MANATEE PROTECTION PLAN AT SELECTED NAVIGATION & WATER CONTROL STRUCTURES IN CENTRAL AND SOUTHERN FLORIDA PART I

MAIN REPORT

SYLLABUS

This report is in partial response to authorization and appropriations provided in the Energy and Water Development Appropriation Act of 1994 (P.L. 103-126). The results of engineering and environmental studies are presented for the implementation of the Manatee Protection Plan, Part I at twenty selected water control structures with vertical lift gates in Central and Southern Florida. As a response to recent manatee mortality trends associated with water control structures, the purpose of the project is to provide operational changes and implement the installation of a manatee protection system on spillway and lock vertical lift gates. The beneficial outcome of this project will be the reduction of risk, injury, and mortality of the manatee which is considered to be one of the most endangered species in Florida.

The recommended plan is to implement the operational protocol for locks and spillways as contained in the Manatee Protection Plan for Water Control Structures and install a pressure sensitive device system on the water control structure gates. This device will immediately reverse the lowering of a vertical water control gate when an object is detected under a closing gate. The device consists of a series of pressure sensitive devices on the bottom of the water control gate which transmit a signal used to reverse the gate direction when resistance is encountered. When the gate sensors are activated by an object or manatee, the gate will open. At this time, a manatee will be able to travel under the gate. After the gate opens, it will fully close unless an object remains under the gate. Then, the opening process will repeat the cycle as the sensors are activated again. Due to this structural modification, manatees will be at a significantly less risk as they encounter locks and spillways. The project modification has a total estimated cost of $2,412,000.

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INTRODUCTION

AUTHORITY

Specific authorization and appropriations for this project are provided by the Energy and Water Development Appropriation Act of 1994 (P.L. 103-126). The conference report on the act states:

> *"The committee commends the efforts of the South Florida Water Management District for its efforts to develop innovative and relatively low cost pass-through gates for Manatees on existing Central and Southern Florida project flood protection structures. The Committee has provided $3,000,000 to install these gates on the S-25 B, S-28, S-20F, S-20G, S-21, S-21A, S-22, S-26, S-27, S-123, S-13, S-29, and S-33 spillways and on the S-193, S-135, S-302, S-127, S-131 and Henry Creek locks, and directs the Corps of Engineers to expeditiously move their construction ahead on cooperation with the South Florida Water Management District."*

STUDY PURPOSE

The purpose of this study is to develop a recommended plan and the appropriate documentation in compliance with environmental statutes for the operational and structural modifications of water control structures to reduce manatee risk and mortality. At the Federal level, manatees are protected by the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, as amended. Protection of the manatee at water control structures is a part of the long range recovery goal of the Florida Manatee Recovery Plan directed by the Endangered Species Act of 1973, to maintain "the health and stability of the marine ecosystem" and to determine and maintain manatee numbers at "optimum sustainable population" in the southeastern United States.

LIMITS OF STUDY SCOPE

The Manatee Protection Plan has been divided into a two part study. Part I of this study is limited to operational changes and the selective installation of a manatee protection system on the twenty vertical lift gated

water control structures listed in Table 1. Part II of the study will address the installation of manatee protection systems at seven sector-gated locks which include S-193, S-310, Ortona Lock, St. Lucie Lock, Port Mayaca Lock, Moore Haven Lock, and W. P. Franklin Lock. Separate studies were initiated because the manatee protection devices initially developed for vertical lift gates were not functional on sector gates; therefore, an effective protection system for sector gates is under development. If the study had not been divided into two parts, the installation of protective devices on the vertical lift gates would have been delayed awaiting the development of effective protection devices for sector gates.

For the Part I study, existing information was used to the fullest extent possible for the hydraulic, mechanical, and electrical designs; environmental benefits; and resulting recommendations. The operational modifications involve changes in gate operating policies and procedures at several structures. The proposed protection system incorporates sensor devices to be designed, constructed, and installed on selected lock and spillway vertical lift gates. Manatee protection systems were specifically authorized for seventeen vertical lift gated structures under the authority of the Energy and Water Development Appropriation Act of 1994. Three additional vertical lift gated structures which are owned and operated by the U.S. Army Corps of Engineers (USACE) were included in this study due to the potential for manatees mortalities to occur or continue at these structures. Thus, a total of twenty vertical lift gated structures were included in this Part I study.

This project will include reduced risk, injury, and mortality of the manatee which is considered to be one of the most endangered species in Florida. In response to recent manatee mortality trends associated with water control structures, this study identifies actions at water control structures to prevent further decline and assist in the recovery of manatee populations.

DESCRIPTION OF VERTICAL LIFT GATED LOCKS AND SPILLWAYS

The water control structures addressed in this report are vertical lift gated spillways and vertical lift gated locks which are briefly described below:

Vertical Lift Gated Spillways

The function of a spillway is to provide an efficient and safe means of discharging water. The vertical lift gated spillway is one type of spillway provided with gates so that the outflow rate can be adjusted. The vertical lift

gate of a spillway is typically rectangular in shape and slides up and down to allow water to pass beneath it.

Vertical Lift Gated Locks

A lock is used in the development of the navigability of a channel. A lock chamber is necessary to move vessels either upstream or downstream of the structure. Lying between an upper pool of water and a lower pool of water, the lock chamber allows a vessel to proceed from the water level in the lower pool to the water level in the upper pool, or vice versa. Similar to the spillway vertical lift gate described above, a vertical lift gated lock has a single vertical lift gate at each end of the chamber.

A more thorough description of the water control structures in this project can be found in Appendix E "General Description of Lock and Spillway Operations".

LOCATION

The proposed modifications for manatee protection are located at selected Central and Southern Florida Project navigation locks and water control structures, as shown in Figure 1. The Central and Southern Florida region encompasses most of 18 southern counties covering some 16,000 square miles and running south of Cape Canaveral-Orlando, down the center and east coast of the peninsula, to include the Florida Keys. This region is geographically dominated by Lake Okeechobee.

Lake Okeechobee is a large shallow, fresh water lake in the center of this geographic region. It acts as a drainage basin for the waters moving southward to the Everglades and southeasterly towards the coast. Because of the topography of the region, the two extremes of flood and drought are natural occurrences of the area.

Along the southeast coast of the peninsula, there is a narrow coastal ridge of pine barrens which supports the urban population running southward in Palm Beach, Broward, and Dade Counties. The urban problems in this area include large population, serious water utilization, and sewage disposal.

The structures included in this study and their location are shown in Table 1. The types of structures include vertical lift gated spillways and locks which are described in Appendix E, "General Description of Lock and Spillway Operations". Seventeen of these twenty structures are operated by the South

Florida Water Management District (SFWMD) in accordance with criteria specified by the USACE. The remaining three structures are operated by the USACE. Figure 1 shows the locations of the locks and water control structures.

TABLE 1. CENTRAL AND SOUTHERN FLORIDA PROJECT LOCKS / WATER CONTROL STRUCTURES INCLUDED IN PART I STUDY

STRUCTURE	LOCATION	OPERATED BY/ DATE CONSTRUCTED
S-13	Broward Co.	SFWMD/1954
S-20F	Dade Co.	SFWMD/1967
S-20G	Dade Co.	SFWMD/1966
S-21	Dade Co.	SFWMD/1961
S-21A	Dade Co.	SFWMD/1966
S-22	Dade Co.	SFWMD/1956
S-25	Dade Co.	SFWMD/1976
S-25B	Dade Co.	SFWMD/1976
S-26	Dade Co.	SFWMD/1974
S-27	Dade Co.	SFWMD/1958
S-28	Dade Co.	SFWMD/1962
S-29	Dade Co.	SFWMD/1953
S-33	Broward Co.	SFWMD/1954
Moore Haven Spillway (S-77 Spillway)	Glades Co.	* USACE/1966
W.P. Franklin Dam (S-79 Spillway)	Lee Co.	USACE/1965
S-123	Dade Co.	SFWMD/1966
Buckhead Ridge Lock (S-127)	Glades Co.	SFWMD/1963
Lakeport Lock (S-131)	Glades Co.	SFWMD/1963
S-135 Lock	Martin Co.	SFWMD/1969
S-308C Spillway	Martin Co.	USACE/1977

*NOTE: At Moore Haven, HGS-1 was built in 1935. In 1966, S-77 Spillway was built and HGS-1 was converted into Moore Haven Lock.

REPORT PARTICIPANTS AND COORDINATION

The USACE initially proposed to the SFWMD that a study encompassing a comprehensive manatee protection program should be implemented. On June 1, 1993, the SFWMD sent a letter of intent to act as the non-Federal sponsor of this study. The USACE, Jacksonville District, had the primary responsibility of preparing this document. The SFWMD coordinated and conducted the research and development of sensor devices and other alternative protection devices with the Jacksonville District.

An Inter-Agency Manatee Task Force was established in 1991 to recommend means to reduce water control structure related manatee mortalities. Members of the Manatee Task Force include: Dade County Department of Environmental Resources Management, Florida Department of Environmental Protection, South Florida Water Management District, U. S. Army Corps of Engineers Jacksonville District, and U. S. Fish and Wildlife Service. Throughout this study, the Jacksonville District attended Manatee Task Force meetings and maintained contact with members of the task force concerning issues and developments of this study. The Manatee Task Force was instrumental in providing information pertaining to alternatives for protecting manatees at water control structures and identifying crucial manatee mortality issues. The U.S. Fish and Wildlife Service provided the Coordination Act Report which was used to prepare the Environmental Assessment.

The Jacksonville District furnished appropriate Federal, state, and local agencies with a scoping letter. A scoping letter was also sent to many private and non-profit interest groups, as well as other interested parties. The purpose of the scoping letter is to identify potential problems concerning policy and the acceptability of the project as early as possible in the planning process. Other purposes of a scoping letter are to seek suggestions, alternative methods, or comments on a concept set forth in the letter. The scoping component is a source of communicating the USACE's study with interested persons, and it enables the USACE to receive valuable feedback. Responses to the scoping letter were incorporated into the plan formulation process. The scoping process also satisfies the National Environmental Policy Act (NEPA) scoping requirements for the project.

EXISTING PROJECT HISTORY

The modifications for manatee protection are proposed at structures which are part of the Central and Southern Florida (C&SF) Project. The

C&SF Project continues to be a large undertaking of the USACE, Jacksonville District. Initially in the 1800's, the promoters of South Florida felt it was a simple matter of dredging a few canals to drain off excess waters in this region, leaving rich and fertile farmland. The canals drained the land and lowered the water table, permitting the advance of saltwater through the aquifer and providing avenues for the saltwater to flow inland and disperse out into the surrounding land. Saltwater intrusion became a problem as the fresh water supply was contaminated with salt water due to increased drainage and consumption.

