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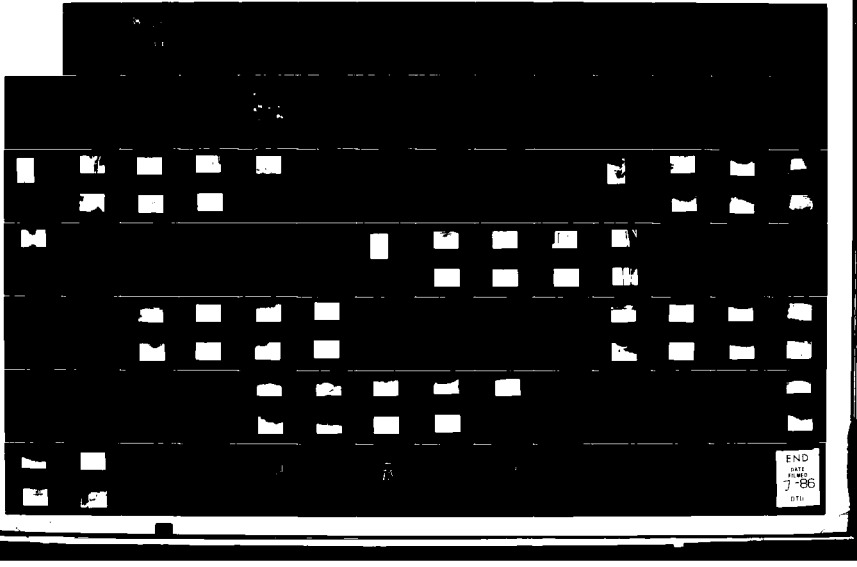

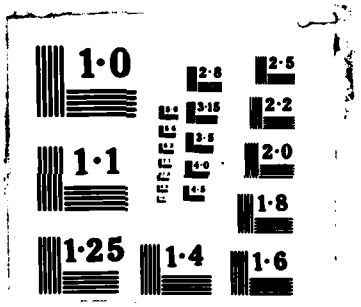
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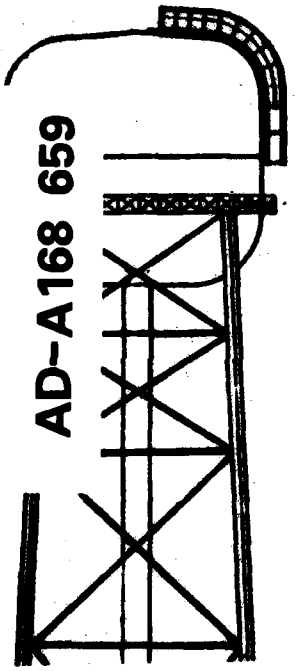
POTABLE WATER STORAGE FACILITIES INSPECTIONS AND ASSESSMENTS

NAVAL AMPHIBIOUS BASE LITTLE CREEK NORFOLK, VIRGINIA

FPO-1-84(41) OCTOBER 1984



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OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374

POTABLE WATER STORAGE FACILITIES
INSPECTION AND ASSESSMENT
AT

NAVAL AMPHIBIOUS BASE
LITTLE CREEK
NORFOLK, VIRGINIA

FPO-1-84(41) OCTOBER 1984

PERFORMED FOR:

OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374

UNDER:

CONTRACT N62477-83-D-0387
TASK 3

BY:

COLLINS ENGINEERS, INC.
600 WEST JACKSON BOULEVARD
CHICAGO, ILLINOIS 60606

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19. ABSTRACT (Continue on reverse if necessary & identify by block number)
In October of 1984, an underwater inspection was conducted at the Naval Amphibious Base, Little Creek, Norfolk, Virginia to assess the condition of seven potable water storage facilities.
Each facility was inspected by a team of engineer- & technician-divers (Con't)

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22a. NAME OF RESPONSIBLE INDIVIDUAL Jacqueline B. Riley	22b. TELEPHONE 22c. OFFICE SYMBOL 202-433-3881

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using visual, tactile and non-destructive techniques. Ultrasonic thickness readings of the three elevated, steel water tanks were taken. The detailed inspection included documentation of the condition of the interior and exterior of the facilities with color photography.

Minor repairs are necessary in order to insure the long term serviceability of the structure. Cost estimates for the repairs are included in this report except for the repainting of the interior of the steel tanks. A contract has been awarded for the repainting of the interior of Facilities 1553, 3266 and 3850 and for this reason the cost estimates for repainting have been omitted. It is recommended that additional repairs be added to the painting contract in order to minimize their cost.

Prior to the inspection, all diving equipment, tools and photography equipment equipment were disinfected. The disinfection consisted of immersing the equipment in a tank filled with water containing a minimum of 500 mg/l of free chlorine. Each diver wore a dry suit with a full face mask. The divers, fully dressed in their drysuits were also disinfected by rinsing the exterior of thee suits in the concentrated solution.

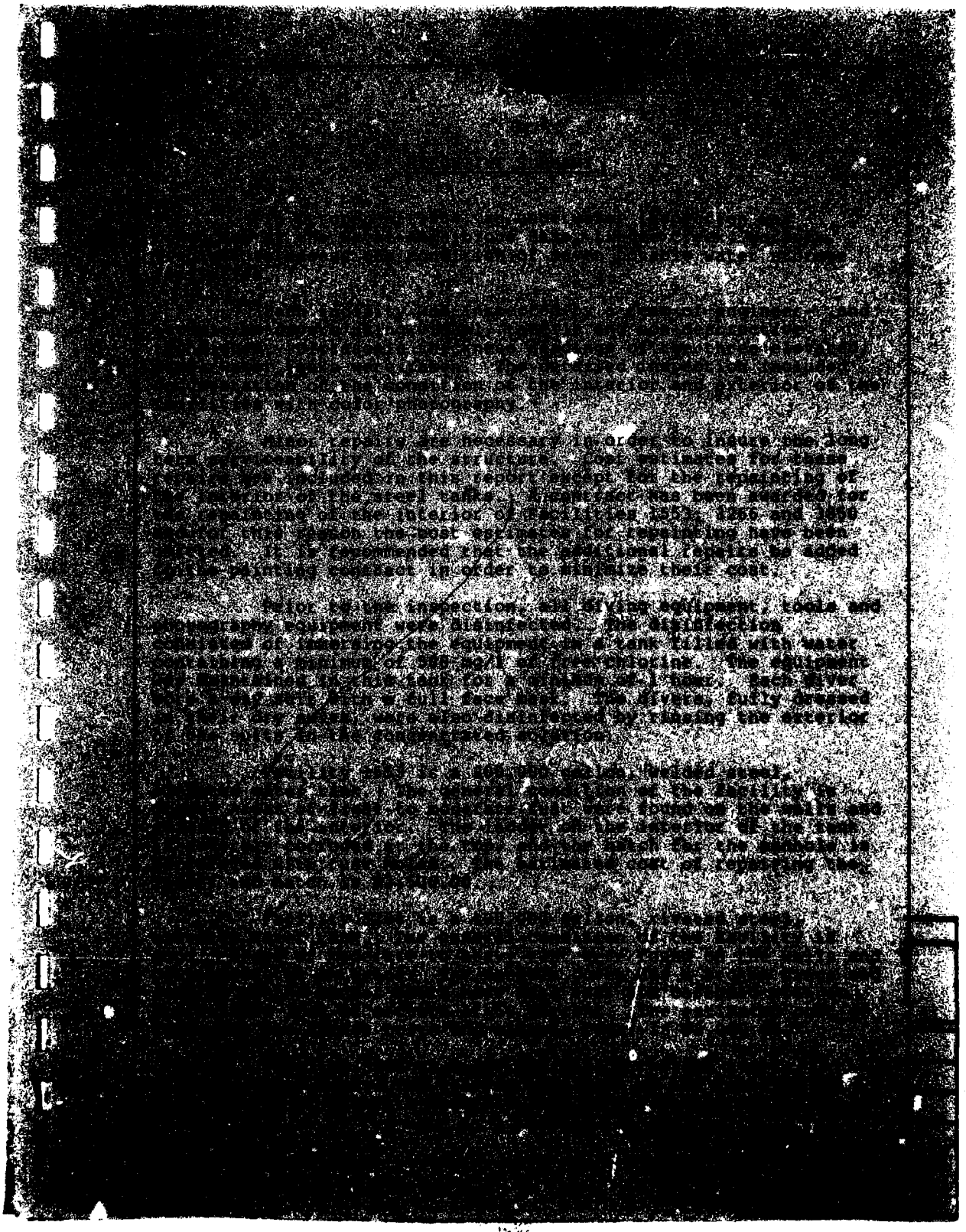
Facility 1553 is a 200,000 gallon, welded steel, elevated water tank. The general condition of the facility is good. Areas of light to moderate rust were found on the walls and ceiling of the interior. The ladder on the interior of the tank is severely corroded at the top, and the hatch for the manhole is perforated with rust holes. The estimated cost of repairing the ladder and hatch is $2,500.00.

Facility 3266 is a 100,000 gallon, riveted steel, elevated water tank. The general condition of the facility is good. Areas of moderate to heavy rust were found on the walls and ceiling of the interior. The manhole cover has a broken hinge and several of the anchor bolts have nuts that are corroded with an approximate loss of section of 50 percent. The estimated cost of repairing the anchor bolts and manhole cover is $2,000.00.

Facility 3850 is a 200,000 gallon, welded steel, elevated water tank. The general condition of the facility is good. Areas of light to moderate rust were found on the walls and ceiling of the interior. The exterior ladder and safety cage are in poor condition due to corrosion. There is a cracked weld in one of the supports for the overflow pipe. The estimated cost for replacing the ladder and repairing the pipe support is $14,000.00. It is also recommended that no one use the ladder until it is repaired.

Facility 3080 is a 250,000 gallon, concrete reservoir. The general condition of the facility is good. On the interior of the reservoir, there are minor hairline cracks on the ceiling, and areas of minor concrete scaling were found on the walls and ceiling. A quarter of an inch of brown sediment has accumulated on the bottom of the reservoir. There are hairline cracks on the exterior of the walls with efflorescence along them. These defects are minor and no repairs are recommended.

Facility 3081 is a 250,000 gallon, concrete reservoir. The general condition of the facility if good. On the interior of the reservoir, minor areas of concrete scaling were found on the ceiling and walls. A quarter of an inch of brown sediment has accumulated on the bottom of the reservoir.



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Facility 3080 is a 250,000 gallon, concrete reservoir. The general condition of the facility is good. On the interior of the reservoir, there are minor hairline cracks on the ceiling and areas of minor concrete scaling were found on the walls and ceiling. A quarter of an inch of brown sediment has accumulated on the bottom of the reservoir. There are hairline cracks on the exterior of the walls with efflorescence along them. These defects are minor and no repairs are recommended at this time.

Facility 3081 is a 250,000 gallon, concrete reservoir. The general condition of the facility is good. On the interior of the reservoir, minor areas of concrete scaling were found on the ceiling and walls. A quarter of an inch of brown sediment has accumulated on the bottom of the reservoir. There are also hairline cracks, with efflorescence along them, on the exterior of the walls. These defects are minor and no repairs are recommended at this time.

Facility NAB 753 is a 1.5 million gallon concrete reservoir. The facility is generally in good condition. On the interior, spalled areas with reinforcing steel exposed were found on the ceiling. A layer of silt, one-eighth inch deep, covers the bottom of the reservoir. The vent cap is heavily rusted along one of its welds. Cracks approximately one-eighth inch wide are in the roof and there are hairline cracks with, efflorescence along them, on the exterior walls. It is recommended that the spalled areas and vent cap be repaired. The estimated cost of these repairs is $10,000.00.

Facility NAB 754 is a 1.5 million-gallon concrete reservoir. The facility is generally in good condition. On the interior there are spalled areas, with reinforcing steel exposed, on the ceiling. A layer of silt on the interior, one-eighth inch deep, covers the bottom. Cracks, approximately one-eighth inch wide, are in the roof and hairline cracks, with efflorescence along them, are on the walls of the exterior. The vent cap has severe rust along one of its welds. It is recommended that the spalled areas, cracks in the roof and vent cap be repaired. The estimated cost of these repairs is $10,000.00.

[redacted] WATER TANKS

INSPECTION AND ASSESSMENT

AT

NAVAL AMPHIBIOUS BASE

[redacted]	Type of Structure	Dimensions** (Height x Diameter)	Location Within Amphibious Base	Recommendations	Estimated Cost of Recommendations
[redacted]	[redacted] Gallon Elevated, Steel Water Tank	132'-6" x 36'	Northeast of Gate 1	Repair Interior*** Ladder; Replace Hatch	[redacted]
[redacted]	[redacted] Gallon Elevated, Steel Water Tank	131'-6" x 24'	At the Intersection of "D" Street and 3rd Street	Repair Anchor Bolts; Replace Hinge on Manhole Cover	[redacted]
[redacted]	[redacted] Gallon Elevated, Steel Water Tank	132'-6" x 36'	At the Intersection of 10th Street and Helicopter Road	Repair Pipe*** Support; Replace Exterior Ladder and Cage	[redacted]
[redacted]	[redacted] Gallon, Concrete Reservoir	22'-3" x 56'	At the Intersection of "D" Street and 3rd Street	No Repairs Recommended	
[redacted]	[redacted] Gallon, Concrete Reservoir	22'-3" x 56'	At the Intersection of "D" Street and 3rd Street	No Repairs Recommended	
[redacted]	1.5 Million Gallon, Concrete Reservoir	32'-6" x 113'	At the Intersection of Murray Road and Amphibious Drive	Repair Spalled Areas on Interior; Repair Cracks in Roof; Replace Vent Cap	$10,000
[redacted]	1.5 Million Gallon, Concrete Reservoir	32'-6" x 113'	At the Intersection of Murray Road and Amphibious Drive	Repair Spalled Areas on Interior; Repair Cracks in Roof; Replace Vent Cap	$10,000

[redacted] facility at five year intervals.
[redacted] was awarded to repaint the interior of the elevated tanks prior to this report.
** Height of elevated tanks are from ground level to top of tank.
Height of concrete reservoirs is from ground level to crown of roof.
*** Personnel should not be allowed to use ladder until recommended repairs are made.

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POTABLE WATER STORAGE FACILITIES

INSPECTION AND ASSESSMENT

AT

NAVAL AMPHIBIOUS BASE

LITTLE CREEK

NORFOLK, VIRGINIA

1. INTRODUCTION

This report consists of the results of a detailed inspection and assessment of seven water storage facilities at the Naval Amphibious Base, Little Creek, Norfolk, Virginia.

The investigation was conducted by Collins Engineers, Inc. for the Ocean Engineering and Construction Project Office (FPO-1) of the Chesapeake Division, Naval Facilities Engineering Command (CHESNAVFACENGCOM) as Task No. 3 of Contract N62477-83-D-0387.

1.1 Task Description

The task consisted of furnishing the engineering services necessary to achieve an assessment of the apparent general condition of the interiors of the facilities listed below:

Facility No.	Description
1553	200,000 Gallon Elevated Steel Tank
3266	100,000 Gallon Elevated Steel Tank
3850	200,000 Gallon Elevated Steel Tank
3080	250,000 Gallon Ground Level Concrete Reservoir
3081	250,000 Gallon Ground Level Concrete Reservoir
NAB 753	1.5 Million Gallon Ground Level Concrete Reservoir
NAB 754	1.5 Million Gallon Ground Level Concrete Reservoir

The task consisted of two phases: a field investigation phase and an assessment phase.

The field investigation phase consisted of an underwater inspection of the interior of the water storage facilities by an engineer-diver and two technician-divers. The inspection was conducted in such detail so as to make a general assessment of the physical condition of the entire interior surface of the structures. A visual "swim-by" inspection was made of all facilities under investigation, and a more detailed visual and tactile inspection was made of selected facility components. This detailed inspection included scraping, cleaning, and measurement of the components. Non-Destructive Testing (NDT) techniques were employed during the inspection of the elevated, steel tanks in order to determine the remaining thickness of the steel plates from which the tank was fabricated.

The assessment phase of the investigation consisted of documenting the configuration of the existing structures, summarizing the conditions encountered during the field inspection, evaluating their structural significance, and recommending actions that should be taken in order to insure long-term, cost-effective maintenance and utilization of the facilities. Estimated costs for repairs were also developed.

1.2 Report Content

Section 2 of the report contains a description of the Naval Amphibious Base, Little Creek, Norfolk, Virginia and its facilities including location, mission, environmental data and climatic conditions, along with a discussion of the inspection procedures. The report also contains the results of the inspection and the assessment of the findings, accompanied by pertinent drawings and photographs. The inspection results include a description of the structural configuration of each facility along with its apparent condition and a structural assessment of the conditions found. Recommendations including cost estimates for any repair or maintenance work are also included.

1.3 Points of Contact

Management of this contract by the Ocean Engineering and Construction Project Office (FPO-1) of the Chesapeake Division, Naval Facilities Engineering Command was provided by Mr. Wade F. Casey, Project Engineer in Charge. Points of contact at the Public Works Department of the Naval Amphibious Base were as follows: Lieutenant Commander J. R. Doyle, Public Works Officer; Mr. Keith Roberts, Head of the Architectural/Structural/Civil Branch within the Engineering Division; and Mr. James Corbitt, Civil Engineer.

1.4 Exit Briefing

An exit briefing was provided for base personnel on 2 November 1984. Discussion of pertinent conditions found during the inspection was provided for the seven facilities inspected. Attendees were as follows:

Names	Function	Phone No.
LCDR J. R. Doyle	PWO	(804)464-7285
Mr. W. L. Niven	PWO Engr. Div. Dir.	(804)464-7302
Mr. Keith Roberts	PWO Engr. Div.	(804)464-7302
Mr. James Corbitt	PWO Engr. Div.	(804)464-7302
Mr. Wade F. Casey	CHESDIV NAVFAC	(202)433-3881
Mr. Thomas J. Collins	Collins Engineers	(312)454-1060

2. ACTIVITY DESCRIPTION

2.1 Name of Activity

Naval Amphibious Base, Little Creek, Norfolk, Virginia

2.2 Location of Activity

Located at latitude 36 degrees 55 minutes north and longitude 76 degrees 11 minutes west, the Naval Amphibious Base is located near the mouth of Chesapeake Bay just east of the Sewells Point Naval Complex (See Figures 2.2-1 and 2.2-2). This strategic location enjoys immediate access to the Atlantic Ocean through the Chesapeake Bay thus providing a natural protected site for its main function of home porting amphibious type ships.

2.3 Mission of Facility

The Naval Amphibious Base, Little Creek contains 61 piers of various lengths available for the berthing, fueling, and repair of home ported and transient ships.

2.4 Description of Activity

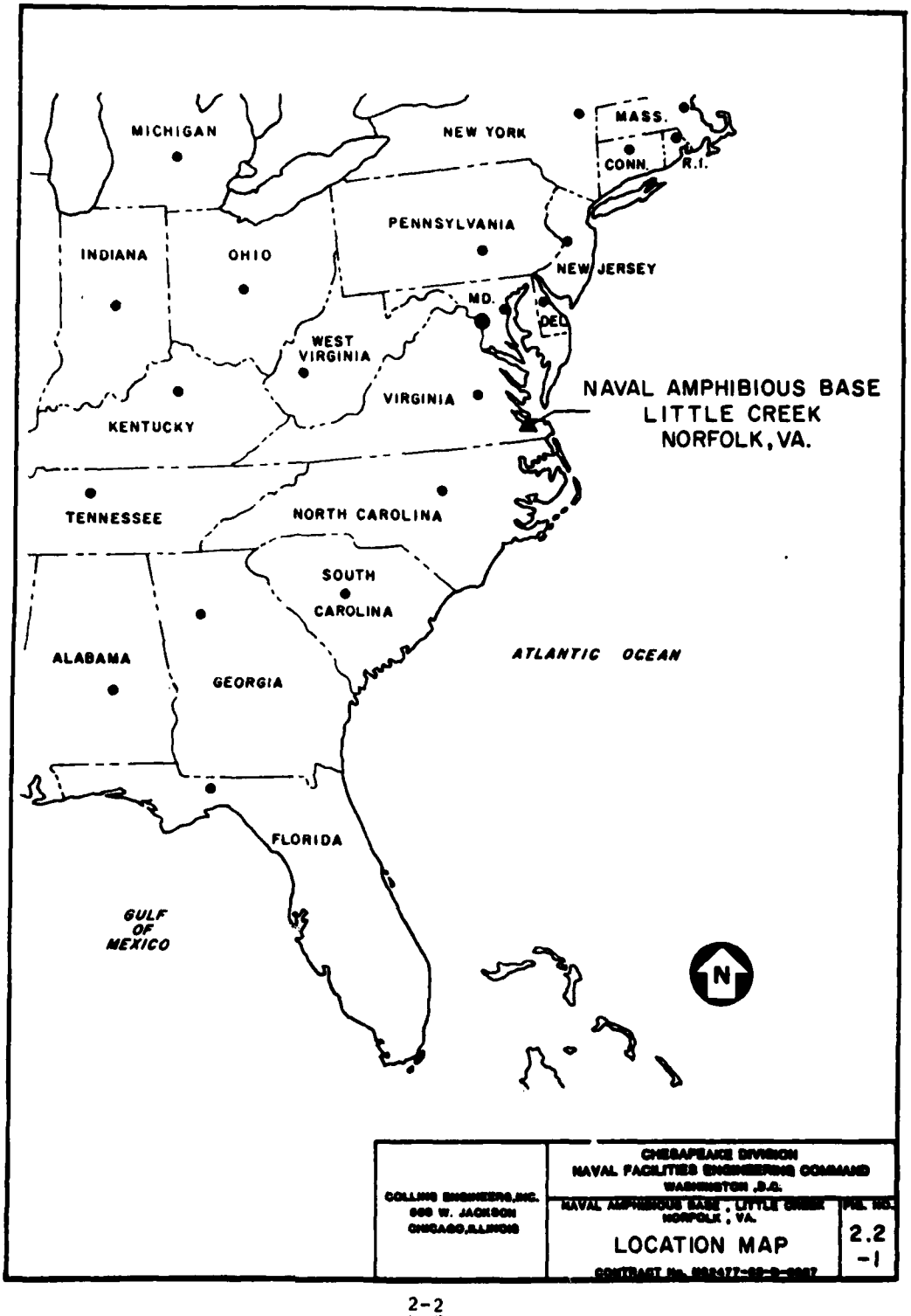
This report is concerned with the potable water storage facilities that serve the permanent base facilities and home ported and transient ships. The water storage facilities inspected are shown in Figure 2.2-3 and listed below:

Facility 1553	Facility 3850
Facility 3080	Facility NAB 753
Facility 3081	Facility NAB 754
Facility 3266	

2.5 Environmental Data

2.5.1 Climate

The area's climate is moderate, with the winters relatively mild. Warm summers are frequently tempered by northeasterly breezes from the Atlantic Ocean. The mean minimum temperature for this region is 50.5 degrees F. The mean maximum temperature is 68 degrees F, with monthly averages varying from 41.2 degrees F in January to 78.6 degrees F in July. Prolonged cold waves seldom penetrate this area and the daily minimum temperature rarely goes below 20 degrees F. The average frost free period covers 239 days from March 23rd to November 18th. Precipitation is well distributed throughout the year. The annual average is 46.25 inches, with a high of 6.5 inches occurring during July. Snowfall averages 9.1 inches per year occurring chiefly during December and January. Major melting occurs within 24 hours after the snowfall has ceased. Frost penetration for design use is calculated to be 12 inches. The wind velocity is less than 12 knots 80 percent of the time and seldom exceeds 20 knots. The prevailing wind direction is generally southwest in the early winter, spring, and early summer, with the highest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PENNSYLVANIA
INDIANA
OHIO
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MD.
DEL.
WEST VIRGINIA
VIRGINIA
KENTUCKY
NAVAL AMPHIBIOUS BASE
LITTLE CREEK
NORFOLK, VA.
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
ATLANTIC OCEAN
ALABAMA
GEORGIA
FLORIDA
GULF OF MEXICO
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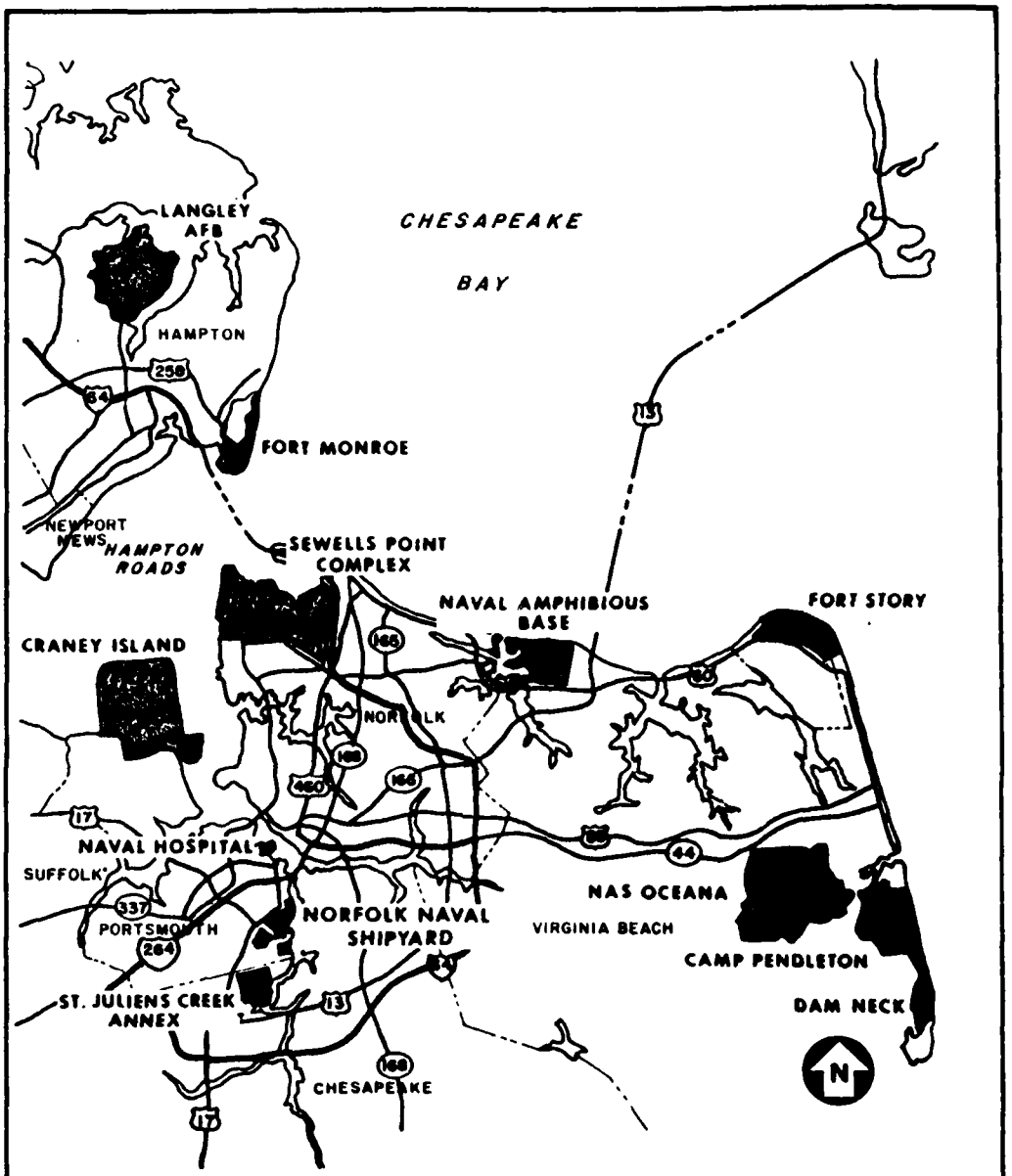
CHICAGO, ILLINOIS
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
NAVAL AMPHIBIOUS BASE, LITTLE CREEK
NORFOLK, VA.
LOCATION MAP
FIG. NO.
2.2
-1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CONTRACT No. N62477-80-C-0007
DWG. NO.
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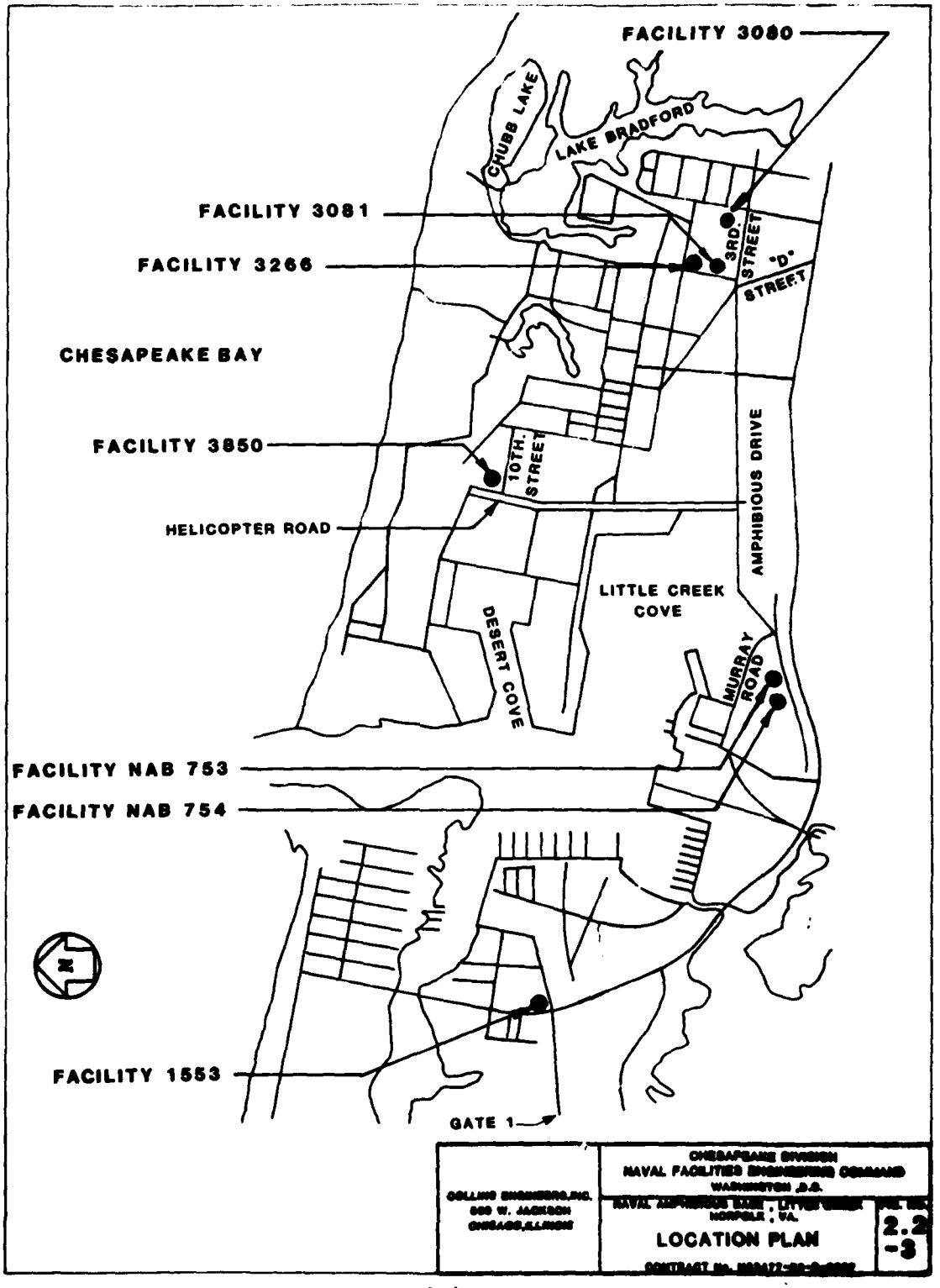

FACILITY 3080
CHUBB LAKE
LAKE BRADFORD
FACILITY 3081
3RD. STREET
"D" STREET
FACILITY 3266
CHESAPEAKE BAY
FACILITY 3850
10TH. STREET
AMPHIBIOUS DRIVE
HELICOPTER ROAD
LITTLE CREEK COVE
DESERT COVE
MURRAY ROAD
FACILITY NAB 753
FACILITY NAB 754
N
FACILITY 1553
GATE 1
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
LOCATION PLAN
2.2
-3

velocity usually occurring during the hours of darkness. However, northeasterly winds prevail about 25 percent of the time with highest velocity occurring during the daylight hours. The geographical position of the complex with respect to principal storm tracks is especially favorable, being south of the average path of the storms originating in the higher latitudes and north of the usual track of hurricanes and other tropical storms. Winds of hurricane force have occurred on an average of once every seven years (Reference 1).

2.5.2 Seismic Activity

The Naval Amphibious Base is located in Seismic Probability Zone 1, where only minor earthquake damage would be expected.

2.6 References

1. Sewells Point Area Navy Complex Master Plan, Naval Station, Norfolk

3. INSPECTION PROCEDURE

Between October 29, 1984 and November 2, 1984 an underwater inspection of the interior of seven potable water storage facilities was performed by a team of engineer- and technician-divers at the Naval Amphibious Base, Little Creek, Norfolk, Virginia. The inspection was conducted in such detail as to permit a general assessment of the physical condition of the structures.

The level of inspection and the type of structures to be inspected required the selection of inspection tools and methods that were effective and efficient. The inspection techniques used were selected for three reasons: to yield sufficient information to make a general assessment of the supporting structures of each facility; to identify areas of significant damage or deterioration; and to determine rates of deterioration through non-destructive testing. Divers were used so that the activity did not have to dewater the facilities to be inspected.

3.1 Level of Inspection

The extent of the inspections conducted at each facility was pre-determined. Generally, a swim-by inspection was conducted of all interior surfaces of the tanks. Some cleaning was performed on the steel surfaces which required NDT measurements. NDT measurements were taken only on steel tanks.

Representative, as well as unusual, conditions observed during the various levels of inspection, were documented with color photographs.

3.2 Inspection Procedure

A detailed underwater inspection was made of the accessible interior portions of the facilities described above. The inspection included the walls, roofs and bottoms of the reservoirs and tanks. The exterior portions of the facilities which were accessible from the ground, or the roofs, balconies and ladders of the structures were also inspected.

The underwater inspection was conducted by a four person team, including one engineer-diver, two technician-divers, and one engineer-tender. The divers, using scuba equipment, entered the water storage facilities through access manholes located on the roof of each facility.

Six hours before the inspection, base personnel raised the chlorine residual level in each facility to 1 part per million free chlorine. Prior to the inspection, all diving equipment, tools, and photography equipment were disinfected. The disinfection consisted of immersing the equipment in a tank containing a minimum of 500 mg/l of free chlorine. The equipment was maintained in this tank for a minimum of one hour. Each diver wore a dry suit, dedicated solely to work in potable water environments, and a full face mask or full helmet. Two alternate

procedures were used to disinfect the suited divers. In the first method, the divers, fully dressed in their dry suits, were disinfected by rinsing the exterior of their suits in the concentrated solution. In the second method, the suits were soaked in the solution, and the divers' hands, feet and headgear were rinsed immediately prior to entering the facilities. All equipment, after disinfection, was placed in a clean plastic bag inside a canvas bag and hauled to the point of access.

The water in each facility was raised to the overflow level in order to provide for easier access and egress. The interior of the tanks was generally dark, and the divers used underwater lights.

In making the swim-by inspection, the divers entered the tanks negatively buoyant, starting at the bottom and working upward. All areas below water were visually inspected. Areas of apparent distress were tactilely inspected, and silt, sediment, and rust were wiped from surfaces where necessary. The divers inspected the interior surfaces above the waterline by floating at the surface. The divers attempted to enter the standpipes of the steel tanks, but gratings at the bottom of each tank prevented access. On the surface, the divers reported the general conditions encountered to the tender located at the access opening.

Steel tank surfaces were cleaned in order to take ultrasonic thickness measurements (NDT). In general, this only required the diver to wipe loose sediment from the surface with a gloved hand.

An NDT inspection was made of each steel tank to determine the remaining thickness of the steel plates from which the tank was fabricated. One vertical line of measurements was taken from the bottom of the steel tank, near the standpipe, to above the waterline using an ultrasonic thickness measuring device. Measurements were made at intervals of approximately two feet vertically.

Underwater photography, along with detailed notes and sketches, were utilized to document the conditions encountered in the inspection. Also, a daily on-site report of the progress of the inspection was made to the on-site government representative.

3.3 Inspection Equipment

During the inspection various pieces of equipment were used to accomplish different tasks. A sounding line was used to determine the depth of the ground level facilities. A 50-foot and 6-foot tape were used to measure the facility and any defect encountered. A Nikonos IV-A underwater camera, with Creata wide-eye lens and an F-1 strobe, was used to document the inspection findings.

A Krautkramer D-meter ultrasonic thickness gauge, DM-2, was used to measure the thickness of the steel tanks. Miscellaneous minor equipment included dive lights, knives, scrapers, ropes, and safety belts.

4. FACILITIES INSPECTED

The facilities inspected at the Naval Amphibious Base are discussed in the following sections. The discussion in each section is presented in four parts:

1. A description of the structural configuration.

2. A discussion of conditions observed during the inspection.

3. An assessment of the structural condition.

4. Recommendations to ensure long term serviceability.

In the sections which describe the structural configuration, the figures included were developed from available drawings and inspection notes. Their general conformance with actual field conditions was verified by visual observations and measurements.

Of the seven facilities inspected, three were elevated, steel water tanks and four were ground level, concrete reservoirs. Ultrasonic thickness measurements were taken of the three steel tanks. A structural analysis of tanks of the three steel facilities was made using the ultrasonic thickness measurements. These analyses may be found in the Appendix. Refer to the Appendix also for the detailed cost estimates for the recommended repairs.

4.1 Facility 1553

4.1.1 Description

Facility 1553 is located northeast of the entrance to Gate 1. The facility is a 200,000 gallon, elevated, steel potable water tank with an overall height of approximately 130 feet. The outside diameter of the tank is 36 feet. The outside diameter of the standpipe is 4 feet. There is a balcony located approximately 110 feet from ground level which encircles the tank.

The water tank is constructed of steel plates that are butt welded together. Four wide-flange columns support the tank. The columns are laterally braced with horizontal beam struts and diagonal tension rods. A fixed steel ladder, which starts approximately ten feet above ground and extends to the balcony, is attached to one of the columns. The ladder is equipped with a safety cage. A curved ladder, also surrounded by a safety cage, extends from the balcony to, and can be rotated about, the vent at the center of the top of the tank.

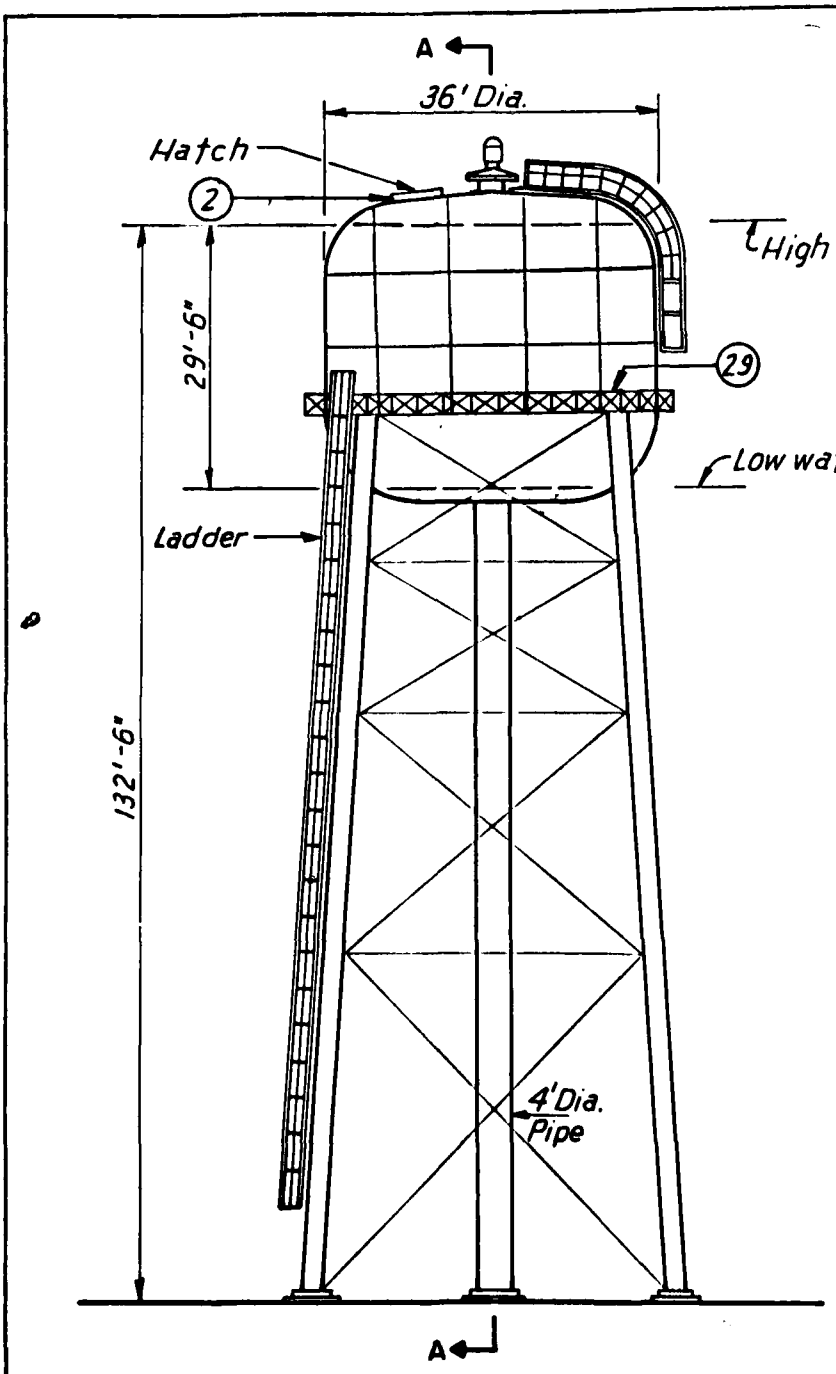
A drawing of the structure was developed from Y&D Drawing No. 511619 and Y&D Drawing No. 577268. No original design drawings are available. Refer to Figure 4.1 for an elevation of the tank showing its general configuration. For an overall view of the structure, see Photograph 4.1-1.

4.1.2 Observed Inspection Condition

The tank is generally in good structural condition. There are, however, two areas of severe localized corrosion. The sidepieces of the ladder on the interior of the tank are severely corroded at the top, where the ladder is connected to the tank, with holes extending completely through the sidepieces as shown in Photograph 4.1-2. The hatch which covers the access opening of the tank has small holes due to corrosion around its perimeter as shown in Photograph 4.1-3.

On the interior of the tank, areas of minor corrosion were found on the ceiling as shown in Photograph 4.1-4. Areas of light to moderate corrosion were found on the walls with the most severe areas being near the highwater line, and the less severe areas generally being submerged. Refer to Photographs 4.1-5 through 4.1-7 for typical conditions near and below the highwater line. Access to the standpipe from the bottom of the tank was prevented by a steel grate which covers the opening. Refer to Photograph 4.1-8 for a picture of the grate. The inspection notes are included on Figure 4.1.

