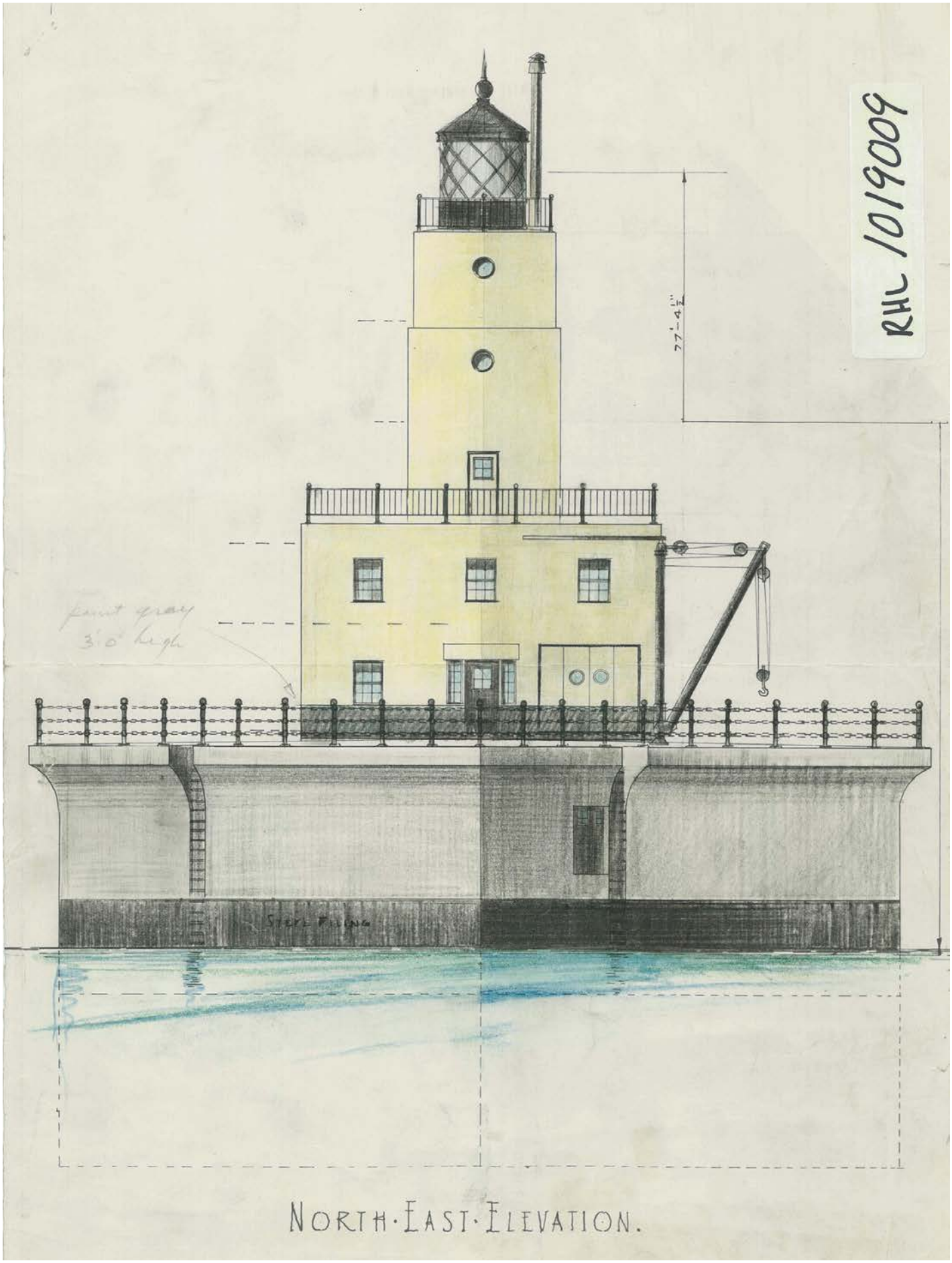


Figure 1B-37: Undated colored sketch of the station. This was likely drawn in 1933 or early 1934, as the boat derrick is still shown on the corrner.

OPERATIONAL YEARS

The North Manitou Shoal Light Station was officially put into service on May 1, 1935. The 1935 *Light List* states that its fourth-order, 240,000 candlepower, red flashing light flashed in 15-second intervals (flashed for 0.5 second with a 14.5 second eclipse) and could be seen twelve miles away. The TYFON diaphragm air horns blasted for two-seconds between 18 second intervals of silence. The Class C radio beacon installed at North Manitou Shoal Light Station consisted of an antenna atop the lantern with a transmitter, signal timer, electric generator, primary clock, radio receiver, and warning device installed inside the light station. The radio signal's reliable average range was 20 miles. The radio signal was synchronized with the lighthouse's fog signal to serve as a distance-finding station. The *Light List* listed the following details regarding these signals:

> TYFON steam: Blast 2 sec., silent 18 sec. A group of a long and a short blast, the latter 1 sec. and the interval 1 sec., occurring near the end of the minute is substituted for the characteristic blast during the operating minute of the radiobeacon for distance finding.
>
> RADIOBEACON: Transmits single dots. When the fog signal is sounding, a long dash (3 secs.) is transmitted near the end of the operating minute of the radiobeacon. The end of this dash is made to coincide with the beginning of the long fog signal blast for distance finding.[86]

Mariners aboard vessels in the vicinity could determine their approximate distance from the station by counting the time difference between when a radio signal was received (instantaneously with its transmission) and the time it took for the audible fog signal to travel from the station. By dividing this time difference in seconds by 5.5, the approximate distance in nautical miles from the light station can be calculated. Figure 1B-38 is a photo of the station thought be taken in the late 1930s.

Figure 1B-38: Circa late 1930s - early 1940s photo of the station.

The Lighthousefriends.com website indicates that the first head keeper was John A. Reneham, who served in that role until at least 1940. He was joined at the station by First Assistant Keeper John C. McDonald. and later in 1939, Second Assistant Keeper Jerry P. Conley. In July 1939, the Lighthouse Service was abolished as a separate federal agency and its duties subsumed by the U.S. Coast Guard. Lighthouse keepers and assistants employed by the Lighthouse Service were eventually phased out and replaced by U.S. Coast Guard personnel. The crew serving at the station increased to three in about 1939. Lighthousefriends.com notes each of whom served two weeks at the station followed by a week off. To pass time, the men watched television, read books and magazines, played board games, and chatted with passing

Figure 1B-39: Circa 1925 photo of the Glen Haven dock.

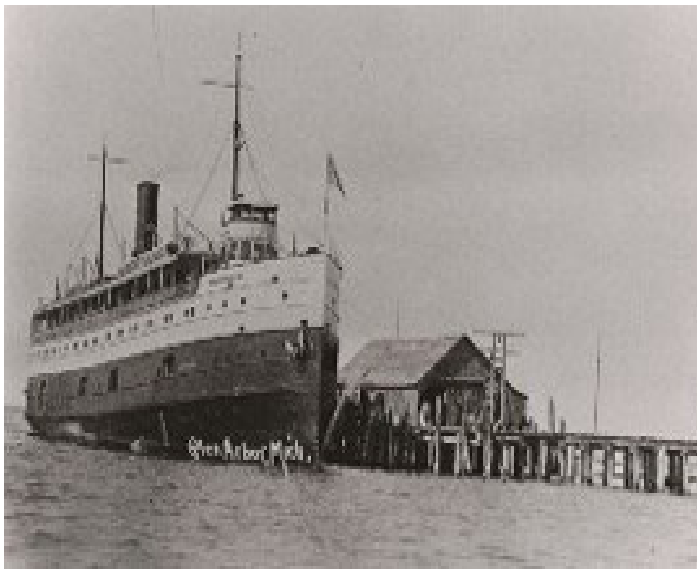


Figure 1B-40: Undated photo of the Glen Haven dock.

ship captains by radio. One coastguardsman perfected his rappelling skills by using ropes to descend from the gallery outside the lantern room to the concrete deck below.

Review of documents at the National Archives indicates that the USLHS often used a private dock in nearby Glen Haven (Figures 1B-39 and 1B-40) for launching and returning from the station. On September 8, 1937, former US Army Captain George Maines sent the Secretary of War a telegram asking what the department could do to take over the private dock. Currently closed, Captain Maines noted that the North and South Manitou island communities and the three light stations relied on this dock. However, it was in poor condition and he stated that even the mail boat had a difficult time docking at it.

Owned by the Day family of Glen Haven, the dock was often referred to as "Day's Dock." Captain Maines wrote another letter regarding the dock later in September, but this time to Commissioner Putnam. Maines wrote:

> Mr. David H. Day, Jr. informed me that the Day estate would deed to the Government, or a proper subdivision of the Government, the dock at that point, providing your department or the Coast Guard or any other unit of the Government would maintain it. Would your Department be interested in obtaining title to this property?
>
> There is no question but what the lighthouse on South Manitou Island is very necessary, as is the new lighthouse near north Manitou Island. The Coast Guard has a station about 1/4 of a mile west of this David Day dock site. They also maintain a station on South Manitou Island.[87]

A week later, David H. Day, Jr. wrote to Superintendent Skinner (apparently the Superintendent Hubbard has been succeeded by Superintendent Skinner between 1935 and 1937) informing him that the Day estate had fenced off the dilapidated dock. He wrote that the estate would sell the dock to the federal government for $1.00 and in his opinion, it wouldn't cost much to repair it:

> Dear Sir: I am in receipt of a letter from Washington, also copy of letter written by this party to the Commissioner of Lighthouses at Washington regarding the pier at Glen Haven, Michigan.
>
> In the past there has been considerable discussion regarding this pier as being essential to the well being of North and South Manitou Islands, Coast Guard Stations and Lighthouses, also the residents of those Islands, now the new

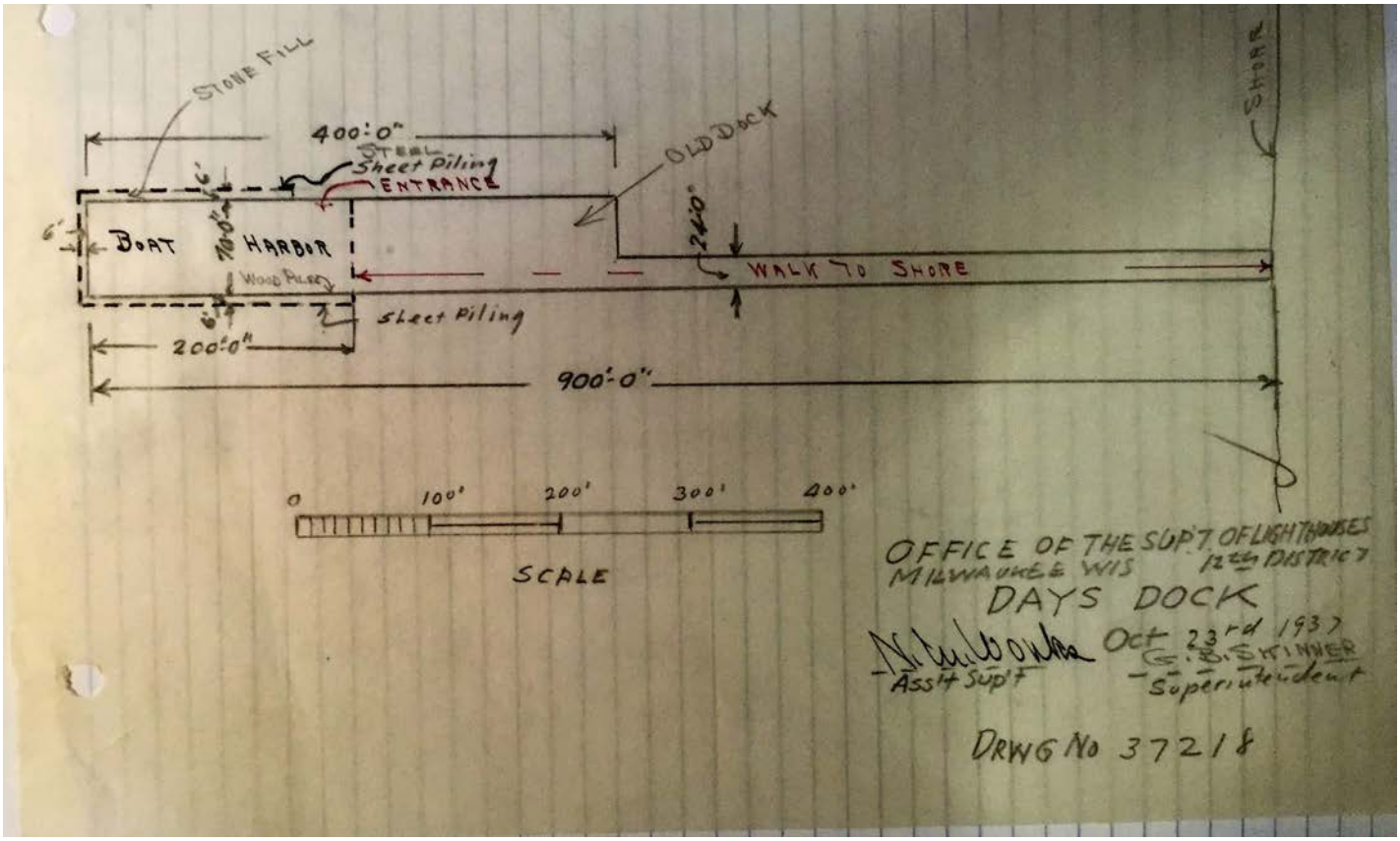


Figure 1B-41 Sketch drawn by Superintendent Skinner showing proposed modifications to the Glen Haven dock.

lighthouse at North Manitou Shoals. However when anyone has been around that was in authority to discuss the Government taking over the pier they have never done anything but talk with a few of the natives at Glen Haven as to what might be done, and the writer is the only one on the ground with property data on the D.H. Day Estate, and authority to go ahead with any kind of proposition to turn the dock over to the Government if they saw fit to take it over.

In order to relieve ourselves of any liability we were forced to fence the entrance to the dock this year to keep the public off as there are some bad spots in the pier and it is becoming worse each year that nothing is done to it and it will get worse as each year goes by as a small section went in the lake last winter from ice and heavy seas. At the present Mail boats, Coast Guard boats and Lighthouse boats land at the pier right at the shore and take their supplies around the fence which is alright as that relieves the Estate of any liability as the fence does that. But what is desired is for the Government to take it over and the between the two departments put it in proper condition as it would not cost a great deal of money, and there are at least six weeks of the average winter that the harbor at Leland is ice blocked, and in any kind of normal winter it is blocked longer than that. There is very seldom weather that the boats cannot make Glen Haven in the winter, and when they cannot get to the dock they land on the edge of the ice right in front of the Sleeping Bear Coast Guard Station 1/4 miles west of Glen Haven and there is an excellent Trunk Line Highway from Glen Haven to the Station and it is always open regardless of weather.

Should you desire to go further into this matter by having someone on the ground the writer would be only too glad to meet your representative and look the situation over. I am satisfied that the Administrators would be glad to deed the dock property to the Government for $1.00 under the stipulation that it be put in usable condition.[88]

Superintendent Skinner subsequently wrote to Commissioner in late October recommending that the USLHS take Mr. Day up on his offer. He wrote that the dock was located in a strategic location both from access from the mainland and in a somewhat sheltered area for resistance

to sea damage:

> Recommendation is made that the United States take over Day's Dock on a nominal payment of $1.00 to the Day Estate for the benefit of the Lighthouse Service and Coast Guard Service.
>
> Referring to Lake Survey chart 784 herewith (also see chart No.78) Day's Dock is shown located on Sleeping Bear Bay at Glen Haven just back of the Great Sand Hill known as Sleeping Bear Point which makes this location well sheltered from the major storms on Lake Michigan. The dock is at an end of the main paved highway coming in from Frankfort and the South (and continuing farther North). The dock is located near the Sleeping Bear Coast Guard station (2200 ft).
>
> The Day's Dock was built many years ago to serve for storage and for shipping lumber from the sawmill which stood on the nearby shore. Since the mill was discontinued, the dock has been maintained by the Day Estate, largely as a public benefit and served to a minor degree the Glen Haven Canning Company operated by Mr. D.H. Day. However, the automobile truck has displaced marine transportation, especially since the Northern Michigan Steamship Line discontinued operation some ten or more years ago.
>
> Day's Dock seems to occupy an especially advantageous location as demonstrated by the fact that the dock which is of pile construction still continues to stand after long years of service with only minor repairs from year to year, whereas numerous other docks built along the neighboring shore in the lumber days have been subjected to heavy damage and all of them were finally completely destroyed by the ice shoves which are experienced in this vicinity. The Day Dock location seems to be unique in that the ice shove has never swept the pile structure away and only winter repairs have been necessary to make good the abrasion by ice, sea and decay.[89]

The letter further states, "The distance from South Manitou Island to Day's Dock is only 8 miles as compared with 17 miles to Leland. The fact the South Manitou Island Light Station and the North Manitou Shoal Lighthouse have direct telephone connection into the mainland, the Day's Dock, (Sleeping Bear Point Coast Guard Station) is a matter of importance in considering the desirability of acquiring and improving Day's Dock as a landing place for traffic from South Manitou Island and from North Manitou Shoal."

Skinner also provided his recommendation for rehabilitation of the dock:

> Recommendation is made that the structure be reconditioned in the following manner. Drive a single row of arch-web steel sheet piling about the outside of the outer end of the dock, spaced out from the outside of the wooden piles about 6 feet and tie the sheet piles to the wooden piles and fill the 6 ft. space with stone, this for a length of about 150 or 200 feet of the dock at the outer end.
>
> Remove the plank deck of the entire dock and pull the interior piles (but not the outside piles) of the entire structure and construct a new plank deck supported by a double row of wooden piles from the shore end of the steel pile enclosed portion to shore. See sketch attached drawing No. 37218, showing the existing structure and showing by dotted line the steel sheet piling to be provided.
>
> This will give at small cost an enclosed harbor or anchorage for lighthouse and Coast Guard boats with walk connecting into shore.[90]

Superintendent Skinner attached a sketch of his recommendation to his letter (Figure 1B-41). Handwritten notes on Superintendent Skinner's letter (presumably written by the Commissioner or someone else at the Bureau) comment that the dock had been "used considerably in connection with" construction of the North Manitou Shoal Light Station and that the "advantages are no doubt important to" the light stations. Another note, though, advises against acquiring the dock, stating "District does not estimate cost of repair which would be considerable and without a waterhouse there would always be danger of fire and of course continuous trespass. Probably inadvisable or impracticable

to acquire under any plan which would bind US to maintain." A memo dated October 27, 1937 (though not signed, presumably written by the Commissioner or someone else at the Lighthouse Bureau), states that the dock was already in poor condition back in 1931 and that there was a better docking location available in Leland. The memo concludes that acquisition of the dock would not be approved:

> When Ch. Clk., in company with Supt. Hubbard, visited Day Dock. In landing, the tender SUMAC was carefully placed alongside, cautiously feeling way in to guard against striking bottom and sheering into and breaking down. Care had to be used in walking over deck of dock on account of decay of stringers and planking. This was Sept. 15, 1931 and since no upkeep has been placed on dock, its condition probably is far from satisfactory for use in any reconstruction project.
>
> The shore has a tendency to fill, therefore open pile construction is required - sheet piling and stone boat harbor would serve as a revetment and intensify the filling.
>
> At Leland the Engineers (War Dept.) have a project (if not already done) to install piers to improve the river outlet from Lake Leelanau - from the spillway of the lake to the beach is a wonderful small boat harbor and this is the place for lighthouse boats.
>
> No. Manitou Lt. Sta. closes before ice conditions are such that Leland Harbor cannot be used. On South Manitou Island there is a settlement - the Keeper's wife runs the "corner grocery" and it is doubtful if So. Manitou keepers ever come ashore in station boat during winter season when severe ice conditions exist.
>
> To take over this property would only invite the assumption of the burden of constructing and maintaining dock facilities more generally for use of the public and island shippers of fruits, vegetables, etc. than a benefit to the Lighthouse Service.
>
> Do not concur in recommendations of the 12th. [91]

Historic documentation that has been located from the 1940s thus far is limited to two circa 1940s photographs (Figures 1B-42 and 1B-43) and some of the keepers' log books. Review of the logbooks reveal that in addition to documentating the weather and shipping traffic, the entries were mainly related to everyday task the keepers had completed. These included cleaning, painting, and changing out machinery parts. The logs also note when there were problems with the aids to navigation, resulting in either the fog signal or radiobeacon being temporarily out of service. A 1945 drawing, with as-built notes added in 1954, indicates that the diesel generators and associated electrical panels were replaced between 1945 and 1954 (Figure 1B-44).

Figure 1B-42: Circa 1940 photo of the station.

Figure 1B-43: Circa 1940s photo of the station.

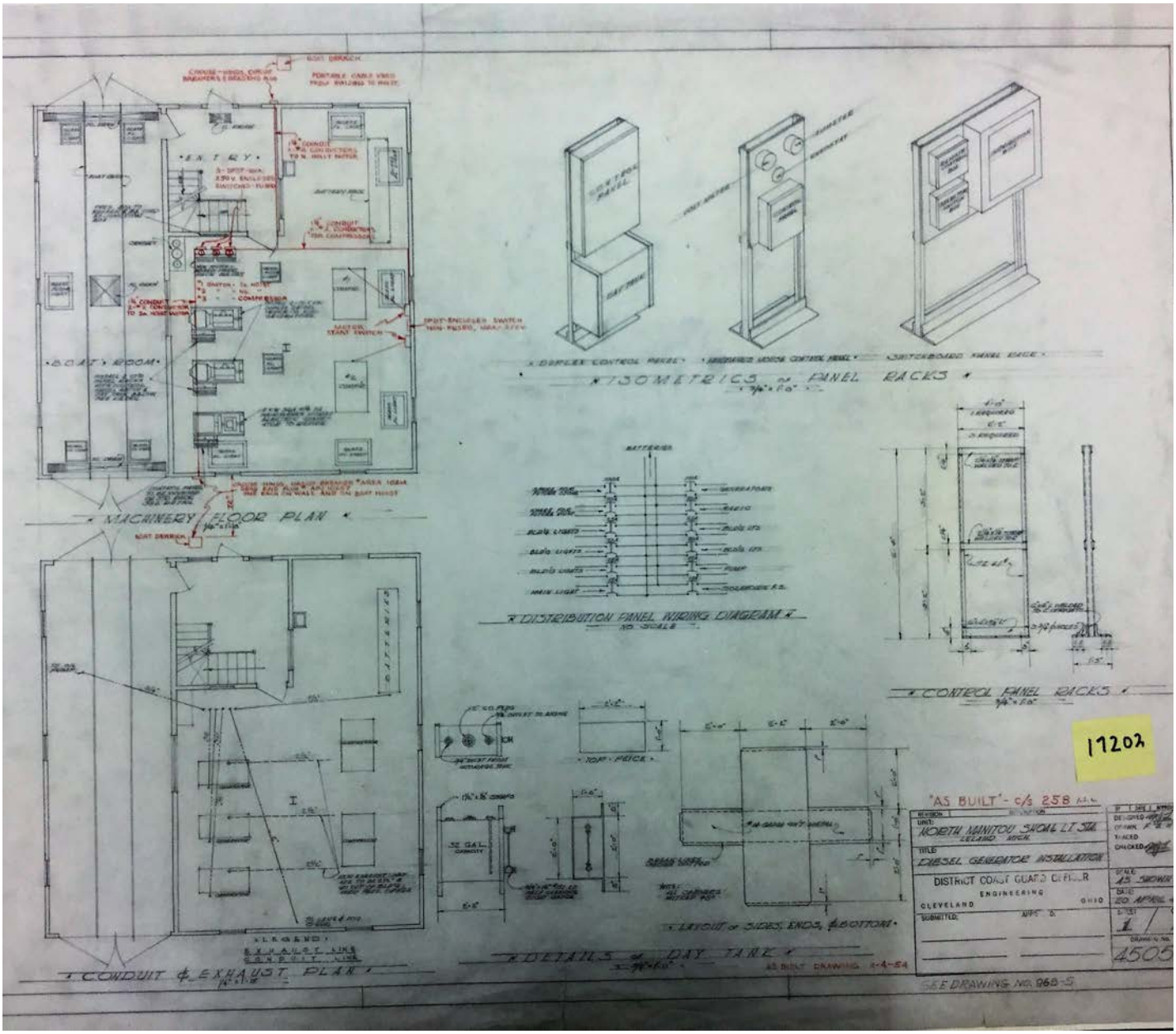


Figure 1B-44: 1945 drawing for replacement generators and associated electrical panels.

The boat derrick booms were replaced in 1952 with new 12 inch by 12 inch x 19 feet long fir timbers. Two drawings dated August 15, 1957 indicate that the heating system was changed at that time. The new heating system included a 209,000 BTU/hr boiler and 30 gallon compression tank that provided steam to new radiators units throughout the station. One of the drawings shows four new steel deck plates on steel framing to accommodate fuel storage.

Jennifer Brantley recently reached out to NMLK and donated several photos Her father, George C. Brantley, was stationed at North Manitou Shoal in the early 1950s. Jennifer recalls her father telling her many stories in her youth, including how the "lighthouse would rock on the concrete base in gale force winds." Several of the photos are included on the next two pages (Figures 1B-B1 through 1B-B9), offering a glimpse into life at the station in the 1950s.

Review of keepers' log books from April 1960 and December 1961 reflect entries for seasonal tasks related to opening and closing the station in the spring and fall respectively. Spring tasks included reinstalling the boat derrick booms; removing storm windows; and testing

Figure 1B-B1: Photo of George C. Brantley, who was stationed at North manitou Shoal in the early 1950s.

Figure 1B-B2: Circa early 1950s photo of the station.

Figure 1B-B3: Circa early 1950s photo of the lifeboat docked on the pier deck.

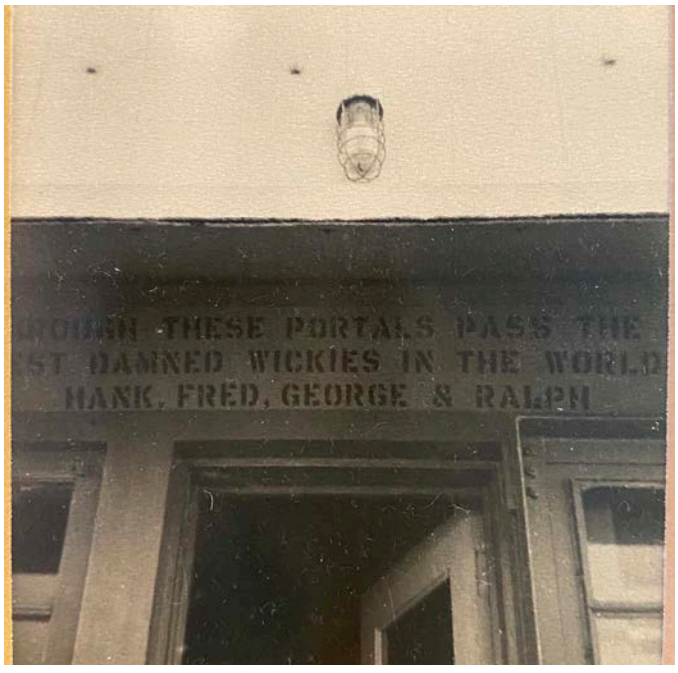


Figure 1B-B4: Circa early 1950s photo of the sign the crew painted over the door into the station.

Figure 1B-B5: Circa early 1950s photo of the radio equipment at the station.

Figure 1B-B6: Circa early 1950s photo of the generators at the station.

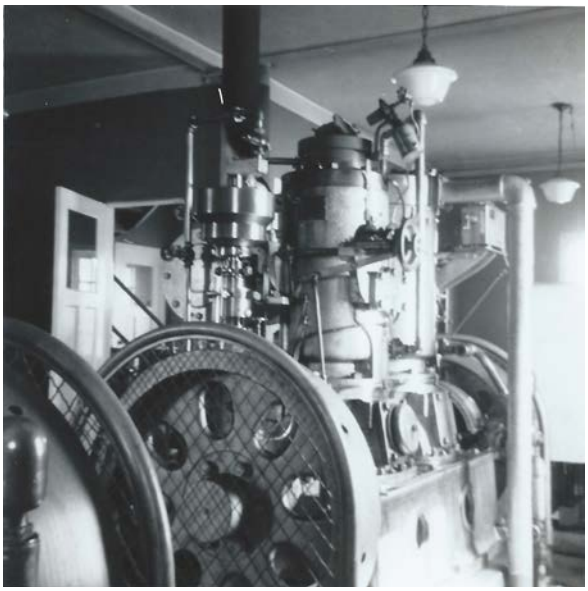


Figure 1B-B7: Circa early 1950s photo of the fog signal equipment at the station.

Figure 1B-B8: Circa early 1950s photo of the kitchen.

Figure 1B-B9: Circa early 1950s photo of crew members in the kitchen.

