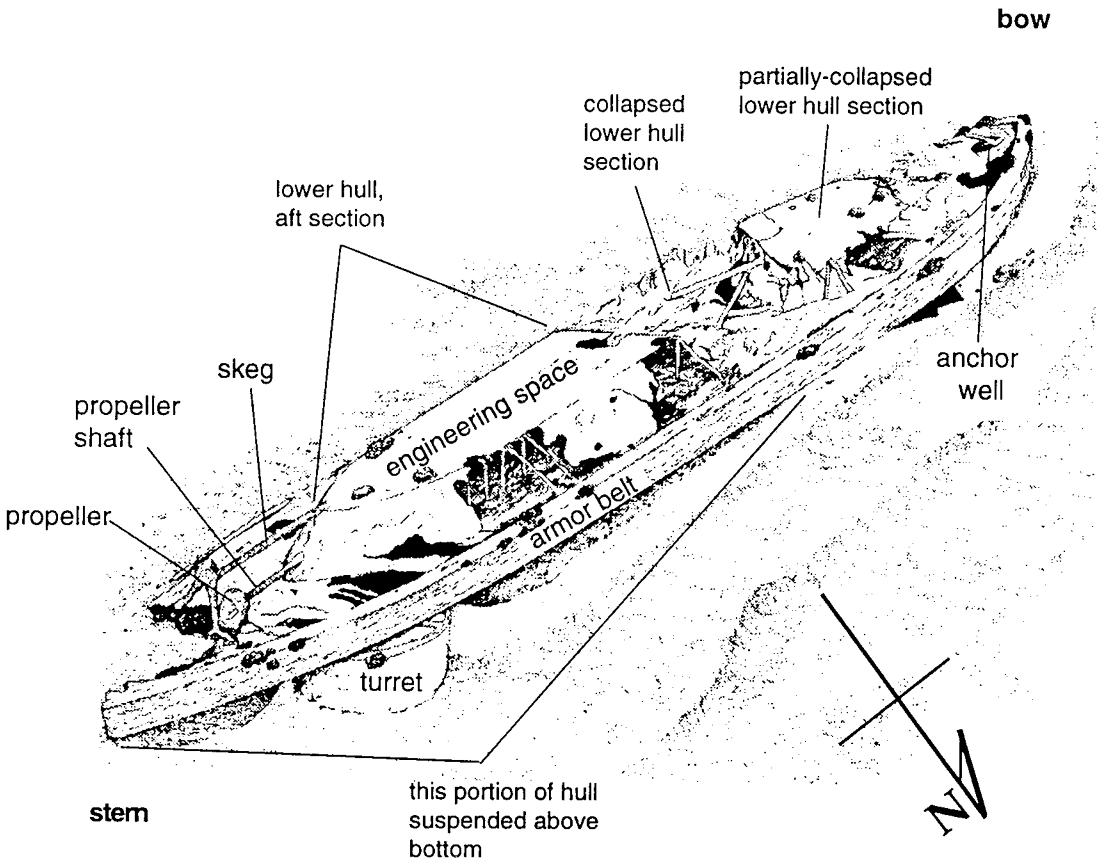
CHARTING A NEW COURSE FOR THE *MONITOR*

A Comprehensive, Long Range Preservation Plan With Options for Management, Stabilization, Preservation, Recovery, Conservation and Exhibition of Materials and Artifacts from the *Monitor* National Marine Sanctuary

April 1998

National Marine Sanctuaries

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Ocean Service
Office of Ocean and Coastal Resource Management
Sanctuaries and Reserves Division



Frontispiece: *An isometric drawing identifying key features of the* Monitor*'s hull.*

Management Summary

The National Oceanic and Atmospheric Administration (NOAA) is confronting a serious management situation at the *Monitor* National Marine Sanctuary: the collapse of the *Monitor*'s hull is imminent. To forestall the inevitable collapse and preserve the *Monitor*'s most significant components for future generations, this long-range, comprehensive preservation plan calls for the remains of the *Monitor* to be preserved through a combination of stabilization and selective recovery actions.

In March 1862, the Civil War ironclad USS *Monitor* survived a four-hour assault by the Confederate ironclad CSS *Virginia* at Hampton Roads, Virginia, before succumbing a few months later to a severe storm off Cape Hatteras, North Carolina. Now the *Monitor* is facing a new crisis. Photographic evidence clearly shows that there has been a marked increase in the rate of disintegration of the *Monitor*'s hull since 1990, the result of both natural and human causes. Current data suggest that collapse of the *Monitor*'s hull could occur at any time and that the result would be the loss of much of the ship's structure and many of its historic contents. In 1993, after extensive archival and on-site research, NOAA initiated a revised planning effort designed to further define the extent of the problem and to identify viable options for preservation of the *Monitor*.

The *Monitor* was undeniably one of the most significant ships in U. S. history. The *Monitor* wreck site is listed on the National Register of Historic Places and is also a National Historic Landmark. In 1975, in recognition of the *Monitor*'s unique historical and archaeological significance, the Secretary of Commerce designated the remains of the *Monitor* as the first National Marine Sanctuary. The Sanctuary is administered by NOAA's Office of Ocean and Coastal Resource Management, National Ocean Service.

In section 4 of Public Law 104-283 (The National Marine Sanctuaries Preservation Act) Congress responded to NOAA reports of the *Monitor*'s disintegration by mandating that the Secretary of Commerce produce "a long-range, comprehensive plan for the management, stabilization, preservation, and recovery of artifacts and materials of the U.S.S. MONITOR." The Secretary of Commerce was also directed, "to the extent feasible utilize the resources of other Federal and private entities with expertise and capabilities that are helpful" and to submit the plan within twelve months of the date of enactment of the Act (October 11, 1996). NOAA, on behalf of the Secretary, developed a draft preservation plan within the required one-year time frame and submitted the plan to Congress on November 6, 1997. NOAA's rapid response was possible only because the planning process had already begun and because valuable assistance was rendered by several key organizations, as described herein. Because of the *Monitor*'s exceptional historical significance and the severity of the current threat to its hull and contents, NOAA elected to release the plan in draft form in order to permit a panel of experts and the public at large to review and comment on the plan. Those comments were taken into account during the revision of this plan.

The result is this final preservation plan which outlines a variety of possible options for the stabilization and preservation of the *Monitor*, provides supporting data, discusses the advantages and disadvantages of each option, presents preliminary cost estimates for evaluation purposes and describes the selected option. The goals of this plan are in keeping with the National Marine Sanctuary Program's "Strategic Plan for the 21st Century." The plan should not only prove to be effective at the *Monitor* Sanctuary, but may serve as a model for other cultural resource projects as well.

Preservation of the *Monitor* will involve considerations of technological feasibility, compliance with the National Historic Preservation Act and other applicable laws, consistency with the Division's Strategic Plan, and availability of adequate funding. The technological requirements for implementation of the plan can be met by any major ocean engineering firm. Since the combined costs of stabilization, recovery and conservation are estimated to be in excess of $20 M, possibly the greatest challenge for NOAA will be to create a partnership of interested organizations that can generate the required funds. The next phase of planning will include detailed engineering and conservation plans and a "business" or funding plan. NOAA is confident that this preservation plan contains the necessary information for decisionmaking and for implementing the next phase of planning and preservation.

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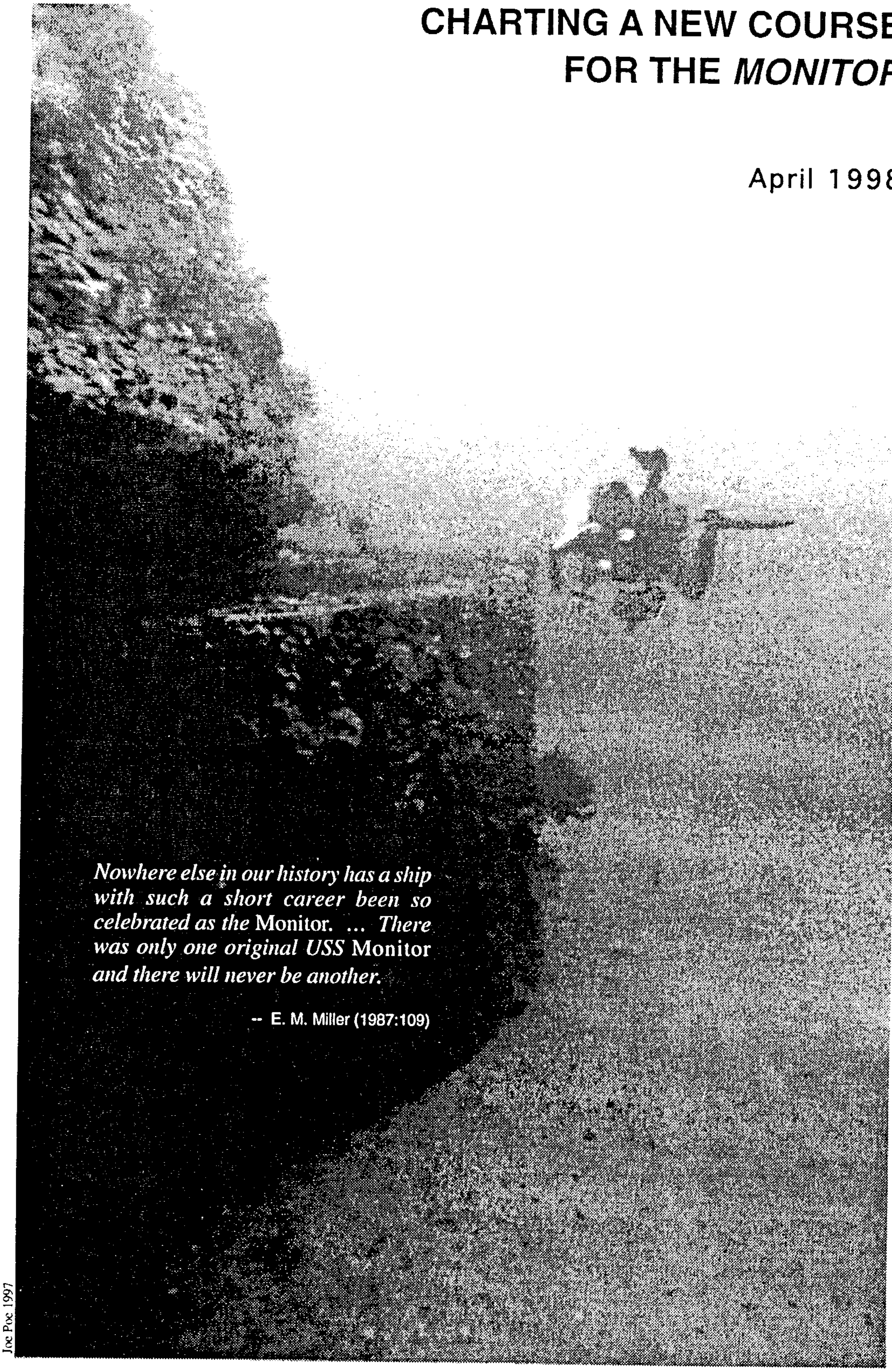


Joe Poe 1997

CHARTING A NEW COURSE FOR THE *MONITOR*

1.0 Introduction

1.1 Crisis: The Disintegration of the *Monitor*

NOAA has determined that the collapse of the *Monitor*'s hull is imminent. Photographic evidence from the *Monitor* National Marine Sanctuary clearly shows that there has been a marked increase in the rate of disintegration of the *Monitor*'s hull since 1990. The *Monitor* was first mapped in April, 1974, shortly after it was located off Cape Hatteras, North Carolina, the previous August. The mapping expedition produced a detailed photomosaic of the wreck that has served for more than two decades as the initial reference for assessing changes to the site. Since its discovery, the *Monitor* has suffered notable deterioration of almost every portion of its hull, with the most extensive damage occurring in the stern.

This accelerated deterioration since 1990 apparently results from several causes. The primary long-term factor contributing to hull deterioration is exposure to the high-current, high-temperature, saltwater environment. The *Monitor*'s iron components are being reduced by oxidation and electrochemical corrosion while the wooden structures are suffering cellular deterioration and destruction by shipworms. There are also human causes. In 1991, a private fishing vessel was cited by the U. S. Coast Guard for illegally anchoring in the Sanctuary. Evidence documented by NOAA strongly suggests that stresses on the hull caused by that anchoring incident initiated a chain reaction of deterioration in the *Monitor*'s stern. Over the years and as recently as 1997, commercial fishing gear has been found tangled in the wreck, signalling the potential for even more extensive damage.

There is a general consensus that the *Monitor*'s hull has reached a critical state of decomposition beyond which catastrophic collapse could occur at any time. In 1990, even before the anchoring incident, a NOAA consultant reported that without corrective action the *Monitor* might be unrecognizable in ten years (Arnold, *et al.* 1991:85-86) and the archaeologist who was codiscoverer of the *Monitor* also predicted catastrophic deterioration (*Ibid.*:214-216). In summary, current evidence points to the unavoidable conclusion that the *Monitor*'s hull is collapsing and that a rapid response to the crisis is required.

1.2 NOAA's Response to the Crisis

In 1992, responding to the alarming degradation of the *Monitor*'s hull, NOAA delayed issuance of a newly-revised management plan for the *Monitor* National Marine Sanctuary in order to conduct additional site assessments. NOAA's Sanctuaries and Reserves Division (SRD) then commenced a broad range of initiatives including several expeditions to the Sanctuary, a cooperative effort with the U. S. Navy and other organizations to help stabilize the *Monitor*'s hull, and development of a comprehensive plan for management and preservation of the Sanctuary and possible recovery of portions of the *Monitor*. Because of the importance of these efforts and the limitations on funding, SRD developed partnerships with several organizations, including the U. S. Navy, the National Undersea Research Program, The Mariners' Museum, Key West Diver, Inc., private research groups and others.

In 1993 and 1995, NOAA conducted major engineering and archaeological surveys at the Sanctuary in conjunction with further archival research and several small-scale site operations. Private research divers also assisted NOAA during this period in the recovery of additional data on the *Monitor*'s condition. The results of this research led to the conclusion that a concerted, well-planned effort would be required to preserve the remains of the *Monitor*. Planning was initiated for the conduct of additional archival, engineering and on-site research aimed at identifying viable options for the preservation of the *Monitor*. SRD also communicated the situation to NOAA administration, Congress and the public.

In 1996, Congress formally expressed its interest and concern. Section 4 of Public Law 104-283 (The National Marine Sanctuaries Preservation Act), contained a Congressional mandate for the Secretary of Commerce to produce "a long-range, comprehensive plan for the management, stabilization, preservation, and recovery of artifacts and materials of the U.S.S. MONITOR." The Secretary was also directed, "to the extent feasible utilize the resources of other Federal and private entities with expertise and capabilities that are helpful" and to submit the plan within twelve months of the date of enactment of the Act (October 11, 1996). In response, NOAA produced this plan, "Charting a New Course for the *Monitor*."

In this plan NOAA, on behalf of the Secretary of Commerce, presents a comprehensive management strategy that should ensure that, insofar as possible, the *Monitor* will be preserved and protected for future generations. The plan recommends the application of state-of-the-art ocean technology in overcoming the crisis at the Sanctuary through the combined strategies of stabilization and selective recovery. Therefore, the plan is in keeping with the National Marine Sanctuaries Program's "Strategic Plan for the 21st Century." The Program's primary goal is to "protect sanctuary resources, making our sanctuaries world-class models for effective innovative management of protected areas" (NOAA 1997).

1.3 A Brief History and Significance of the *Monitor*

The *Monitor*, designed by Swedish-American engineer John Ericsson, was a radical departure from traditional warship design. The vessel was built almost entirely of iron; it was fully steam powered with no masts or sails; the engineering spaces, crew's and officers' quarters, and galley were all below the waterline; the hull was completely armored with a 5-foot-high, 32-inch-thick armor belt encircling the vessel for protection during battle. The most novel feature was the *Monitor*'s 22-foot-diameter, 9-foot-high iron turret. Positioned amidships, the armored turret could be rotated to train its two 11-inch Dahlgren smoothbore cannon in any direction.

The *Monitor* was launched at Greenpoint, New York, on January 30, 1862. In early March, the *Monitor* was ordered to Hampton Roads, Virginia where, on March 9, it engaged the CSS *Virginia*, a Confederate ironclad constructed over the modified hull of the scuttled USS *Merrimack*. In the ensuing four-hour battle, the two vessels frequently bombarded each other at point-blank range with no substantial damage to either vessel (Figure 1). Although the battle ended in a draw, the *Monitor*'s performance impressed the U.S. Navy and introduced features—including the combination of iron armor, low freeboard and revolving turret—that altered naval technology forever.

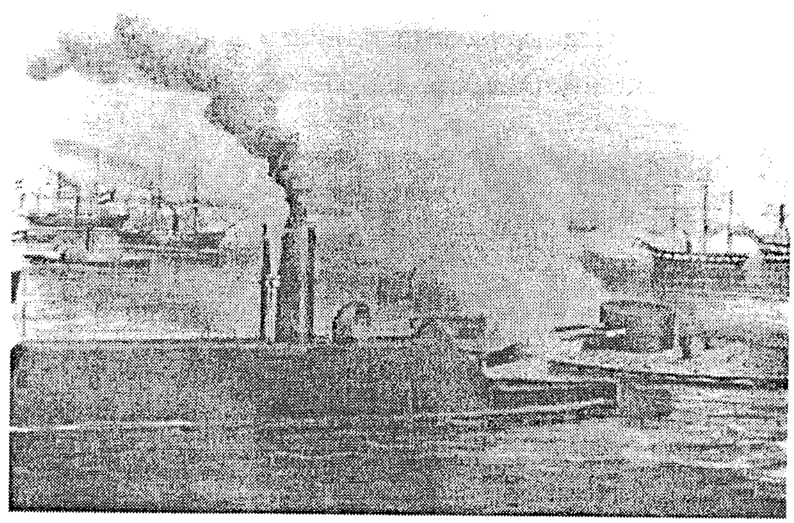


Figure 1. The USS Monitor *(right) battling the CSS* Virginia *at Hampton Roads, Virginia on March 9, 1862 (*Monitor *Collection, NOAA).*

With the exception of the engagement with the *Virginia*, the *Monitor*'s brief career was uneventful. Shortly after midnight on December 31, 1862, while under tow by the USS *Rhode Island* to Beaufort, North Carolina, the *Monitor* sank in a storm off Cape Hatteras, North Carolina, with a loss of sixteen officers and crewmen (Figure 2). Note: this brief history is presented here in order to provide background information appropriate to the understanding of this preservation plan. Numerous volumes have been written on the history of the Monitor and the interested reader is referred to the enclosed Bibliography, Appendix H.

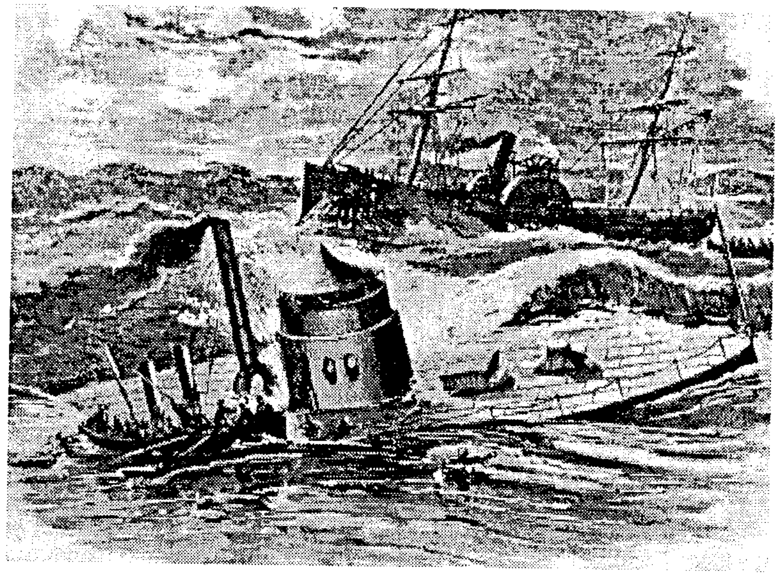


Figure 2. Contemporary illustration of the sinking of the Monitor off Cape Hatteras, North Carolina, on December 31, 1862 (Harpers Weekly, *January 1863).*

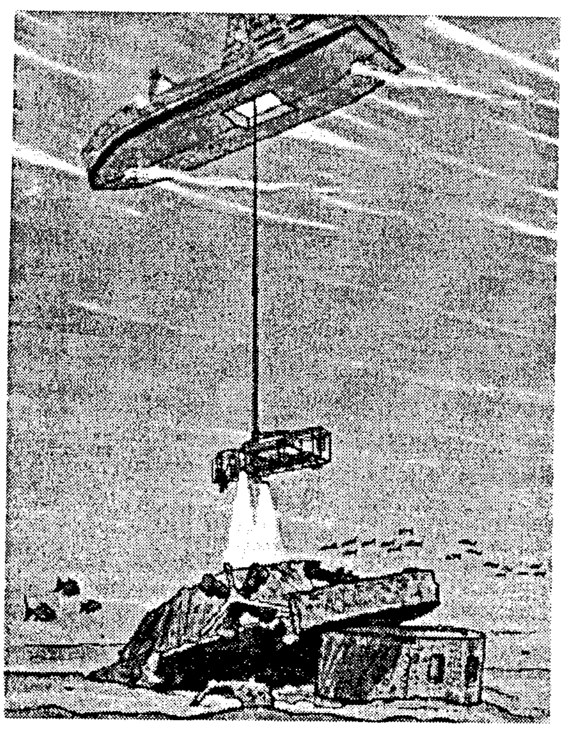


Figure 3. Photographic survey of the USS Monitor *by the* R/V Alcoa Seaprobe, *1974* (National Geographic Magazine).

Discovery and Identification of the Wreck

In 1973, after nearly a year of intensive historical research, an interdisciplinary team of scientists isolated a high-probability area for the *Monitor*'s sinking. A search was carried out in August 1973 by the Duke University Research Vessel *Eastward*, utilizing a side-scan sonar and remotely-operated cameras. The survey located twenty-two shipwrecks, one of which proved to be the *Monitor*. A second expedition in April 1974, partly sponsored by the U.S. Navy and the National Geographic Society, provided detailed photographic documentation from which an assessment of the wreck was made (Figure 3). A photomosaic produced by the Naval Intelligence Division revealed that, with the exception of damage to the stern section and the collapse of the lower hull forward of the midships bulkhead, the wreck appeared to be in relatively good condition (See Frontispiece).

Significance of the *Monitor*

The USS *Monitor* had a profound impact on naval technology and the way in which nations wage war. The *Monitor* was without question one of the most significant ships in American history. The *Monitor*'s battle with the CSS *Virginia* on March 9, 1862, was the first confrontation between ironclad vessels. While the battle was a virtual draw, the *Monitor* design proved to be quite successful and spawned several generations of monitor-type vessels, all of which incorporated its unique revolving turret (Figure 4). Unfortunately, the USS *Monitor*'s career was brief. Of the *Monitor's* loss, one historian lamented, "This battle was not of heavy shot versus iron plating, since the *Monitor* had already proven her

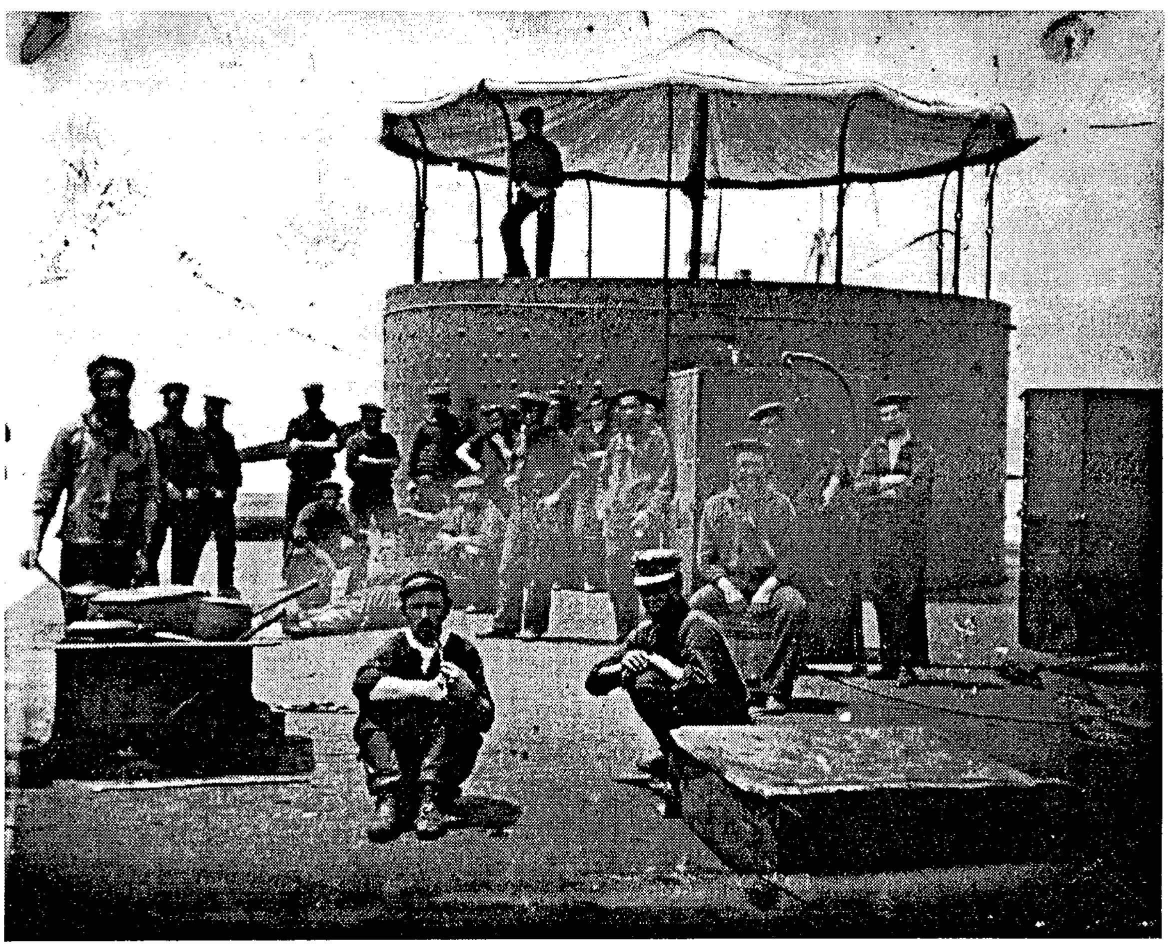


Figure 4. Members of the USS Monitor'*s crew at Harrison's Landing, Virginia in July, 1862* (Library of Congress)

ability to fight another ironclad. The battle was a perennial one, man and ship against the sea, in which the heavy iron armor of the *Monitor* was no defense" (U. S. Naval Academy 1974:404).

The significance of the USS *Monitor* in American and naval history has been widely acknowledged. At a conference held in Raleigh, North Carolina, in April, 1978, the vessel was discussed in both nineteenth and twentieth century terms. U. S. Department of the Interior cultural resource manager Charles M. McKinney (1978:99-101) viewed the ship as important "not just as a ship that changed the course of naval warfare, but as a symbol of a people, their ingenuity, their capabilities, and most importantly, their recognition of those Americans who contributed to the technological success we enjoy today." Larry E. Tise, North Carolina State Historic Preservation Officer (1978:63), stated that "much of the value of the *Monitor* is based on legend, an incredible history, and very good public relations on the part of people associated with the *Monitor*, from John Ericsson right down to the present." A U.S. Naval Academy study (U.S. Naval Academy, 1974:403) expressed a similar view of this symbolic aspect, stating that the significance of the *Monitor* is "... not as a defense against Rebel guns, but as a reminder of that black Sunday in 1862 when the resolve of a few who called themselves the 'Monitor Boys' became a triumph for a new technology, for a man who believed in himself and for a nation torn apart by civil war; a story that is so much a part of our naval heritage."

In management terms, however, the significance of the *Monitor* can be somewhat more readily qualified and quantified utilizing criteria established for the National Register of Historic Places. The *Monitor* is one of relatively few cultural resources that meets all four criteria for National Register listing (Appendix E; Delgado 1988:1). The *Monitor* was placed on the National Register of Historic Places in 1975 and designated a National Historic Landmark in 1986 (*Ibid.*:19,31).

Miller (1987:109) captured the essence of the *Monitor*'s significance when he wrote

> Nowhere else in our history has a ship with such a short career been so celebrated as the *Monitor*. The story behind *Monitor* and her role at a crucial juncture of our history will continue to intrigue and inspire all who are familiar with it. There was only one original USS *Monitor* and there will never be another.

The *Monitor*'s uniqueness and remarkable historical significance, along with its status as an American icon, argues strongly for a concerted preservation effort.

1.4 Description of the Sanctuary

The Sanctuary encompasses a vertical water column from the surface to the seabed that extends horizontally one nautical mile in diameter from a center point in the Atlantic Ocean located 16.1 nautical miles SSE of Hatteras Light, North Carolina. (Figure 5; also see Appendix D for more information).

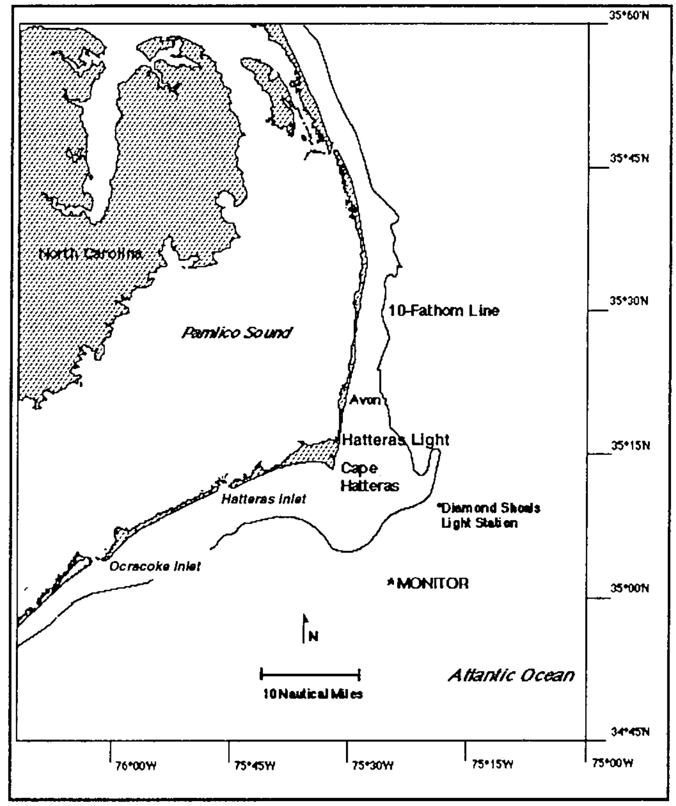


Figure 5. Location of Monitor *National Marine Sanctuary (NOAA map).*

The *Monitor*'s hull lies upside down on a relatively flat, sandy bottom, with the stern partially supported on the displaced and inverted turret, as illustrated in the frontispiece and Figure 6. The hull lies nearly east-west, with the bow at a compass heading of 280 degrees. In the area of the Sanctuary, the Gulf Stream interacts dynamically with the southerly-flowing Labrador Current, creating unpredictable, changing conditions and eddies. As a result, environmental factors such as weather, surface sea conditions, current, water temperature and visibility often change rapidly and without warning.