Ultrasonic thickness measurements of the tank walls and bottom indicate that the tank was constructed using steel plates with two thicknesses. Measurements of the lower portion of the tank indicated values ranging from 0.36 to 0.44 inches with an average value of about 0.39 inches. Measurements of the upper



ELEVATION
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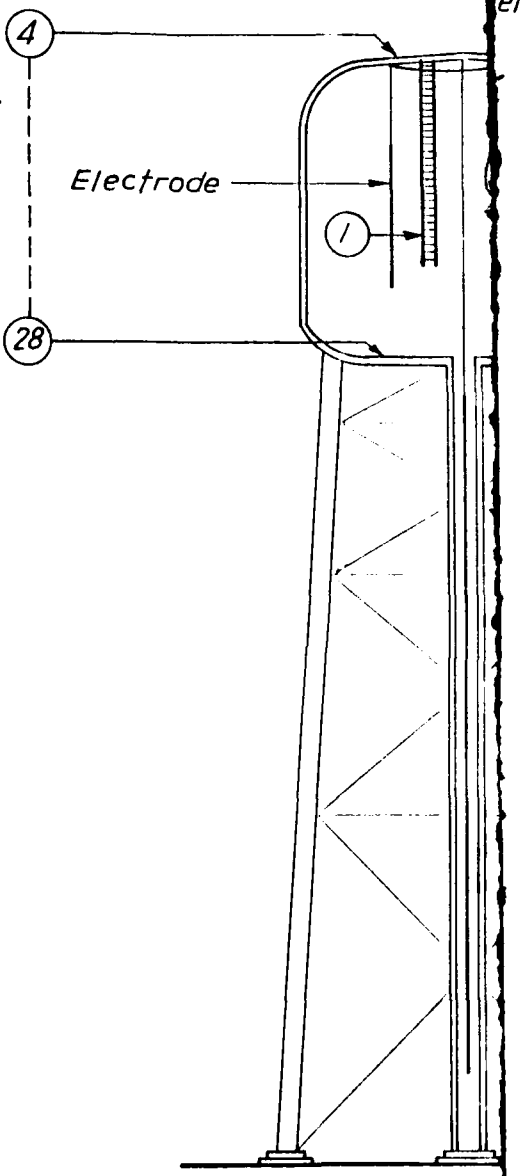
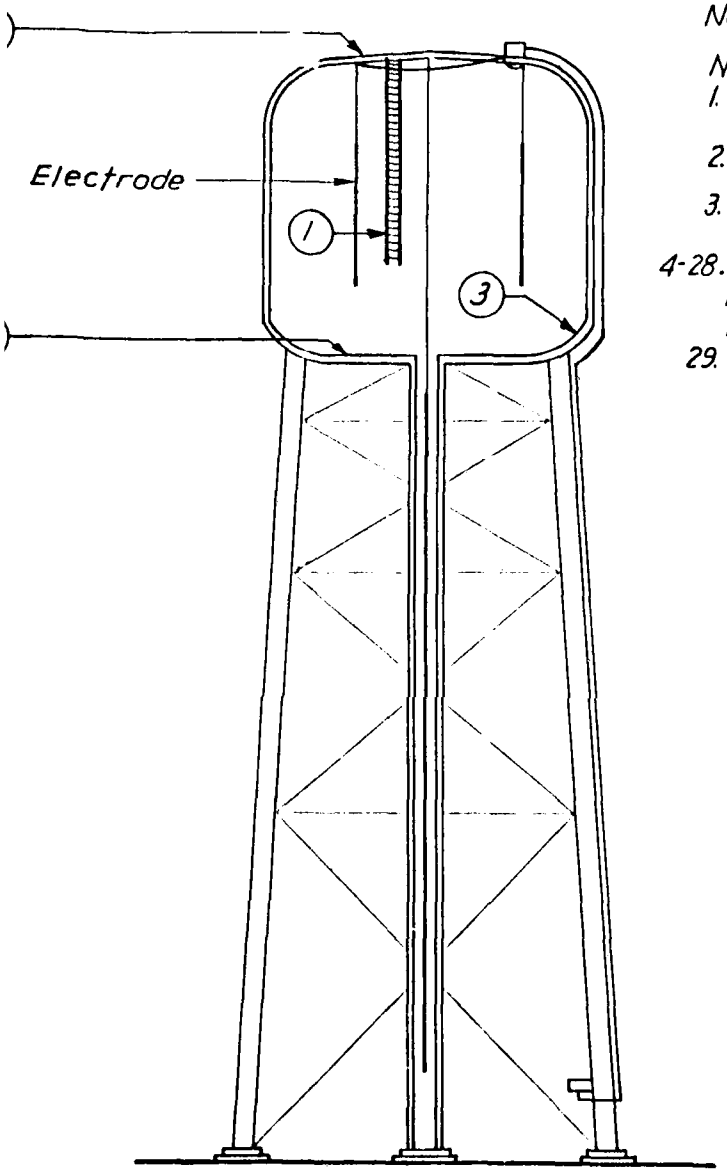


SECTION
Cathodic Prote
Scale: 1/16"



SECTION A-A

Cathodic Protection System
Scale: 1/16" = 1'-0"

GENERAL NOTES:
Drawing was developed from FEC Drawing No. 4-028-758 and Y & D Drawing No. 577268.

NOTES:
1. Ladder on interior of facility is severely corroded at top.
2. Holes due to corrosion in hatch
3. Areas of light to moderate corrosion on interior.
4-28. Ultrasonic thickness measurements. Measurements taken at approximately 2" intervals. Values given in table below.
29. Minor areas of corrosion on floor plate of balcony.

ULTRASONIC THICKNESS MEASUREMENTS			
4	0.30"	16	0.44"
5	0.29"	17	0.40"
6	0.29"	18	0.41"
7	0.29"	19	0.40"
8	0.29"	20	0.36"
9	0.29"	21	0.38"
10	0.31"	22	0.37"
11	0.28"	23	0.36"
12	0.31"	24	0.36"
13	0.31"	25	0.37"
14	0.28"	26	0.37"
15	0.29"	27	0.40"
		28	0.40"

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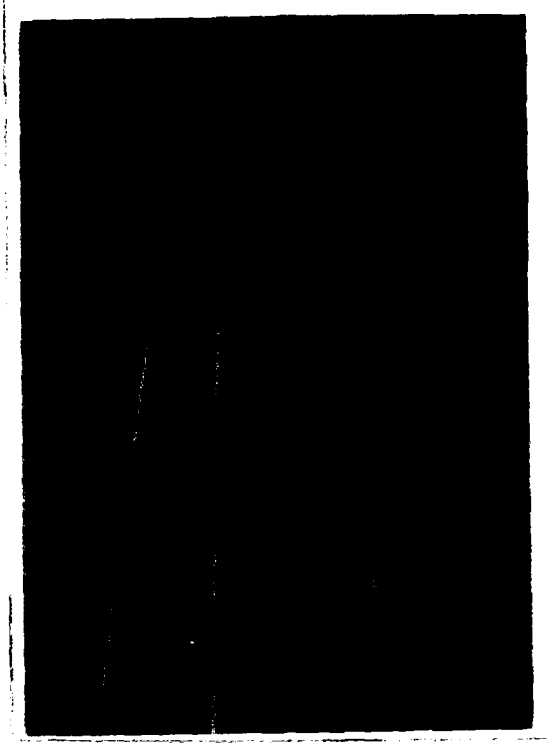
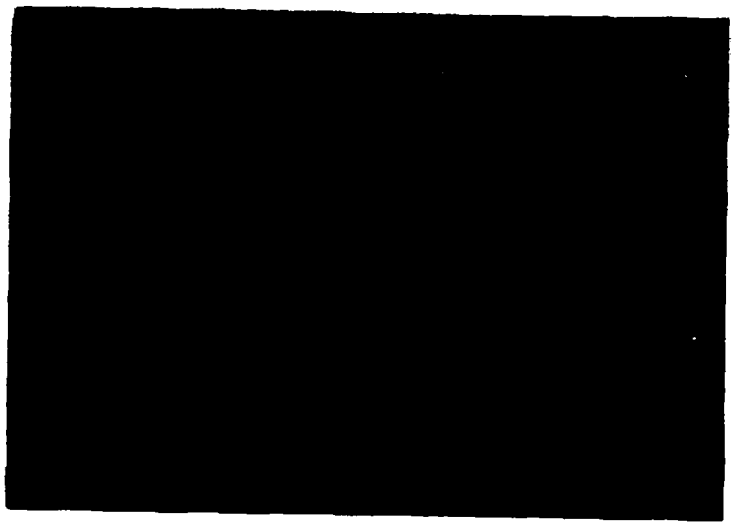
	NAVAL AMPHIBIOUS BASE, LITTLE CREEK NORFOLK, VA. FACILITY 1553 CONTRACT No. N62477-88-D-0387	FIG. NO. 4.1



PHOTOGRAPH 4.1-1
Overall View of Facility 1553.

PHOTOGRAPH 4.1-2
Facility 1553, Ladder on Interior of Tank.
Note Holes in Sidepieces at Top of Ladder.

PHOTOGRAPH 4.1-3
Facility 1553, Hatch for Access Hole. Note
Rust Holes in Hatch.

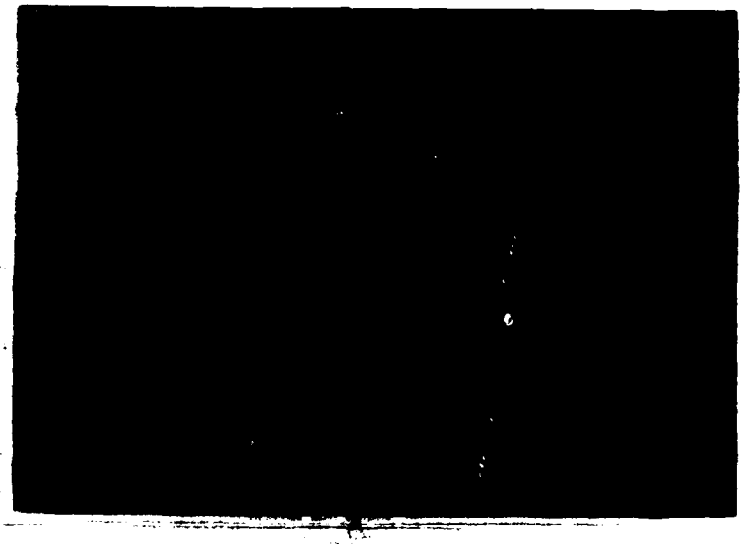


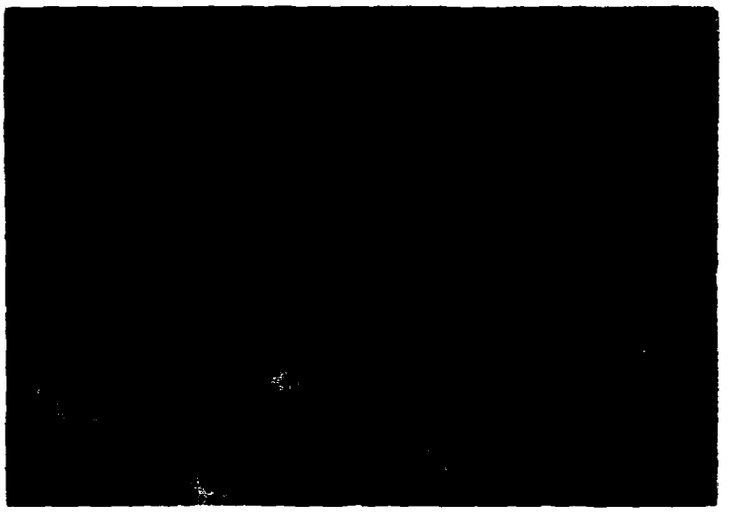
PHOTOGRAPH 4.1-4
Facility 1553, Interior of Tank. Typical Condition of Ceiling. Note Light Rust.

PHOTOGRAPH 4.1-5
Facility 1553, Interior of Tank. Underwater Photograph of Walls at Waterline.

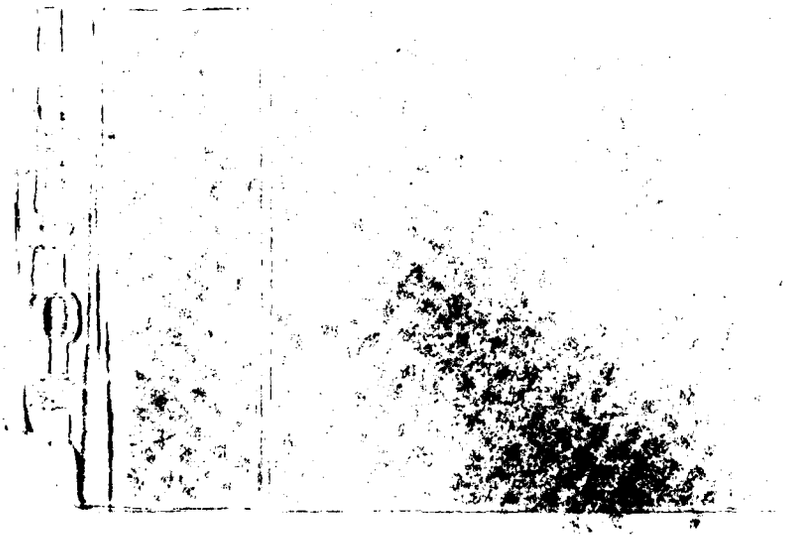
PHOTOGRAPH 4.1-6
Facility 1553, Interior of Tank. Typical Condition of Walls Below Waterline. Note Light Rust.

PHOTOGRAPH 4.1-7
Facility 1553, Interior of Tank. Typical Condition of Walls Below Waterline. Note Light Rust.





PHOTOGRAPH 4.1-8
Facility 1553, Interior of Tank.
Note Grate Covering Hole to Standpipe.



portion indicated values which varied from 0.28 to 0.31 inches with an average of 0.29 inches. The original thicknesses of the plates are not known. Values of thickness measurements obtained during the inspection are included on Figure 4.1.

4.1.3 Structural Condition Assessment

The facility is generally in good structural condition. The areas of corrosion on the interior of the tank are minor and have not resulted in any significant loss of section. If the interior is not maintained more extensive corrosion can be expected which will increase the amount of labor required to prepare the surface for repainting and could eventually weaken the structure.

The ladder on the interior of the tank is in poor condition and should be replaced. Personnel should not be allowed to use the ladder until repairs are made. The hatch cover on the top of the tank is in poor condition and should be replaced in order to prevent dirt and other debris from entering the tank. The exterior of the tank was in good condition.

A structural analysis of the tank portion of the steel structure was made using average thickness measurements determined during the inspection. The analysis indicates that the stresses in the steel plates are relatively low, and the tank has not been significantly weakened by corrosion. The water levels used for the analysis were obtained from Y&D Drawing No. 577268. A copy of the analysis is included in the Appendix of this report on Pages A-2 and A-3.

4.1.4 Recommendations

The Public Works Department informed the inspection team that a contract had been awarded to apply a new paint coating on the interior of the elevated water tank. A review of the contract documents for that work indicates the coating and surface preparation specified will be satisfactory in light of the conditions found during the inspection.

It is recommended that the following repairs be made in addition to the repainting now under contract. The ladder on the interior of the tank should be repaired by welding two pieces of steel to the sidepieces at the top of the ladder, and the hatch cover should be replaced. The estimated cost of these repairs is $2,500. Refer to the Appendix, Page A-8, for a detailed cost estimate. These repairs should be made by the painting contractor, if possible, at the same time the tank is drained for repainting in order to minimize the cost.

The cathodic protection system, particularly within the standpipe, should be inspected after the painting work, prior to refilling the tank, and repaired as necessary. It is also recommended for future tank painting contracts that the contractor be required to guarantee his work for one year from acceptance of the work. It is further recommended that regular inspections of the facility be made at five year intervals in accordance with American Water Works Association Standard D101.

4.2 Facility 3266

4.2.1 Description

Facility 3266 is located at the southeast corner at the intersection of "D" Street and 3rd Street. The facility is a 100,000 gallon elevated, steel, potable water tank with an overall height of approximately 130 feet. The outside diameter of the tank is 54 feet. There is a balcony, located approximately 100 feet from ground level, which encircles the tank. The diameter of the standpipe is 5 feet.

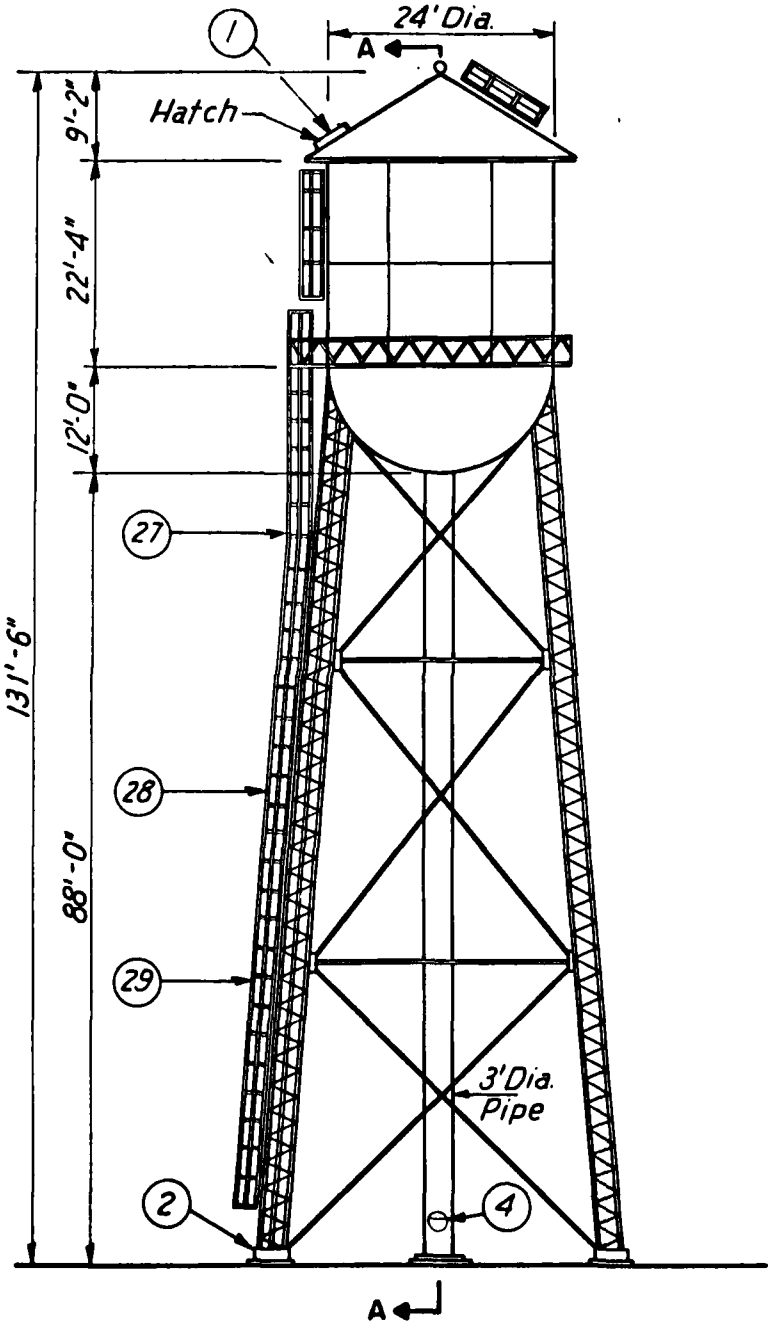
The water tank is constructed of steel plates that are riveted together. Four steel channel and plate columns support the tank. The columns are laterally braced with horizontal beam struts and diagonal tension rods. A fixed steel ladder, which starts approximately ten feet above ground and extends to the balcony, is attached to one of the columns. The ladder is equipped with a safety cage. Another fixed ladder, with a safety cage extends from the balcony to the roof of the tank. A third ladder, also surrounded with a safety cage, extends from the edge of the roof to, and can be rotated about, the vent at the center of the top of the tank.

A drawing of the structure was developed from Y&D Drawing No. 1108-115. No original design drawings of the structure are available. Refer to Figure 4.2 for an elevation of the structure showing its general configuration. For an overall picture of the structure, see Photograph 4.2-1.

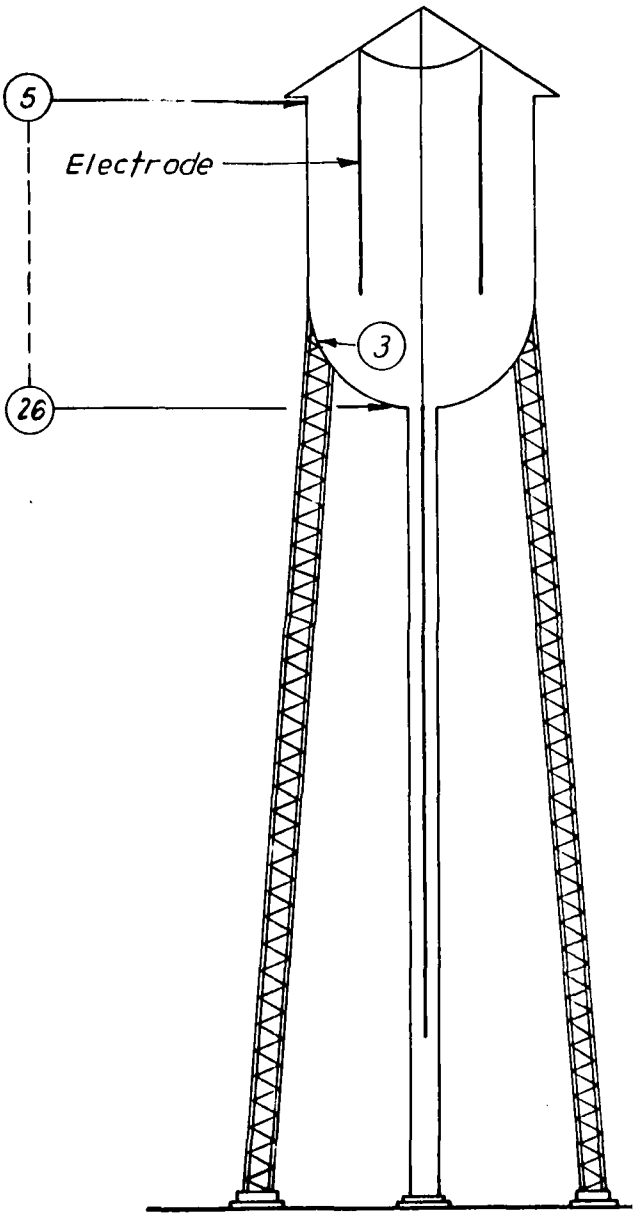
4.2.2 Observed Inspection Condition

Light to moderate corrosion was found on the interior of the tank, and the interior coating is generally deteriorated. The outstanding leg of the horizontal ring stiffener angle, where the roof and walls meet, has experienced losses of section of up to about 25 percent as shown in Photograph 4.2-2, and there are light areas of corrosion on the ceiling. Below the highwater line, the walls are generally covered with a coating of rust as shown in Photograph 4.2-3. The corrosion on the lower submerged portions of the wall are generally less severe than those areas at the highwater line as can be seen in Photographs 4.2-3 and 4.2-4. Debris was found caught in the rungs of the interior ladder as shown in Photograph 4.2-5, and there was approximately 3 inches of sediment on the bottom of the tank.