Construction of drainage canals from the Everglades through the coastal ridge to Biscayne Bay by local interests was begun about 1910. Since 1948, a number of canals have been modified or constructed as a part of the C&SF Project. Small dams or spillways have been installed on the coastal canals to prevent salinity intrusion and excessive drainage. By the 1970's, most of the spillways were modified to include remotely operated hydraulic gates. Currently, the canals and salinity control structures are operated by the SFWMD for the primary objectives of flood control and water supply.

When the Everglades Drainage District initially built canals in the area, these waterways were built for the purpose of drainage. In the 1920's, a plan was developed to create a cross-Florida waterway. After two hurricanes devastated communities bordering Lake Okeechobee in 1926 and 1928, Congress provided disaster relief in the form of flood control and navigation in the Rivers and Harbors Act of 1930. The 1930 Act included, among other provisions, improvements to the Caloosahatchee River and Canal from Lake Okeechobee to the Gulf of Mexico to provide a 2,500 cfs capacity outlet from Lake Okeechobee and a navigation channel at least 6 feet deep. The 1930 Act also provided improvements to the St. Lucie River to provide a channel 6 feet deep. These works were constructed by the USACE. This project was known as the Caloosahatchee River and Lake Okeechobee Drainage Areas (CR&LODA) Project.

Under the Flood Control Act of 1948, the CR&LODA Project was modified and expanded. This act created the Central and Southern Florida Project. The completed work under the CR&LODA project that did not pertain to navigation has been maintained as a part of the C&SF Project since 1950, and the navigation project since then has been known as the Okeechobee Waterway Project. Under the C&SF Project, Lake Okeechobee serves a number of purposes including flood control; navigation; water supply for agricultural irrigation, municipalities and industry, and Everglades National Park; regional groundwater control, and salinity control; and enhancement of

fish and wildlife; and recreation. The 155-mile Okeechobee Waterway originally consisted of three navigation locks operated and maintained by the USACE: St. Lucie, Moore Haven, and Ortona. W.P. Franklin Lock and its adjacent spillway, S-79, were added to the project in 1965. Originally called the Olga Lock and Dam, it was renamed in 1967, the W.P. Franklin Lock and Dam. The lock and spillway (S-308) at Port Mayaca were added in 1977.

PROBLEM IDENTIFICATION

EXISTING CONDITIONS

In the United States, the largest population of West Indian manatees is comprised of the Florida manatee. The endangered Florida manatee is a large herbivorous aquatic mammal which inhabits the coastal waters, rivers, and springs of Florida and Georgia. The habitat requirements for this species include access to shallow channels, freshwater sources, aquatic vegetation, and warm water refugia in the colder months of the year. At least 1,860 Florida manatees inhabit the waters of the contiguous United States. Except for isolated individuals, Florida harbors the entire United States population in the winter. High mortality, associated with human activity, as well as a low reproductive rate and loss of habitat have caused the population of manatees to decrease and threaten the species' future. As a result, government agencies, universities, private conservation groups, and concerned corporations have responded by promoting research and identifying actions needed to promote the recovery of manatee populations.

In 1974, the Manatee Salvage Program was established. The primary focus of the program involved research and conservation efforts to identify and quantify manatee mortality. Information gathered through the Manatee Salvage Program has led to the identification of some manatee mortality causes which include: boat/barge collisions, loss of habitat, crushing or drowning in flood gates, poaching, ingestion of fish hooks and monofilament line, entanglement in crab trap lines, cold water temperatures, and "red tide", known as algal blooms.

Because manatee mortalities are associated with locks and water control structures, means to reduce these deaths are imperative. From 1974 through February 1995, the Manatee Salvage Program data set shows that 111 manatee mortalities were associated with Florida water control structures. The U. S. Army Corps of Engineers Waterways Experiment Station (WES) compiled and provided the data summary of manatee mortalities found in Appendix G. Of these 111 deaths, 93 incidents were located in 5 southeastern counties (Dade 46, Martin 18, Glades 18, Okeechobee 7, and Broward 4) (Appendix G, Table 1a). Both spillway and lock types of water-control structures have been known to cause manatee mortalities; however, the majority have occurred at spillways.

There were 16 manatee deaths attributed to water-control structures in 1994, making it the worst year since record keeping began in 1974 (Appendix

G, Tables 2a,b and Figures 2a,b). The 1994 annual mortality attributed to water control structures is a 220% increase over 1993. The reason for the increase is unclear but most likely related to the increased structure activity as a result of unusually heavy rainfall periods. Although there are no strong temporal trends for these mortalities, June has been the month with the highest number of deaths (Appendix G, Table 3a and Figures 3a,b). Since many of the water-control structures do not have on-site personnel for monitoring, the extent of unreported manatee mortalities is also unknown.

The operation of spillways and locks are cited as the second leading cause of human related manatee mortalities. At most of these structures, manatees are undetectable, unless they are observed surfacing for air or feeding close to the water surface. As the animals follow the water edges and bottoms to feed, they pass under operable control gates. If the gates are closing at that time, the manatee can be trapped and drown. If the gate is completely closed, the manatee can be crushed or suffer body damage. In combination with the operation of spillways, high water velocities at several high head structures are also suspected to cause manatee mortalities. In such cases, the flow of water forces the manatee against or partially into the gate opening and results in the drowning of the manatee.

Due to the fact that all of the twenty water control structures in this study operate with vertical lift gates which pose a danger to manatees, the continuing possibility of future manatee mortalities exists at all of the structures in this study. Although there have not been any manatee mortalities attributed to eight structures of the twenty structures in the past twenty years, manatees travel through all of these locations. In fact, some of these structures have been noted in articles as excellent sites for the public to view manatees. For instance, according to lock tender records of manatee sightings for the period of January 1991 through September 1994, a total of 2,450 manatees were sighted at W.P. Franklin Lock and Dam (S-79) which has zero mortalities attributed to this structure. As a result of the potential danger for manatees at all of the structures in the project, a low cost and effective protection system is recommended to be implemented to protect manatees at all twenty of the water control structures.

PROJECT GOAL AND OBJECTIVES

General Goal

The primary goal of this project is to reach zero structure-caused manatee deaths. Striving to meet this goal, this project addresses modifications devised to protect manatees at water control structures.

Project Objectives

The project objectives are to design and install manatee sensing devices and to implement operational modifications at navigational locks and water control gates r manatee protection. As stated in the project authority, an economic constraint for this project involves devising relatively low cost pass through gates for manatees on existing C&SF water control structures. Due to this constraint, a value engineering approach is emphasized to implement the most efficient and cost effective protection at all of the twenty structures in this study. A time constraint is also involved, since the USACE has been directed to "expeditiously move their construction ahead in cooperation with the South Florida Water Management District."

PLAN FORMULATION

PREVIOUS EFFORTS TO REDUCE MANATEE DEATHS

Over the past ten years, project field offices made operational improvements and modifications to place the manatee at less risk at vertical gated locks and water control structures. The following manatee protection efforts were implemented at the vertical gated structures included in this study.

Iron Grate Barriers

In 1979, an iron grate barrier was installed eight feet downstream of the gate on S-25B in the Tamiami Canal. Although the barrier had a self-cleaning design, trash accumulation on the barrier interfered with the flow. In 1991, the barrier was abandoned because it interfered with existing manatee travel and habitat use patterns.

Manatee Circuits

Manatee circuits consisting of timers, relays, and limit switches were installed to modify gate openings on S-22, S-26, S-25B, S-21, and S-20-F. These electrical control circuits cause gates to hold 2.5 feet openings. This opening was determined large enough for manatees to pass through. In 1991, the SFWMD improved the telemetry system which increased the reliability of the manatee circuit. Computer algorithms were developed to minimize oscillations or "yo-yo" effects of the gates. Most oscillations were associated with upstream/downstream differentials rather than upstream open/close criteria. Since the oscillations increase the number of operating cycles which pose an increased opportunity for manatee entrapment, reducing the gate oscillation ("yo-yo") significantly increased manatee safety at these sites.

Over-the-Top Structures and Slot Gates

Design features for minimizing the number of gate openings and closings, including over-the-top structures and slot gates, were included at some structures. Slot gates were subsequently welded shut by SFWMD due to problems of trash accumulation, vandalism, and salt water infiltration at high tides. During moderate to high flow conditions, the over-the-top structure did not release enough flow to meet the flood protection criteria; therefore, gate operations were not minimized.

Magnetic Plunger/Reed Switch

The SFWMD conducted research to develop a plunger-type gate reverse sensor device which has been installed along the lower upstream edge of the vertical gates at S-27 in January 1993. In March 1994, plunger sensitive devices were installed at both the upstream and downstream edges of the vertical lift gates at S-29. This mechanical device will immediately reverse the lowering of a vertical water control gate when an object is detected under a closing gate. The sensing device consists of a series of encapsulated reed switches and pressure sensitive plungers on the bottom of the water control gate which transmit a signal used to reverse the gate direction when resistance is encountered. When the gate sensors are activated by an object or manatee, the gate will re-open, and manatees will be able to travel under the gate. The gate will begin to close unless an object remains under the gate. Then, the opening process will repeat the cycle as the sensors are activated again.

Flood Gate Operational Protocols

In August 1993, the SFWMD cited that minimum 2.5 foot gate openings had a major impact on reducing manatee fatalities. As a result, in February 1994, the USACE concurred with the SFWMD that the gates at certain low head coastal structures, can be safely set at unbalanced openings up to 2.5 feet for head differentials of up to 3.0 feet. This policy was applied to the following structures: S-33, S-29, S-28, S-27, S-26, S-25, S-25B, S-22, S-123, S-21, S-21A, S-20F, S-20G, S-13, S-308C, S-77, and S-79. Furthermore, vertical lift gates at structures within the scope of this project were designed to raise and lower at a rate not to exceed 6 inches/minute.

Operational Protocol

Through interagency coordination in 1992, the USACE South Florida Operations Office implemented much of the operational protocol for locks and spillways as contained in the draft Manatee Protection Plan for Water Control Structures (Appendix C) on an interim basis. Information on water management criteria is available in water control plans and manuals. Also, both the SFWMD and the USACE use a three volume set of USACE manuals for guidance on operational protocol entitled "Operations and Maintenance Manual - Central and Southern Florida Flood Control Project".