The hull has deteriorated to a considerable degree, with the only relatively intact portions being the turret, armor belt and the lower hull section directly over the engineering space, where it is partially supported by the boilers and machinery (See frontispiece for a site plan with hull components labeled). The forward portion of the lower hull has completely collapsed and the stern hull and armor belt aft of the propeller have disintegrated. Most of the side plating on the lower hull has fallen away, exposing the interior of the machinery space. Much of the deck plating is still intact, although several holes completely penetrate the deck.

1.5 Evidence of Recent Deterioration

Since 1991 significant changes have been noted at the Sanctuary by NOAA and NOAA-permitted researchers (Figures 6 and 7). Since the *Monitor* is an iron ship lying in a high-current, high-temperature, saltwater environment, its iron components are continually being reduced by oxidation and electrochemical corrosion. Until 1990 researchers assumed that the deterioration of the *Monitor*'s hull and contents was a relatively slow but continual process; various efforts were made to predict a rate of metal loss for its iron hull and armor. Analysis of a hull plate recovered in 1977 revealed that the plate had lost 78% of its thickness during its 116 years of immersion in the ocean (Beachem, et al. 1979). As one reviewer pointed out, calculations based on that single plate sample indicate that the *Monitor*'s plating may now retain only 9% of its original thickness. Structural framing elements can be expected to

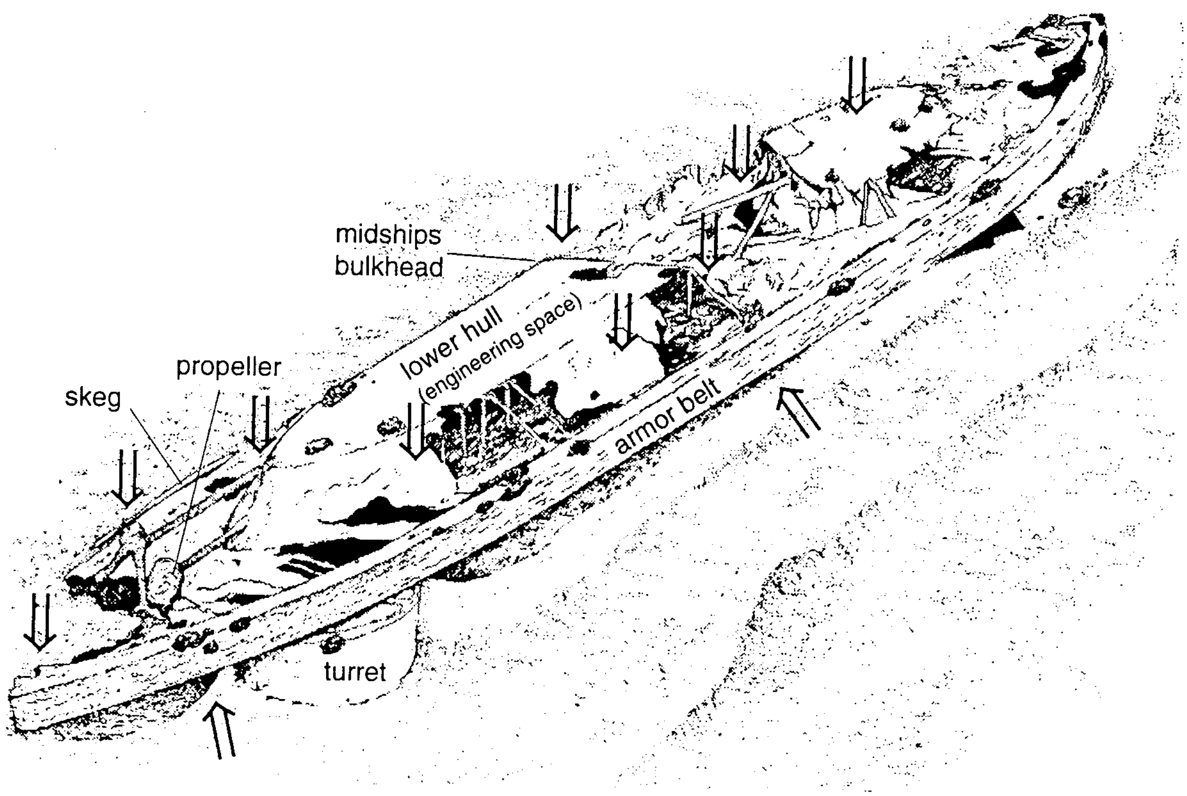


Figure 6. The hull of the Monitor *as it appeared in 1974; the bow faces West. Arrows indicate key areas of recent deterioration (NOAA illustration).*

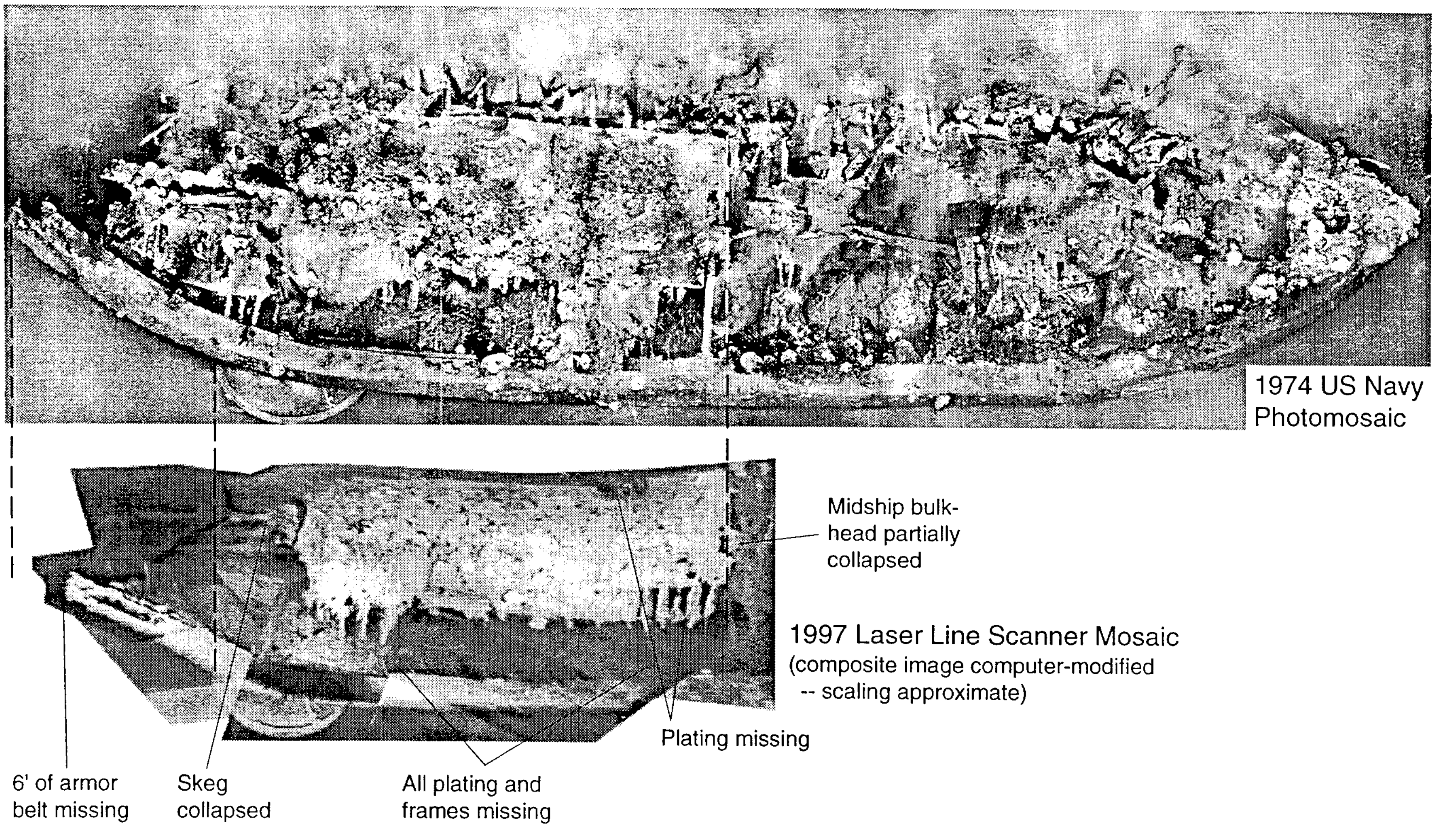


Figure 7. A Comparison of images of the Monitor*'s hull, showing recent deterioration in the stern (U.S. Navy)*

exhibit similar degradation. In fact, the observed collapse of many of the lower hull frames since 1990, including the midships bulkhead frame, supports NOAA's assumption that the *Monitor*'s hull retains very little mechanical strength. Wooden components that made up much of the underlying strength of the upper deck and armor belt are suffering from cellular deterioration and the action of shipworms. The *Monitor* contents include wood, hemp, leather, cloth, brass, bronze and other materials, all of which are deteriorating at different rates. Human intrusion, including anchoring and fishing activities, has also become a significant factor in recent degradation. Although NOAA is well aware of the continuing deterioration of the *Monitor*'s hull, the extent of that deterioration since 1991 was not expected. The observed increase in the rate of deterioration does not appear to be the result of the continual slow corrosion of iron but, rather, consists primarily of the periodic collapse or disintegration of hull components as those components reach stress limits.

The majority of changes have occurred aft of the midships bulkhead. At the extreme stern, the skeg and propeller assembly, once in the same plane with the keel and parallel with the sediment below, now cant downward. The skeg has separated from the lower hull and shifted to the side, almost certainly a result of being snagged by a private fishing boat anchor in 1991. The hull plate at the aft end of the lower hull separated with the skeg, thus exposing the shaft, tunnel and after end of the engine room.

The lower hull forward of the midships bulkhead has collapsed; the portion of lower hull aft of the bulkhead has sagged and now rests on the boilers and machinery which, in turn, appear to have settled sufficiently to be supported by the sand beneath the hull. A number of plates are missing from the top and sloping sides of this section, as are many of the iron frames. Immediately aft of the turret on the port side, a large section of deck, including plates and the material to which they were attached, has separated from the underlying structure and can be seen hanging from the wreck. Although many of the plates remain attached to the wood backing material, displaced hull plates can be seen in the sand near the section of separated deck. A six-foot section of the stern end of the port armor belt has disintegrated since the wreck was first documented in 1974. An examination of the back side of the armor belt revealed that in many places the wood to which the plates are attached has almost completely disappeared.

The turret itself appears to retain a great deal of structural integrity. However, it bears the immense weight of a large portion of the hull and machinery. Any further structural collapse in the vicinity of the turret could shift the angle of force on the turret wall and seriously compromise the apparent stability of the turret. A careful examination in 1993 revealed that the deck of the inverted turret, now the upper end, has disintegrated and that the turret has filled with silt. The weight of the hull resting on the turret has caused the deck to fracture and the turret to push through the deck. Lumps of coal on the turret floor indicate that material is falling through the deck from the engineering space above.

Failure of structural integrity, resulting from long-term corrosion, strong currents and other forces, is the primary factor contributing to the *Monitor*'s accelerating collapse rate. Based on this assumption, the next phase of deterioration can reasonably be predicted. The collapse of the remaining lower hull structure is imminent. The hull cannot continue to support the weight of the engine and machinery that is concentrated in the stern where the hull is suspended above the bottom by the turret. The disruption that will result from the collapse of the lower hull will almost certainly bring the entire hull down around the turret. The extent of damage to components of the hull, artifacts within the hull and the turret, itself, can only be speculated.

1.6 Overview of the Comprehensive Preservation Plan

The increased rate of deterioration of the *Monitor* represents a management crisis for the NOAA National Ocean Service. The *Monitor* is one of the most significant shipwrecks in America, made more so by its designation as the nation's first marine sanctuary. The location of the wreck, 16 miles offshore and in 230 feet of water, poses challenges for protection, management and research. In its 21-year stewardship of the *Monitor* National Marine Sanctuary, NOAA has employed sound management practices and state-of-the-art technology to investigate the wreck. Through NOAA's efforts, public understanding of and interest in the *Monitor* has been enhanced and the need for continued preservation of this unique resource has been emphasized.

This comprehensive plan reflects new data from the Sanctuary as well as recent deepwater technological advances. The resulting plan is critical to NOAA's determining the fate of the *Monitor*. In addition, it will aid NOAA in managing, protecting and assessing shipwrecks in other active and proposed sanctuaries. From a broader perspective, the plan should also be of benefit to submerged cultural resource managers throughout the world. The plan's management strategy and content may be particularly relevant to other deepwater sites, including the shipwrecks of the proposed Thunder Bay National Marine Sanctuary, the *Titanic*, the *Britannic*, the War of 1812 brigs in Lake Ontario and others.

This plan develops a framework for research and preservation, identifies all viable options for stabilization and preservation of the *Monitor* and comprehensively evaluates those options, based upon the best available historical, archaeological and engineering information. The overall goal of the plan is to present and assess available data and to present detailed considerations and recommendations to be used by NOAA program managers in determining the course of action to be followed. Major components of the plan include a detailed description of the *Monitor*'s hull and recent deterioration, a range of possible preservation options, discussions of each option, and recommendations for future planning and preservation.

2.0 Review of the Options for Preserving the *Monitor*

2.1 Introduction

This section describes and discusses a wide range of options for comprehensive preservation and management of the *Monitor* National Marine Sanctuary. In developing these options NOAA reviewed all previous reports and proposals for on-site activities, including papers presented at a *Monitor* conference in 1978 (National Trust for Historic Preservation 1978), previous engineering and corrosion reports (See Bibliography, Appendix H) and the Draft Revised Management Plan for the *Monitor* National Marine Sanctuary (NOAA 1992), all of which addressed preliminary studies and recommendations. NOAA also held informal discussions with numerous engineers, archaeologists, and other specialists in order to identify new technology that might be applicable for the *Monitor* situation. In addition, NOAA also received 35 comments, mostly from specialists in such fields as ocean and corrosion engineering, ocean salvage, nautical archaeology, historic preservation and conservation. Many of the comments were helpful and have been incorporated, to the extent possible in this plan.

This report presents all options for stabilizing and/or preserving the *Monitor* that were identified by NOAA as being viable. Time and budget constraints prevented full development of the options; however, this plan contains sufficient information to permit the formulation of a comprehensive phased approach to the problem. Now that a preferred option has been selected it is necessary to seek expert assistance from appropriate disciplines (ocean engineers, nautical archaeologists, artifact conservators, etc.) for the development of a detailed implementation plan.

The options discussed below were carefully reviewed; they are presented along with pertinent information on advantages, disadvantages, required action and estimated costs; advantages and disadvantages address potential impacts on the *Monitor* and its contents. The options are then discussed and compared, and recommendations are presented. A preliminary analysis of these options was developed for NOAA and the U. S. Navy by

Oceaneering International, Inc. at no cost to the government. The Oceaneering report is summarized in Appendix A. NOTE: The cost estimates presented in this section are for evaluation purposes only; no final estimates are available and no funding sources have been identified.

2.2 Non-Intervention

This option could be selected if it is determined that on-site stabilization and/or recovery operations are beyond the technological and budgetary capabilities of NOAA. NOAA would continue to manage the *Monitor* National Marine Sanctuary in accordance with the current policy. NOAA and/or private researchers would continue to conduct periodic on-site inspections; the resulting data would be documented and disseminated; NOAA would continue to work cooperatively with private diving expeditions for the recovery of small artifacts that are exposed and in danger of damage or loss; NOAA would continue to maintain a strong education program. The cost to NOAA for this option would be within current budgetary limits.

Advantages:

- This option requires no additional NOAA commitments;
- The *Monitor* would remain an active site to be visited by researchers and recreational divers, although the location limits access to only a few;
- No supplementary funds would be required.

Disadvantages:

- The *Monitor* would continue to disintegrate at an accelerated rate due to natural causes;
- The *Monitor* may also continue to be damaged by illegal human activities (e.g., anchoring and commercial fishing);
- This option would eventually result in the inevitable collapse of the hull and loss of much of the remaining cultural material and archaeological information.

Action Required: None, NOAA would continue the current management program.

Estimated cost: None, this option requires no additional NOAA commitments or funding.

2.3 *In Situ* Preservation by Encapsulation

This option could reduce the rate of deterioration without removing the *Monitor* or parts of the *Monitor* from their current location. This would include some form of capping that would entomb the *Monitor* in an acceptable manner (i.e. covering with sand, grass mats, etc.). Possibly the simplest method would be to pump sand from the surrounding area under, around and over the *Monitor*, then covering the site with crushed stone and/or some type of stabilizing matting. However, in order to adequately reduce the amount of oxygen reaching the hull, clay or fine silt may have to be substituted for nearby sand as the covering material.

Advantages:

- The *Monitor* would no longer be exposed to damage from strong currents, anchors, divers or commercial fishermen;
- The *Monitor*'s exposure to oxygen-rich water would be reduced;
- Operating costs would be greatly reduced, since on-site research would be limited to a periodic site inspection;
- The method is relatively simple and could be accomplished with conventional equipment.

Disadvantages:

- The *Monitor* would no longer be visible or readily accessible, and public interest in the site would likely wane;
- The responsibility for research and recovery of artifacts would be delegated to future generations;
- Encapsulation would have to be preceded by shoring (sect. 2.4), since the weight of the sand might otherwise collapse the hull;
- Even with hull shoring, damage to interior components could result from the weight of encapsulating sand;
- If seabed material in the Sanctuary prove to be unsuitable for encapsulation, material may have to be barged to the site, creating high costs for hauling and handling, especially if the selected material is clay or silt;
- Encapsulating material would have to be inspected, maintained and, possibly, replenished due to erosion;
- Because encapsulation would not eliminate the deterioration process, this option would only delay the inevitable collapse of the hull. The *Monitor* would continue to deteriorate due to electrochemical action and oxidation, and burial will create an anaerobic environment that may accelerate the deterioration rate. In addition, the weight of sand in and over the hull could, itself, cause further collapse.

Action Required: Detailed engineering and corrosion plans would have to be developed by consultants; a review would have to be conducted under section 106 review process; funds would have to be obtained for procurement of the necessary planning and implementation phases; and a long-term monitoring program would have to be established.

Estimated cost: No accurate estimate available, but probably $ 4-5 million.

2.4 *In Situ* Preservation by Shoring

This option could stabilize the *Monitor*'s hull in its present location. Shoring would be accomplished through the use of approved methods and materials, such as sand bags, grout bags or jacks to support portions of the hull that are suspended above the bottom by the position of the turret.

Advantages:

- The *Monitor* would remain visible and accessible for future research;
- The collapse of the upper hull could probably be delayed by at least 5-10 years;
- The cost for this option would be moderate, compared to the recovery options discussed below.

Disadvantages:

- Since the *Monitor* would still be exposed, it would continue to disintegrate due to natural and human causes;
- The appearance of the wreck would be unnatural, degrading its scenic and aesthetic value;
- The shoring system(s) would require frequent inspection and expensive maintenance to be carried out at the Sanctuary;
- The inevitable collapse of the hull and loss of much of the enclosed cultural material and archaeological information would be delayed but not eliminated;
- Because of the instability of the hull and the difficulties of installing shoring gear, this option for stabilizing the hull could result in further deterioration or collapse.

Action Required: Detailed engineering and corrosion plans would have to be developed by consultants; a review would have to be conducted under section 106 review process; funds would have to be obtained for procurement of the necessary planning and implementation phases; and a long-term monitoring program would have to be established.

Estimated cost: No accurate estimate available, but probably $ 3-4 million, not counting annual maintenance.

2.5 *In Situ* Preservation by Cathodic Protection

This option would involve the installation of a passive (sacrificial anode) or active (impressed current) cathodic protection system to reduce the corrosive action from the marine environment.

Advantages:

- The *Monitor* would remain visible and accessible for future research;
- This option utilizes proven and well-established technology and it is possible that hull corrosion could be greatly reduced;
- The collapse of the hull would probably be delayed by several years;
- The cost for this option would be moderate, compared to the recovery options discussed below.

Disadvantages:

- Since the *Monitor* would still be exposed, it would continue to disintegrate due to natural and human causes;
- Maintenance and replacement of system components would require the use of divers on a regularly-scheduled basis;
- As has been reported from past corrosion studies, the degraded condition of the hull and probable lack of electrical continuity from plate to plate would greatly reduce the effectiveness of such a protection system;
- Because of the degraded condition of the hull, cathodic protection would only be effective if combined with mechanical shoring (sect. 2.4);
- The inevitable collapse of the hull and loss of much of the enclosed cultural material and archaeological information would be delayed but not eliminated;
- Because of the instability of the hull and the difficulties of installing shoring gear, this option for stabilizing the hull could actually result in further deterioration.

Action Required: Detailed engineering and corrosion plans would have to be developed by consultants; a review would have to be conducted under section 106 review process; funds would have to be obtained for procurement of the necessary planning and implementation phases; a scheduled maintenance program would have to be developed and implemented; and a long-term monitoring program would have to be established.

Estimated cost: No accurate estimate available, but probably $ 4-5 million, for shoring and cathodic protection, not counting annual maintenance.

2.6 Selective Recovery

This option includes a selective approach to recovering hull components and artifacts that are of significant historic value. Objects being considered for selective recovery include the propeller, turret, cannons, engine and small artifacts.

Advantages:

- The *Monitor* would remain visible and accessible for future research and visitation;

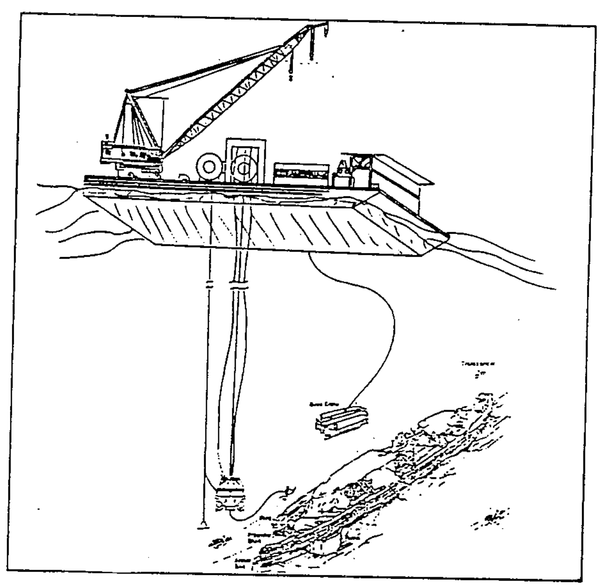


Figure 7. Conceptual drawing showing a possible equipment configuration for the recovery options (Oceaneering International 1997).

- Significant objects would be recovered, conserved and placed on exhibit where they could be viewed and appreciated by large numbers of people;
- The recovered objects would be preserved and made available to the public indefinitely, regardless of the fate of the remaining hull and contents;
- The cost for this option would depend upon the numbers and types of objects selected for recovery, but would be far less expensive than recovery of the entire hull and its contents.

Disadvantages:

- Because of the instability of the hull and the difficulties of conducting recovery operations at the Sanctuary, recovery could result in severe collateral damage to the hull and contents, including the objects slated for recovery;
- Since the remaining portions of the *Monitor* and its contents would still be exposed, they would continue to disintegrate due to natural and human causes;
- The inevitable collapse of the remaining hull, cultural material and archaeological information may be delayed but not eliminated;
- Because of the depth and adverse environmental conditions, on-site recovery operations would be expensive, particularly for the recovery of large objects.

Action Required: Detailed engineering plans would have to be developed by consultants; a review would have to be conducted under section 106 review process; funds would have to be obtained for procurement of the necessary planning, mapping, recovery, conservation and exhibition phases; and a long-term monitoring program would have to be established.

Estimated cost: Approximately $ 10 million for recovery, plus an additional $ 8-10 million for conservation (see Appendices A and B) for a total of $ 18-20 million. This estimate does not include costs for annual inspection and maintenance of the site.

2.7 Full Recovery

In this option, the entire hull, turret, cannons and all contents would be recovered, conserved and, eventually, displayed; this could propose recovery of the entire hull as a single unit or, alternatively, recovery in a series of smaller recoveries.

Advantages:

- If successful, the entire *Monitor*, all its equipment and stores, and all military and personal effects would be preserved and would be accessible for exhibition;
- NOAA would no longer be required to expend funds to maintain the Sanctuary or to conduct expensive offshore research and monitoring activities.

Disadvantages:

- Because of the depth and adverse environmental conditions, large-scale on-site recovery operations would be extremely expensive;

- Because of the instability of the hull and the difficulties of conducting recovery operations at the Sanctuary, recovery attempts could result in severe damage to the hull and contents;
- Because of the advanced state of deterioration, conservation would be expensive and time-consuming;
- Because of the advanced state of deterioration, the reconstructed hull remains of the *Monitor* might be a visual disappointment to viewers.

Action Required: Detailed engineering, recovery and conservation plans would have to be developed by consultants; a review would have to be conducted under section 106 review process; a detailed curation and exhibition plan would have to be developed by consultants; and funds would have to be obtained for procurement of the necessary planning and implementation phases.

Estimated cost: No accurate estimate available, but based on the preliminary estimate for selective recovery (sect. 2.6), full recovery and conservation costs could be expected to exceed $ 50 million.

2.8 Combined Options

2.8.1 Selective Recovery Followed by Encapsulation

This option combines selective recovery (sect. 2.6) with *in situ* preservation by encapsulation (sect.2.3). Following recovery of all selected hull components and artifacts, the site would be encapsulated for protection of the remaining cultural material.

Advantages and Disadvantages: As presented in the above sections.

Action Required: As presented in the above sections.

Estimated cost: No accurate estimate available, but at least $ 20-22 million, including conservation.

2.8.2 Shoring Combined With Selective Recovery

This option combines *in situ* preservation by shoring (sect. 2.4) with selective recovery (sect. 2.6).

Advantages and Disadvantages:

- Refer to sections 2.4 and 2.6;
- Has the advantage of permitting shoring to take place before recovery, thus decreasing the likelihood of collateral damage to the wreck and its contents during recovery;

- Has the additional advantage of leaving the wreck in a stabilized condition following the selective recovery phase;
- Has the disadvantage of additional on-site cost.

Action Required: As presented in the above sections; stabilization by shoring would precede recovery.

Estimated cost: No accurate estimate available, but at least $ 20-22 million, including conservation.

2.9 Expanded Enforcement of Sanctuary Regulations

There is evidence of increased illegal encroachment on the Sanctuary. In addition to the destructive 1991 anchoring incident, increasing quantities of commercial and sport fishing gear are being found on the site (Figure 8). NOAA will continue to review its enforcement policy in cooperation with the U. S. Coast Guard and the National Marine Fisheries Service; however, because of the *Monitor*'s remote location it will be difficult to expand enforcement efforts to an appreciable degree.

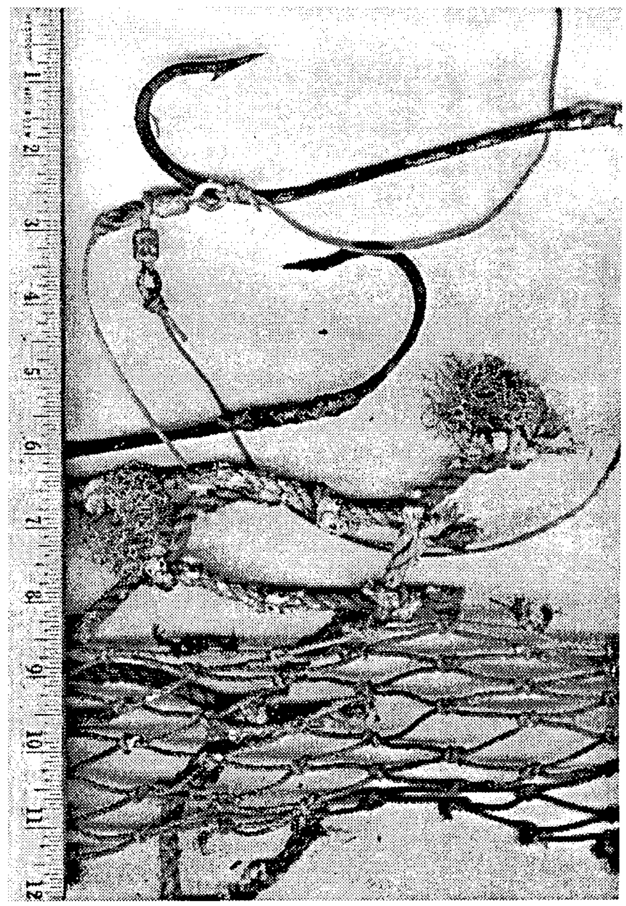


Figure 8. A sample of fishing gear recovered from the Monitor*'s hull in 1997 (NOAA).*

Advantages: An expanded enforcement program could provide an increased level of protection for the *Monitor*.

Disadvantages: Distance of the Sanctuary (approximately 21 miles offshore from the nearest inlet) makes it impossible to provide more than periodic surveillance of the *Monitor*.

Action Required: Periodic review of cooperative agreements with the U. S. Coast Guard and the National Marine Fisheries Service, as well as expanded efforts at educating commercial and sport fishermen of Sanctuary regulations.

Estimated cost: Both the Coast Guard and Fisheries Service are already engaged in enforcement activities in the Hatteras area; costs associated with expanded enforcement would be for providing coverage further offshore than necessary for currently-mandated routine surveillance.

TABLE I: SUMMARY OF ALL OPTIONS

	Option	Advantages	Disadvantages	Est.Cost
2.2	Non-Intervention	Requires no added committments or funds, site remains active	Monitor continues to disintegrate, inevitable collapse	none
2.3	Encapsulation	Monitor no longer exposed to elements, minimal operating costs, method is relatively simple	Monitor not accessible, shoring still required, deterioration continues, weight of sand may cause added collapse	$ 4-5 M
2.4	Shoring	Monitor accessible, collapse of hull delayed, moderate cost	Monitor continues to deteriorate, unnatural appearance, frequent inspections required, inevitable collapse	$ 3-4 M
2.5	Cathodic Protection			
2.6	Selective Recovery			
2.7	Full Recovery			
2.8.1	Selective Recovery & Encapsulation			
2.8.2	Shoring & Selective Recovery			

TABLE I: SUMMARY OF ALL OPTIONS

Option

2.2 Non-Intervention

2.3 Encapsulation

2.4 Shoring

2.5 Cathodic Protection

2.6 Selective Recovery

2.7 Full Recovery

2.8 Combined Options

- 2.8.1 Selective Recovery & Encapsulation
- 2.8.2 Shoring & Selective Recovery

3.0 Selected Option

3.1 Final Considerations

In deciding which large components are to be recovered from the *Monitor*, consideration was given to several critical factors, especially technological feasibility, conservation and curation facilities, and financial capability. The decision to recover, conserve and curate (retain and care for in perpetuity) large objects that have been deteriorating in seawater represents a major long-term commitment of resources. The historical and archaeological significance of the object must be weighed against pragmatic factors such as the condition of the object, its diagnostic importance, its size and weight, its exhibit potential and available and projected curation resources. The tragedy of the USS *Cairo*, a Union gunboat described in Section 4, presents a valuable lesson for planners contemplating the recovery of large historical objects from an underwater site. The *Cairo* story begins with a botched recovery attempt and culminates in the virtual abandonment of the recovered remains. (Fortunately, the National Park Service (Bearss 1980) has since conserved and interpreted the surviving material in a very impressive display at Vicksburg National Battlefield.)