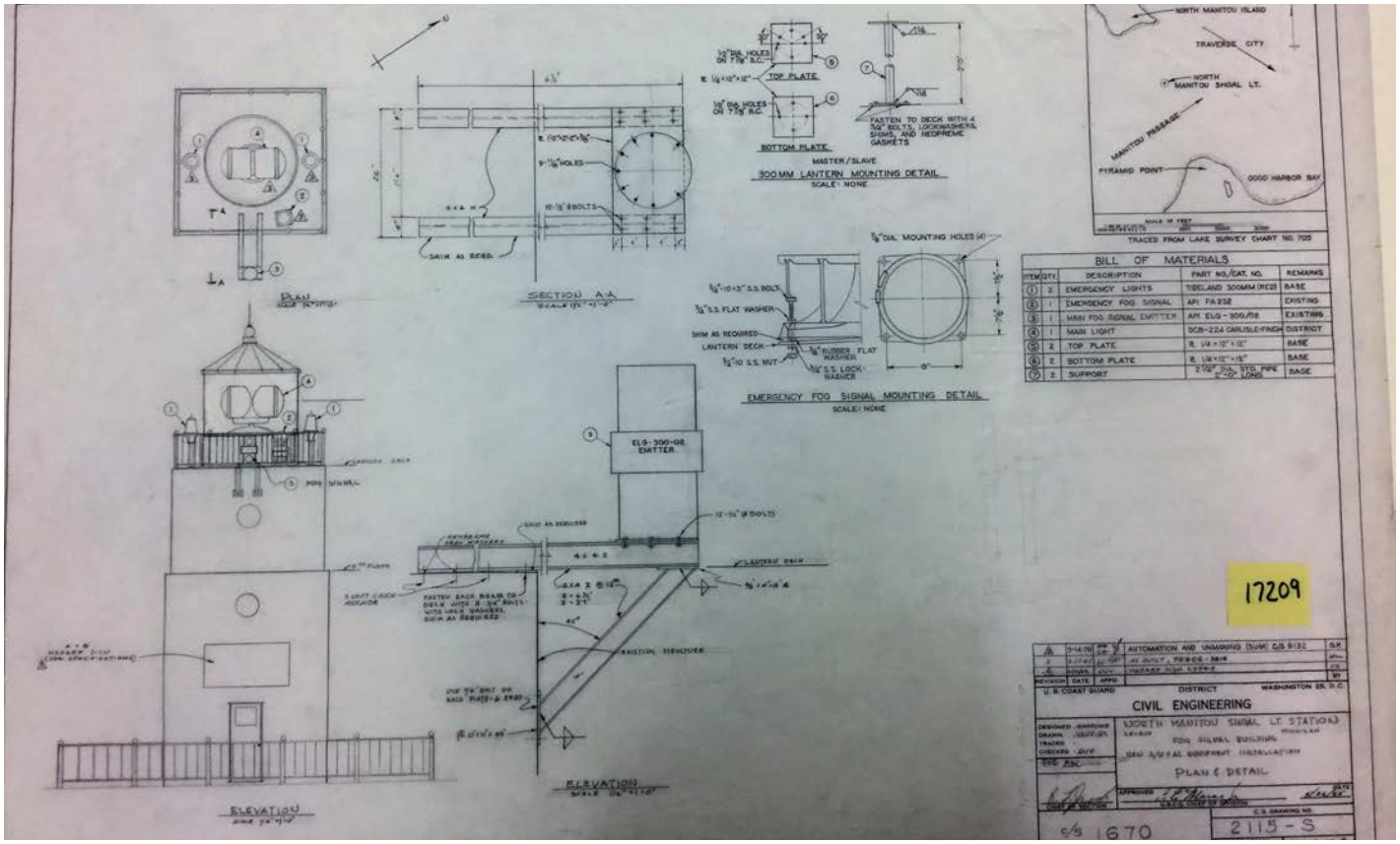


Figure 1B-45: 1965 drawing for changes to the aid to navigation equipment. This drawing was later revised in 1979 for automation of the station. The fog signal was replaced per this drawing in 1966, and the lens was replaced in 1980.

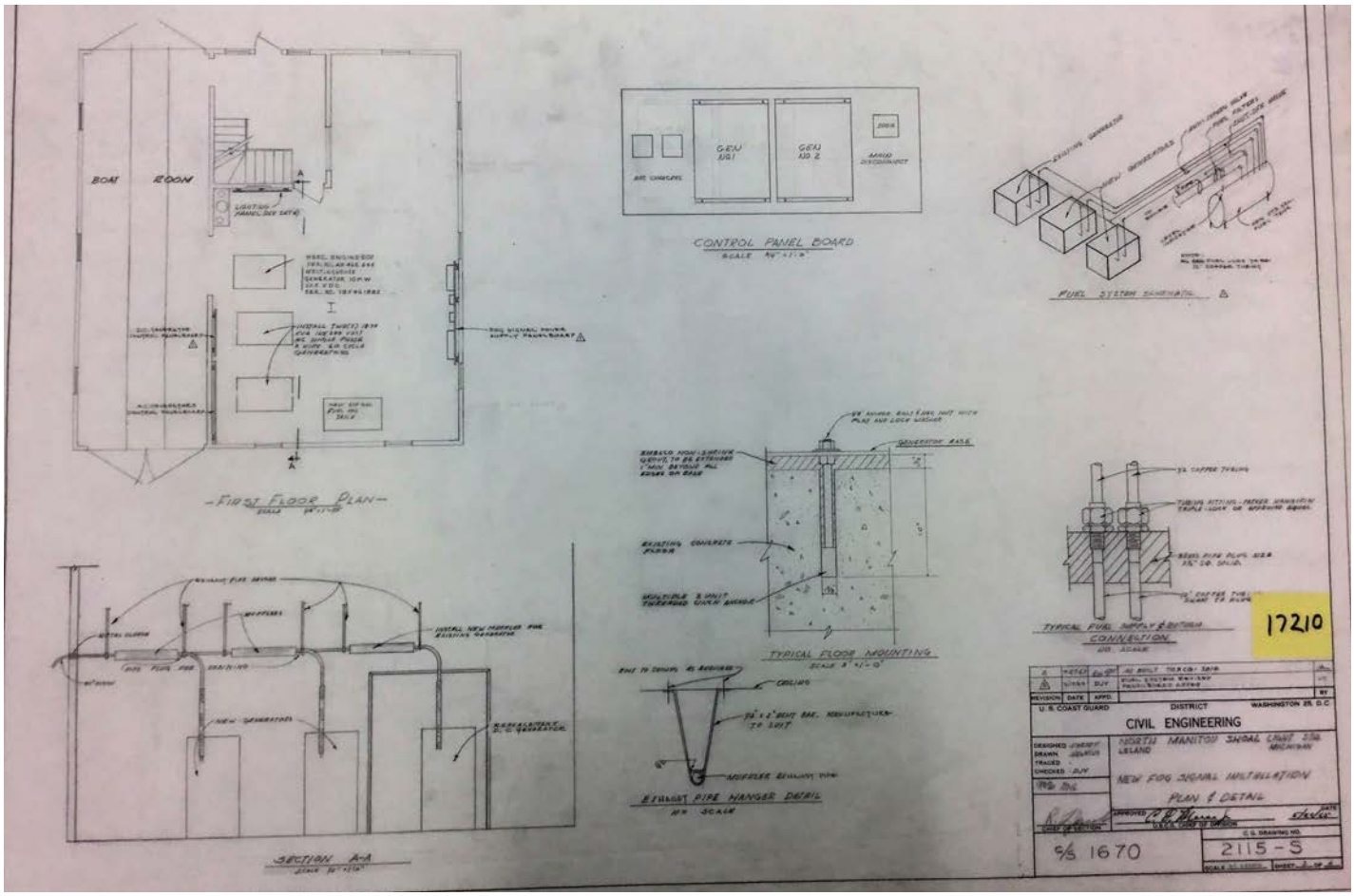


Figure 1B-46: 1965 drawing for the replacement fog signal equipment.

Figure 1B-47: Circa late 1960s photo of the station.

Figure 1B-48: 1966 photo of sunbathers on the Manitou Transit ferry headed toward the station (and the Manitou Islands).

and inspecting all equipment. Year end tasks included securing the sea doors; closing vents in the lantern; covering the lens; putting the winter light into operation; and shutting down the fog signal and radio beacon equipment.

The fog signal was replaced in 1966, and an emergency version was also added (Figure 1B-45 and 1B-46). New generators were installed in conjunction with replacement of the fog signal equipment. The Tyfon air horns were removed from the sides of the fifth floor and a new fog signal emitter was installed on a new steel bracket constructed off the side of the lantern deck (Figures 1B-45 and 1B-47). Photos from 1966 show that at least some of the equipment was delivered to the station on the Manitou Transit ferry on its way out to the Manitou Islands (Figures 1B-48, 1B-49 and 1B-50). Figures 1B-51 and 1B-52 are views in the equipment room after the new equipment was installed.

The USCG contacted the US Bureau of Land Management (BLM) in December 1966 stating the USCG's "stating your intent to relinquish control, accountability and custody of approximately 12.63 acres of land situated at and being the South Manitou Island Light Station Reservation, Lake Michigan, Glen Arbor Township, Leelanau County, Michigan." The BLM responded back to USCG in January 1966 that the USCG would be notified once action was taken on this.[92] That summer, George F. Grosvenor with the Manitou Mail Service wrote to the USCG asking that the South Manitou Island Light Station be reestablished for maritime safety. The USCG responded to Grosvenor that the gas buoy on South Manitou Shoal and the North Manitou Light Station's provided adequate aids to navigation and that the area was well within the coverage area for helicopters from the Traverse City Air Station, with additional coverage provided by USCG stations in Frankfort and Charlevoix. In the

Figure 1B-49: The station crew welcoming the ferry.

Figure 1B-50: Hoisting an air tank up to the station.

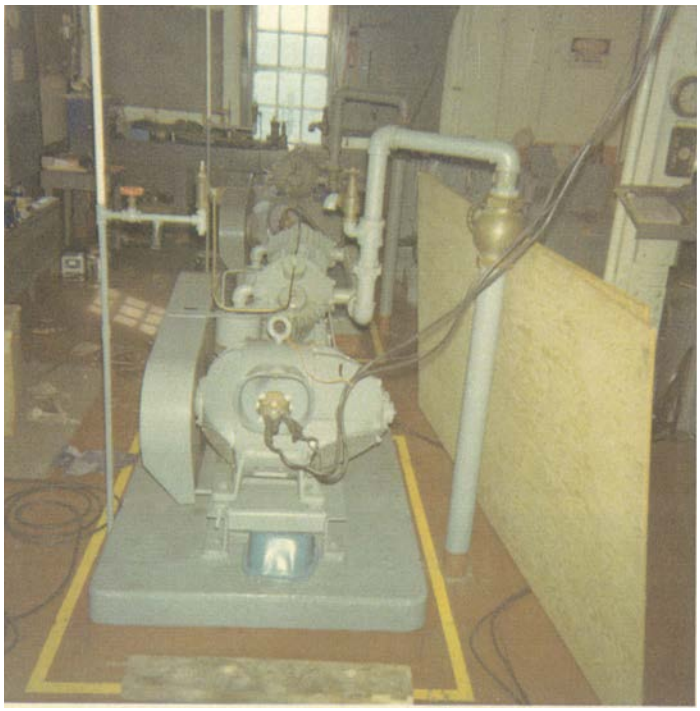


Figure 1B-51: 1966 photo of the new equipment.

Figure 1B-52: 1966 photo of the new equipment.

letter, Admiral Smith, USCG, indicated that the South Manitou land had already been turned over to the General Services Administration (GSA) for disposal. However, the National Park Service has requested that the property be held pending legislation to obtain it for the Sleeping Bear Dunes National Seashore. Much of the land surrounding the Manitou Passage, including all of North and South Manitou Islands, were later incorporated into the new Sleeping Bear Dunes National Lakeshore in 1970.

Figure 1B-53: 1966 photo taken in the living/dining/radio room looking into the kitchen.

Figure 1B-54: 1966 photo of the radio room. The crewman in the chair appears asleep. Former Coastguardsman Coby Thenikl said that the lowest ranking crew member was assigned the midnight shift.

Photos donated to the Leelanau Historical Society by Charlie Hannert, Assistant Station Engineer from March-December 1966, give a glimpse into station life in the 1960s (Figures 1B-53 and 1B-54).

A circa late 1960s-early 1970s photo of the outside of the station (Figure 1B-55) shows a TV antennae mounted to the south corner of the watch deck. Reviewing Figure 1B-50, the TV antennae is mounted on the lantern deck - likely moved up for better reception. Review of Figure 1B-55 reveals that the flagpole had also been moved up from the watch deck to lantern deck by 1966.

A 1962 drawing noted "as-built" in June 1969 indicates that deadbolts were added to and the sea doors were permanently secured closed (Figure 1B-56).

Figure 1B-55: Circa late 1960s - 1970s photo of the station.

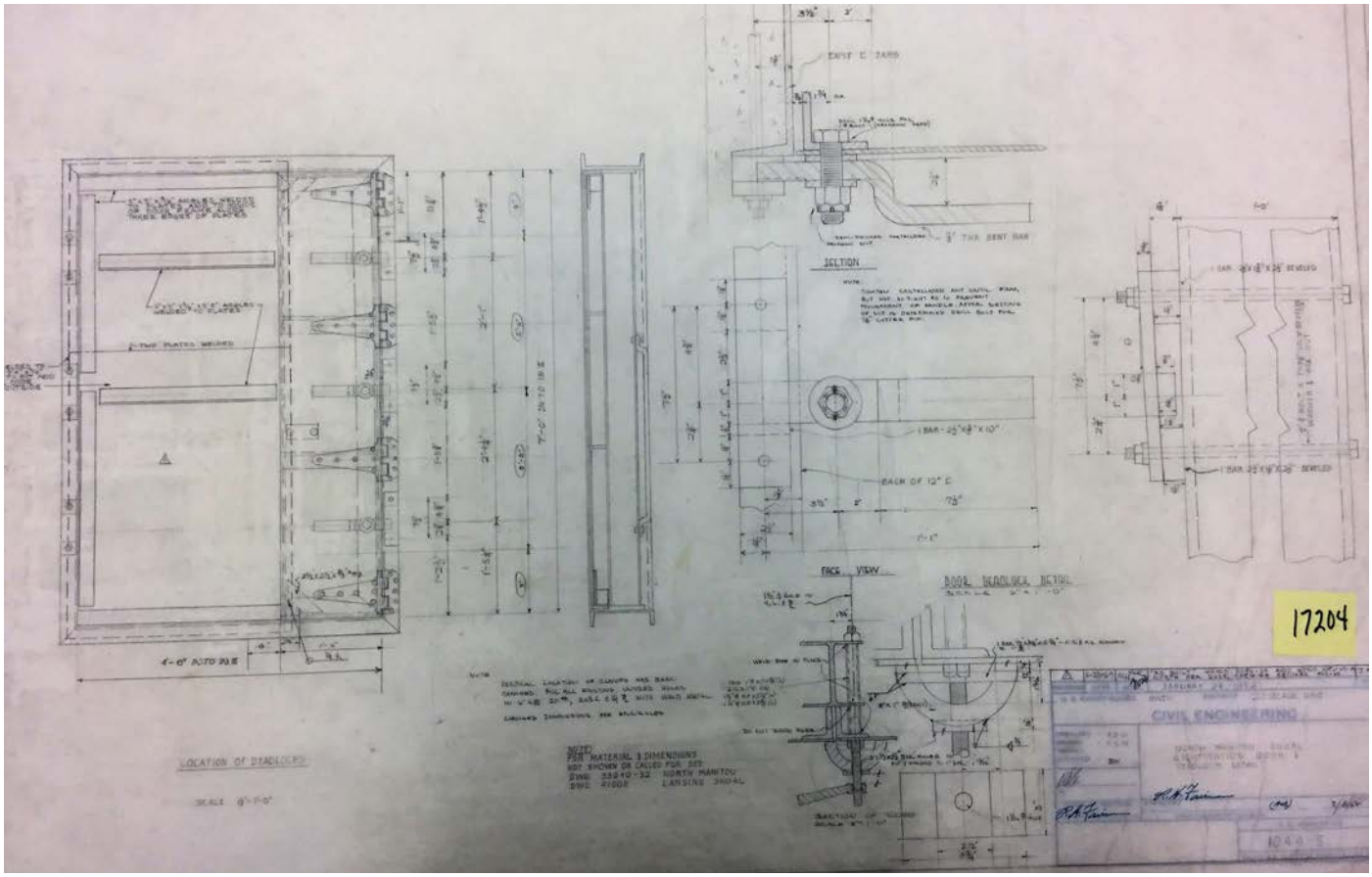


Figure 1B-56: 1962 drawing, marked as-built in 1969, showing modifications to the sea doors.

Review of photos from the late 1960s - early 1970s (Figures 1B-47 and 1B-55) indicate that the some of the exterior paint colors had been changed by this time. The lantern roof and radiobeacon antennae were now red instead of black; and the railings at the perimeter of the three decks were now gray instead of the former black. The red, white and blue USCG emblem had also been painted on the east face of the concrete pier and a large USCG sign was mounted to the southeast side of the tower.

Review of the July and August 1970 log books state that a member of the crew made rounds of the entire station hourly, 24 hours and 7 days a week to ensure that everything was secure and operating properly. One entry noted that the station's boat "leaks excessively above water line when raining or taking spray." A May 1976 drawing indicates that a 3-mile fog detector was installed that year.

Figure 1B-57: Circa 1976-78 photo of the pool table/ping pong table in the basement. Most recently, the pool table could be seen at Main Street Gallery in Leland. The North Manitou Light Keepers have recently reacquired the pool table and it will once again be reunited with the Crib.

Figure 1B-58: Circa 1976-78 photo of Coastguardsman Coby Thenikl getting a lift on the 25' motor lifeboat as it is hoisted up to the pier deck.

Figure 1B-59: Circa 1976-78 photo of two men on the pier deck holding a large fish the DNR had given them. Although they tried fishing themselves, they rarely caught any due to large vibrations from the station's generators.

Figure 1B-60: Circa 1976-78 photo in the dining/living/radio room of a crewman showing off his baking accomplishment. Coby Thenikl stated that the crewmembers would take turns cooking. They ate well - each season they would buy and butcher half a cow and were often given salmon by the DNR.

Figure 1B-61: Circa 1976-78 photo of the kitchen.

Figure 1B-62: Circa 1976-78 photo of the station dog "Daisy."

Figure 1B-63: Circa 1976-78 photo showing the freshly painted lighthouse and one of the boat derricks and the fog signal emitter. During a recent interview, Coby Thenikl said that the USCG crew repainted the entire lighthouse with rollers and brushes annually. Mr. Thenikl also stated that when not on watch, he would drown out the loud sound of the automated fog signal by wearing earplugs and listening to music on an eight-track headset.

Figure 1B-64: Circa 1976-78 photo of the boat derrick.

Figure 1B-65: Circa 1976-78 photo looking down at the Manitou Ferry docked at the station. The ferry would often bring supplies and mail out to the crew, unloading them at the water-level seadoors.

Figure 1B-66: Circa 1976-78 photo of a crewman sealing the joints in the concrete of the watch deck.

Figure 1B-67: Circa 1978-80 photo of a crewman and Daisy taking a nap.

Figure 1B-68: Circa 1978-80 photo of a crewman working on the radio beacon.

Figure 1B-69: Circa 1978-80 photo of a crewman in the lantern.

Figure 1B-70: Circa 1978-80 photo of a crewman climbing the ladder on the side of the lantern.

Figure 1B-71: Circa 1978-80 photo of a crewman looking out the window.

Photos provided by retired Coastguardsmen Coby Thenikl (station at the Crib 1976-1978) and Steven Licht (stationed 1978-1980) provide details of station life in the late 1970s, including that station dog. Mr. Thenikl's photos also include detailed view of some of the equipment that no longer remains at the station. In a recent interview, Mr. Thenikl said the crew spent time playing a lot of pool, table tennis, and cards; doing target practice with their guns; building model airplanes and motorcycles; playing cards and watching television. He also said that the entire lighthouse would shake during storms and high waves. Mr. Licht was a member of the last crew stationed at North Manitou Shoal Light Station.

AUTOMATION

An important trend in the U.S. Coast Guard's aid to navigation program during the second half of the twentieth century was automation. This conversion of the way lighthouses were operated obviated the need for resident keepers. By 1980 North Manitou Shoal Light Station was the last offshore light station in the Great Lakes manned by Coast Guard resident keepers. Its automation that year ended the era of keeper-occupied offshore light stations in the region.[93]

A key component of the automation, the original lens was removed from the lantern and replaced with a DCB-224 beacon powered by an underwater cable from the mainland.[94] A photo accompanying a period newspaper article about the unmanning of the station shows that everything was apparently removed from the interior, including furniture and appliances (Figure 1B-72).

Physical modifications to the structure included the construction of short concrete walls around the perimeter of the boatroom. These walls were constructed for spill containment, and a 10,000 gallon diesel tank was placed in the boatroom to power the generators during winter. Metal plates were installed over the windows, and the sea doors were welded shut and reinforced with steel angles.

Drawings from 1981 or 1987 (the pencil is smudged and unclear on the drawings) indicate that steel plates were installed over the concrete at the pier deck and watch deck (Figures 1B-73 and 1B-74). The steel plates were lapped and welded at joints. The steel plates extended down the vertical face and were bolted into the concrete at the perimeter.

A submarine electrical cable was installed out to the station sometime between 1980-1990. The North Manitou Lightkeepers have noted that the cable does not appear on the 1988 nautical charts but does appear on the 1990 chart. The NMLK have located the cable utility box on mainland Michigan near Pyramid Point (Figures 1B-75, 1B-76 and 1B-77) but the operating condition is still undetermined. Figures 1B-78, and 1B-79 are thought to be taken in the late 1980s, after the underwater electrical cable was installed. Note the sign on the side of the tower that reads: "U.S. COAST GUARD CABLE CROSSING DO NOT ANCHOR ." It is assumed that the boat derricks were removed sometime in the 1990s, as they are no longer present in photos with solar panels (Figure 1B-80).

Last manned light station

Coast Guard crewmembers load furniture and personal belongings from the North Manitou Shoals light station to the Coast Guard cutter Biscayne Bay on Friday — signaling the end of an era. North Manitou Shoals was the last manned off-shore light station in the Great Lakes, according to the Coast Guard. The lighthouse, now fully automated, has been manned by a crew of five (three at the station at all times) during every shipping season (April to December) since it was built. Frequently called "the crib," the 78-foot high lighthouse was built in Frankfort in 1934 and was floated out and sunk at its permanent location nine miles from Leland, five miles from South Manitou Island, three miles from North Manitou Island, and four miles from Pyramid Point in Leelanau County. More photos and stories will be published in the Record-Eagle next week.

Figure 1B-72: 1980 article in the Traverse City Record Eagle regarding the automation of the station.

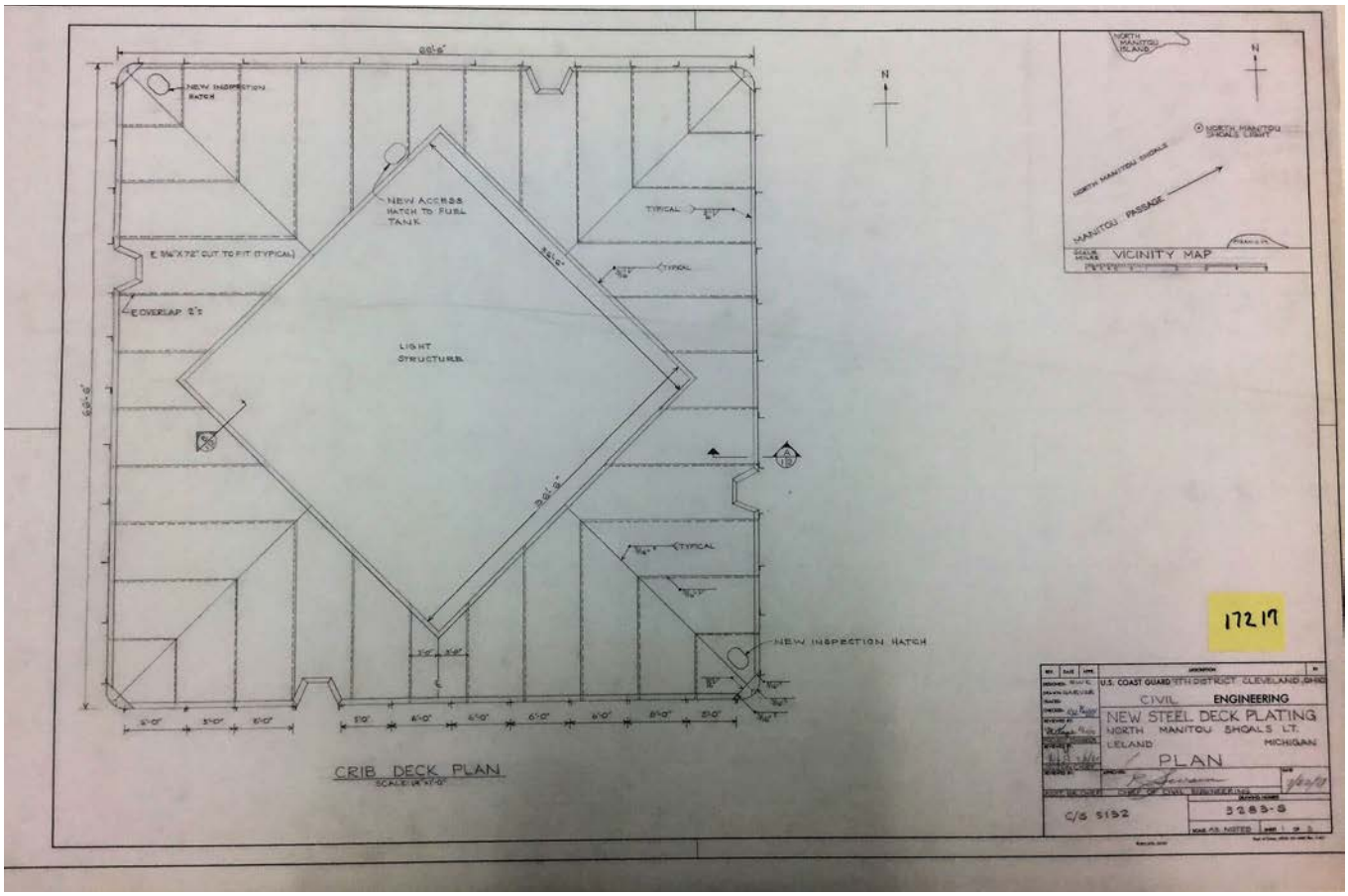


Figure 1B-73: 1980s drawings for installation of steel plates on the pier deck.

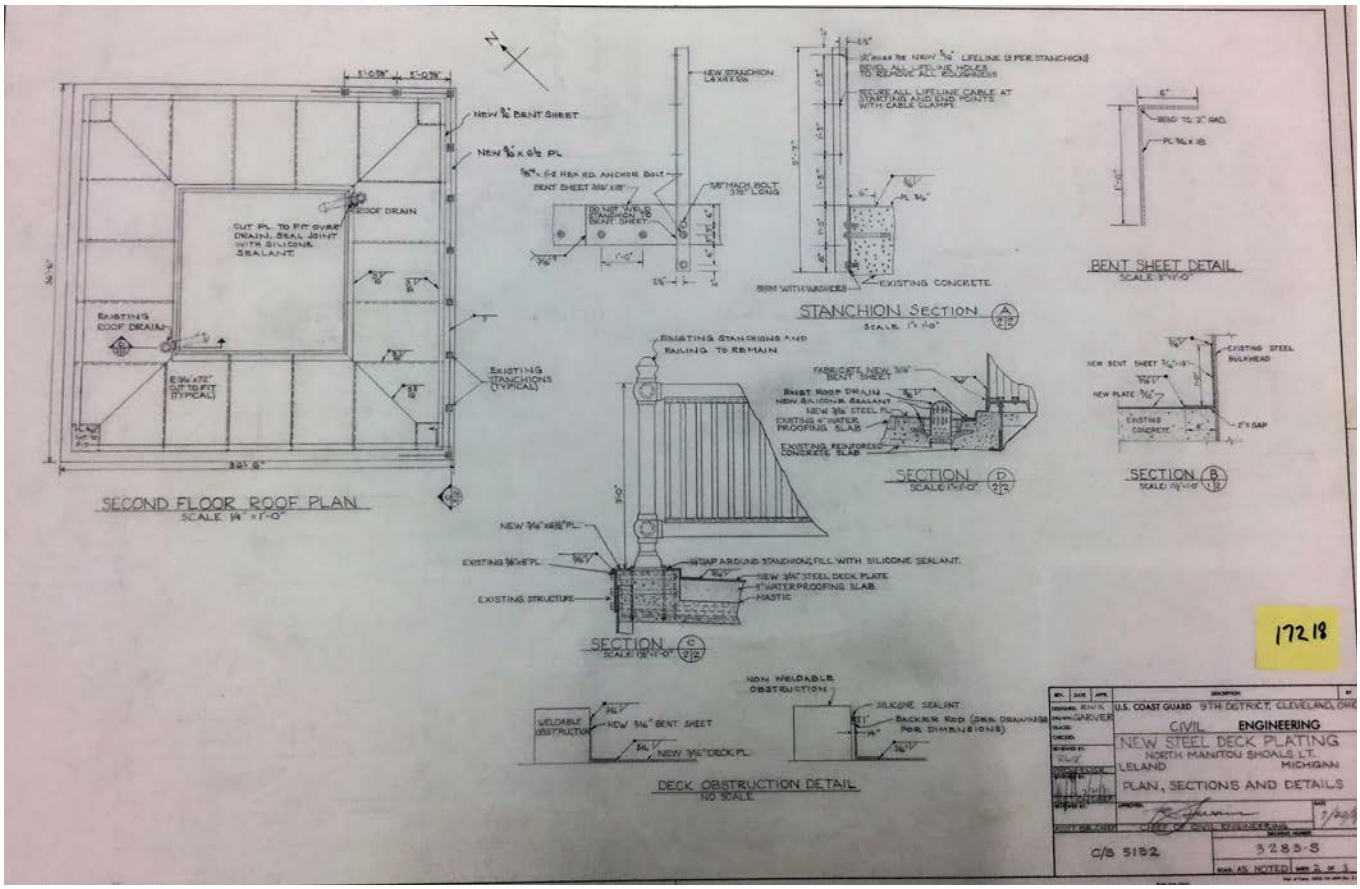


Figure 1B-74: 1980s drawings for installation of steel plates on the pier and watch decks.

Figure 1B-75: Google Earth capture showing the location of the location of the cable utility box.

Figure 1B-76: Google Earth capture showing the location of the location of the cable utility box.

Figure 1B-77: 2019 photo of the cable utility box.

Figure 1B-78: Circa 1978-80 photo of the station.