Speed Zones

In the spring of 1994, the USACE established idle speed zones in the form of "No Wake" restrictions around locks and spillways. These zones were primarily designated for public safety near locks where boat traffic can be excessive; however, the protection of manatees is another beneficial effect of this restriction. Within approximately 1000 feet of the lock, "Idle Speed" signs are posted and enforced by USACE staff. Manatees often traverse through the Okeechobee Waterway and various navigation lock chambers in conjunction with heavy boat traffic. The zones assure that boats are traveling at idle speed in the congested lock area, thereby reducing the risk of public safety and potential injury to manatees. Although the USACE does not have regulatory guidance to establish and enforce state mandated "manatee zones", the USACE will continue to enforce the idle wake zones which benefit manatees.

RELATED EFFORTS

Currently, additional manatee protection device measures are in the process of being prototype tested or developed for structures not included in Part I of the Project Modification Report. The proposed measures which will be studied in Part II of the Manatee Protection Plan include sector gate protection devices, spillway barriers, and acoustical detection methods. In this second report, a manatee protection system will be recommended for sector-gated locks at St. Lucie Lock, Ortona Lock, Port Mayaca Lock, Moore Haven Lock, W. P. Franklin Lock, S-193 Lock, and S-310 Lock.

Sector Gate Protection Devices

Currently, the USACE and the SFWMD are developing three pressure activated systems for the sector gates: the hinge plate switch, the piezo electric film sensor, and the hydraulic tube system.

Hinge Plate Switch

The SFWMD, working in coordination with the USACE, Jacksonville District, developed a pressure activated system comprised of a hinge plate switch. A drawing of the hinge plate system is shown in Appendix D, Plate ME-5. The hinge plate concept was developed when problems occurred with the sector lock "nesting" into the gate recesses and the lack of clearance between the lock wall seal and the gate seal to allow the plunger assembly to pass. The hinge plate would be located at the leading and trailing edges of the sector gate's contact edges. In this manner, a manatee caught or pushed into

a closing gate would move a spring-loaded "hinge-plate" which activates a limit switch. Then, the operator would open the gate a required distance to allow the manatee to safely pass while ensuring the safety of boat traffic and of the structure.

In January 1995, hinge plates were installed at the SFWMD sector gated lock, S-193, and several problems with this device occurred. When the hinge plate was installed, the dimensions of the hinge plate assembly impaired the gates from fully recessing. Although this is not a problem at S-193 since the lock is used by small boats which can pass through the partially opened gates, it is a potential problem at other structures used by larger vessels. Another problem arose with one of the hinges being damaged by a fishing boat. Lastly, another difficulty encountered with the hinge plate was the rebound when the hinge is moved. The confined space of the closed hinge restricted the spring size, since the existing coil spring located at the bottom of the hinge plate was inadequate to fully open the hinge. A potential solution to this problem is being devised which would utilize a urethane spring located between the hinge and base plate. The elasticity of these springs offers a progressive type spring action; moreover, they are suited for high loads in confined spaces and corrosion conditions. Initial contact by a manatee compresses the urethane a small amount, and the alarm is activated by a small movement of the hinge. During the hinge closing, the increased compression stores more energy to re-open the hinge as required.

In September 1995, the SFWMD installed a revised hinge plate system on S-193. This system was revised to include modified springs and hinge plate edges to allow the hinge plate to fully re-open after it is activated. This system will be tested at S-193 until a preferable device is developed for manatee protection at sector gates.

Hydraulic Tube

Recently, another type of protection device, a hydraulic tube, has evolved as an option for protection at the sector gates. In order to protect a manatee from being caught between the edges of the gates, a hydraulic tube (flexible, reinforced hydraulic hose) would be installed at the J-seal and/or the bumper block line. The hydraulic tube would have a metal cylinder at one end to include a piston driven by the compression of the tube when compressed by a manatee. In this manner, a microswitch could be activated to relay a signal to detect the presence of a manatee. Currently, this possible option is in the testing and development stage.

In May and July 1995, the USACE tested the hydraulic tube protection device at the Port Mayaca Lock. During the first test, the device interfered with the complete closure of the gate. Since the diameter of the cap was larger than the diameter of the tube, the gate could not close properly. For the second test, the newly designed device had beveled end caps welded to each end. These caps had a smaller diameter than the original caps; therefore, they did not impede the complete closure of the gate. During the second test, the tube detected pressure; however, a leakage problem developed and a new assembly device was required. In an upcoming October 1995 test, the hydraulic tube will be fastened to a slotted base bar with screw clamps every two feet, and a new o-ring assembly of copper seal washers will be used to prevent leakage. This device will be tested for period several months to determine its effectiveness.

Piezo-Electric Film Sensor

In August 1995, the piezo-electric sensor device was introduced as a new technology which could sense the presence of a manatee between closing gates. The SFWMD contracted Harbor Branch Oceanographic Institute, Inc. (HBOI) to evaluate the problem of manatee mortality at S-193 and propose a solution. HBOI recommended installing piezo-electric film based contact sensors in the existing j-seals of sector gates as a manatee detection system.

Piezo film, a thin flexible material manufactured from polyvinylidene fluoride plastic, converts mechanical energy to an electrical response. As described in HBOI's report in Appendix I, three approaches to using piezo-electric film sensors were designed, fabricated, and subjected to preliminary testing. The j-seal contact sensor was recommended by HBOI as the proposed design to install and test on a sector gated structure. The j-seal sensor would be fabricated by sandwiching the piezo film between the j-seal and a protective neoprene cover layer. The sensor would connect to a junction box assembly mounted on the gate. This junction box would contain the sensor condition module used to report contacts over a cable run to the control room. A control room junction box would contain the gate trip and alarm connections, in addition to the hardwired connections to the present gate closure circuitry. The detected presence of a manatee would trip-out the gate closure and activate the alarm. Then, an override switch would allow the system to be bypassed and restore operator control. The SFWMD anticipates that this device will replace the hinge plates and be tested at S-193 in November or December 1995.

The HBOI report also states that the piezo film is an excellent candidate for the vertical lift gate application.

Spillway Barriers

In the fall of 1994, an additional manatee protection measure was devised by the USACE, South Florida Operations Office. An alarming number of manatee mortalities in 1994 were associated with the operation of spillway structures that have high head differentials between their upper and lower pools. In response to the increased mortalities, barriers were designed and constructed to restrict manatee access to spillway gates and to prevent manatees from being subject to the high velocities found near gate openings.

The initial test of the barriers was conducted at the Ortona spillway (S-78). At this site, there is a navigation lock adjacent to the spillway which allows manatees to continue utilizing normal travel and foraging routes when the barriers are installed. The barriers were designed to fit easily into the needlebeam recesses located six to eight feet in front of the spillway structure. These recesses are normally used for dewatering equipment when maintenance is necessary.

The first barrier designs were developed and tested at S-78 in the fall of 1994. The first prototype incorporated two designs. The first design consisted of half inch pipe spaced vertically on seven inch centers and encompassed by a steel frame. The other design was a bull panel comprised of 6 by 6 inch mesh and encompassed by a steel frame. Two barriers of each design were constructed: one measuring 19.6 feet by 19.6 feet and the other measuring 23 feet by 24 feet. All four barriers were installed to correspond with the four spillway gates at S-78. Due to record rainfall events in 1994, vegetation accumulation became a serious problem which necessitated the removal of the barriers on several occasions for cleaning and repair. The barrier design with the bull panel was discarded as an alternative due to its inability to withstand debris loading. The vertical pipe design proved to be a viable option which provided a basis for the next generation barrier.

In February 1995, the second generation barrier design consisted of reinforcing the basic vertical pipe design with cross bracing comprised of galvanized box tubing and flat bar. This design was installed at all four S-78 spillway gates for testing and monitoring. Vegetation accumulation presented difficulties in the attempts to clean the barriers and allow water discharges. Due to the large single section design per gate, it was necessary for an available barge and crane be used to lift and clean the barriers on a routine basis.

In March 1995, the USACE South Florida Operations Office submitted a design for a third generation barrier which incorporated three removable panels supported by the main steel frame and seated into the needlebeam recess of the spillway structure. In an attempt to alleviate the problem of vegetation accumulation, the removable panels were designed with half inch pipe spaced horizontally, rather than vertically, on eight and one-half inch centers. The removable panels were designed to be more manageable than the previous single section frame barrier. To more effectively facilitate the removal and cleaning of the removable panels, a small tracked electrical hoist was installed at S-78 above the gate recesses.

This third generation barrier was constructed and field tested in April 1995. Two barriers of this design were constructed and installed at the S-78 spillway in the recesses of gates number two and three. The second generation single section frame barrier with vertical pipe design remained in the recesses of gates number one and four. After a testing period, the horizontally-spaced pipe on the removable panels proved to be the most successful design in passing vegetation and floating debris. However, during high discharges, the pipe tended to vibrate causing the welds to break. In instances where welds broke on the removable panels, the pipe was replaced with half inch flat bar. Through experimentation, the flat bar withstood higher water velocities and allowed the passage of more vegetation and debris than the rounded pipe. As of August 1995, no substantial problems have been reported concerning the use of the third generation barrier design at S-78. Since the first prototype of the barriers was installed, there have not been any manatee mortalities attributed to the operation of S-78.

To continue the experimentation of using flat bar rather than pipe in the removable panels, a barrier was constructed and installed at the St. Lucie spillway (S-80). Field testing and monitoring began in July 1995 to evaluate the feasibility of installing this design of barrier across the entire spillway area (seven gates total).

The installation of spillway barriers will be investigated at structures having the potential for high head differentials between their upper and lower pools. At these high head structures, there is an adjacent navigation lock. The following spillways are future potential sites for spillway barriers: the S-77 spillway, adjacent to the Moore Haven lock and the S-308C spillway, adjacent to the Port Mayaca lock. Also, the USACE will investigate other potential spillway barrier sites at water control structures without an adjacent lock if the USFWS and DEP agree that limiting manatee habitat in certain areas is acceptable.

Acoustical Detection Methods

In January 1995, the U.S. Army Corps of Engineers Waterways Experiment Station (WES) conducted tests to evaluate the feasibility of developing acoustic equipment to detect manatees. First, the acoustic tests were performed in a concrete swimming pool at an 8.5 foot depth of water. The results showed that a swimming person could be detected under these circumstances. It was determined that a preliminary assessment would be needed under real conditions at a water control structure to assess the feasibility of using hyrdoacoustic techniques to detect manatees. In May 1995, personnel from WES and the SFWMD participated in a pilot field test at Port Mayaca Lock (S-308) to assess:

- Logistic limitations of the placement of monitoring equipment and transducers.