The circumstances of the *Monitor* and *Cairo* are quite different, however. The *Cairo*, buried in the soft, protective mud of the freshwater Yazoo River, might have survived many decades with little degradation; the *Monitor*, on the other hand, is almost completely exposed on the seabed, subject to the ravages of currents, storms, corrosion and even illegal commercial fishing and salvage activities. The *Monitor*'s hull is under extraordinary stresses due to the configuration of the wreck. It could collapse at any time, an event that would result in severe damage or total destruction of many of the machinery and hull components and numerous significant artifacts. Therefore, some form of on-site intervention is necessary if NOAA is to prevent catastrophic disintegration of the *Monitor*'s hull and contents.

In reviewing all intervention options, one major decision point is clear: all options involve either preservation by stabilization *in situ* or preservation by recovery and conservation. Stabilization options can be achieved with less technological difficulty and lower cost than can recovery options; however, stabilization will, at best, only delay the inevitable collapse of the *Monitor*'s hull. Eventually, NOAA will still have to decide if major hull components will be recovered for preservation and exhibition. Therefore, the present analysis paid considerable attention to comparing the short-term advantages and disadvantages of stabilization with those of moving directly into large-scale recovery.

3.2 Conclusions

The Selected Option is Shoring Combined With Selective Recovery (2.8.2). This decision was based on a consensus among NOAA planners and outside reviewers. This option includes two principal phases: *in situ* preservation by shoring (Section 2.4) followed by selective recovery (Section 2.6). The first phase will entail shoring up unstable portions of the *Monitor*'s hull using sand bags, grout bags, jacks, or a combination of methods; the second phase will be the recovery of all selected major components, as discussed below.

Stabilization by cathodic protection alone is not recommended because of the disadvantages listed in Section 2.5. The consensus of corrosion experts indicates that cathodic protection is not a viable option. In fact, one reviewer estimates that approximately 91% of the thickness of the hull plating has already disintegrated. However, additional consultations will be held with corrosion engineers to determine the technological and economic feasibility of installing cathodic protection on portions of the wreck not selected for recovery. Determining the feasibility and effectiveness of cathodic protection is critical, since shoring and selected recovery will not halt the ongoing natural deterioration of the remaining portions of the wreck. Evaluation of cathodic protection as a viable option must consider not only the initial cost of installation but long-term maintenance and/or periodic replacement of the system.

This combined option offers a number of disadvantages while, at the same time, minimizing the drawbacks:

Advantages:

- The stabilized portions of the *Monitor* would remain visible and accessible for future research and recreational visitation;
- The collapse of the portions of the hull left at the site would probably be delayed, possibly by 25 years or more;
- Significant objects would be recovered, conserved and placed on exhibit where they could be viewed and appreciated by large numbers of people;
- The recovered objects would be preserved and made accessible to the public on a permanent basis, regardless of the fate of the remaining hull and contents;
- Stabilizing the hull before commencement of recovery operations would minimize damage to the hull and contents.

Disadvantages:

- Since the remaining portions of the *Monitor* and its contents would still be exposed, they would continue to disintegrate due to natural and human causes;
- The appearance of the wreck would be altered, and its scenic and aesthetic value might be diminished;

- Because of the instability of the hull and the difficulties of conducting on-site operations, there is a possibility that stabilization and recovery efforts could result in collateral damage to the hull and contents, including the objects slated for recovery;
- The inevitable collapse of the remaining hull, with the subsequent loss of considerable cultural material and archaeological information, may be delayed but not eliminated;
- The shoring system(s) would require inspection and maintenance to be carried out at the Sanctuary;
- Because of the depth and adverse environmental conditions, on-site stabilization and recovery operations would be expensive, particularly for the recovery of large objects.

The criteria for selecting objects for eventual recovery included historical and archaeological significance, ability to answer research questions about the site, probability that the object would be damaged or destroyed if left on the site and suitability for inclusion in a major interpretive exhibit on the *Monitor*. More information is included in Appendices E and F.

As shown in Table II, implementation of this option will require a number of related activities to take place over a period of at least three years before on-site stabilization and recovery operations could be completed. The first steps, which could take place during FY98 and FY99, would be the development of detailed plans for stabilization and recovery, archaeology, conservation, exhibition and curation, and funding. An environmental assessment will also have to be submitted for review. The funding, or business plan will provide a framework for project managers to develop the necessary partnerships or alliances, schedule and fund each phase or activity and track overall fundraising efforts.

Concurrent with the above planning activities, on-site research activities will continue. On-site research involves the long-term process of surveying and mapping the site, recovering small artifacts that might be damaged by the major stabilization and recovery operations, and initiating the stabilization process. The U. S. Navy has reviewed the initial stabilization objectives and has identified several tasks that would be ideal as realistic training exercises for Navy salvage divers. As a result, Mobile Diving and Salvage Unit Two, Little Creek, Virginia, has scheduled a three-week training operation at the *Monitor* Sanctuary in 1998 in order to assist NOAA with implementation of the preservation plan. Some of the initial mapping and recovery activities will therefore be completed during FY98, with a possible continuation of the effort during FY99. The Navy expedition will accomplish several major goals and thus reduce the amount of on-site time required during the final stabilization and recovery phase. At least two private diving organizations have also expressed interest in

Six Phases of the Shoring and Recovery Plan

On-site shoring and recovery operations will be conducted in six phases, as shown on these two pages. Depending on the funding and equipment available, it may be possible to complete Phases I and II during FY 98 and FY99, thereby reducing the number of tasks that must be completed when large-scale recovery operations take place. The six phases are as follows:

Phase I: Pre-Shoring Archaeological Survey, Mapping and Recovery: A NOAA-approved archaeological survey team will closely survey and map all exposed artifacts beneath the hull, from the bow to the eastern end of the stern debris field, then will conduct limited excavation, mapping and recovery in the following areas: (1) beneath the hull, in accessible areas beneath the hole in the deck just forward and to port of the midships bulkhead; (2) inside the hull between the armor belt and the lower hull; (3) in the debris field aft of the propeller; and (4) in any accessible areas beneath the hull that might be affected by the planned shoring activities. All encountered artifacts will be mapped and recovered, insofar as personnel safety permits; divers should not venture beneath the hull. An effort will be made to locate and record the rudder, which is assumed to lie in the stern debris field.

Phase II: Shoring Beneath the Hull: The hull will then be shored up using pumped sand, sandbags, "grout bags" (a type of cement that will harden after being pumped into bags), mechanical jacks, or a combination of methods; the lower hull will also be shored by some method that will support the engine until it can be removed.

Phase III: Removal of Skeg, Propeller, Lower Hull and Engine: The skeg will be removed and placed on the seabed to the south of the hull; the propeller and shaft will be recovered; the lower hull will be cut away and the engine recovered; lower hull plating and beams will be placed on the seabed near the skeg.

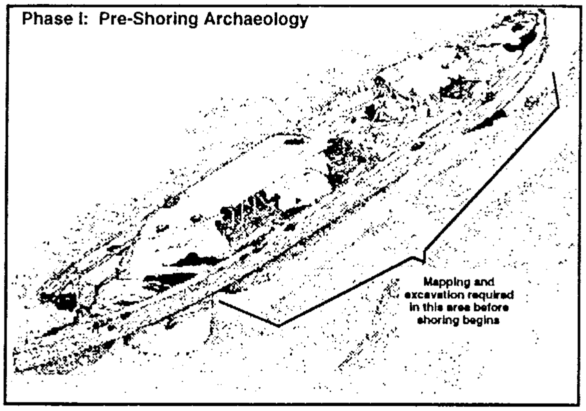
Phase IV: Removal of Armor Belt and Hull Section Above the Turret: With the hull shored from beneath and the engine and other machinery components removed, the section of armor belt and hull that obstruct access to the turret can be cut away; these objects can be placed on the seabed, near the other material removed from the hull.

Phase V: Removal of Turret: With the turret now clear of overhead obstructions, it can be recovered; a support cradle will be worked beneath the turret and the turret will be supported on all sides before being lifted to the surface.

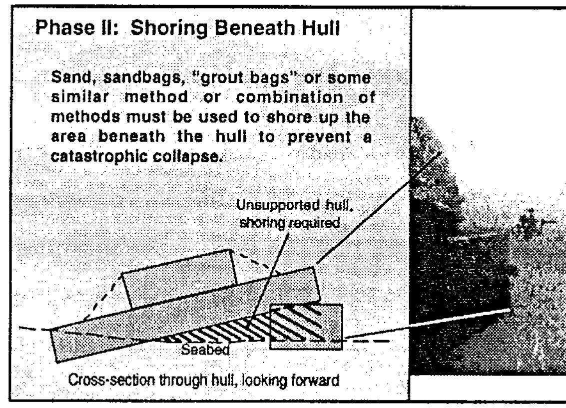
Phase VI: Post-Removal Survey and Stabilization: Following completion of all recovery activities, an archaeological and engineering survey must be conducted to assess the condition of the hull and contents; additional stabilization should be carried out, if necessary. (Excavation of forward areas will be excavated as time and resources permit.)

Six Phases of the Shoring and Recovery Plan

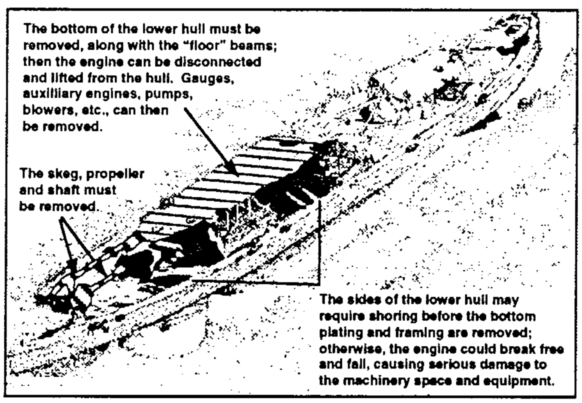
Phase I: Pre-Shoring Archaeology



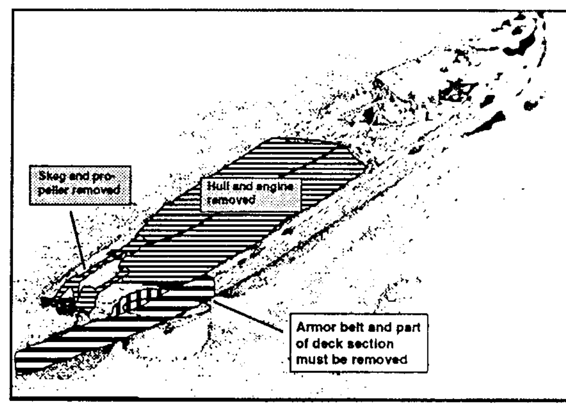
Phase II: Shoring Beneath Hull



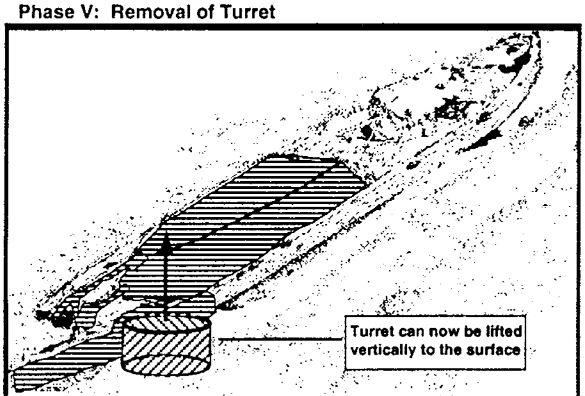
Phase III: Removal of Skeg, Propeller, Lower Hull and Engine



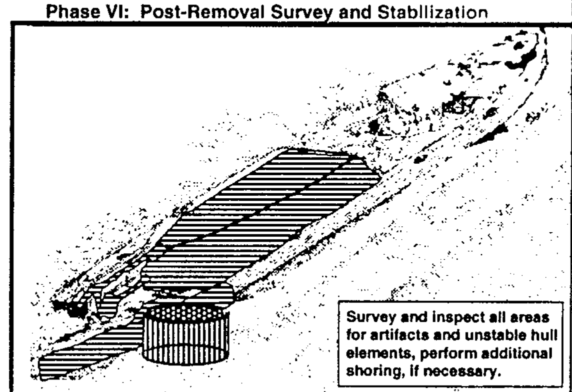
Phase IV: Removal of Armor Belt and Hull Above Turret



Phase V: Removal of Turret



Phase VI: Post-Removal Survey and Stablilzation



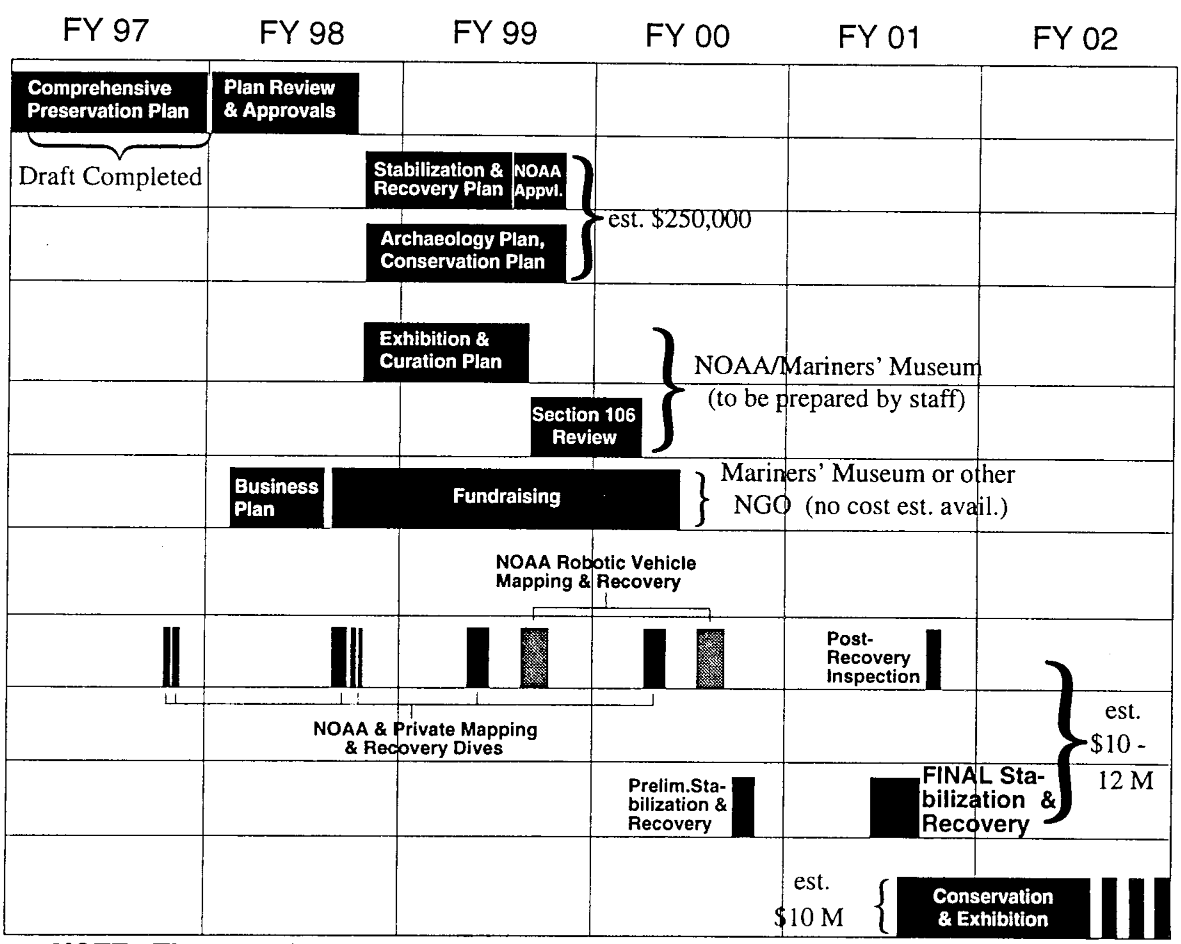
participating in the mapping and recovery of small artifacts, all of which can take place on an ongoing basis, concurrent with planning activities.

4.0 Considerations for Selecting the Recommended Option

4.1 Introduction

Section 2 presents all major viable options that were identified for preservation of the *Monitor*, along with advantages, disadvantages, action required and estimated costs for implementation of each option or combination of options; Section 3 describes the selected option. The discussions below provide additional considerations that were taken into account in making the final selection. Because of the complex nature of deepwater recovery

TABLE II: PRELIMINARY SCHEDULE and BUDGET FOR IMPLEMENTATION



NOTE: The cost estimates presented above are for evaluation purposes only; no final estimates are available and no funding sources have been identified.

operations, the adverse environmental conditions at the Sanctuary and the extreme historical significance of the *Monitor*, review comments by outside experts were solicited and taken into account before a final decision was made and before the preservation plan was finalized. During this review period, the public at large was also given an opportunity to review the draft plan. All comments were reviewed and taken into consideration during preparation of the final plans for the various aspects of the project, including on-site activities, conservation, exhibition and funding.

4.2 Technological and Engineering Considerations

One of the most important factors to be borne in mind when planning research or recovery operations at the *Monitor* National Marine Sanctuary is the severity and unpredictability of the site environment. As discussed in Appendix D, the most favorable weather window is historically June through September; unfortunately, however, that window overlaps the annual hurricane season. A review of NOAA and private expeditions to the Sanctuary since 1990 indicates that, on average, it was only possible to conduct diving operations on one day in three. That estimate includes expeditions staged from large research vessels and U. S. Navy salvage ships as well as from smaller craft. Therefore, planning must include a generous allocation of time to account for adverse weather. Also, the weather history must be considered when planning the total on-site schedule, especially since most options will require equipment and personnel to remain on site for weeks at a time. With proper equipment and support, and skilled personnel, diving and recovery operations can be conducted in relatively heavy weather and strong currents, but conditions at the Sanctuary can change very rapidly, causing potential safety and operational problems.

Planners must also take into account that the *Monitor* is a highly significant historical resource, a National Historic Landmark. The hull may also contain the remains of some of the *Monitor*'s officers and crew, requiring a plan for the proper handling and disposition of human remains, as discussed in Appendix E. Therefore, special precautions must be taken to ensure the maximum protection of the hull and its contents during all on-site operations. Some conventional forms of salvage methodology, such as the use of explosives, will probably not be applicable to this project. Appendix A, the preliminary study prepared by Oceaneering International, discusses various technological options in more detail, subjects each option to trade-off analysis, and makes recommendations as to which options offer the highest probability of success.

For any given option, it is possible to propose several combinations of equipment and procedures to accomplish the desired results. However, a careful and thorough evaluation of each proposed approach should yield a preferred methodology for the given conditions at the Sanctuary. The final choice of methodology and equipment for any of the stabilization and/or recovery options will be made as part of a detailed engineering plan, based on the shoring and selective recovery option chosen by NOAA.

Stabilization options, including cathodic protection, shoring by mechanical supports and shoring with sand, sandbags or grout bags, even though they are designed to help stabilize the *Monitor*'s hull, pose additional threats to the hull and its contents. The process of installing stabilization material may, if not carried out properly, cause more damage than it was intended to prevent. The plan must take all factors into account, including pressures exerted on the hull during support/sandbag installation, possible incidental damage from equipment and divers during installation, and the potential benefits to be gained from the various options.

Recovery operations will require even more precautions, since the most dangerous phase of any recovery operation is raising large objects through the air-water interface. Such operations should only be attempted when sea and current conditions are sufficiently calm to minimize the additional dangers of boat and lifting gear motion. There are countless instances of recovery operations that successfully rigged and raised large objects from the seabed, only to have them dashed to pieces against the side of a barge or torn apart by the forces created when they were raised from the water and, suddenly, all of their weight was concentrated on a few cables or straps. The Civil War gunboat USS *Cairo*, completely intact when discovered in a Mississippi river in the mid-1950s, was literally ripped into pieces in 1965 when cables slung under its hull sliced through the water-damaged wood planking (Figure 9). More recently, an intact 19th-century steam engine was raised from the Chesapeake Bay, only to break apart immediately after it cleared the water's surface. Both of these disastrous failures occurred in shallow water and calm weather. Not all such salvage projects ended in disaster, however. The Swedish warship *Vasa*, which sank in 1628 (Figure 10) was successfully raised in 1959 and is Sweden's most popular tourist attraction. Also, King Henry VIII's warship *Mary Rose*, raised in 1982, is a major tourist attraction in Portsmouth, England.

4.3 Archaeological and Historical Considerations

Protection and proper archaeological control of the *Monitor* and its contents are of paramount importance in the development of a detailed stabilization/recovery plan. The plan must define the archaeological objectives and provide an approach that maximizes the recovery of information and documentation of the site, which will be continuous throughout all phases of the project. The plan must clearly delineate the responsibilities of all project directors and provide guidelines and thresholds for possible cessation or termination of on-site activities due to weather, technological problems or other factors. As discussed in Appendix E, all on-site operations must be conducted under the close scrutiny of a qualified archaeologist who is intimately familiar with the *Monitor* and the site. The project archaeologist must have the authority to halt operations if, in the opinion of the archaeologist, continuation might damage the *Monitor* beyond acceptable limits. In preparation for the initial survey, which will take place during 1998, two of the *Monitor* Sanctuary staff, both trained nautical archaeologists, will take part in rigorous dive training that will allow them to supervise in-water activities. Appendix E presents a more detailed preliminary archaeology plan.

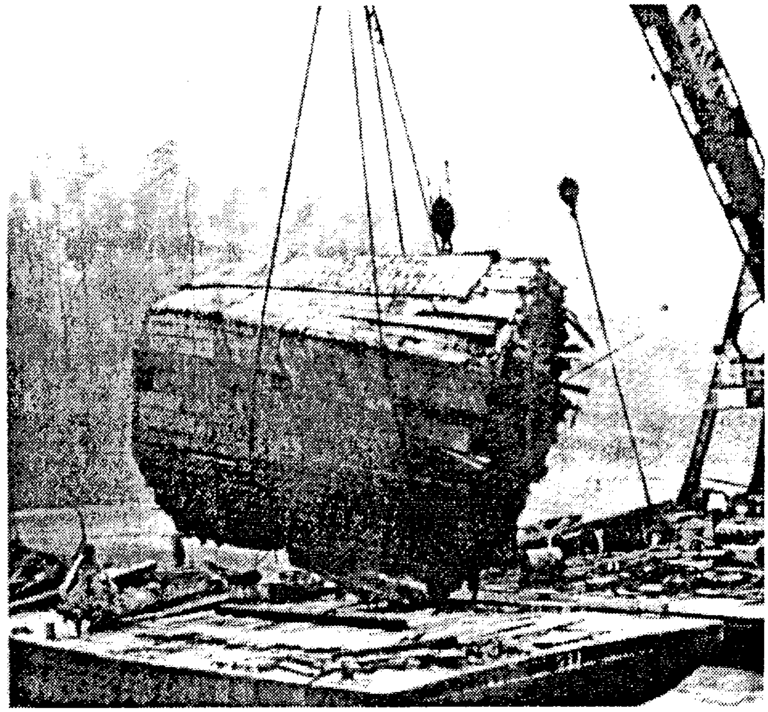


Figure 9. Raising a badly-damaged hull section of the Union gunboat USS Cairo *in 1965 (National Park Service).*

Archaeological survey, mapping and recovery operations must take place before any large-scale stabilization or recovery operations commence. This pre-intervention effort will be extensive, requiring hundreds of

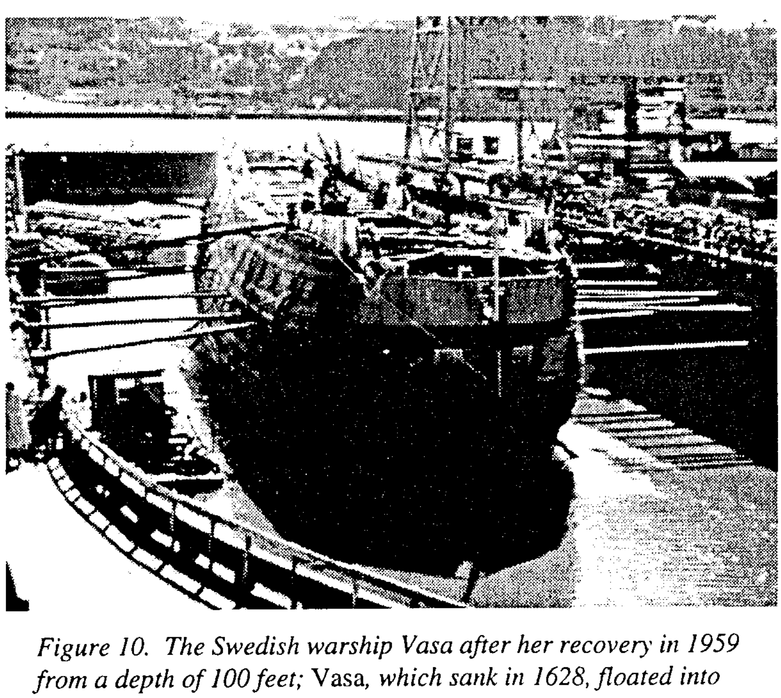


Figure 10. The Swedish warship Vasa after her recovery in 1959 from a depth of 100 feet; Vasa, *which sank in 1628, floated into drydock on her own hull (Bass 1972).*

hours of effort by divers working under the supervision of qualified archaeologists. At least one archaeologist must be involved in all critical in-water operations to ensure that the quality of data collection and recovery meets accepted archaeological standards. Pre-intervention activities will be designed to map and recover artifacts that are likely to be damaged or destroyed during stabilization/recovery operations.

Prior to the initiation of the recovery of large hull components, the major research objectives will be outlined and incorporated into a detailed archaeology plan which, like the engineering plan, must specify the methodology, equipment and personnel required for adequate mapping, documentation and recovery of cultural material. As described in Appendix E, the major components selected for recovery were chosen because of their historical significance as well as the likelihood of their destruction if left on the bottom. The archaeological plan will provide contingencies should any of the components selected for recovery prove to be in more fragile condition than initial investigations indicated. The plan will also make provisions for the proper recovery of human remains, should they be encountered.

Following the large-scale stabilization/recovery phase of on-site operations, another archaeological survey must be conducted. If necessary, additional exposed artifacts will be mapped and recovered. The final phase of mapping is important, since the post-intervention site map will serve as a new baseline for long-term site monitoring and assessment.

Technical reports on each phase of field operations will be prepared and published within one calendar year of operations. These reports will be available upon request from the *Monitor* Sanctuary office. Upon completion of all phases of the plan a final report will be prepared and published to fully document all activities associated with the project.

In addition to archaeological planning and research, ongoing historical research and the collection and interpreta of historical data on the USS *Monitor* is being conducted as a key component in the overall preservation plan. In order to gain as much knowledge as possible on the *Monitor*'s construction, machinery and contents, a wide range of contemporary plans, drawings and documents are being examined and compared with photographs, video and measurements from the site. A research model of the wreck is being constructed to augment this effort and to serve as a visual aid during planning and on-site operations.

The forward areas of the ship that contain the officers' and crew's quarters and ship's stores have suffered considerable damage and collapse. It is likely that much of the archaeological record has been damaged or destroyed, thus limiting the information that can be obtained concerning stowage, provisions and shipboard life. Therefore a major research effort is being directed toward expanding an earlier study of the *Monitor*'s crew to include a synthesis of available data such as nationality, previous sea experience, adaptations to shipboard life, incidence of desertion, and subsequent service on other monitors. Historical documents being researched include official and personal correspondence; enrollment, service, and pension applications; and published and unpublished family histories. A tentative publication date for this study is the summer of 2001.

Other research projects currently underway include a comprehensive *Monitor* bibliography that is a cooperative effort of The Mariners' Museum and the Sanctuary staff. This is the first in a series of *Monitor* bibliographies that will include manuscripts, images, and artifacts. *Cheesebox*, the Sanctuary activities report, is published twice a year and includes up-to-date information on current on-site and historical research, little-known historical facts, and educational opportunities including exhibits, presentations, workshops. Also, plans are underway to reprint a study on the significance of the USS *Monitor* authored by James Delgado and printed for NOAA by the National Park Service in 1988. Also under consideration is a revised version of the invaluable book *Drawings of the U.S.S. Monitor* which has been out of print since 1987 (Peterkin 1984). This large volume of plans of the *Monitor* and its components has facilitated ongoing comparisons between areas of the *Monitor* observed at the site and actual specifications of the ship.

4.4 Conservation Considerations

Conservation must always be a major consideration when planning archaeological recovery operations. Planned activities at the *Monitor* site will result in the recovery of cultural objects consisting of a wide variety of materials, including iron, brass, copper, wood, hemp, ceramics and glass. Some of the objects will be comprised of more than one material. These "composite" artifacts are the most difficult to treat, since they often must be disassembled so that each type of material can be treated separately. Initially, however, on-site conservation will consist primarily of ensuring that recovered objects are stabilized and protected from damage until they can be transferred to a laboratory for treatment. Most on-site conservation activities can easily be carried out by relatively unskilled personnel, as long as at least one qualified conservator supervises the operation. As described in Appendix B, laboratory conservation will be a major effort and will require a sizeable facility and staff.

4.5 Exhibition/Curation Considerations

The criteria for removal of cultural material during the stabilization phase of the project is to recover objects that may be adversely impacted by shoring activities. Although some of the objects that will be removed from the *Monitor* may be less than desirable for exhibition because of poor condition, unwieldy size or other factors, all material will be made available for exhibition purposes, along with special handling and exhibition guidelines. Exceptions will be limited to those items that, in the opinions of conservators, are too fragile to travel. Objects that are not requested for exhibition will be placed into secure storage following conservation, where they can be maintained in a stable condition and where they can be accessed for study and inspection. These considerations are discussed in more detail in Appendix F.

The preliminary exhibition/curation considerations included in Appendix F provide a concept for exhibiting major objects from the *Monitor*. As planning progresses, a more detailed exhibition/curation plan will be developed specifically to address those artifacts to be recovered. Also, exhibit design will include the conservation laboratory which will incorporate public access features to assist in interpreting the complexities of conservation. Serious consideration will be give to design elements in the laboratory, such as viewing windows and catwalks over large tanks, that will allow viewing of large artifacts that will be in conservation for extended periods of time.