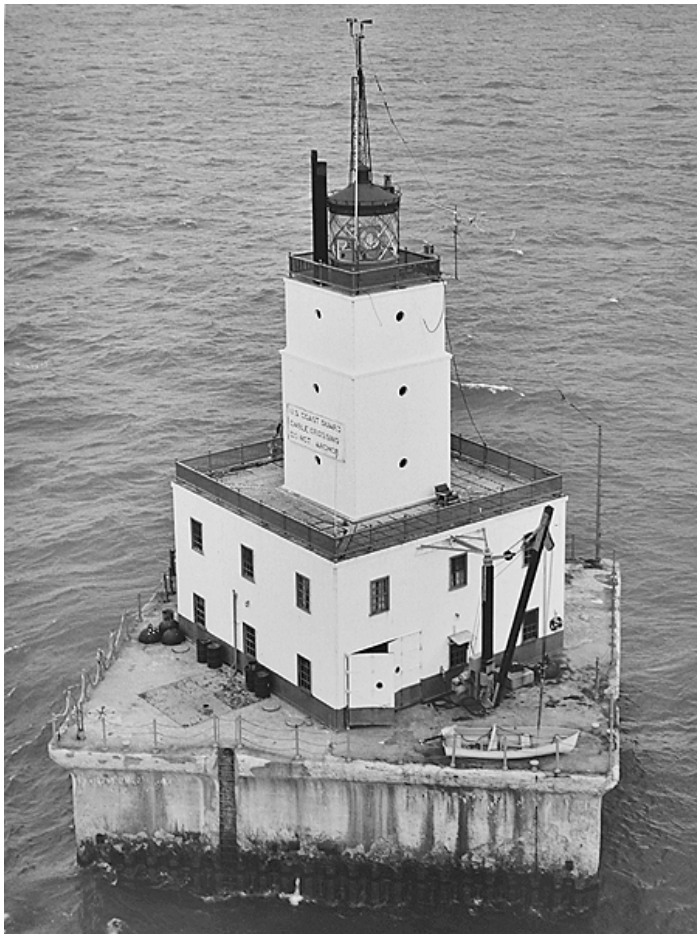


Figure 1B-79: Circa late 1980s - 1990s photo of the station.

Figure 1B-80: Circa 2000 or later photo of the station.

RECENT HISTORY

According to the National Register nomination form, the light's power source was replaced in 2000 with a battery system recharged by a solar array mounted on the light tower. This power system also powers the lighthouse's automated modem fog signal and the RACON radar beacon. According to the Lighthouse Friends website, "In December 2000, concerned citizens from Glen Arbor, Maple City, and Walled Lake, Michigan, met to form North Manitou Shoal Light Preservation Society (NMSLPS), a nonprofit organization whose goal was to promote the preservation and restoration of North Manitou Shoal Lighthouse. After determining that the dollar amount for restoring the lighthouse to an acceptable standard would be considerable, the group abandoned its effort."

The USCG prepared a nomination in 2004 and the station was then listed in the National Register of Historic Places in 2005. The nomination form states that in 2004-2005, the station was being leased to the aforementioned NMSLPS. The nomination stated that the modern Vega Industries VRB-25 marine beacon in place at the time signaled a flash every 15 seconds and had 23-mile range. The automated fog signal sounded two 2-second blasts every 20 seconds year-round. A RACON radar beacon was also mounted on the lantern deck.

After sitting vacant and minimally maintained for 35 years, in May 2015, North Manitou Shoal Lighthouse was declared excess to the needs of the United States Coast Guard and made available to eligible organizations under the provisions of the National Historic Lighthouse Preservation Act of 2000. Qualified entities were

given sixty days to submit a letter of interest and were required to obtain a conveyance from the State of Michigan for the bottomlands on which the lighthouse stands. When a new custodian was not found, the General Services Administration initiated an online auction for the lighthouse on July 15, 2016 with an opening bid of $25,000. Four bidders participated in the auction, which ended on September 27, 2016.

The non-profit North Manitou Lightkeepers (NMLK) was the winning bidder. In June 2017 NMLK completed its acquisition upon receiving approval from the Michigan Department of Environmental Quality to occupy the "bottomlands" (at the bottom of Lake Michigan) on which The Crib sits.

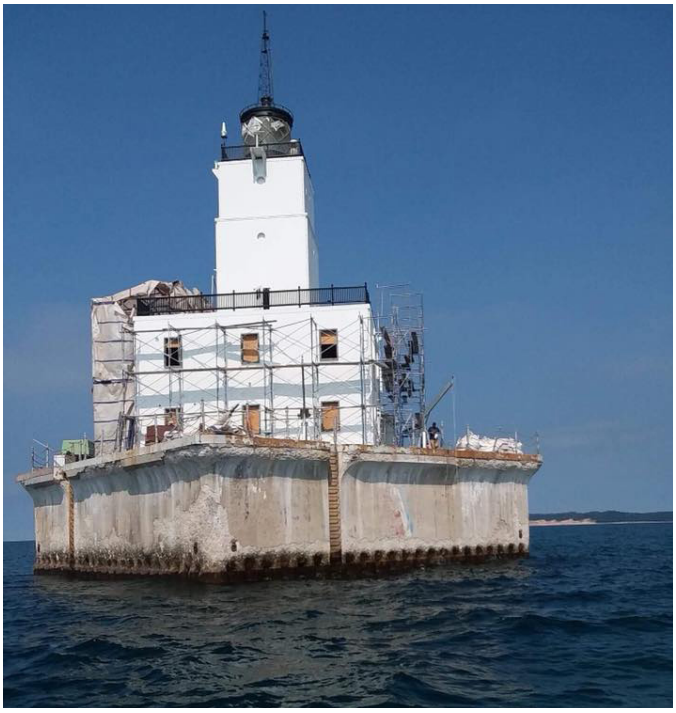


Figure 1B-82: 2018 photo of exterior painting in progress. Note several windows have been removed for restoration.

Figure 1B-81: 2018 photo with scaffolding installed for exterior painting.

Figure 1B-83: 2018 photo of exterior painting in progress.

Figure 1B-84: 2018 photo of lantern restoration.

Figure 1B-86: 2018 photo of windows being restored at Mihm Enterprises shop.

Figure 1B-85: 2018 photo of windows being restored at Mihm Enterprises shop.

Figure 1B-87: 2019 photo of restored window being reinstalled.

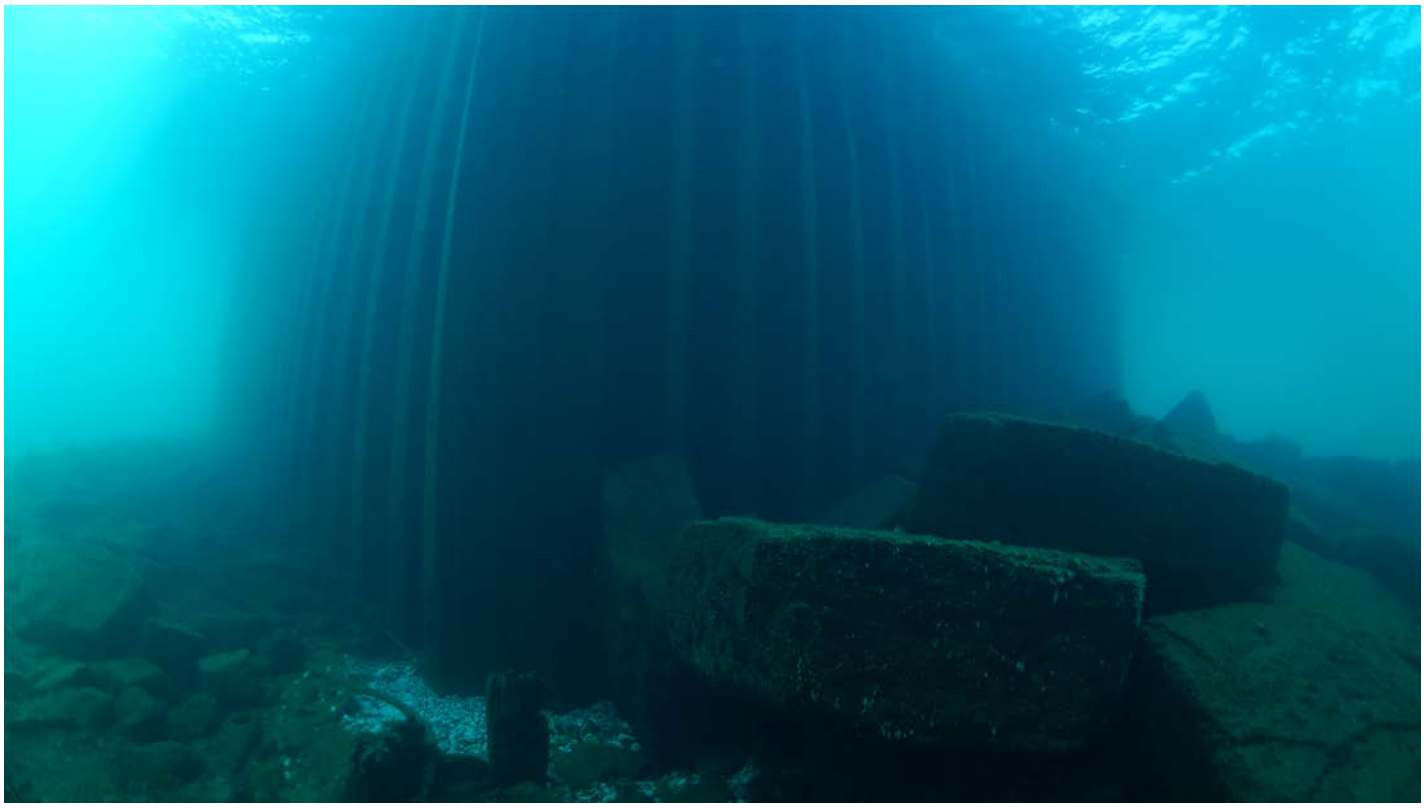


Figure 1B-88: May 2020 photo of the foundation and surrounding bottomland.

The NMLK has undertaken several stabilization and restoration projects since acquiring the station. Work completed to date includes removal of hazardous materials (lead-based paint, asbestos and bird guano) and general cleanup; installation of temporary boat/equipment hoists; extensive exterior painting; interior painting of the lantern; and restoration of the windows. NMLK has a membership program inviting those who share the passion, dream and commitment to care for this piece of history to join in on the mission. They have also launched their "Campaign for the Crib" capital fundraising effort to cover the rehabilitation costs of the coming years. Further, NMKL has committed matching funds to the Michigan Lighthouse Assistance Program grant they received to develop this Historic Structure report.

Figures 1B-81 through 1B-87 are several photos of the restoration efforts in progress. In July 2019, the LED lens was replaced and a smaller solar panel was installed. The NMLK conducted an underwater evaluation of structure and bottomlands in May 2020 (Figure 1B-88). Figure 1B-89 is a photo of the station in the summer of 2020.

Figure 1B-89: Summer 2020 photo of the station.

PART 1B ENDNOTES

1. Hyde, Charles K, National Register of Historic Places Nomination: United States Coast Guard Lighthouses and Light Stations on the Great Lakes: Multiple locations in IL, MI, MN, NY, OH, PA and WI, Historic American Engineering Record and the U.S. Coast Guard, 1979.

2. Edwards, Lissa, "Explore Manitou Passage Shipwrecks, Lighthouses and Legends," August 20, 2018, My North, https://mynorth.com/2018/08/explore-manitou-passage-shipwrecks-lighthouses-legends/, accessed January 15, 2020.

3. Campbell, Christina, "Mysterious, madness and intrigue of the Manitou Passage," July 31, 2003, Glen Arbor Sun: Here to enlighten you, http://glenarborsun.com/mysterious-madness-and-intrigue-of-the-manitou-passage/, accessed January 15, 2020.

4. Quinn Evans Architects, "Historic Structure and Cultural Landscape Report: South Manitou Island Light Station (Historic Structures 51-120 A-I), Sleeping Bear Dunes National Lakeshore, Empire, Michigan," National Park Service, 1999.

5. Lighthouse Clipping Files, South Manitou Island Light Station, Lake Michigan, Michigan, General Records of the U.S. Coast Guard, Record Group 26; National Archives Building, Washington, DC.

6. "Historic Structure and Cultural Landscape Report: South Manitou Island Light Station," 1999.

7. "North Manitou Shoal, MI," Lighthouse Friends, https://www.lighthousefriends.com/light.asp?ID=714, accessed January 8, 2020.

8. Ibid.

9. "1908 Light Vessel," Lighthouse Clipping Files, South Manitou Island Light Station, Lake Michigan, Michigan, General Records of the U.S. Coast Guard, Record Group 26; National Archives Building, Washington, DC.

10. Bisher, Karmen, & Perunko, Jennifer, Koski-Karrell, Daniel, Ph.D. (Eds) National Register of Historic Places Nomination: North Manitou Shoal Light Station, Michigan Historical Commission, May 3, 2005.

11. Ibid.

12. Ibid.

13. "Lightship Huron LV 103/WAL 526, MI," Lighthouse Friends, https://www.lighthousefriends.com/light.asp?ID=166, accessed January 8, 2020.

14. Hathitrust.org, "Light list, Volume VII, Great Lakes, United States and Canada, Department of Transportation, U.S. Coast Guard," https://babel.hathitrust.org/, accessed January 10, 2020.

15. Ibid.

16. "Lightship Huron LV 103/WAL 526, MI," Lighthouse Friends.

17. Works, N.M., Assistant Superintendent, Office of Superintendent, 12th District, Milwaukee, Wisconsin, to the Commissioner of Lighthouses, Department of Commerce, Lighthouse Service, Washington, D.C., January 6, 1932, Records of the United States Coast Guard, Record Group 26; National Archives Building, Washington, D.C.

18. It is interesting to note that the form stated the permanent station would be in position for twelve months of the year. While that statement is true, it was still only fully operation by USLHS keepers approximately eight months of the year. Only a small automated winter light was in place during the winter months.

19. "Form 80: Recommendations as to Aids to Navigation, Department of Commerce, Lighthouse Service, Office of Superintendent of Lighthouses, 12th District, Milwaukee, Wisconsin," November 12, 1932, Records of the United States Coast Guard, Record Group 26; National Archives Building, Washington, D.C.

20. Virginia Commonwealth University. edu, "Emergency Relief & Construction Act of 1932," VCU Libraries Social Welfare History Project, Virginia Commonwealth University. https://socialwelfare.library.vcu.edu/eras/great-depression/emergency-relief-and-construction-act-of-1932/, accessed January 27, 2020.

21. "Form 80: Recommendations as to Aids to Navigation, Department of Commerce, Lighthouse Service, Office of Superintendent of Lighthouses, 12th District, Milwaukee, Wisconsin," November 12, 1932, Records of the United States Coast Guard, Record Group 26; National Archives Building, Washington, D.C.

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23. Ibid.

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88. Letter from David H. Day, Jr., Glen Haven Canning Company to Supeterintedent of Lighthouses, Milwaukee, Wisconsin. Set. 28, 1937.

89. Letter from G. B. Skinner, Superintendent, 12th District, Milwaukee, Wis. To Commissioner of Lighthouses, Washington, D.C. October 23, 1937.

90. Ibid.

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92. Letter from Doris A. Koivula, Manager, Land Office, United States Department of the Interior, Bureau of Land Management, Eastern States Land Office to Commandant (FS-6) US Coast Guard, Washington, DC. January 7, 1966.

93. NRHP nomination form

94. The NRHP nomination form states that the underwater cable was installed in 1980. A 1979 drawing for automation corraborates this, as it calls for installation of the installation of the cable crossing hazard sign on the side of the light tower. However, the NMLK believes that it was installed later in the 1980s, as the cable does not appear on the 1988 nautical charts but does appear on the 1990 chart.

NORTH MANITOU
LIGHT KEEPERS

1C Chronology of Development + Use

This section provides a summary of the construction, modifications, and use of the station. This section was developed through analysis and coordination of the historical information obtained with the physical evidence observed during on-site physical investigation.

CHRONOLOGY & ANALYSIS OF ALTERATIONS

This section provides a summary of the modifications of the existing structure at the North Manitou Shoal Light Station. This section was developed through analysis and coordination of the historical information obtained with the physical evidence observed during on-site physical investigation and materials analysis.

Exterior Paint Colors

Review of historic documentation indicates that the original exterior paint scheme consisted of:

- Cream: Metal structure
- Black: Windows, deck railings, lantern and radiobeacon antennae

Review of the annual *Light Lists* and historic photos indicates that the exterior paint scheme changed to white, gray and red between 1959 and 1961.

- White: Metal Structure
- Gray: Windows, deck railings, lantern
- Red: Lantern roof and radiobeacon antennae

The original paint colors were applied when the station was painted in 2018-2019.

Light/Lens Replacements

- The original Westinghouse airway lens remained in the lighthouse the entire time it was a manned station from 1935 through 1980 (Figure 1C-01). A small light was also installed on the exterior of the lantern in 1935 and was used as the winter light until 1980.
- The original lens was removed in 1980 and replaced with a Directionally-Coded Beacon DCB-224 manufactured by Carlisle-Finch when the station was automated (Figure 1C-02). A drawing made in preparation for automation of the station shows that two emergency lights were also installed on the lantern deck. These were noted as Tideland 300MM (RED).
- The DCB-224 lens was replaced with an acrylic variable rotating beacon (VRB) at an unknown date before 2005, presumably in the 1990s (Figure 1C-03).
- The first LED lens was installed in the station sometime after 2005 (Figure 1C-04).
- A temporary, smaller LED lens was installed in November 2017 (Figure 1C-05). This temporary beacon was installed due to the removal of the large solar panel for exterior painting.
- The third and current 2-layer LED lens was installed in July 2019 (Figure 1C-06).

Fog Signal Equipment Changes

- New diesel generators, electrical distribution and control panels on racks were installed in the machinery room between 1945 and 1954.
- The Tyfon air diaphones were replaced with a fog signal emitter in 1966. This change included removal of the two Tyfon air horns from Level 5 and the openings through which they projected were covered with steel plate. The new fog signal emitter was noted on the bill of materials as an API ELG-300/02. It was mounted on new metal brackets that extended from the lantern deck. An emergency fog signal was also installed on the lantern deck in 1980. It was noted as an API FA 232.
- An automated fog detector was installed in 1976.
- A new fog signal, which is an on-demand, boater activated fog horn, was installed in July 2019. A new RAYCON radiobeacon was also installed on the lantern deck.

Figure 1C-01: Photo of the original 4-sided airway-beacon lens installed in the North Manitou Shoal Light Station from 1935 - 1980. This lens is currently on display at the Cannery Boat Museum in historic Glen Haven within the Sleeping Bear Dunes National Lakeshore.

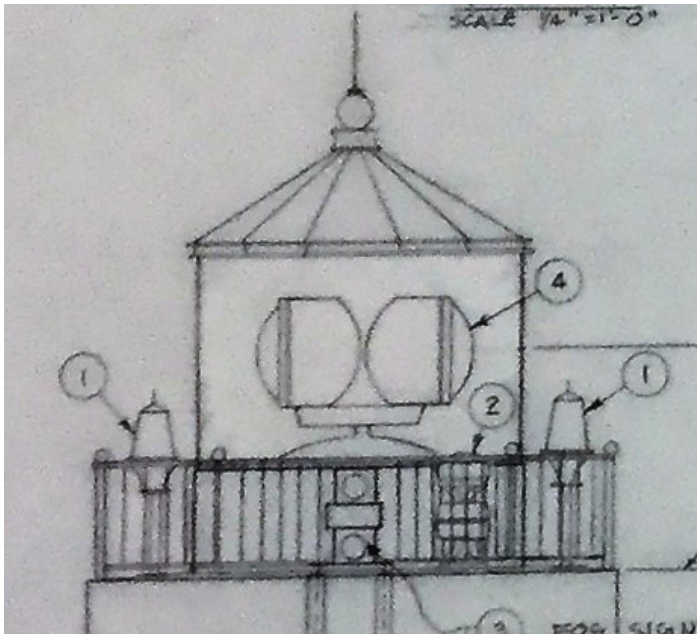


Figure 1C-02: Portion of a drawing for installation of the DCB-224 lens installed in 1980 when the station was automated.

Figure 1C-03: Photo of the VRB lens installed circa 1990s.

Figure 1C-04: Photo of the first LED lens installed at the station sometime after 2005..

Figure 1C-05: Photo of the temporary lens installed during construction in 2017.

Figure 1C-06: Photo of the VLB44R-2.5-2T light by Vega Industries currently installed in the North Manitou Shoal Light Station.

Other Exterior Modifications

- Flagpole removed from southwest corner of pier deck (L-1) and shorter flagpole installed at lantern level – (between 1940-1967 based on photos)
- Metal covers installed over windows (1980)
- Cable crossing sign HAZARD SIGN added to exterior side of tower (similar to one that had been on Charlevoix light (ca 1980-1989). It is unknown when this sign was removed.
- Steel plates installed over concrete at pier and watch decks (1981 or 1987)
- Solar panels installed on watch deck (2000)
- Metal flues that extended from lantern deck to above lantern roof removed (ca 1990s)Two boat-hoisting derricks removed from pier deck (ca 1990s)
- Temporary boat hoists installed (2017)
- Large solar panel removed from watch deck and smaller, temporary solar panel attached to south side of Lantern Deck to accommodate exterior painting (2017)
- Exterior painted (2017-2018)
- Windows restored (2018-2019)
- New, smaller and more efficient solar array on the lantern (2019)

Other Interior Modifications

- Wood-framed walls were constructed in the equipment room, dividing it into three rooms (ca 1970s-80s)
- Spill containment walls added around perimeter of boatroom (1980)
- The concrete containment wall in front of one of the boat doors was removed so that the contractor could roll their equipment in to the boat room for winter storage. (2017)

Chronological Timeline

As presented previously in detail, the navigational aids at North Manitou Shoal and adjacent islands have continually evolved during their lifetimes. As was typical for all light stations, physical change was often directly correlated with necessity in terms of continuous efforts to improve the efficiency of the aids to navigation to mariners navigating this region of Lake Michigan. Due to this particular station being confined on a single pier structure, physical modifications of the current structure were quite limited.

The following is a summary of the development and use of the North Manitou Shoal Light Station, including the former lightships at the shoal. The operation and discontinuing of the light stations at North and South Manitou Islands are also included as reference of the context of navigational aids in the vicinity. This chronological timeline is divided into distinct episodes of time that are based on significant events, activities, and/or physical changes at the station.

Episode 1: 1908 - 1932

Significant features and/or events: Shoal had developed requiring need for aid to navigation; light vessels operated as navigation aids; preliminary planning for permanent light station

1908

- USLHS recommends appropriation for lightship due to recent development of shoal in the Manitou Passage southeastward of North Manitou Island

1910

- Change from United States Lighthouse Board to the United States Lighthouse Service / Bureau of Lighthouses
- First lightship put into service (Light Vessel LV55)

1926

- First lightship (LV55) taken out of service at end of navigation season

1927

- Second lightship put into service (Light Vessel LV89)

1932

- Assistant Superintendent visits Detour Reef Light Station for information relative to building similar offshore Light at North Manitou Shoal
- Preliminary plans prepared for station
- Site surveyed and stakeholders' input acquired for specific location of station on shoal
- Cost estimates prepared
- District Superintendent submits forms for Aid to Navigation appropriation
- Conference held at USLHS HQ in Washington to discuss details of project

Episode 2: 1933 – 1980

Significant features and/or events: Construction of the permanent station, manned operation, automation

1933

- Funding secured and construction begins
- Second lightship (LV89) taken out of service at end of navigation season

1934

- Third lightship put into service (Light Vessel LV103) at beginning of season and then taken out of service at end of navigation season and moved to Port Huron. Last surviving lightship. Now a museum in Port Huron.
- Construction nearly completed at end of year

1935

- Construction completed and station put into operation May 1st
- Exterior painting completed in summer

1937

- Discussions to acquire and rehabilitate private dock in Glen Haven, however, not undertaken.

1939

- USCG takes over operation from USLHS, station crew increased to three men

Circa 1945-1954

- Diesel generators and associated electrical system replaced

1952

- Boat derrick timber booms replaced

1957

- Heating system changed

Circa 1959-1961

- Exterior paint colors changed from cream with black accents to white with gray and red accents

1966

- Fog signal changed and emergency fog signal added
- Generators replaced

1969

- Deadbolts added and sea doors secured shut

Late 1960s - 1970s

- USCG sign hung on side of tower and USCG emblem painted on side of concrete pier

Episode 3: 1980 – 2015

Significant features and/or events: Station automated and no longer crew stationed; degradation of station; historical awareness with NRHP nomination

1980

- Aid to navigation equipment changed and emergency signals replaced
- Spill containment walls added in boatroom and large diesel tank installed to supply electricity to aids to navigation during winter
- Last year that the station is manned - all residential furnishings and appliances removed
- Metal plates installed over windows

1980-1990

- Underwater/submarine power cable extended to station from mainland

1990s circa

- Boat derricks removed or lost to weather/ sea

2000

- Solar power provided at station

Early 2000s circa

- RAYCON radar beacon installed on lantern deck

2005

- Station listed on the National Register of Historic Places

2015

- Station declared excess and made available through the National Historic Lighthouse Preservation Act (not transferred)

Episode 4: 2016 – Present

Significant features and/or events: North Manitou Light Keepers (NMLK) acquires station and begins preservation and restoration work, HSR

- 2016
  - North Manitou Light Keepers acquires station through GSA on-line auction
- 2017
  - Clean-up, temporary boat hoists installed, upper portion of exterior painted
- 2018
  - Remainder of exterior painted, lantern interior painted, replaced lantern glass, and steel windows removed
- 2019
  - Steel windows restored and re-installed
- 2019-2020
  - Historic Structure Report

PERIOD OF SIGNIFICANCE

The North Manitou Shoal Light Station was listed on the National Register of Historic Places in 2005. The Period of Significance is listed as 1935 to 1955 with Maritime History, Transportation, Architecture, and Engineering stated as the areas of significance. Applicable National Register Criteria that qualify the property for National Register listing are:

A: Property is associated with events that have made a significant contribution to the broad patterns of our history.

C: Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

The 1935 to 1955 Period of Significance was appropriate in that it spanned from the year that the station was put into operation through fifty years prior to the preparation of the National Register nomination. The end date of 1955 was likely established based on the National Register of Historic Places Criteria for Evaluation that indicates that "properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register." Interpretation of this aspect of the criteria often resulted in establishing an end date fifty years prior to the preparation of the "National Register of Historic Places Registration Form" for properties that had significance spanning several years (often beyond the end date set by the "50-year rule"). It is recommended that the Period of Significance be extended from 1955 through 1980 to include the entire time period that the North Manitou Shoal Light Station was a manned aid to navigation and includes the automation of the station.

Recommended Period of Interpretation

Period of Interpretation is utilized in this Historic Structure Report to inform the appearance of the station as it undergoes rehabilitation rather than the period used to guide educational or interpretive programming. The Period of Interpretation has been established to provide an appropriate, specific period of time within the station's evolution that should be recognized as a guide for specific rehabilitation treatments. The Period of Interpretation is based on the station's history, existing conditions and the recommended rehabilitation treatment strategy. The Period of Interpretation does not diminish the importance of the Period of Significance and the recommendation that the station's full history (especially including the recent and on-going rehabilitation) be included in future interpretive programming.

Since its construction, the North Manitou Shoal Light Station has served only one purpose—to serve as an aid to navigation. As such, alterations were mainly limited to technological upgrades and subsequent modifications have been related to these upgrades. Alterations over the last twenty years have been mainly deterioration of elements (rather than purposeful alterations) and the subsequent, recent stabilization and rehabilitation efforts undertaken by the North Manitou Light Keepers.

The alterations that had the most visual impact on the station were removal of the foghorns and boat hoisting derricks. Although the changes of paint color did change its appearance, the overall theme of very light tower with darker color accents, was maintained. Therefore, it is recommended that the period of 1935 - 1979 be established as the Period of Interpretation that should be recognized as decisions and details are made for the preservation and rehabilitation of the station. Specific treatment recommendations are included in Part 2.

The Crib
NORTH MANITOU
LIGHT KEEPERS

1D Physical Description

Documentation of the existing conditions at the North Manitou Shoal Light Station was performed by Mr. Ken Czapski, AIA, a registered architect in Michigan, and Ms. Cheryl Early, PE, a licensed professional engineer in Michigan, during a site visit on August 23, 2019. This team was accompanied by Mr. Dave McWilliam of the North Manitou Light Keepers, Inc. This section includes an assessment of the present day conditions at the light. Drawings of the existing present day conditions are located in Appendix C.

GENERAL

The North Manitou Shoal Light Station is a multi-level steel structure that rises over 80 feet above the surface of Lake Michigan. It is constructed on a massive concrete base, known as a "crib", that measures approximately 67 feet square at the main deck level. This concrete structure is supported by a submerged timber crib filled with both concrete and stone that rests on the Lake Michigan bottomland.

For purposes of this report, the different levels in the structure are identified as the Basement and Levels 1 through 6, as indicated in Figure 1D-01. Level 1 is also referred to as the Pier Deck level; Level 3 is referred to as the Watch Deck level; and Level 6 is referred to as the Lantern/Lantern Deck level. Overall views of the structure are seen in Figures 1D-02 and 1D-03. This report does not include any observation or assessment of the structure below the water.

Figure 1D-02: View of the North Manitou Shoal Light Station looking northwest.

Figure 1D-03: View of the North Manitou Shoal Light Station looking west.

Figure 1D-04: Water level steel access door on north side of concrete crib. Note spalling of concrete around opening and heavy organic growth above the water. The top of the steel sheet piling is visible on the right side of the photo at the water level. The steel ladder is missing

STRUCTURAL SYSTEM AND ANALYSIS

Overall, the existing steel framed tower with concrete slab decking is constructed as per the 1933 construction drawings. The "stacked cube" steel tower structure is set atop a square footprint concrete crib structure that, as per the drawings, is bearing on a square footprint timber cribbing system. A basement level is located at the top of the concrete crib, with the basement floor located approximately 9 feet above the 1933, 579.6 feet design datum (above sea level) of Lake Michigan, per the Construction Drawings.

Foundation

Cement grout was placed between the timber cribbing at the perimeter 10 feet of the square foundation and 7-inch furnace stone was placed in the spaces between the central timber cribbing members. Above the timber cribbing system, a 4-foot deep concrete mat foundation was placed. Approximately 6 feet of gravel fill is located above the mat and covered with a 4-inch concrete slab which serves as the basement floor of the tower. The side walls of foundation extending from the mat foundation to the Pier Deck Level, Level 1, are of formed cast-in-place concrete.