- Potential problems from environmental limitations such as changing water depth, concrete walls, noise, air bubbles, turbidity, trash and vegetation, boat traffic, and other swimming organisms.

- Challenges posed by SONAR shadowing and resolution.

- Equipment limitations and selection of appropriate equipment.

- Feasibility of further development of this technique.

The acoustical equipment included a Furuno Color video sounder Model #FCV-522 with a Furuno narrow angle transducer, Model #200B-8B-15M. First, the narrow beam angle transducer was attached to the end of a 30 foot, half-inch galvanized pipe and secured to the south side of the lock chamber wall, approximately 100 feet from each sector gate. The transducer was placed underwater at a depth of 10 feet. The tilt of the transducer was adjustable and positioned to allow for the most coverage within the chamber while minimizing the amount of scatter produced from the reflective surfaces of the chamber walls, bottom, and sector gates.

During the field test, a SCUBA diver was used as a mock manatee, and he was positioned between the transducer and the sector gates. The diver was repeatedly detected by the acoustic equipment as he swam at the surface and at various depths within the water column.

The sector gates were opened and closed several times to determine the equipment's viewing capability through the opened gates into the approach area of the navigational lock. While the gates were in the open position, a real manatee was detected on the monitor by the acoustic equipment as the manatee entered the area which was insonified by the transducer. The manatee was detected at the surface, and the equipment tracked the manatee's movements as it moved up and down through the water column. This test indicated that unsophisticated, commercially-available acoustic equipment could be successfully used to detect manatees in and around the navigational lock.

Limitations of using commercial acoustic equipment include reflection scatter from the lock chamber walls and limited coverage area within the chamber as a result of using a narrow transducer cone angle. The reflective scatter can be eliminated or controlled with more sophisticated equipment. Scanning sonar has the capability of eliminating on the display monitor any objects which are stationary such as the reflective walls. Imaging sonar equipment is designed to provide an image of the stationary walls and sector gates as well as any manatees in the chamber. Scanning sonar overcomes the problem of limited coverage area by using a single fixed narrow transducer which sweeps the entire lock chamber. The results of this pilot study indicated that further field testing was viable to evaluate the effectiveness of scanning sonar and imaging sonar for detecting manatees at water control structures. By using more sophisticated acoustic equipment at locks, the devices could also provide a means to gain valuable insight of manatee behavior in locks.

Further evaluation of acoustical equipment will be incorporated in the Part II of the Manatee Protection Plan. Equipment evaluations will include: effectiveness for detecting manatees; installation logistics; ability to work in shallow, turbid water, with boat traffic; and ease of preparation for water control structure operators.

DESCRIPTION OF ALTERNATIVES

Operational and structural modifications to all twenty of the water control structures in this study are crucial for reducing or eliminating manatee risk or mortality by preventing a vertical lift gate from closing on a manatee. Manatees travel through all of the vertical lift gated structures included in this study; therefore, protection devices on these gates are necessary to reduce harm to these manatees. The following alternatives were evaluated to protect manatees at the twenty structures for this study:

1. No Action
2. Bubble Curtain
3. Folding Screen
4. Pressure Sensitive Device Systems
5. "Over the Top" Control Gates

Plan 1: No Action

The "No Action" alternative would not provide modifications to the water control structures for manatee protection.

Plan 2: Bubble Curtain

A bubble curtain is the underwater release of pressurized air. The rapid expansion of air forms bubbles which cause a loud gurgling sound as the bubbles expand and rapidly move to the water surface and burst. This curtain formed from pressurized air and piped from a remotely located air compressor is directed and forced through perforations along a pipe at the bottom of the channel. Both the wall of air bubbles and the noise of the air expanding as it moves from the piping into the water was devised to startle the manatee and prevent the mammal from passing through the "bubble curtain" into the operating gate(s) area.

Plan 3: Folding Screen

Two configurations of the folding screen design are described below.

Plastic Netting

When the gates are closed, the collapsible plastic netting is weighted to fold on the channel bottom. Cabling on either side of the channel supports the netting. This folded screen is located in the upstream channel side of the water control structure, and the operator can raise the screen during a manatee alert or sighting prior to gate operation. Raising the supporting cabling with a motor operated windlass on one side of the channel would unfold the screen. Cabling on the opposite side anchors the screening. When fully raised, the tightened plastic webbing would resemble a screen with the bottom anchored to a beam across the channel bottom. In this manner, the manatee would be restrained from entering the operating gate area while water would still be allowed to flow through the screen as required for water control.

PVC Frame

The alternate configuration is a weighted PVC frame conformed to the outline of the channel bottom and both sides. This frame would be fitted with screening from the water level to the channel bottom. Hinged to a bottom anchor beam, the frame would be raised by motor driven windlass to a vertical position across the channel prior to gate openings. In doing so, manatees would be prevented from entering the operating gate area while water would still be allowed to flow through the screen as required for water control.

Plan 4: Pressure Sensitive Device Systems

Four types of pressure sensitive device systems were evaluated for the purpose of manatee protection at vertical lift gates.

Magnetic Plunger/Reed Switch

General. The SFWMD developed a conceptual sensor system using a multi-plunger system of pressure sensitive devices (PSD's) as the Manatee protection circuit activator. Two versions of this system were evaluated where the pressure sensitive devices would be activated by either a reed switch or sensi-switch. Plate ME-2 in Appendix D shows a typical magnetic plunger and reed switch for spillway gates. Photograph numbers I through VI in Appendix D show the magnetic plunger and reed switch installation at S-27 and S-29.

The plastic plungers, spaced at six-inch intervals along both the upstream and downstream gate edges, initiate the manatee protection circuit when one or more are depressed. The six-inch interval is spaced to include the detection of younger manatees. The plunger contains a solid, cylindrical magnet which energizes a reed switch bank as it moves over the reed switches. If the plungers are obstructed by a manatee while the gate is being lowered, the switches trigger the manatee protection circuit and the lowering gate is reversed.

The reed switch bank consists of three switches in parallel per plunger. This offers a fail-safe device so that the failure of one reed switch does not incapacitate that particular reed switch bank. By checking the resistance across each individual reed bank circuit, the number of active reed switches remaining in the reed switch bank can be determined. Seven plungers make up a sensor assembly. The circuitry for seven plungers consists of a circuit board with seven reed switch banks and the seven individual wire leads from each reed switch bank. The circuit board and reed switch banks are

encapsulated in neoprene for protection. Each individual reed switch bank wire is attached to the manatee protection circuit.

The plungers and the encapsulated circuit board assembly fit into a stainless steel support which is fastened to the gate contact area. Each assembly is about forty-two inches in length, providing ease of installation across the gate edge to allow plungers to protrude about three inches and be spaced at six-inch intervals along the gate edge. A thirty-foot wide gate has sixty switches on the upstream side and downstream side. Many wires are contained and directed to the central manatee monitoring system.

Two water control structures, S-27 and S-29, are currently equipped with the plunger system. The plunger system at S-27 has one row of plungers which was installed only on the upstream side of the gate. In order to provide a more 'fail-safe' system, two rows of plungers were installed at S-29; one row on the upstream edge and one row on the downstream edge of the gate.

Manatee Protection Circuit. The manatee protection circuit consists of Direct Current (DC) operated pressure switches and a DC relay. The DC relay contacts are interlocked with the gate open/close Alternating Current (AC) operating circuit. The DC system is operational between the gate opening of 2 inches to approximately 2.5 feet. Outside this range, the gate operation is normal under the AC system and DC system; thus, the manatee protection circuit must be deactivated by two gate mounted limit switches.

(1) Automatic Gate Operation. The plastic plungers activate an electrical circuit when one or more plungers are depressed by a passing manatee. The plunger contains a cylindrical magnet which energizes the encapsulated reed switch bank as it moves over the reed switches and changes the magnetic field around the switch.

The switch activates a DC relay. A normally closed DC relay contact in the gate close circuit disables and stops the gate closing operation, and a normally open contact in the gate open circuit enables the gate opening circuit and initiates gate opening. The gate travels to an opening of approximately 2.5 feet where a two prong momentary contact limit switch interrupts the gate opening and starts gate closing cycle. The automatic gate opening/closing cycle continues until the manatee has cleared the gate closing area or the remaining gate closing has reached the 2-inch zone when the DC portion, and thus the manatee protection circuit, are disabled. See plate ME-3 in Appendix D.

(2) Manual Gate Operation. Due to the mechanical and electrical system limitations, some of the USACE structures may be operated manually. For manual gate operation, the DC portion of the manatee protection circuit will not change and will function as explained above. At energization of the DC relay, the normally closed DC relay contact in the gate close circuit will disable the closing operation, stop the gate in place, and trigger an audio/video alarm. At this point, the operator will make the decision to open or close the gate until the manatee clears the gate closing area and the alarm circuit does not activate at gate closure.

During the manual operation, the presence of an operator is required for the complete gate closing duration. Modifications may be required to the current gate operating procedure. It should be noted that the two gate operating procedures, automatic gate reversal and manual gate operation, will be further analyzed during the plans and specification stage to best fit each structure's mechanical and electrical equipment and limitations.

(3) Testing. Meter testing of all systems at S-27 and S-29 has been implemented to ensure proper operation of the devices. The protocol to test and record the condition of the switches is currently being developed. Previous testing has been accomplished approximately weekly, and the direct functionality of the gate switches has been tested on site by physically impairing the closing gate to observe gate reversal and sensor activation.

Magnetic Plunger/Sensi-Switch

During the search for alternative pressure switch, a waterproof sensi-switch was found. One manufacturer makes a solid, flexible, half-round urethane rubber form which encloses continuous lengths of stainless steel foil tape. ("Sensi-Switch" is a product made by the Recora Company, Batavia, Illinois). Discussions with the manufacturer indicated that the sensi-switch could be furnished in any desirable length. Compression of the urethane completes the contact of the foil tape to activate the connected electronics. Once the sensi-switch is activated as the plunger system is depressed by a manatee, the manatee protection circuit and gate operation are the same as described the Manatee Protection Circuit section.

Collapsible Tube Switch

During the development of the pressure sensitive devices, a type of gate protection using an collapsible air tube switch was investigated. The collapsible tube switch is a device that operates similarly to the pressure

sensors used on automatic closing garage doors. Collapsible air tubes are located on the lower edge of these doors. One end of the tube is tightly sealed and the other end is attached to a fitting on a sensitive air pressure switch. If the edge of the tube is compressed while the door is closing, the door will stop or reopen automatically. The tube compresses the air and activates the pressure switch and circuitry which stops the door or reverses the door action. A modification to this device would be a flexible tube constructed with foil contacts at opposite interior sides of the tube. Compression of one side against the other would cause electrical contact to reverse or stop the door. Then, the manatee protection circuit and gate operation would be in effect as explained in the Manatee Protection Circuit section.