4.6 Funding Considerations

If any of the major stabilization or recovery options outlined herein are selected for implementation, the costs will run into millions of dollars. A final comprehensive plan involving large-scale stabilization and/or recovery operations must also include a detailed budget and identify sources of funding. Except for initial mapping and small-scale artifact recovery, no on-site intervention should take place until adequate funding has been committed for completion of all phases of the project. If large components of the *Monitor*'s hull are recovered their conservation and long-term curation must be assured.

Consideration must be given to all possible sources of funding and in-kind support pursuant to the revenue enhancement authority of the NMSA and other pertinent laws. The most feasible approach appears to be the creation of an alliance of Federal, state and private organizations with an interest in the preservation of the *Monitor*. Partnerships are being sought with governmental agencies and private entities with resources, skills and equipment that might be used in the preservation effort. A comprehensive fundraising program must be implemented within the context of the existing system-wide National Marine Sanctuary fundraising program. Appendix G discusses the development of a site-specific business and fundraising plan. It should be noted that the cost estimates presented in this draft plan are for evaluation purposes only; no final cost estimates are available and no funding sources have been identified. It should also be noted that adequate funding to carry the project through to completion need to be identified prior to the initiation of recovery of major components from the wreck.

4.7 National Historic Preservation Act Considerations

Federal law provides that sites listed on the National Register of Historic Places are subject to protection, and criteria have been developed for the review of proposed activities that might result in potential adverse effects to the resource. Since the *Monitor* is listed on the Register and, in addition, is a National Historic Landmark, any plan proposing on-site activities that will disturb the site in any way must be reviewed by state and Federal officials, in compliance with the National Historic Preservation Act, section 106 criteria and other pertinent laws. Also, NOAA will need to consult closely with other preservation and maritime organizations and expert individuals concerning on-site activities. The Section 106 consultation process will facilitate such contacts.

In establishing a realistic archaeology plan, suitable for NHPA review, consideration must be given to the fact that the *Monitor*'s hull and contents are threatened with damage or loss due to the rapid deterioration of the hull and loss of structural integrity. NOAA considers the *Monitor* to be a threatened site and, therefore, will develop the archaeology plan accordingly. There are special provisions for threatened sites, with consideration being given to the relative impact to a threatened resource if no action is taken versus taking positive action to preserve the resource. In the *Monitor*'s case, an effective argument can be made that if positive steps are not taken to stabilize the hull and/or recover some of the material, the entire site could be irreparably damaged by continued deterioration in as little as one to five years. Appendix E discusses the review procedure in more detail.

5.0 Summary and Final Conclusions

The recommended option calls for actions that will substantially alter the *Monitor*'s hull and contents. If no action is taken, however, the *Monitor* will inevitably collapse. Therefore, the risk of collateral damage during shoring and recovery operations is somewhat mitigated, especially when it is recognized that recovered portions of the *Monitor* will be preserved in perpetuity. In addition, shoring the hull before recovery not only reduces the chance of collapse, but it also greatly diminishes the risk of damage during component recovery.

Details of this option have not been fully developed, and an outside consultant will be required for the final engineering plan. It is expected that this plan will develop numerous activities, including initial reconnaissance, mapping and artifact recovery; shoring of the hull and engine; removal of the propeller and skeg; removal of the lower hull above the engine; disconnection of the engine from its mounts and piping; removal of the engine and associated machinery; removal of the portion of armor belt above the turret; excavation of the turret interior; removal of the two cannons and other turret contents; recovery of turret; recovery of other selected components; recovery of artifacts encountered during recovery operations; post-recovery inspection; and additional shoring (if necessary).

Equipment will probably be similar to the equipment suggested by the preliminary proposal (a summary is included as Appendix A). A large-capacity crane mounted on a seagoing barge will probably be employed for all lifting operations; one or more tugboats will be used to propel and control the barge; diving operations will be conducted by commercial divers using a saturation system (a system used widely by the offshore oil industry because of the extended work time afforded the divers); diving and recovery activities will be carefully observed by project archaeologists. NOAA is planning to create an advisory committee to ensure that there is adequate professional input to the project.

Although shoring and selected component recovery will alter the appearance and character of the *Monitor*'s remains, the site would still contain the major portion of the hull, and the stabilization will extend the life of the remaining hull considerably, almost certainly 25 years or more. Thus the Sanctuary would continue to provide an opportunity for continued research and artifact recovery as well as an historic and exciting experience for visiting divers. In the future, archaeological excavation can take place on an annual basis, as time and resources permit, in the forward areas of the hull where living and stowage areas are located.

The option for stabilization combined with selective recovery appears to offer results that conform with SRD's long-range strategic objectives and that offer the best possible prospects for preservation of the *Monitor*. However, this option is expensive, with costs estimated to be in the range of $ 20-22 million, including conservation. Comments on the draft plan suggest that this initial cost estimate is low, possibly by as much as 100 percent. The level of priority assigned to large-scale stabilization and/or recovery operations at the *Monitor* National Marine Sanctuary should be in proportion to both the documented and perceived significance of this historic ship, its value to the public, and the long-range goals of the National Marine Sanctuary Program. The praise received by the USS *Monitor* over more than a century and the sustained high level of public interest and excitement over the wreck since its discovery in 1973 suggest that the site has significance to the American public that transcends Federal guidelines and National Register criteria. This plan provides an opportunity to preserve the *Monitor* for future generations.

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Appendices

Appendix A
Summary of the Stabilization and Recovery Plan

Note: *In order to provide details on the engineering aspects of the stabilization and recovery options proposed in this Plan, the Oceaneering preliminary proposal is summarized herein.*

Preliminary Proposal for the Emergency Recovery,

Stabilization, and Preservation of the *Monitor*

Submitted to:

Officer of the Director of Ocean Engineering
Supervisor of Salvage and Diving
Naval Sea Systems Command, SEA OOC
Department of the Navy
2531Jefferson Davis Highway
Arlington, VA 22242-5160

Submitted by:

OCEANEERING INTERNATIONAL, INC.
501 Prince George's Boulevard
Upper Marlboro, MD 20774

25 April 1997

Table of Contents for *Monitor* Proposal

1.0 EXECUTIVE SUMMARY

This preliminary proposal for the emergency recovery, stabilization and preservation of the *Monitor* was developed by Oceaneering International, Inc. (Oceaneering) at the request of the Office of the Director of Ocean Engineering, Supervisor of Salvage and Diving (SUPSALV); and the National Oceanic and Atmospheric Administration (NOAA). The urgency for generating a plan is based on observations made by NOAA that since 1987 an alarming increase in the disintegration or collapse of hull components has occurred.

The objective of Oceaneering in this preliminary proposal is to provide a top level concept of operation for the emergency recovery, stabilization and preservation of the *Monitor*; and to provide an initial plan for state and federal Section 106 review. We believe that the proposed plan is feasible with the proper equipment, personnel and a sufficient weather window. To successfully execute the operation, a detailed Recovery Operations Plan needs to be developed by Oceaneering in conjunction with SUPSALV and NOAA.

This preliminary proposal is the beginning of Phase I of a multi-phase plan. Phase I is the Planning & Budgeting Phase. It's objectives are to develop a detailed recovery, stabilization and preservation plan; to research and conduct any additional studies or tests to mitigate risk and aid in the recovery operations; and to develop the basis of estimates for the cost of the recovery operation. Phase II is the Recovery & Stabilization Phase. It's objective is to successfully execute the recovery, stabilization and preservation plan with the assets necessary, within the scheduled weather window of opportunity (April-August), and within the budgetary constraints. Phase III is the Conservation & Exhibition Phase. It's objective is the preservation of the recovered artifacts, the studies of their historic value, and the exhibition to the general public. The sections of the preliminary proposal are divided into:

- Trade Studies Summation
- Concept of Operation
- Cost Estimate
- Recommendations
- Appendices

To optimize the objectives of the emergency recovery and concept of operations, Oceaneering conducted six trade studies on the concept of operations methodology using the Kepner-Tregoe approach for decision analysis. These trade studies, summarized in Section 2.0, consisted of:

- Evaluation and selection of the top level management options for preservation
- The best recovery methods
- The optimum offshore work platform
- Maintenance of the archaeological integrity of the site
- Minimization of deterioration during recovery operations
- Most cost-effective underwater intervention work system

Key to a successful operation is a realistic and feasible concept of operation for emergency recovery, stabilization and preservation of the *Monitor*. In Section 3.0, we have outlined a preliminary concept of operation and resources required which is the foundation for Phase II, The Recovery & Stabilization Phase. The operations are estimated to be conducted over a 143 day period which includes a weather contingency of 26 days. Phase II is laid out into 7 distinctive segments of operations as shown in following Figure 1.1.

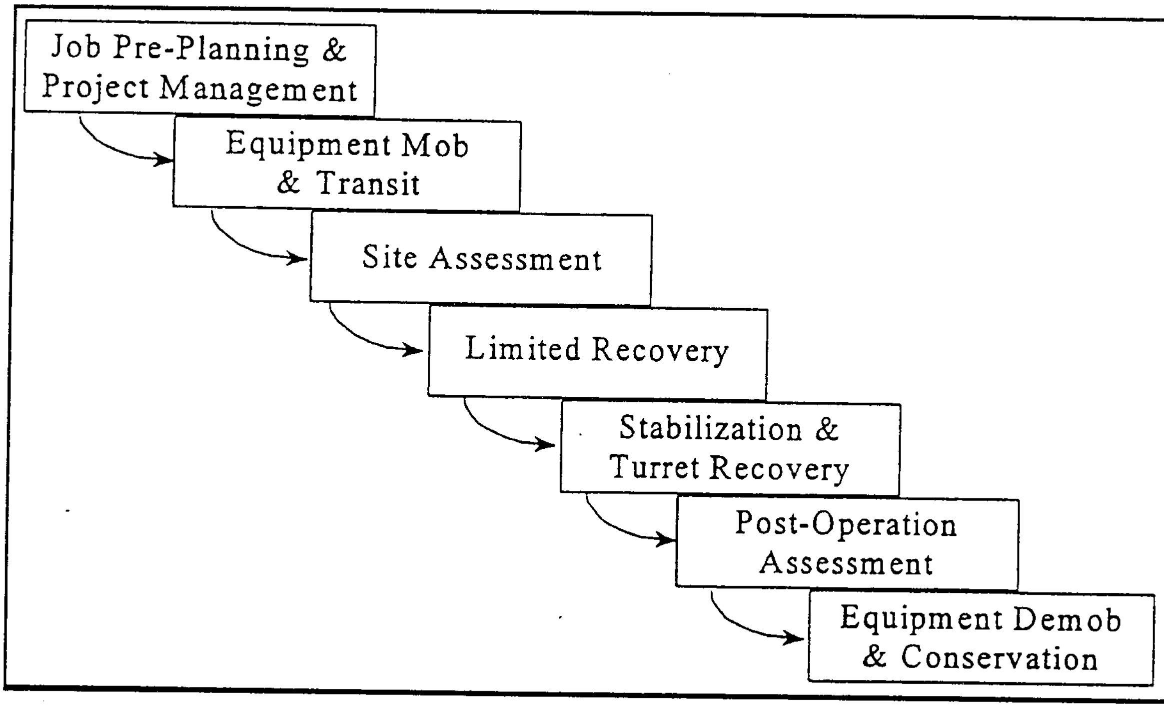


Figure 1.1. Monitor *Recovery Operations Plan: Seven Segments of Operation*

The preliminary cost estimate is a rough order of magnitude (ROM) for Phase II and is based on the concept of operation described in Section 3.0. The cost of Phase II is summarized at a top level by segment of operation (Work Breakdown Structure (WBS) Level 1) and is presented in Section 4.0. The phase costs are broken down to a WBS Level 2 in Appendix B with individual Basis of Estimates (BOEs) sheets which contain the task descriptions, and assumptions.

To enhance the success and mitigate risk, recommendations are made in Section 5.0 that would aid in the advance planning and on-site operations. These include the generation of a list of artifacts by priority to be recovered, an industry search for the optimum method for underwater cutting of highly corroded iron, determining the position of the Dahlgren guns and preparing a detailed Recovery Operations Plan.

The success of the emergency recovery, stabilization, and preservation of the *Monitor* project is contingent on the knowledge of the project team; a well developed and detailed Recovery Operations Plan; the proper selection of equipment; and good weather off the coast of Cape Hatteras during the operations. A team of SUPSALV, NOAA and Oceaneering

ID	Task Name	Duration
1	Emergency Recovery and Stabilization	143d
2	Job Pre-Planning & Project Management	14d
3	Equipment Mob & Transit	21d
4	Site Preperation & Artifact Listing	15d
5	Limited Recovery	53d
6	Stabilization and Turret Recovery	27d
7	Post-Operations Assesment	18d
8	Demob and Conservation	9d

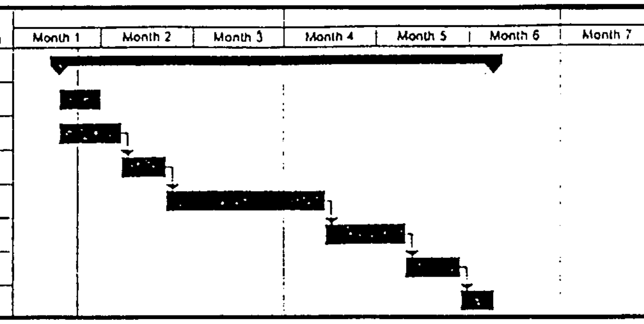


Figure 1.1. Monitor *Recovery Operations Plan: Seven Segments of Operation*

personnel will have the expertise, knowledge and experience to succeed in this challenging and historic project.

2.0 TRADE STUDIES SUMMATION

Since the discovery in 1974 of the *Monitor*'s present location, several expeditions and many studies have been conducted for determining the *Monitor*'s structural condition and to explore possible solutions for reducing its deterioration. Many of these studies were used to formulate concepts of operation for recovery or preservation of the *Monitor*. Given the voluminous amount of information generated by these past efforts, it was decided to perform a series of Trade-off Studies using the more viable concepts to determine the best combined approach for providing the long-term preservation of the *Monitor* and associated historic artifacts. The objective of these Trade Studies are to select a single approach or *Concept of Operation* that would lead to a successful mission. In short, this section will present an overview of these Trade Studies that ultimately lead to the proposed *Concept of Operation* presented in Section 3.0.

Oceaneering assembled a proposal team to research, select and propose the best alternative for the long term preservation of the historic *Monitor*. Using available information, the team created six Trade Studies that assisted in selecting the best operational methods. Based on the available information the following six Trade Studies were conducted:

- Top Level Methodology
- Site Investigation
- Recovery Methodology
- Stabilization Methodology
- Platform Selection
- Intervention Methodology

After the Trade Studies were identified, an objective for each was defined by the Oceaneering proposal team to help establish the desired outcome for each study. Once the objective was determined, the proposal team then selected various methodologies to be evaluated for each study. The next step was to list the major advantages and disadvantages for each of the selected methodologies. This information was then used to evaluate each methodology based on a set of selection criteria. The selection criteria was weighted on a 1 to 10 scale based on the teams judgement of the perceived value to the American public as related to the study being performed.

Finally, after the Trade Studies were determined, the objectives defined, methodologies listed and the weighted selection criteria assigned, each trade study was conducted by the team and validated by a separate panel. The panel consisted of three individuals outside of the proposal team. Each methodology of a given study was scored from 1 to 10. A score of 1 being less desirable and 10 being the most desirable. Table 2.1 lists the final outcome of each Trade Study.

Table 2.1. Trade Study Summary Table

TRADE STUDY	OBJECTIVE	CONCLUSION
Top Level Methodology	To establish a single management option for preservation of the MONITOR	Perform recovery of select items that are of high value or interest.
Recovery Methodology	To determine best methodology for supporting a limited recovery approach of the MONITOR	Perform a direct lift using a heavy lift system of key artifacts, such as the turret.
Platform Selection	Select optimum work platform that will accommodate a direct lift of selected items from the MONITOR for recovery	Derrick barge capable of heavy lift and four point moor.
Site Investigation	To select the best methodology of maintaining appropriate archeological integrity during recovery efforts involving the MONITOR	Use SHIP SHAPE℠ (a US Navy Integrated Database System) to record video, position, and historic data during recovery operations.
Stabilization Methodology	To select the best methodology to minimize deterioration of the MONITOR during recovery activities	Use jacks, sandbags, grout bags, etc. to help support and stabilize the MONITOR during recovery efforts.
Intervention Methodology	To determine best underwater work system methodology for MONITOR preservation and recovery efforts	Combination of surface-support diving, saturation diving, and ROV.

3.0 CONCEPT OF OPERATION (Recovery and Stabilization Plan)

The *Monitor* lies in about 230 feet of water 16 miles off the coast of Cape Hatteras. Observations during the past five years have convinced NOAA that the *Monitor*'s structure has been severely weakened by corrosion, water currents and mechanical stress. Catastrophic collapse of portions of the hull and corrosion of major items will continue if no action is taken to stabilize, recover and preserve historical items.

NOAA has requested a comprehensive plan for the management, stabilization and recovery of significant artifacts and material from the *Monitor*. The primary goal is the successful recovery of the historically significant artifacts at the wreck site. The second goal is the archaeological documentation and preservation of the remains of the *Monitor* in a manner that appropriately enhances the historical significance as well as the scientific and educational aspects of the warship. We propose an operation with a duration of 143 days, depicted in Figure 3.1 Recovery Flow Chart.

3.1 Pre-job Planning and Project Management

Pre-job planning will be performed by a nine member team of diving, engineering, and artifact preservation personnel at the Upper Marlboro office.

Overall project management will be under the supervision of U.S. Navy and NOAA personnel. Operations management will be administered by a qualified person who can function as an arbitrator between diving operations supervisors and archaeological personnel to determine the best course for the project.

The major activities to be performed during this phase are meetings with all participating agencies and the various parties participating in the recovery effort to refine the work scope and personnel responsibilities. Coordinating the various equipment and resources to ensure the mobilization and follow on logistical support of the operation is understood and well planned.

3.2 Equipment Mobilization and Transit

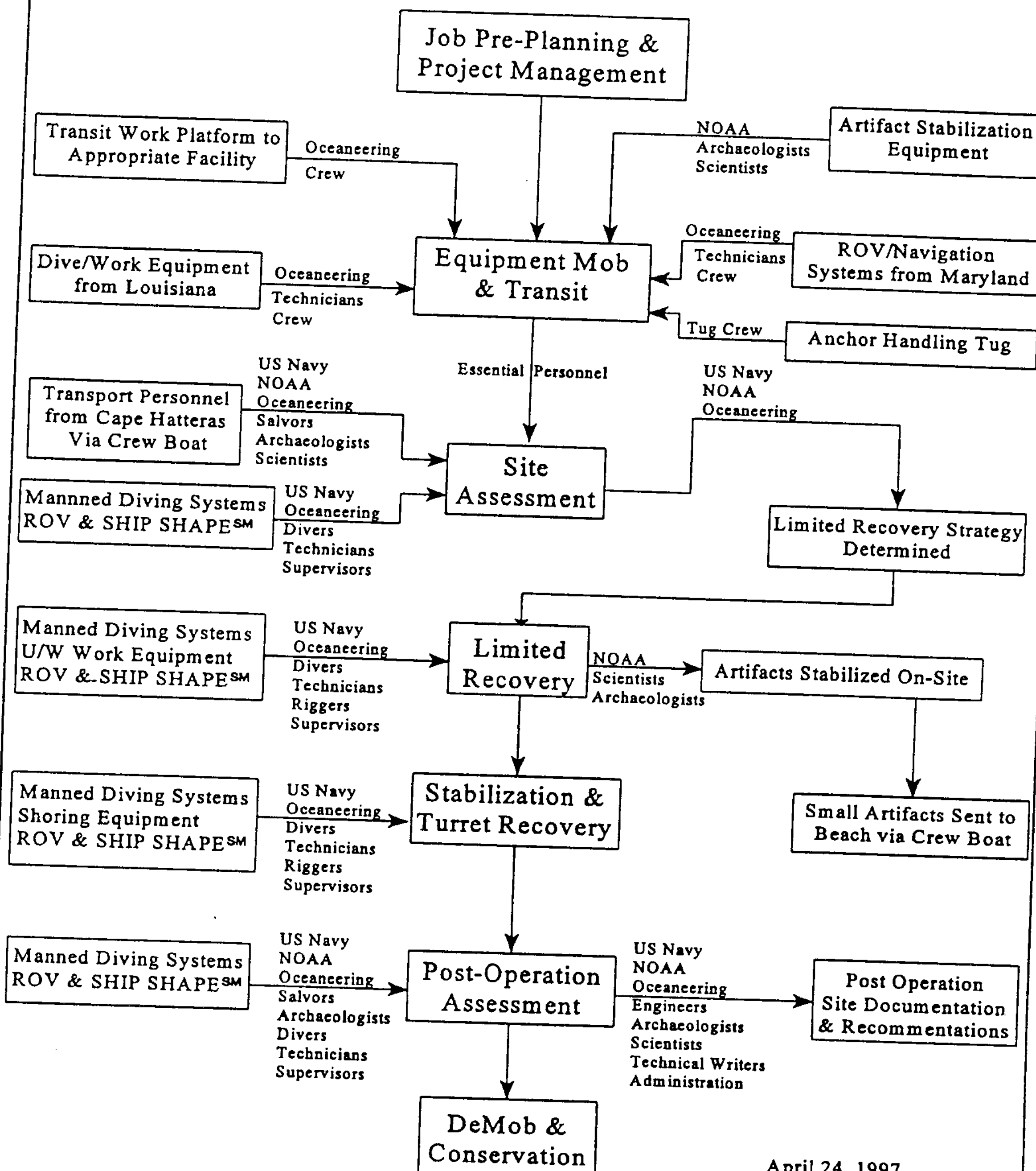
This phase of the operation involves bringing all the different equipment and personnel together and mobilizing it onto the work vessel. The major activities to be performed in this phase of the operation are as follows.

- Mob equipment and personnel onto the derrick barge and transit to site
- Set anchors and moor derrick barge at site
- Deploy real time current monitoring buoys and sensors

Major Resource Used: Work Vessel

Based on the trade studies a derrick barge was chosen as the most desirable work platform for the recovery of the *Monitor*. The benefits of using a derrick barge for this portion of the operation are as follows.

Figure 3.1
Recovery Flow Chart



April 24, 1997

- Crane for heavy and light lifts.
- Deck space for sat system, ancillary mission equipment, ROV system, surface support diving equipment and artifact preservation equipment.
- Accommodations for 110 persons.
- Station keeping capability during operations and rough weather by four-point moor.
- Helicopter landing pad.
- Tug boat included for propelling barge and setting mooring anchors.
- Economical alternative to an equivalent 4-point vessel and material barge system.

3.3 Site Assessment

The first task, once the derrick barge has been anchored over the wreck site, will be to begin the site assessment. The major activities to be performed during this phase of the operation are as follows:

- Deployment of the navigation system
- Site survey to further refine the recovery procedures and design of the lifting frames and rigging
- Documentation and cataloging

The site assessment and preparation will be conducted primarily by saturation divers deployed by diving bell from the derrick barge. Surface gas divers and the ROV Deep Drone will also be employed during this and the subsequent phases.

Major Resource Used: Saturation Diving System

The benefits of using saturation diving as the primary recovery method are as follows:

- The safest method, based on amount of bottom time expected
- Cost effective
- Twice the working time of surface-supplied and eight times that of SCUBA (Tech Diving)

Major Resource Used: SHIP SHAPE

SHIP SHAPE has been identified as the best method for mapping and documenting the remains of the *Monitor*. This system will allow continuous documentation during all phases of the operation without unnecessarily delaying the recovery efforts. The divers position and video from the divers helmet mounted camera can be combined to provide the information necessary to completely document the wreck site.

The benefits of using SHIP SHAPE as the primary navigation and documentation tool are as follows:

- Precise location of artifacts in three dimensions
- Ability to guide divers and the ROV to exact positions on the wreck site
- Creation of a database incorporating video and text to be used for future conservation and documentation efforts

The purpose of the site survey is to systematically conduct a visual survey of the area around and on the *Monitor* to locate, identify and document materials having an archaeological interest. This information will be used to develop a comprehensive engineering evaluation of the condition of the wreck and establish the selection and location of recoverable artifacts.

The activities to be performed during the Site Assessment phase include:

- Inspect, measure, and map key features or obstructions
- Inspect the entire area for exposed artifacts that can be removed
- Record all observations and measurements which will assist topside in refining the detailed recovery plan

Major Resource Used: Deep Drone

In addition to the survey performed by the saturation divers, the Deep Drone ROV will be employed throughout the operation that will increase productivity.

The benefits of using the Deep Drone ROV include:

- System has previously been deployed to survey *Monitor* site
- Proven Reliability. During TWA Flight 800 recovery, system operated for 14 weeks with less than 30 hours downtime
- Provides constant in-water presence for diver support
- Can assist in rigging and recovering artifacts
- Can provide support for archaeological documentation and scientific investigations of the site
- U.S. Navy asset

3.4 Limited Recovery

Following the site assessment and preparation phase of the operation the next step is the recovery of selected artifacts. These artifacts will have been identified and located in the site assessment phase and the appropriate methods of recovery will have been determined. For this phase of the operation to proceed in the most efficient manner, as much work towards identifying and assigning priorities to artifacts is necessary prior to the start of the recovery operation.

Major Resource Used: Lifting and Rigging Equipment

During this phase of the operation, lifting and rigging equipment from Oceaneering's Upper Marlboro, Maryland and Morgan City, Louisiana offices will be used. The benefits of using these resources are as follows:

- Oceaneering has provided subsea rigging and recovery services for over 33 years, acquiring extensive experience and equipment applicable to this project.
- Oceaneering has the engineering and manufacturing resources to fabricate the necessary custom recovery and preservation equipment

The major activities to be performed during this phase of the operation are as follows:

- Excavate to free artifacts
- Select the appropriate sling and attachments for each item to minimize possible damage to the artifact or the protective marine covering
- Small significant artifacts and materials are to be placed in plastic bags and stored inside the diver's underwater containment recovery box
- Place each artifact in the proper preservation container aboard the vessel. These containers will be built prior to the operation and will be based on input from the archaeologists.
- Document each article by the use of still photos, high resolution video, and data base entry for each item.

<u>Major resource used: Air and water lift systems</u>

Both air and water lifts will be used to excavate and free articles for recovery. The benefits of these methods are as follows.

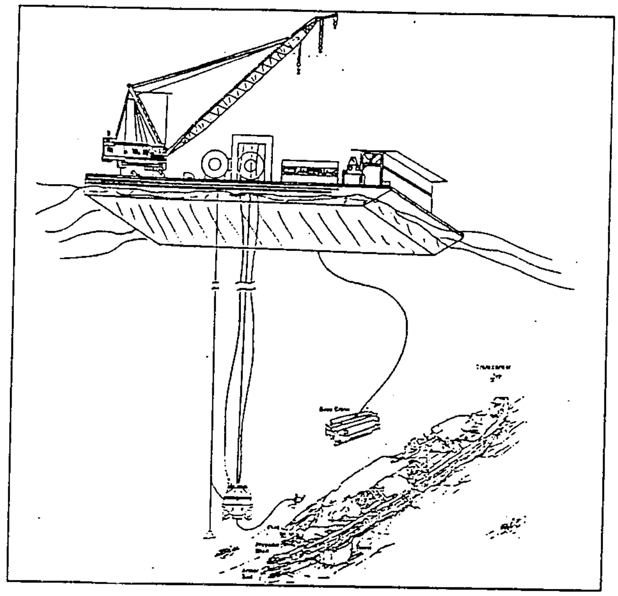
- Air and water lift systems will gently uncover large artifacts so they may be rigged for successful recovery
- Small artifacts indistinguishable as marine growth will be sucked up into recovery baskets, brought on deck, and identified by archaeologists.

Determining the proper type of recovery method to be employed for each artifact in order to reduce the amount of damage done during the excavating and recovery process will be key to the recovery effort. Specialized lifting frames, spreader bars and slings will be needed for many of the larger artifacts. These will be designed and fabricated ahead of time based on existing photograph and drawings of the *Monitor*. In addition to the specialized equipment fabricated prior to the operation it will be necessary to modify and build rigging equipment on site. The necessary raw materials such as steel, wire rope, wire rope termination equipment and welding equipment will be on the barge to rapidly respond to the conditions on site.

Many of the items recovered will be transferred ashore for more extensive preservation than can be performed on board the barge. For this purpose and to provide the logistical support necessary for this recovery effort a crew boat will be used to transport personnel and equipment between the vessel and shoreside facilities.

3.5 Stern Stabilization and Turret Recovery

The objective of this phase of the operation is to recover the turret and Dahlgren cannons to the surface for preservation. The major activities to be performed during this phase of the operation include:



- Install 3:1 concrete mix and sand bags for hull stabilization and support
- Remove stern portion of hull above turret
- Archaeological excavation in vicinity of turret
- Determine location of cannons and if necessary lift them to the surface before attempting to lift turret
- Install supportive lifting frame and rigging
- Lift to surface

Stabilizing the hull prior to recovery of the turret is vital to the turret recovery process and for the long term preservation of the *Monitor*. The steps necessary to accomplish this are as follows:

- Install hull stabilization 3:1 mix/sand bags under the hull and armor belt forward and aft of the turret to support the suspended areas
- Install jacking support frame between 3:1 mix/sand bags and hull
- Jack-up to support hull to remove weight from turret
- Install additional 3:1 mix/sand bags
- Transfers hull weight from jacks to 3:1 mix/sand bag support base

Following the stabilization of the hull the next step is to remove the section of armor belt and hull section on top of the turret. Note: There have been proposals to remove the turret by first sliding it out from under the stern, however, there is evidence that a shield of 4' high 1" thick armor plate was added to the turret after the first engagement and the presence of this armor would hamper the likelihood of the turret sliding out. The steps necessary to recover the turret are listed below:

- Cut armor belt above the turret and recover to surface for preservation
- Clear hull area above the turret to gain access to the turret and the surrounding area
- Remove and conserve artifacts from the outside perimeter and interior of the turret
- Remove sand and debris from around the turret collecting the artifacts
- Excavate sand and artifacts from inside turret

By jetting outside the perimeter of the turret, it will be determined if the rifle shield is present or not. If so, it will present an obstacle to recovery. This information will present two options:

Option 1: No rifle shield

- Jet out areas at opposing sides of turret to install lifting "I" beams
- Install lifting "I" beams under lip of turret
- Install support frame to turret's top
- Install side support frame between top, bottom sections
- Install slings to lifting "I" beam frame
- Gently lift turret to work barge and store in specialized preservation container
- Secure crane to lifting slings and take strain
- Jet out around turret while lifting with crane to facilitate removal
- Store turret in specialized preservation container

Option 2: Rifle shield exists

Note: This method requires that the turret's armor have sufficient side wall strength to support the nylon sling lifting bridles. However, at one location on the turret's armor during an earlier (1987 expedition) corrosion survey the CP probe penetrated 2 to 3 inches, releasing a cloud of corrosion products and scale. This would indicate that the corrosion activities and possible other factors have severely compromised the integrity of the armor plate at this location and the outer armor would not support the turret during the extraction and lifting process without irreversible damage to the turret. In this case it may be necessary to shore up or brace the inside of the turret to handle the loads expected during the lifting process.