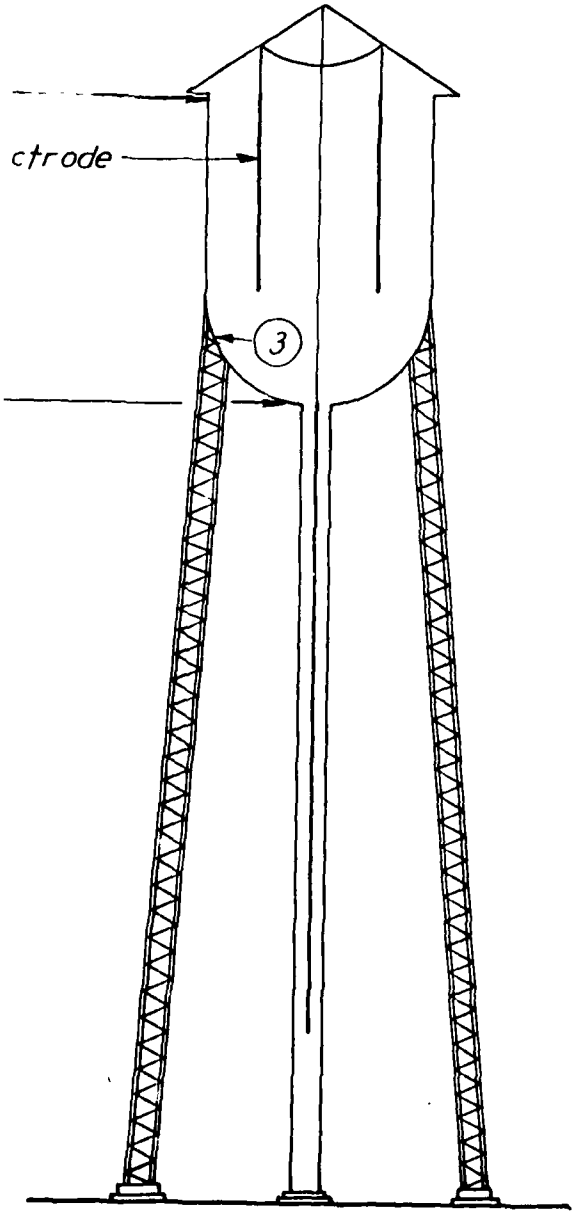
The paint on the exterior of the tank was generally in good condition. The cover for the access opening on the top of the tank has a broken hinge as shown in Photograph 4.2-6. Several of the anchor bolts at the base of the structure have nuts which are corroded with approximate losses of section of 50 percent. Refer to Photograph 4.2-7 for a picture of a typical anchor bolt. The inspection opening at the base of the standpipe shows evidence of seepage as can be seen in Photograph 4.2-8. On the ladder from



ELEVATION
Scale: 1/16"=1'-0"



SECTION A-A
Cathodic Protection Syster
Scale: 1/16"=1'-0"



SECTION A-A

Cathodic Protection System
Scale: 1/16"=1'-0"

GENERAL NOTES:
Drawing developed from Y.&D. Drawing No. 1108-115.

NOTES:
1. Hinge broken on manhole cover.
2. Several nuts on the anchor bolts are corroded with approximate loss of section of 50%.
3. Areas of light to moderate corrosion on interior.
4. Water seeping from inspection hole.
5-26. Ultrasonic thickness measurements. Measurements taken at approximately 2' intervals. Values given in table below.
27. Cracked nut on ladder bracket.
28. Two nuts missing on ladder bracket.
29. One bolt and nut missing on safety cage.

ULTRASONIC THICKNESS MEASUREMENTS			
5	0.22"	17	0.27"
6	0.27"	18	0.29"
7	0.29"	19	0.28"
8	0.28"	20	0.28"
9	0.28"	21	0.28"
10	0.24"	22	0.32"
11	0.25"	23	0.26"
12	0.26"	24	0.43"
13	0.31"	25	0.41"
14	0.36"	26	0.36"
15	0.31"		
16	0.29"		

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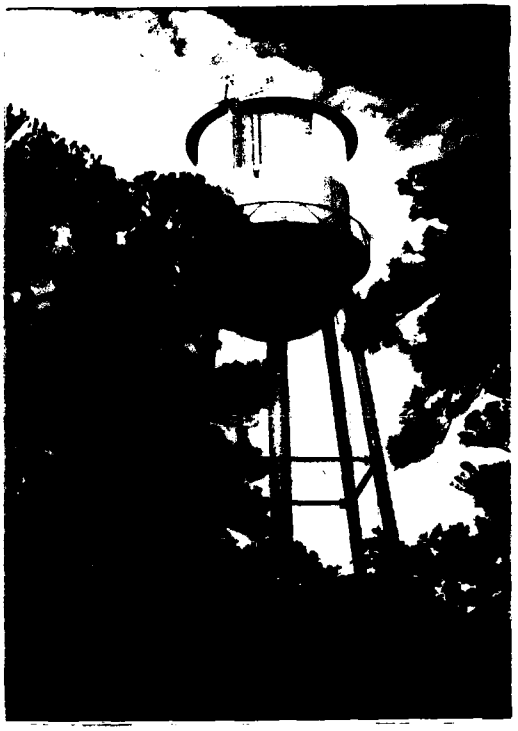
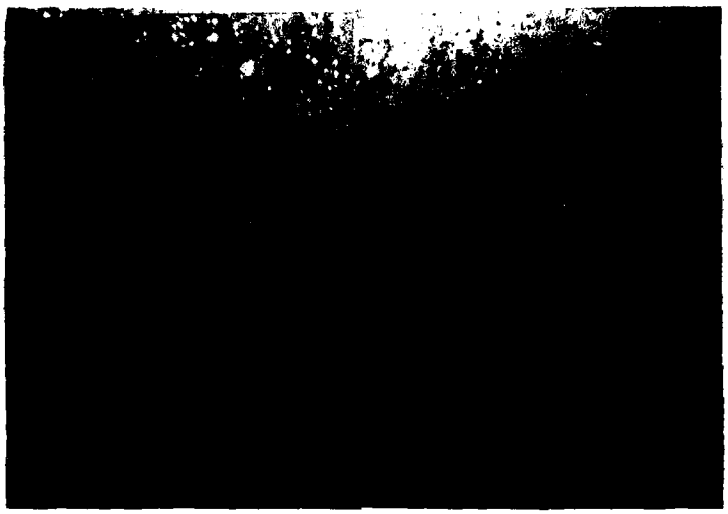
	NAVAL AMPHIBIOUS BASE, LITTLE CREEK NORFOLK, VA.	FIG. NO.
	FACILITY 3266	4.2
	CONTRACT No. N62477-83-D-0367	



PHOTOGRAPH 4.2-1
Overall View of Facility 3266.

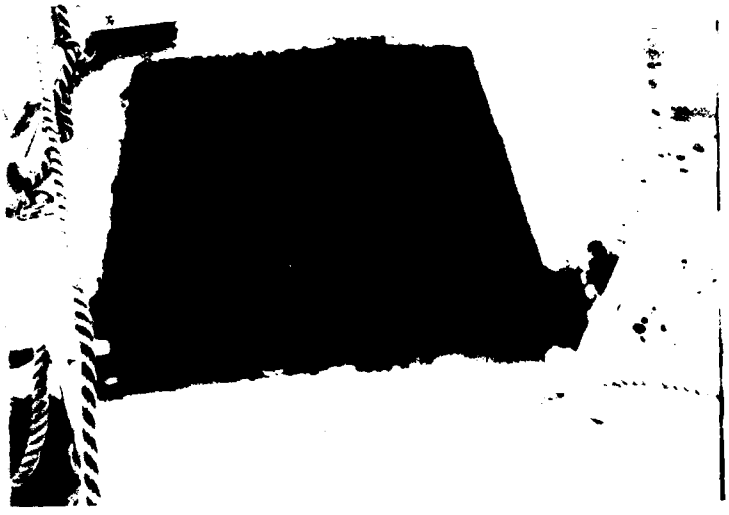
PHOTOGRAPH 4.2-2
Facility 3266, Interior. Typical Condition of Walls and Ceiling. Note Rust.

PHOTOGRAPH 4.2-3
Facility 3266, Interior. Typical Condition of Walls Below the Waterline. Note Rust.



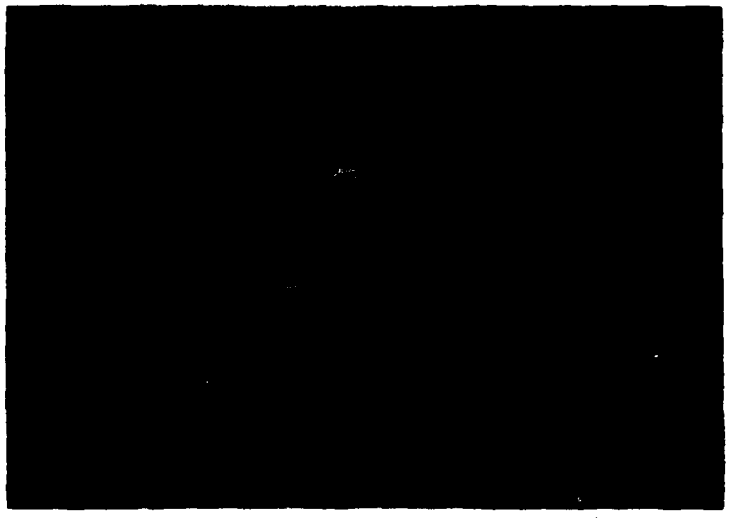
PHOTOGRAPH 4.2-4
Facility 3266, Interior. Typical Condition of Walls Below Waterline.

PHOTOGRAPH 4.2-5
Facility 3266, Interior. Note Debris Caught Behind Rung of Ladder.



PHOTOGRAPH 4.2-6
Facility 3266, Exterior. Note Upper Hinge On Cover for Access Hole is Broken.

PHOTOGRAPH 4.2-7
Facility 3266, Exterior, Anchor Bolt. Note Corroded Nut on Anchor Bolt.



PHOTOGRAPH 4.2-8
Facility 3266, Exterior. Note Seepage From Inspection Hole in Standpipe.

the ground to the balcony, there was one cracked nut, two missing nuts, and one missing nut and bolt.

Ultrasonic thickness measurements of the tank walls and bottom indicate that it was constructed with steel plates of different thicknesses. Measurements of the bottom portion of the tank indicated plate thicknesses ranging from 0.26 to 0.43 inches with an average thickness of about 0.36 inches. The thickness of the plates in the lower vertical portion of the tank varied from 0.27 to 0.36 inches with an average thickness of 0.30 inches. The thickness of the plates in the top portion had a range of 0.22 to 0.31 inches and an average thickness of 0.27 inches. The original thicknesses of the plates are not known. A table of thickness measurements obtained during the inspection is included on Figure 4-2.

4.2.3 Structural Condition Assessment

The facility is generally in good structural condition. The areas of corrosion on the interior of the tank walls are minor and structurally insignificant at this time. If the interior of the tank is not cleaned and repainted, however, more extensive corrosion can be expected to increase the amount of labor required to prepare the surface for repainting and could eventually weaken the structure. The stiffening angle at the top of the vertical walls is not a main structural member, and its corrosion has not become severe enough at this time to warrant replacing it. If cleaned and protected with paint, it should be adequate.

The corrosion of the nuts on the anchor bolts is severe and the nuts should be replaced. The broken hinge on the hatch cover and the minor ladder defects should also be repaired.

A structural analysis of the tank portion of the structure was made using average thickness measurements determined during the inspection. The analysis indicates that the stresses in the steel plates are relatively low, and the tank has not been significantly weakened by corrosion. A copy of the analysis is included in the Appendix of this report on Pages A-4 and A-5.

4.2.4 Recommendations

The Public Works Department informed the inspection team that a contract had been awarded for applying a new paint coating on the interior of the elevated tank. A review of the contract documents for the work indicates that the coating and surface preparation specified will be satisfactory in light of the conditions found during the inspection.

It is recommended that the following repairs be made in addition to the painting of the interior now under contract. The corroded nuts on the anchor bolts should be replaced. If the nuts cannot be removed without damaging the anchor bolts, a steel collar, with a diameter greater than the nut and a length shorter than the exposed portion of bolt, can be placed over the bolt. A

steel washer could then be placed over the bolt and a new nut used to anchor the column. It is also recommended that the broken hinge on the manhole cover be replaced. The cracked and missing nuts and bolts on the ladder should also be replaced. The estimated cost of these repairs is $2,000. These repairs should be accomplished by the painting contractor, if possible, to reduce the cost of the work. A detailed cost estimate is included in the Appendix on Page A-8.

It is also recommended the plug for the inspection hole in the base of the standpipe be inspected and the repairs necessary to stop water from seeping be made when the tank is drained for repainting.

It is further recommended that in future contracts for tank painting the contractor be required to guarantee his work for one year from acceptance of the work. The cathodic protection system, particularly within the standpipe, should be inspected after the painting work, prior to refilling the tank and repaired as necessary. It is also recommended that regular inspections of the facility be made at five year intervals in accordance with American Water Works Association Standard D101.

4.3 Facility 3850

4.3.1 Description

Facility 3850 is located at the intersection of 10th Street and Helicopter Road. The facility is a 200,000 gallon elevated, steel, potable water tank with an overall height of approximately 130 feet. The outside diameter of the tank is 36 feet and the diameter of the standpipe is 4 feet. There is a balcony, located approximately 110 feet from ground level, which encircles the tank and provides a safe work area.

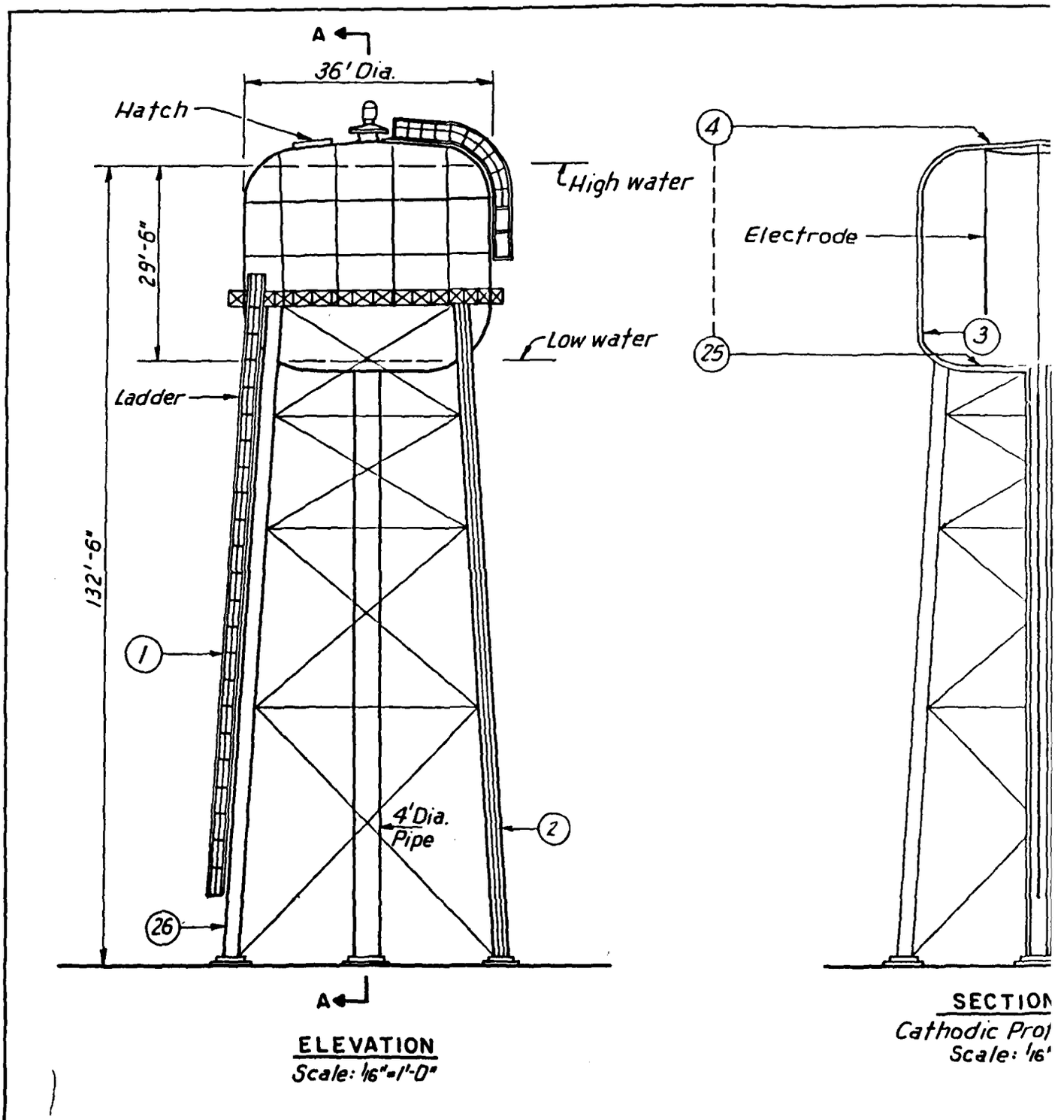
The water tank is constructed of steel plates that are butt welded together. Four wide-flange columns support the tank. The columns are laterally braced with horizontal beam struts and diagonal tension rods. A fixed steel ladder, which starts approximately ten feet above ground and extends to the balcony, is attached to one of the columns. The ladder is equipped with a safety cage. A curved ladder, also surrounded by a safety cage, extends from the balcony to, and can be rotated about, the vent at the center of the top of the tank.

A drawing of the structure was developed from Y&D Drawing No. 511619 and Y&D Drawing No. 577268. Refer to Figure 4.3 for an elevation showing the general configuration of the structure. For an overall picture of the facility, see Photograph 4.3-1.

4.3.2 Observed Inspection Condition

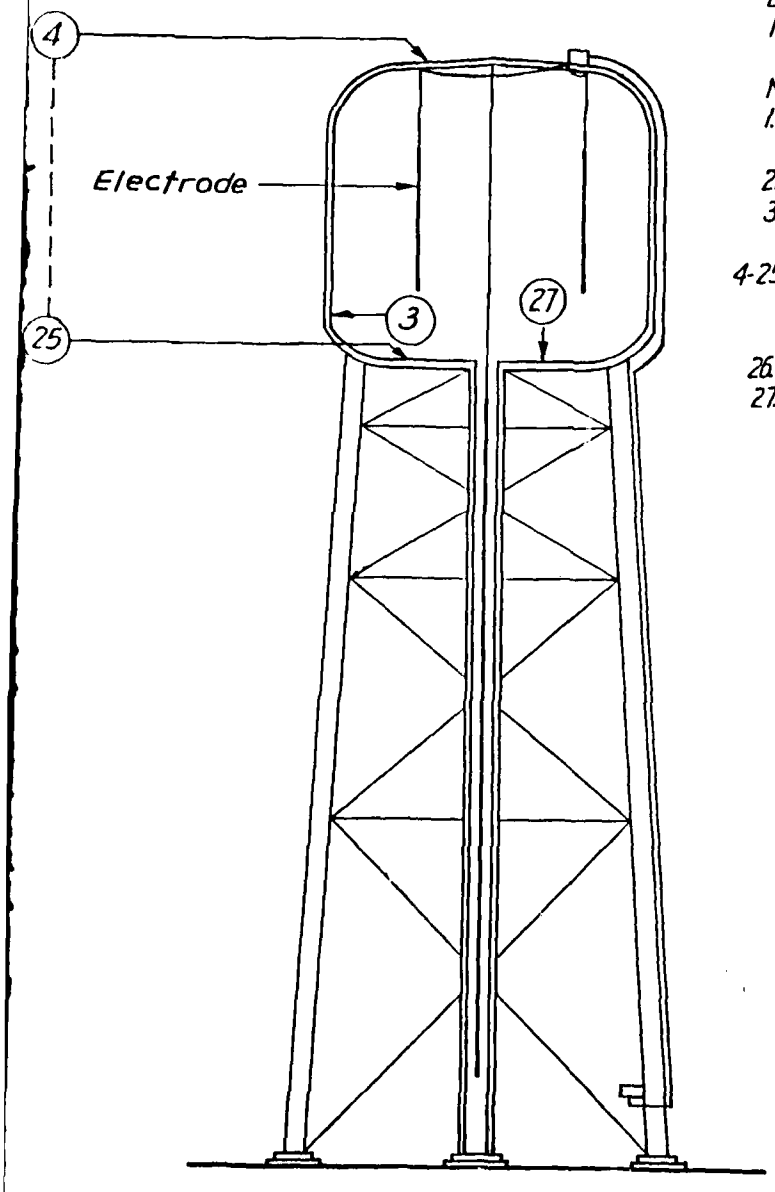
The tank is generally in good structural condition. There are, however, areas on the interior of the tank where the paint has deteriorated, and light to moderate areas of corrosion were found on the walls above and below the waterline. Localized areas of light rust were found on the interior ceiling as shown in Photographs 4.3-2 and 4.3-3. Photograph 4.3-3 also shows the light corrosion occurring in the area of the highwater line. This light corrosion, also illustrated below water by Photograph 4.3-4, is typical of the conditions found on the vertical sides of the tank below water. General areas of moderate corrosion, with a 3 inch accumulation of corrosion products and sediment were found on the bottom of the tank as shown in Photograph 4.3-5. Access to the standpipe through the bottom of the tank was prevented by a steel grate covering the hole.

The exterior ladder and safety cage which lead to the balcony of the tank are in very poor condition. The sidepieces of the ladder are heavily pitted and several of the rungs are bent. The bars of the safety cage are also pitted and have areas with holes in them due to corrosion. There is also one location where the sidepieces are completely severed so that the ladder is not connected to the column. The length of the unsupported portion of the ladder is approximately 4 feet. Refer to Photographs 4.3-6 through 4.3-8 for pictures showing the condition of the ladder.