Piezo-Electric Film Sensor

In HBOI's preliminary evaluation of the piezo-electric film sensor device as an alternative for manatee protection at sector gated structures, HBOI stated that the piezo electric film would be also feasible as a pressure sensitive device on vertical lift gated structures. According to HBOI, the sensor could possibly be installed at the bumper block located at the bottom of the vertical lift gate in the same type of layout for the J-seal sensor as described in the Sector Gate Protection Device Section and Appendix I. Using the piezo strip sensor as a sensing device would eliminate the need for plungers. The sensor would connect to junction box assemblies which contain the gate trip and alarm connections. The detected presence of a manatee would stop or reverse the gate closure. The manatee protection circuit and gate operation would proceed in the same manner as described in the Manatee Protection Circuit section.

Plan 5: "Over The Top" Control Gates

During early development of USACE lock and spillway gates, consideration was given to both passing water "over the top" and through the middle of the gates. As part of this study, a search was conducted to determine what types of methods have been used to pass water through a structure other then conventional passage under the gate. Gates passing water "over the top" have been used, and some are currently in use in central and northeastern United States. These gates were primarily used to pass ice and provide supplemental filling in locks.

The type of "over the top" gates used were either submergible tainter gates, multiple leaf vertical lift gates or slot gates. The submergible tainter gate is similar to a conventional tainter gate; however, it descends into a pit in

the chamber floor to allow passage of water over the top of the gate. The multiple leaf vertical lift gate is similar to a conventional single leaf lift gate in terms of structural framing. The difference is that the multiple leaf system provides for vertical movement downward of the top leaf to allow for water passage over the top of the gate. The slot gate is similar to a single leaf vertical lift gate; however, a notch is provided in the top of the gate and a smaller movable gate is provided to control flow through the notch. Another system used for the passage of water other than from below the gate is the split leaf tainter gate. This gate appears similar to a conventional tainter gate; however, an extensive hydraulic system is used to raise the upper portion of the tainter gate to allow passage of water through the center of the gate.

Butterfly valves have also been used to pass water through the center of gates. Butterfly valves were used during early lock design as a means to supplement filling of lock chambers similar to multiple leaf lift gates. The final type of structure identified during this study that passes water over the top was a multiple stacked bulkhead system. This method utilizes a movable gantry crane that travels along the top of a lock wall and vertically stacks bulkheads until the required level of water control is established.

EVALUATION OF ALTERNATIVES

Plan 1: No Action

The "No Action" alternative would not be a practical solution, since according to the USFWS, manatees will continue using the Okeechobee Waterway and the Central and South Florida area. The trends of manatee mortality indicate that the future of the manatee could be adversely affected if no action is taken.

Plan 2: Bubble Curtain

A bubble curtain was originally installed at W. P. Franklin for the prevention of salt water intrusion. As a secondary benefit, the bubble curtain application was thought to be a viable option for preventing manatees from passing through the curtain and entering the lock. For the purpose of manatee protection, the bubble curtain was not successful at W. P. Franklin Lock. Manatees became accustomed to the gurgling sounds of the system and appeared to enjoy playing in and around the bubble curtain. Thus, this alternative was abandoned as a manatee deterrent, but it is still in operation to control salt water intrusion.

Plan 3: Folding Screen

The folding screen alternative was eliminated due to biological and economical reasons. The collapsible PVC frame and plastic netting concepts would require individual fitting to conform to each particular channel outline and would be very costly. It also would be possible that manatees could slip past a raising screen/frame and move between the screen/frame and the operating water control structure, thus endangering the manatee. No further evaluation was done on this alternative.

Plan 4: Pressure Sensitive Device Systems

Magnetic Plunger/Reed Switch

The SFWMD concept is sound. Considerable analysis and work went into fabricating the workable assemblies. The advantages, disadvantages, and field results for this system are noted as follows:

Advantages. (1) The plastic pieces are corrosion free.

(2) The plunger mechanism conforms to the manatee body surface more closely than any other mechanism evaluated.

(3) After installation, replacement is relatively easy. Divers can replace the short modules; dry-out of the structure is unnecessary.

Disadvantages. (1) Production of the parts is labor intensive. The circuit boards are hand-made for the particular application. The plastic parts are machined from plastic stock, as is the plastic holder for the encapsulated circuit board. The circuit boards are encapsulated and wired by hand. Each assembly requires several wire conduits from it to the monitoring panel.

(2) Very few parts are "off-the-shelf" or readily available.

(3) Due to problems such as biofouling, the total system is very maintenance intensive. When a problem develops, each individual switch must be tested to determine the fault source.

Field Results. Since the time that the devices were installed at S-27 and S-29, there have been three manatee deaths at S-27. The SFWMD

Manatee Mortality Report for the manatee mortality which occurred in November 1994 is included in Appendix G. The SFWMD report on this death at S-27 indicates the following:

(1) The manatee protection system functioned successfully on both gates preceding the probable mortality time.

(2) The pressure sensitive switches functioned normally when tested shortly after the mortality was reported.

(3) Failure of the manatee protection system to be triggered by a manatee is believed to be due to the failure of the enable/disable switches to be tripped by the closing gate. If the horizontal trip arm attached to the top of the gate does not engage and rotate the enabling switch mounted on the structure sidewall as it passes during the downward motion of the gate, the entire array of PSD's will remain shut off during gate closure. SFWMD maintenance staff experienced trouble adjusting these switches due to the excessive lateral gate movement at S-27. The excessive gate wobble could allow the trip arm to miss the enable switch if the gate is leaning upstream in its track.

As a result of the aforementioned findings, SFWMD identified, implemented, and addressed several issues:

(1) Replacement of the Enable/Disable Switch System
(2) Formalized Manatee Protection System Testing and Reporting
(3) Formalized Control Room Operator Manatee Alarm Log
(4) Increased Manpower Allocation to SFWMD Manatee Program
(5) Enhanced System Maintenance Capability
(6) Field Testing of PSD system
(7) Further Refinement of Gate Control Algorithms
(8) Consideration of Additional Tension in PSD Trigger Springs

Since the November 1994 manatee mortality attributed to the S-27 water control structure, there not have been any manatee mortalities at this structure. Improvements to the existing plunger systems have been incorporated at S-27 and S-29. Switches have been replaced with a magnetic strip switch at both structures. This system uses a magnet moving in proximity to a metal circuit strip to activate the circuit. Since the time of the installation of the new switches in March 1995, there have not been any manatee mortalities attributed to either S-27 or S-29.

HBOI has also investigated improvements to the plunger system device. These improvements which would prevent the growth of fouling organisms on the devices include the use of anti-fouling paint or coating on the devices and the placement of copper sleeves in the plunger assembly.

There have not been any manatee mortalities at S-29 since the pressure sensitive devices were installed at this structure in March 1994. At S-29, a redundant PSD system has been installed on the gates for additional protection. The plunger system has been installed on both the upstream and downstream edges of each gate. As a result of the success at S-29, a type of redundant system was determined to be a viable alternative for this project.

Magnetic Plunger/Sensi-Switch

In the conceptual design, the Sensi-Switch is applicable as an alarm activator. A contact device would be needed between the manatee and the Sensi-Switch. The Sensi-Switch and the plunger concept from the SFWMD were considered in combination. This system would embrace the advantages of the two concepts. The urethane encased foil strip contacts with a single wire and the plunger point contact every six inches offer a reliable, simple, self-cleaning manatee contact sensor.

Preliminary informal testing showed that submerging the sensi-switch did not presented any insurmountable problems. Initially, the manufacturer forwarded a foot-long sample for evaluation, and underwater testing involved submerging the sample in a pail of water with the leads connected to a siren alarm. Submergence for five days revealed no problems in water resistance and alarm activation of the sample part. The sensi-switch was tested for five days and elastic rebound properties were excellent.

In August 1995, Harbor Branch Oceanographic Institution, Inc. (HBOI) tested the sensi-switch for durability and resistance to leakage. The switch was pressurized to 75 psig in fresh water for 30 minutes. No visible damage or water intrusion occurred as a result of pressure testing. The switch was found to still function after the test, and it maintained an open resistance of greater than 2000 Mega Ohms at 100 Volts.

Currently, HBOI is conducting biofouling tests of the sensi-switch. Further field testing of the sensi-switch would be necessary to determine the effectiveness of this switch in actual field conditions.

Collapsible Tube Switch

The collapsible tube switch required adaptation to the underwater environment to be a viable protection device for gates. The tube would have to be constructed similar to a watertight hose. In a search for manufacturers who could furnish this type of waterproof device, no one manufacturer could be found who recommended their product for underwater service. As a result, this pressure sensitive device was not selected as a viable device for further testing at the structures.

Piezo-Electric Film Sensor

HBOI's preliminary evaluation of the piezo-electric film sensor is provided in Appendix I. Although further evaluation and field testing of the piezo-electric film sensor would be necessary to determine its actual effectiveness, HBOI listed several advantages of this type of sensor. Since the piezo film manatee sensor is an uncomplicated design with no moving parts, the maintenance of this device is anticipated to be much less than the maintenance for the plunger system. According to HBOI, the ability of the sensors to null out stresses, the lack of any moving parts, and the innate toughness of the sensors should provide high reliability. Ease of repair, installation, and operation of the piezo-electric film sensors were also stressed as advantages of the device.

Plan 5: "Over The Top" Control Gates

The use of a submergible tainter gate would require an extensive pit located in the floor of the lock chamber or spillway bay. This pit and the necessary anchorage in the walls of the structure to support the gate would require major structural rehabilitation. By placing a deep pit in the floor of the structure, uplift pressure is increased during dewatering conditions. This increase in hydrostatic uplift pressure on the base of the structure will effect the stability of the structure. In addition, the existing machinery would also require replacement or extensive rehabilitation. Additional operational and maintenance problems also develop from trying to maintain the pit clear of debris and sedimentation. Another problem that exists with gates passing water "over the top" is that they tend to be more prone to vibration problems. When vibrational modes are developed, they can cause stress cycles that reduce the fatigue life of the gate. Consequently, premature cracking can occur in the gate.