- Install nylon sling lifting bridle around turret
- Secure crane to lifting slings and take strain
- Jet out area around the turret while lifting with crane to facilitate removal

3.6 Post Operation Assessment

The objective of the post operations assessment is to continue the documentation of the wreck site begun in the original site assessment with an emphasis on documenting changes in the wreck caused by the recovery efforts. This survey should provide the baseline for assessing the future deterioration of the *Monitor* and assist in the planning of any further conservation effort. All the resources used in the recovery operation will be utilized and this portion of the operation should continue until all the archaeological information necessary has been collected or until weather becomes the deciding factor in terminating the operation.

3.7 Demobilization and Conservation

Immediately upon termination of the operation, the work vessel will recover its mooring system and begin to transit to the chosen port to begin offloading of the equipment. As personnel are no longer needed for this effort, they will be released from the operation. Most of the equipment can be broken down while in transit and be ready for offloading, to begin immediately upon arrival in port. The exception to this is the saturation system and support equipment needed to operate it. The saturation divers will need a little over 3 days to decompress from their working depth of 230 feet.

The conservation effort will have already begun, based on planning by the archaeological and preservation experts.

3.8 Post Operation Report and Recommendations

This report will document the actual operation, cost and artifacts recovered. A comparison between how the operation actually worked to how it was planned to work will be included. Final recommendations for the future of the *Monitor* will be offered.

4.0 COST ESTIMATE

Due to the tentative nature of this operation, assumptions had to be made to provide an ROM cost estimate. The assumption with the greatest impact on total cost is the availability of a work vessel. This proposal assumes a realistic day rate of $24,860 for the vessel featured in Section 3.1. If the US Navy can provide assets that meet the deck space and lifting requirements, a savings of up to $2.8 million will result. A second assumption with significant impact to the operation is adverse weather. A 20% margin for weather down time has been included and could be refined in detailed planning. The last major assumption is that SUPSALV will make available their ROV Deep Drone, which would require funding for mob/demob and personnel only.

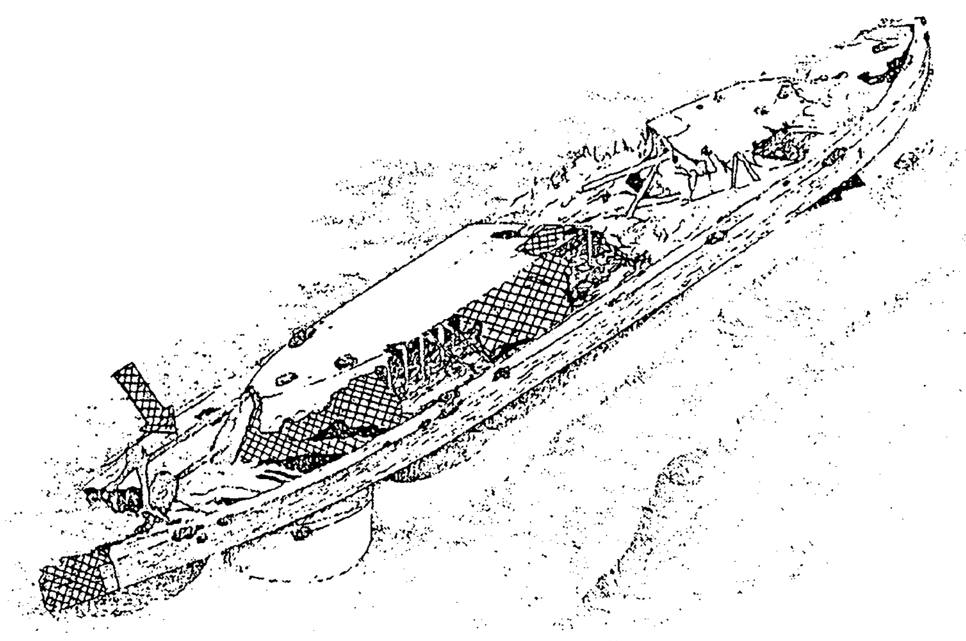
The daily cost of the recovery operation is roughly $70,000. This includes the work vessel, crew boat, all diving equipment, deck crane, preservation equipment, diving operation consumables, and required diving personnel (32). What is not included in this estimate is the day rate of Navy, NOAA, governmental and archaeological personnel.

<u>RECOVERY OPERATIONS TOTALS</u> 18 weeks (sea time) **$9,800,000**

5.0 RECOMMENDATIONS

The success of the emergency recovery, stabilization, and preservation of the *Monitor* project is contingent on the knowledge of the project team, a well developed and detailed Recovery Operations Plan, the proper selection of equipment, and good weather off the coast of Cape Hatteras during the operations. To enhance the success and mitigate risk, the following recommendations are made:

- Generate a list of artifacts by priority to be recovered and preserved. This list should be developed by the National Oceanic and Atmospheric Administration's *Monitor* Sanctuary Manager with input from Section 106 members and be factored into the Recovery Operations Plan.
- Conduct industry search for optimum method for underwater cutting of highly corroded wrought iron and rolled iron armor plate. Trade Studies should be performed based on the information received to select the best method and actual underwater testing conducted to confirm cutting capability on representative samples.



- Determine the location and position of the two 11 inch Dahlgren Shell Guns that were located in the turret, then factor this information into the Recovery Operations Plan for recovery of the turret. These guns and carriages probably came off their tracks as the *Monitor* rolled and capsized. They may have exited the turret before the *Monitor* impacted into the seafloor, stern first; or are contained in or under the turret. Suggest conducting an industry search for ground penetrating acoustic sonar (i.e., sub-botom profiler) that can be used by technical divers with limited bottom time or underwater vehicles of opportunity.

- Prepare a detailed Recovery Operations Plan for the project. The plan development should be a cooperative effort by OOC, NOAA and Oceaneering. Details of the plan should include a day by day schedule of events, personnel, and asset requirements during the pre-planning stage; equipment mobilization; site assessment; recovery of priority artifacts; stabilization of armor belt and hull; recovery of the turret; post-recovery operational assessment; equipment demobilization; and transfer of recovered artifacts and turret to the conservation facility.

These four preliminary recommendations are based on what is considered feasible with the current limits of time and budget. Please review and suggest any other recommendations that would optimize procedures, increase cost-effectiveness and mitigate risk of the recovery operations.

ATTACHMENT A: TRADE STUDIES

A.1 TRADE STUDY #1: Top Level Methodology

OBJECTIVE: To establish a single management option for preservation of the *Monitor.*

METHODOLOGIES:

Method #1- **In-Situ Preservation by Encapsulation.** Method for decreasing deterioration without removing the *Monitor* from its current position. This would include some form of capping that would entomb the *Monitor* (i.e. covering with sand, grass matts, etc.)

Advantages: The *Monitor* would not be as exposed to an oxygenated marine environment or strong currents; the risk of damage due to vessels anchoring and fishing nets would be greatly reduced.

Disadvantages: The *Monitor* would no longer be visible or readily accessible; the responsibility for recovery of artifacts would be delegated to future generations at a much greater cost; eliminating the artificial reef.

Method #2- **In-Situ Preservation by Shoring.** Method of decreasing mechanical deterioration without removing the *Monitor* from its current location. Methods could include sand bags, grout bags, and jacks.

Advantages: Cost; remains visible and readily available for future archaeological work; remains as an artificial reef.

Disadvantages: Won't arrest corrosive deterioration; would require regular maintenance; site exposed to anchoring and fish nets.

Method #3- **Limited Recovery.** This concept includes a selective approach to recovering artifacts that are of significant historic value. An example of limited recovery may include recovery of the propeller, turret, engines, and small artifacts.

Advantages: Displaying artifacts to the general public in a museum; taking control of the deterioration and preservation of the recovered artifacts.

Disadvantages: Disruption of the *Monitor* site; altering the artificial reef.

Table A.2: Recovery Methodology Trade Study

METHODOLOGY	COST		TECHNICAL RISK		TIME		RESOURCES		ENVIRONMENTAL IMPACT		PRESERVATION		HISTORIC VALUE		TOTAL SCORE
	5		8		3		4		4		9		8		
Surface Grab	5	25	7	56	8	24	5	20	2	8	3	27	3	24	184
Cofferdam/Caisson	1	5	2	16	1	3	3	12	2	8	9	81	9	72	197
External Buoyancy	5	25	3	24	5	15	6	24	6	24	7	63	6	48	218
Internal Buoyancy	4	20	4	32	6	18	5	20	5	20	6	54	6	48	212
Direct Lift	6	30	8	64	8	24	7	28	7	28	7	63	8	64	302

Method #5- **Direct Lift**. This method includes the use of traditional heavy lift systems from floating assets (i.e. derrick barge, surface vessel, etc.) using wire or nylon slings. Also includes the use of lift baskets, cages, etc.

Advantages: Flexibility in rigging methods; discretion in item recovery; proven success; ability to calculate safe working loads.

Disadvantages: Lifts subjected to weather; size of recovered object dependent on capacity of lifting asset; requires some form of underwater intervention.

A.3 TRADE STUDY #3: Platform Selection

OBJECTIVE: Select optimum work platform that will accommodate a direct lift of selected items from the *Monitor* for recovery.

METHODOLOGIES:

Method #1- **Jack-up Rig**. Three leg platform capable of jacking up out of the water and out of the effects of surface waves in 240 fsw.

Advantages: Ability to work in very bad weather; stable platform for lifting heavy objects; helicopter pad.

Disadvantages: Limited number of rigs capable of 230 fsw, none on the East Coast; mobilization expense that includes towing vessel; positioning of leg cans around Monitor site; short term lease availability; cost.

Method #2- **Semi-Submersible**. Drill platform that maintains stability by using large submerged hull.

Advantages: Large stable platform to stage operations from; no bottom contact; helicopter pad.

Disadvantages: Availability of such platforms to the East Coast of the US; mobilization expense that includes towing vessel; short term lease availability; cost.

Method #3- **Dynamic Positioning Vessel**. A vessel capable of keeping station without mooring by use of GPS controlled trusters.

Advantages: The ability to work in deep water or sea floors that are sensitive to mooring activities; self propelled; helicopter pad.

Disadvantages: Short term lease availability; cost.

Method #4- **Four Point Mooring Vessel**. A vessel capable of maintaining a sustained moor using anchors.

Advantages: Availability; cost; self propelled.

Disadvantages: Limited deck space; no heavy lifting capability; accommodations; mooring and anchor tug required.

Table A.3: Platform Selection Trade Study

METHODOLOGY	COST 7		TECHNICAL RISK 8		AVAILABILITY 7		STATION KEEPING 9		WORK/STORAGE SPACE 8		PRESERVATION 5		CAPABILITY 7		ACCOMMODATION 5		TOTAL SCORE
Jack-up	2	14	8	64	2	14	10	90	9	72	7	35	8	56	8	40	385
Semi-Submersible	2	14	7	56	1	7	8	72	8	64	8	40	8	56	9	45	354
DP Vessel	5	35	6	48	4	28	7	63	7	56	8	40	7	49	7	35	354
Four Point Vessel	8	56	8	64	8	56	8	72	7	56	7	35	7	49	6	30	418
Derrick Barge	6	42	8	64	6	42	7	63	10	80	8	40	9	63	8	40	434

Method #5- **Derrick Barge.** A barge equipped with a permanently mounted large crane capable of making heavy lifts.

Advantages: Heavy lifting capability; large open deck space for diving operations and artifact preservation efforts; berthing and office space accommodations; helicopter pad.

Disadvantages: Four point moor; availability of such platforms on the East Coast of the US; requires towing and anchoring tug.

A.4 TRADE STUDY #4: Site Investigation

OBJECTIVE: To select the best method of maintaining appropriate archaeological integrity during recovery efforts involving the *Monitor.*

METHODOLOGIES:

Method #1- **No Site Investigation.** Full attention placed on recovery activities without consideration for documenting the location from which artifacts are recovered.

Advantages: Recovery activities are not hampered by site documentation activities; decreased operational cost.

Disadvantages: No archaeological information of historic value is recorded.

Method #2- **Uncontrolled Photo Survey**. This method would include using hat mounted video cameras, ROV cameras (still and/or video), or photographs taken by scientific divers. Logs of precise location will not be recorded.

Advantages: Recovery activities are not hampered; a photographic record is captured for historic purposes.

Disadvantages: No records of precise location where artifacts are recovered.

Method #3- **Controlled Photo Survey**. This method would include using hat mounted video cameras, ROV cameras (still and/or video), or photographs taken by scientific divers. Logs of precise location will be recorded.

Advantages: A photographic record is captured for historic purposes; photographic mosaics and detailed drawings can be later generated from the information gathered.

Disadvantages: Data collection activities may slow recovery activities; additional cost.

Method #4- **SHIP SHAPE.**_ An integrated data management and positioning system for collecting, storing and presenting data that includes: underwater video, thickness readings, diver/ROV position on site and text based information.

Advantages: One integrated system that collects and stores a variety of information; indicates and documents points of interest on site; data collected can be archived and later played back for viewing; later activities can also be added to the database; bottom is relatively flat making an ideal environment for SHIP SHAPE_; minimal impact on recovery activities; system is owned by the US Navy.

Disadvantages: Requires a transponder field; additional cost associated with manning requirements.

Method #5- **Trackpoint**. An acoustical system used for underwater positioning and navigation.

Advantages: Provides for automated positioning of ROV and or divers; minimal impact on recovery activities.

Disadvantages: Replacement and maintenance of system components; erratic coverage; leaves site exposed.

Table A.5: Stabilization Methodology Trade Study

METHODOLOGY	COST		TECHNICAL RISK		ENVIRONMENTAL IMPACT		PRESERVATION		HISTORIC VALUE		TOTAL SCORE
	7		5		3		8		4		
Mechanical Shoring	5	35	7	35	7	21	4	32	5	20	143
Encapsulation	4	28	6	30	2	6	7	56	5	20	140
Ionic/Chemical Stabilization	3	21	4	20	4	12	6	48	6	24	125
Cathodic Protection	5	35	3	15	5	15	6	40	6	24	129

A.6 TRADE STUDY #6: Intervention Methodology

OBJECTIVE: To determine best U/W work system methodology for *Monitor* preservation and recovery efforts.

METHODOLOGIES:

Method #1- **Technical Diving**. This method utilizes advanced SCUBA equipment with tri-mix gases to extend bottom time.

Advantages: Limited support vessel impact.

Disadvantages: Limited working bottom time; No reliable communications with work platform; no video link to surface; high degree of technical expertise; all in-water decompression; high risk of hyperbaric related medical problems.

Method #2- **Surface Gas Diving**. This method utilizes surface supplied gas to extend bottom time and reduce non-productive, in-water, decompression time.

Advantages: Unlimited gas supply; direct audio/video link to surface; safety line back to work platform.

Disadvantages: Increased risk of decompression sickness due to scope of project; limited amount of bottom time; increased cost due to scope of project and amount of bottom time required.

Method #3- **Saturation Diving**. This method utilizes a living quarters and diving bell complex located on the work platform, which is pressurized to the working depth. This habitat provides housing and transportation to the work site for the sat divers.

Advantages: Least risk of decompression sickness; greatest possible bottom time.

Disadvantages: Extensive manning requirements and support equipment required.

Method #4- **ROV**. This method utilizes Remotely Operated Vehicles equipped with inspection, survey, construction and salvage tool packages to complete many sub sea tasks. ROV's are extensively used for a variety of u/w construction tasks in the oil field sector.

Advantages: No direct hazards to operations personnel; nearly unlimited bottom time; rapid surface to site delivery vehicle; lifting capacity.

Disadvantages: Support personnel and extensive equipment required; mechanical failures possible.

Method #5- **ADS**. This method utilizes an Atmospheric Diving Suit (ADS) to enable a trained operator to work in water depths to 2,250 fsw while remaining in surface-pressure environment, eliminating decompression time.

Advantages: No limitations related to decompression requirements.

Disadvantages: Limited dexterity for conducting detailed mechanical operations; currents may inhibit work productivity.

Method #6- **Combination:** A combination of surface support diving, saturation diving and ROV.

Advantages: Flexibility to handle most contingencies; multiple back-up systems; allows sat divers to concentrate on recovery tasks.

Disadvantages: Cost; deck space required.

Table A.6: Intervention Methodology Trade Study

	COST		TECHNICAL RISK		WEATHER/ PRESERVATION/RECOVERY		SUPPORT VESSEL IMPACT		TIME (BOTTOM TIME)		RESOURCES (PERSONNEL)		AVAILABILITY		TOTAL SCORE
METHODOLOGY	7		8		7		5		8		6		5		
Tech. Diving	6	42	2	16	4	28	9	45	2	16	6	36	6	30	213
Surface Gas Diving	6	42	7	56	7	49	7	35	5	40	8	48	9	45	315
Saturation Diving	7	49	7	56	7	49	6	30	9	72	8	48	9	45	349
ROV's	8	56	5	40	6	42	6	30	10	80	9	54	8	40	342
ADS	7	49	6	48	5	35	6	30	8	64	6	36	6	30	292
Combinations	7	49	8	64	7	49	5	25	10	80	8	48	8	40	355

EVALUATION: Score is from 1 - 10 with 1 being least desirable and 10 being most desirable.

Appendix B
Summary of the Conservation Plan

Preliminary Conservation Plan for the Major Components and Artifacts from the *Monitor* National Marine Sanctuary

By: Herbert D. Bump and David L. Johnson
International Artifact Conservation and Research Laboratory, Inc.
P.O. Box 91
Belle Chase, Louisiana 70037

Artifacts targeted for possible recovery include the heavy iron turret with its two 11-inch Dahlgren cannons and custom-built carriages. Also targeted are the propeller, the unique engine and its associated components, and most of the auxiliary machinery such as pumps, blowers, condensers, and valve mechanisms. The turret probably contains many discarded sea bags containing the personal effects of the crew as they attempted to abandon ship during the sinking.

All artifacts recovered from long exposure to sea water require a conservation stabilization treatment in order to prevent their disintegration when exposed to air. Some treatments require that the artifacts be placed in large treatment tanks with electrical current to extract corrosive salts. Others incorporate chemicals that prevent shrinkage and distortion of wood and other materials when they are dried. These stabilization processes sometimes require a number of years for completion and also require specialized equipment and personnel trained in conservation sciences. Several conservation methods may be employed for artifacts recovered from the *Monitor* Sanctuary.

Conservation Methods

Electrolysis

For most metal artifacts, including wrought or cast iron, copper, brass, bronze, tin, pewter, or silver, the method of choice will probably be electrolysis. Metals in sea water are corroded by the corrosive action of oxygen, chlorides, sulfur-reducing bacteria, and the galvanic action between the different elements that make up the metal or dissimilar metals in contact with it. Over time, chlorides and other water-borne ions (carbonates, sulfates, etc.) migrate into the porous cavities and voids present in cast and wrought metals. If not removed after recovery from the ocean, these chemicals will cause the artifact to corrode even if the exterior has been cleaned and freshly painted. On drying out, the corrosion products will expand, which causes the artifact to crack, which in turn will lead to sections falling away. Over time, the artifact may become unrecognizable. Electrolysis treatment is one of the most effective methods used to remove these chemicals and to stabilize metallic artifacts.

The Monitor*'s anchor before electrolysis treatment (NOAA)*

Electrolysis is an oxidation-reduction reaction requiring six components when treating artifacts. The component parts are the metallic artifact, a suitable tank to hold the artifact, an electrolyte solution, suitable anode(s), and a dc power supply. When the system is set up correctly, the electrical current (as charged positive ions) travels from the positively charged anode through the electrolytic solution to the negatively charged artifact. This causes the chloride molecule to break down into negative charged ions. Since opposite charges attract, the chloride ion migrates out of the artifact, through the electrolyte toward the positively charged anode. Any iron ions (positively charged) remain behind with the negative charged artifact. This process removes the corrosive chloride ion from within the artifact, where it would cause disintegration. Chloride removal from the artifact can be monitored by measuring the increase in the chloride concentration in the electrolyte solution.

Upon completion of the electrolysis treatment and after the electrolyte has been removed from the artifact, it is necessary to coat the artifact to protect it from atmospheric corrosion. The coating is applied after appropriate surface cleaning has taken place. A different coating system is required for an artifact retained in storage than for one that is placed in an out-of-doors exhibit, or put on display in a museum. The type of coating and the surface preparation for the coating must be determined by the conservator after the decision as to the disposition of the artifact is determined.

Consolidation

For waterlogged wood and other organic materials, a method known as consolidation, or chemical impregnation, will be used. This treatment is required to remove contaminates (salts) and prevent shrinkage of the artifact when the water is removed. The first phase of treatment requires that the organic artifact be soaked or washed in fresh water for extended periods to ensure the salt water has been removed from the fabric of the artifact. Chloride monitoring of the wash water is used to determine when a water change is required and when this phase of treatment is completed.

Once the soaking has removed the sea salts, the artifact can begin the second phase of the treatment, which consists of impregnating the fabric of the artifact. Since long exposure to water will cause the cell walls of most organic materials to weaken, a consolidant or bulking agent is needed to impregnate and fill the voids between and within the cell walls. This bulking provides dimensional stabilization and inhibits shrinkage when the artifact is dried.

Polyethylene glycol (PEG) is one of a number of water soluble consolidants that can be used. It is one that has performed well in other shipwreck conservation projects. The facility conservator will need to determine the proper type of consolidant to use for each artifact recovered.

Typically water soluble consolidants are introduced at increasing concentrations over extended periods of time. Consolidation treatment is ended when testing concludes that the treating agent has penetrated the object as far as possible. The final phase of treatment is the drying or water extraction phase. It has been found that freeze drying is the best procedure to remove water from most artifacts that have been treated with chemical consolidation. The size of the artifact that can be treated by freeze drying is dependent on the chamber size of the drying unit.

Freeze Drying

Water is removed from an artifact in a freeze dryer by sublimation. The consolidated artifact is first frozen so that any remaining water is turned to ice. It is then placed in the freeze drying chamber with appropriate support to prevent distortion. The freeze dryer is a vacuum chamber that controls the temperature of the treating chamber so that the water in the artifact goes directly from a solid state to a gaseous state without going through the liquid state. Since water is not in the liquid state when it is extracted, the solidified consolidant mitigates shrinkage and distortion to the fabric of the artifact.

The size of the artifact that can be treated is based on the chamber size of the freeze dryer. A chamber large enough to treat the wooden cheek plates of the cannon carriages of the *Monitor* are practical (48" diameter x 72" long). A unit larger than that would lose efficiency and other means of drying should be explored. Larger wooden timbers should be fully consolidated after documentation and then dried over extended periods of time in chambers or rooms that slowly have the relative humidity reduced. Some shrinkage may need to be tolerated in order to treat large timbers.

Hydrogen Reduction

Hydrogen reduction furnaces used in marine iron conservation are electrical furnaces which have provisions for heating objects in a hydrogen atmosphere. The size of the artifact treated is determined by the size of the retort or chamber of the furnace. Since hydrogen is one of the most active elements known, it only takes heat, in a controlled environment, for it to combine with oxides and corrosive chemicals to reduce them back to their basic elements. Rust or iron oxide can be reduced back to metallic iron in a hydrogen reduction furnace. This process is beneficial for cast iron artifacts that are composed totally of iron oxides as these can be reduced back to stable metallic iron. Corrosive compounds in the artifact are vaporized out or combine with the hydrogen forming chemicals that vaporize off and are eliminated from the furnace.

Composite Artifacts

Unfortunately, there is presently no treatment procedure acceptable to most conservators for simultaneously treating composite artifacts of wood and iron. The treatment techniques for iron are not effective if treatment cannot occur on all sides of the iron. Wood in contact with iron prevents treatment at the contact points. The electrolyte is also absorbed by the wood and would need to be removed prior to consolidation of the wood. Additionally, in some iron electrolyte treatment solutions, the alkaline pH can be destructive to the wood. Likewise, consolidation solutions used to treat wood can be corrosive to iron that is left attached to wood. Attempts to clean and separate these components and treat each independently are recommended. After treatment the component parts can be reassembled.

Cleaning and Documentation Requirements

In addition to conservation of the artifacts, it will be necessary to clean each artifact cautiously to retrieve any and all information that may be present. Concretion or marine growth should be removed only after it has been recorded and samples have been collected and preserved for identification. Organic artifacts will typically go through a wash/soaking process to remove salt water from the fabric of the artifact. Inorganic artifacts such as ceramics will also require washing and soaking for salt removal. If sea salts are not removed, the glazes on ceramics can spall off as the salts crystallize under the glaze layer during drying. Since sea water has a different specific gravity than fresh water, the soaking process for ceramics is done over time by slowing increasing the proportion of fresh water to salt water until all freshwater is used.

All treatment steps should be fully documented by measurement, drawing, and treatment description as well as photographic and video documentation. Electronic record keeping should be utilized to compile the records being generated and store the drawings and sketches generated for each artifact.

For artifacts undergoing electrolysis treatment, only a carefully cleaned small area is needed in order to fasten the electrolysis lead to the artifact. After it has been in electrolysis for a few weeks, it can be removed, washed, and all loose encrustation removed. If any information is disclosed at this time, the findings should be documented by measurement, drawings, and photographic techniques. Data concerning the full treatment process to date should also be recorded. The artifact should then be returned to treatment for a few more weeks and the same process repeated until all concretion is removed. This sequence is continued until the artifact is stable and all information concerning its treatment process has been documented.

Facility Requirements

Conservation of the *Monitor* artifacts under consideration will require a building or group of buildings that have a floor area between 12,000 and 15,000 square feet. The minimum area required to provide electrolysis treatment alone is 4,000 square feet. The additional area is needed for the consolidation treatment of organic materials and the disassembly of component parts (e.g. disassembly of engines and pumps). Closed off areas that can be used as grit blasting and water blasting/cleaning areas are also required. An area to house a hydrogen reduction furnace and a dust-free paint room plus a room to house a freeze dryer and an environmentally controlled storage room are needed. A documentation room with photo laboratory and an office must also be included. The square footage requirement of each area will be discussed below. A single large facility is favored over multiple smaller ones because a large internal crane system is needed to move the heavy *Monitor* artifacts. Multiple facilities will require redundant lifting equipment in each facility.

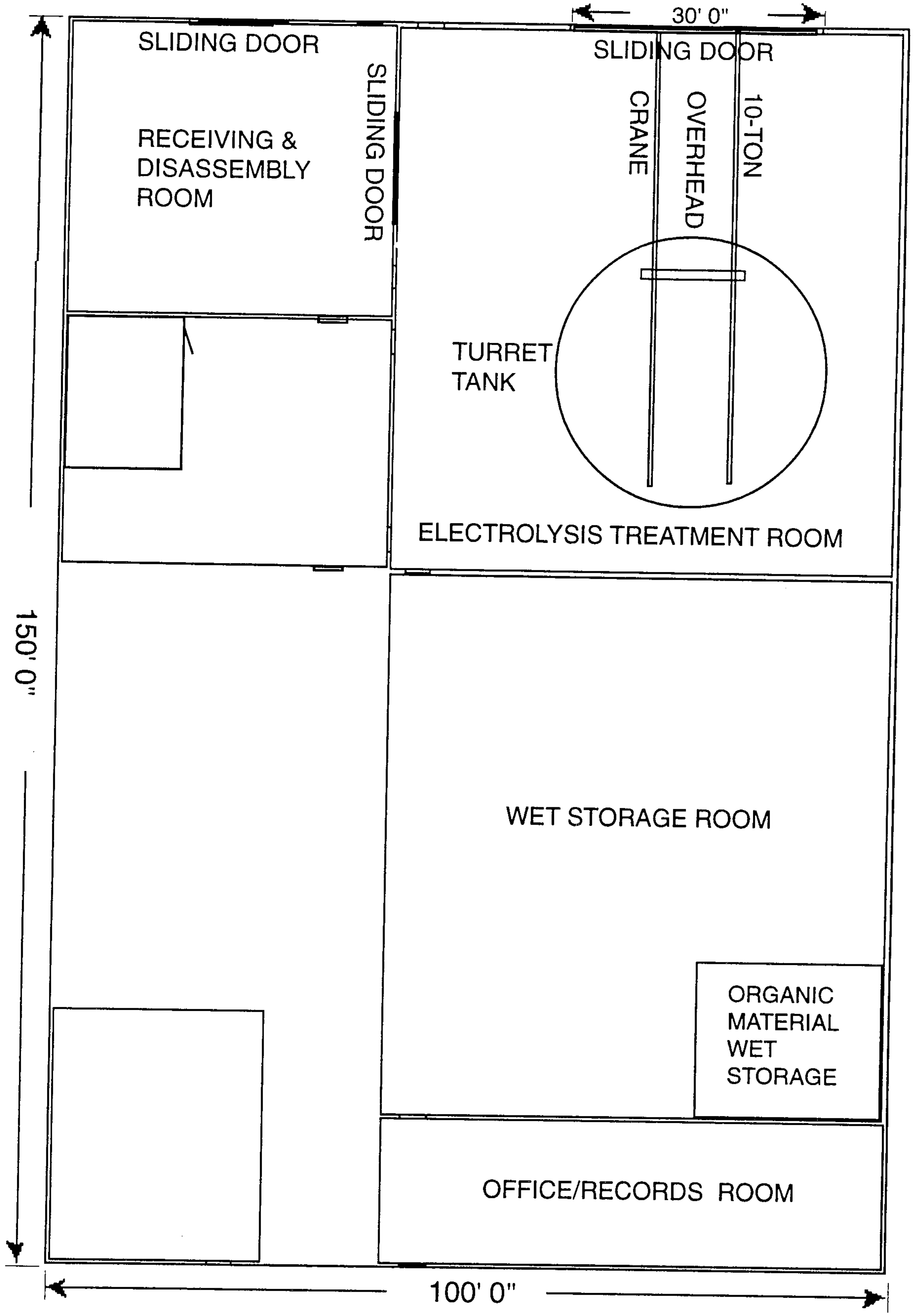
The facility should have a large doorway that can be opened to a minimum of 24 feet. The door should not interfere with the operation of the overhead crane needed to move heavy iron artifacts about the facility. A minimum of a 10-ton overhead crane system integral with the building will be required.

The treatment tanks should be designed integrally into the design of the building as a number of them should be submerged into the floor of the building to reduce the height above the floor. The sunken tanks can be covered over with flooring once treatment is complete and also utilized for equipment storage. The turret treatment tank and fabricated steel tanks not exceeding 6 feet in height can be placed above the floor and moved as needed.

Wet Storage Requirements

The wet storage is estimated to require about 4,000 square feet. The electrolysis tanks should be utilized for wet storage until the artifacts are prepared for treatment. Organic material wet storage is estimated to be about 450 square feet.

Objects that are made up of metallic components fixed to organic components should be held in wet storage until the items can be cleaned and the metallic components removed from the organic components. The organic material can then be transferred to consolidation treatment tanks and the metallic to electrolysis treatment tanks.