The concrete crib at the pier deck level is nearly square with an edge length of approximately 67 feet. The square crib is oriented to true north, with north, east, south and west sides. At the top of the crib, located 20 feet above the datum water level, the concrete is fluted outward from the

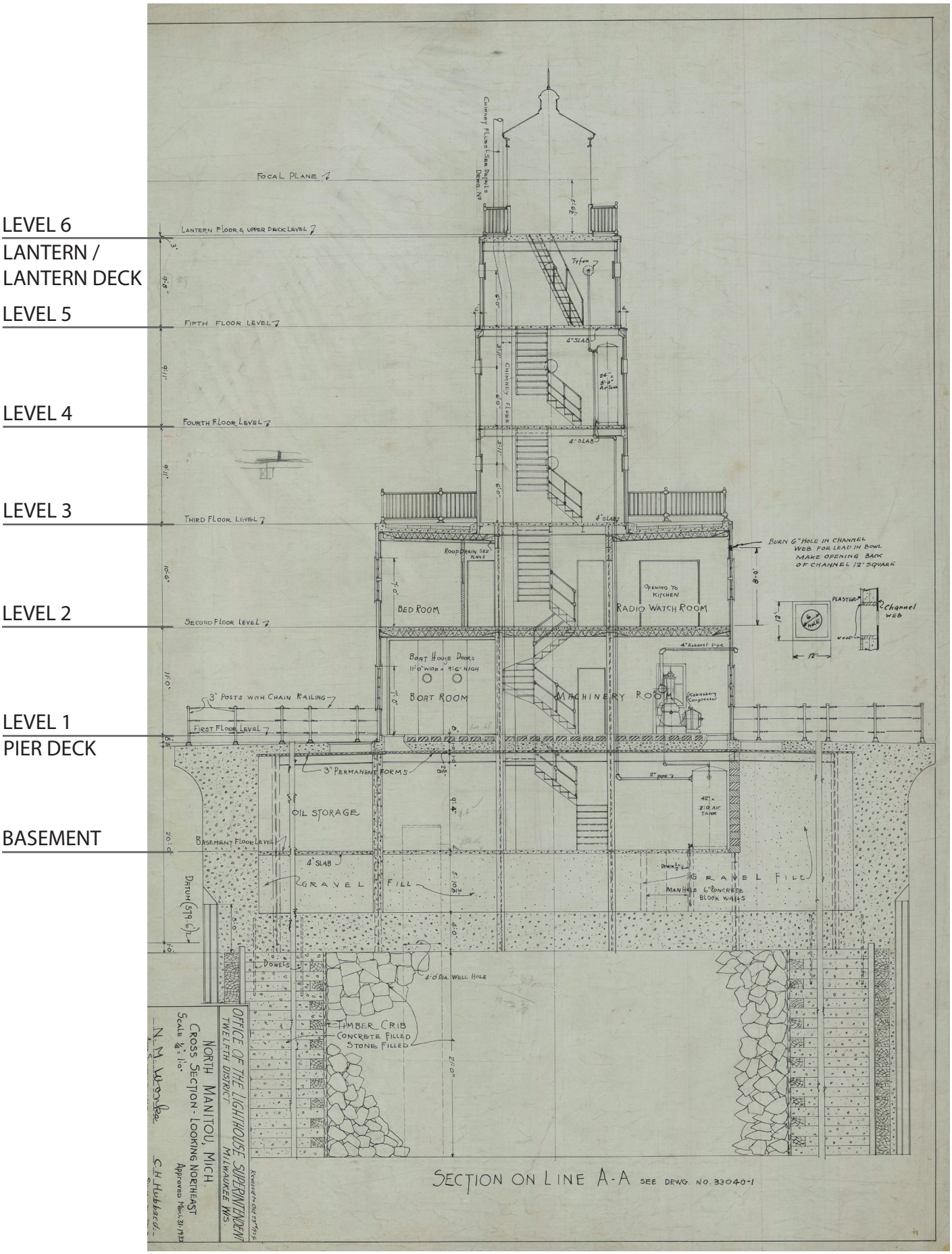


Figure 1D-01: Section drawing of the North Manitou Shoal Light Station

base on each side. The base of the concrete and timber crib is noted as 62 feet 6 inches square per the revised April 10, 1933, "Plan of Floating Slab and Sectional Elevations of Basement" drawing sheet in the original construction drawings, but as 60 foot square per a survey/soundings drawing dated August 8, 1933 (see opposite page). Historical written documentation from during construction also refers to it as 60 foot square.

Per the Construction Drawings and project specifications of the steel sheet piling, the bottom of the crib is located approximately 22 feet below the water datum level on the bottomlands of Lake Michigan. The steel sheet pile wall does not continue for the full height of the concrete crib; it was specified to be 50 feet in height, extending 4 feet above the 1933 design datum. In August 2019, the top of the sheet pile is just visible above the water (Figure 1D-04). The visual assessment of the structure was limited to the areas above the existing water level for this report.

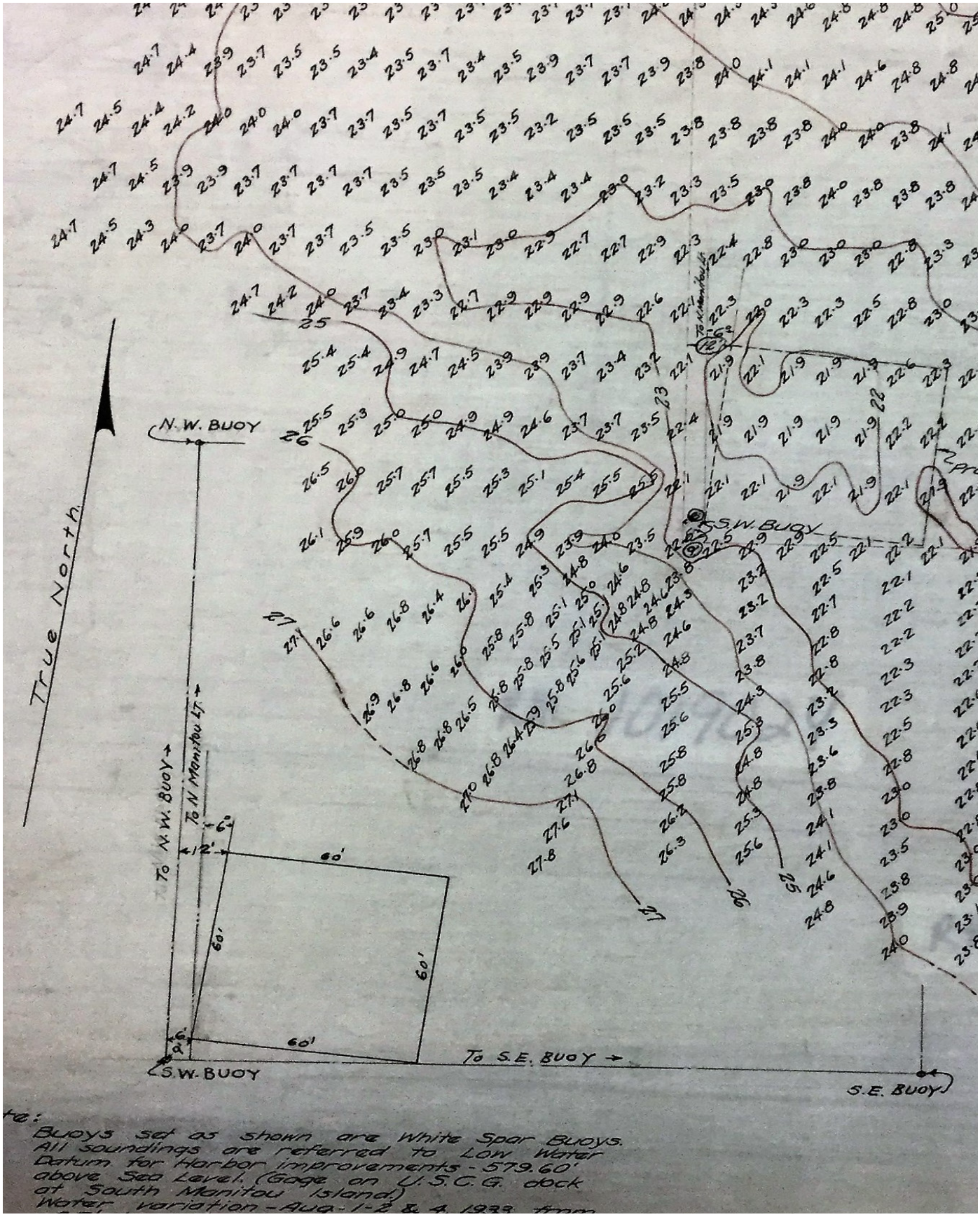
Organic growth is prevalent on the concrete crib for approximately 3 feet above the current water level (Figure 1D-04). Inset on each of the four sides of the concrete crib is a riveted steel framed ladder. The steel is visually corroded. Rungs are bent in some locations, and two are missing on the north elevation, at the ladder adjacent to a door located at the water level (Figure 1D-04). This steel framed door is corroded and allows water to infiltrate into the crib structure and basement of the tower. The concrete is spalled around the perimeter of the door.

The concrete is spalled over large areas in multiple locations exposing the outermost layer of steel reinforcing bars (Figure 1D-05). The reinforcing bars were observed to be square shaped with surface corrosion present. Significant deterioration of the concrete is visible near the water line, most likely related to freeze-

Figure 1D-05: Spalling over large areas of the concrete crib exposing reinforcing bars. Note the fluted top edge of the crib and the turned down steel plate bolted to the vertical edge of the flute. The steel sheet piling is visible at the water line.

Figure 1D-06: Crazed cracking at the vertical and underside surfaces of the fluted edge of the concrete crib.

Figure 1D-07: Overall northeast elevation.



Portion of August 8, 1933 drawing titled "NORTH MANITOU SHOAL LIGHT STATION DETAIL SOUNDINGS AT SITE #4, SOUNDINGS TAKEN AUG. 1-2 & 4, 1933. BY - D. BAILLIES & CREW OF U.S.L.H.S. LIGHT VESSEL #103"

Figure 1D-08: Corroded steel plates on exterior surface of pier deck, Level L-1.

Figure 1D-09: Typical guard rail post. Note eye nuts for anchor bolts at base of column and base plate with vertical stiffeners. Note missing top chain on left side of post.

thaw damage and erosion of the concrete. Crazed cracking is visible on the underside of the fluted top edge of the crib where the concrete has yet to spall (Figure 1D-06). Remnants of a painted flag can be seen on the east wall of the concrete crib.

The tower is located on top of the concrete crib, with a nearly 38 foot square footprint at the base of the tower, and nearly centered on the crib, but rotated 45 degrees respective of the square footprint of the crib (Figure 1D-07). This orientation creates triangular northeast, southeast, southwest, and northwest "corner" decks on the top surface of the crib. These corner decks and all the exterior portions of the top surface of the crib are covered with steel plates that extend down over the edge of the crib approximately one foot. This turned-down plate is bolted at a regular spacing to the concrete crib flute's vertical edge.

These steel plates were added as part of the USCG's 1980s mothballing effort, and are noted on the 1980 drawings as 5/8 inch steel plates. On the top surface, the plates are buckled and deflect underfoot. The edges of the steel plates are welded to each other. The top surface of the plates may have been previously coated but is currently corroded throughout (Figure 1D-08). An approximate three square foot area in the northwestern corner deck of the crib has undergone full section loss, exposing a granular fill between the steel and the concrete, and the top of the concrete crib surface. The thickness of the corroded plate in this area was measured to be 7/16 inches. The concrete surface was sound when struck with a hammer and exhibited no visible distress.

At the perimeter of the crib, three of the corners are chamfered approximately two feet. The southwest corner is square. There is a perimeter railing system in a state of disrepair that has undergone multiple repairs and replacements, although keeping intact the general concept of steel posts bolted to the top of the crib surface and three chains draping between the posts. The posts are generally spaced 6 feet on center. The style of base plate and anchor bolts vary, indicative of multiple repairs. Some plates are rounded or bell shaped in cross section, others are flat with vertical stiffener plates between the plate and post. The anchor bolts have either a square nut or an eye nut. The chain links are approximately 3/8 inch in thickness and 2 inches in length. Multiple posts are missing, and of those remaining, nearly all are corroded at the base of the post creating a "necked" section of the post. Several chains are missing or otherwise damaged (Figure 1D-09).

Figure 1D-10: Exterior curb between the pier deck, Level L-1, and the tower walls. Note single bolt of curb at the corner and the corner angle bolted to the end channels of each tower wall surface. The corroded steel plates on the deck surface are also visible.

Figure 1D-11: Warped steel leg of angle at window framing bolted to wall structure related to corrosion of the steel in this area.

Tower Exterior

The walls of the tower are painted steel channels aligned in a proud position with the channel extending for the height of the wall and the flanges turned inward. The width (or "d") of the channels is either 12 or 15 inches depending upon location and wall. Per the Construction Drawings, the 12 inch channels are designated as 12"-20.7#C and the 15 inch channels are designated as 15"-33.9#C. The 38 foot square footprint is continuous for two levels. At the third level, Level L-3, the footprint of the tower reduces to approximately 15 feet 6 inches square and continues upwards with this geometry until the fifth level, Level L-5. At the fifth level, the footprint reduces again to 14 foot 6 inches square. The cylindrical metal and glass lantern structure sits atop the steel framed tower at the sixth level, Level L-6. A steel framed antenna is centered and bearing on the sloped lantern roof. The insetting of the various floor levels creates walkable roof areas at the Watch Deck Level, Level L-3 and the Lantern Deck Level, Level L-6.

To create the corners of the steel channel framed walls, the channels are oriented 90 degrees respective to each other. The outermost flanges of each corner channel are secured with square headed bolts to a steel angle located on the exterior wall surface. The bolts were measured to be 7/8 inch diameter and spaced at 12 inches on center, but staggered respective of the legs of the connecting angle (Figure 1D-10).

At the base of the wall at the Pier Deck, Level L-1, there is an exterior metal curb that extends 3 inches above the Pier Deck and 5-1/2 inches outboard of the exterior walls. There is a continuous sealant bead between the vertical wall channels and the metal curb that is painted with no visible distress. There is a bolt extended up through the top surface of the curb at each of the corners of the tower (Figure 1D-10).

The doors and Level L-1 and Level L-2 window openings are framed with an outermost steel angle which is lapped and riveted to a second angle at the perimeter of the opening. The second angle is bolted with square headed bolts to the vertical steel channels of the wall structure. The leg of the second angle that is bolted to the wall structure is pitted and warped between the bolts in multiple locations indicating potential corrosion-induced section loss of these angles (Figure 1D-11). Holes located in the outermost angle leg were observed at a regular spacing, potentially for the anchorage of boards or shutters used to protect the windows.

The windows at Levels L-3, L-4 and L-5 are circular, port style windows inset within the thickness of the steel channel wall structure (Figure 1D-12).

The exterior walls of the tower and punched window and door openings had been painted recently. The steel surface is non-uniform in localized areas, indicating pitting of the steel had occurred prior to the recent re-coating effort (Figure 1D-13). Section loss for the full thickness of the webs of the channels was not observed from the respective deck levels.

Watch Deck Level, Level L-3

At the Watch Deck level, Level L-3, the walkable roof is sloped down towards the center of the tower, presumably to prevent water shedding down onto the Pier Deck, Level L-1, below. Roof

Figure 1D-12: Port style windows and corner angle connections of the upper portions of the tower wall assemblies.

Figure 1D-13: Pitted exterior surfaces of the wall channels and window angle frame.

Figure 1D-14: Roof drain and corroded steel plate at the watch deck, Level L-3. Exterior curb with single anchor bolt at corner of tower is visible.

Figure 1D-15: Corroded steel plates on exterior surface of watch deck, Level L-3. Note roof drain at bottom right of photo.

Figure 1D-16: Guard rail and bolted connection of turned down steel plate at edge of watch deck, Level L-3.

Figure 1D-17 Corroded steel plates on exterior surface of watch deck, Level L-3. Exterior curb with single anchor bolt at corner of tower is visible.

drains at Level L-3 were reported to be recently cleared to allow drainage of the Watch Deck level (Figure 1D-14). Both drain covers are broken.

The surface of the Watch Deck level, Level L-3, is covered with steel plates, similar to the Pier Deck level, Level L-1. The steel plates at Level L-3 are corroded in multiple locations with apparent section loss occurring (Figure 1D-15). At the edge of the Watch Deck level, Level L-3, the steel plate is turned down and a five-bolt pattern secures the vertical edge of the plate to each of the steel channels of the wall below (Figure 1D-16).

Similar to the Pier Deck, Level L-1, there is an exterior, metal curb between the tower wall and the Watch Deck exterior surface. The mainly horizontal surface of the curb is at a greater slope up toward to the tower wall than the curb at Level L-1. The metal curb is bolted to the structure below with a single bolt at each corner (Figure 1D-17).

The perimeter railing at the edge of the Watch Deck level, Level L-3, is more ornate than the rail at the edge of the Pier Deck, Level L-1. Painted black, the rail extends 36 inches above the Watch Deck level with 2-7/8 inch outside diameter steel pipe sections used as both vertical posts and horizontal top and bottom rails. Square balustrades, closely spaced together, are welded to a bar that is bolted to the top and bottom rails. The vertical posts are spaced 5 feet apart and are bolted to the Watch Deck, Level L-3, with base plates that have rounded or bell-shaped cross sections. One ball spindle at a corner location is missing atop the vertical post (Figure 1D-18).

Figure 1D-18: Missing top "ball" of guard rail at corner post.

Figure 1D-19: Lantern deck, Level L-6.

Lantern Deck Level, Level L-6

A textured rubber walking mat covers the surface of the exterior Lantern Deck, Level L-6. The perimeter railing is similar to the rail at the Watch Deck, Level L-3, excepting the vertical posts are spaced with 80 inches clear between the posts. There is a cementitious material partially embedding the posts at the base plate connection, presumably as an effort to maintain the watertightness of the structure (Figure 1D-19).

The lantern structure is cylindrical shaped with a central peaked metal roof. The walls of the lantern are of steel construction with a latticed, curved glass window pattern on the upper half of the walls. Both the interior and exterior of the lantern have been recently re-coated. No evidence of significant corrosion prior to the recent re-coating was observed.

Tower Interior

Overall, the interior of the tower appears to be nearly unaltered from its original finishes and room configuration. The plaster walls and concrete floors are painted and the paint is peeling. Floor finishes in the living areas have been removed in some areas leaving in place remnants of the flooring adhesive. Painted ceilings are primarily intact. Access to the structural framing members is limited to localized areas where the finishes have deteriorated or been removed.

Figure 1D-20 Steel beam and CMU wall construction visible in basement. Note water staining on CMU walls and skylight opening in ceiling. Note vertical crack between chamfered concrete corner and CMU wall.

Figure 1D-22: Vertical crack in interior surface of the concrete crib wall at west end of water level access door.

Figure 1D-21: Horizontal steel reinforcing extending past end of CMU wall at chamfered concrete corner. Lower bar is further inset into CMU than upper bar.

Basement

The basement rooms are clean and free of debris. The painted concrete slab floor is in good condition with little to no distress observed excepting flaking of the paint. The walls are located as and of the material indicated in Construction Drawings. Specifically, the northwest wall of the basement is a reinforced concrete wall; the north wall of the water level access door is the interior surface of the concrete crib wall; and the walls around and above the water level access door are reinforced concrete walls. The remaining walls are of concrete masonry unit (CMU) construction of 6 inch, 8 inch, and 12 inch widths. Notes included in the Construction Drawings indicate more of the construction detail of the floor and walls including embedded steel reinforcing sizes and spacings.

The area below the north deck at Level L-1 is open allowing access to the water level access door through the crib. Water was observed to be washing into the space below the access door, at the bottom of the concrete stairs that extend down from the basement floor slab to the access door. There is a drain at the interior door landing level, which is shown in the original Construction Drawings. The drawings are unclear on where the water exits the drain. Considering the elevation of the water at the time of the survey, the drain may regularly be filled with water.

Figure 1D-23 Step cracking at base of CMU wall.

The exterior steel columns of the tower are visible within or at the top of the basement walls in multiple locations (Figures A-1 and A-2). The tower corner columns are bearing on a concrete pier, constructed integrally with the concrete crib (Figure A-3). The interior most surface of the concrete piers is visible in the basement corners, as chamfered wall corners due to the orientation of the tower with the crib structure.

Figure 1D-24: Corroded southernmost interior column at basement level.

The basement walls are painted, and the paint is peeling and flaking off the walls. Water staining is prevalent on the perimeter basement walls (Figure 1D-20). The reinforcing bars designated in the construction drawings within the CMU wall mortar joints extend beyond the length of the masonry walls at the chamfered corners of the tower foundation construction (Figure 1D-21). Where the concrete chamfered basement corners intersect with the adjacent basement walls, the basement wall is typically cracked vertically, with the cracks measuring up to 3 mm in width (Figure 1D-20). At the west end of the water level access door, the concrete crib wall is cracked on the interior surface vertically; the width of the crack was measured to be 3 mm (Figure 1D-22). A minor step crack is present in the base courses of the CMU wall in the coal room (Figure 1D-23).

Figure A-1 Exterior steel column of tower within the basement wall.

Figure A-2 Exterior steel column of tower within the basement wall.

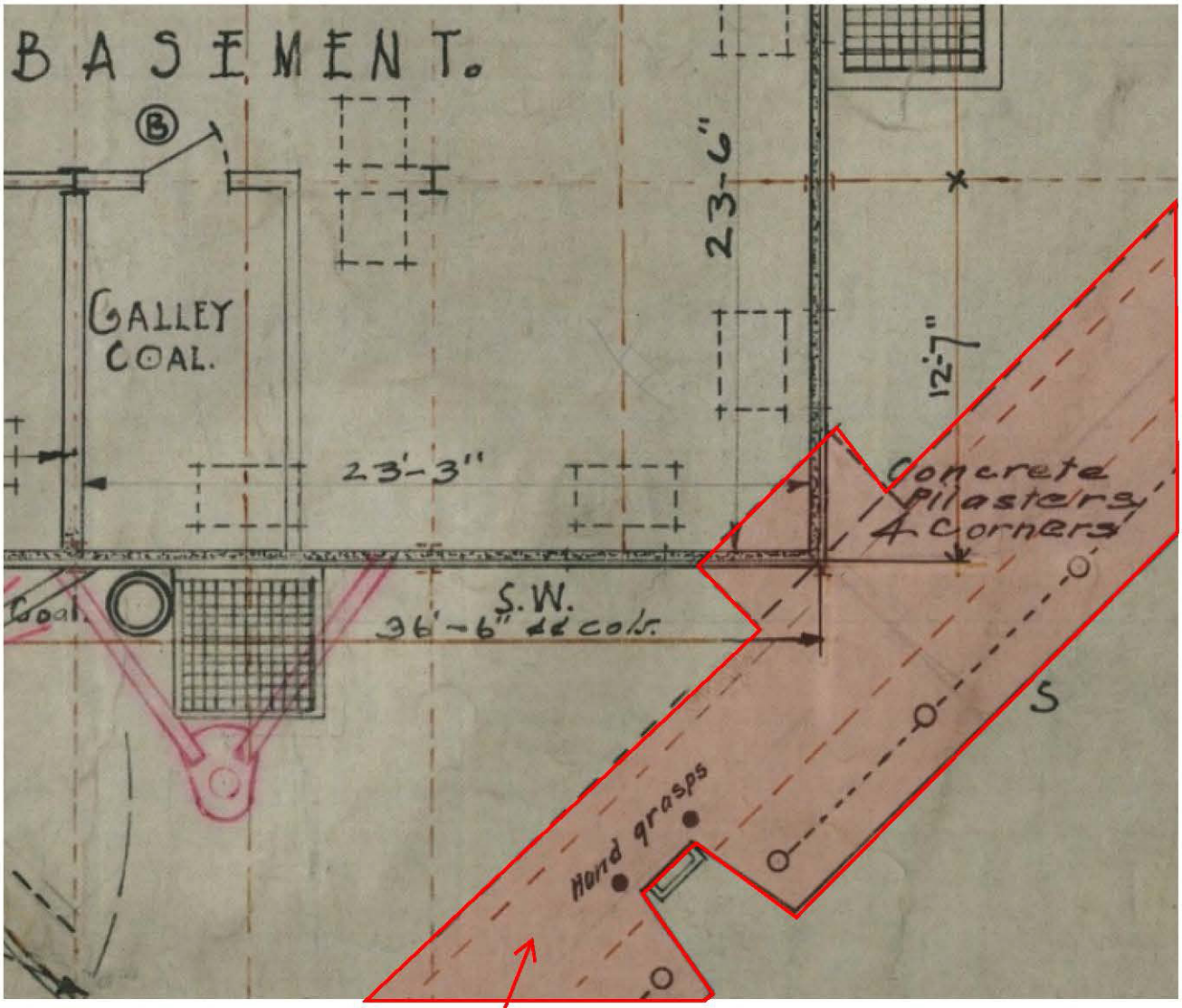


Figure A-3 Portion of original construction drawing at basement level.

Figure 1D-25 Base of southernmost interior column at basement level.

Figure 1D-26: Floor drains at boat room at pier deck, Level L-1.

Figure 1D-27: Typical plaster finishes on interior, note painted steel column between doors.

Figure 1D-28 Damaged plaster and lath in stairwell.

Figure 1D-29 Cracking in plaster at right side of door from boat room to entry. Note horizontal crack at top of wall near ceiling.

Figure 1D-30 Ghosting of metal lath through plaster ceiling. Note dark fiberglass insulation indicating potential water infiltration by boarded-up window.

Figure 1D-31 Interior wall construction in equipment room.

Figure 1D-32 Southern end of ceiling joists over equipment room that are supported on wood plate but wall studs are missing.

The steel columns supporting the tower framing above are typically embedded within the basement walls except for the corner columns that are bearing on top of the concrete piers constructed integrally with the concrete crib walls. Except for the corner columns, the steel columns are embedded into the basement concrete slab, and per the Construction Drawings extend through the concrete mat foundation to the top of the stone fill in the timber crib at the bottom of the structure.

The steel columns, where exposed, are painted. The paint is flaking, and surface corrosion is present, especially at the base of the columns. There are four central wide flange ("H") steel columns. The painted columns are 8 inches in depth, 8 inches in width, and the flanges are 3/4-inch thick with the painted coating at the basement level. The southernmost interior column, the column that is not embedded in a CMU wall, is significantly corroded (Figures 1D-24 and 1D-25) for its full height. The corrosion of this column is related to water infiltration from the Watch Deck, Level L-3, above.

Interior Tower Spaces

In general, the floors are painted concrete, with evidence of past floor finishes on the second level, Level L-2. Glass skylights are present in multiple locations on the Pier Deck level, Level L-1. Floor drains are located in the boat room and at the main entry door on the interior of the tower at the Pier Deck level, Level L-1. The rails for transporting the boat inside the boat room are extant in the floor of the boat room (Figure 1D-26).

Figure 1D-33 Pitted and section loss of steel angle window framing.

Figure 1D-34 Skylight in basement room ceiling in room for water level access door. Note cracking and deterioration of vertical edges of concrete at skylight opening.

Figure 1D-35 Crazed cracking and staining of concrete at glass skylight opening in pier deck, Level L-1 floor structure.

Figure 1D-36 Typical steel beam to column connections exposed in basement of pier deck, Level L-1 floor structure.

Overall, the plaster wall and ceiling finishes on interior lower levels of the tower spaces are intact. The paint on the plaster is peeling and flaking, but the plaster is mainly sound and well bonded to the metal lath behind (Figure 1D-27). There are isolated areas of missing or damaged plaster throughout (Figure 1D-28). A vertical crack in the plaster finish extends upwards from the southwestern edge of the northeastern most interior door of the boat room on both sides of the wall (Figure 1D-29). A horizontal crack is located at the top of the wall near the ceiling of the boat room near this door (Figure 1D-29). The lath is ghosting through the plaster in the ceiling near the northernmost window of the southwest elevation at Level L-1 (Figure 1D-30). This window was boarded with plywood at the time of the assessment and there is evidence of water infiltration in this area.

A secondary wall system was constructed on the interior of the western equipment room walls. Constructed of nominal 2x4 studs and plywood sheathing on both the exterior and interior sides of the studs, fiberglass insulation was placed between the studs (Figure 1D-31). A 1 inch air cavity was maintained between the typical plaster over steel channel exterior wall system and this interior wall system.

The interior walls are of wood stud or CMU construction, depending upon location. A wood framed ceiling is framed in the westernmost equipment room (between the westernmost and southernmost interior column lines). The easternmost ceiling joists are currently unsupported east of the southernmost interior column (Figure 1D-32).

The windows are framed with painted steel angles. The horizontal legs of the angles are corroded with evidence of pitting and full section loss occurring near the edges of the windows (Figure 1D-33).

Level L-1, Pier Deck Structure

The Pier Deck floor structure, or basement ceiling, is comprised of structural steel I-beams supporting 3-inch thick wood planks and a minimum 12-inch thick concrete slab. Where visible, the wood planks are in good condition with no signs of deterioration. On the interior of the tower structure above, atop the 12-inch thick concrete slab, is an 8-inch concrete slab. Per the Construction Drawings (see Figure 1B-18 and the appendix), the 8-inch slab is a tee-joist slab with masonry forms or infill between the webs of the tee-joists.

The glass skylights located throughout the Pier Deck floor structure, mainly in the interior of the tower but also in the northeast corner deck, were intended to provide light to the basement rooms. All of the skylights are covered in paint or other coverings, but appear to be intact with the exception of less than a dozen individual glass lights as observed from the underside. Cracked or deteriorated concrete is visibly present at the edges of the skylight in the northeast corner deck (Figure 1D-34). At the skylights on the interior of the tower, the 12-inch concrete slab is tapered to a wider opening at the bottom of the slab to help filter the light into the basement spaces. Crazed cracking is present on this tapered concrete surface (Figure 1D-35).