The use of multiple leaf vertical lift gates results in similar major rehab to the structure. Multiple vertical slots would be required to be cut into the sides of the existing structures. Cutting slots in the sides of the walls would mandate the removal of existing vertical reinforcing and simultaneously reduce the thickness of the walls. This loss of reinforcement and reduction of wall thickness would be detrimental to the strength and stability of the walls. In addition, the redistribution of the horizontal hydrostatic loads into the walls from the multiple leaf gate would be significantly different from the original design such that extensive rehabilitation would be required. Another concern with multiple leaf lift gates is the vibration problem similar to the submergible tainter gate. In addition, debris that becomes lodged between the moving leaves results in excessive wear in water stops and reduction in the operation efficiency of the gate.

To convert the existing vertical slide gates to slot gates would require cutting a notch in the top of the gates and installing the additional framing necessary to support the slots. The stiffness of the gates would be changed by the creation of the slots. This change in stiffness could result in distortion along the vertical edges of the slot. The distortion would tend to bind the movement of the slot gate and hinder operation. Additional framing may be required to minimize this distortion. The slot gate could be operated either manually or through the use of a mechanical system. If a manual system was used, a walkway would be required on the top of the gate. If a hydraulic system were used, additional control mechanisms would be required, some of which would be attached to the gate. Independent of the selected operational system, the self weight of the gate would increase. This increase in weight could effect the operability of the existing machinery used to raise the existing gate when large flows exceed the capacity of the slot at the top of the gate.

Butterfly valves can be used to pass low flows; however, to pass large flows, the existing gates would have to be raised to allow passage of water under the gate. The operation of the butterfly valves would require either hydraulic controls or a torque tube for each valve that would be manually operated from the top of the gate. The framing system on the existing gate would have to be extensively stiffened to transfer the hydrostatic loads on the gate around the valves. The additional framing to stiffen the gate and support the valves would increase the gate self weight as would the weight of the valve itself. In addition, if a manual torque tube system were used to control the valves, a walkway along the top of the gate would be required. Similarly, if a hydraulic control system were used for the valves, additional self weight would be added from any necessary hydraulic control mechanisms. Since the existing machinery used to actuate the gate did not include this additional weight,

rehab of the machinery or new machinery will likely be required. The use of butterfly valves will also introduce additional point loads on the gate that were not considered in the original design. Additional framing will be required to transmit the valve loads into the gate.

The multiple stacked bulkhead system requires the use of a gantry crane. The gantry crane must operate from above the structure. For the crane to function, a rail system would have to be installed on top of the structure and sufficient clearance allotted for the crane to travel. Storage for bulkheads not in use would be required. This storage could possibly be obtained by cutting slots in the top of some existing structures or by constructing a new cradle system. If slots were cut in existing structures, this would reduce the stiffness of the structure and supplemental reinforcement would be required. Also, the raising and lowering of stacked bulkheads could cause manatees to be subjected to a potential crushing risk.

In addition to the structural problems and the lack of economic feasibility of over the top control gates, this alternative was not investigated further because it eliminates the upstream travel of manatees through the waterway. This alternative could also cause high flow impingement due to slots and valves which could cause risk to manatees.

SELECTED PLAN

GENERAL

Plan 4 was determined to be the best low cost, effective plan which will produce significant environmental benefits by protecting manatees at vertical lift gated structures. Plan 4 consists of the implementation of operational changes and the phased installation of a pressure sensitive manatee protection system on selected spillway and lock vertical lift gates at twenty water control structures in Central and Southern Florida.

The selected plan consists of installing the pressure sensitive device system on selected vertical lift gated structures. At this point, variations of the manatee protection system utilizing pressure sensitive devices have been chosen for further analysis and testing: the magnetic plunger/reed switch system, the magnetic plunger/sensi-switch system, and the piezo-electric film sensor system. In principle, the systems are identical in operation. These systems are actuated by pressure (by a passing manatee, for example), which activates an electrical switch. The activated electrical switch generates a signal which modifies the gate open/close circuit accordingly.

Future advancements in the technology of pressure sensitive devices will also be incorporated in the selected manatee protection system. All of these chosen systems have similar circuitry, testing and monitoring procedures, and operation and maintenance requirements as described below.

Manatee Protection Circuit

The electrical activation and deactivation of the manatee protection circuit by pressure sensitive device systems is the same. Therefore, the gate open-close cycle as activated by the manatee protection circuit is also the same. A detailed description of the manatee protection circuit is in the DESCRIPTION OF ALTERNATIVES section.

Testing and Monitoring

The manatee protection system would proceed on selected structures with high risk to manatees for testing prior to committing to a final design for installation on all identified structures. Standard product and quality control criteria for the Contractor's installation of the Manatee Protection system for each structure would include dry testing with manatee models. These models would be situated along the gate edges and the sensors verified by activating

the gate closing operation. Measuring gate drop after alarm activation and observation of the manatee model would be a portion of acceptance criteria.

In coordination with the USFWS, effective field testing procedures which have been proven to be successful by the SFWMD and USACE will be incorporated in the testing of the devices. One procedure proposed by the SFWMD includes using divers to perform on-site testing with soft obstructions to ascertain relative impacts of the plunger devices. The effectiveness of proposed protection systems can be determined by comparing manatee sitings and/or number of device activations at the structure with any mortalities attributed to the structure.

Structures operating under the test and implementation modes would be closely monitored under a variety of conditions for a period sufficient to ascertain the effectiveness of the operational and structural changes. Monitoring of the of the effectiveness of the selected pressure sensitive device system will transpire prior to further installations of the system. Improved technology in the development of pressure sensitive devices will also be adapted in providing manatee protection on vertical lift gates.

Inspection and Operation and Maintenance (O&M)

Continued reliability for each gate manatee protection system would be assured through scheduled testing of the manatee protection circuits and plunger assemblies. This testing is contemplated to be included in the daily operational instructions. More intensive reliability testing would be scheduled for biannual, or more frequent intervals, if determined necessary. Regularly scheduled O&M would involve repairing/replacing those parts subject to wear as determined during operations of the structures with the Manatee protection devices. The SFWMD has a proposed testing sequence at structures which entails testing in three steps: first, checking the inactive PSD's to ensure that no circuits are shorted; second, testing the PSD's to ensure that all switches will activate correctly; and finally, generating a test signal from the PSD circuit to the SFWMD Control Room to confirm that the alarm is fully functional.

In order to ensure the effectiveness of the system, sufficient back-up replacement parts to allow quick replacement (rather than repair) of the devices would be beneficial. Currently, the SFWMD is expediting the construction of additional switches for S-27 and S-29 sufficient to provide a 50 percent backup capability. Their proposed repair protocol would allow divers to unbolt an entire 4 foot assembly from the gate (eight switches) and

immediately replace the unit. The defective array would then be benched for testing and repair, and it will be added to backup stocks.

Description of Selected Systems

Magnetic Plunger/Reed Switch

The plunger/reed switch system consists of magnetic plungers with springs and reed switch assemblies as described in the DESCRIPTION OF ALTERNATIVES section. This system has proven to provide effective manatee protection at S-29 for the current testing period which began at the time of its installation in March 1994. As a result, the cost estimates for this device are used as a basis for the cost of this project.

Magnetic Plunger/Sensi-Switch

The merits of the sensi-switch and its preliminary testing success along with the benefits of the plunger evolved into a decision to combine them. A typical plunger and sensi-switch assembly is shown in photo VII in Appendix D. Both the SFWMD and USACE would develop and test this new concept jointly. In this system, the plunger concept would be retained and the Sensi-Switch would replace the reed switch bank. See plate ME-4 in Appendix D.

Additional testing for this system will be developed during the Plans and Specifications Phase so that the PSD's can be tested more extensively in the field. The sensor sensitivity would be determined by using divers to activate the system at various depths of water along with other testing procedures.

Piezo-Electric Film Sensor

HBOI's preliminary assessment of the piezo electric film sensor shows that this technology is a promising solution to detect manatees at water control structure gates. A major advantage to this non-mechanical system is that it would likely require less maintenance than the mechanical plunger systems. During the Plans and Specifications Phase, this system would require further investigation and field testing to determine its actual reliability and effectiveness.

IMPLEMENTATION SCHEDULE

Considerations

The installation of manatee protection devices will require coordination between the USACE, USFWS, and SFWMD. During the Plans and Specifications phase, schedules will be developed using the following considerations and new information as it becomes available.

Manatee Mortality Considerations

The most important considerations in the implementation schedule are the number of manatee mortalities and the cost of installing protection devices at each structure. First, the protection devices should be installed on the downstream edges of the gates at S-27. This structure has protection devices only on the upstream edges of the gates, and it has been documented as the structure causing the highest number of manatee mortalities. After the completion of this effort, S-27 will be equipped with pressure sensitive devices on both of the upstream and downstream gate edges as recommended in the Recommended Plan. Retrofitting the downstream edges of the gates at S-27 prior to any other structures is important due to the risk it poses to manatees.

Next, model tests are recommended at S-22 and/or S-25B for a period of approximately six months to ascertain the effectiveness of the devices. During the Plans and Specifications Phase, this testing of the piezo electric film sensor and the plunger/sensi-switch system will be necessary to determine their reliability and effectiveness. Then, the selected manatee protection device would be installed and tested in a phased approach at four or five structures which have the most manatee fatalities associated with them. A phased implementation approach will allow the inclusion of further refinements or technical modifications before implementing the installation of protection devices on the remaining structures. The mortality information presented in Appendix G and the construction costs for each structure from the Cost Estimate in Appendix B for the Reed Type Switch devices were used to prioritize the implementation of manatee protection devices at structures as shown in Table 2.

TABLE 2. IMPLEMENTATION ORDER ACCORDING TO MANATEE MORTALITY CONSIDERATIONS

STRUCTURE	# OF GATES	MANATEE DEATHS	*COST
**S-27	2	15	$76,718
S-22	2	6	$59,640
S-25B	2	5	$58,937
S-308C	4	5	$111,869
S-28	2	4	$64,868
S-77	4	4	$104,325
S-13	1	3	$20,036
S-26	2	2	$70,225
S-20F	3	2	$72,686
S-33	1	1	$35,559
S-135	2	1	$58,492
S-25	1	0	$26,042
S-20G	1	0	$36,271
S-123	2	0	$52,609
S-127	2	0	$58,492
S-131	2	0	$58,492
S-21A	2	0	$62,073
S-21	3	0	$97,652
S-79	8	0	$342,382

*NOTE: Cost/Structure was determined by using the construction costs for each structure from the Cost Estimate in Appendix B for the Reed Type Switch on page 2. S-29 may be included, if the current manatee protection devices will be replaced with modified recommended devices.

**NOTE: The protection devices would be installed on the downstream edges of the gates at S-27, since S-27 has been equipped with PSD's on only the upstream gate edges.