ELEVATION
Scale: 1/16"=1'-0"

SECTION
Cathodic Prot
Scale: 1/16"



SECTION A-A
Cathodic Protection System
Scale: 1/16"=1'-0"

GENERAL NOTES:
Drawing was developed from Y.&D. Drawing No. 511619 and Y.&D. Drawing No. 577268.

NOTES:
1. Ladder and safety cage are heavily pitted and several of the rungs are bent.
2. Crack in weld of pipe support.
3. Areas of light to moderate corrosion on interior
4-25. Ultrasonic thickness measurements. Measurements taken at approximately 2" intervals. Values given in table below.
26. Pitted areas on column.
27. Approximately 3 inches of sediment on bottom.

ULTRASONIC THICKNESS MEASUREMENTS			
4	0.30"	16	0.34"
5	0.27"	17	0.32"
6	0.29"	18	0.33"
7	0.28"	19	0.35"
8	0.28"	20	0.33"
9	0.28"	21	0.44"
10	0.27"	22	0.52"
11	0.29"	23	0.46"
12	0.28"	24	0.44"
13	0.41"	25	0.50"
14	0.40"		
15	0.39"		

2

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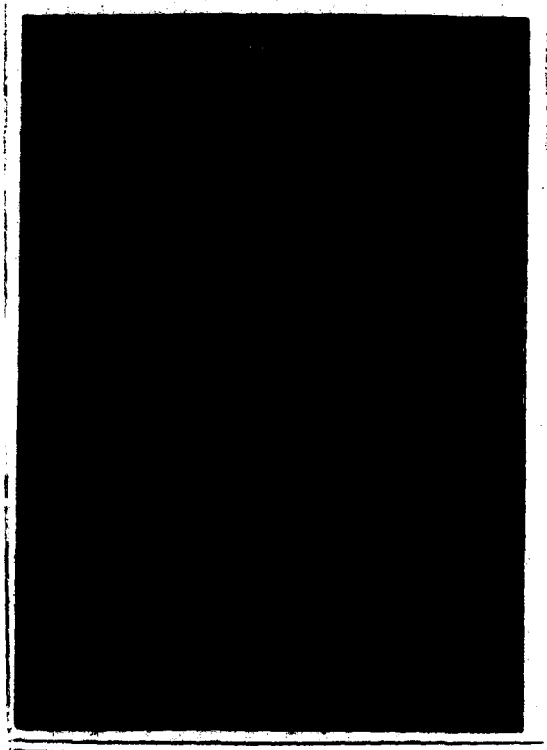
NORFOLK, VA.

FACILITY 3850

FIG. NO. 4.3

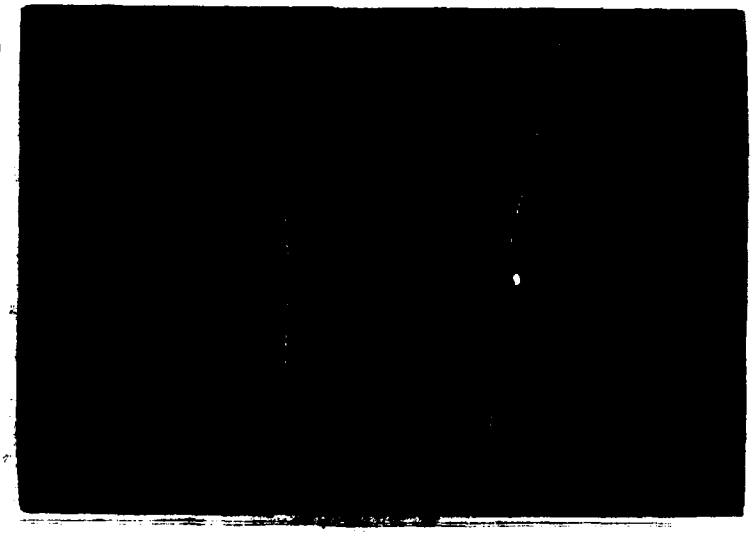
CONTRACT No. N62477-83-C-0387

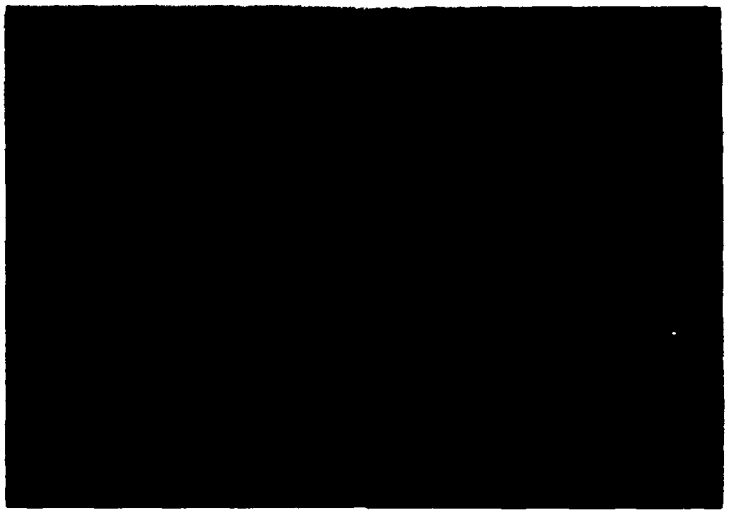


PHOTOGRAPH 4.3-1
Overall View of Facility 3850.

PHOTOGRAPH 4.3-2
Facility 3850, Interior, Typical Condition of Ceiling. Note Light Rust.

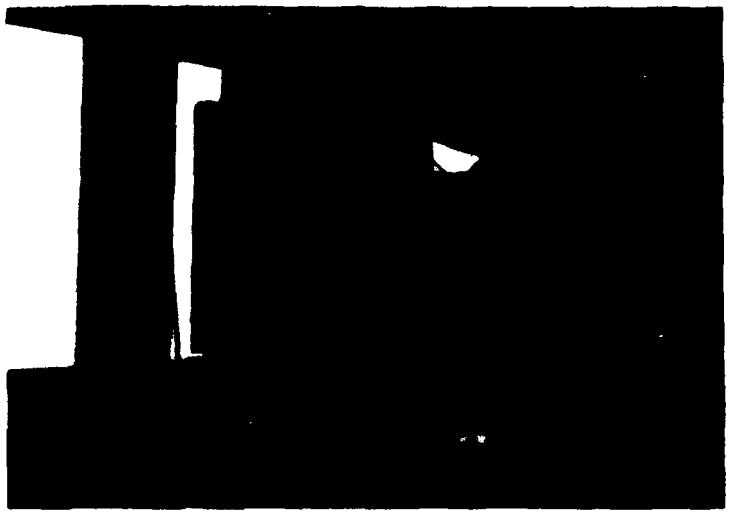
PHOTOGRAPH 4.3-3
Facility 3850, Interior. Typical Condition at Waterline. Note Rust.





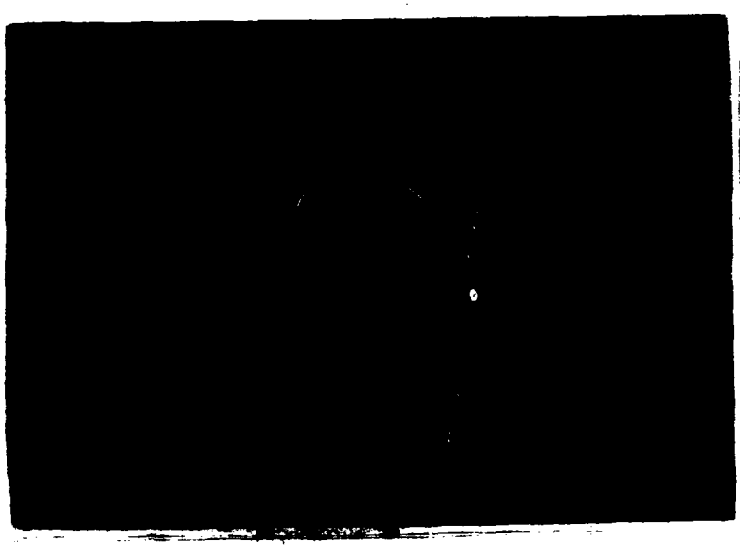
PHOTOGRAPH 4.3-4
Facility 3850, Interior. Typical Condition of Walls Below Waterline. Note Rust.

PHOTOGRAPH 4.3-5
Facility 3850, Interior. Typical Condition of Bottom. Note Rust.



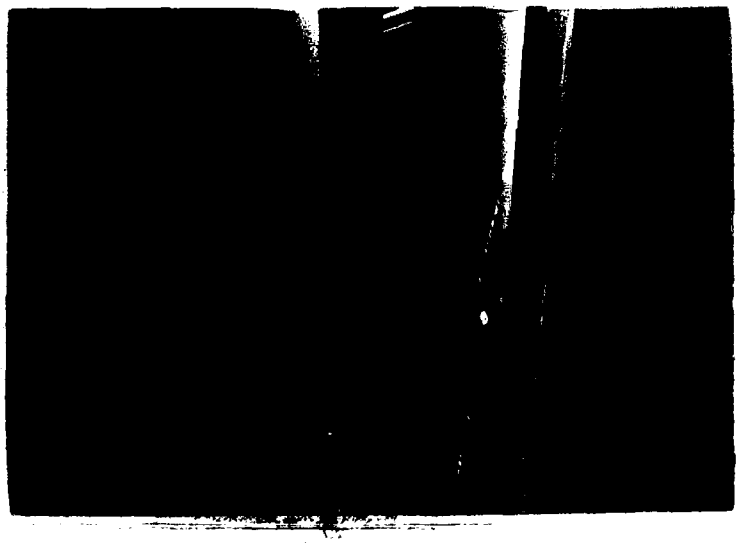
PHOTOGRAPH 4.3-6
Facility 3850, Exterior Ladder. Note Ladder is Not Connected at This Point.

PHOTOGRAPH 4.3-7
Facility 3850, Exterior. Note Rust Holes in Safety Cage of Ladder.



PHOTOGRAPH 4.3-8
Facility 3850, Exterior Ladder. Note Heavy Pitting and Bent Rung.

PHOTOGRAPH 4.3-9
Facility 3850, Exterior. Note Crack in Weld of Pipe Support.



Photograph 4.3-8 also shows the severe localized corrosion and pitting which has occurred on the columns of the structure. There is also a cracked weld in one of the brackets attaching the overflow pipe to the column as shown in Photograph 4.3-9.

Ultrasonic thickness measurements of the walls and bottom of the tank indicate it was constructed of plates of two different thicknesses. Measurements of the lower portion of the tank indicated values ranging from 0.52 to 0.32 inches with an average thickness of about 0.40 inches. Measurements of the top portion of the tank indicated thicknesses ranging from 0.27 to 0.30 inches with an average thickness of about 0.28 inches. The original thicknesses of the plates are not known. A table containing values of determined thicknesses is included on Figure 4.3.

4.3.3 Structural Condition Assessment

The facility is in good structural condition. The areas of corrosion on the upper portions of the interior of the tank are localized and minor. On the lower portions of the tank, however, the corrosion is moderate and extensive. If the interior of the tank is not repainted more extensive corrosion can be expected which may reduce its structural capacity and will increase the amount of labor required to prepare the surface for repainting.

A structural analysis of the tank portion of the steel structure was made using average thickness measurements obtained during the inspection. The analysis indicates that the stresses in the tank are relatively low, and the remaining steel section is adequate. A copy of the analysis is included in the Appendix on Pages A-6 and A-7.

The ladder and the safety cage of the tank are in poor condition and should be replaced.

4.3.4 Recommendations

The Public Works Department informed the inspection team that a contract had been awarded for applying a new paint coating on the interior of the tank. A review of the contract documents for that work indicates that the coating and surface preparation specified will be satisfactory in light of the conditions found during the inspection.

It is recommended that the following repairs be made in addition to the painting of the interior which is now under contract. The ladder and safety cage should be replaced. The broken weld on the overflow pipe bracket should be repaired. The estimated cost of these repairs is $14,000. A detailed cost estimate is included in Appendix A on Page A-9. It is further recommended that no one be allowed to use the ladder until it has been repaired.

The cathodic protection system, particularly within the the standpipe, should be inspected after the painting work, prior to refilling the tank, and repaired as necessary. It is also recommended for future tank painting contracts that the painting contractor be required to guarantee his work for one year from acceptance of the work. It is further recommended that regular inspections be made of the facility at five year intervals in accordance with American Water Works Association Standard D101.

4.4 Facility 3080

4.4.1 Description

Facility 3080 is located at the southwest corner of the intersection of "D" Street and 3rd Street. The facility is a 250,000 gallon, ground level, concrete reservoir. The reservoir is a vertical, reinforced concrete cylinder with an outside diameter of approximately 56 feet. The roof of the reservoir is an elliptic, reinforced concrete shell roof. The height of the structure from ground level to the crown of the roof is approximately 22 feet. Design drawings of the structure were not available. The dimensions given above are from field measurements made of the structure during the inspection. Refer to Figure 4.4 for a drawing showing the general configuration of the structure, and Photograph 4.4-1 for a general view of the exterior of the facility.

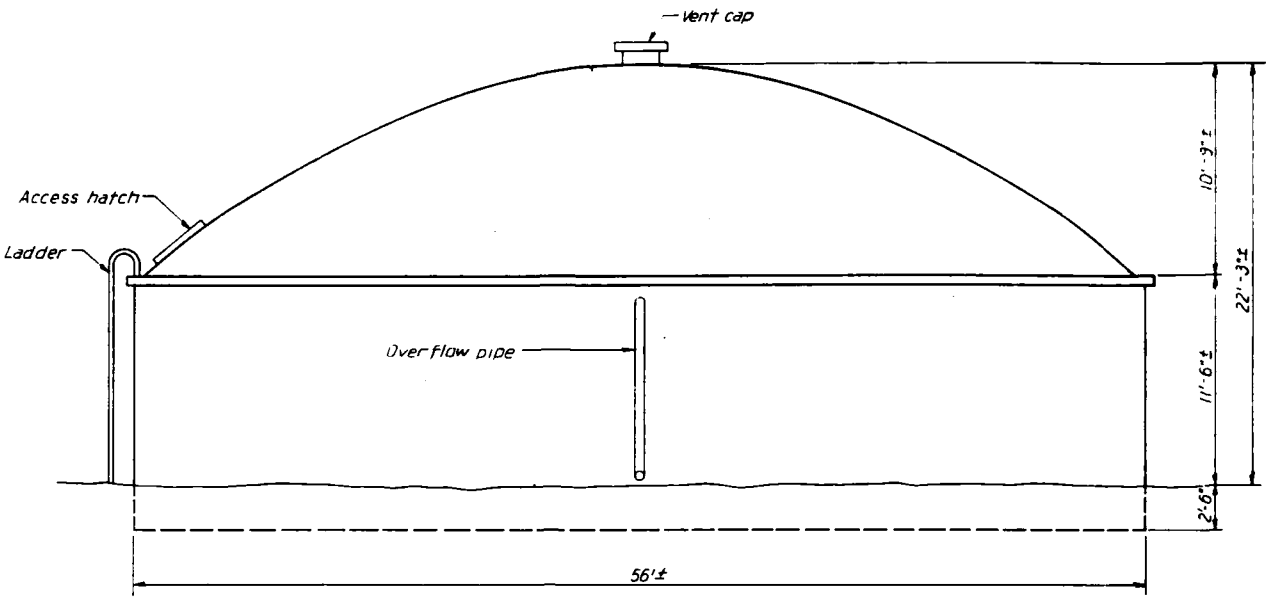
4.4.2 Observed Inspection Condition

The facility is generally in good condition, although there are areas of minor deterioration. During the inspection of the reservoir's interior, hairline cracks and moist areas were found on the ceiling as shown in Photographs 4.4-2, 4.4-3, and 4.4-4. These cracks and moist areas were primarily located in the north quadrant of the structure. The walls have a mortar coating which appears to have been pneumatically applied and then smoothed with a broom. The mortar is in excellent condition and no cracks were found. Refer to Photograph 4.4-5 and 4.4-6 for typical views of the interior wall. Some areas of minor concrete scaling were found at the line where the roof and wall of the reservoir meet and around the outlet of the overflow pipe. There was a 1/4 inch accumulation of brown sediment on the bottom of the reservoir.

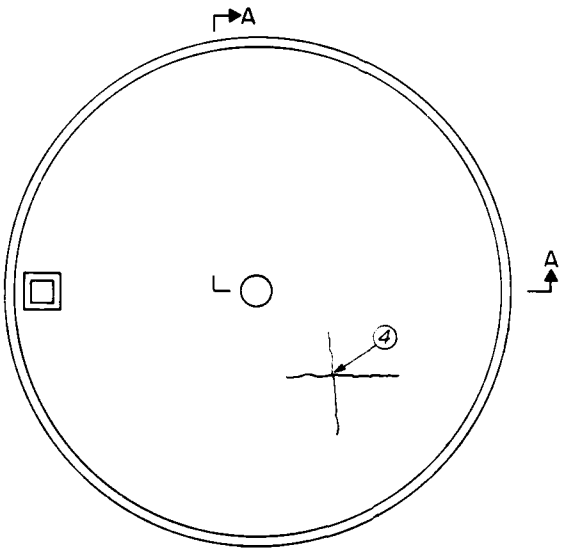
On the exterior of the reservoir there are horizontal, hairline cracks on the walls all around the facility, and a few vertical hairline cracks. There is efflorescence due to leaching along these cracks and the cracks vary in length from approximately 5 to 20 feet. Refer to Photographs 4.4-1 and 4.4-7 for typical views of these cracks. There are also minor random hairline cracks on the top of the roof slab as shown in Photograph 4.4-8. Inspection notes are included on Figure 4.4.

4.4.3 Structural Condition Assessment

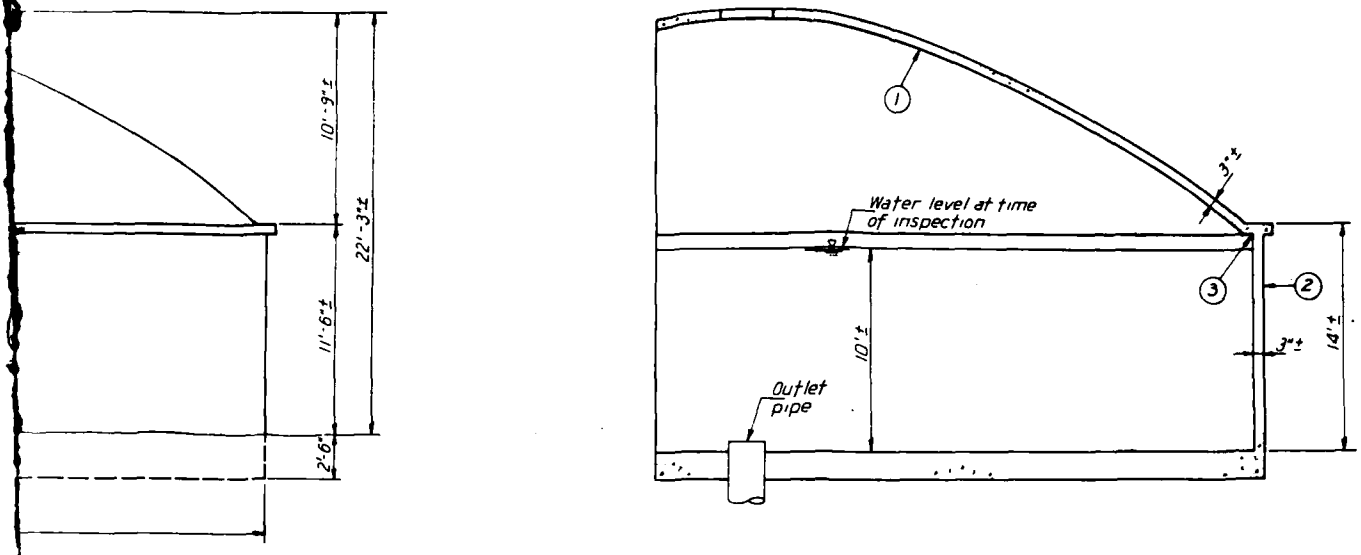
The facility is in good structural condition. None of the defects described above has significantly reduced the strength of the reservoir. No rust stains were found along the cracks either on the interior or exterior of the tank which would indicate that the reinforcing steel is corroding, and there was no evidence of present leakage. It is possible that the efflorescence present on the exterior walls developed prior to the application of the interior mortar coating. The areas of concrete



ELEVATION
Scale: 1/8"=1'-0"



PLAN
Scale: 1/16"=1'-0"



SECTION A-A
Scale: 1/8"=1'-0"

GENERAL:
Drawing was developed from field measurements taken at the time of inspection.
Location of construction joints is unknown.

NOTES:
1. Hairline crack on ceiling of interior.
2. Horizontal hairline cracks on exterior of wall with effloresence.
3. Minor scaling where roof and walls of resevoir meet.
4. Hairline cracks on roof.