The steel I-beams are spanning to the steel columns. The sizes of the beams vary by location, ranging in depth from 10 inches to 20 inches. The beams connect with steel angles to the columns or other beams with both rivets and through-bolts (Figure 1D-36). The rivets were most likely installed on the main land in a steel fabricator's shop and the through-bolts installed

Figure 1D-37 Column splice of southernmost interior column at pier deck, Level L-1. Note riveted connection at bottom and through-bolted connections at top of splice plates. Extra rivet at top of connection for splice plate to accommodate change in flange thickness of columns.

Figure 1D-38 Corrosion of nuts at through-bolt connection of column splice of southernmost interior column at pier deck, Level L-1.

Figure 1D-39 Corrosion of steel framing members and connection at underside of second floor structure, Level L-2, at southernmost interior column.

Figure 1D-40 Significant corrosion of steel flanges of beams and columns at second floor structure, Level L-2, at southernmost interior column.

Figure 1D-41 Nearly full section loss of nut at through-bolt connection.

Figure 1D-42 Selective demolition of concrete slab at bathroom tub access. Embedded steel reinforcing bars are exposed at cut for utility penetration.

as the steel frame was erected. The beams are painted, and the paint is flaking in areas where minor corrosion of the beams is present (Figure 1D-36).

Level L-2 Floor Structure

The use of a shim plate at the column splice above the Pier Deck, Level L-1, of the southernmost interior column indicates the column size is reduced on the upper portion of the splice. The splice plates are both riveted and through-bolted to the column flanges (Figure 1D-37). Although the surface of the column is corroded, minimal section loss has occurred at the base of the column. The nuts of the through-bolts at the column splice connection, however, are more significantly corroded (Figure 1D-38).

The plaster ceiling prevented visual assessment of the Level L-2 floor structure except near the southernmost interior column where the plaster finish was damaged from water infiltration. The steel beams and column at this location are corroded (Figure 1D-39). The depths of the I-beams correlate with the sizes specified in the Construction Drawings.

The corrosion of the steel beams framing into the southernmost interior column is advanced and has caused section loss of the steel flanges that may affect the load-bearing capacity of the beam, depending on the extent of the section loss (Figure 1D-40). The through-bolts and clip angles of the beam to column connections have also been compromised with nearly full section loss of at least one nut in the beam to column connection (Figure 1D-41).

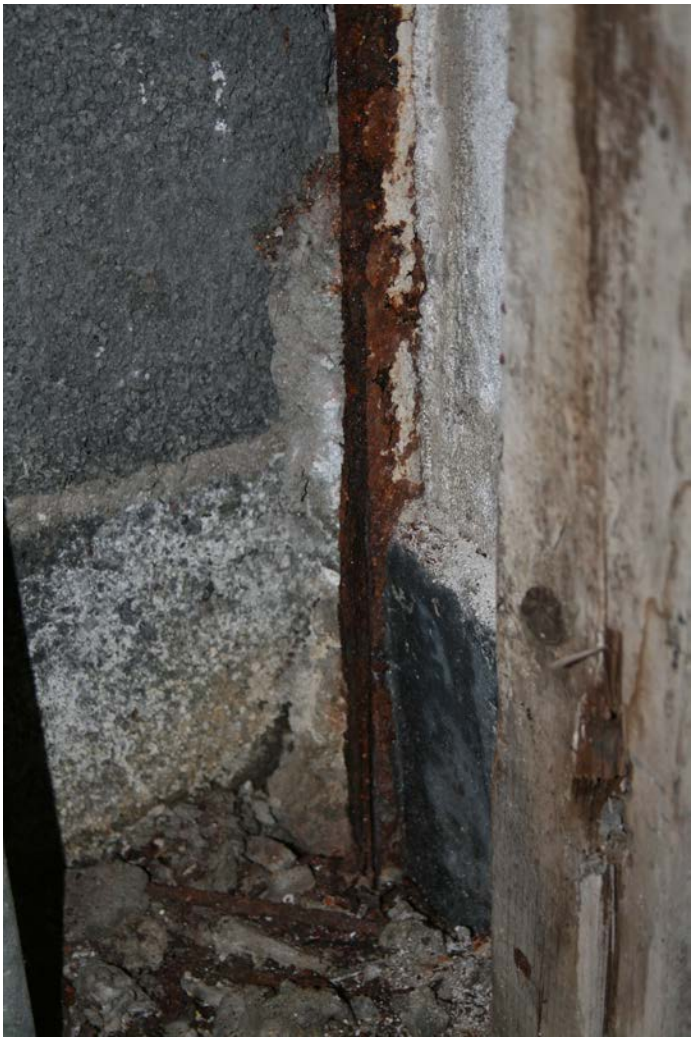


Figure 1D-43 Corroded at warped flange at southernmost interior column. Note portions of the steel column are on debris on top of floor.

Figure 1D-44 Corroded steel connections of beam to column at watch deck, Level L-3, structure.

Figure 1D-45 Missing ceiling finish below watch deck, Level L-3, structure. Note insulation is tight to steel bar joists.

Figure 1D-46 Missing ceiling finish below watch deck, Level L-3, structure. Note stalactites forming on steel bar joist surfaces.

Figure 1D-47 Corroded metal bar joists.

Figure 1D-48 Localized corrosion of metal bar joists.

Figure 1D-49 Upper tower wall framing bearing on watch deck, Level L-3, structure. Note water staining of wood furring, corrosion of steel, and stalactites.

Figure 1D-50 Corroded and warped brace between top of interior wall and bar joist bottom chord.

At the bathtub access hatch located in the wall of the stairwell between Level L-1 and Level L-2, the concrete slab for Level L-2 was previously chiseled away allowing for the piping penetrations. The small area of demolition exposed cut steel reinforcing bars embedded in the 4-1/2 inch concrete slab. The reinforcing bars are ½-inch diameter bars located near the bottom of the slab and oriented in both directions. A 1-inch grout bed is placed over the concrete slab in the Level L-2 bathroom (Figure 1D-42).

Level L-3, Watch Deck Structure

The exposed flange of the southernmost interior column at Level L-2 is corroded and warped; significant section loss has occurred and is loosely laying on the debris at the base of the column (Figure 1D-43). Corrosion is also present at the beam to column connections of the westernmost interior column at this level (Figure 1D-44).

The ceiling finish is missing in the second level, Level L-2, easternmost and southernmost rooms exposing the Watch Deck structure (Figure 1D-45 and 1D-46). The plaster ceilings were supported with metal lath that was secured to the underside of open web bar joists. The bar joists are spaced, on average, 18 inches apart and are 8 inches in depth. Insulation is tight in the voids between and through the bar joists. The concrete slab atop the bar joists is formed with a metal form. The metal form is surface corroded where exposed (Figure 1D-47).

Figure 1D-51 Corroded joist bearing seat and flanges of steel support beam. Note water stained wood furring.

Figure 1D-52 Web member of steel bar joist is deformed, curved upward.

Figure 1D-53 Underside of upper tower wall framing bearing on watch deck, Level L-3, structure. Note water staining of wood furring, corrosion of steel, and stalactites.

Figure 1D-54 Top of westernmost interior column and beam framing into the column. Note minor corrosion of steel.

In the area of the missing ceiling in the easternmost room at Level L-2, the steel joists are surface corroded and three of the joists have lost section of the bottom chords due to the corrosion. The joists consist of a 2 inch channel oriented flat-wise with 1-1/8 inch wide flanges; 3/8 inch square web members; and a 1-1/4 inch by 1/4 inch bar bottom chord (Figure 1D-47). Where the bottom chord was observed to be corroded, once the loose scale was removed, the thickness of the chord was nearly equivalent to the thickness of the chord where there was no loose scale or section loss evident, except for one location where the thickness of the chord was measured to be 0.17 inches (Figure 1D-48). The end web member, a 3/4 inch by 1/4 inch steel bar, is expanded in size along the bottom chord where the corrosion is greatest (Figure 1D-48).

In the southernmost room, stalactites are hanging from the Watch Deck structure where the ceiling finish is missing (Figure 1D-49), near the southernmost interior column. The stalactites are evidence that water is traveling through the concrete slab above, dissolving minerals from the concrete, and redepositing them as the stalactites. In this area, all of the steel is corroded with evidence of section loss occurring. The steel bracing of the top of the wall to the bottom chord of the open web steel joists in three locations is nearly fully corroded and warped (Figure 1D-50). The bearing seat of the steel joists has expanded due to the corrosion activity (Figure 1D-51). The I-beams in this area are also corroded with pitting and section loss occurring (Figure 1D-51). The web members of at least one of the bar joists is visually deformed (Figure 1D-52).

In this same area of the southernmost room, the underside of the connection of the upper levels of the tower to the Watch Deck, Level L-3, structure is visible. The channels for the exterior walls of the upper level are visible. The channels are secured to each other and the top chord of the Watch Deck, Level L-3, bar joists with steel angles and through-bolts (Figure 1D-53). The steel clip angles and through bolts are significantly corroded; but the wall channels are only surface corroded.

At an opening in the plaster wall finish in the stair between Level L-2 and Level L-3, the top of the northernmost interior column was observed. The beams, connections, and column in this area are all corroded with minimal section loss (Figure 1D-54).

Level L-4 and Level L-5 Floor Structures

The spaces at Level L-3 and up are primarily used for equipment and to provide covered access to the lantern level. The finishes are basic with painted concrete floors, painted plaster walls, and painted board formed concrete ceilings. The plaster finish is typically cracked horizontally at mid-height of the walls and vertically in the corners of the walls. A central steel beam, parallel with the run of the stair, is located below the concrete ceiling and is supported with bolted gusset plates at the exterior walls (Figure 1D-55). The concrete slabs are 4 inches in depth. Holes have been made through the slabs for utility penetrations (Figure 1D-56). Cracking is present at the corners of the slab penetrations.

Level L-6, Lantern Deck Structure

The Lantern Deck, Level L-6, floor structure is an 8 inch thick concrete slab. Stalactites are forming on the underside of the deck at the lantern wall anchor locations and at the perimeter of the exterior Lantern Deck (Figures 1D-57 and 1D-58).

Figure 1D-55 Typical center steel beam of floor structures of upper levels of tower.

Figure 1D-56 Utility penetrations through concrete slab of floor structures of upper levels of tower.

Figure 1D-57 Stalactites on underside of lantern deck concrete slab at perimeter of Level L-5.

Figure 1D-58 Stalactites on underside of lantern deck concrete slab at location of lantern anchorage.

Figure 1D-59 Minor corrosion of stair stringer at basement level.

Figure 1D-60 Stair tread and plate stringer on ladder between Level L-5 and Level L-6.

Stairs

The stair structures are all steel framed with channel section stringers. Bent plate treads and risers are secured with clip angles to the stringers. Between the Pier Deck level, Level L-1, and Level L-2, the treads are 10-1/2 inches wide and the risers are 8 inches tall. All of the stairs are painted, and the paint is flaking. Minimal corrosion of the steel members is present at the uppermost and basement levels (Figure 1D-59).

The ships ladder from Level L-5 up to the Lantern Deck, Level L-6, is steep in regards to its rise and run and has a grated, non-slip metal tread and steel plate stringers (Figure 1D-60).

EXTERIOR CONDITIONS AND ANALYSIS

The exterior surfaces of the North Manitou Shoal Light Station include the vertical and horizontal concrete surfaces of the base structure, steel C-channel walls on the upper structure, and concrete decks covered with various membranes. The Lantern is discussed as a separate item in this section.

As previously discussed in the structural section, the surface of the vertical concrete walls of the concrete crib are in poor to fair condition with considerable spalling and damage in many areas. Heavy damage to the concrete surface from water and ice has occurred on all sides, with significant deterioration and loss of material on the south and west faces. The north face of the crib is seen in Figure 1D-62; the east face in Figure 1D-61; the south face in Figure 1D-63; and the west face in Figure 1D-64. Close-up views of the deterioration at the base of the concrete where it transitions from the steel sheet piling face are seen in Figures 1D-65 and 1D-66. The large indentations at the base of the concrete where it meets the sheet piling are part of the original design and are not due to deterioration. Conditions at the wave edge, which extends 2 feet from the vertical face and is located at the top of the concrete crib, are seen in Figures 1D-67 and 1D-68. Exposed steel reinforcing bars

Figure 1D-61 East face of the concrete crib.

Figure 1D-62 North face of the concrete crib.

Figure 1D-63 South face of the concrete crib.

Figure 1D-64 West face of the concrete crib.

Figure 1D-65 Deteriorated concrete near the water surface above the steel sheet piling.

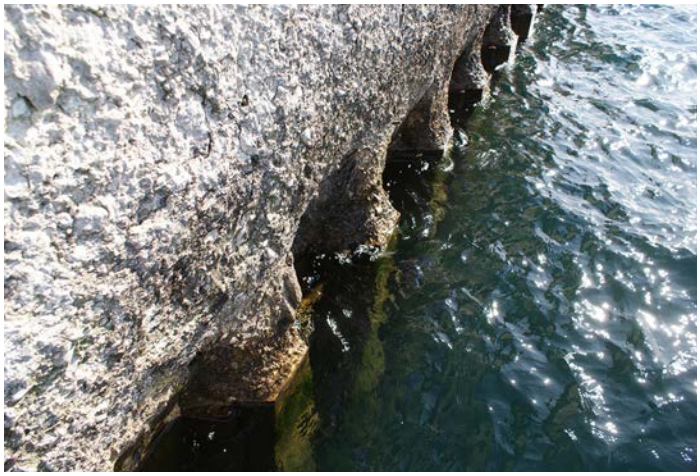


Figure 1D-66 Deteriorated concrete near the water surface above the steel sheet piling.

Figure 1D-67 Transition of steel deck plate at ladder.

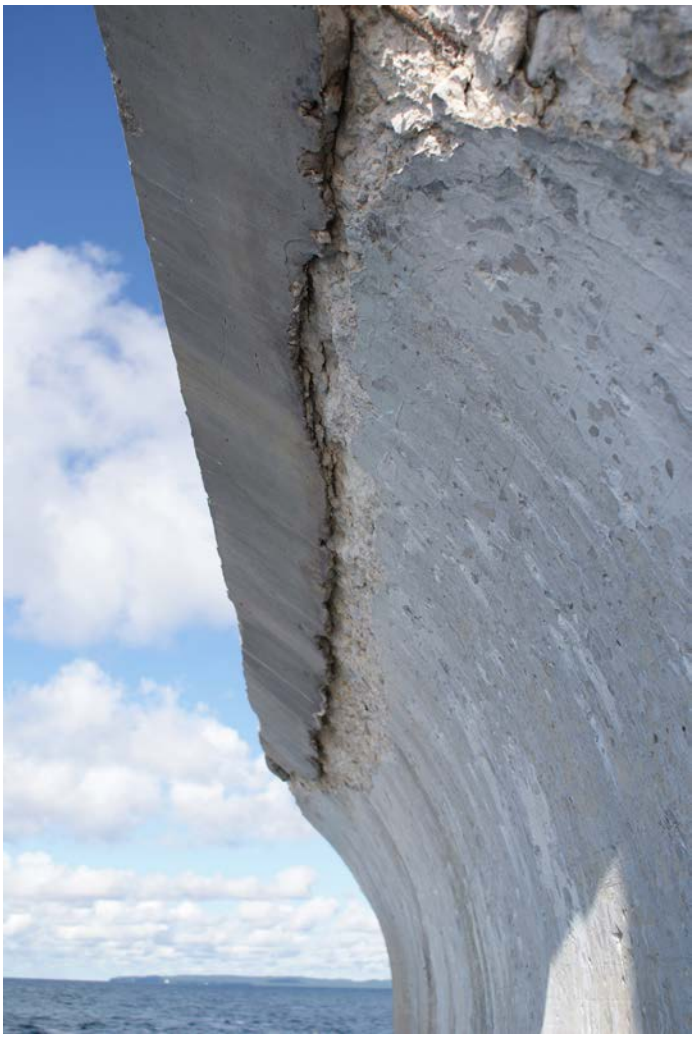


Figure 1D-68 Concrete repair at wave edge.

Figure 1D-69 Deteriorated concrete and exposed reinforcing bars on the northwest corner.

Figure 1D-70 Deteriorated concrete and exposed reinforcing bars on the southwest corner.

Figure 1D-71 Vertical steel ladder. Bent rungs are visible near the water surface.

Figure 1D-72 Vertical steel ladder on the north wall next to the sea door. Two rungs are missing near the bottom.

Figure 1D-73 Steel mooring anchors near the corner of the crib.

Figure 1D-74 View of the deteriorated surface of the steel plate on the Pier Deck.

Figure 1D-75 View of the deteriorated surface of the steel plate on the Pier Deck.

Figure 1D-76 View of the deteriorated surface of the steel plate on the Pier Deck.

can be seen on the northwest, Figure 1D-69, and southwest, Figure 1D-70, corners.

There are four steel ladders, one on each side, set into the vertical concrete face of the crib for access. Ladder rungs are 1-½ inch diameter steel bars spaced 12 inches on center vertically fixed to steel angles set into the concrete structure. The finish on the ladder rungs and embedded angles is in very poor condition. The majority of the steel rungs are intact, however there are some bent rungs near the water level, as seen in Figure 1D-71. The ladder on the north face, adjacent to the sea door that provides access to the basement, has two rungs missing at the bottom. This condition, along with deterioration of the concrete around the sea door, is seen in Figure 1D-72.

Two steel mooring anchors, Figure 1D-73, are located near each corner of the crib. The anchors appear in good condition, however there is considerable damage to the concrete at two corners.

The Pier Deck, the main deck surface surrounding the multi-level steel structure, is approximately 16 feet - 1 inch above the surface of Lake Michigan on the date of this inspection, which is at a record high level in 2019. Originally an exposed concrete deck surface, the Pier Deck has been covered with steel plate to protect the original concrete surface. The condition of the concrete deck surface will not be known until the steel plate is removed. The steel plate, which has been painted and covered with other coatings, is in very poor condition as seen in Figures 1D-74, 1D-75, 1D-76 and 1D-77, with open seams

Figure 1D-77 View of the deteriorated surface of the steel plate on the Pier Deck.

Figure 1D-78 View of the deteriorated surface of the steel plate on the Pier Deck.

Figure 1D-79 View of the steel deck plate turned down and bolted to the concrete structure at the edge.

Figure 1D-80 Steel pipe posts and chain link guardrail at the perimeter of the Pier Deck.

Figure 1D-81 Steel pipe posts and chain link guardrail at the perimeter of the Pier Deck.

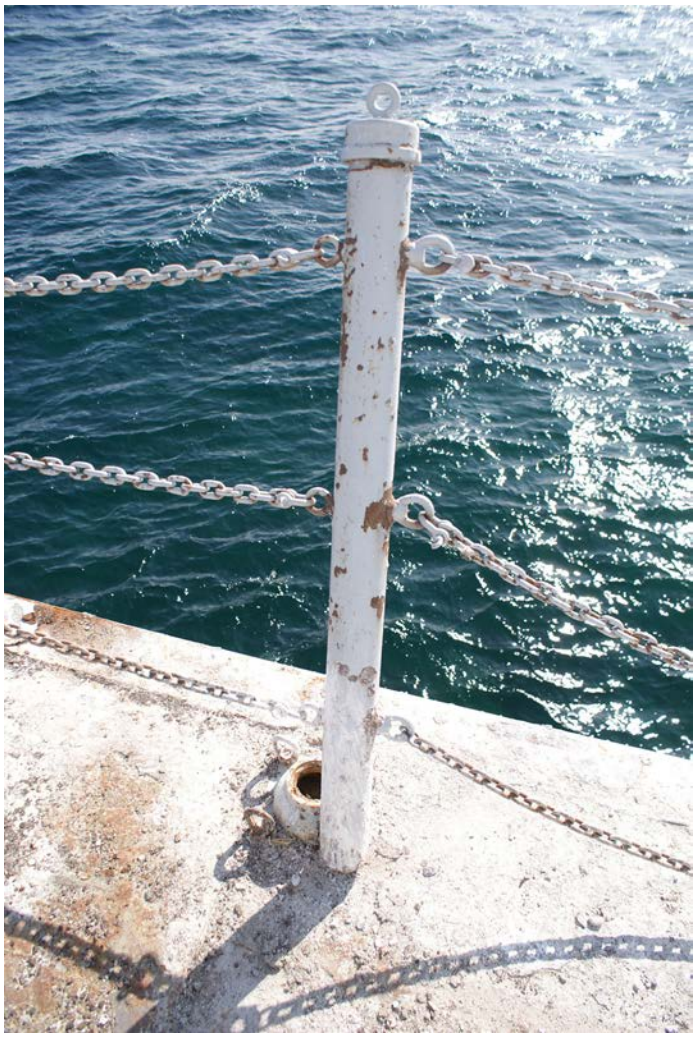


Figure 1D-82 View of damaged guardrail post broken from the base.

Figure 1D-83 View of damaged guardrail post broken from the base.

Figure 1D-84 Guardrail posts with hand-holds at one of the vertical ladders.

Figure 1D-85 A typical stanchion located near the edge of the Pier Deck.

and rust on the steel plate surface. A close-up view of the deck surface is seen in Figure 1D-78. The steel plate extends vertically approximately 12 inches down the face of the structure and is secured with anchor bolts. This edge condition is seen in Figure 1D-79.

A guardrail with steel posts and chain link rail is intended to provide fall and safety protection along the perimeter of the Pier Deck. This rail system is in poor condition with damaged and missing components, including posts and chain link rails. The paint finish is in extremely poor condition. Views of the guardrail system, which consists of 3-½ inch outside-diameter (O.D.) steel pipe posts spaced approximately 6 feet on center and three horizontal rails of chain link, are seen in Figures 1D-80 and 1D-81. A damaged post broken from its base is seen in Figures 1D-82 and 1D-83. The guardrail posts are slightly offset at the four vertical ladders, Figure 1D-84.

There are eight steel bollards located on the top of the Pier Deck near the edge and in alignment with the guardrail system, as seen in Figure 1D-85. The paint finish is in poor condition on all bollards.

There are two small deck cranes/hoists located on the east side of the Pier Deck. These cranes, seen in Figures 1D-86 and 1D-87, are new units installed by the contractor recently performing exterior restoration work to handle material and boat lifting. Each crane has a lifting capacity of 5,500 pounds.

Figure 1D-86 Small deck cranes/hoists for material handling.

Figure 1D-87 Small deck cranes/hoists for material handling.

Figure 1D-88 View of the steel plate deck surface at the Watch Deck, Level 3.

Figure 1D-89 View of the steel plate deck surface at the Watch Deck, Level 3.

Figure 1D-90 Steel guardrail at the perimeter of the Watch Deck.

Figure 1D-91 Missing decorative ball at a corner post.

Figure 1D-92 Deteriorated surface condition of the steel deck plate at the Watch Deck.

Figure 1D-93 Deteriorated surface condition of the steel deck plate at the Watch Deck.

Figure 1D-94 One of two roof drains on the Watch Deck.

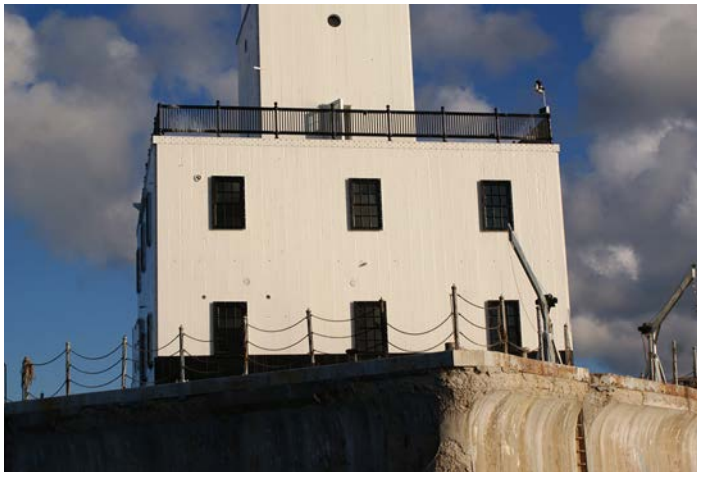


Figure 1D-95 View of recently restored exterior wall surfaces.

Figure 1D-96 View of recently restored exterior wall surfaces.

Figure 1D-97 View of small steel awning above the entry door on the northeast wall.

Figure 1D-98 Metal components fixed to the exterior wall surface below the Watch Deck guardrail.

The next deck level, at the third level (L-3) of the tower and also referred to as the Watch Deck, is accessed from a door at the base of the tower. This deck is approximately 10 feet wide and is also the roof of the second level of the metal structure. Views of this deck are seen in Figures 1D-88 and 1D-89. A metal guardrail is located around the perimeter of the deck, Figure 1D-90. It is constructed with 2-7/8 inch O. D. metal posts spaced approximately 5 feet on center with a 4-½" diameter decorative ball, and 2-7/8 inch O. D. top and bottom horizontal rails with 1 inch x 1 inch square metal bar balustrades spaced 3 inches on center. The guardrail is 3 feet high from the deck level to the top of the upper horizontal rail. The guardrail was recently painted as part of the exterior restoration work and is in very good condition, although somewhat dirty with bird droppings. The decorative ball is missing at one corner post, as seen in Figure 1D-91.

This deck surface is also covered with steel plate, similar to the Pier Deck. Paint and other waterproof coatings applied to this steel plate surface are in very poor condition, as seen in Figures 1D-92 and 1D-93, where the deck surface meets the tower walls. Rust on the surface of the steel plate is also present. Significant roof leaks into the space below are attributed to the poor condition of this deck surface and possibly the structure underneath. The condition of the concrete surface below the steel plate will not be known until the steel plate is removed. A flat metal coping 1 foot - 4 inches wide all around the perimeter is slightly raised above the deck surface and forms the base for the guardrail posts. This coping appears to be in good condition and was recently painted. A somewhat unique construction feature of this roof structure/roof deck is that it slopes from

Figure 1D-99 Exterior view of a typical metal window.

Figure 1D-100 Interior view of a typical metal window.

the outermost edge back to the tower where two roof drains are located, one near the east corner and one near the west corner. A roof drain is seen in Figure 1D-94. It was reported that these drains were plugged with debris and non-functional, but were cleaned as part of the recent exterior restoration work and now appear to be working properly.

The exterior walls of the structure above the concrete base are steel C-channels bolted together. The exterior face of all walls was restored and painted in 2017-2018 as part of the initial restoration work. All walls, including the paint, are in very good condition. Views of the exterior walls are seen in many previous photographs and in Figures 1D-95 and 1D-96.

A small awning structure constructed of steel angle and plate protects the main entry door on the Pier Deck level. This awning is seen in Figure 1D-97. Metal plates and brackets fixed to the exterior face of the southwest wall, seen in Figure 1D-98 below the guardrail at Level 3, were part of the support system for a large crane once located on this side of the structure but no longer present.

There are a number of windows throughout the structure including porthole windows and divided light metal windows. The typical metal window found on Levels 1 and 2 is 2 feet 6 inches wide by 4 feet 4 inches high with six lights (6/6) on the fixed lower sash and six lights on the inward swinging bottom hinged upper sash. Glass in each light is 8 inches wide by 10 inches high and is single glazed. A typical unit is seen from

Figure 1D-101a Temporary plywood panel at a window opening.

Figure 1D-101b Metal window stored inside to be installed.

the exterior, Figure 1D-99, and from the interior, Figure 1D-100. All windows have been restored as part of the initial exterior restoration work. Restoration included removing all glass, blasting of all metal surfaces to white metal, prime and finish paint coats and replacement of glass. New glass was installed where existing glass was broken or missing. At three window locations on Level 1, temporary plywood panels are in place at the window opening, Figure 1D-101a, and the restored window sash are stored in the Boat Room on Level 1, as seen in Figure 1D-101b. A steel plate covers one window opening on the southwest face. The steel C-channel that forms the window frame is also seen in Figure 1D-101a. Two slightly smaller windows of the same type are located on either side of the main entry door into the structure on Level 1. These 6/6 units measure 2 feet 3 inches wide by 4 feet 4 inches high, refer to Figure 1D-102.

Porthole style windows are found in the upper tower at Levels 3, 4 and 5, typically one on each wall. The window opening measures 1 foot 4 inches in diameter. It is presumed that all porthole windows had the typical brass unit allowing the window to open and swing in, however all are missing. The window opening is covered with plexiglass screwed to the interior face as seen in Figure 1D-103. A simple circular opening in the outside face of the steel wall panels frames the round opening, Figure 1D-104.

Not including the Lantern door which will be discussed separately, there are five exterior doors on the structure: the "sea door" at water level that provides access into the Basement; the main entry door on the Pier Deck, Level 1; two doors on the Pier Deck, Level 1 that provide access into the Boat Room; and the access door

Figure 1D-102 Metal windows flanking the tower entry door at the Pier Deck.

Figure 1D-103 Interior view of a typical porthole window.

Figure 1D-104 Exterior view of a typical porthole window.

Figure 1D-105 Interior view of the metal sea door and interior concrete stair.

on Level 3 from the tower that provides access to the Watch Deck.

The sea door is a unique feature of the North Manitou Shoal Light Station only found in a few other crib-style structures. When it was operational, this door would have allowed the easy movement of personnel, equipment and supplies from boats onto the light station at water level. The landing inside the sea door is 4 feet 7 inches below the Basement level and is accessed by a small concrete stair as seen in Figure 1D-105. The door opening is 4 feet 6 inches wide x 7 feet high and is framed with a steel C-channel cast into the concrete structure. The door originally had two leaves, one 3 feet wide and one 1 foot 6 inches wide, but both leaves have been removed and the opening closed with steel plate welded to miscellaneous

Figure 1D-106 View of landing and floor trench drain inside the sea door.

Figure 1D-109 Small door leaf of the sea door inside the basement.

Figure 1D-107 Exterior view of the sea door on the north wall.

Figure 1D-108 Exterior view of the sea door on the north wall.