Monitor Conservation Laboratory: Preliminary Floor Plan

Treatment Tanks Requirements

The electrolysis treatment tanks should consist of a large number and a variety of sizes to accommodate the various listed *Monitor* artifacts. The large artifact tanks should be 18 to 24 inches larger on all sides than the artifact to be treated. The tanks should not have drains as the electrolyte will be transferred in and out of the tanks via submersible or self priming pumps. Drains are always a source of leakage and are therefore to be eliminated. Tanks over six feet deep, other than the turret tank, should be submerged in the floor of the conservation facility. The walls of the tank should extend 24" above the floor. All submerged tanks should be sloped so that all the electrolyte will drain to one corner where an 18-inch-square by 12-inch-deep sump has been placed during the fabrication of the tanks. These tanks are of poured concrete as is the building foundation and should be internally coated with 16 mils of coal tar epoxy. The sump and sloping of the bottom of these tanks should be integral with their design and fabrication.

Tanks of six feet or less in depth should be fabricated from steel plate with 2-inch angle iron reinforcement on 36-inch centers. The tanks should have a 12-inch-square by 5-inch-deep sump in one corner and should be fabricated on top of 6-inch "I" beam runners on 18-inch centers. The plate on the bottom of the steel tanks should be one quarter inch thick. The plate on the sides of the tanks should be 3/16 of an inch thick. All steel tanks should be internally and externally sand blasted and coated with 16 mils of coal tar epoxy. Four lifting pad eyes should be fabricated into the upper four corners of these tanks.

The largest tank will be a 30-foot-diameter by 12-foot-deep round modular bolted tank that is commonly used in the oil industry. This tank will be used to treat the turret of the *Monitor*. The turret can be placed over the assembled floor of the tank and the tank walls can then be assembled around the turret. After the turret has been treated the tank walls can be taken apart, stacked, and stored. The tank walls can also be removed periodically to facilitate the disassembly of the turret if that is deemed necessary to its treatment. This tank should be of galvanized steel and the internal surfaces factory coated with a coating compatible with the electrolyte.

As soon as the turret is removed from the sea and assessed, a decision should be made as to whether to disassemble it immediately or decide if it needs to be treated and later disassembled. If the decision is to begin treatment prior to disassembly, construction of the turret tank floor should begin immediately. If immediate turret disassembly is required, then numerous tanks should be fabricated to accommodate the turret plating and the 30-foot-round tank will not be required. The treatment area designated for the 30-foot tank in the treatment facility can then be occupied by the tanks required to treat the turret plating.

Numerous smaller table top tanks that are approximately 24 inches wide by 30 inches long with a depth of 24 inches will be required to treat small recovered artifacts and component parts of the larger objects. These can be plastic tanks that are readily available in most houseware store departments.

Electrolysis treatment systems utilize a large amount of water. Collection, storage, and utilization of rain water from the roof drain system of the facility building should be considered. This will reduce area run-off and reduce water treatment costs for the facility. The estimated area requirement for the electrolysis treatment tanks is 4,000 square feet.

The consolidation treatment tanks should be thermally insulated tanks with covers or lids. They are typically fabricated from one-inch marine plywood that has been reinforced with wooden timbers appropriate to the size of the tank. The exterior of the tank should be insulated with one-inch of Styrofoam sheeting and then an outer layer of one inch plywood. The interior and exterior sides of the tank should be sprayed with reinforced fiberglass to a minimum thickness of 1/8 of an inch. The tanks should have a fluid heating, circulation, and filter system. Plumbing fitting to facilitate the circulation of the fluid should be designed integral with the tank. Tanks without the heating and fluid circulation system will be required to provide wash /soaking of wood artifacts prior to consolidation treatment and will be of the same design. This would allow their conversion into consolidation treatment tanks if required. The estimated area requirement for consolidation treatment is 450 square feet.

Ventilation Area Requirements

The ventilation system should incorporate large fans that should be designed to change the air in the entire facility every thirty minutes. The fans should have speed controls so that they can be run on either low or high speed. The electrolysis treatment area will not have climate control other than ventilation with outside air and heat for winter. The building should be insulated to retain heat during the winter to prevent water lines and artifact storage tanks from freezing.

Time Requirements for the Conservation of Major Items

The 22' Diameter by 9' High Turret of the *Monitor*

It is hard to estimate the conservation difficulties that may be involved with this artifact. The 8 inch thick turret is made up of eight layers of plate with a nominal thickness of one inch each. Each layer is made up of numerous plates bolted together using hundreds of bolts. The internal three layers have additional fasteners between the bolts holding them together. To adequately treat all plates, the turret may need to be disassembled and each plate and fastener individually treated. Disassembly and treatment time for the iron will conservatively take five to six years and assembly after treatment may require an additional twelve to eighteen months.

The Turret Contents (general list of anticipated contents)

- Interior Structural Elements (framing beams, bracing, gunport pendulums, etc.)

It is difficult to estimate this time requirement without knowing the actual number of artifacts involved, but it would not be unreasonable to estimate the treatment time requirement to be about three years. The time will differ according to the size and complexity of each component part.

- Two 11-inch Dahlgren Smoothbore Cannons

Each cannon will require a treatment time of between three and four years due to their size and mass.

- Two Metal-Wood Composite Carriages for *Monitor* Cannons

These objects are labor intensive, as the treatment for the wooden components will require about five to seven years for washing and consolidation treatment. This will be followed by twelve to eighteen months for drying and assembly. The iron components may require two to three years of electrolysis treatment and will need to be held in storage until the wooden components are completed.

- Artillery Items (Worm, Sponges, Rammers, etc.)

These are typically composite artifacts made up of wood, iron, and fibers (the sponge head). Soft reamers of heavy rope may also be present. The treatment time for each component part may vary from 30 days for small iron components to a few years for the organic components.

- Personal Items (discarded sea bags with clothing, etc.)

The personal items may contain an array of organic as well as inorganic materials, all of which the facility must be able to treat. These artifacts may include items made from bone, ivory, tortoise shell, leather, glass, ceramics, and wood. The textiles found may be either animal or plant fibers in origin. The items may also contain metallic materials. Many techniques will need to be employed to clean, stabilize, consolidate, and dry each item. The time required to treat these objects will vary from a few weeks to several years for each item.

The Propeller and 6' Section of Shaft

The propeller of the *Monitor* may be a fragile artifact. Much of its iron mass may have graphitized, leaving it soft and brittle. During the treatment process, the section of the shaft should be removed from the propeller hub in order to fully treat the two components. Marine shipwreck objects of similar age and material have required four to five years for treatment.

The Engine and Associated Fittings, Valves, and Gages (not the boiler)

The engine of the *Monitor* is made up of many component parts. It will contain components made of cast and wrought iron, brass, copper, and lead. Additionally, fiber packing will most likely be found under the piston rings, around the water pump piston, and at other shaft sealing joints. During the treatment process the engine will need to be disassembled and these component parts properly documented and treated. The different materials will require different treatment techniques in order to fully stabilize each part. The engine will then need to be assembled for display. For an engine of this size one to two years of treatment is required to clean and loosen parts so disassembly can take place. Once disassembled, the iron parts may require an additional three years of treatment. The other component parts will require less time. After all treatment is complete, the assembly of the engine may require 6 to 12 months as armatures may need to be fabricated to support the engine and parts too weak to support themselves. Additionally, parts that have totally disintegrated in the ocean may need to be reproduced in order to rejoin two existing pieces. The engine is therefore expected to require about six years of treatment.

The Auxiliary Machinery and Equipment

- Condenser Box and Valve Mechanism

The condenser box and valve mechanism would require treatment similar to the engine as described above. Since these components are smaller in size, a shorter treatment time would be expected. The condenser box and valve mechanism would require about four years of treatment. If support armatures and reproduction pieces are necessary to aid in assembly, then additional time in the facility will be required.

- Forced-air Blower, Leather Belt, and Auxiliary Steam Engine

The forced-air blower, leather belt, and auxiliary steam engine would have the same requirement as the condenser box listed above. Similarly, these components would require about four years to complete treatment.

- Bilge Pumps

The bilge pumps would have the same requirement as the condenser box listed above. Similarly, these components would require about three to four years to complete.

- Bilge Strainer Box and Connector Piping

The bilge strainer box and associated piping would have the same requirement as the condenser box listed above. The component parts are less numerous and therefore a shorter treatment time can be expected. It is estimated that about two years will be required to complete treatment of these objects.

From the above estimates it can be seen that many of the parts may require at least 6-years of treatment. Since not all objects can be handled at one time, the need for wet storage is very apparent. It may take up to a year or two before some objects can begin the treatment process. Some of the large artifacts may require additional treatment to ensure that chloride removal has taken place and the artifact is as stable as possible. It would not be unreasonable to estimate that the conservation plan for the *Monitor* must be at least a 10-year project. At the end of the treatment phase, a part of the facility can be converted to exhibition space, while part is still retained for collection storage and a downsized treatment facility.

Building and Annual Cost Estimates

- Facility Cost Estimate

The estimated cost for the minimum recommended facility of 12,000 square feet is approximately $1,200,000. This price is based on an average of $100 per square foot for construction cost. Some areas within the building should not cost that amount per square foot since they are only a concrete floor within an insulated prefabricated building with heat for the winter. However, other areas within the facility such as the artifact storage room, office, freeze dry room, and documentation room will require environmental controls and would be enclosed with the main facility building. These areas may require building costs in excess of $100 per square foot. Depending on design, the facility construction cost is estimated to be between $1,000,000 to $1,500,000 with no allotment for land costs.

- Equipment and Supplies

A 10-ton beam crane system needs to be built into the building and has an estimated cost of $100,000. The other equipment listed in the first section of this plan have an estimated value of $300,000. This cost includes the electrolysis tanks and equipment as well as all of the additional equipment needed to document and treat the recovered artifacts. The start-up cost for treatment chemicals is estimated to be $100,000. This includes the electrolyte that will be required to charge the treatment tanks for the first year. Chemical cost from then on is estimated to be approximately $50,000 per year. The total cost for equipment and supplies is estimated to be $500,000.

- Personnel

The facility will require a staff of eight personnel. This will need to include a lead conservator, two assistant conservators, a graphic illustrator who is familiar with all forms of documentation, two facility laborers, a laboratory assistant, and an office secretary for data entry. Estimated total cost with benefits is estimated at $350,000 per year.

- Annual Operating Cost

The annual utilities cost of the facility is estimated to be $50,000 per year. This covers power, water, phone, and any other utilities that may be required. Therefore the operating cost is estimated to be between $450,000 to $500,000 per year. This cost is made up of the total estimated annual personnel cost, annual estimated consumable chemical cost, and the annual estimated utilities cost.

- Additional Funding Requirements

Additional funding should be included for contract services such as hydrogen reduction treatment for large components and specialized consultants for unique conservation problems. Membership in professional associations and participation in conferences dealing with shipwreck and waterlogged artifacts will also be necessary. These associations will allow the staff to stay on the cutting edge of the technology and solve some of the complicated conservation problems that occur in a project such as this. The staff may also need to maintain a web site to disseminate information to the public and the object conservation community. An additional cost of $25,000 per year is recommended to meet these requirements.

- Total Estimated Cost

Conservation for a project of this size will require 10 years to complete. The total building, staffing, and operating cost for the 10 years is therefore estimated to be between $9.5 and $10.5 million.

<u>Physical and Environmental Concerns</u>

Any object removed from the ocean after years of exposure to sea water will be saturated with chlorides. The conservation treatments described above have been successful in stabilizing these artifacts for museum exhibit. Iron in the metallic state is never stable as oxygen and moisture can activate corrosion of the iron. Coatings put on iron objects after treatment are used to inhibit atmospheric corrosion and should be inspected and repaired as needed. They must be reversible in case re-treatment of the artifact is necessary. Even after long-term treatment, some residual chlorides may still be present in some artifacts. If chloride leaching is evident on any artifact, the artifact should be returned to the facility for additional treatment.

Periodic Examinations

Periodic examination is necessary to mitigate any damage that may occur on artifacts. Full stabilization is never attained for any object and that applies to artifacts as well as newly fabricated objects. All materials are corroded in some fashion by the atmosphere, light, molds and fungi, and other degrading actions. Periodic examinations are necessary to detect this degradation so corrective actions can be taken. For the first year after treatment the objects should be inspected at monthly intervals for the first six months and then every three months if no major problems are found. After the first year, inspection at six month intervals for objects placed on display would not be deemed excessive.

Maintenance and Other Considerations

If problems are detected, the object should be sent back to the treatment facility. The facility conservator must then determine if the object or component part of the object must be re-treated totally or given additional treatment.

Atmospheric degradation is mitigated through the use of environmental controls in the exhibit and storage areas. Exhibited artifacts should be maintained in an environment with a temperature at about 70 degrees Fahrenheit and a relative humidity of about 50%. In storage areas the relative humidity should be lowered to 45%, plus or minus 2%, and the temperature should be held at 70 degrees Fahrenheit, plus or minus 2 degrees.

Site Recommendation

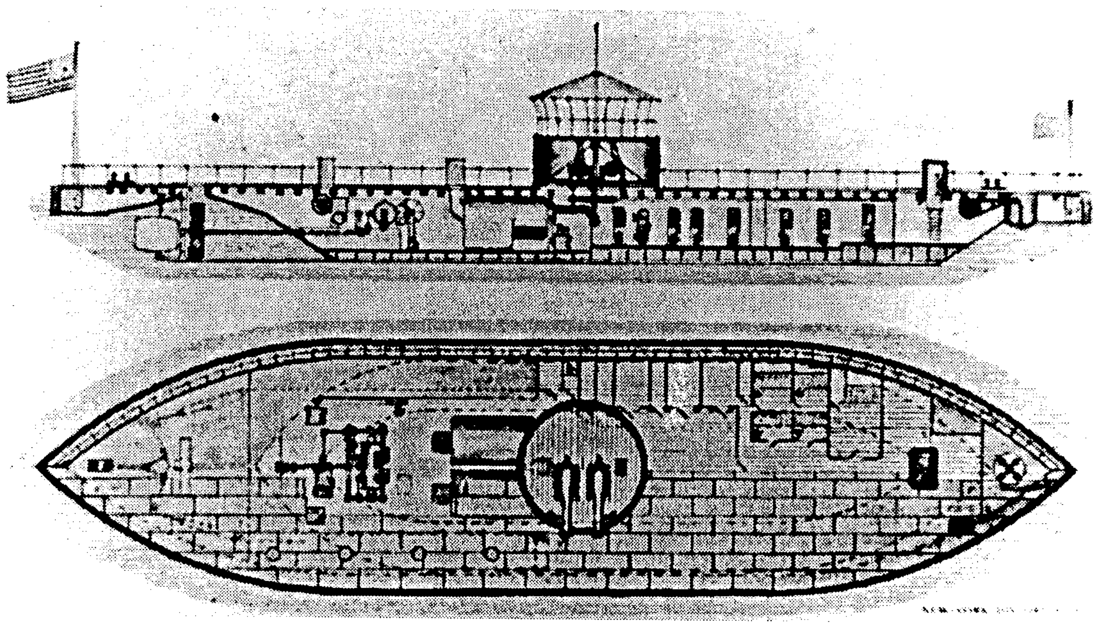
Presently no facility exists in the United States with the capability to treat the artifacts of the *Monitor* that are listed for possible recovery. Other facilities exist that could perform treatment on the smaller components, but no facility presently has the capacity to treat the turret, engine, and other large machinery pieces. It will require a specially built facility as outlined above. After visiting The Mariners' Museum in Newport News, Virginia, in July 1997, the authors of this report recommend that the Museum be considered for the following reasons;

Location

- The Mariners' Museum is within a few miles of Hampton Roads, the famous battle site where the USS *Monitor* fought the CSS *Virginia* (ex-*Merrimack*) on March 9, 1862.
- The Museum is located on a 550-acre park that has ample room to house this facility at no cost. No land cost has been calculated into the construction costs included in this document.
- The Museum is located close to docks to receive the *Monitor* artifacts after recovery.
- Many fabrication contractors are located nearby to service facility needs (naval ship yards, etc.).

Facilities

- The Museum has security systems already in place. The cost estimate in this document has no allotment for security and additional funds would be required if the facility was placed at another location.
- The Museum has some existing treatment tanks to augment the requirements of the facility.
- The Museum has additional lifting equipment onsite to augment the requirements of the facility.
- The Museum has existing storage facilities to take any overflow produced by this project.
- The administration personnel that manage the *Monitor* National Maine Sanctuary are located on The Mariners' Museum property.



Builder's Plan of the USS Monitor, 1862

J. Ericsson's Armor Vessel

[National Archives, Record Group 45, Subject File AD]

Weight as amended by sketch & letter of 21 Oct. 1861.

Contract

Iron in Construction of Vessel	142 1/2 tons
Wood in dº dº	137 1/2 "
Total Weight of Armor	335 "
Two 11-inch Guns & Carriages	25 "
Ammunition	40 "
Stores	15 "
Engines complete (400 Horse Power), Boilers with water, & coal bunkers	125 "
Eight days' Coal (4 lbs per hour per Horse Power)	137 "
Blowers & Engines with pipes, & Donkey Engine	10 "
Windlass, capstan, anchors, cables, hawsers, railings	20 "
Officers & Crew, with their effects, provisions, watertanks with water, interior fittings for cabins & crew	50 "
Masts, Spars, Riggins, Boats, Davits, Accommodations, furniture, Galley, Cooking appliances & utensils, &c.	70 "
Weight Total	1107 Tons
Displacement at 10 feet draft of water	1038 Tons
Surplus Weight	69 Tons

At 10 ft draft of water, the vesel's deck would be 18 inches above water-line. The above Surplus Weight increases the draft $\frac{6}{1383}$ ins = 5 in thus bringing the vessel's deck down to 13 inches above the water line.

(Nov 11th 1861)

Weights and Dimensions of Hull Components

Propeller:	Diameter -	9.0 feet
	Hub length -	2.0 feet
	Weight (est) -	4015 pounds
	Material -	Iron
Shaft:	Length * -	17 feet from propeller to coupling
	Diameter -	9 inches
	Weight (est) -	3740 pounds (~ 220 pounds/foot)
	Material -	Wrought iron
	* Shaft length to coupling	
Skeg:	Length -	25.5 feet
	Width -	Approx. 6 inches
	Weight -	Approx. 5000 pounds
	Material -	Wrought iron
Rudder:	Height -	6 feet
	Width -	7 feet
	Thickness -	Approx. 6 inche
	Stock size -	10 feet x 4.5 inches diameter
	Weight -	Estimated at under 4000 pounds
	Material -	Iron and wood
Turret:	Height -	9 feet
	Outside diameter -	21 feet 6 inches
	Thickness -	Approx. 8 inches
	Weight * -	126.3 tons
	Material -	Wrought iron
	* Weight includes both guns and carriages	

NOTE: The above weights include an extra 10% to account for the weight of corrosion products and marine fouling growth; however, corrosive deterioration of the iron has, in all cases, reduced metal weight. Therefore, the above weight estimates should be "worst-case" values.

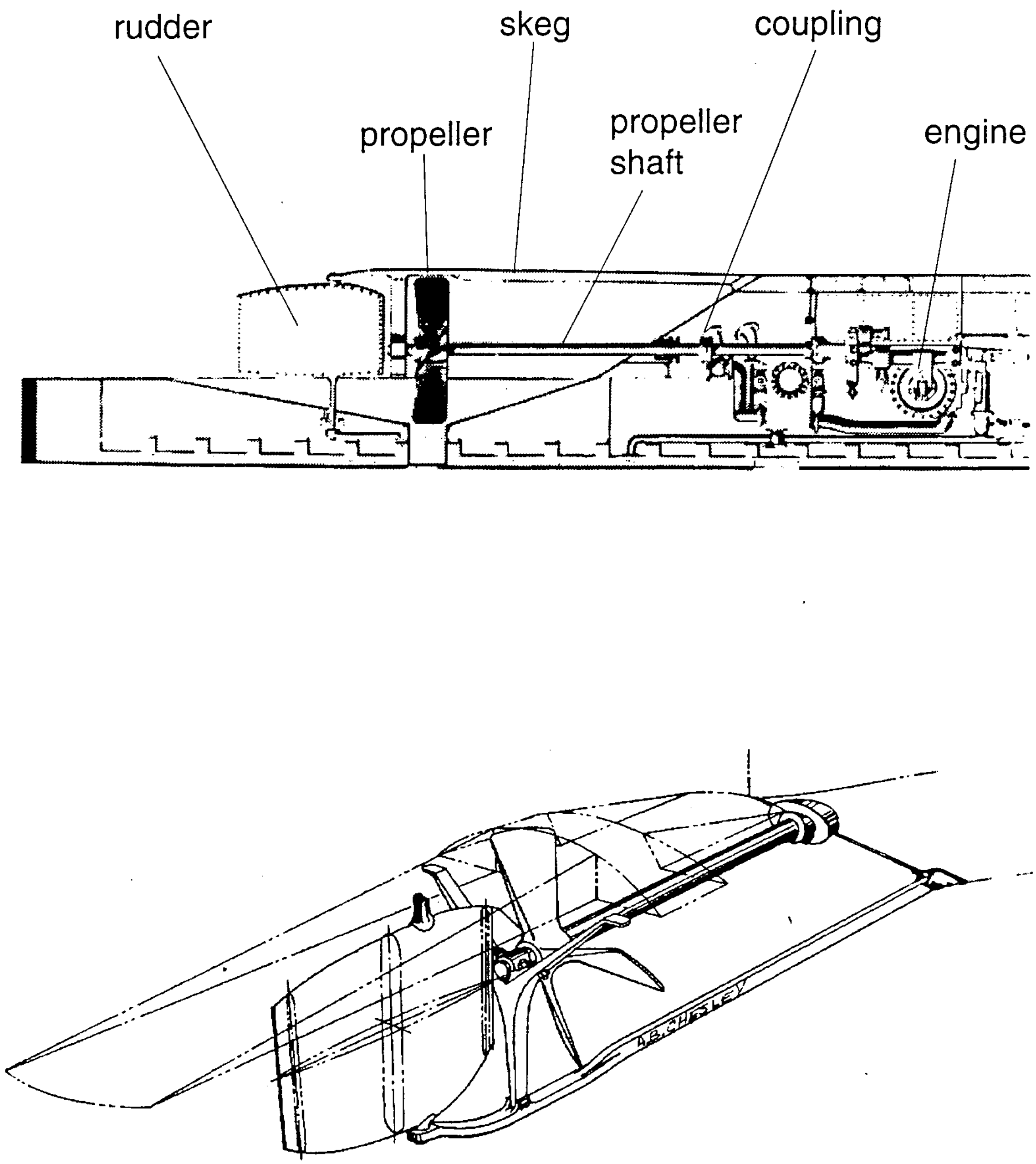


Figure C.1. Profile and perspective drawings of skeg, propeller, shaft and rudder.

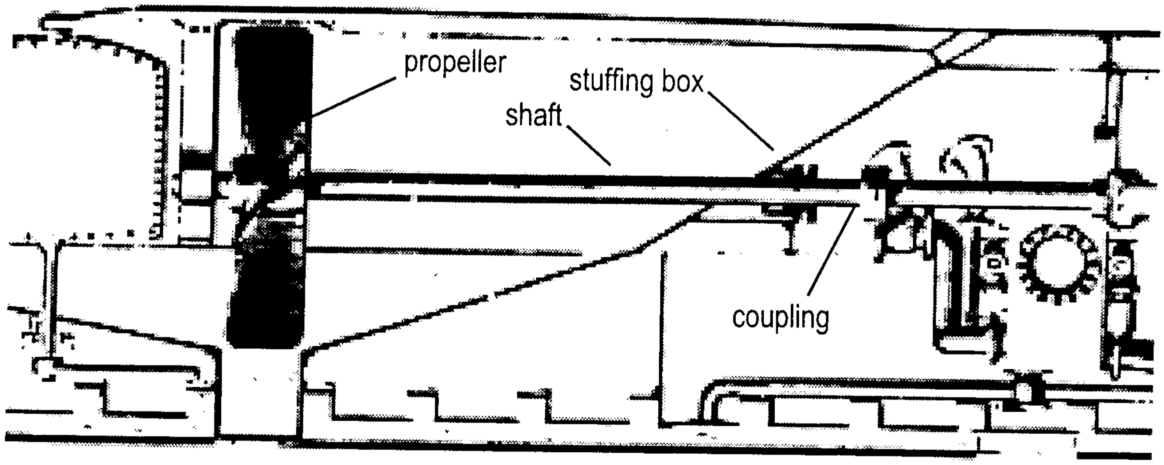


Figure C.2. Propeller, shaft, coupling and stuffing box

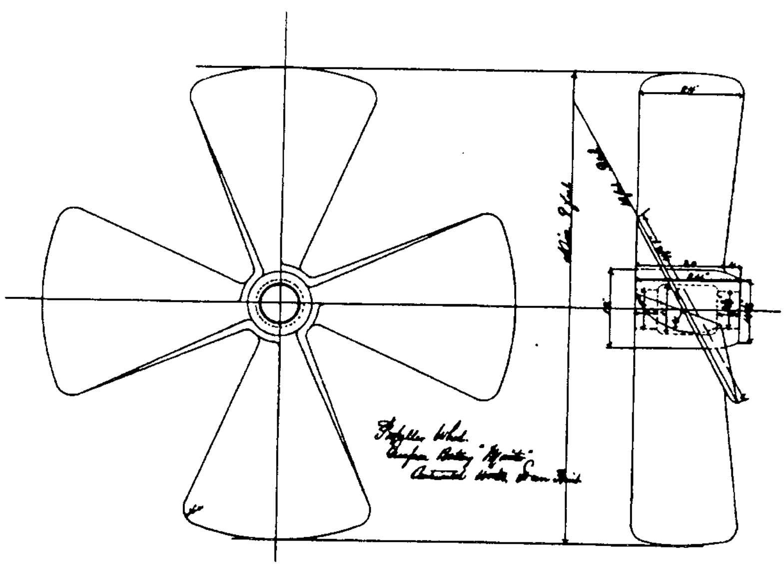


Figure C.3. Monitor's Propeller
(diameter 9.0 feet)

Appendix D
Detailed Description of the *Monitor* Site

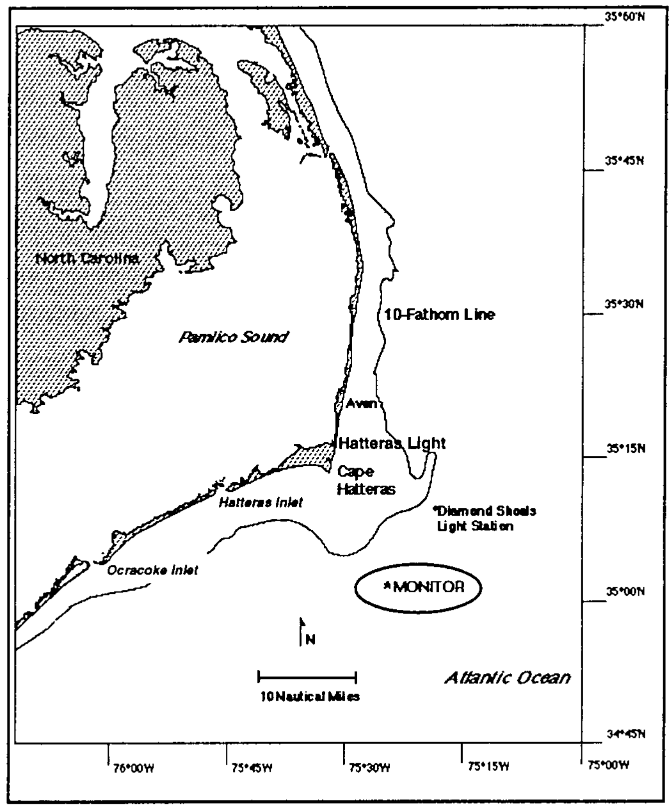
Location and Environment

Monitor National Marine Sanctuary: The sanctuary encompasses a vertical water column from the surface to the seabed and extending horizontally one nautical mile in diameter from a center point in the Atlantic Ocean located at coordinates:

35°00' 23" N
75°24'32" W

(NOAA Chart 11555, 33rd Ed., 1991)

16.1 nautical miles SSE of Hatteras Light, North Carolina.



Location of Monitor *National Marine Sanctuary (NOAA map).*

The nearest harbor facilities are at Hatteras, NC, accessible via Hatteras Inlet which can only accommodate shallow-draft vessels.

NOAA support facilities at the site consist of a 6000-pound anchor attached to a 42-inch-diameter subsurface buoy, to be used for a research boat mooring; a 1000-pound concrete block attached to a small subsurface buoy, to be used for a diver down line; a recording current meter, on an anchored tether; and four small concrete reference markers.

Environmental Conditions:

The *Monitor* lies on a featureless, relatively flat seabed consisting of sand and shell hash. At the northwest and southeast margins of the Sanctuary lie a series of exposed rocky areas that support a variety of sea life. The Gulf Stream is the dominant current, creating a prevailing current across the hull in an approximately northeast direction. However, in the area of the sanctuary, the Gulf Stream interacts dynamically with the southerly-flowing Labrador Current, creating unpredictable, changing conditions and eddies. As a result, environmental factors such as weather, surface sea conditions, current, water temperature and visibility often change rapidly and without warning.