2

SCALE 1/8"=1'-0"
SCALE 1/16"=1'-0"

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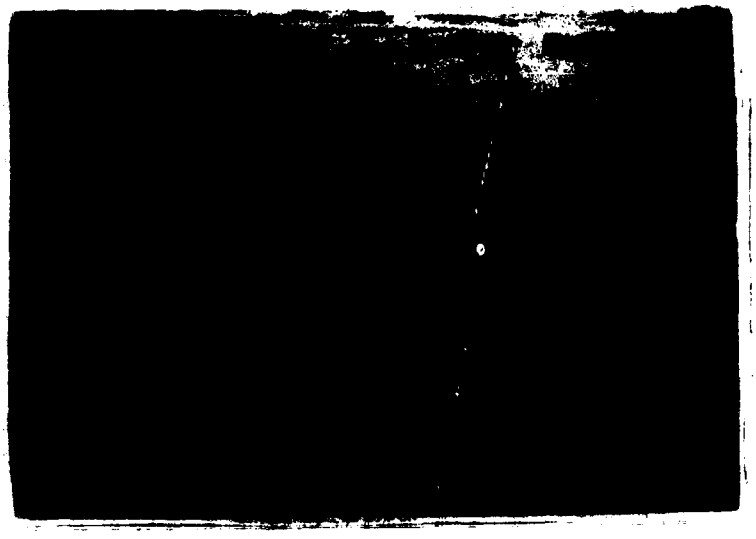
FACILITY 3080

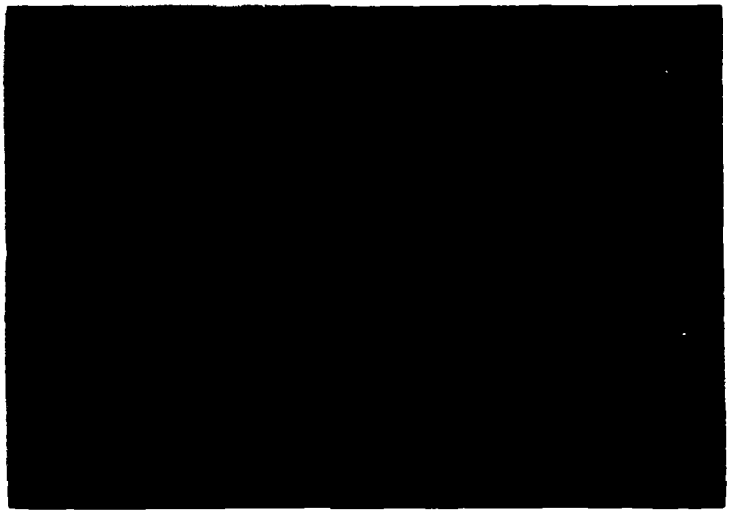
FIG. NO. 4.4

CONTRACT No. N62477-83-D-0387

PHOTOGRAPH 4.4-1
General View of Facility 3080.

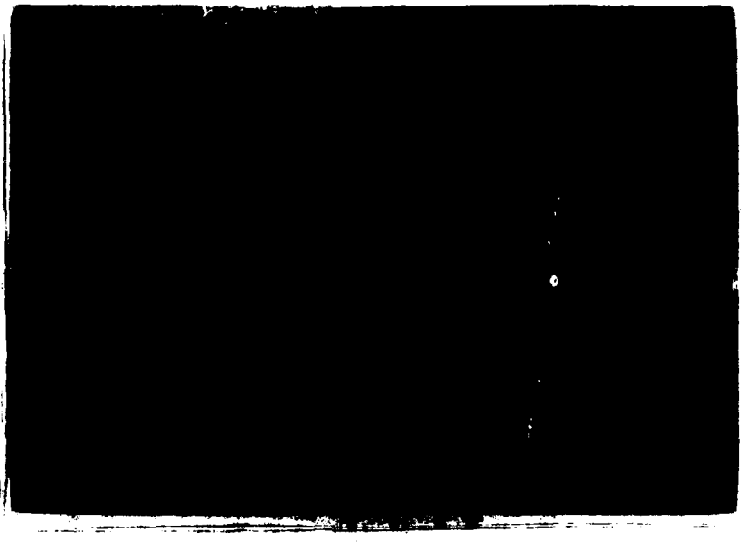
PHOTOGRAPH 4.4-2
Facility 3080, Interior. Typical Condition of Ceiling.





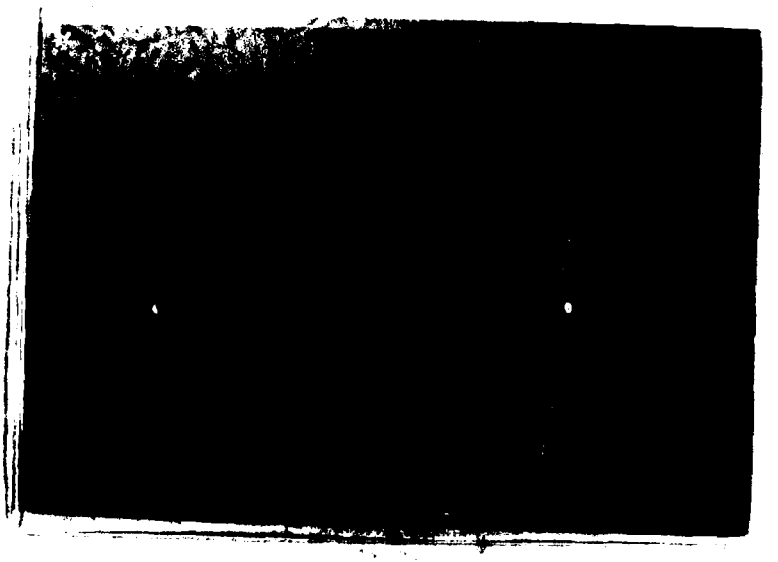
PHOTOGRAPH 4.4-3
Facility 3080, Interior. Note Hairline Crack in Ceiling. Typical Condition of Walls at the Waterline.

PHOTOGRAPH 4.4-4
Facility 3080, Interior. Typical Condition of Walls and Ceiling.



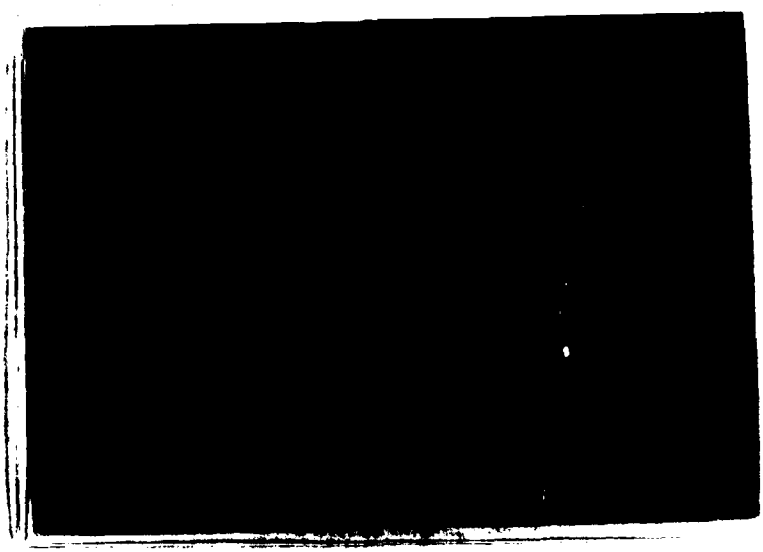
PHOTOGRAPH 4.4-5
Facility 3080, Interior. Typical Condition of Walls Below Waterline.

PHOTOGRAPH 4.4-6
Facility 3080, Interior. Typical Condition of Walls Below Waterline.



PHOTOGRAPH 4.4-7
Facility 3080, Exterior. Typical Hairline Crack with Efflorescence on Wall.

PHOTOGRAPH 4.4-8
Facility 3080, Exterior. Typical Hairline Crack in Roof.



scaling found are minor and do not warrant repair at this time.

4.4.4 Recommendations

Facility 3080 is in good condition. The coating on the interior walls of the structure show no signs of deterioration. The defects described above are minor and have not reduced the structural capacity of the facility. No repairs are recommended at this time. It is recommended, however, that the facility be regularly inspected at intervals not to exceed five years in accordance with American Water Works Association Standard D101.

4.5 Facility 3081

4.5.1 Description

Facility 3081 is located at the southwest corner of the intersection of "D" Street and 3rd Street. The facility is a 250,000 gallon, ground level, concrete reservoir. The reservoir is a vertical, reinforced concrete cylinder with an outside diameter of approximately 56 feet. The roof of the reservoir is an elliptic, reinforced concrete shell roof. The height of the structure from ground level to the crown of the roof is approximately 22 feet. Design drawings of the structure were not available. The dimensions given above are from field measurements made of the structure during the inspection. Refer to Figure 4.5 for a drawing showing the general configuration of the structure, and Photograph 4.5-1 for a general view of the exterior of the facility.

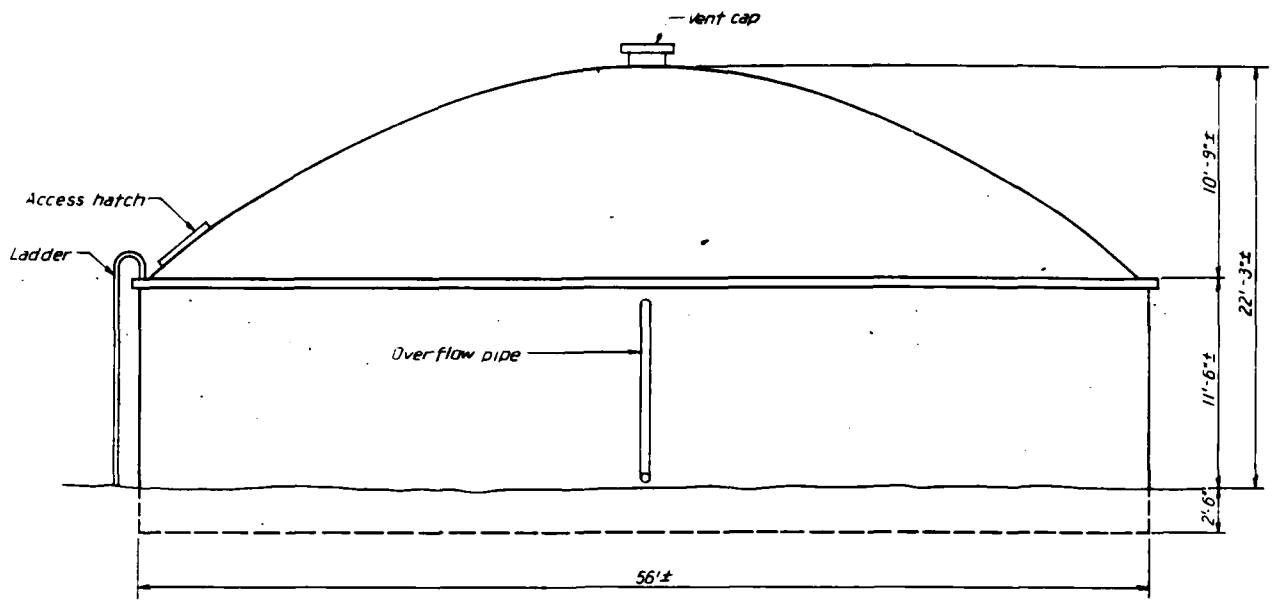
4.5.2 Observed Inspection Condition

The facility is generally in good condition, although there are areas of minor deterioration. During the inspection of the reservoir's interior, some minor scaling was found on the walls above water near the overflow pipe and near a hole through the wall on the north side as shown in Photographs 4.5-2 and 4.5-3. In general, however, the walls above and below water were in excellent condition as shown in Photograph 4.5-4. The walls have a mortar coating which appears to have been pneumatically applied and then smoothed with a broom. The mortar is in excellent condition and no cracks were found. Refer to Photograph 4.5-5 and 4.5-6 for typical views of the interior walls below water. There was a 1/4 inch accumulation of brown sediment on the bottom of the reservoir.

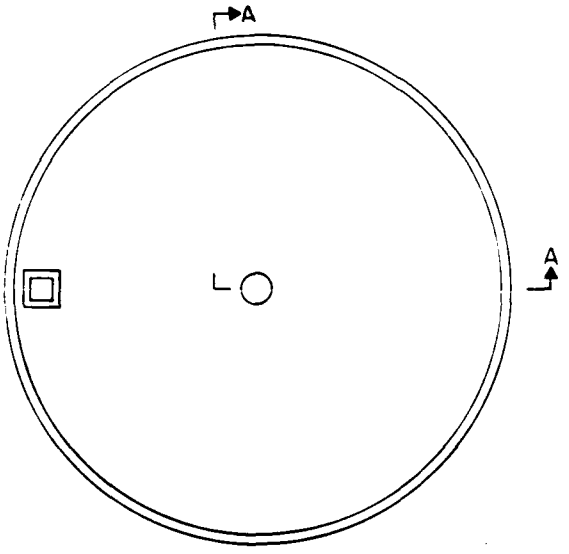
On the exterior of the reservoir there are horizontal, hairline cracks on the walls all around the facility, and a few vertical hairline cracks. There is efflorescence due to leaching along these cracks and the cracks vary in length from approximately 5 to 40 feet. Refer to Photographs 4.5-1, 4.5-7, and 4.5-8 for typical views of these cracks. Inspection notes are included on Figure 4.5.

4.5.3 Structural Condition Assessment

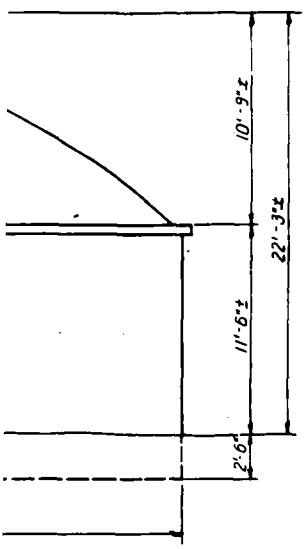
The facility is in good structural condition. None of the defects described above has significantly reduced the strength of the reservoir. No rust stains were found along the cracks on the exterior of the tank which would indicate that the reinforcing steel is corroding, and there was no evidence of present leakage. It is possible that the efflorescence present on the exterior walls developed prior to the application of the interior mortar coating. The areas of concrete scaling found are minor and do not warrant repair at this time.

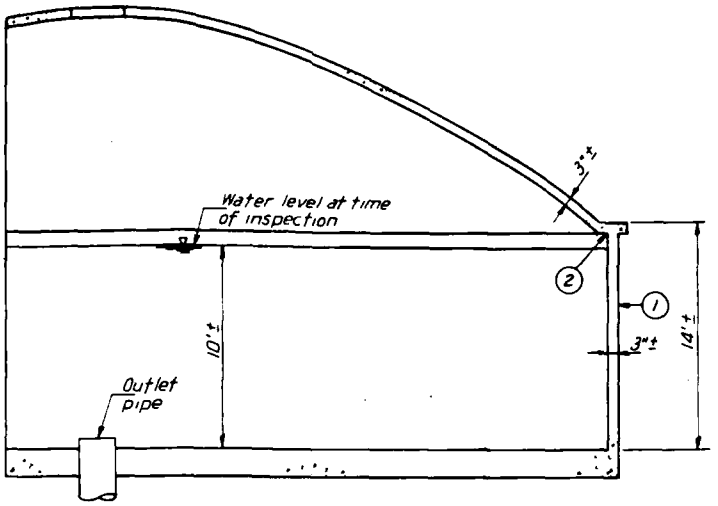


ELEVATION
Scale: 1/8"=1'-0"



PLAN
Scale: 1/8"=1'-0"





SECTION A-A
Scale: 3/8"=1'-0"

GENERAL:
Drawing was developed from field measurements taken at the time of inspection.
Location of construction joints is unknown.

NOTES:
1. Horizontal hairline cracks on exterior of walls with efflorescence.

2. Minor scaling where roof and walls of reservoir meet.

2

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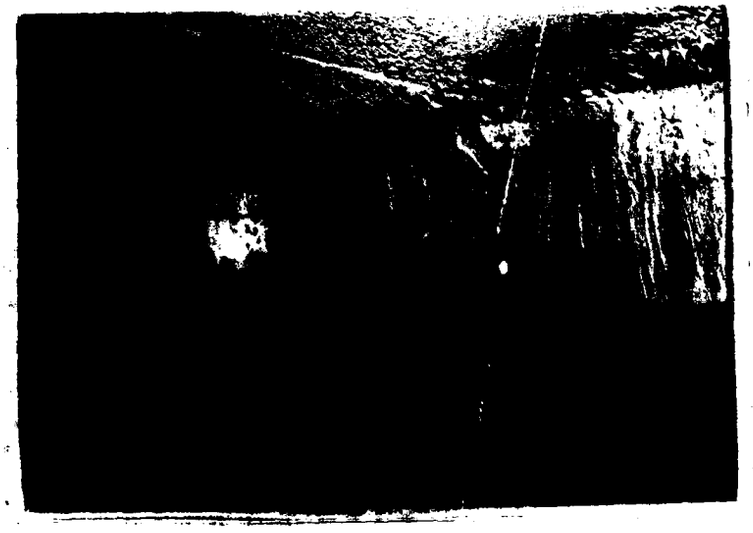
FACILITY 3081

FIG. NO. 4.5

CONTRACT No. N62477-83-C-5067

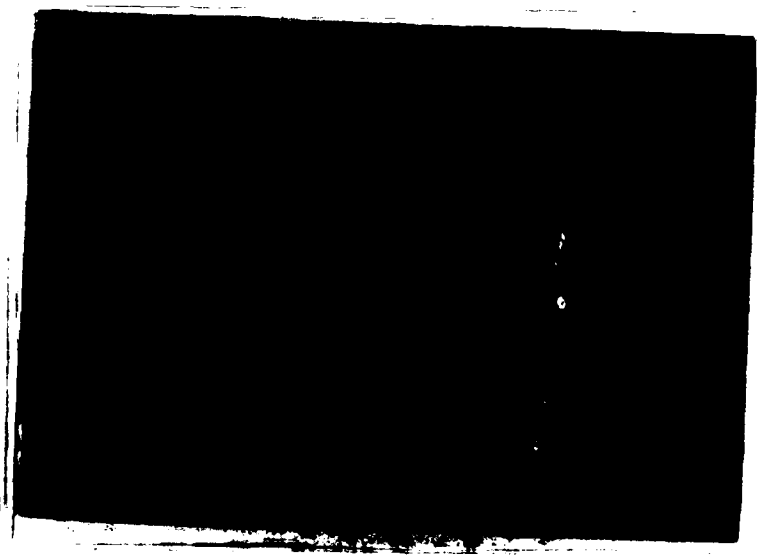
PHOTOGRAPH 4.5-1
General View of Facility 3081.

PHOTOGRAPH 4.5-2
Facility 3081, Interior. Typical Condition of Walls at Waterline.



PHOTOGRAPH 4.5-3
Facility 3081, Interior. Typical Condition of Walls at Waterline and Ceiling.

PHOTOGRAPH 4.5-4
Facility 3081, Interior. Typical Condition of Walls at Waterline.

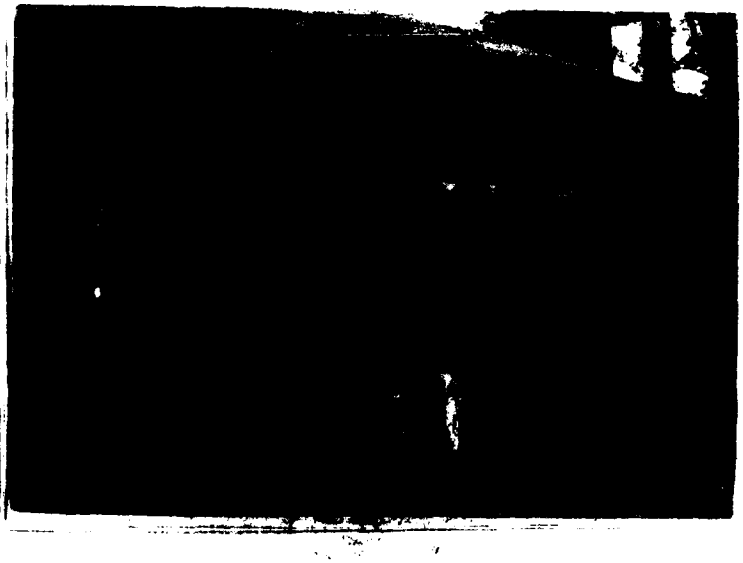


PHOTOGRAPH 4.5-5
Facility 3081, Interior. Typical Condition of Interior.

PHOTOGRAPH 4.5-6
Facility 3081, Interior. Typical Condition of Walls.

PHOTOGRAPH 4.5-7
Facility 3081, Exterior. Hairline Cracks with Efflorescence on wall.

PHOTOGRAPH 4.5-8
Facility 3081, Exterior. Hairline Cracks with Efflorescence on wall.



4.5.4 Recommendations

Facility 3081 is in good condition. The coating on the interior walls of the structure shows no signs of deterioration. The defects described above are minor and have not reduced the structural capacity of the facility. No repairs are recommended at this time. It is recommended, however, that the facility be regularly inspected at intervals not to exceed five years in accordance with American Water Works Association Standard D101.

4.6 Facility NAB 753

4.6.1 Description

Facility NAB 753 is a 1.5 million gallon, ground level, concrete reservoir located at the intersection of Amphibious Drive and Murray Road within the Naval Amphibious Base.

The reservoir is a vertical concrete cylinder with an outside diameter of approximately 113 feet. The roof is an elliptic, reinforced concrete shell. The height of the structure, from ground level to the crown of the roof, is approximately 32 feet. A steel vent cap for the tank is located at the crown of the roof.

Design drawings of the structure were not available. The dimensions given above are from field measurements taken at the time of inspection. Refer to Figure 4.6 for a drawing showing the general configuration of the structure. For a general view of the exterior of the facility, see Photograph 4.6-1.