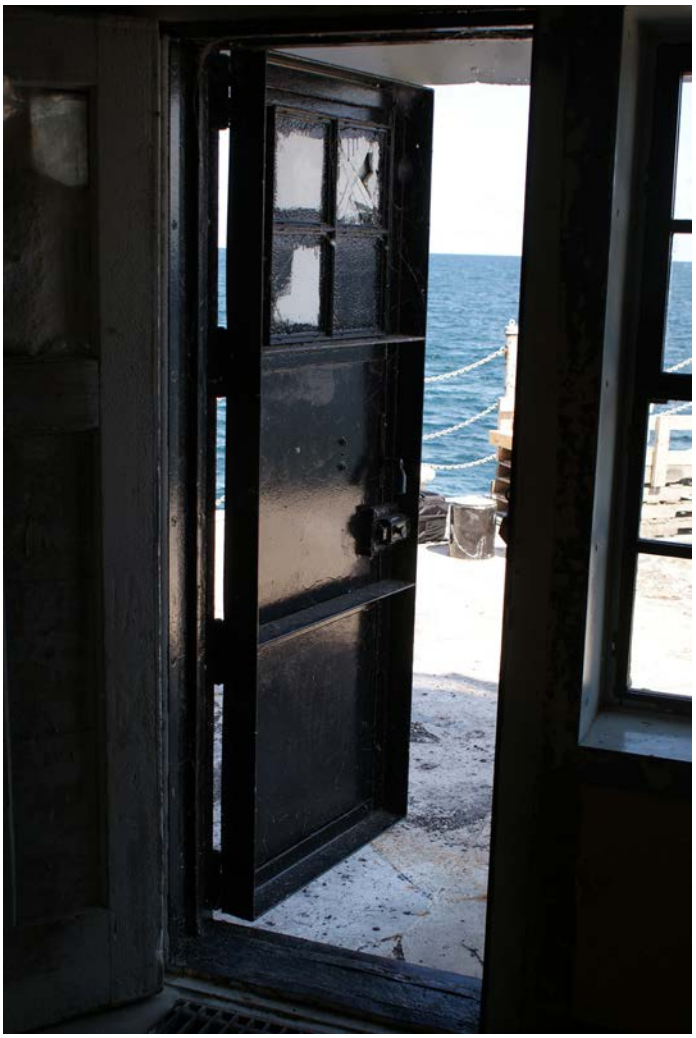


Figure 1D-110 Exterior, out-swinging metal door at entry from the Pier Deck.

Figure 1D-111 Interior view of in-swinging wood door at entry from the Pier Deck.

Figure 1D-112 Exterior view of metal Boat Room doors on the northeast wall.

steel framing. An interior view of the door is seen in Figure 1D-106 and exterior views in Figures 1D-107 and 1D-108. Vertical steel pipe grab bars are fixed to the concrete walls on both sides of the door. A close-up inspection of these grab bars did not occur due to high waves, but they appear in fair condition. The 1 foot 6 inch wide door leaf is laying on the Basement floor, Figure 1D-109, near the sea door opening. The steel plate face is welded to a 3 inch wide steel angle frame. This door leaf is in poor condition.

The main entry door at the Pier Deck, Level 1, is 2 feet 6 inches wide by 6 feet 8 inches high and consists of both an in-swinging wood door and a heavy steel exterior storm door. The outward-swinging exterior door, Figure 1D-110, is constructed of 1/8-inch thick steel plate welded to 3½-inch steel angle frame. There are four 10-inch x 10-inch glass lights in the upper portion of the door; one glass section is broken. This exterior door has been restored. The lever style hardware is in good operating condition. The in-swinging wood door, Figure 1D-111, is 1-¾ inch thick with two panels and a single 1′-8″ x 1′-8″ glass light. The glass is missing. The door and paint finish are in poor condition. Hardware consists of hinges and a lockset with cylindrical knob, all in poor condition. The door is bored for a deadbolt, which is missing.

On the first level there is a large Boat Room with 11 feet wide by 9 feet 6 inches high doors at either end. The steel plate doors are double-hinged with four leaves each 2 feet 9 inches wide and are constructed of 1/8-inch thick steel plate welded to a 3-½ inch steel angle frame. The exterior of the doors on the northeast wall, adjacent to the main entry door, is seen in Figure

Figure 1D-113 Steel beam across the interior face of the Boat Room doors on the northeast wall.

Figure 1D-114 Interior view of metal Boat Room doors on the southwest wall.

1D-112. These doors have been secured by a steel beam bolted across the interior face, Figure 1D-113, and are non-operational. Two 10 inch diameter porthole windows are missing and covered with steel plate.

The Boat Room doors on the southwest wall are operational. The interior face is seen in Figure 1D-114 and the exterior face in Figure 1D-115. The porthole windows are missing and are covered with plexiglass. Both sets of Boat Room doors have been painted as part of the recent restoration work and are in good condition. Door hardware includes large strap hinges and regular hinges and pull handles. One strap hinge on the door on the southwest wall is broken loose from the door leaf, as seen in Figure 1D-116. Some interior hardware to secure the doors appears to be missing.

Figure 1D-115 Exterior view of metal Boat Room doors on the southwest wall.

The door at Level 3 on the southeast wall at the base of the tower that provides access onto the exterior Watch Deck also includes an in-swinging wood door and an outward-swinging storm door. The storm door is seen in Figures 1D-117 and 1D-118. This door is 2 feet 6 inches wide by 6 feet 8 inches high and is constructed of 1/8 inch steel plate and a 3-½ inch steel angle frame. There are four 10 inches by 10 inches glass lights at the top of the door and an opening for a ventilation louver near the bottom. The louver is missing. Hardware consists of hinges and a lever-type handle. Except for the missing louver, this door is in good condition. The in-swinging wood door is a 2 feet 6 inches wide by 6 feet 8 inches high x 1-¾ inch thick two-panel door with a 1 foot 8 inches by 1 foot 8 inches glass light. This door is seen in Figure 1D-119. Hardware consists of hinges, a cylindrical lockset and deadbolt, Figure 1D-120. The door and hardware are in poor condition.

Figure 1D-116 Damaged strap hinge on the Boat Room doors, southwest wall.

Figure 1D-117 Exterior metal door at the Watch Deck on Level 3.

Figure 1D-118 Exterior metal door at the Watch Deck on Level 3.

Figure 1D-119 In-swinging wood door at the Watch Deck door.

Figure 1D-120 Door hardware on the in-swinging wood door.

Figure 1D-121 View of the Lantern and Lantern Deck.

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Figure 1D-122 View of the Lantern and Lantern Deck.

Figure 1D-123 Floor access hatch into the Lantern.

Figure 1D-124 Vent opening in the Lantern wall. The vent cover is missing.

Figure 1D-125 View of the ceiling of the Lantern with the smoke shield intact.

Figure 1D-126 Vents in upper walls of the Lantern

Figure 1D-127 Interior view of the curved metal mullions and glass in the Lantern.

The Lantern of the North Manitou Shoal Light Station, on the sixth level of the structure, has undergone a complete interior and exterior restoration as part of the restoration project completed by Mihm Enterprises in 2017-2018. Although a few components are missing, the majority of the components of the Lantern, and exterior Lantern Deck, are in very good condition. The Lantern is a beautiful circular cast iron structure with helical bars and curved glass, refer to Figures 1D-121 and 1D-122. Not often seen, an antenna tower with integral ladder, approximately 14 feet high, is placed on top of the Lantern roof. The Lantern, which is 8 feet in diameter, rests upon the square metal tower which is 14 feet - 10 inches by 14 feet - 10 inches in plan.

The Lantern is accessed through a floor hatch that measures 2 feet 1 inch by 2 feet 7 inches in size. The hatch is protected by a hinged metal hatch door as seen in Figure 1D-123. The unpainted concrete floor can also be seen in this photo. Interior wall surfaces above and below the glass are painted cast iron. There are nine ventilation openings in the lower wall, as seen in Figure 1D-124, however, the brass open/close device is missing. The Lantern ceiling with intact smoke shield is seen in Figure 1D-125. Operable vents in the upper wall above the glass can be seen in this photo and in an enlarged view in Figure 1D-126 along with curtain hooks.

Curved glass, 3/16 inch thick, in both square and triangular sections, are set in an intricate curved metal mullion system as seen in Figures 1D-127 and 1D-128. These metal glazing mullions are

Figure 1D-128 View of the curved metal mullions and glass.

Figure 1D-130 Exterior view of glazing mullion covers.

Figure 1D-129 Exterior view of Lantern glazing.

Figure 1D-131 Exterior view of glazing mullion covers.

Figure 1D-132 Glazing mullion cover with integral hand-hold.

Figure 1D-133 Spare glass stored in the Lantern.

Figure 1D-135 Ventilation opening at base of Lantern.

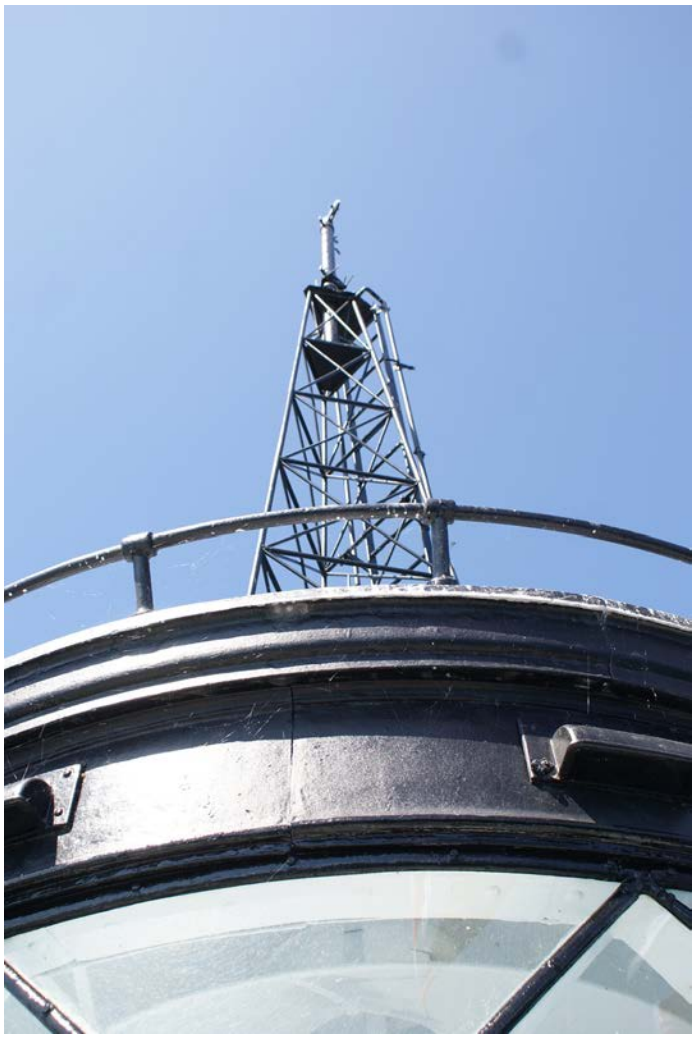

Figure 1D-134 Lantern fascia and ventilation openings.

Figure 1D-136 Ventilation opening used as a wiring raceway.

5/8 inch by 3 ½ inches in size and are painted white. Glass is secured to the mullions with semicircular metal glazing bars that are painted black, enhancing the lightness of the structure. Various components of the glazing system are seen in Figures 1D-129, 1D-130 and 1D-131. Hand-holds are integrated into the glazing mullions around the perimeter, as seen in Figure 1D-132. A few extra panels of triangular sections of glass remain in the Lantern, as seen in Figure 1D-133.

All exterior wall and roof surfaces of the Lantern are painted black. The metal roof terminates at a simple circular fascia. Below the fascia, small metal hoods protect the upper vent openings, as seen in Figure 1D-134. A metal safety rail is located around the roof perimeter. Ventilation

Figure 1D-137 Exterior view of metal door from Lantern to the Lantern Deck and metal guardrail.

Figure 1D-138 Interior view of the metal door.

openings at the base of the lantern are covered with metal screen. Based upon the presence of screw holes, metal hoods, similar to those on the upper wall, may have once covered these openings. A typical ventilation opening is seen in Figure 1D-135. One ventilation opening at the base of the Lantern is used as a wiring raceway. Refer to Figure 1D-136.

A 2 feet 4 inches wide by 5 feet 4 inches high curved metal door, with a single panel of curved glass provides access from the Lantern to the Lantern Deck. This door is seen in Figures 1D-137 and 1D-138. The door and hardware are in very good condition, however, it was not possible to adequately lock the door and it is secured by a heavy strap fastened to the stair.

Figure 1D-139 EPDM membrane on the Lantern Deck surface.

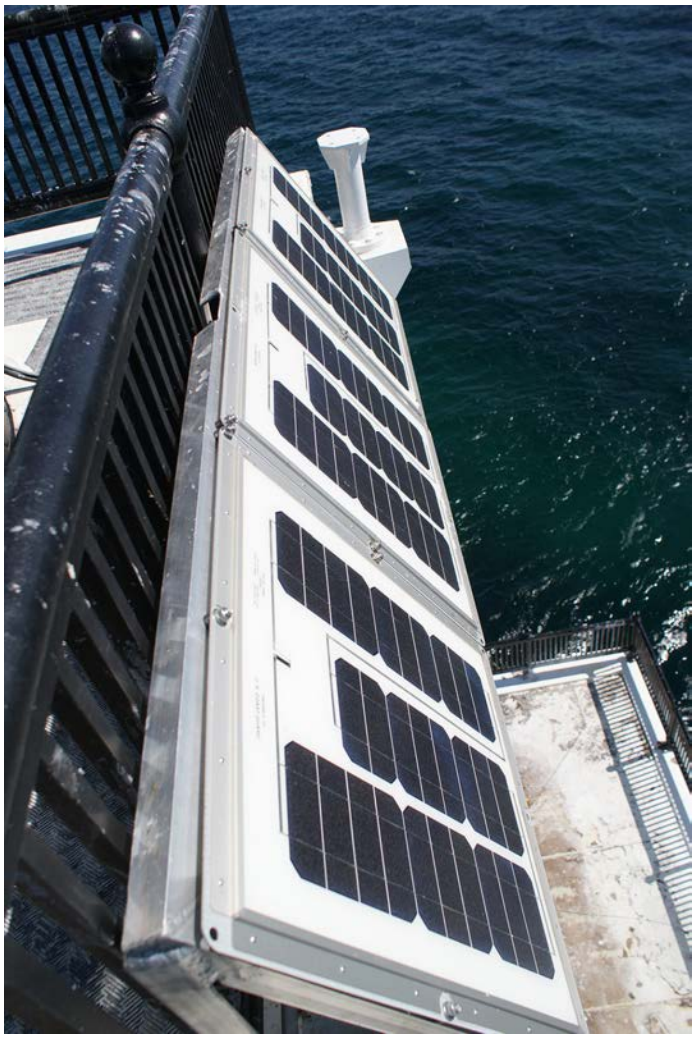

Figure 1D-140 Solar panel array fixed to the metal guardrail.

Figure 1D-141 Radar unit secured to the metal guardrail.

Figure 1D-142 Fog signaling device.

The Lantern Deck, previously described as 14 feet 10 inches square, is protected on all sides with a metal guardrail of the same design as the deck at Level 3. The rail system is 3 feet high from the deck surface to the top of the upper rail. It is constructed with 2-¾ inch O. D. metal posts with a 4-½ inch diameter decorative ball, and 2-¾ inch O. D. top and bottom horizontal rails with 1 inch by 1 inch square metal bar balustrades spaced 3 inches on center. Posts are located at the four corners and in the center of a section.

The surface of the Lantern Deck has been recently covered with a "white" single-ply Ethylene Propolyne Diene Monomer (EPDM) membrane, as seen in Figure 1D-139. Metal termination bar flashing is installed at the base of the Lantern wall surface. Textured, anti-slip walkway pads integrated into the membrane surface are

Figure 1D-143 Unused metal bracket for previous navigation equipment.

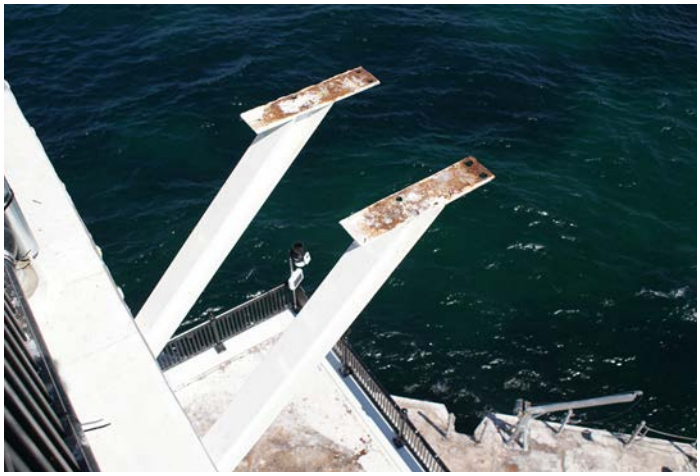

Figure 1D-144 Unused metal beams for previous equipment mounting.

Figure 1D-145 VEGA Marine LED navigation light.

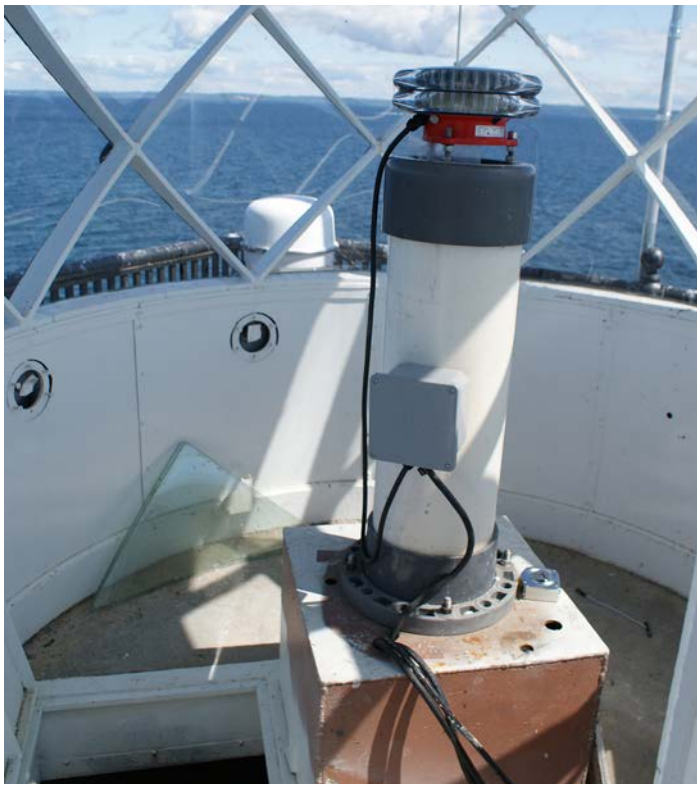

Figure 1D-146 Navigation light and pedestal base.

placed around the Lantern Deck. At the west corner of the Lantern Deck, near the hinge side of the Lantern door, the membrane covers some bolts, presumed to be the location of the metal chimney pipe that is no longer extant.

Various aids-to-navigation are fixed to the structure and located around the Lantern Deck including a solar panel, Figure 1D-140; a radar unit, Figure 1D-141; and a fog signaling device, Figure 1D-142. The solar panel array, located on the southwest face, is approximately 7 feet by 2 feet 5 inches in size. A metal equipment bracket is located on the south corner, Figure 1D-143, and two 4 inch wide-flange beams, Figure 1D-144, are located on the southeast face. Navigation aids are no longer present on these elements.

An uncommon feature is the radio beacon antenna located on top of the Lantern. Refer to previous Figures 1D-121 and 1D-134. This antenna appears to be in good condition and was painted in 2017-2018.

The active navigation light is a VEGA Marine LED Lantern #VLB44R-2.5-2T. This light, Figure 1D-145, is mounted on a small pedestal that rests on a 9 inch square steel pedestal, as seen in Figure 1D-146.

Figure 1D-147 Upper run of stairway to Basement.

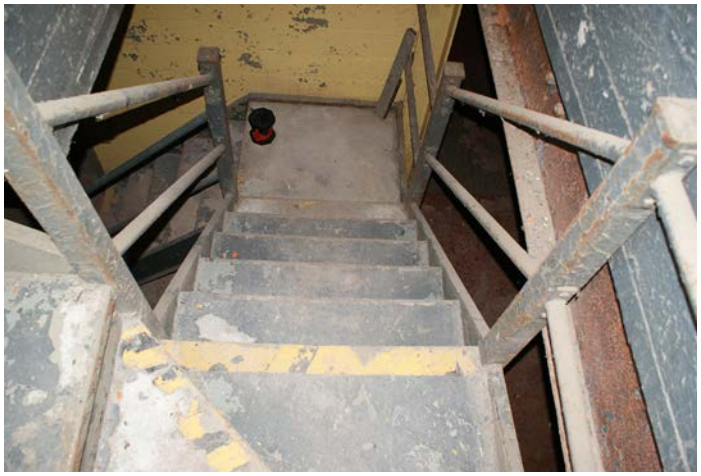

Figure 1D-148 Lower run of stairway and landings to Basement.

INTERIOR CONDITIONS AND ANALYSIS

Using the cross-section of the light station (Figure 1D-01) as a reference, there are five levels of interior space: the Basement, which was a machinery and equipment level; Level 1, the Pier Deck level also used for equipment and the Boat Room; Level 2, living quarters; and tower Levels 3, 4 and 5.

Basement

Access to the Basement, which is 12 feet 2 inches below Level 1, is from a stairway positioned near the main entry door on Level 1. Stair

Figure 1D-149 Lower run of stairway at Basement.

Figure 1D-150 View of open stair and open space in Basement.

Figure 1D-151 Door leading into room at the sea door.

Figure 1D-152 Water tank in the Water Room.

Figure 1D-154 View of Basement bathroom (note missing fixtures).

Figure 1D-153 Steel grate cover over the open water well in the Water Room.

construction is metal pan with concrete treads and landings with steel C-channel stringers. The stair has 1-5/8 inch O.D. steel pipe railings and 3 inch square steel newel posts. The upper section of the stair, at Level 1, is seen in Figure 1D-147, and a view down the middle run is seen in Figure 1D-148. The stair terminates in the Basement in a large open equipment room, seen in Figures 1D-149 and 1D-150. All components of the stair are in good condition; the paint finish is in poor condition.

In the Basement the construction is a concrete floor slab, poured concrete and concrete masonry unit (concrete block) walls, some exposed steel beams and columns and a wood plank ceiling. The wood plank ceiling was used as formwork for the poured concrete floor slab above, and left in place as the finished ceiling.

Figure 1D-155 Bathroom door with glass panel.

Figure 1D-156 General open rooms in the Basement.

This wood plank ceiling is 10 feet 4 inches above the floor. These materials are generally in good condition but the painted surface is in very poor condition as seen in many of the photographs.

At the base of the stair there is a 5 feet 4 inches wide by 6 feet 10 inches high door opening that leads into the sea door access room. This door opening is seen in Figure 1D-151. There is one six-panel wood door 3 feet 4-½ inches wide by 6 feet 10 inches high by 1-¾ inches thick in place; a second smaller leaf is missing. The door knob and latchset are missing; the door and paint finish are in poor condition.

Adjacent to this room is a small room where the water well and a water storage tank are located, as seen in Figure 1D-152. This room is also identified as a laundry room on some original drawings. The water well is a 4 feet diameter opening in the floor covered with a steel grate mounted to a circular steel frame that rises one foot above the floor. Refer to Figure 1D-153. At the time of this site inspection, open water in the well was observed approximately 4 feet 10 inches below the basement floor level. The water storage tank is on a 12 inch high raised concrete pad. The poor condition of the painted concrete floor surface is seen in these photographs.

A corner of this Laundry Room has been partitioned off to form a small, 4 feet by 5 feet Bathroom. These walls are 3-½ inch wood studs with a plaster finish on each side. Plumbing piping indicates where the fixtures were placed but all plumbing fixtures are missing, as seen in Figure 1D-154. The wood door into this small Bathroom, seen in Figure 1D-155, is a 2 feet 6 inches wide by 6 feet 8 inches high by 1-3/8 inches thick two-panel door with a large glass light. The door and paint finish are in poor condition.

Other large open rooms are seen in Figures 1D-156 and 1D-157. Paint finishes are in generally poor condition throughout. A 2 feet 8 inches by 6 feet 8 inches by 1-3/8 inches thick wood door with 2 panels and a large glass light leading into another small room is seen in Figure 1D-158.

Figure 1D-157 General open rooms in the Basement.

Figure 1D-158 Wood door and general view of Basement.

Figure 1D-159 View of the Coal Room and coal chutes.

Figure 1D-160 View of a coal chute and partial view of the hatch cover at the Pier Deck.

Figure 1D-161 View of the underside of a second manhole hatch from the Pier Deck.

Figure 1D-162 Precast concrete and 24 glass block deck light as seen from Level 1.

Figure 1D-163 Underside of a deck light as seen from the Basement.

Figure 1D-164 Large deck light adjacent to the main entry door at Level 1.

Figure 1D-165 Smaller deck light with 16 glass blocks.

Figure 1D-166 View of the Boat Room on Level 1.

Figure 1D-167 View of the Boat Room on Level 1.

Figure 1D-168 Poured concrete containment wall in the Boat Room.

Figure 1D-169 Poured concrete containment wall across a door opening leading to the Boat Room.

Figure 1D-170 Trench drain across the Boat Room door opening with adjacent deck light.

Figure 1D-171 View of the steel angle boat rails in the floor of the Boat Room.

In the west corner of the Basement there is one room that measures 11 feet 10 inches by 11 feet 6 inches and was formerly the Coal Room. Interior walls are constructed of 8 inch thick concrete masonry units. Two coal chutes are located in the northwest wall as seen in Figures 1D-159 and 1D-160 that extend down from manholes in the Pier Deck. A 2 foot diameter manhole is also located in the opposite corner. A view of this manhole is seen in Figure 1D-161. These manholes and covers are not visible from the Pier Deck because of the steel plate that covers the entire surface of the deck and are presumed to be in poor condition. A 2 feet 8 inches by 6 feet 8 inches door opening leads into the Coal Room, but the door is missing.

A unique feature found throughout the Basement are the deck lights, which are small glass blocks set into a precast concrete frame

Figure 1D-172 View of door opening and main entry room at Level 1.

Figure 1D-173 View of borrowed light and partial view of deck light in the main entry room at Level 1.

Figure 1D-174 View of the open stairway at Level 1 showing the steel pipe guardrail.

that is cast into the concrete floor structure. The deck lights are located below the windows on Level 1 allowing light to filter into the basement for natural daylighting. The deck lights have different configurations with 16, 24 and 64 individual glass blocks. The glass blocks are 3-½ inches square. A 24 glass block unit is seen from above, Figure 1D-162, and from below, Figure 1D-163. The large 64 glass block unit deck light is located near the main entry door, as seen in Figure 1D-164, and allows light to filter around the Basement stair. A 16 unit deck light is seen in Figure 1D-165. The deck lights appear to be in fairly good condition, however, some individual glass blocks are damaged.

Level 1 (L1)

The main floor of the light station, Level 1, was originally constructed with three rooms:

Figure 1D-175 Close-up view of the borrowed light at Level 1.

Figure 1D-176 View of general work/equipment rooms on Level 1.

Figure 1D-177 View of general work/equipment rooms on Level 1.

Figure 1D-178 View of general work/equipment rooms on Level 1.

Figure 1D-179 Doorway leading into a small equipment room on Level 1.

Figure 1D-180 Interior view of the small equipment room on Level 1.

the Boat Room, Entry and a large Equipment Room. The large Equipment Room has been subdivided into smaller rooms (circa 1970s) and the Boat Room has been modified for liquid spill containment (circa 1980).

The Boat Room occupies about one third of the floor at Level 1 and has large doors at both ends. This room was originally used for securely storing boats used to access the light station. The room is 12 feet wide and is separated from the other rooms by a 6 inch thick concrete wall.

Figure 1D-181 Interior view of the small equipment room on Level 1.

Figure 1D-183 Generally poor condition of interior paint and plaster finishes on Level 1.

Figure 1D-182 Steel column on Level 1 with extreme rusted finish.

Views of the Boat Room are seen in Figure 1D-166 and 1D-167. A 7 inch thick by 2 feet high poured concrete wall was constructed across the entire width of the Boat Room at the north end, as seen in Figures 1D-167 and 1D-168. A 7 inch thick by 2 feet high concrete wall was also constructed across two 5 feet 6 inches wide by 6 feet 10 inches high door openings, as seen in Figure 1D-169. The doors have been removed. It is not known when the second large opening into the Boat Room was created, but this opening, located near the south corner of the room, does not appear on the original building plans. The opening is rough cut into the concrete wall with no casing or trim. The top of the opening is seen in Figure 1D-239, to the right of the roof drain lines. These walls were constructed for spill containment when the station was automated in 1980, and a 10,000 gallon diesel tank was placed in the Boat Room to power the generators during winter.

A large floor drain is located at each exterior door, Figure 1D-170. One of the deck lights previously discussed is also seen in this photograph. Two 2-¼ inch wide embedded steel angles spaced 3 feet 6-½ inches apart for a track for a boat cart run the length of the room. Refer to Figure 1D-171. Original drawings indicate that these boat rails extend out onto the Pier Deck, however, the steel plate conceals this condition. An electric transformer, to be discussed later in this report, is located at one end of the room. The floor in the Boat Room is concrete with a paint finish. The concrete substrate is in reasonably good condition; all paint finishes are in poor condition. Walls and ceiling are cement plaster and are in fair condition. The ceiling height in the Boat Room is 9 feet 9 inches.

Figure 1D-184 Metal pan and concrete stair leading up to Level 2.

Figure 1D-185 Poor condition of interior finishes along with the winder style treads of the stair to Level 2.

The Entry contains the stairs to the Basement and to the living quarters on the second level. Views of this room are seen in Figures 1D-172 and 1D-173. The stairs are seen in Figure 1D-174. A steel pipe guardrail protects the stair opening. A 4 feet wide by 3 feet 1 inches high borrowed light is located on one interior wall, Figure 1D-175. There are two door openings from this room, both 2 feet 6 inches wide by 6 feet 8 inches high. The doors are missing. Two walls are 5-½ inch thick wood stud walls with a plaster finish; the wall common with the Boat Room is a concrete wall. Previously discussed, there is a large deck light in the floor of this room. The plaster surface is in poor condition and all paint finishes are in poor condition. There are some painted wood ceiling panels in this room that are also in poor condition.