Specific conditions at the site are as follows:

- Water depth - between 65 and 70 meters (212 - 230 feet).
- Water temperature - During July and August, water temperature on the wreck normally ranges from approximately 20°C to 23°C (68°F to 74°F); surface temperatures are usually higher. Because of the erratic interaction between the Gulf Stream and the Labrador Current, thermoclines are often encountered at various depths within the water column.
- Currents - Surface currents can range from zero to three knots or more; bottom currents are even more variable and have been observed to occasionally exceed two knots. The prevailing direction of currents at the Sanctuary is northeast. Subsurface currents often differ in velocity and direction from those at the surface.
- Bathymetry - The bottom slopes gently downward from northwest to southeast, and the seabed is relatively flat throughout the Sanctuary.
- Obstacles - The only objects protruding from the seabed within the Sanctuary are the wreck of the USS *Monitor* and two NOAA subsurface buoys. The *Monitor*'s inverted hull rises to a maximum elevation above the bottom of approximately 5.2 meters (17

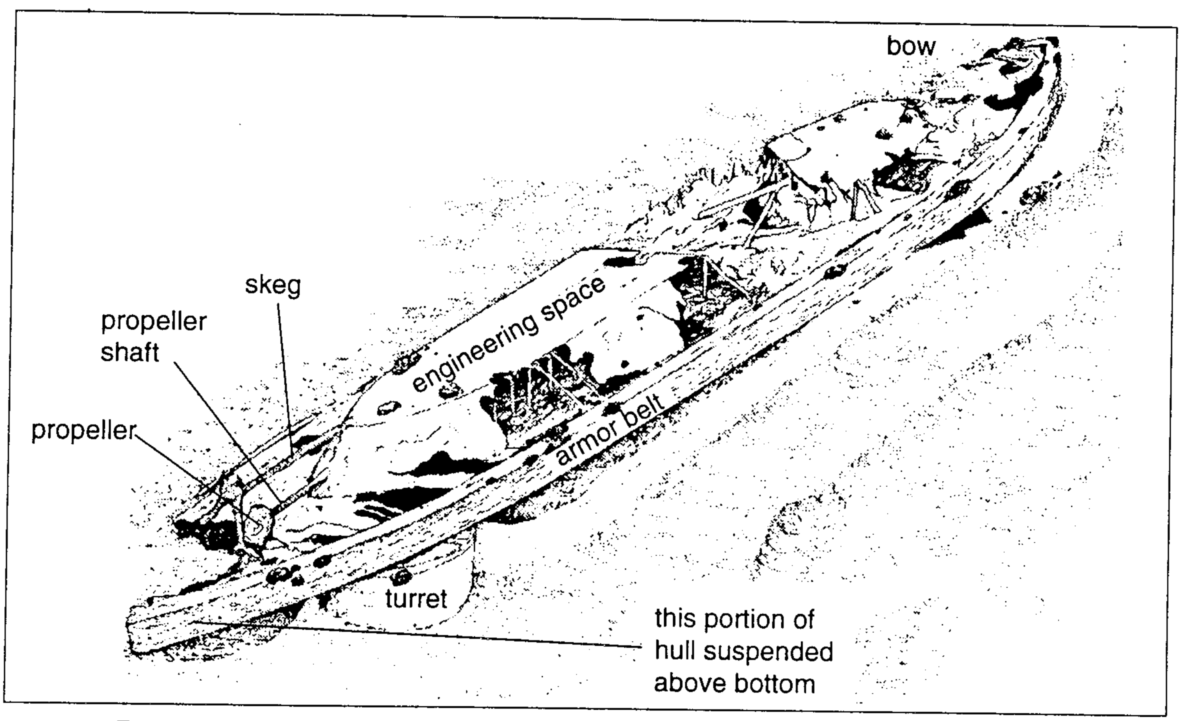
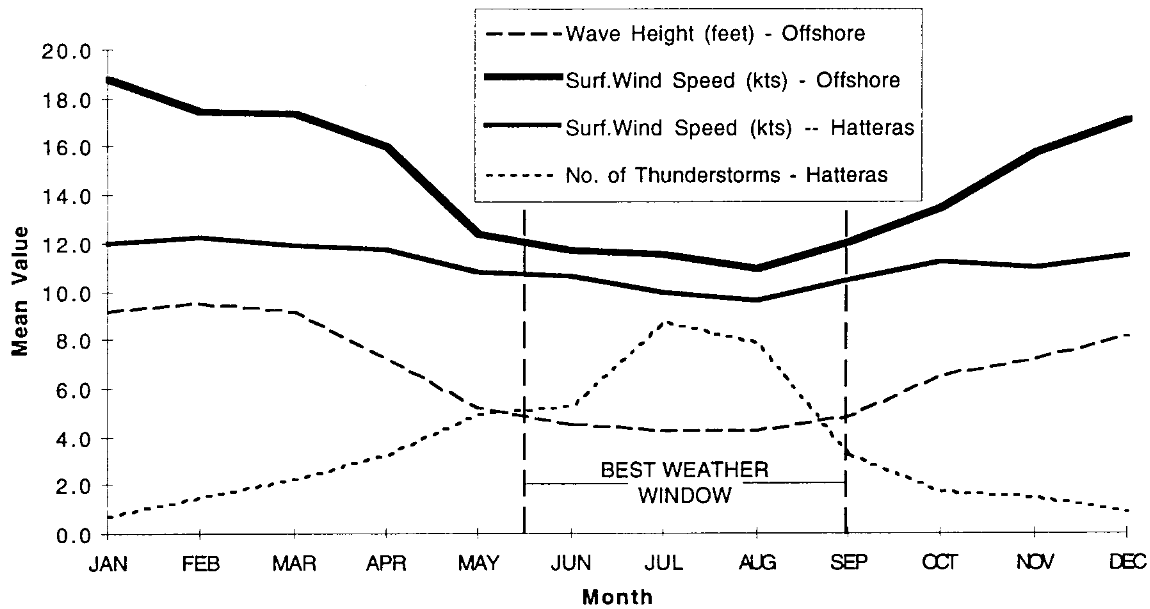


Figure D.1. The Monitor *wreck site, before displacement of the skeg* (NOAA illustration) feet). The subsurface buoys are positioned at a depth of approximately 15 meters (50 feet) to avoid contact with passing ships.

- Sea Conditions - Although never predictable, sea conditions are most likely to be optimal in July and August.
- Weather conditions at the Sanctuary that affect on-site research include wind, sea state, surface and subsurface currents, and water clarity. On average, conditions are most favorable between June and September, with July and August being the best months. However, hurricanes can disrupt the Hatteras environment during that same season, making it difficult to predict the best time to schedule on-site activities.

MEAN ENVIRONMENTAL CONDITIONS IN HATTERAS AREA



The Wreck Site:

The *Monitor*'s hull lies upside down on a relatively flat, sandy bottom, with the stern partially supported on the displaced and inverted turret, as illustrated in Figure B.1. The hull lies nearly east-west, with the bow oriented 280 degrees. The hull has deteriorated to a considerable degree, with the only relatively intact portion being that directly over the engineering space, where it has been partially supported by the boilers and machinery. The forward portion of the lower hull has completely collapsed and the stern hull and armor belt aft of the propeller have disintegrated. Most of the side plating on the lower hull has fallen away, exposing the interior of the machinery space. Most of the bottom plating is still intact.

The following drawings and photographs illustrate the previous and current condition of the *Monitor*'s hull.

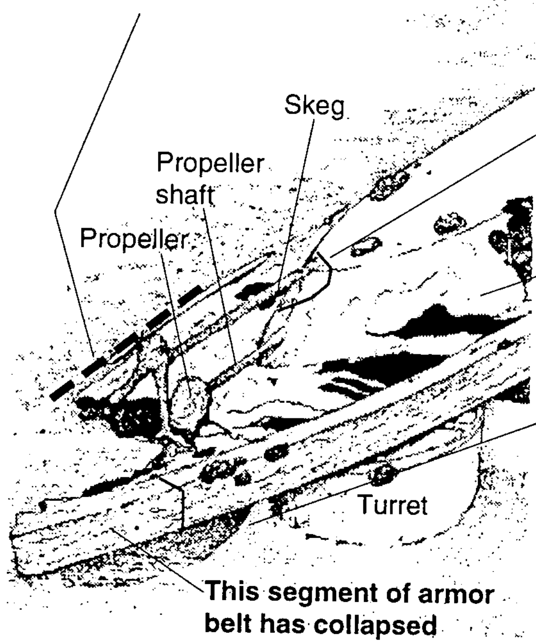


Figure D.2. The Monitor*'s stern, indicating key hull components and areas of deterioration.*

Figure D.2, above, indicates the principal hull components discussed in this Operations Manual and illustrates the primary areas of rapid deterioration. The observed areas of deterioration of most concern are:

- **The skeg**, which has pulled free from the lower hull, ripping away the aftermost section of hull plating and shifted to starboard.
- **The lower hull**, where almost all of the hull plating has fallen away, exposing the machinery space to increasing pressure from strong currents.
- **The armor belt**, which is losing structural integrety due to deterioration of the iron plating and the wooden support structure; more than six feet of the armor belt aft of the turret has disintegrated.
- **The deck beams and plating**, which are also deteriorating, further weakening the hull.

It can be seen that the weight of the skeg and propeller bears down on the weakened portion of the stern that is suspended approximately 6-7 feet above the bottom. The photographs on the following two pages further illustrate the situation.

Displacement of the skeg: the photographs on the next page illustrate the changes to the skeg and lower hull as a result of displacement of the skeg to starboard. This damage was probably caused by a fishing boat snagging its anchor on the skeg (the U.S. Coast Guard caught a boat anchored in the Sanctuary in 1991, just before the above damage was observed). The skeg has now fallen further off to the north side.

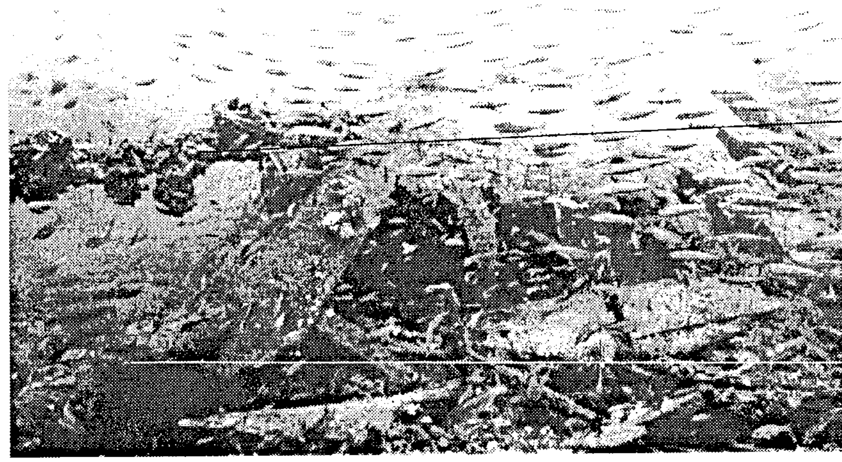


Figure D.3. The skeg and lower hull in 1990, before displacement.
(Photo © 1990 Farb Monitor Expeditions)

Figure D.4. The skeg and lower hull in 1992, after initial displacement.
(Photo © 1992 Farb Monitor Expeditions)

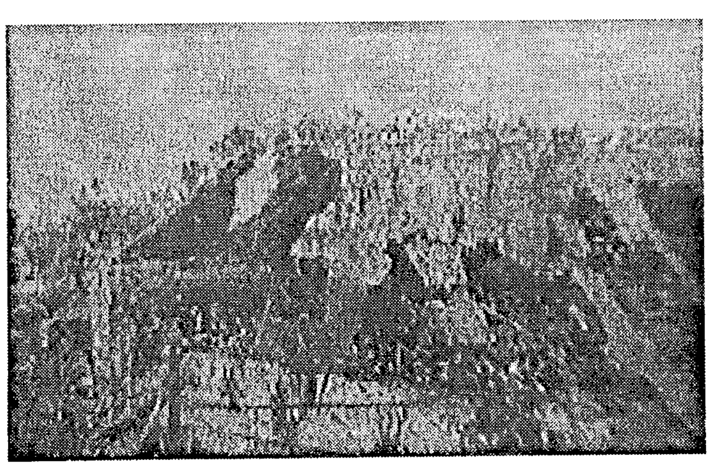


Figure D.5. The skeg and lower hull in 1997, after further displacement.
(Photo © 1997 Joe Poe, Farb Monitor Expeditions)

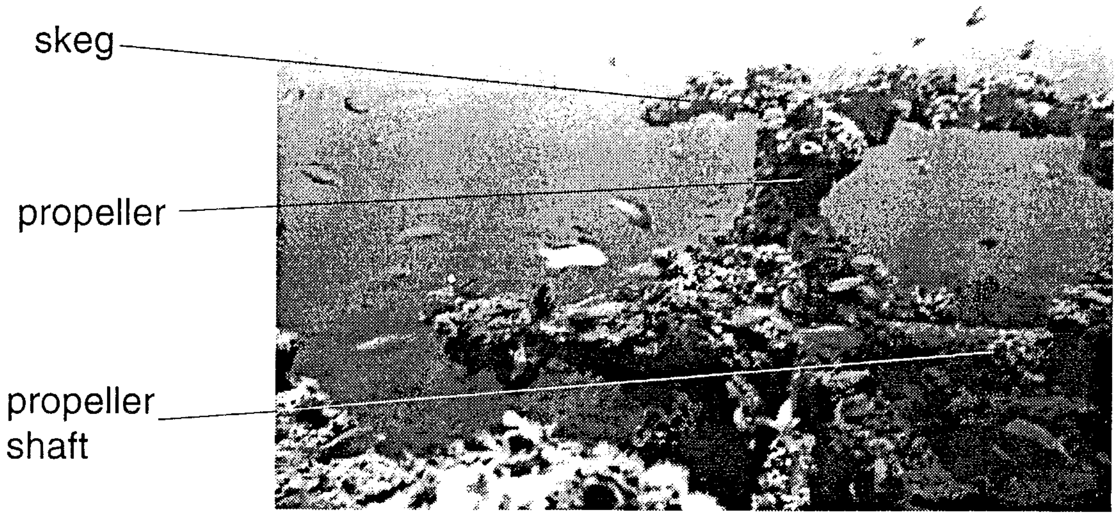


Figure D.6. The skeg, propeller and propeller shaft in 1990, before displacement. (Photo © 1990 Farb Monitor Expeditions)

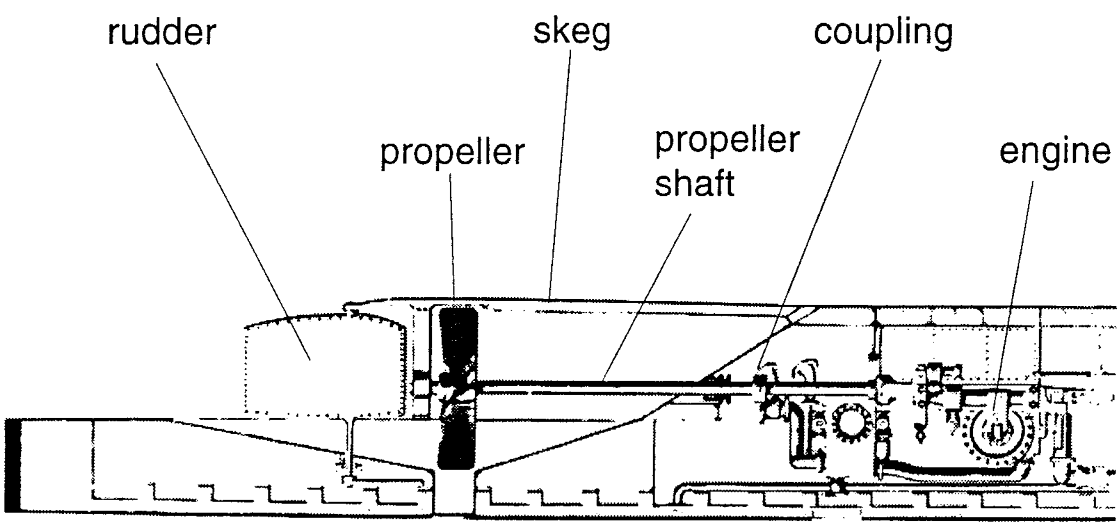


Figure D.7. Plan of the Monitor, showing the skeg, propeller, shaft and rudder.

The skeg and propeller are heavily encrusted with oxidation products and marine growth, making the propeller difficult to recognize. The encrustations will make removal of the propeller difficult.

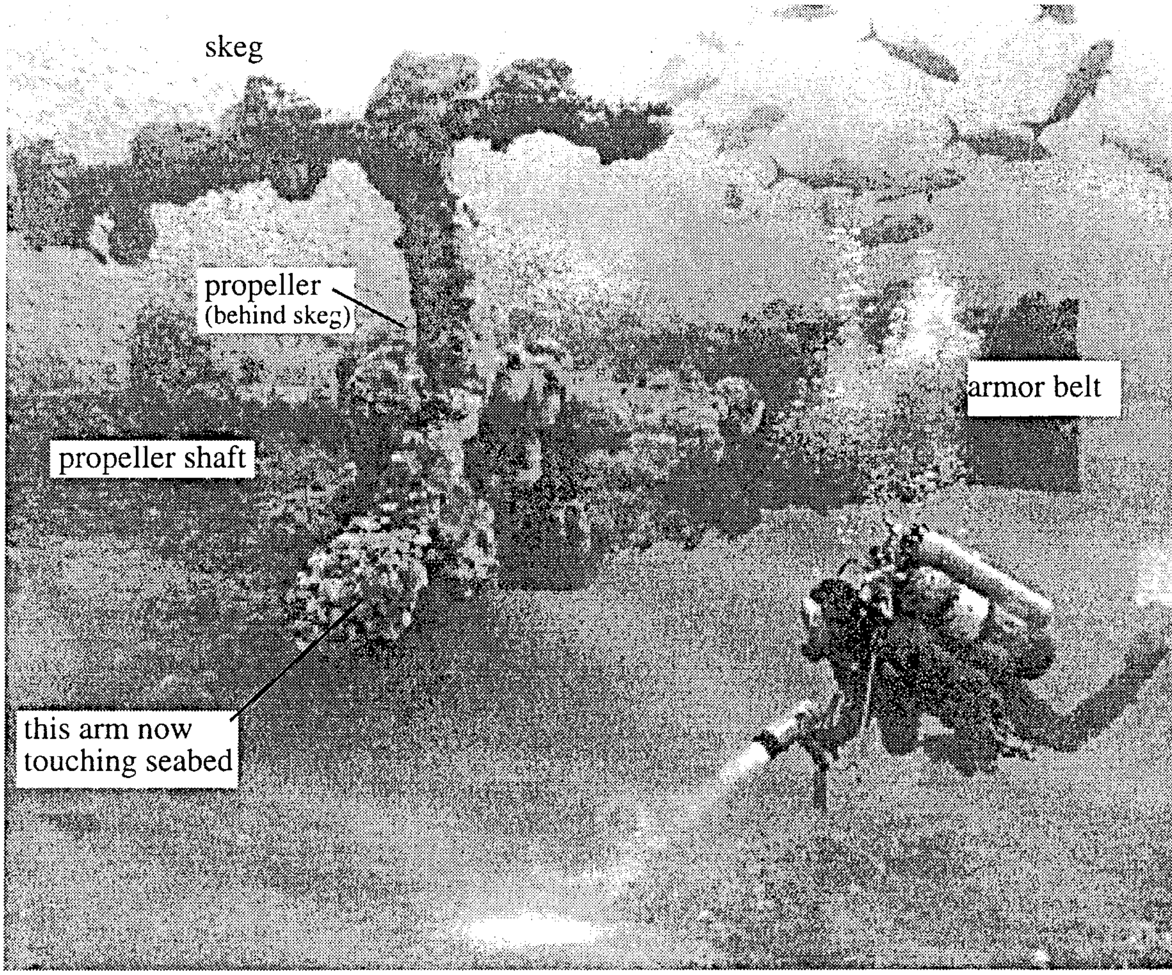


Figure D.8. A view of the skeg, propeller and propeller shaft facing nearly north (port); this photograph, taken in 1990, shows the skeg before displacement.
(Photo © 1990 Gary Gentile)

The above view of the stern was taken from near the centerline at the very stern end of the hull, clearly showing how the stern is suspended above the bottom and illustrating the damage to the hull in this area. Since 1990, when this photograph was taken, the skeg and its support have slowly fallen toward the south (toward the camera), rotating counter-clockwise as they fell. The skeg support arm nearest the camera has rotated downwards until it now rests on hull debris on the seabed. Although this arm now seems to be providing some support for the skeg, the skeg appears to remain unstable, slipping further to the side and placing additional stress on the already-damaged stern.

The *Monitor* in 1997

Figure D.9. View of the lower hull and armor belt, looking forward, showing damaged and missing supports and missing plating; dashed lines show extent of original hull structure.
(Photo © 1997 Joe Poe, Farb Monitor Expeditions)

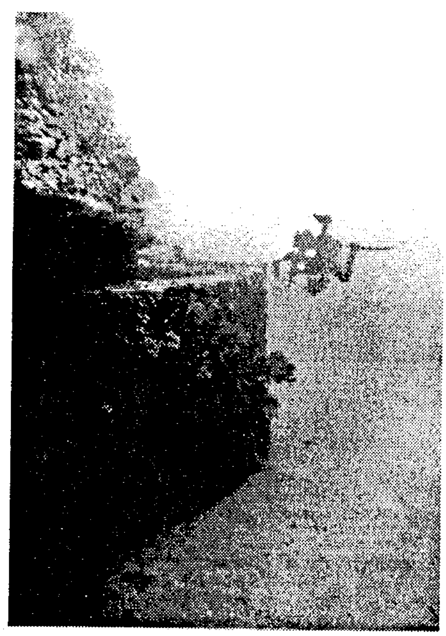


Figure D.10. View of the interface between the turret and armor belt, looking forward, showing that the area of contact is small and that the weight of the hull pressing against the turret has created a hole in the deck.
(Photo © 1997 Joe Poe, Farb Monitor Expeditions)

Appendix E
Summary of the Archaeology Plan

Introduction

The USS *Monitor* was without question one of the most significant ships in American history. The *Monitor*'s remains constitute one of relatively few cultural resources that meets all four criteria for inclusion on the National Register of Historic Places: a) the ship was associated with broad patterns and events in American history, namely the development of the United States Navy in the nineteenth century, the rise of industrial facilities in the United States, and the American Civil War; b) it was associated with an individual significant in American history, Swedish-American inventor and engineer, John Ericsson; c) it embodies the distinctive characteristics as a prototype for a type of warship used by the United States Navy and other naval powers well into the twentieth century; and d) its remains are likely to yield information important to American history since archaeological examination will provide a more detailed understanding of the vessel and a means for assessing the American mind-set through anthropologically generated research questions that probe human interaction with new technology and how modern industrial societies prepare for war (Delgado 1988:1). The *Monitor* was placed on the National Register of Historic Places in 1975 and designated a National Historic Landmark in 1986 (*Ibid.*:19,31).

Miller (1987:109) captured the essence of the *Monitor*'s significance when he wrote

> Nowhere else in our history has a ship with such a short career been so celebrated as the *Monitor*. The story behind *Monitor* and her role at a crucial juncture of our history will continue to intrigue and inspire all who are familiar with it. There was only one original USS *Monitor* and there will never be another.

The *Monitor*'s uniqueness and exceptional historical significance, along with its status as an American "icon," argues strongly for a concerted preservation effort and strict adherence to professional archaeological standards. All on-site operations must be conducted under the close scrutiny of NOAA-approved nautical archaeologists. In establishing a realistic archaeology plan, however, consideration must be given to the fact that the *Monitor*'s hull and contents are threatened with damage or loss due to the rapid deterioration of the hull and loss of structural integrity. NOAA considers the *Monitor* to be a threatened site and, therefore, is establishing the Archaeology Plan accordingly, in compliance with Federal Section 106 review criteria. When a significant archaeological site is threatened, the proposed mitigating actions are evaluated within the context of the seriousness and immediacy of the threat. NOAA believes that the *Monitor*'s situation calls for quick and decisive action in order to minimize the loss of irreplaceable cultural material and data.

Six Phases of the Archaeology Plan

(Refer to illustrations on facing page)

Phase I: Pre-Shoring Archaeological Survey, Mapping and Recovery: A NOAA-approved archaeological survey team will closely survey and map all exposed artifacts beneath the hull, from the bow to the eastern end of the stern debris field, then will conduct limited excavation, mapping and recovery in the following areas: (1) beneath the hull, in accessible areas beneath the hole in the deck just forward and to port of the midships bulkhead; (2) inside the hull between the armor belt and the lower hull; (3) in the debris field aft of the propeller; and (4) in any accessible areas beneath the hull that might be affected by the planned shoring activities. All encountered artifacts will be mapped and recovered, insofar as personnel safety permits; divers should not venture beneath the hull. An effort will be made to locate and record the rudder, which is assumed to lie in the stern debris field.

Phase II: Shoring Beneath the Hull: The hull will then be shored up using pumped sand, sandbags, "grout bags" (a type of cement that will harden after being pumped into bags), mechanical jacks, or a combination of methods; the lower hull will also be shored by some method that will support the engine until it can be removed.

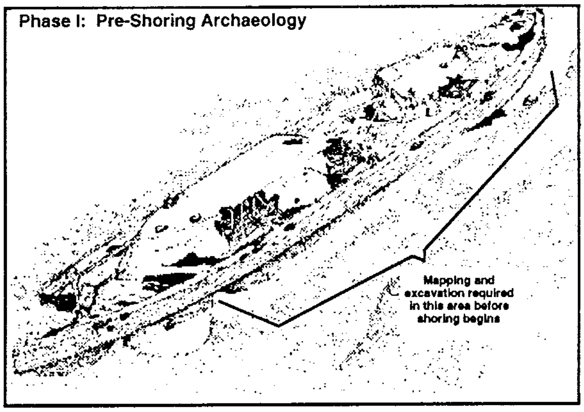
Phase III: Removal of Skeg, Propeller, Lower Hull and Engine: The skeg will be removed and placed on the seabed to the south of the hull; the propeller and shaft will be recovered; the lower hull will be cut away and the engine recovered; lower hull plating and beams will be placed on the seabed near the skeg.

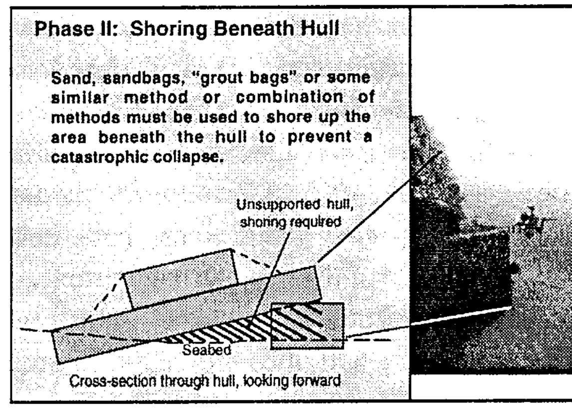
Phase IV: Removal of Armor Belt and Hull Section Above the Turret: With the hull shored from beneath and the engine and other machinery components removed, the section of armor belt and hull that obstruct access to the turret can be cut away; these objects can be placed on the seabed, near the other material removed from the hull.

Phase V: Removal of Turret: With the turret now clear of overhead obstructions, it can be recovered; a support cradle will be worked beneath the turret and the turret will be supported on all sides before being lifted to the surface.

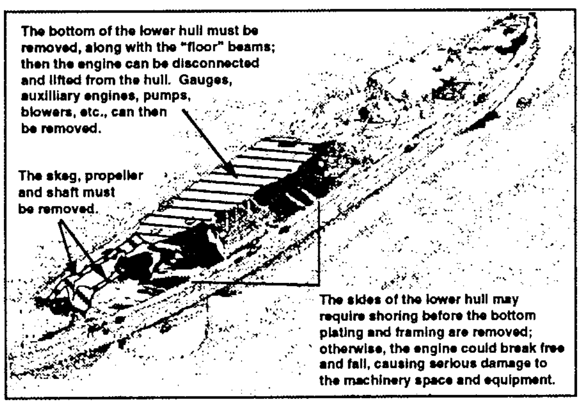
Phase VI: Post-Removal Survey and Stabilization: Following completion of all recovery activities, an archaeological and engineering survey must be conducted to assess the condition of the hull and contents; additional stabilization should be carried out, if necessary.

Six Phases of the Archaeology Plan

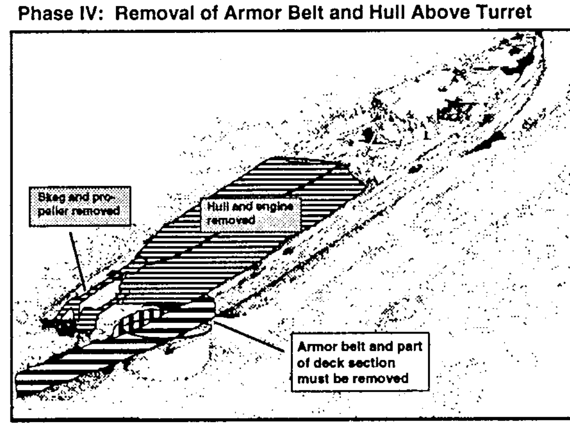




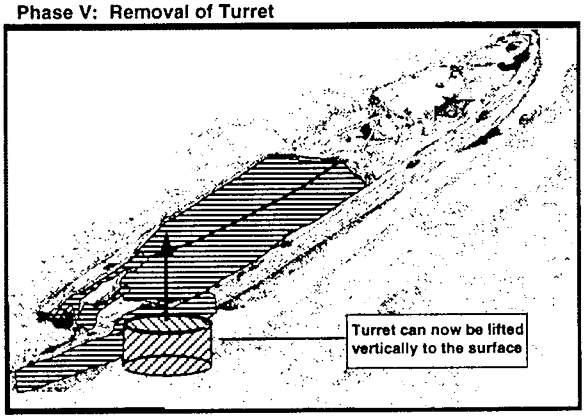
Phase III: Removal of Skeg, Propeller, Lower Hull and Engine



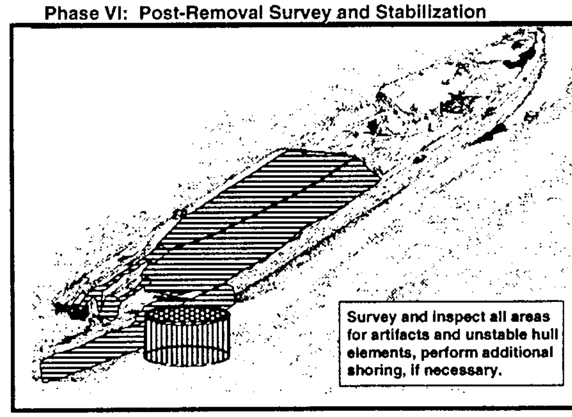
Phase IV: Removal of Armor Belt and Hull Above Turret



Phase V: Removal of Turret



Phase VI: Post-Removal Survey and Stabilization



Archaeological Activities and Issues

Pre-Shoring Archaeological Mapping and Recovery: Archaeological survey, mapping and recovery at the *Monitor* site will require a variety of techniques and equipment. As shown in Figure E.1 and elsewhere, the hull of the *Monitor* is elevated as much as seven feet above the seabed. At least six holes have developed in the deck, allowing artifacts from inside the hull to fall to the seabed where some have become buried or carried away by strong currents. Remaining artifacts must be mapped and recovered before shoring activities are begun in order to prevent their damage or destruction.

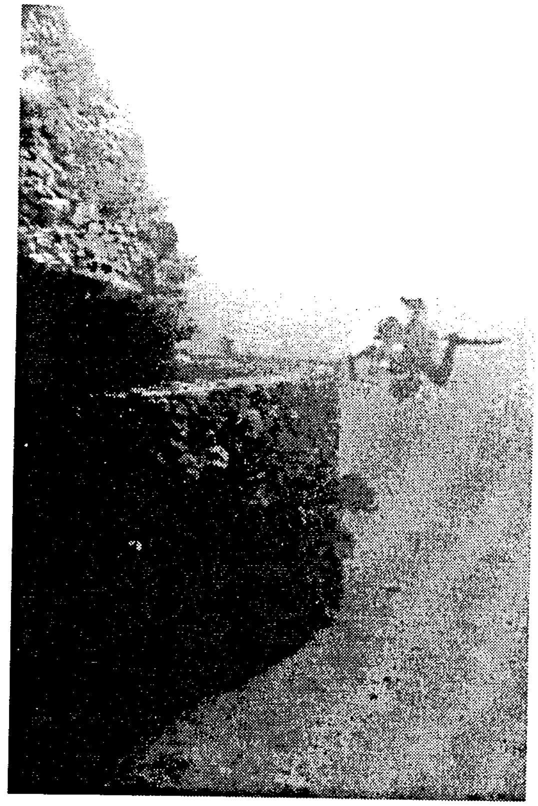


Figure E.1. Many artifacts will be found beneath the hull, where they have fallen through holes in the elevated deck (J.Poe).