Water Management Considerations

Manatee protection device installation at Okeechobee Waterway and Lake Okeechobee locks should be coordinated with the regularly scheduled maintenance dewatering of these structures. During the dewatering phase for routine maintenance of the structures, preliminary gate preparation (hole drilling) for the installation of the devices can be completed so that divers can install the system at a later date. Only one gate per water control structure should be dewatered at a time to permit flows through the structure; an exception is S-79 Spillway where two gates may be dewatered concurrently.

Dewatering of the structures for the purpose of the complete installation of manatee protection devices at spillways and culverts is recommended during the dry season (November 1 through May 31) to keep the structures functional during the wet season (June 1 through October 31). Potential problems with installing manatee protection devices at spillways and culverts during the wet season include:

1. At multiple-gated spillways, dewatering one of the gates for installation work takes the gate out of operation so that the water cannot be discharged through that gate for flood control purposes. At a single-gated water control structure, of which there are four in this study, the entire structure loses its discharge capability. In either case, rain events and rising water levels could require that construction be halted, the dewatering stoplogs be removed, and the gate be put back into operation. Preliminary estimates of how long this would take have varied from four hours to two days. Putting a gate back into operation might not be accomplished in time to prevent flooding in lands upstream of the structure. At multiple gated structures, such flooding might be prevented by making high discharges using gates which are still operational. However, high discharges through unbalanced gate openings can result in erosion which can damage the structure.

2. During wet periods, installation might repeatedly have to be halted and restarted. This may affect the installation schedules for other structures in the study and the maintenance schedules for structures which require the same dewatering equipment.

Although the USACE will attempt to install the PSD's during the dry season, flexible scheduling will be implemented to accommodate peak manatee aggregation sites, extreme water conditions, and annual maintenance schedules. If dewatering is required for the devices to be installed at a gate during the wet season, a provision should be included in the contract that a

crane be kept on site to remove dewatering stoplogs so that the gate can be put back into operation as quickly as possible.

Navigation Considerations

The manatee protection devices should be installed on Buckhead Ridge Lock (S-127) and S-135 Lock either during their regularly scheduled maintenance dewaterings or under a separate contract. Coordination between USACE, USFWS, and SFWMD will be necessary to include the installation of the manatee protection devices.

Contract Considerations

After the installation and testing of the protection devices at four or five of the structures which pose the greatest risk to manatees, separate contracts would include structures in the two regions; that is, the Lake Okeechobee and Okeechobee Waterway structures would not be grouped with the South Florida coastal structures. Specifying the maximum number of structures to be worked on concurrently will require coordination between USACE Engineering and Construction-Operations Divisions to ensure satisfactory supervision and inspection. Specifying order of work will require coordination between the USACE and SFWMD unless a requirements contract (delivery order) is written with separate bid items for each structure.

Operation and Maintenance Considerations

SFWMD's structures maintenance program is excellent and should not be compromised to accommodate the manatee protection plan; that is, new dewatering equipment will be required if SFWMD needs their dewatering equipment for maintenance at other structures. Coordination between USACE and SFWMD will be necessary to make optimum use of the existing needle beams.

The USACE and SFWMD have schedules (in Appendix F) that identify when a structure will be dewatered to perform scheduled maintenance. Whenever possible, coordination between USACE and SFWMD will be necessary to include the preliminary gate preparation or installation of the manatee protection devices at scheduled dewaterings. While the scheduling of the installation of the PSD's during a dewatering time is ideal, "high risk" structures may need to be retrofitted with protection devices prior to scheduled maintenance periods. However, the pre-drilling of holes for the PSD's can be

completed during the dewatering period for ease of installation of the devices at a later time.

Dewatering Requirements

The dewatering requirements will be similar to those performed for typical maintenance work. Bulkhead and needle systems will generally be used to isolate the vertical lift gate. Once the stoplogs are in position, dewatering will commence to allow installation of the necessary manatee protection devices in the dry. S-25 is a gated culvert and does not have any provisions for dewatering; therefore, a dewatering plan will need to be developed. If it is necessary that some of the work must be performed in the wet during future development of the proposed manatee protection study, it will be possible, but not desirable.

Dewatering Equipment

An inventory of Jacksonville District stoplogs (bulkhead and needle systems) is included in Appendix F; this equipment will be available for dewatering.

As-built information and existing information on needle beam systems used at SFWMD structures is also included in Appendix F. The timber stoplogs that were provided by the original structure construction contract deteriorated and were replaced with aluminum needles. These aluminum needles will not be available because they will be in use for maintenance by the SFWMD; consequently, timber stoplogs similar to the original stoplogs will be required. (Timber needles are more cost effective than aluminum needles for this project.) The needle beams will not be available if SFWMD requires their use for maintenance. Coordination between USACE and SFWMD will be necessary to make optimum use of the existing needle beams.

Time of Construction

One month for a single bay water control structure will be required to mobilize, dewater, install the manatee protection device, and rewater; three weeks each would be required for additional bays.

Contracts

The plan will be implemented under a phased approach with three possible separate construction contracts. The first contract will be a model test

with phased installation/field testing on the four or five most "high risk" structures, since further refinements or technical modifications may be required. After successfully implementing the first contract, the second contract will include the south Florida coastal structures. Then, the third contract will include the water control structures (includes locks with vertical lift gates) on the Okeechobee Waterway and Lake Okeechobee.

First Contract. The first contract will include the implementation of the manatee protection system in a phased approach as prioritized at the highest risk structures: S-27, S-22, S-25B, S-308C, S-28, and S-77. S-29 may be included in this contract, if the current manatee protection devices will be replaced with modified recommended devices. At least six months of field testing on a model representative structure will be necessary prior to further installation at the next priority structure. In June 1996, the SFWMD will begin a six month period of testing the piezo electric film sensor at S-26. The SFWMD may receive credit for the costs incurred in the performance of the six month test at S-26 and further installation of the device at S-22, S-25B, S-27, and S-29 after successful test results.

Second Contract. During the Plans and Specifications phase of the project, the SFWMD, USFWS, and USACE will coordinate the schedule for the remaining south Florida coastal structures for inclusion in this contract.

Third Contract. During the Plans and Specifications phase of the project, the SFWMD, USFWS, and USACE will coordinate the schedule for the remaining structures on the Okeechobee Waterway and Lake Okeechobee for inclusion in this contract.

IMPLEMENTATION RESPONSIBILITIES

The authorities to cost share the Manatee Protection Plan project are the Flood Control Act of 1948 (P.L. 858) and the Flood Control Act of 1958 (House Document 186). The non-Federal sponsor will be required to provide the following amounts towards construction of the project modifications:

1) 15 Percent of total project costs for the modifications to structures S-13, S-22, S-26, S-27, S-28, S-29, S-33, and S-77. (Authorized in Section 203 of the Flood Control Act of 1948.)

2) 20 Percent of total project costs for the modifications to structures S-20F, S-20G, S-21, S-21A, S-25, S-25B, S-79, S-127, S-131, S-135, and S-308. (Authorized in Section 203 of the Flood Control Act of 1958.)

3) 0 Percent of total project costs at S-123 since this structure was built with 100% Federal funds.

Cost sharing for the recommended plan is shown below in Tables 3a and 3b. Construction costs are shown for each structure in Table 3a. According to the policy establishes in 1948, the Non-Federal cost sharing for the total project costs for eight out of twenty structures is 15 percent. As shown in Table 3b, the factor of eight-twentieths multiplied by 15 percent is used in determining the non-Federal cost sharing for planning, engineering, design, and construction management costs. Eleven out of twenty structures are cost shared according to the policy established in 1958, requiring the Non-Federal sponsor to make a cash contribution of 20 percent of the total project costs. Also shown in Table 3b, this factor of eleven-twentieths multiplied by 85 percent is used in determining the non-Federal cost sharing for planning, engineering, design, and construction management.

The draft Project Cooperation Agreement contains a complete listing of Federal and non-Federal implementation responsibilities. Construction costs will be reapportioned during the implementation period to meet the cost-sharing requirements. The Federal and non-Federal costs for the recommended plan are $1,993,000 and $419,000, respectively. These costs were determined from the cost estimate prepared for the plunger system with the reed switch, since this system has been the most thoroughly evaluated and field tested system. After the evaluation and refinement of the most effective and cost efficient pressure sensitive device, value engineering will prevail in the selection of the best pressure sensitive device system. A summary of the Plans and Specifications cost is shown in Appendix A, and the Construction cost estimate for the plunger system with the reed switch is provided in Appendix B.

OPERATIONS AND MAINTENANCE REQUIREMENTS

The modifications as detailed in this report are not expected to have any incremental OMRR&R costs. Therefore, the operation and maintenance responsibilities and/or requirements as provided in the existing authorized project are applicable. The SFWMD will be responsible for operations and

maintenance of SFWMD structures, and the USACE will be responsible for operations and maintenance of USACE structures as listed in the structures description of Appendix D, Mechanical & Electrical Description of Vertical Lift Gated Structures and as shown on Plate ME-1.

TABLE 3 A
COST SHARING

STRUCTURE	TOTAL COST	FEDERAL	NON-FEDERAL
		85%	15%
S-13	$ 20,000	$ 17,000	$ 3,000
S-22	$ 60,000	$ 51,000	$ 9,000
S-26	$ 70,000	$ 59,500	$ 10,500
S-27	$ 77,000	$ 65,450	$ 11,550
S-28	$ 65,000	$ 55,250	$ 9,750
S-29 *	$ 153,000	$ 130,050	$ 22,950
S-33	$ 36,000	$ 30,600	$ 5,400
S-77	$ 104,000	$ 88,400	$ 15,600
SUBTOTAL	$ 585,000	$ 497,250	$ 87,750
		80%	20%
S-20F	$ 73,000	$ 58,400	$ 14,600
S-20G	$ 36,000	$ 28,800	$ 7,200
S-21	$ 98,000	$ 78,400	$ 19,600
S-21A	$ 62,000	$ 49,600	$ 12,400
S-25	$ 26,000	$ 20,800	$ 5,200
S-25B	$ 59,000	$ 47,200	$ 11,800
S-79	$ 342,000	$ 273,600	$ 68,400
S-127	$ 58,000	$ 46,400	$ 11,600
S-131	$ 58,000	$ 46,400	$ 11,600
S-135	$ 58,000	$ 46,400	$ 11,600
S-308	$ 112,000	$ 89,600	$ 22,400
SUB TOTAL	$ 982,000	$ 785,600	$ 196,400
		100%	0%
S-123	$ 53,000	$ 53,000	$ -
SUB TOTAL	$ 53,000	$ 53,000	$ -
TOTAL CONSTRUCTION COSTS	$ 1,620,000	$ 1,335,850	$ 284,150

*NOTE: Structure S-29 was included in the cost estimate, since the current modification devices may be replaced with modified recommended devices.