The remainder of the floor space on Level 1 is a general open area used for storage and staging of equipment and material being used for the exterior restoration work. Views of this area are seen in Figures 1D-176, 1D-177 and 1D-178. Wood partitions and ceiling enclose a small room at the east corner, identified as an Electrical Equipment Room. The entry door to this room is a 2 feet 8 inches by 6 feet 8 inches hollow metal door, as seen in Figure 1D-179. The interior of this room is seen in Figures 1D-180 and 1D-181. There are some exposed steel columns and partially exposed floor/ceiling beams with significant rust. There is also some deterioration of the concrete floor and plaster ceiling, as seen in Figures 1D-182 and 1D-183. As with other rooms, all paint finishes are in poor condition.

Figure 1D-186 Square steel newel post at Level 2.

Figure 1D-187 View of the bathtub located in the Bathroom on Level 2.

Level 2 (L2)

The stairway from Level 1 to Level 2 is also a metal pan stair with concrete treads and steel C-channel stringers. The 2 feet 9 inches wide stair, seen in Figures 1D-184 and 1D-185, also have 1-5/8 inch O. D. handrails and 3 inch square steel newel posts, Figure 1D-186. On Level 2, immediately at the top of the stair is a very small Bathroom. The bathtub, Figure 1D-187, is the only remaining plumbing fixture. A recessed medicine cabinet remains on the wall where the lavatory was located, as seen in Figure 1D-188.

The room identified as the Kitchen on original drawings is seen in Figure 1D-189. There are no cabinets or any fixtures remaining in this room, however, there are shadow lines and plumbing line remnants that indicate non-extant cabinet locations that appear to match original drawings. There is a significant section of damaged ceiling plaster and metal lath where roof leaks from the Level 3 Watch Deck have occurred. Refer to Figure 1D-190. Adjacent to the Kitchen is a large room, identified as the Radio Watchroom on original drawings. Historic photos show this room was also used as a Dining and Living Room. This room is seen in Figure 1D-191 and also shows a large section of damaged ceiling. A loose fill, poured insulation material is seen in these damaged ceiling areas.

Three Bedrooms are located on Level 2, each with a small closet, and one small room possibly used as an Office, but noted as a Bedroom on original drawings. Views of the various Bedrooms are seen in Figures 1D-192, 1D-193 and 1D-194. All Bedroom doors, and the Office door, on Level 2 are 2 feet 6 inches wide by 6 feet 8 inches high

Figure 1D-188 Small recessed medicine cabinet in the Bathroom on Level 2.

Figure 1D-189 View of the Kitchen on Level 2.

Figure 1D-190 Extreme damage of the plaster ceiling and metal lath in the Kitchen on Level 2.

Figure 1D-191 View of the Dining/Living/Radio Room on Level 2.

Figure 1D-192 View of a Bedroom on Level 2.

Figure 1D-193 View of a Bedroom on Level 2.

Figure 1D-194 View of a Bedroom on Level 2.

Figure 1D-195 Two-panel wood door with glass light at Office on Level 2.

Figure 1D-196 Two-panel wood door with glass light at Office on Level 2.

Figure 1D-198 Small wood door at storage closet on Level 2 below the stair.

Figure 1D-197 Typical three-panel wood closet door.

Figure 1D-199 Borrowed light in the Office wall.

Figure 1D-200 Typical painted wood base and wood parquet floor in Bedroom on Level 2.

Figure 1D-201 Wood base in the Hallway on Level 2.

Figure 1D-202 Typical interior wood door frame on Level 2 with metal plaster stops.

Figure 1D-203 Typical interior wood door frame on Level 2 with metal plaster stops.

Figure 1D-204 View of exposed steel column on Level 2 and poor interior finishes.

Figure 1D-205 View of exposed steel beam and column on Level 2.

Figure 1D-206 View of exposed steel beam and column on Level 2.

Figure 1D-207 Rusted steel beam and missing and damaged metal lath and plaster on Level 2.

Figure 1D-208 Wood parquet flooring in a Bedroom on Level 2.

by 1-3/8 inches thick 2-panel wood doors with a single large glass light. Refer to Figures 1D-195 and 1D-196. A typical closet door is seen in Figure 1D-197. It is similar to the other doors except that the glass panel is replaced with a wood panel. Some latchsets with cylindrical knobs remain, but much of the hardware is missing. The door leading into the Radio Room is 2 feet 8 inches wide. Doors on two closets and the Bathroom are missing.

Figure 1D-209 Stairway and landing from Level 2 leading to the Tower.

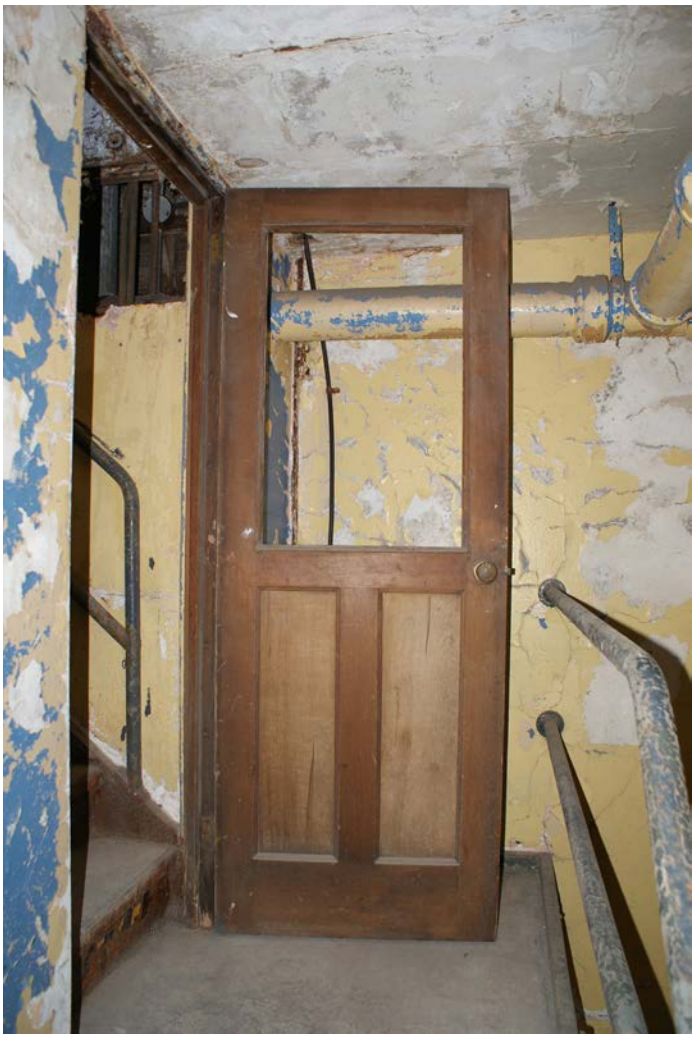

Figure 1D-210 Wood two-panel door with missing glass.

Other features on Level 2 include a small closet below the tower stairway, as seen in Figure 1D-198. The door on this closet is a 2 feet 6 inches wide by 4 feet 11 inches high by 1-3/8 inches thick two-panel wood door. A 4 feet wide by 3 feet 1 inch high borrowed light is located in the wall of the small Office. The glass on this borrowed light, Figure 1D-199, has been painted.

Interior walls at Level 2 are wood stud walls with plaster finish and are 5-¾ inches thick. An 8 inch high wood base with a 7/8 inch wide by 1 ½ inch high shoe moulding is found throughout Level 2 as seen in Figures 1D-200 and 1D-201. A typical door jamb, seen in Figures 1D-202 and 1D-203, includes a wood jamb and stop, and metal quarter rounds that serve as plaster stops. The steel C-channel frame serves as the finish trim around all windows.

In some locations the steel columns and beams are exposed and there is significant rust due to roof leaks. Refer to Figures 1D-204, 1D-205 and 1D-206. Some steel beams are wrapped with metal lath and plaster and there is also substantial damage, as seen in Figure 1D-207.

Flooring on Level 2 includes 9 inches by 9 inches tile in the Bathroom and remnants of wood parquet flooring in other rooms. Wood parquet flooring in one of the Bedrooms is seen in Figure 1D-208. All finishes on Level 2, including the plaster on walls and ceilings, are in extremely poor condition throughout.

From the living quarters on Level 2, the structure transitions to the tower which is 15 feet 6 inches square at the base. A small two step stair leads to a landing, where a 2 feet 6 inches wide by 6 feet 8 inches tall door at the base of the first tower stair

Figure 1D-211 View of stairway looking down from Tower Level 3.

Figure 1D-212 View of the open stair, railings and metal chimney on Level 3.

Figure 1D-213 In-swinging wood door from the tower Level 3 to the Watch Deck.

Figure 1D-214 Stairway from Level 3 leading to tower Level 4.

Figure 1D-215 View of metal pan and concrete stairway at Level 4.

Figure 1D-216 Stairway and steel pipe guardrails around stair opening at Level 4.

Figure 1D-217 Square steel newel post at Level 4.

Figure 1D-218 Metal chimney pipes passing through Level 4.

Figure 1D-220 Metal chimney pipes terminating at the underside of the Lantern Deck.

Figure 1D-219 Metal chimney pipes passing through Level 4.

Figure 1D-221 Unused metal ladder stored on tower Level 4.

Figure 1D-222 Metal stair from Level 5 and floor hatch into the Lantern.

Figure 1D-223 Poor condition of exposed steel beams and concrete surfaces on Level 5.

Figure 1D-224 Poor condition of exposed steel beams and concrete surfaces on Level 5.

is located. Refer to Figures 1D-209 and 1D-210. The glass is missing on the door. The stairway up to Level 3 is 3 feet 2 inches wide with steel pipe handrails on both sides. Figure 1D-211 is a view looking down this stair from Level 3.

Level 3 (L3)

Level 3 is an open room with substantial space occupied by the stairwell to the Lantern and two metal chimney pipes, one 7 inches in diameter and one 12 inches in diameter. The stairway, steel pipe guardrails around the stair opening and the underside of a section of stair are seen in Figure 1D-212. The doorway from Level 3, Figure 1D-213, provides access to the Watch Deck. The stairway, Figure 1D-214, continues up to Level 4.

Level 4 (L4)

Details of the tower stairs and guardrails are seen in Figures 1D-215 and 1D-216 at Level 4. The guardrail is 1-5/8 inch O. D. steel pipe with two horizontal rails. The top rail is 3 feet 1 inch above the floor level. A square steel newel post is seen in Figure 1D-217. All stair and railing components are in good condition; the paint finish is in poor condition.

The two chimney pipes passing through Level 4 are seen in Figure 1D-218. A larger framed floor opening for the chimney pipes at Level 5 is seen in Figure 1D-219. The chimney pipes offset and now terminate and are capped at the Lantern Deck, Figure 1D-220.

Figure 1D-225 Main electric cable entering the structure at the sea door in the Basement.

Figure 1D-226 Main electric cable secured to the Basement floor.

Figure 1D-227 Main electric cable running up the wall in the Basement Water Room.

A steel ladder with double rungs is laying on the floor at Level 4. The original location of this ladder, seen in Figure 1D-221, is not known. At Level 5, a near vertical steel stair provides access to the floor hatch of the lantern. Refer to Figure 1D-222. This stair is 2 feet wide with 6 inch by 3/16 inch steel stringers and 7 inch deep steel plate treads. This ladder is in good condition; the paint finish is in poor condition.

Level 5 (L5)

In the three levels of the tower, the concrete floor and wall surfaces are in generally good condition. At the roof of Level 5, which is also the Lantern and Lantern Deck floor, there is deterioration of the concrete, Figure 1D-223, and rusting of the exposed steel beams, Figures 1D-223 and 1D-224. Paint on all surfaces is in very poor condition.

Figure 1D-228 Electrical transformer in the Boat Room on Level 1.

Figure 1D-229 Electrical transformer in the Boat Room on Level 1.

Figure 1D-230 Electrical panels on Level 1.

Figure 1D-231 Surface mounted electrical conduit on Level 1.

Figure 1D-232 Typical surface mounted electrical devices.

Figure 1D-233 Electrical equipment panels in tower Level 5.

MECHANICAL AND ELECTRICAL SYSTEMS CONDITIONS AND ANALYSIS

There is no electrical power at the North Manitou Shoal Light Station, or operational plumbing or mechanical systems, although remnants of these various systems remain.

An underwater electric cable remains in place from the mainland to the light station, however it has not been tested to determine if it is intact. The electric cable enters the structure through a corner of the sea door in the Basement, Figure 1D-225, and runs exposed along the floor for a short distance, Figure 1D-226, before running up the wall, Figure 1D-227, to an electrical transformer located in the north corner of the Boat Room on Level 1. Views of the electrical transformer are seen in Figures 1D-228 and 1D-229. A main electrical panel is located in the hallway on the wall opposite the stairway to Level 2. This panel, seen in Figure 1D-230, is labeled "125 amps, 120/240 volt, single phase, 3-wire". Surface mounted metal conduit is found throughout running to lights, receptacles and switches, as seen in Figures 1D-231 and 1D-232. Other electrical sub-panels are located in various rooms and in the tower, Figure 1D-233.

Light fixtures in the light station include surface mounted, industrial fluorescent fixtures, Figure 1D-234, and various incandescent fixtures, Figure 1D-235 and 1D-236. There are no remaining light fixtures on the exterior of the structure, however, there are some wall openings with conduit indicating the past presence of exterior wall mounted lighting. Although somewhat difficult to see, it appears there was a light fixture above the sea door, semi-recessed into the concrete structure.

All electrical elements including wiring, receptacles, lighting and panels are in very poor condition.

Figure 1D-234 Surface mounted fluorescent light fixture.

Figure 1D-235 Surface mounted incandescent light fixture.

Figure 1D-236 Surface mounted incandescent light fixture.

Figure 1D-237 Wiring in Basement Water Room from telegraph signaling system.

Figure 1D-239 Cast iron roof drain line exposed in the Boat Room on Level 1.

Figure 1D-238 Cast iron sanitary waste line exposed in the Basement.

Figure 1D-240 Abandoned cast iron radiator located on tower Level 5.

Figure 1D-241 Large chimney pipes located in the Basement.

Figure 1D-242 Large chimney pipes located in the Basement.

Figure 1D-243 Large chimney pipes located in the Basement.

Dave McWilliam with North Manitou Light Keepers, Inc. indicated that a large wire located in the Basement Laundry Room, is a remnant of a telegraph signaling system from the light station to the life-saving station located on North Manitou Island. This wire is seen in Figure 1D-237. Details of this system are not known.

Except for the bathtub located in the Bathroom on Level 2, there are no plumbing fixtures. As previously discussed, there is a large 3 foot diameter water tank located adjacent to the water well in the Basement Water Room and there are remnants of galvanized piping. Some cast iron sanitary waste line piping remains in the basement Coal Room, as seen in Figure 1D-238.

Some large 6 inch diameter cast iron pipes are exposed on Level 1, such as this one seen in the Boat Room, Figure 1D-239, and on Level 2. These pipes serve the roof drains located on the Watch Deck on Level 3. These drain pipes were cleaned in 2017-2018 and are presumed to be operational.

There is no heating system in the light station and few remnants of a heating system, including a single section of cast iron radiator located in the tower on Level 5 and a wall mounted cast iron radiator in the Basement. Refer to Figure 1D-240. Two chimney pipes were previously discussed and shown as they pass through the three tower levels. In the Basement these chimney pipes are cast iron, 12 inches and 6 inches in diameter. Refer to Figures 1D-241, 1D-242 and 1D-243. A small raised concrete pad 4

Figure 1D-244 Aids-To-Navigation equipment in tower Level 5.

Figure 1D-245 Aids-To-Navigation equipment in tower Level 5.

Figure 1D-246 Fire alarm pull station located on Level 1.

feet by 2 feet 8 inches by 4 inches high is adjacent to these pipes. Original drawings indicate this was the location of a boiler.

In addition to the aids-to-navigation noted in the section on the Lantern, there are some aids-to-navigation components in the tower on Level 5. These items are seen in Figure 1D-244 and 1D-245.

LIFE SAFETY SYSTEMS CONDITIONS AND ANALYSIS

There are remnants of an alarm or fire protection system located on Level 1, as indicated by this pull station seen in Figure 1D-246. The details of this system are not known and there are no other life safety alarms, devices or systems in the structure.

NORTH MANITOU
LIGHT KEEPERS

PART II: TREATMENT + USE

This section of the Historic Structure Report presents the overall recommended treatment strategy and specific treatment recommendations for the future of the North Manitou Shoal Light Station with an emphasis on preserving existing materials and maintaining the longevity of this remote structure. An in-depth study of historic documentation and existing conditions was undertaken to determine the most appropriate treatment strategy and specific treatments for the station.

Part 2 includes the following:

2A - Ultimate Treatment and Use

This section is based on the findings presented in Part 1: Developmental History and the North Manitou Light Keepers' intentions for future programming and use of the structures. This section includes a Summary of the NMLK, including its background and mission, goals and aspirations for the future of the light station, as well as a description of how the station is currently accessed and will be in the future.

The recommended rehabilitation strategy and use plan presented takes into account maintaining character-defining features from the Period of Interpretation; preserving and mitigating the loss of as much original building fabric as possible and, at the same time, providing safe access. A narrative on the four distinct, yet interrelated approaches of the Secretary of the Interior's Standards for the Treatment of Historic Properties (preservation, rehabilitation, restoration and reconstruction) is included for background on the selection of the rehabilitation strategy.

2B - Requirements for Treatment

This section outlines applicable laws, regulations and functional requirements specifically addressing issues of human safety, fire protection, energy conservation, abatement of hazardous materials and handicapped accessibility that meet current code (2015 Michigan Rehabilitation Code for Existing Buildings) requirements.

2C - Specific Treatment Recommendations

This section provides specific treatment recommendations that follow the U.S. Secretary of the Interior's Standards for the Treatment of Historic Properties. These recommendations are prioritized into a phased work schedule according to condition and relation to the overall recommended Ultimate Treatment and Use Plan.

2D - Preliminary Cost Budget Estimates

This section includes cost budget estimates for the treatment recommendations contained in this report.

2A
Ultimate Treatment + Use

This section is based on the findings presented in Part 1 and review of the North Manitou Light Keepers (NMLK) website and related media and press regarding their efforts to date, and discussions with NMLK Board Members regarding plans for and future programming and use of the station. Unless otherwise noted, the information regarding the NMLK is from the NMLK website and press coverage. The following treatment strategy takes into account preserving and mitigating the loss of as much original building fabric as possible, at the same time allowing for safe and enjoyable access.

NORTH MANITOU LIGHT KEEPERS

North Manitou Light Keepers (NMLK) is a team of stewards dedicated to rehabilitating, maintaining, and appreciating the North Manitou Shoal Light in Leelanau County, Michigan. They realize that: "this offshore lighthouse, known locally as "The Crib" due to its design, is a wonderful piece of Lake Michigan maritime history. It sits amidst the Sleeping Bear Dunes National Lakeshore and the Manitou Islands, in the middle of some of America's most beautiful landscape." Recognizing that the structure has been "lightly maintained" since its automation by the US Coast Guard in 1980, the NMLK states that a meaningful restoration of the lighthouse structure is necessary to stop its further deterioration, make it "pretty" again, and make it available to the public for viewing and appreciation.

In the summer of 2016, the U.S. General Services Administration opened an auction to sell the North Manitou Shoal Light. Upon hearing this news, four families of dreamers and doers rallied together to bid on and win the auction for the lighthouse. Daniel and Anna Oginsky, Dave and Sherry McWilliam, Todd and Natalie Buckley, and Jake and Suzanne Kaberle founded NMLK, with the goal of acquiring The Crib and completing its restoration and opening it to the public by July 4, 2021. Officially, NMLK was established on August 16, 2016 as a Michigan non-profit corporation named North Manitou Light Keepers, Inc. NMLK is managed by its board of directors, who are Daniel Oginsky (President), Anna Oginsky, Dave McWilliam, Todd Buckley, and Jake Kaberle.

After winning the public auction for the North Manitou Shoal Light, NMLK received official notification from the U.S. General Services Administration that its bid was accepted on September 28, 2016. In June 2017 NMLK completed its acquisition upon receiving approval from the Michigan Department of Environmental Quality to occupy the "bottomlands" (at the bottom of Lake Michigan) on which The Crib sits.

NMLK Previous Stabilization and Restoration Efforts

NMLK has undertaken several stabilization and restoration projects since acquiring the station. Work completed to date includes removal of hazardous materials (lead-based paint, asbestos and bird guano) and general cleanup; installation of temporary boat/equipment hoists; extensive exterior painting; interior painting of the lantern; and restoration of the windows. They are also considering an underwater evaluation of structure and bottomlands. NMLK has a membership program inviting those who share the passion, dream and commitment to care for this piece of history to join in on the mission. They have also launched their "Campaign for the Crib" capital fundraising effort to cover the rehabilitation costs of the coming years. Further, NMKL has committed matching funds to the Michigan Lighthouse Assistance Program grant they received to develop this Historic Structure report.

NMLK Plans for Future Use of the Station

The only access to the North Manitou Shoal Light Station is via boat. NMLK members and restoration contractors currently reach the station via private and chartered boats and climb the ladders inset into the concrete pier to access the structure. The recently installed boat/equipment hoists are used for loading and unloading construction materials and equipment, as well as lifting boats onto the main deck when people are on the crib for an extended period.

NMLK's goal is to open the station to public tours and viewing on July 4, 2021. Intended public access is via the to-be-restored sea door located at the water/basement level. Long-term aspirations include holding special events and hosting overnight guests. The NMLK recognizes the important balance of respecting and sharing the history of the station and strategically incorporating contemporary elements to allow visitors to safely enjoy the station.

TREATMENT STRATEGY (AND USE PLAN)

The Secretary of Interior's Standards are divided into four distinct, yet interrelated approaches to the treatment of historic properties: preservation, rehabilitation, restoration, and reconstruction. Preservation focuses on the maintenance and repair of existing historic materials and retention of a property's form as it has evolved over time. Rehabilitation acknowledges the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character. Restoration depicts a property at a particular period of time in its history, while removing evidence of other periods. Reconstruction re-creates vanished or non-surviving portions of a property for interpretive purposes.

The selection of an appropriate treatment(s) depends on a variety of factors, including the property's historical significance, physical condition, proposed use, and intended interpretation. These factors have been considered in determining the appropriate treatment approach for the North Manitou Shoal Light Station. Based on this analysis, the recommended treatment approach is rehabilitation with recognition of the Period of Interpretation of 1935 – 1966.

The Secretary of the Interior's Standards for Rehabilitation

The Standards (Department of Interior regulations, 36 CFR 67) pertain to historic buildings of all materials, construction types, sizes, and occupancy and encompass the exterior and the interior, related landscape features and the building's site and environment as well as attached, adjacent, or related new construction. The Standards are to be applied to specific rehabilitation projects in a reasonable manner, taking into consideration economic and technical feasibility. The following is a list of the ten specific standards that have guided the specific treatment recommendations provided in this report.

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.
2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.
3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.
4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8. Significant archaeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Recommended Treatment Phases

Phase 1: Continued Rehabilitation and Limited Visitor Access

This phase of work includes structural repairs; exterior repairs and drainage improvements to ensure the structure is watertight; exterior and limited interior rehabilitation treatments; and restoration of the sea door to improve visitor access. These recommendations continue the stabilization and rehabilitation efforts of NMLK. Rehabilitation treatments take into account the appearance and configuration of features during the Period of Interpretation where feasible. Work recommended in later phases may be able to be completed in this phase to maximize efficiency of construction mobility and schedule.

Phase 2: Rehabilitation and Enhanced Visitor Access

Phase 2 Rehabilitation includes a continuation of interior work.

Phase 3: Continued Rehabilitation

Phase 3 includes additional work to supplement enhanced use of the light station by visitors for longer time periods, as well as non-structural repairs of the vertical faces of the concrete crib.

Phase 4: Reconstruction of Missing Features

Phase 4 includes reconstruction of missing features from the Period of Interpretation.

2B Requirements for Treatment

This section outlines applicable laws, regulations and functional requirements, specifically addressing issues of life safety, fire protection, energy conservation, abatement of hazardous materials and handicapped accessibility for existing buildings in the state of Michigan and how they apply to the recommended treatments for the North Manitou Shoal Light Station.

MICHIGAN REHABILITATION CODE FOR EXISTING BUILDINGS

Background and Applicability of the Code

The Michigan Rehabilitation Code for Existing Buildings (MRCEB) is the applicable governing code for modifications to the North Manitou Shoal Light Station. The current version is MRCEB 2015, which was adopted by the state on December 13, 2016. The MRCEB adopts by reference, in R 408.30551 of the Michigan Administrative Code, the International Existing Building Code (IEBC) 2015 edition, as published by the International Code Council, Inc. and includes deletions, additions, and amendments specific to the State of Michigan.

Internationally, code officials recognize the need for a modern, up-to-date code addressing repair, alteration, addition or change of occupancy in existing buildings. The IEBC (and subsequent MRCEB) is designed to meet this need through model code regulations that safeguard the public health and safety in all communities, large and small. These comprehensive existing building codes establish minimum regulations for existing buildings using prescriptive and performance-related provisions. The codes are founded on broad-based principles intended to encourage the use and reuse of existing buildings while requiring reasonable upgrades and improvements.

Per [A] 101.2 of the MRCEB, the provisions of the code apply to the repair, alteration, change of occupancy, addition, and relocation of existing buildings. Although doubtful, given the small footprint of the crib, any new buildings constructed at the station should be designed to meet the requirements of the Michigan Building Code for new construction.

MRCEB CHAPTER 12 FOR HISTORIC BUILDINGS

The North Manitou Shoal Light Station is listed on the National Register of Historic Places and thus the existing structure is defined as an historic building in the MRCEB. The MRCEB states that historic buildings shall comply with the provisions of Chapter 12 of the MRCEB relating to their repair, alteration, relocation and change of occupancy.

Section 1201 - General Provisions

MRCEB Section 1201 provides general code requirements. Section 1201.2 specifically states that historic buildings that undergo repair, alteration, or change of occupancy shall be investigated and evaluated. Initial investigation and evaluation have been undertaken as part of the preparation of this HSR. If it is determined that compliance with code requirements would be damaging to contributing historic features, a registered design professional may prepare a report describing the feature and demonstrate how an equivalent level of safety is provided.

Section 1202 - Repairs

MRCEB Section 1202 provides requirements for repairs to historic buildings. Repair is defined in the MRCEB as "The reconstruction or renewal of any part of an existing building for the purpose of its maintenance or to correct damage." Repairs include the patching or restoration or replacement of damaged materials, elements, equipment or fixtures for the purpose of maintaining such components in good or sound condition.

Section 1202 indicates that repairs shall be permitted with original or like materials and original methods of construction with the exception of hazardous materials such as asbestos and lead-based paints. Replacement of existing or missing features using original materials is permitted, as

well as partial replacement for repairs that match the original in configuration, height, and size. The intention of the repairs recommended in this HSR is to match the original (original in this case being the configuration, size, color, appearance, etc. of the feature during the Period of Interpretation) as close as practical and technically feasible.

The MRCEB sections relative to repairs states that repairs shall be done in a manner that maintains the level of fire protection provided, the level of protection provided for the means of egress and the level of accessibility. None of the proposed treatment recommendations reduce the level currently maintained in these areas.

Section 1202 further states that conditions determined to be unsafe shall be remedied. No work shall be required beyond what is required to remedy the unsafe conditions. Upon initial review for this HSR, the conditions noted as potentially unsafe are the main level deck (exterior area of Level 1), watch deck (exterior area of Level 3), and the lantern gallery because the height and configuration of the perimeter railings do not meet current MBC code requirements for a guardrail. Guardrails are required at all walking surfaces located 30" above grade. Because altering the railing into a code-compliant guardrail would significantly alter the historic appearance of the structure, it is recommended that access to these areas be restricted. Alternatively, other lighthouse stewards have implemented practices explaining the risks to potential visitors and have them sign a waiver of liability before accessing similar areas.

Section 1203 - Fire Safety

Applicable portions of this section include:

1203.3 Means of egress: There is flexibility that if existing door openings and corridor and stairway widths are less than those specified by the code, they may be approved, provided that there is sufficient width and height for a person to pass through the opening or traverse the means of egress.

1203.5 Interior finishes: Existing historic finishes of walls and ceilings are acceptable (and thus do not require fire-resistance rating).

1203.6 Stairway enclosure: The doors leading into and out of the stair enclosure shall be tight-fitting and solid to prevent the spread of smoke.

1203.9 Stairway railings: The existing handrails and guards at the stairs can remain, provided they are not structurally dangerous.

1203.11 Exit signs: Where exit signs would damage the historic character of the building, alternative exit signs are permitted with approval of the code official. Alternative exit signs shall identify the exits and egress path.

Section 1204 - Alterations

Section 1204.1 indicates that the accessibility requirements of the chapters for alterations (specifically Sections 705, 806 and 906), as applicable, shall apply to facilities designated as historic structures that undergo alterations, unless technically infeasible.

The MRCEB designates three levels of alterations to existing buildings:

- Level 1
  Includes the removal and replacement or the covering of existing materials, elements, equipment, or fixtures using new materials, elements, equipment, or fixtures that serve the same purpose.
- Level 2
  Includes the reconfiguration of space, the addition or elimination of any window or door, the reconfiguration or extension of any system, or the installation of any additional equipment.
- Level 3
  Applies where the work area exceeds 50 percent of the building area.

Section 705 of the code applies for these Level 1 alterations, which states that a building, facility, or element that is accessible shall remain accessible. Due to site access to the structure and access between floor levels being only via ladders or stair, the site and integral building are currently not accessible. Therefore, the code does not require them to made such.

Section 806 applies for Level 2 alterations and Section 906 for Level 3. These sections state that a building, facility, or element that is altered shall comply with Section 410. Section 410.9 addresses historic buildings provides alternative requirements for when compliance with the requirements for accessible routes, entrances or toilet rooms would threaten or destroy the historic significance of the facility.