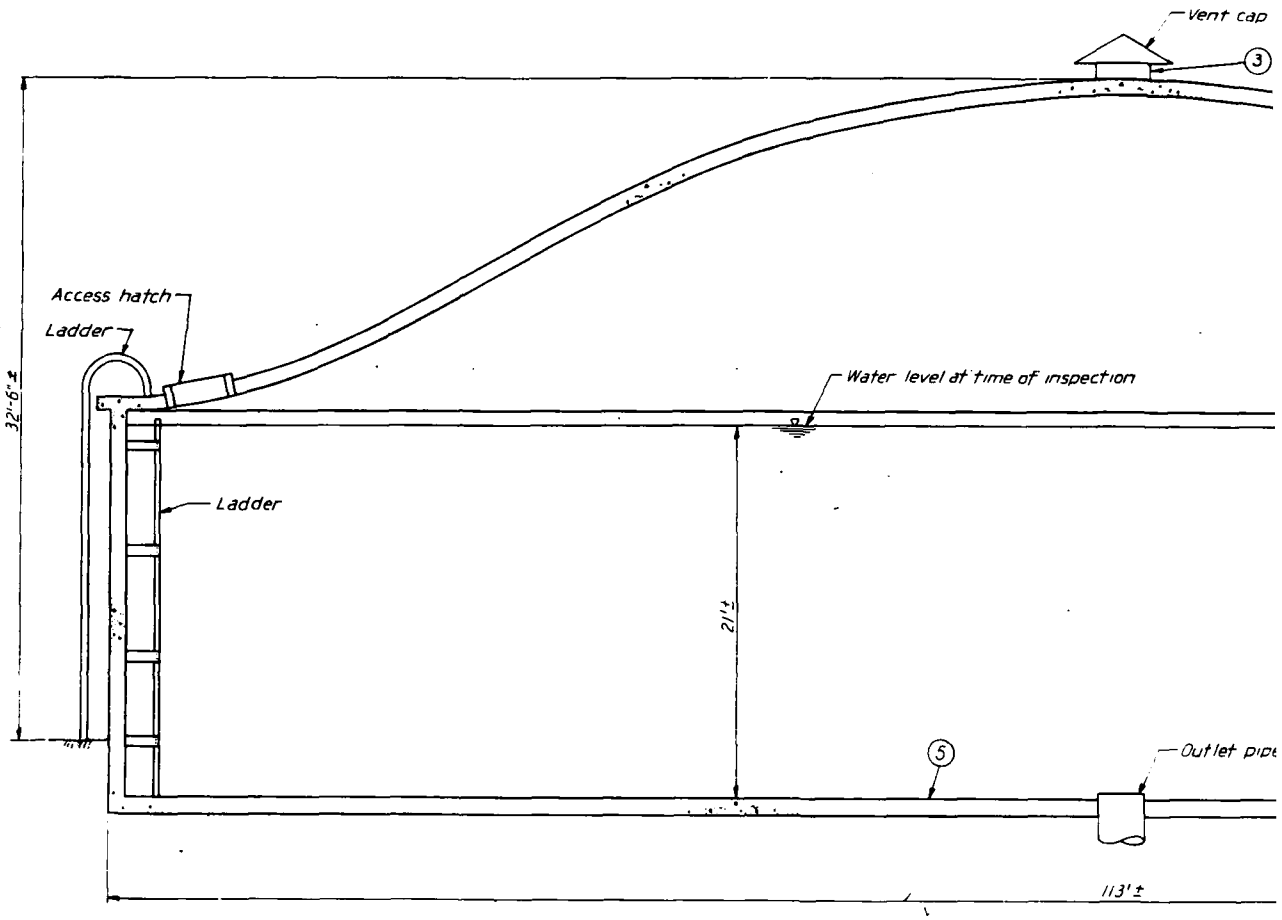
4.6.2 Observed Inspection Condition

During the inspection of the reservoir's interior, areas of minor concrete spalling were found, with reinforcing steel exposed, on the ceiling as shown in Photographs 4.6-2 through 4.6-4. There are approximately twenty similar areas of varying sizes. The wall of the reservoir, both above and below water, was in good condition as shown in Photographs 4.6-5 and 4.6-6. It has a mortar coating which appears to have been pneumatically applied and then smoothed with a broom. A layer of silt, approximately one-eighth inch deep, covered the bottom of the facility.

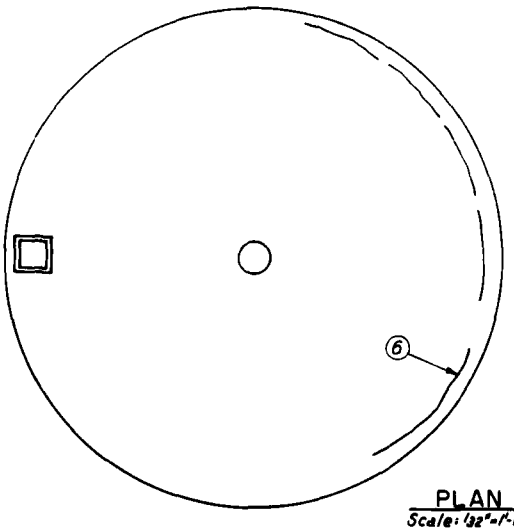
The vent cap at the crown of the roof is severely rusted and split along one of its welds as shown on Photograph 4.6-7. Minor cracking, some of which has been patched, was also found on the top of the roof slab as shown in Photograph 4.6-8. Intermittent hairline cracks, with efflorescence along them, were found on the exterior of the wall as shown in Photograph 4.6-9. Inspection notes are included on Figure 4.6.

4.6.3 Structural Condition and Assessment

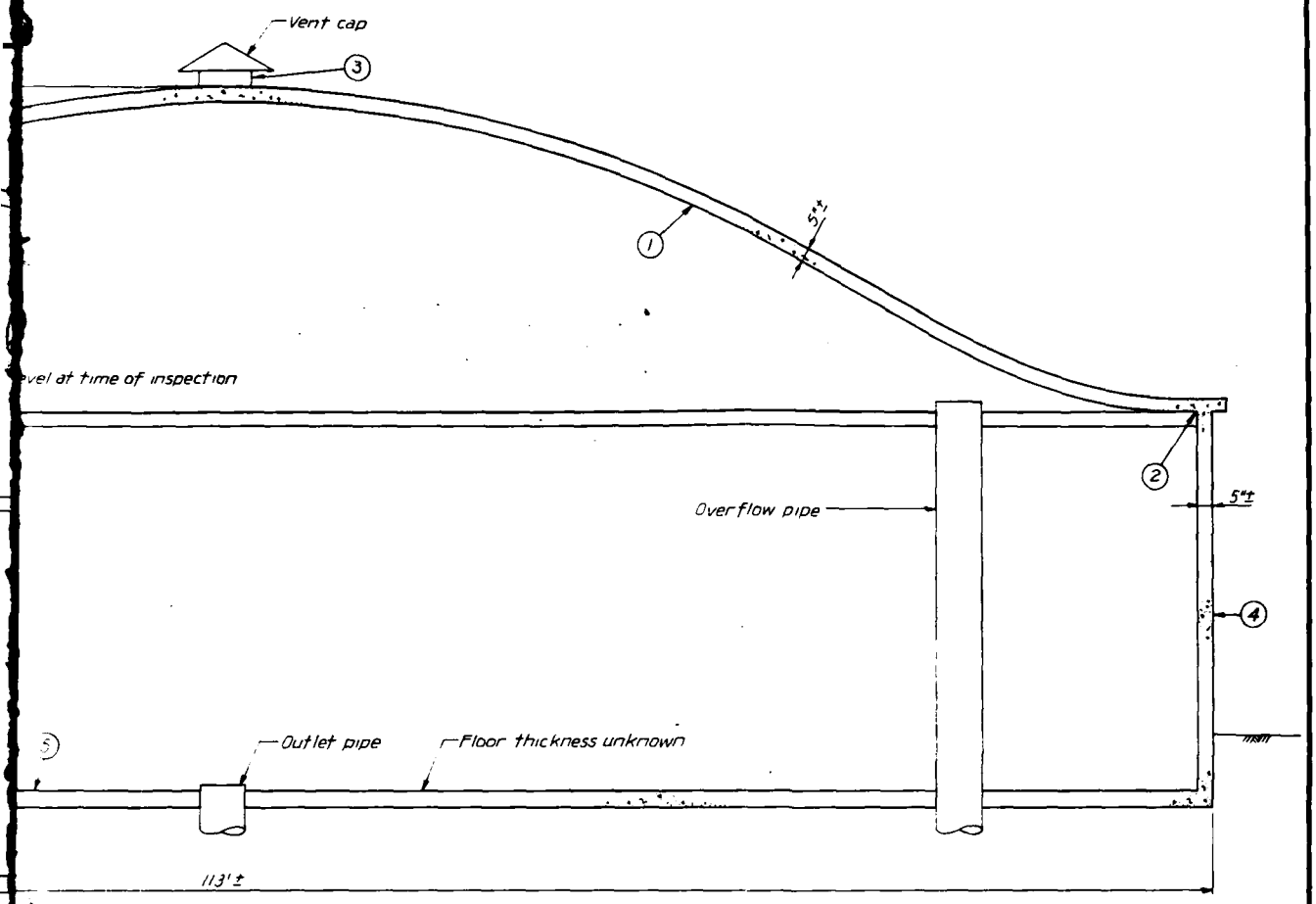
Facility NAB 753 is generally in good structural condition. The spalled areas on the ceiling and the cracks in the roof of the reservoir have not affected the structural capacity of the reservoir. In time though, these defects may allow water and oxygen to reach other reinforcing steel causing it to corrode and reduce the load carrying capacity of the roof. The exterior cracks in the roof of the structure should be sealed, and the exposed reinforcing steel should covered to prevent further corrosion.



CROSS-SECTION
Scale: 1/8"=1'-0"



PLAN
Scale: 1/32"=1'-0"



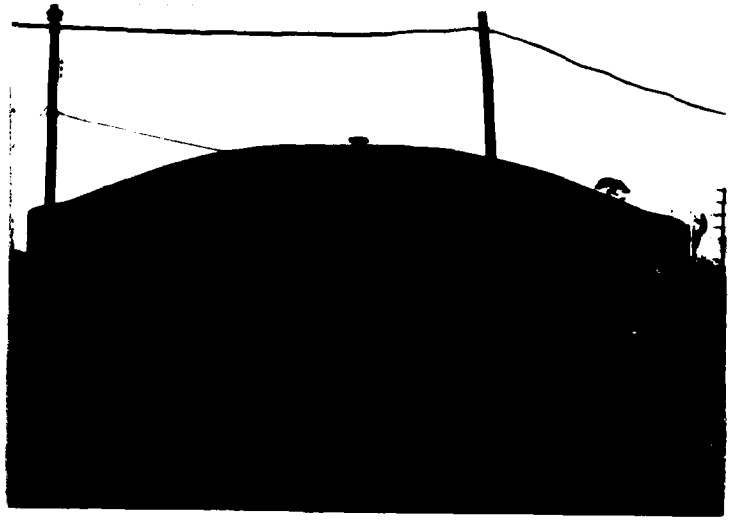
CROSS-SECTION
Scale: 1/8"=1'-0"

GENERAL:
Drawing was developed from field measurements taken at the time of inspection.
Location of construction joints is unknown.

NOTES:
1. Spalled areas on interior of reservoir, with reinforcing steel exposed, on ceiling.
2. Minor concrete scaling on interior where roof and walls meet.
3. Vent cap is severely corroded along one of it's welds.
4. Hairline cracks with effloresence on exterior of walls.
5. Layer of silt, approximately one-eighth inch thick, on bottom of reservoir.
6. Cracks in roof, approximately one-eighth inch wide.

SCALE 1/8"=1'-0"

COLLINS ENGINEERS, INC. 600 W. JACKSON CHICAGO, ILLINOIS	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. NAVAL AMPHIBIOUS BASE, LITTLE CREEK NORFOLK, VA. **FACILITY NAB 753** CONTRACT No. N62477-83-D-0387	FIG. NO. **4.6**



PHOTOGRAPH 4.6-1
Overall View of Facility NAB 753.

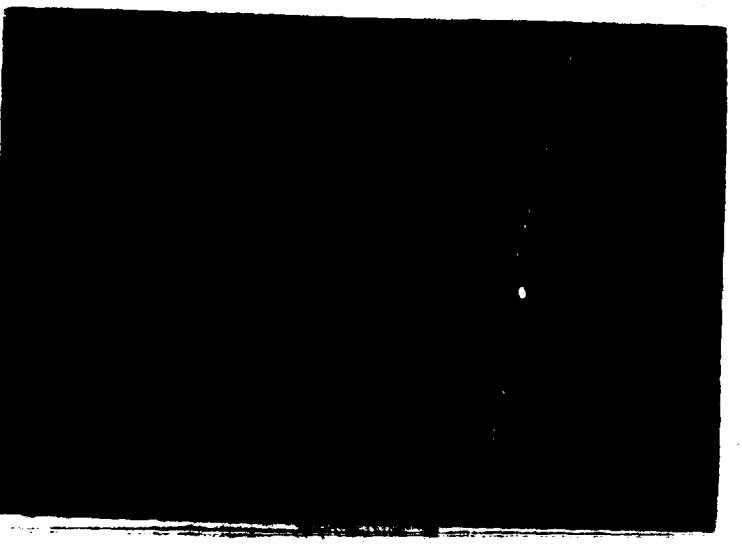
PHOTOGRAPH 4.6-2
Facility NAB 753, Interior. Typical Spalled Area on Ceiling.

PHOTOGRAPH 4.6-3
Facility NAB 753, Interior.
Note Spalled Areas on Ceiling Around
Intake Pipe.

PHOTOGRAPH 4.6-4
Facility NAB 753, Interior.
Typical Spalled Area with Reinforcing
Steel Exposed on Ceiling.

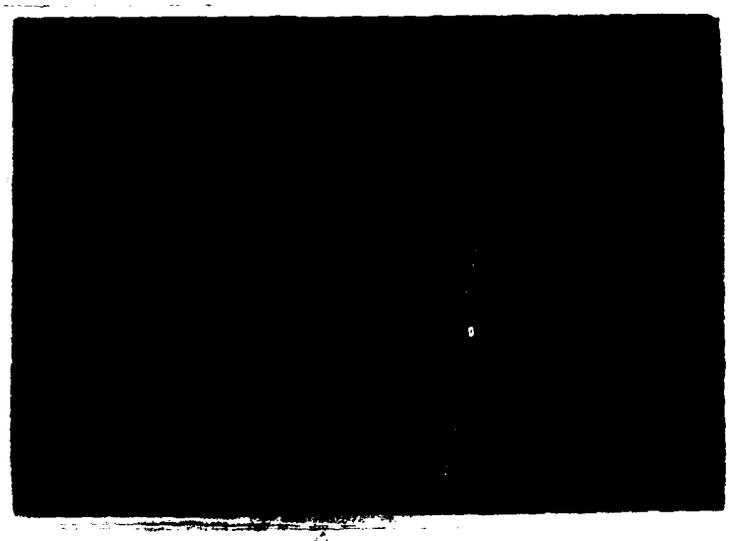
PHOTOGRAPH 4.6-5
Facility NAB 753, Interior. Typical Condition of Walls at Waterline and Ceiling.

PHOTOGRAPH 4.6-6
Facility NAB 753, Interior. Typical Condition of Walls Below Waterline.



PHOTOGRAPH 4.6-7
Facility NAB 753, Exterior. Typical Condition of Vent Cap. Note Rust.

PHOTOGRAPH 4.6-8
Facility NAB 753, Exterior. Note Cracks on Roof of Facility.



PHOTOGRAPH 4.6-9
Facility NAB 753, Exterior. Note Hairline Cracks with Efflorescence on Wall.

The other defects found during the inspection are minor at this time and have not affected the structural capacity of the facility. No rust stains were found along the exterior cracks which would indicate that the reinforcing steel is corroding, and although there are some moist spots, there is no evidence of active leaking. It is possible that the efflorescence developed prior to the application of the interior mortar coating, and the moist areas may be due to external water leaking from the roof area.

4.6.4 Recommendations

It is recommended that the spalled areas on the ceiling of the reservoir be repaired with epoxy grout, and the cracks on the exterior of the roof be sealed with a flexible sealer that can be applied with a caulking gun. It is also recommended the corroded vent cap be replaced. The estimated cost of these repairs is $10,000. A detailed cost estimate is included in the Appendix on Page A-9.

It is further recommended that regular inspections of the facility be made at five year intervals in accordance with American Water Works Association Standard D101.

4.7 Facility NAB 754

4.7.1 Description

Facility NAB 754 is a 1.5 million gallon, ground level, concrete reservoir located at the intersection of Amphibious Drive and Murray Road within the Naval Amphibious Base.

The reservoir is a vertical concrete cylinder with an outside diameter of approximately 113 feet. The roof is an elliptic, reinforced concrete shell. The height of the structure, from ground level to the crown of the roof, is approximately 32 feet. A steel vent cap for the tank is located at the crown of the roof.

Design drawings of the structure were not available. The dimensions given above are from field measurements taken at the time of inspection. Refer to Figure 4.7 for a drawing showing the general configuration of the structure. For a general view of the exterior of the facility, see Photograph 4.7-1.

4.7.2 Observed Inspection Condition

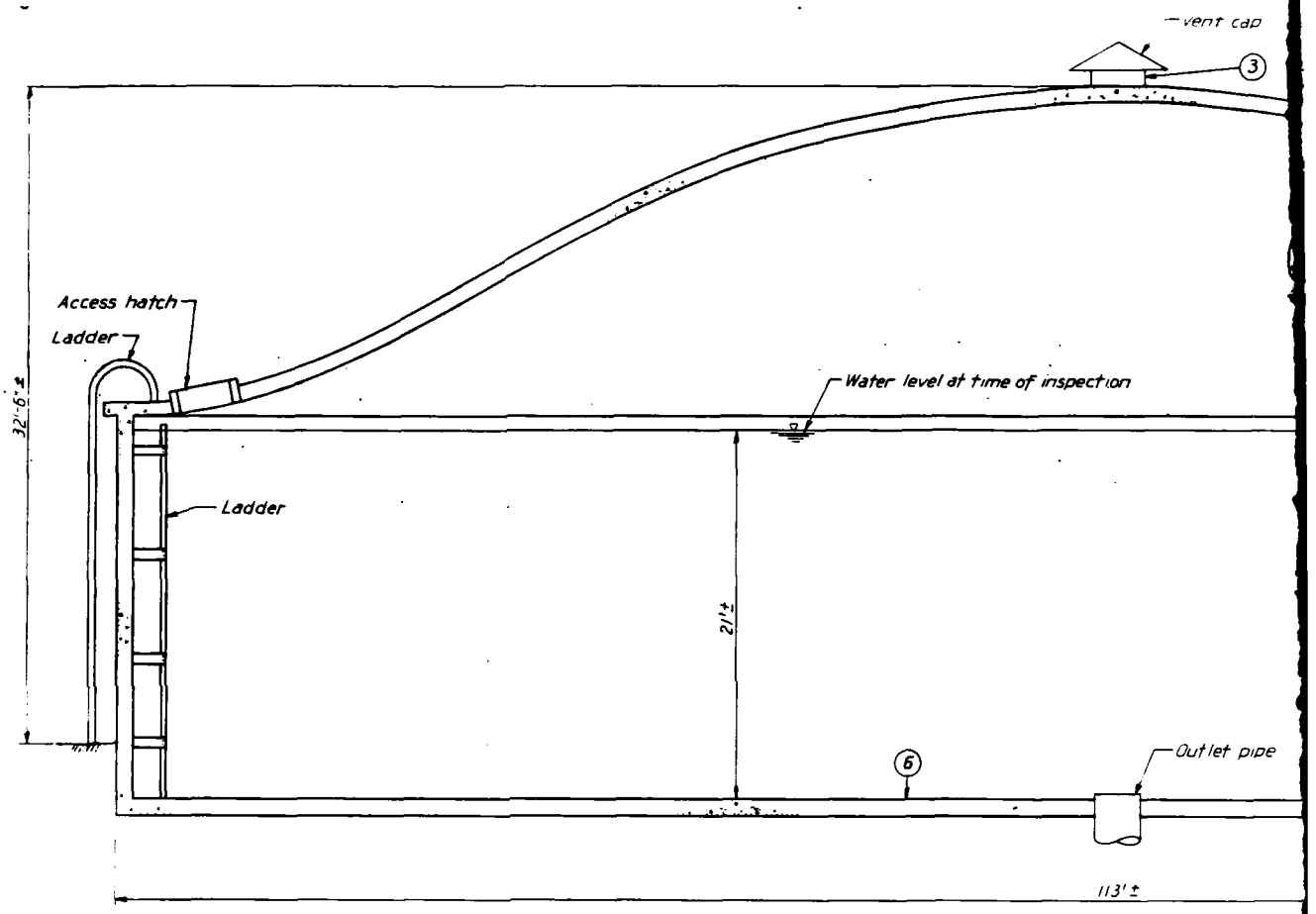
During the inspection of the reservoir's interior, areas of minor concrete leaching and spalling were found, with reinforcing steel exposed or rust stains present on the ceiling as shown in Photographs 4.7-2 through 4.7-4. There are approximately ten areas of rust staining and three small areas of exposed reinforcing steel. The wall of the reservoir, both above and below water, was in good condition. It has a mortar coating which appears to have been pneumatically applied and then smoothed with a broom.

A layer of silt, approximately one-eighth inch deep, covered the bottom of the facility. Tracks of some type of small insect life were found in many areas on the floor of the tank as shown in Photograph 4.7-5. Specimens of these insects, as shown in Photograph 4.7-6, were collected and given to the Public Works Department for identification.

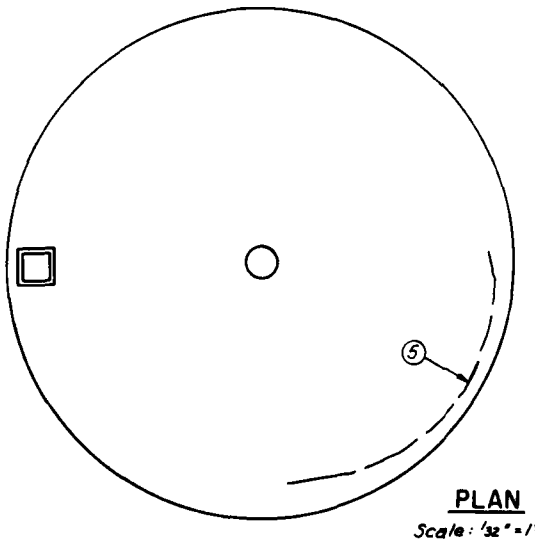
The vent cap at the crown of the roof is severely rusted and completely split along one of its welds as shown on Photograph 4.7-7. Minor cracking, some of which has been patched, was also found on the top of the roof slab as also shown in Photograph 4.7-7. Intermittent hairline cracks, with efflorescence along them, were found on the exterior of the wall as shown in Photograph 4.7-8. Inspection notes are included on Figure 4.7.