Recovery of Material Beneath the Hull: It will not be possible to safely map and excavate artifacts from beneath the hull except near the edge, where archaeologists will not be threatened by the overhanging armor belt and deck. Any artifacts lying further beneath the hull and buried in the seabed will have to remain in place or will have to be recovered by robotic devices such as remotely-operated vehicles (ROVs). Objects encountered during the survey will be mapped using a simple grid and reference system, and excavated by hand or with a small hydraulic dredge.

Mapping and excavation will also have to be conducted in the stern debris field, behind the engine, and within the hull along the armor belt. Those areas will not require working in an overhead environment. Figure E.2 illustrates the excavation conducted within the hull in 1979. That excavation took place in the port bow, in an area where the lower hull had completely collapsed, thus presenting no overhead threat.

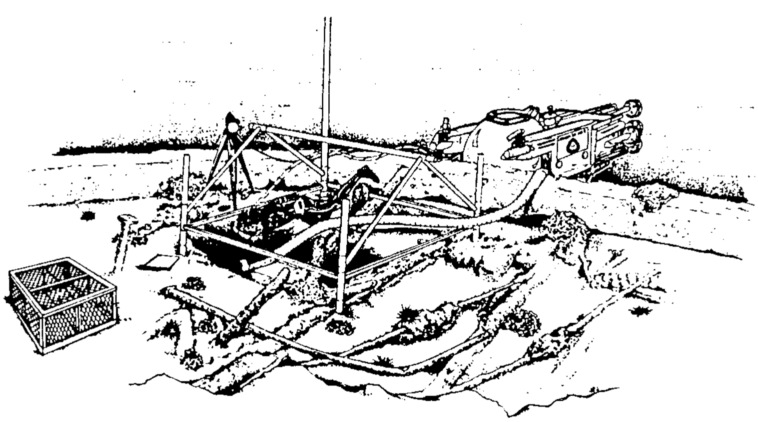


Figure E.2. Excavation in the Monitor's port bow, 1979, using a metal grid and hydraulic dredge (NOAA).

Variety of Recovered Material: Based on the 1979 expedition and on subsequent research expeditions, the required excavations can be expected to yield a wide variety of cultural material. As shown on the next page, there will be objects of metal, glass, ceramics, wood, and countless objects made up of more than one material, such as the brass and glass lantern and the iron, bronze and leather pump assembly. These objects will create more of a problem for the conservators than for the archaeologists, and on-site conservation will have to take place until the objects can be transported to a permanent laboratory for treatment. Fortunately, on-site conservation will consist primarily of stable storage, and provisions will be made to transport recovered objects ashore at frequent intervals.

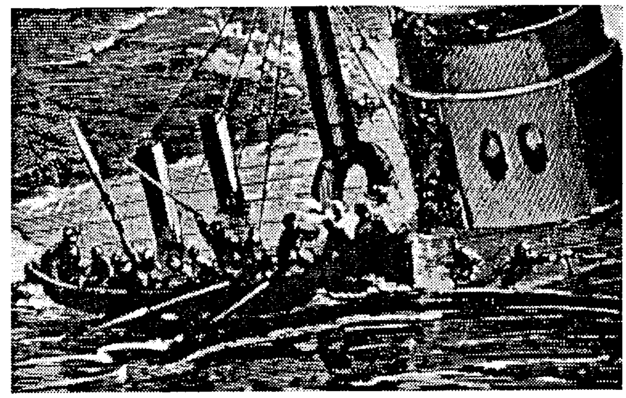


Figure E.3. Monitor*'s crew abandoning ship.*

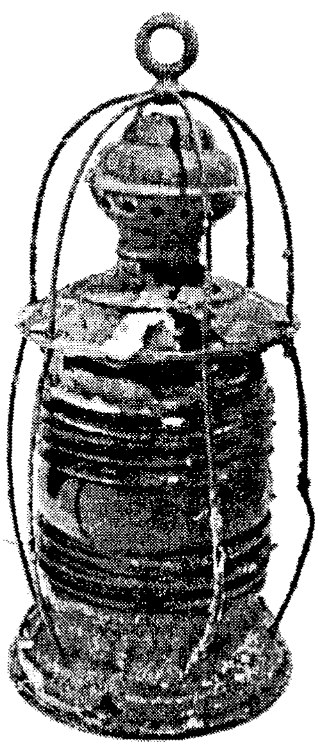
Discovery of Human Remains: Remains of the *Monitor*'s crew may be encountered during excavation. Because the *Monitor* sank in a storm, and not as the result of hostile action, the site is not considered by the U. S. Navy to be a war grave. According to the official report filed by Commander John P. Bankhead on January 3, 1863, four officers and twelve crewmen were lost when the *Monitor* sank on December 31, 1862. According to eyewitness accounts, at least six of these men were lost overboard during the storm while trying to cut the tow line or attempting to reach the rescue boats from the USS *Rhode Island*, the vessel that had been towing the *Monitor*. Acting Master Rodney Browne, commanding the first cutter from the *Rhode Island*, noticed several men atop the turret when he brought off the *Monitor*'s captain and other officers and crew. Although he promised to return for the remaining men, the *Monitor* apparently sank before he could complete the second trip. It is unknown how many, if any, remained inside the turret and subsequently went down with their ship. Because the turret was the only exit from the ship, it is highly likely that any of the *Monitor*'s crew were left aboard, their remains will be found in the turret.

Officers and Crew Listed as Missing after the Sinking of the USS *Monitor*

December 31, 1862

Allen, William	landsman, no known location at time of sinking
Atwater, Norman	acting ensign, lost attempting to board the *Rhode Island*
Bryan, William	yeoman, no known location
Cook, Robert	first class boy, no known location
Eagan, William	landsman, no known location
Fenwick, James	quarter gunner, swept overboard while cutting the hawser
Frederickson, George	acting ensign, last seen on the berth deck
Hands, Robinson W.	engineer on duty; no known location
Howard, Robert	officers' cook, no known location
Joice, Thomas	first class fireman, no known location
Lewis, George H.	third assistant engineer, no known location
Littlefield, George	coal heaver, no known location
Mickley, Jacob	ordinary seaman, no known location
Moore, Daniel	officers' steward, no known location
Stocking, John	boatswains mate, swept overboard while cutting the hawser
Williams, Robert	first class fireman, no known location

Figure E.4. *Types of objects likely to be encountered on the* Monitor *(clockwise from upper left): the anchor, recovered in 1983; an iron centrifugal pump, with a leather belt; a glass jar containing relish; and a signal lantern (NOAA).*



The Archaeological Plan must include appropriate procedures for documenting and removing human remains. Human remains will be treated with dignity and respect at all times. Once located and mapped, the remains will be left in place until a suitable container is brought to the site to receive them. With the concurrence of the Naval Historical Center, the remains will be taken to the physical anthropology laboratory at the Smithsonian Institution for examination and, if possible, determination of age and characteristics that might assist in identifying specific individuals.

Again with the concurrence of the Naval Historical Center, arrangements will be made for interment of the remains at an appropriate site in the Hampton Roads area. Sites currently under consideration include the vicinity of Fortress Monroe, where the *Monitor* was moored for most of her career, the National Cemetery in Hampton, and the Portsmouth Naval Hospital where crewmen from the USS *Congress* and CSS *Virginia* are buried. Interment could include appropriate mid-nineteenth century burial rites with an honor guard of Union sailor reenactors. The grave would be marked with a suitable headstone identifying the men assumed to have gone down with the *Monitor*, the date of the sinking, and the date(s) of recovery of the remains.

National Historic Preservation Act Review: As discussed in Section 4.7, a review must be completed prior to any large-scale stabilization or recovery operations at the *Monitor* National Marine Sanctuary under the National Historic Preservation Act and other pertinent laws. The Preservation Plan must obtain the concurrence of the State Historic Preservation Office of the State of North Carolina and the (Federal) Advisory Council on Historic Preservation. In submitting the final plan for review under the National Historic Preservation Act, section 106, NOAA will present extensive evidence that the *Monitor* is threatened with the certainty of collapse and disintegration unless action is taken to stabilize the hull and recover important components and artifacts. Under section 106, when a significant archaeological site is threatened, the proposed mitigating actions are evaluated within the context of the seriousness and immediacy of the threat. As explained in this draft plan, NOAA believes that the *Monitor*'s crisis must be met with a large-scale stabilization and recovery effort.

The *Monitor*'s uniqueness and exceptional historical significance, along with its status as an American "icon," will be addressed as part of the environmental review. In the strictest sense the *Monitor* is also an artificial reef, supporting a diverse variety of plant and animal life. This aspect of the Sanctuary must also be addressed in the environmental review. As a habitat for sea life, the *Monitor* is too small to be considered significant, especially in the context of the many acres of live rock bottom that lie just outside the Sanctuary on two sides. Nevertheless, if the recommended option is carried out, much of the *Monitor*'s habitat potential will be preserved, since most of the hull will be left in place.

As described below, the plan will clearly define the roles of the persons in charge of on-site activities, and will state that a qualified NOAA-approved nautical archaeologist will oversee all operations.

Diving and Excavation Equipment and Procedures: During pre-shoring on-site archaeological activities, NOAA archaeologists will oversee all archaeological work, while a NOAA-approved diving specialist will supervise all diving operations. NOAA-approved dive safety procedures will be observed at all times and an approved recompression chamber and crew will be available at all times. A dive plan will be developed in cooperation with the NOAA Dive Office and the NOAA Dive Safety Board, and the dive plan will be included as part of the final operations plan for the project. The equipment selected will depend upon the type of tasks to be performed and equipment availability.

Most of the archaeological mapping and recovery will probably be accomplished by free-swimming archaeological divers using "technical" dive gear consisting of twin cylinders filled with a breathing gas designed for the *Monitor*'s depth (NOAA Trimix I, or "*Monitor* Mix"), and additional cylinders filled with decompression gasses (NOAA Nitrox II and oxygen). Decompression will be accomplished in-water, with divers tethered to a secure line running between an anchor near the turret to a surface buoy. Divers will always decend and ascend this "down-line" for safety reasons.

Excavation procedures and equipment will be kept as simple as possible in order to minimize logistical requirements. Initial survey activities will employ hand-fanning of sediment and, if necessary, a small dredge constructed from a portable diver propulsion vehicle (DPV). For excavation, a DPV will be rigged for use as a dredge. If necessary, a more powerful hydraulic dredge will be provided, using water power supplied by a pump mounted on the support vessel.

Once engineering operations commence (shoring and recovery activities), the prime engineering contractor will be responsible for all diving operations. The types of personnel and equipment used will be specified by the contractor.

Archaeological Control: A NOAA-approved archaeologist will oversee all initial mapping and limited recovery activities. During all stabilization and recovery operations, NOAA-approved archaeologists and conservators will be on site to monitor activities. The project archaeologist will have the authority to halt operations if, in his/her opinion, continuation is likely to cause collateral damage beyond acceptable limits.

Selection of Artifacts to be Recovered: The objects listed in Appendix B, pages 39-40, were selected for recovery based on several factors: All are threatened with eventual disintegration if not recovered, all have historical significance and, taken together, the assemblage would accurately depict the *Monitor* for researchers and museum visitors. The turret, its two Dahlgren cannons and the other expected contents are especially significant, since the *Monitor*'s turret was its most unique and recognizable feature.

Appendix F
Summary of the Exhibition/Curation Plan

Introduction

As discussed in Appendix E, when artifact recovery is contemplated it must be done in concert with plans for conservation and exhibition. Appendix B discusses the complex, time-consuming and expensive tasks that would be involved in conserving large components of the *Monitor*; this appendix addresses several key questions concerning the long-term disposition of the recovered objects. If major components of the *Monitor* are recovered and conserved, (a) can they be effectively displayed and interpreted? (b) can they be maintained in a suitable stable environment while on display? and (c) will the display and associated interpretive material have a sufficient historical significance and visitor impact to warrant the expense and difficulty of recovery and exhibition? All these questions should be answered in the affirmative before any attempts at major recovery are made. Note: This plan can not be developed in detail until a firm decision is made as to which objects will be recovered.

Background

Curation, exhibition and interpretation have always been important components of NOAA's management strategy for the *Monitor*. In 1986, NOAA sought a formal partnership with a suitable maritime museum or similar facility in order to provide a permanent repository for the artifacts and archival material relating to the *Monitor* and to the Sanctuary and also to establish a long-term public exhibition on the *Monitor*. In response to a request for proposals published in the *National Register*, NOAA received proposals from the City of Portsmouth, Virginia, the state of North Carolina, The Mariners' Museum in Newport News, Virginia, and the South Street Seaport Museum in New York.

In March,1987, following an evaluation of the proposals by a committee of representatives from the Council of American Maritime Museums, The Mariners' Museum was designated Principal Museum for the *Monitor* National Marine Sanctuary. A long-term cooperative agreement was developed between NOAA and the Museum, providing for professional curation services for the *Monitor* Collection, a Federal collection that includes historical material on the USS *Monitor*, research material generated by investigations in the *Monitor* National Marine Sanctuary, and artifacts recovered from the wreck of the *Monitor*. The Museum also maintains a permanent *Monitor* exhibit that features the history of the *Monitor*, the battle with the CSS *Virginia* (ex-*Merrimack*), and information on the *Monitor* Sanctuary. The exhibit includes artifacts recovered from the *Monitor*, material from the *Virginia*, and photographs and video of the wreck.

Also in 1986 NOAA contracted with the Harpers Ferry Center, the exhibition planning and development facility for the National Park Service, located in Harpers Ferry, West

National Marine Sanctuary." The latter would encompass research on the wreck and the recovery of artifacts and components.

The purpose of interpretation is to convey information and significance. Information may be regarded as the vehicle by which to arrive at significance. Significance may be regarded as the framework and reference by which facts are chosen. In either approach, or if both are employed simultaneously, choices are necessary. Not all information can be conveyed in a museum setting, either from the standpoint of effectiveness in a given medium, or in terms of total "load' on a museum visitor. Priority must be given to those elements of story and significance which are most essential. Myth and image form an essential component of the *Monitor*'s impact on history and public support of real developments in naval architecture and will combine well in an interpretive effort.

For the purpose of interpreting the full significance of the *Monitor*, mythical elements, which are also the dramatic elements, can be utilized to introduce elements which are less likely to stand on their own in a museum setting. For example, the matter of integrated design based on need was little understood by the public in the 1860s. Today we are inclined to take it for granted. The hero-cult attached to the vessel's designer might be the proper vehicle to convey the subject.

Another item in the significance category is 'Archaeology to meet public need for tactile response." Although an artifact generally needs identification, and often considerable explanation, it is the object itself by which a viewer experiences a connection with history. While information is necessary to gain an appreciation of significance, the object is essential to lend reality to the information; the combination constitutes a museum experience. It is unlikely that there would ever have been widespread modern interest in the *Monitor* had the ship's remains not been discovered, along with the tantalizing possibility of raising major portions of it. Although there are a number of ways to utilize documentation in interpretation of the *Monitor* to the public, such interpretation becomes far more valuable with the presence of major portions of the wreck.


The Monitor's anchor on exhibit (NOAA).

Fortunately for an interpretive planner, the available resource material is considerable, both in terms of documents and exhibitable material. The *Monitor* Collection, the NOAA collection curated by The Mariners' Museum, includes photographs, plans, illustrations, and research material. Numerous photographs and video tape records of the wreck exist from NOAA's numerous research expeditions to the *Monitor.* Nineteenth-century paintings and engravings depicting the battle between the *Monitor* and the *Virginia* , as well as illustrations and photographs of other ironclads, can be found in The Mariners' Museum collection along with models of the *Monitor* and memorabilia related to it. Underwater photography of the wreck of the *Monitor* not only provides information but is a resource in itself related to the story of modern scientific investigation of the *Monitor*, a story with much potential in terms of public interest.

More than 150 artifacts have been recovered from the *Monitor.* These include the ship's unique four-fluked anchor and a brass signal lantern, both of which are included in the current *Monitor* exhibit at The Mariners' Museum. Other artifacts on exhibit at The Mariners' Museum and at other facilities include condiment and apothecary bottles, wine and bitters bottles, an ironstone dinner plate, the remains of an iron hull plate, and brass oarlocks for the *Monitor*'s ship's boats. In summary, sufficient support material already exists to produce a superior interpretive exhibit of major components of the *Monitor.*

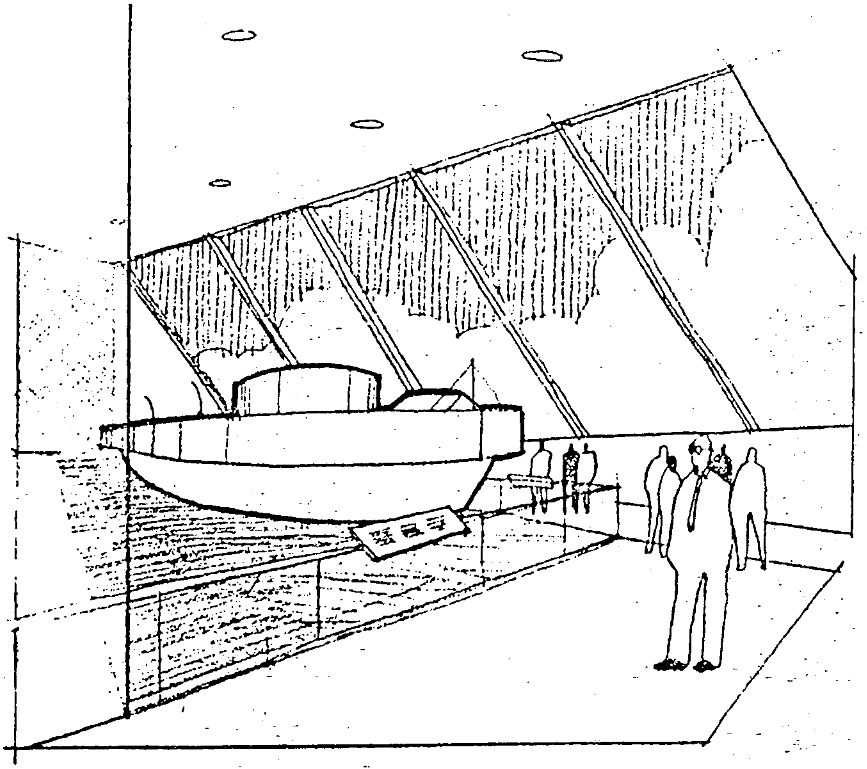
The recovery of major components of the *Monitor* would provide a unique opportunity to incorporate the conservation process into an interpretive exhibit. Since large iron objects require several years to conserve, an interpretive exhibit based on conservation is even more desirable. The exhibit could be supported by video of the recovery efforts, a "mock-up" of the *Monitor* showing where the material was located on the ship and on the wreck, and other interpretive material explaining the conservation process and why it is necessary.

Final Interpretive/Exhibition Plan

Once the final recovery plan has been approved and agreement has been reached on which components of the *Monitor* will be recovered, final design of a interpretive exhibit should begin. As stated above, in order to maximize the amount of public involvement in the events surrounding the recovery, integrating the conservation of at least some of the major components and smaller artifacts into an interpretive exhibit should be given serious consideration.

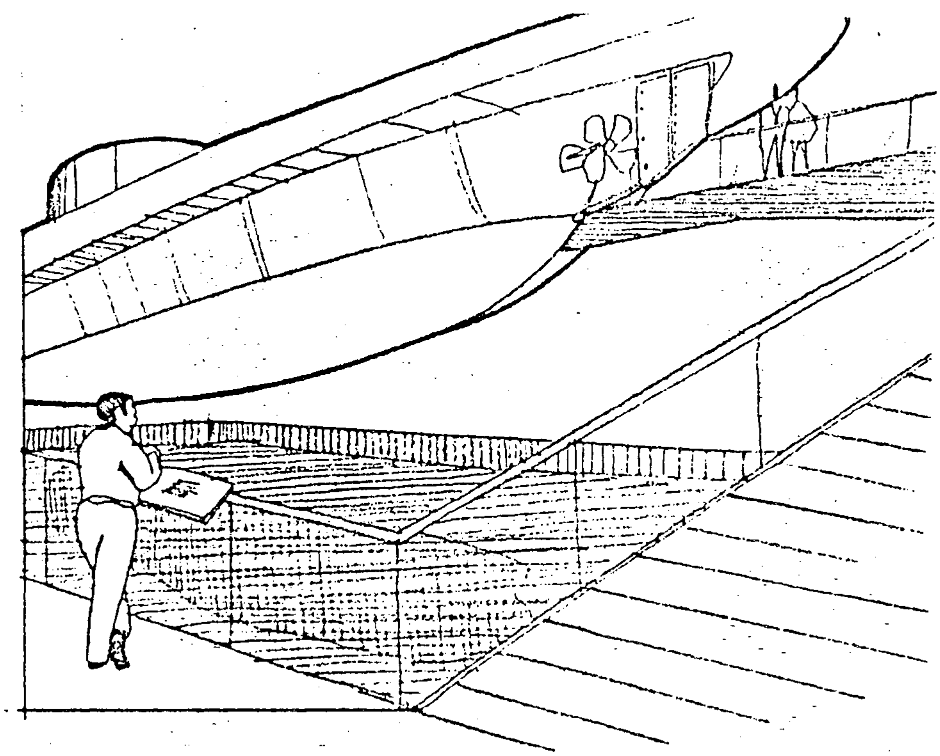
Long-Term Curation Plan

Through an ongoing Cooperative Agreement between NOAA and The Mariners' Museum, all artifacts recovered from the *Monitor* will receive long-term care by professional curators, with all procedures and facilities meeting the standards of the Council of American Maritime Museums.



Monitor exhibition concept drawings prepared in 1986 by the Harpers Ferry Center, National Park Service (NPS).

EARLY CONCEPTSKETCH –NOT PART
OF CURRENT EXHIBITION PLANS



Appendix G
Business Plan Concept and Plan Participants

All phases of the stabilization and recovery option outlined in this draft plan will cost at least $20-25 million. The final comprehensive plan for large-scale stabilization and recovery operations must include a detailed budget that identifies all costs and sources of funding. Except for initial mapping and small-scale artifact recovery, no on-site intervention should take place until adequate funding has been committed for completion of all phases of the project. Consideration must be given to all possible sources of funding and in-kind support pursuant to the revenue enhancement authority of the National Marine Sanctuaries Act (NMSA) and other pertinent law.

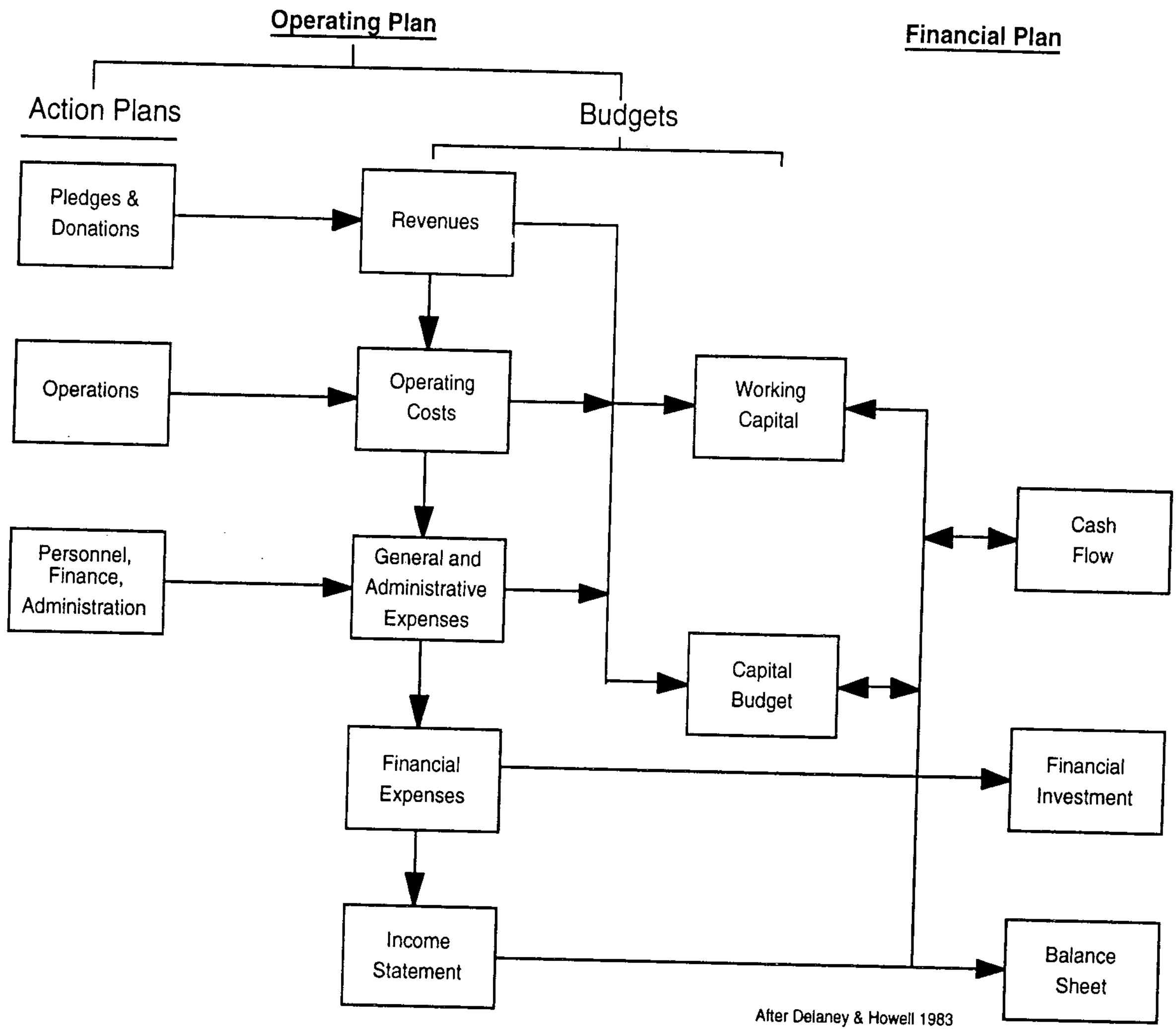
The conventional means of organizing these costs and income sources is through a project budget; however, since the costs associated with this project will most likely have to be generated from a variety of sources over a period of several years, a more comprehensive plan is required. It is recommended that it take the form of a business plan. A business plan for the *Monitor* Project should contain the following elements:

1. The Project Mission and Goals
2. The Project Partners/Sponsors
3. The Project Needs
4. The Marketing/Fundraising Strategy
5. The Management Team
6. The Financial Plan

The schematic diagram on the following page illustrates the flow in a typical annual business plan. In its simplest form, the business plan defines the structure of the organization, identifies sources of revenues (pledges, donations, other fundraising) and predicts revenue amounts, describes operations and administration, defines and estimates all costs, and predicts the net increase in funds.

One possible approach to establishing the business or fundraising organization would be to create an alliance of Federal, state and private organizations with an interest in the preservation of the *Monitor*. Partnerships could be sought with governmental agencies and private entities with resources, skills and equipment that might be used in the preservation effort. The *Monitor* business plan should be implemented within the context of the existing system-wide National Marine Sanctuary strategic goals and fundraising program.

Schematic Representation of a Typical Business Plan



After Delaney & Howell 1983

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PARTICIPANTS IN THE PREPARATION OF THIS DRAFT PRESERVATION PLAN

This draft comprehensive preservation plan was developed by NOAA, working with other Federal and non-governmental organizations representing a broad spectrum of interests, skills and experience:

- **National Oceanic and Atmospheric Administration**

The *Monitor* National Marine Sanctuary is managed by the Sanctuaries and Reserves Division, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration (NOAA), U. S. Department of Commerce. The National Marine Sanctuary Program was established by Congress in 1972 with the passage of Title III of the Marine Protection, Research, and Sanctuaries Act (commonly cited as the National Marine Sanctuaries Act). The Act authorizes the Secretary of Commerce to designate marine areas of exceptional significance and to promote comprehensive management and protection of their special conservation, recreation, ecological, historical, research, educational or aesthetic resources. The *Monitor* National Marine Sanctuary is staffed by two persons, a manager and education coordinator, plus two temporary research assistants who are assisting with the development of a long-range preservation plan.

- **The Mariners' Museum**

The Mariners' Museum, Newport News, Virginia, was designated the Principal Museum for the *Monitor* National Marine Sanctuary in 1987. In that capacity, the Museum has curatorial responsibility for the *Monitor* Collection, a Federal collection that includes artifacts recovered from the *Monitor* as well as historical material and research data generated by on-site research. The Museum also maintains a permanent exhibit on the USS *Monitor* and the *Monitor* National Marine Sanctuary that includes the *Monitor*'s anchor and other artifacts recovered from the Sanctuary;

One of the largest international maritime museums in the world, The Mariners' Museum is dedicated to "preserving the culture of the sea and its tributaries, its conquest by man, and its influence on civilization." The museum's collections of more than 35,000 maritime artifacts includes ship models, scrimshaw, maritime paintings, decorative arts, intricately carved figureheads, working steam engines, and more. Interpretive galleries include the *Age of Exploration* Gallery, Antique Boats Gallery, Carvings Gallery, Chesapeake Bay Gallery, the Crabtree Collection of Miniature Ships, the Great Hall of Steam, Small Craft Collection, *William Francis Gibbs: Naval Architect* Gallery, and others. The Mariners' Museum is cooperating with NOAA for the development of a comprehensive plan for the conservation, curation, exhibition and interpretation of recovered material from the *Monitor*.

- **U. S. Navy**

The U. S. Navy provided engineering assistance for this plan through the Office of the Director of Ocean Engineering, Supervisor of Salvage and Diving (SUPSALV), Naval Sea Systems Command (NAVSEA). SUPSALV possesses extensive experience in all types of marine engineering and ocean salvage involving dive systems, manned and unmanned submersibles and support equipment including salvage ships, barges, cranes and tugboats. In addition to fulfilling mission responsibilities for the Navy, SUPSALV has assisted with other recovery projects such as the Challenger disaster and the crash of TWA Flight 800 off Long Island, New York.

- **Oceaneering Technologies, Inc.**

Oceaneering Technologies, Inc., Upper Marlboro, Maryland, is a division of Oceaneering International, Inc. Oceaneering is an advanced applied technology company that provides engineered services and hardware to customers who operate in marine, space, and other harsh environments. The company's services and products are often combined to offer complete project solutions. Oceaneering is the prime contractor to the U. S. Navy for ocean survey and salvage applications. Oceaneering and SUPSALV operate cooperatively on a wide range of ocean technology projects, including the recent recovery of remains from TWA Flight 800. For inclusion in this comprehensive plan, Oceaneering developed a preliminary proposal for the emergency recovery, stabilization and preservation of the *Monitor*. The proposal was prepared at no cost to the government.

Appendix H
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