Most of the proposed treatment recommendations would be considered repairs or Alteration Level 1. Treatment recommendations that may be considered Level 2 alterations include installation of any mechanical, electrical or plumbing systems if in less than 50% of the building. Installation of any mechanical, electrical or plumbing systems if in greater than 50% of the building would be considered Level 3 alterations.

Section 1205 - Change of Occupancy

Because the existing structure is already owned by NMLK as an historic structure with the main intent to preserve and interpret it, there will not be a change of occupancy and therefore this section is not applicable.

Section 1206 - Structural

Section 1206 indicates that historic buildings shall comply with the applicable structural provisions of the code. Conditions determined by the code official to be dangerous shall be remedied. A complete structural analysis should be undertaken if the station is to be used for large groups of people.

Hazardous Materials

Any remaining hazardous materials should be removed by licensed contractors utilizing lead safety practices and asbestos abatement procedures and according to local, state and federal regulations. Lead-safety practices include minimizing dust, containing the work area, cleaning up thoroughly and proper disposal. For the small areas of paint removal from metal surfaces, chemical paint removers should be utilized in lieu of blasting.

Energy Conservation

The MRCEB indicates that alterations shall conform to the energy requirements of the International Energy Conservation Code (IECC), without the entire building or structure required to comply with the requirements. It is recommended that any new mechanical, electrical or plumbing systems that are installed meet the IECC.

2C Specific Treatment Recommendations

The following specific treatment recommendations are based on historic research, site investigations, and the goals of the NMLK for the future use of the station. These recommendations are prioritized into phases based on condition and relation to the overall recommended Ultimate Treatment and Use. They have been developed to follow the *U.S. Secretary of the Interior's Standards for Rehabilitation.*

EXISTING CONDITIONS DISCUSSION RELATIVE TO RECOMMENDATIONS

The existing distress is primarily related to corrosion of the structural steel elements due to water infiltration through the exterior envelope. The recent re-coating of the exterior and window rehabilitation is a positive action in protecting the exposed steel and preventing further corrosion. However, the steel cover plates over the exterior portions of the Pier Deck, Level L-1, and Watch Deck, Level L-3 are in poor overall condition. Seams and joints related to the steel cover plates lack a means to accommodate thermal expansion and contraction, and, as such, the plates have buckled upwards and the materials used in the joints are missing or damaged. The steel cover plates in their current condition are unable to keep the building weathertight. Other alternatives to protect the exterior portions of the concrete decks may be more appropriate than the retrofitted steel decks, both historically and in regard to the maintenance of the building. Sealants between dissimilar materials should account for full ultraviolet exposure and will require regular maintenance due to the building location.

The most significant deterioration of the steel elements was observed near the southernmost interior column, originating at the Watch Deck, Level L-3, and continuing to the Basement level. The addition of a roof drain near this southernmost interior column at the Watch Deck, Level L-3, may alleviate snow, ice and water from collecting at this location which is between the two existing roof drains at the east and west corners of the tower. Similar consideration should be given to adding a roof drain at the north tower corner if the slope of the deck is to be altered for the new drain at the southernmost interior column. The existing deck slope, to be verified with the removal of the existing steel cover plates, may be able to provide positive drainage along the tower wall to the existing roof drains and if established with any protective layer, could eliminate the need for additional roof drains. All joints should be properly sealed and maintained where the tower structure meets the Watch Deck, Level L-3, exterior surface.

The cracking in the basement walls is believed to be original to the construction of the structure and is most likely related to movements of the adjacent dissimilar materials. It is also possible that the cracking is a result of movements or possible deterioration of the underlying timber crib structure.

Phase 1: Continued Rehabilitation and Limited Visitor Access

Phase 1 work is the highest priority and includes structural repairs; exterior repairs and drainage improvements to ensure the structure is watertight; exterior and limited interior rehabilitation treatments; and restoration of the sea door to improve access. These recommendations continue the stabilization and rehabilitation efforts already completed by North Manitou Light Keepers, Inc. Rehabilitation treatments take into account the appearance and configuration of features during the Period of Interpretation where feasible.

Work recommended in later phases may be able to be completed in this phase to maximize efficiency of construction mobility, schedule and cost.

Item 1a) Restore Sea Door on north wall of Crib

Remove and replace all damaged components and restore to original operating condition. Restoration of the metal sea door is high priority and will significantly improve ease of access for

equipment, supplies and personnel. Install a new steel pipe guardrail around the stairwell opening and a stair handrail at the stair leading down to the sea door. The design of these missing components is to be based on historic drawings. Remove rust and corrosion on all metal components by lightly blasting to white metal. Clean, properly prepare and paint all metal surfaces with rust inhibiting marine grade paint. Match "black" color of other restored exterior surfaces.

Item 1b) Remove plywood ceilings and joists in Equipment Room on Level L-1

Remove the plywood ceiling and wood joists in two equipment rooms to expose the original structure.

Item 1c) Structural inspection and repairs of Level L-3 deck structure

Remove additional areas of plaster ceiling, metal lath and insulation to expose the steel bar joists and concrete deck. Evaluate the extent of corrosion and repair, replace or reinforce as determined through structural analysis. Full replacement of the exterior deck structure is not anticipated, although select areas of the concrete slab may require replacement and select bar joists will require reinforcement.

Item 1d) General structural repairs

Inspect all exposed structural steel including columns, beams, joists and stair framing. Replace fasteners that are corroded with section loss. If corrosion on steel surfaces appears to extend behind interior plaster finish, remove additional plaster to expose the steel. Remove rust and corrosion on all metal components by lightly blasting to white metal. Clean, properly prepare and paint all steel surfaces with rust inhibiting marine grade paint.

Fully expose all four interior steel columns at all levels to properly inspect, clean and paint. Replace connections or reinforce the columns as determined through further review and structural analysis once exposed.

Fully expose all of the bar joists below the Watch Deck, Level L-3, for evaluation of extent of corrosion. Repair, replace or reinforce as determined through structural analysis. Full replacement of the exterior deck structure is not anticipated, although select areas of the concrete slab may require replacement and select bar joist members will require reinforcement.

Fully expose the connection between the upper tower walls and the Watch Deck, Level L-3, structure for further assessment on extent of corrosion. Repair, replace or reinforce as determined through further review and structural analysis. Based upon the one area exposed, the wall channels are anticipated to need to be cleaned and coated, but the connection angles and fasteners will likely require full replacement. Temporary shoring to complete this effort will be required.

Complete structural analysis of wall system considering reduced section loss from corrosion, including door and window framing.

Item 1e) Restore Level L-1 Pier Deck

Remove the steel plates presently covering the concrete deck. Inspect the structural concrete slab and repair as required per Concrete Reinforcing Steel Institutes (CRSI) and American Concrete Institute (ACI) standards. Install a slip resistant waterproof deck coating. Restore the deck light that is located on the exterior

of the tower, concealed beneath the steel plate. A standard "gray" color is recommended for the deck coating color.

Item 1f) Restore guardrails at Pier Deck Level L-1

Remove and replace all missing, damaged and deteriorated guardrail components with similar elements. Restore to original condition. Inspect all base anchors into the structural concrete slab for adequate structural strength. Replace damaged anchors as required. Remove rust and corrosion on all metal components by lightly blasting to white metal. Clean, properly prepare and paint all metal surfaces with rust inhibiting marine grade paint. Match "black" color of upper level guardrails.

Item 1g) Restore vertical ladders on face of concrete crib

Remove rust and corrosion on all metal ladder components by lightly blasting to white metal. Repair or replace damaged or missing components. Replacement components are to match the existing in terms of material, size and profile. Clean, properly prepare and paint all metal surfaces with rust inhibiting marine grade paint. Match "black" color used on other exterior surfaces.

Item 1h) Restore Level L-3 deck

Remove the steel plates presently covering the concrete deck. Inspect the structural concrete slab and repair as required per Concrete Reinforcing Steel Institute (CRSI) and American Concrete Institute (ACI) standards. Install a single-ply roof membrane with walkway pads. Inspect the two roof drains and related piping to insure proper operation. Consider the installation of a third or fourth roof drain for redundancy.

Item 1i) Inspect / test electric sub-marine cable

Inspect the visible ends of the existing sub-marine cable at the light station and at the shore for damage. Conduct continuity tests to determine if the cable is intact and able to be put back into service, or if damaged and not usable.

Item 1j) Install temporary generator for electrical service

Install a temporary generator for electrical power and lighting. Locate the generator in the Boat Room near the electrical transformer.

Item 1k) Install restored windows on Level L-1

Remove the temporary plywood covers from the window openings and install the restored steel windows on Level L-1. Typical at three locations.

Item 1l) Install crack monitoring system in basement

Install crack monitoring system on the cracks in the basement wall near the sea door as a method to monitor the size of the cracks and any movement. Monitor for length, width, displacement on either side of crack or water infiltration.

Phase 2: Rehabilitation and Enhanced Visitor Access

Phase 2 Rehabilitation includes a continuation of interior work. Items include:

Item 2a) Remove non-historic features on Level L-1

Remove non-historic features on Level L-1 including the poured concrete containment walls located in the Boat Room and the wood frame/plywood walls in the Equipment Room area.

Item 2b) Eliminate Boat Room wall opening

At some point a new wall opening was created at the south corner of the Boat Room. This wall opening presently has a containment wall at the bottom of the opening. Remove the containment wall per Item 2a and reconstruct the wall with poured concrete. Match existing wall thickness and texture.

Item 2c) Restore interior concrete floor surfaces

Restore all existing concrete floor surfaces throughout the light station. Repair minor damaged areas with concrete patch material matching the texture of existing material as closely as possible. Refer to NPS Preservation Brief #15, "Preservation of Historic Concrete." Remove all deteriorated paint. Clean, properly prepare and paint the concrete surface with non-slip marine grade floor paint. Paint color was not determined by the Historic Paint Color Report. A standard "gray" is recommended.

Item 2d) Restore plaster walls and ceilings

Restore all damaged and deteriorated plaster wall and ceiling surfaces throughout the light station. Remove all damaged and deteriorated material including the metal lath and repair with new material. Remove all deteriorated paint on sound surfaces. Refer to NPS Preservation Brief #21, "Repairing Historic Flat Plaster – Walls and Ceilings." Clean, properly prepare and paint all plaster surfaces. Paint color shall be in accordance with the Historic Paint Color Report.

Item 2e) Install new flooring

Install new parquet hardwood flooring on Level L-2 in the Bedrooms, Closets, Office, Hall, Dining Room and Radio Watch Room. Install new linoleum in the Kicthen and Bathroom. Flooring shall be based on historic drawings and patterns visible in many rooms.

Item 2f) Replace missing interior doors and hardware

Install two doors in the Basement. Install removable panels on the southeast wall of the Boat Room on Level L-1. Removable panels, four total, are indicated as a two-panel door with full glass light on original drawing 33040-26. These door "panels" are bolted and not hinged. Install two doors in the Entry on Level L-1. Install three missing doors on Level L-2. Replacement doors shall match the profile, style and dimensions of original doors and shall be based on the historic drawings or similar adjacent door styles.

Item 2g) Restore existing in-swing exterior wood doors at Level L-1 and L-3

Restore the existing in-swing wood doors located on the exterior wall at Levels L-1 and L-3. Minor damage on doors shall be repaired. Clean, properly prepare and paint all doors in accordance with paint colors in the Historic Paint Color Report.

Item 2h) Restore existing interior doors

Restore all wood interior doors. Repair minor damage. Restore all hardware to good operating condition. Replace missing or damaged hardware components with new material matching the existing as closely as possible. Clean, properly prepare and shellac all doors and frames in accordance with the Historic Paint Color Report.

Item 2i) Restore interior floor deck lights at Level L-1

In conjunction with Item 2c, remove all paint and other coatings from the upper and lower surfaces of the deck light glass blocks and concrete framework. Thoroughly inspect all components. Remove individual glass blocks that are damaged and replace with new material matching the existing. If any deck lights have major damage, replace the entire unit with a new unit matching the existing design and dimensions as closely as possible. The upper solid surface of the deck lights shall be painted along with the adjacent concrete floor surface.

Item 2j) Install new kitchen cabinets and sink

Install new cabinets in the Kitchen on Level L-2. Cabinet design and configuration shall be based on historic drawings and outlines of non-extant cabinets on the existing painted walls. The new Kitchen sink shall be a new fixture appropriate to the Period of Interpretation.

Item 2k) Restore interior stairs, guardrails and handrails

Remove and replace all missing, damaged and deteriorated stairway, guardrail and handrail components with similar elements. Restore to original condition. Inspect all base anchors into the structural concrete slab for adequate structural strength. Replace damaged anchors as required. Remove rust and corrosion on all metal components by lightly blasting to white metal. Clean, properly prepare and paint all metal surfaces with rust inhibiting marine grade paint. Paint color shall be in accordance with the Historic Paint Color Report.

Item 2l) Install new electrical system

Install a new electrical distribution system throughout the building including lighting and receptacles. New wiring shall be concealed where presently concealed on Levels L-1 and L-2 and surface mounted in the Basement and other locations where concealment is not possible. Light fixtures and other devices shall be appropriate to the Period of Interpretation. Reuse the existing industrial style metal light shades or replace to match existing. All new electrical work shall be in conformance with the current edition of the Michigan Electrical Code.

The power source shall be dependent on the outcome of Item 1i, and may include electrical utility power through the sub-marine cable or from an on-site generator.

Item 2m) Install water well point, pump, filters and purification system

Install new components in the existing water well located in the Basement Laundry Room for a potable water supply system. The system shall meet state and local health code requirements.

Item 2n) Install new water supply and sanitary plumbing piping

Remove all existing water supply piping and install new copper piping. Inspect and test sanitary and other drainage piping and repair or replace as needed. Install a utility sink in the Basement Laundry Room. The plumbing system shall be designed for ease of draining for winter shut-down. All new plumbing work shall be in accordance with the current edition of the Michigan Plumbing Code.

Item 2o) Install new plumbing fixtures in Bathroom on Level L-2

Install new plumbing fixtures in the Bathroom on Level L-2 including a tub/shower, water closet and lavatory. All new fixtures shall be appropriate to the Period of Interpretation.

Item 2p) Install electric heat system

Install electric heat in select rooms in the Basement and on Levels L-1 and L-2 to provide minimal heat for visitor comfort. Retain any existing cast iron radiators on site for future interpretation.

Item 2q) Install septic holding tank or marine sanitation device

Install a new septic tank or marine sanitation device for holding and treatment of sanitary waste. Unit shall be installed in the Basement, location to be determined.

Item 2r) Replace missing porthole style windows in tower

Remove the Plexiglass covers and install new replica in-swing porthole style windows. The design shall match the original design shown on historic drawings as closely as possible.

Phase 3: Continued Rehabilitation

Phase 3 includes additional work to supplement enhanced use of the light station by visitors for longer time periods, as well as non-structural repairs of the vertical faces of the concrete crib. Items include:

Item 3a) Construct a new bathroom in the Basement

Install a new bathroom in the Basement for visitors and staff. The exact location to be determined. Although the light station is not an accessible building, incorporate universal design in the bathroom layout and fixture types. Convert the former bathroom into a utility closet.

Item 3b) Restore damaged concrete surfaces of the vertical face of the crib

Inspect the structural concrete slab and repair as required per Concrete Reinforcing Steel Institute (CRSI) and American Concrete Institute (ACI) standards. Remove all damaged and unsound material and repair surfaces in accordance with NPS Preservation Brief #15, "Preservation of Historic Concrete." Application of a coating shall be considered to maintain a uniform appearance after repairs are made.

Phase 4: Reconstruction of Missing Features

Phase 4 includes reconstruction of missing features from the Period of Interpretation:

Item 4a) Install replica air horns

Fabricate and install missing air horns on the sides of the tower. Remove the 1966 brackets located on the lantern deck. The design shall be based on historic drawings and photographs.

Item 4b) Reconstruct boat derricks

Fabricate and install the boat derricks and related components on Pier Deck Level L-1. The design shall be based on historic drawings and photographs.

Item 4c) Install replica metal chimneys

Fabricate and install the metal chimneys that were located above the Lantern deck. The design shall be based on historic drawings and photographs as well as the existing metal chimneys that remain below the Lantern.

Item 4d) Reconstruct / Restore other missing or concealed features

Restore or reconstruct features concealed by the metal deck plate covering the pier deck surface such as hatchway covers, coal chutes, boat tracks and other items. Document these concealed features during Phase 1 pier deck restoration. Reconstruct other missing features such as the flagpole and radiobeacon antennae pole.

ON-GOING MAINTENANCE AND MONITORING

- Maintain the historic drawings and specifications for future use and knowledge. The information provided in the drawings is difficult to obtain in the field, regardless of the existing conditions of the materials and is essential to completing an analysis of the structure.
- Monitor cracking in basement walls for changes in width, lengthening, displacement on either side of the cracks, or water infiltration through the cracks. Contact a professional engineer if movements of the cracks or water infiltration is observed.
- Maintain the roof drains at the watch deck (Level L-3) to ensure proper operation.

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2D Preliminary Cost Budget Estimates

This section includes budgetary costs for the treatment recommendations contained in this report. The estimates are construction costs only and based on current dollars, i.e., assuming that the work will take place in 2020. All costs are preliminary and based on the level of detail understood and presented in this HSR. Therefore, a twenty percent design and construction contingency is included in the overall costs. The following is not included:

- Escalation for inflation if work takes place beyond 2020.
- Additional mobilization, general conditions, overhead and other contractor costs associated with undertaking the work in multiple phases beyond those delineated herein.
- Contractor bonds costs.
- Long distance travel, lodging, food and other costs incurred by non-local contractor.
- Cost of architectural and engineering services unless specifically noted. It is recommended that ten percent to twelve percent of the construction costs for each specific project be budgeted for architectural and engineering fees for design, bidding assistance and construction administration services.
- Costs for interpretive signage or displays.
- Fundraising costs.
- Donations and costs incurred for volunteer efforts
- Permit fees.

PHASE 1: REHABILITATION AND LIMITED VISITOR ACCESS

Item 1a)	Restore Sea Door on north wall of Crib	$17,600
Item 1b)	Remove plywood ceilings and joists	$6,000
Item 1c)	Structural inspection and repairs of Level L-3 deck structure	$9,000
Item 1d)	General structural repairs*	$17,500
Item 1e)	Restore Level L-1 Pier Deck	$90,000
Item 1f)	Restore guardrails at Pier Deck Level L-1	$30,000
Item 1g)	Restore vertical ladders on face of concrete crib	$15,500
Item 1h)	Restore Level L-3 deck	$72,000
Item 1i)	Inspect / test electric sub-marine cable	$6,200
Item 1j)	Install temporary generator for electrical service	$5,500
Item 1k)	Install restored windows on Level L-1	$24,000
Item 1l)	Install crack monitoring system in basement**	$2,500

* *Does not include cost for structural engineering analysis.*
** *Cost for installation of crack monitors. Assumes NMLK will monitor once in place.*

Phase 1 Construction Cost Subtotal	$295,800
Contractor General Conditions (10%)	$30,000
Contractor Overhead and Profit (10%)	$30,000
Design and Construction Contingency (20%)	$60,000
Total Estimated Phase 1 Project Cost	**$415,800**

PHASE 2: REHABILITATION AND ENHANCED VISITOR ACCESS

Item 2a)	Remove non-historic features on Level L-1	$7,500
Item 2b)	Eliminate Boat Room wall opening	$13,000
Item 2c)	Restore interior concrete floor surfaces	$52,000
Item 2d)	Restore plaster walls and ceilings	$42,000
Item 2e)	Install new flooring	$8,000
Item 2f)	Replace missing interior doors and hardware	$40,000
Item 2g)	Restore existing in-swing exterior wood doors at Level L-1 and L-3	$5,000
Item 2h)	Restore existing interior doors	$27,500
Item 2i)	Restore interior floor deck lights at Level L-1*	TBD
Item 2j)	Install new kitchen cabinets and sink	$12,000
Item 2k)	Restore interior stairs, guardrails and handrails	$43,000
Item 2l)	Install new electrical system	$60,000
Item 2m)	Install water well point, pump, filters and purification system	$30,000
Item 2n)	Install new water supply and sanitary plumbing piping	$20,000
Item 2o)	Install new plumbing fixtures in Bathroom on Level L-2	$12,000
Item 2p)	Install electric heat system	$8,500
Item 2q)	Install septic holding tank or marine sanitation device	$15,000
Item 2r)	Replace missing porthole style windows in tower	$60,000

*Costs for this item still being developed.

Phase 2 Construction Cost Subtotal	$455,500
Contractor General Conditions (10%)	$46,000
Contractor Overhead and Profit (10%)	$46,000
Design and Construction Contingency (20%)	$91,000
Total Estimated Phase 2 Project Cost	**$638,500**

PHASE 3: CONTINUED REHABILITATION

Item 3a)	Construct a new bathroom in the Basement	$20,000
Item 3b)	Restore damaged concrete surfaces of the vertical face of the crib	$79,600
Phase 1 Construction Cost Subtotal		$99,600
Contractor General Conditions (10%)		$10,000
Contractor Overhead and Profit (10%)		$10,000
Design and Construction Contingency (20%)		$20,000
Total Estimated Phase 3 Project Cost		**$139,600**

PHASE 4: RECONSTRUCTION OF MISSING FEATURES

Item 4a)	Install replica air horns and remove brackets at lantern deck	$8,000
Item 4b)	Reconstruct boat derricks	$50,000
Item 4c)	Install replica metal chimneys	$16,000
Item 4c)	Restore/Reconstruct missing/concealed features	$25,000
Phase 1 Construction Cost Subtotal		$99,000
Contractor General Conditions (10%)		$9,900
Contractor Overhead and Profit (10%)		$9,900
Design and Construction Contingency (20%)		$19,800
Total Estimated Phase 4 Project Cost		**$138,600**

SUMMARY OF TOTAL PROJECTED COSTS

Total Estimated Phase 1 Project Cost	**$415,800**
Total Estimated Phase 2 Project Cost	**$638,500**
Total Estimated Phase 3 Project Cost	**$139,600**
Total Estimated Phase 4 Project Cost	**$138,600**
Total Estimated Project Cost - All Phases	**$1,332,500**

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Figure Credits

NMLK "The Crib" logo

NMLK Website

Part 1A

Figure 1A-01
Table created by O|X Studio and Smay Trombley Architecture

Figure 1A-02
"U.S. lighthouse typology chronology" provided on page 14 of Candace Clifford, ed. USDI/NPS NRHP Multiple Property Documentation Form: "Light Stations in the United States" (2002).

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Figure 1A-05 and 1A-06
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Figure 1A-07
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Figure 1A-08
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Figures 1A-09 and 1A-11
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Figure 1A-12
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Figure 1A-13
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Figure 1A-14
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Figure 1A-15
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Figure 1A-16
Photo of drawing "RITER-CONLEY MFG CO. PITTSBURGH. 80'0" SIGNAL TOWER FOR RADIO STATION, ERECTION DIAGRAM. U.S. GOV. CHIEF SIGNAL ENGR. WAR DEPT. WASHINGTON, D.C. 10/18/21" RHL 1025267, C.E.U. Cleveland, Coast Guard Buildings and Lighthouses, Michigan-Lake Michigan (Upper), Manitou Light Station, 1025200-1025275, Formerly Box 23. General Records of the U.S. Coast Guard, Record Group 26; National Archives at College Park.

Part 1B

Figure 1B-01
Contemporary nautical map of the Manitou Massage vicinity

Figure 1B-02
Diagram by Smay Trombley Architecture

Figure 1B-03
Michelle Smay, 1994.

Figure 1B-04
https://www.lighthousefriends.com/light.asp?ID=714

Figure 1B-05
https://www.lighthousefriends.com/light.asp?ID=2013

Figure 1B-06
Leelanau Historical Society
Figure 1B-07 and 1B-08
https://www.nps.gov/slbe/planyourvisit/lighthouses.htm

Figure 1A-09
https://www.lighthousefriends.com/light.asp?ID=714

Figure 1B-10
https://www.lighthousefriends.com/light.asp?ID=709

Figure 1B-11
https://www.lighthousefriends.com/light.asp?ID=716

Figure 1B-12 through 1B-16
National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-17
Handwritten letter/memo from [?] to HBB, "N. Manitou Shoal Lgtsta 12th Dist design", 3/21/33, 3 pages. National Archives and Records Adminstration (NARA), Washington, DC.

Figure 1B-18
OFFICE OF LIGHTHOUSE SUPERINTENDENT. TWELFTH DISTRICT. MILWAUKEE, WIS,. "NORTH MANITOU, MICH. GENERAL SCHEME." Approved March 31, 1933. Revised to April 5th 1933, June 30, 1934 and Oct 23, 1934. Signed by Superintendent and Asst. Superintendent. National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-19
OFFICE OF LIGHTHOUSE SUPERINTENDENT. TWELFTH DISTRICT. MILWAUKEE, WIS,. "NORTH MANITOU, MICH. CROSS SECTION - LOOKING NORTHEAST" 33040-8 Approved March 31, 1933. Revised to Oct 23, 1934. Signed by Superintendent and Asst. Superintendent. National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-20
Colored diagram overlaid onto DWG #33040-2 "NORTH MANITOU SHOAL LIGHT STATION CRIB DETAILS," National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-21
DWG #33040-23 "NORTH MANITOU SHOAL LIGHT STATION DETAILS SHOWING BOAT-ROOM DOOR & LOCK, ALSO PIVOTED & STORM WINDOWS & SCREENS," National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-22
DWG #33040-21 "NORTH MANITOU SHOAL LIGHT STATION TRACK LAYOUT AND DETAILS," National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-23
DWG #33040-11 "NORTH MANITOU SHOAL LIGHT STATION RIP RAP," National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-24
Sketch attached to Letter from N.W. Works, Asst., for and in the absence of the Supt, OFFICE OF SUPERINTENDENT, 12TH DISTRICT, MILWAUKEE, WIS., DEPARTMENT OF COMMERCE, LIGHTHOUSE SERVICE to Commissioner of Lighthouses, October 7, 1933. National Archives and Records Adminstration (NARA), Washington, DC.

Figure 1B-25 through 1B-28
DEPARTMENT OF COMMERCE, BUREAU OF LIGHTHOUSES, WASHINGTON. Memo "N. Manitou Engine Generators," F.I. PHIPPENY, Asst. Radio Enginner, June 5, 1934. National Archives and Records Adminstration (NARA), Washington, DC.

Figure 1B-29
"NORTH MANITOU SHOAL LIGHT STATION DETAIL AND LOCATION OF STEP FOR DERRICK," National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-30
OFFICE OF LIGHTHOUSE SUPERINTENDENT. TWELFTH DISTRICT. MILWAUKEE, WIS,. "NORTH MANITOU, MICH. GENERAL SCHEME." Approved March 31, 1933. Revised to April 5th 1933, June 30, 1934 and Oct 23, 1934. Signed by Superintendent and Asst. Superintendent. National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-31
DWG 34019 "NORTH MANITOU SHOAL LIGHT STATION MACHINERY LAYOUT" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-32 and 1B-33
'NORTH MANITOU SHOAL LIGHT STATION PROPOSED SCHEME FOR ANTENNAE" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-34, 1B-35 and 1B-36
Leelanau Historical Society

Figure 1B-37
Undated, colored ketch "NORTH EAST ELEVATION." National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-38
Leelanau Historical Society

Figure 1B-39 and 1B-40
https://www.nps.gov/slbe/learn/historyculture/glenhaven.htm

Figure 1B-41
Letter from G. B. Skinner, Superintendent, 12th District, Milwaukee, Wis. To Commissioner of Lighthouses, Washington, D.C. October 23, 1937. 4 pages. National Archives and Records Adminstration (NARA), Washington, DC.

Figure 1B-42 and 1B-43
Leelanau Historical Society

Figure 1B-44
DWG 44051 "NORTH MANITOU SHOAL LT. STA. DIESEL GENERATOR INSTALLATION" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-45
"NORTH MANITOU SHOAL LT. STATION LELAND MICHIGAN, FOG SIGNAL BUILDING NEW A/V & AC EQUIPMENT INSTALLATION PLAN & DETAIL" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-46
"NORTH MANITOU SHOAL LIGHT STA. LELAND MICHIGAN, NEW FOG SIGNAL INSTALLATION PLAN & DETAIL" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-47 through 1B-52
Leelanau Historical Society

Figure 1B-53 and 1B-54
Leelanau Historical Society, photos donated by Charlie Hannert.

Figure 1B-55
Leelanau Historical Society

Figure 1B-56
"NORTH MANITOU SHOAL LIGHTSTATION DOOR & DEADLOCK DETAIL" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-57 through 1B-71
Leelanau Historical Society, photos donated by Coby Thenikl and Steven Licht

Figure 1B-72
Leelanau Historical Society

Figure 1B-73
'NEW STEEL DECK PLATING NORTH MANITOU SHOALS LT. LELAND MICHIGAN PLAN" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-74
'NEW STEEL DECK PLATING NORTH MANITOU SHOALS LT. LELAND MICHIGAN PLAN, SECTIONS AND DETAILS" National Archives and Records Adminstration (NARA), College Park, Maryland.

Figure 1B-75 through 1B-77
Dave McWilliam, NMLK

Figure 1B-78
Leelanau Historical Society

Figure 1B-79
USCG Historian's Office website

Figure 1B-80
https://www.lighthousefriends.com/light.asp?ID=714

Figures 1B-81 through 1B-87
Construction progress photos provided by Mihm Enterpises, Inc.

Part 1C

Figures 1C-01 and 1C-03 through 1B-06
Dave McWilliam, NMLK

Figure 1C-02
Portion of "NORTH MANITOU SHOAL LT. STATION LELAND MICHIGAN, FOG SIGNAL BUILDING NEW A/V & AC EQUIPMENT INSTALLATION PLAN & DETAIL" National Archives and Records Adminstration (NARA), College Park, Maryland.

Part 1D

Part 1D photos taken by HSR team members Ken Czapski and Cheryl Early during August 2019 site visit.

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APPENDICES

The following Appendix items are included

- Historic Construction Drawings
- Existing Conditions Drawings
- Paint Sample Log
- Paint Color Analysis
- Material Sample Log
- Environmental Laboratory Analysis Report
- Treatment Recommendation Drawings
- National Register Nomination Form