4.7.3 Structural Condition and Assessment

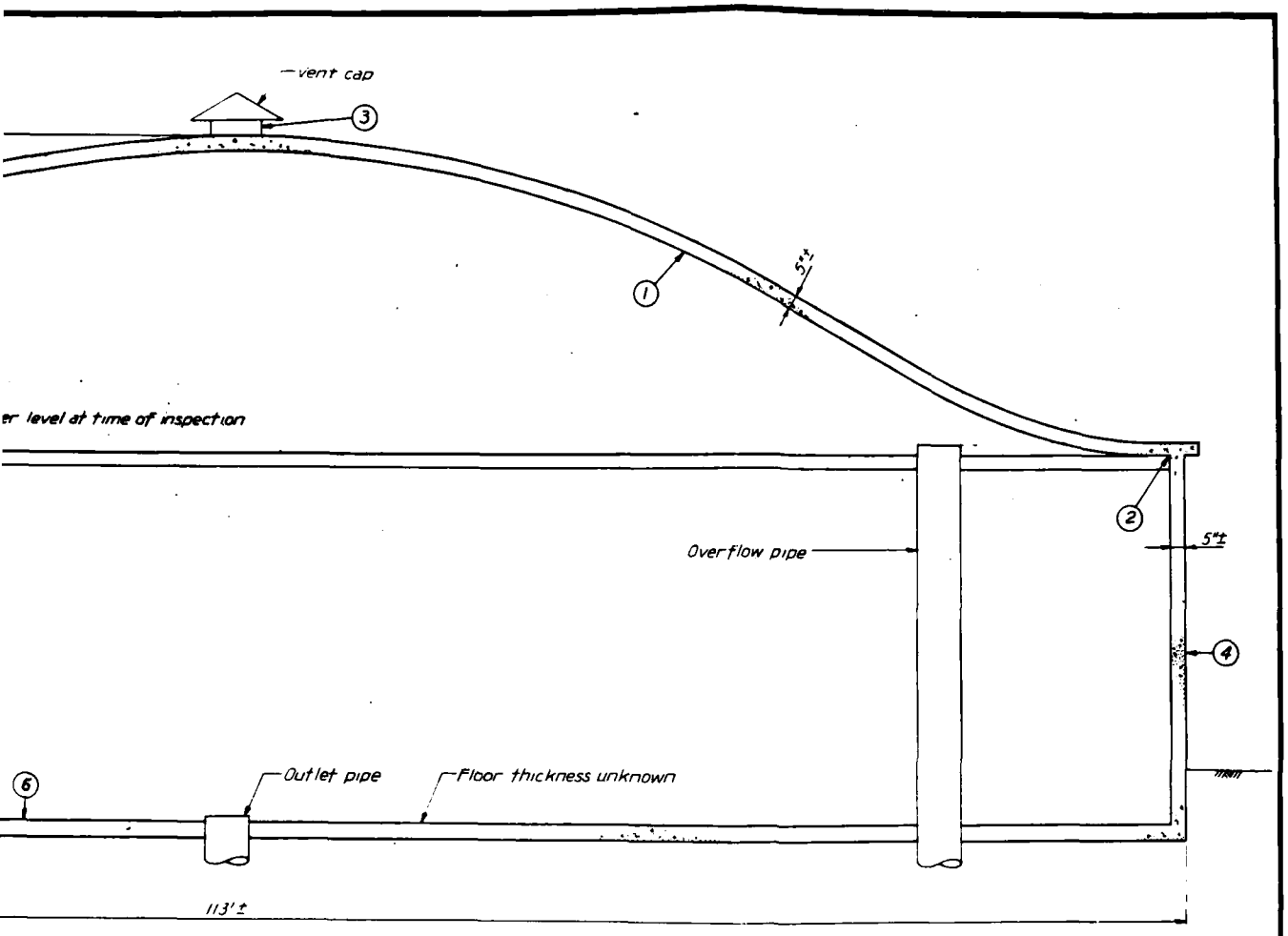
Facility NAB 754 is generally in good structural condition. The spalled areas on the ceiling and the cracks in the



CROSS-SECTION
Scale: 1/8"=1'-0"



PLAN
Scale: 1/32"=1'-0"



CROSS-SECTION

Scale: 1/8"=1'-0"

GENERAL:

Drawing was developed from field measurements taken at time of inspection.
Location of construction joints is unknown.

NOTES:

1. Spalled areas on interior of reservoir, with reinforcing steel exposed, on ceiling.
2. Minor concrete scaling on interior where roof and walls meet.
3. Vent cap is severely corroded along one of it's welds.
4. Hairline cracks with efflorescence on exterior of walls.
5. Cracks in roof, approximately one-eighth inch wide.
6. Layer of silt, approximately one-eighth inch deep, on bottom of reservoir.

2

COLLINS ENGINEERS, INC.
600 W. JACKSON
CHICAGO, ILLINOIS

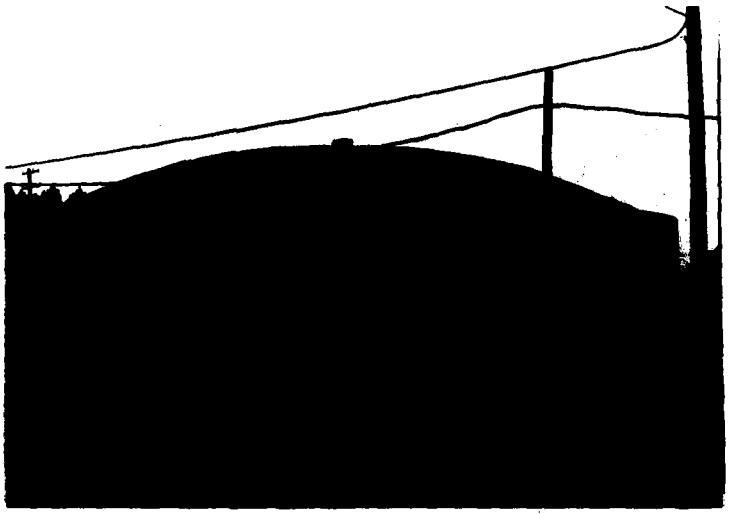
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

NAVAL AMPHIBIOUS BASE, LITTLE CREEK
NORFOLK, VA.

FACILITY NAB 754

CONTRACT No. 62477-83-C-0007

FIG. NO. 4.7

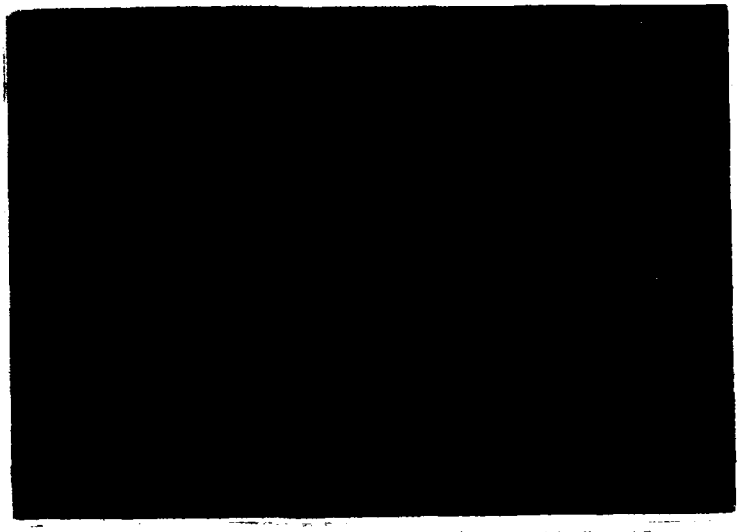


PHOTOGRAPH 4.7-1
Overall view of Facility NAB 754.

PHOTOGRAPH 4.7-2
Facility NAB 754, Interior. Typical Condition of Ceiling. Note Spalled Areas with Reinforcing Steel Exposed.

PHOTOGRAPH 4.7-3
Facility NAB 754, Interior. Typical Spalled Area with Reinforcing Steel Exposed on Ceiling

PHOTOGRAPH 4.7-4
Facility NAB 754, Interior. Typical Spalled Area with Reinforcing Steel Exposed on Ceiling.



PHOTOGRAPH 4.7-5
Facility NAB 754, Interior. Note Trail from Insect in Sediment.

PHOTOGRAPH 4.7-6
Facility NAB 754. Insect Found at Bottom of Reservoir.

roof of the reservoir are minor and have not affected the structural capacity of the reservoir. In time though, these defects may allow water and oxygen to reach other reinforcing steel causing it to corrode and could eventually reduce the load carrying capacity of the roof. The exterior cracks in the roof of the structure should be sealed, and the exposed reinforcing steel should covered to prevent further corrosion.

The other defects found during the inspection are minor at this time and have not affected the structural capacity of the facility. No rust stains were found along the exterior cracks which would indicate that the reinforcing steel is corroding. It is possible that the efflorescence developed prior to the application of the interior mortar coating.

4.7.4 Recommendations

It is recommended that the spalled areas on the ceiling of the reservoir be repaired with epoxy grout, and the cracks on the exterior of the roof be sealed with a flexible sealer that can be applied with a caulking gun. It is also recommended the corroded vent cap be replaced. The estimated cost of these repairs is $10,000. A detailed cost estimate is included in the Appendix on Page A-10.

It is further recommended that regular inspections of the facility be made at five year intervals in accordance with American Water Works Association Standard D101.

Collins Engineers, Inc.

JOB _____
SHEET NO 1 OF 1
SUBJECT **ANALYSIS OF FACILITIES 1553, 3266 AND 3850** BY _____ DATE _____
CHKD BY _____ DATE _____

S = Distance from High Water Line to Spring Line

H = Distance from High Water Line to bottom of tank

R = Radius of bottom

D = Diameter of tank

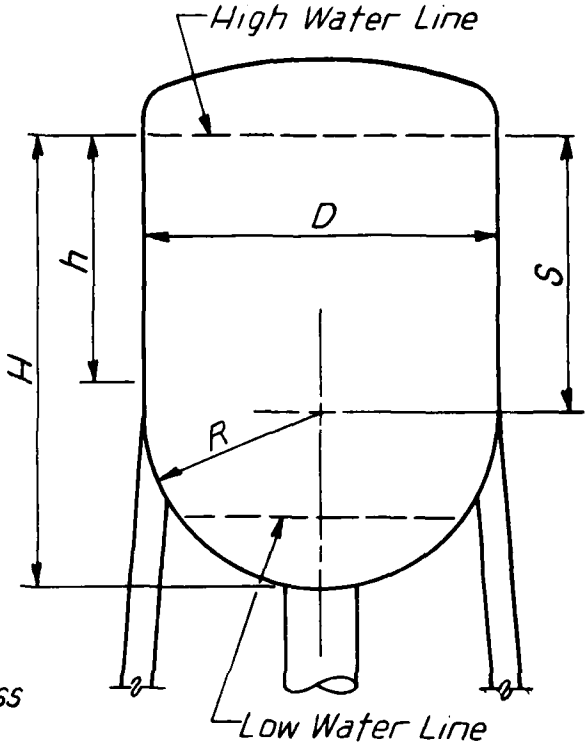
h = Depth from High Water Line

g = Specific Gravity of Liquid

y = Density of Liquid

T_1 = Latitudinal Membrane Stress

T_2 = Meridonal Membrane Stress



Maximum stresses in bottom of tank

$$T_1 = T_2 = \frac{yHR}{2}$$

Stresses at the Spring Line

$$T_1 = yR\left(\frac{S}{2} - \frac{R}{3}\right) \quad T_2 = yR\left(\frac{S}{2} + \frac{R}{3}\right)$$

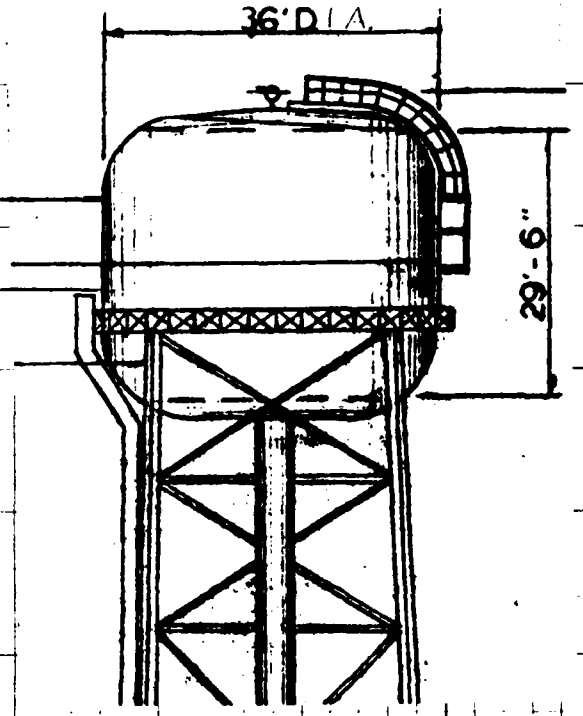
Stresses between Spring Line & High Water Line

$$T_1 = 2.6\,Dhg$$

Developed from : Structural Engineers Handbook
By Gaylord & Gaylord
Published by McGraw-Hill, 1968

Collins Engineers, Inc.

JOB _____
SHEET NO 2 OF 7
SUBJECT ANALYSIS OF [illegible] 155-203,000 GALLON [illegible] TANK
BY RJJ DATE 12/5/84
CHKD BY _____ DATE _____



FROM ULTRASONIC THICKNESS READINGS

.295

.395

(EQUATIONS FROM STRUCTURAL ENGINEERS HANDBOOK BY GAYLORD & GAYLORD)

STRESSES IN BOTTOM OF TANK

$T_1 = T_2 = \frac{\gamma H R}{2}$

$T_1 = T_2 \quad (62.4\ \text{pcf})(29.5')(15') = 16569\ \text{lb/ft}$

$T = 16569\ \text{lb/ft} / (.395 \times 12)\ \text{in/ft}$

$T = 3495\ \text{psi}$

Collins Engineers, Inc.

JOB _____
SHEET NO 3 OF 7
SUBJECT FACILITY 1553 BY RJV DATE 12/84
CHKD BY _____ DATE 2/84

14.75' BELOW HIGH WATER LEVEL

$T = 2.6(14.75)(120)(1)$

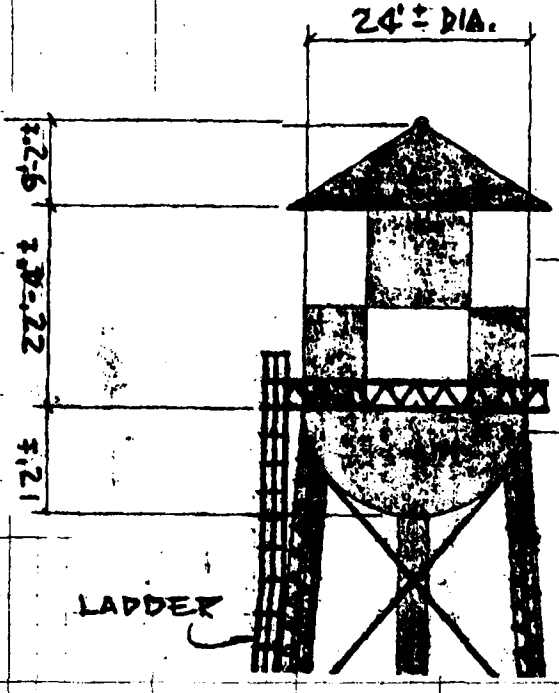
$T = 1380$ lb/in

$\tau = 1380/.295$ psi

$\tau = 4678$ psi OK

Collins Engineers, Inc.

JOB
SHEET NO 4 OF 7
SUBJECT ANALYSIS OF FACILITY 3266 — 100,000 GALLON WATER TANK
BY P.J.I DATE 12/89
CHKD BY K.J DATE 1-4



THICKNESSES FROM ULTRASONIC THICKNESS READINGS

PLATE	THICKNESS
	.246"
	.316"
	.356"

EQUATIONS FROM STRUCTURAL ENGINEERS HANDBOOK (BY GAYLORD & GAYLORD PUB. McGraw Hill)

CALCULATE STRESS IN BOTTOM OF TANK

$$T_1 = T_2 = \frac{YHR}{2}$$

R = 12' H = 34'9"
$\gamma = 62.4\ lb/ft^3$

$$T_1 = T_2 = \frac{(62.4\ lb/ft^3)(34.83')(12')}{2} = 12853\ lb/ft$$

$T = T_1$ or T_2

$$T = 12853\ lb/ft \Big/ (.356 \times 12)\ in^2/ft$$

$$T = 3008.7\ psi$$

Collins Engineers, Inc.

JOB
SHEET NO 5 OF 7
SUBJECT FACILITY 3266 BY RJJ DATE 12/84
CHKD BY DATE 12/84

ASSUME $f_{all} = 15{,}000$ psi (TYPICAL FOR ELEVATED TANK)

$\therefore$ OK.

CALCULATE STRESSES AT SPRING LINE

$S = 22'4''$

$$T_1 = \gamma R \left(\frac{S}{2} - \frac{R}{3}\right)$$

$$T_1 = (62.4\ \#/ft^3)(12)\left(\frac{22.33'}{2} - \frac{12}{3}\right)$$

$$T_1 = 5365\ \#/ft$$

$$T_2 = \gamma R \left(\frac{S}{2} + \frac{R}{3}\right)$$

$$T_2 = 11355.5\ \#/ft$$

$$\sigma = 11355.5\ \#/ft \;/\; (.516 \times 12)\ in^2/ft$$

$$\sigma = 2995\ psi \quad ok$$

CALCULATE STRESS 12'2" BELOW TOP OF WATER LINE

$T = 2.6\ h\ D\ g$

$T = 2.6\,(12.167')(24')(1)$

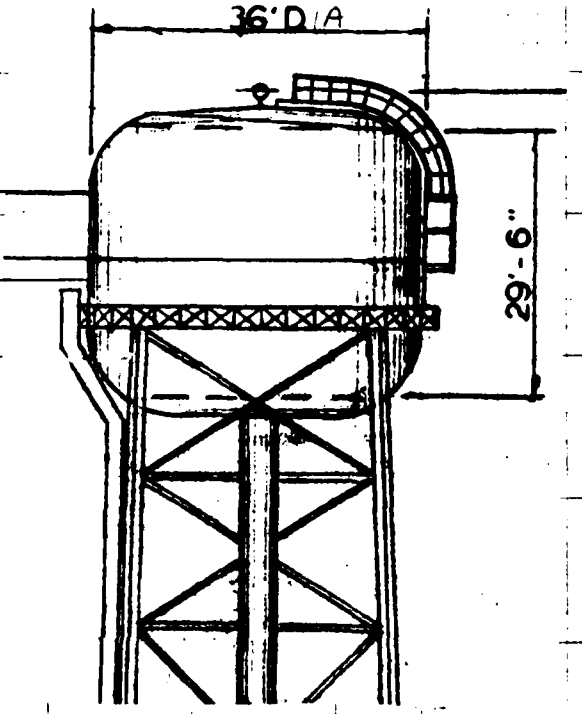
$T = 760\ \#/in.$

$$\sigma = 760\ \#/in \;/\; (.266 \times 1)\ in^2/in$$

$\sigma = 2857\ psi$ OK

Collins Engineers, Inc.

JOB _____
SHEET NO 6 OF 7
SUBJECT ANALYSIS OF FACILITY 3850 — BY RJ — DATE 12/30
200,000 GALLON WATER TANK — CHKD BY _____ — DATE _____



THICKNESSES FROM ULTRASONIC THICKNESS READINGS

.282

.401

CALCULATE STRESS IN BOTTOM OF TANK

$T_1 = T_2 = \frac{4HR}{2}$ $P = 18'$ $R = 24.6'$ $\gamma = 62.4\ \#/ft^3$

$T_1 = T_2 = \frac{(62.4\ \#/ft^3)(2)(24.6')(18')}{2} = 16568\ \#/ft$

$T = 16568\ \#/ft \div (.401 \times 12)$

$T = 3443\ psi$ < 4000 ok

Collins Engineers, Inc.

JOB _____
SHEET NO 2 OF 2
SUBJECT FACILITY 3850 BY _____ DATE _____
CHKD BY _____ DATE _____

CALCULATE STRESS 14.75' BELOW WATER LEVEL

$T = 2.6\ h\ D_g$

$T = 2.6\ (14.75')(36')(\ )$

$T = 1380$ lb/in

$T = 1380$ lb/in $/ (.282 \times 1)$ in^3/in

$T = 4894$ psi - [illegible] psi

REPAIR COST ESTIMATES

FACILITY 1553

1. Repair Ladder

A. Mobilization	$500.00
B. Prepare Ladder for Repair	350.00
C. Repair Ladder	450.00
Subtotal	$1,300.00

2. Replace Hatch

A. Preparation	$350.00
B. Install New Hatch	850.00
Subtotal	$1,200.00
Total for Facility 1553	$2,500.00

FACILITY 3266

1. Replace Nuts on Anchor Bolts

A. Mobilization	$500.00
B. Clean Bolts and Remove Nuts	500.00
C. Install New Nuts	250.00
Subtotal	$1,250.00

2. Repair Hinge on Access Hole Cover

A. Remove Broken Hinge and Prepare Surface	$500.00
B. Replace Hinge	250.00
Subtotal	$750.00
Total for Facility 3266	$2,000.00

FACILITY 3850

1. Replace Ladder with Safety Cage

A. Mobilization	$2,500.00
B. Remove Existing Ladder	2,000.00
C. Install New Ladder	9,000.00
Subtotal	$13,500.00

2. Repair Pipe Support

A. Remove Existing Support and Prepare Surface	$150.00
B. Install New Support	250.00
Subtotal	$400.00

Total for Facility 3850	$13,900.00
Approximately	$14,000.00

FACILITY NAB 753

1. Repair Spalled Areas

A. Mobilization	$2,000.00
B. Preparation	2,000.00
C. Repair Spalled Areas	4,000.00
Subtotal	$8,000.00

2. Replace Vent Cap

A. Remove Existing Cap	$400.00
B. Install New Cap	800.00
Subtotal	$1,200.00

3. Repair Cracks in Roof

A. Clean and Prepare Surface	$500.00
B. Apply Joint Compound	300.00
Subtotal	$800.00

Total for Facility NAB 753	$10,000.00

FACILITY NAB 754

1. Repair Spalled Areas	
A. Mobilization	$2,000.00
B. Preparation	2,000.00
C. Repair Spalled Areas	4,000.00
Subtotal	$8,000.00
2. Replace Vent Cap	
A. Remove Existing Cap	$400.00
B. Install New Cap	800.00
Subtotal	$1,200.00
3. Repair Cracks in Roof	
A. Clean and Prepare Surface	$500.00
B. Apply Joint Compound	300.00
Subtotal	$800.00
Total for Facility NAB 754	$10,000.00

END

DATE
FILMED

7-86