TABLE 3 B
COST SHARING

	TOTAL COST	PROPORTION	FEDERAL	NON-FEDERAL
		8/20ths	85%	15%
			$ 91,800	$ 16,200
REPORT		11/20ths	80%	20%
			$ 118,800	$ 29,700
		1/20th	100%	
			$ 13,500	
TOTAL REPORT COSTS	$ 270,000		$ 224,100	$ 45,900
		8/20ths	85%	15%
			$ 98,600	$ 17,400
PLANS & SPECIFICATIONS		11/20ths	80%	20%
			$ 127,600	$ 31,900
		1/20th	100%	
			$ 14,500	
TOTAL PLANS & SPECIFICATIONS	$ 290,000		$ 240,700	$ 49,300
		8/20ths	85%	15%
			$ 78,880	$ 13,920
CONSTRUCTION MANAGEMENT				
		11/20ths	80%	20%
			$ 102,080	$ 25,520
		1/20th	100%	
			$ 11,600	
TOTAL CONSTRUCTION MANAGEMENT	$ 232,000		$ 192,560	$ 39,440
TOTAL CONSTRUCTION COSTS	$ 1,620,000		$1,335,850	$ 284,150
TOTAL PROJECT COSTS	$ 2,412,000		$1,993,210	$ 418,790
AVERAGE TOTAL PROJECT COSTS	$ 2,412,000		$1,993,000	$ 419,000

Operations and maintenance of the recommended project modifications for Manatee Protection at USACE structures will require the following:

(1) Daily operational checks to ensure proper operation of the Manatee Protection circuits.

The daily operational checks for testing the Manatee Protection circuits are not currently in the Appendix C, Draft Manatee Protection Plan for Water Control Structures Operated by the USACE, Jacksonville District; however, the plan will be updated to include these checks as they are developed.

(2) Scheduled maintenance to test, repair, and/or replace parts.

Scheduled maintenance will occur biannually to conduct more intense reliability testing of Manatee Protection circuits. Necessary maintenance will be performed upon detection of any problem to ensure proper working condition. Inspection and maintenance that is not immediately necessary should be combined when possible and performed in conjunction with the existing structure's inspection and maintenance schedule. These intervals include scheduled dewaterings at 4-year intervals, periodic inspections without dewatering at 5-year intervals and major maintenance at 12-year intervals.

These project modifications will create additional operations and maintenance responsibilities, although it is not expected that these additional responsibilities will be very significant. Scheduled maintenance will involve repair and/or replacement of parts subject to wear and/or corrosion. However, it is difficult to quantify specific O&M requirements and cost until installation and evaluation.

(3) Initial and periodic surveys should be conducted for detection of any scouring or movement of riprap over time. Maintenance should be performed as necessary. When possible, this maintenance should be coordinated with the structure's inspection and maintenance schedule.

(4) The following items constitute a contingency plan for the case in which the proposed pressure-sensitive devices (PSD's) fail:

a. As an additional manatee protection precaution at structures where PSD's have been installed, the operational procedures specified in the Manatee Protection Plan will remain in effect whether the PSD's are operational or not.

b. If during a scheduled maintenance event, or at any other time, repair and/or replacement of parts are found to be necessary to ensure proper operation of the PSD's, the South Florida Operations Office (CESAJ-CO-S) and Operations Technical Support Branch, Operations and Maintenance Technical Support Section (CESAJ-CO-OM) will be notified. Coordination within the Jacksonville District will be performed to determine how to solve the problem, and repair and/or replacement work will be accomplished as soon as possible. Coordination will also be performed to determine whether it is desirable, and if desirable, feasible, to modify structure operations in the interim before the repair and/or replacement work can be accomplished. It should be noted that water management needs may preclude deviations from normal operations.

Operations and maintenance of the recommended project modifications for Manatee Protection at SFWMD structures is summarized in a draft copy of the SFWMD Manatee Protection Device Inspection/Maintenance Procedures which is provided in Appendix C.

Present Operation

As previously stated, water control structures S-27 and S-29 are equipped with magnetic plunger/reed switch manatee protection systems. The pressure sensitive device systems at these structures activate only in the closing mode. The response to an alarm in the opening mode would continue enlargement of the opening to permit the passage of an entrapped animal. Moreover, the collection of debris behind the structures while the gates are closed frequently results in a surge of aquatic weeds and/or urban debris beneath the gate during the initial opening; this could potentially trigger the pressure sensitive devices.

Currently, the SFWMD Control Room notifies the Field Station of any manatee alarms, and field personnel inspect the structure for each alarm. Since most alarms seem to reflect a one-time triggering, the inspection is generally uneventful as the debris or manatee are no longer present. If an inspection reveals that switches are not operating sufficiently, the Control Room can override the automatic operation. The gate can be secured in either an open or closed position (depending on water conditions) for prolonged periods beyond normal scheduled operations to minimize gate closures. If water conditions permit, water management may be affected, requiring the utilization of the remaining gates in the structure until repairs can be made to the malfunctioning system.

Future Testing

SFWMD is planning to incorporate additional testing procedures of the pressure sensitive devices at S-27 and S-29. A draft copy of the SFWMD Manatee Protection Device Inspection/Maintenance Procedures is provided in Appendix C. Scheduled weekly testing and logging of the electrical circuits as part of routine maintenance will be implemented. Routine testing of the telemetry link from the pressure sensitive device circuit to the SFWMD Control Room and backup logging of the test at the site will be included in new protocol procedures. Complete electrical schematics of the manatee protection circuits will also be produced on AutoCad to facilitate testing by local field station electricians. Currently, the SFWMD is investigating a visual aid for weekly inspections which consists of installing a panel with indicator lights showing that each pressure sensitive device is working. A working schematic has been developed and a prototype is in progress.

For the current plunger systems at S-27 and S-29, the SFWMD implements quarterly and semi-annual inspections. During the quarterly inspection, all three switches in a single plunger are checked with an ohm meter to assure that each of the three switches per plunger is working properly. The semi-annual inspections involve a subsurface inspection of the pressure sensitive devices and the removal of any marine growth that may hamper operation.

Additional plans for field testing of the devices are outlined in the Manatee Mortality Report in Appendix G. Actual field testing with a simulation device has not been previously undertaken at S-27 and S-29; however, real time activation by manatees has been observed at S-27. A high flow condition test of the S-27 structure will be undertaken when a suitable test object is devised. During the high flow test, an investigation will be conducted pertaining to the possibility of high velocity discharges against the gate causing the pressure sensitive devices to jam within the slide tubes and inhibit activation. Bench testing will be attempted to determine if this field condition might occur. A field test would follow if the pressure sensitive devices jam during the bench test.

REAL ESTATE REQUIREMENTS

Project lands to support this project consist of selected project structures located within the Central & Southern Florida Project. Underlying lands supporting the selected structures are owned in fee either by the State of Florida or the U. S. Government. Access roads to the project are either on

state-owned lands, government-owned lands, or are accessible by public roads. The entire project is located on existing project lands owned by the State of Florida or U. S. Government and no additional real estate interest is required to support this project.

ENVIRONMENTAL ASSESSMENT

An Environmental Assessment was prepared by the Jacksonville District to evaluate the proposed alternatives and the selected plan for their possible impacts on the environment. The document was distributed for Public comment in late March and comments have been received and addressed to complete the Environmental Assessment. The Environmental Assessment has been reviewed by the District Engineer resulting in a Finding of No Significant Impact (FONSI). A listing of applicable Federal statutes and compliance status is shown in Table 4. The Environmental Assessment and FONSI have resulted in a determination that:

a. Protection of the Florida manatee from risk and mortalities associated with the operation of the water control structures in the study;

b. Water quality of the Okeechobee Waterway and the East Coast Canal system of the Central and Southern Florida Project area will not be degraded;

c. Site survey and coordination have determined that the planned action will not adversely impact historical or archeological resources;

d. In the vicinity of each installation site, there is no potential for the presence of hazardous, toxic, or radiological materials;

e. No documented adverse impacts to the human and natural environment.

TABLE 4
RELATIONSHIP OF PROPOSED PLAN TO ENVIRONMENTAL STATUTES

Federal Statute	Compliance Status
Archeological and Historic Preservation Act, as amended	In compliance.
National Historic Preservation Act, as amended	In compliance. The SHPO's concurrence is attached to the main document.
Clean Air Act, as amended	In compliance. No adverse effects to air quality. The EA will be coordinated with U.S. Environmental Protection Agency as required by Section 176(c) and 309 of the Act.
Clean Water Act	In compliance. No adverse effects to water quality. The Environmental Assessment was coordinated with State and Federal agencies with regulatory responsibility for the Clean Water Act.
Endangered Species Act of 1973, as amended	Compliance pending formal consultation with the USFWS during Plans and Specifications phase. Informal coordination has occurred throughout the life of the project.
Fish and Wildlife Coordination Act, as amended	In compliance. This project was coordinated with the U.S. Fish and Wildlife Service. A USFWS Coordination Act Report is appended to the Environmental Assessment as Attachment A.
National Environmental Policy Act of 1969, as amended	In compliance. Completion of Environmental Assessment process.
Executive Order 11990 (Protection of Wetlands)	In compliance. No wetlands affected by the project.
Archeological Resources Protection Act	Compliance will be coordinated for each structure during the Plans and Specifications Phase.
Resource Conservation Recovery Act	In compliance.
Comprehensive Environmental Response and Compensation Liabilities Act	In compliance.

SUMMARY OF PROJECT EFFECTS

HYDRAULICS

Existing Designs

All of the single and multiple-gated water control structures have been designed as conventional USACE structures. In conjunction with their appurtenant energy dissipators, the gates at these structures are designed to be opened and set at equal openings when passing discharges. The authorized purposes of these structures are flood control, water supply, salt water barriers, and navigation or any combination of these purposes.

Maximum Allowable Gate Opening Curves

The apron length and baffle block configuration of spillway structures have been designed to dissipate the high velocity energy developed by flow from a higher elevation to a lower elevation. The objective of a gate opening operations sequence is to establish uniform flow in which the energy dissipation characteristics of the apron and baffle block configuration are fully utilized. Maximum Allowable Gate Opening (MAGO) Curves have been developed for major structures to provide a ready means of determining allowable gate openings under given headwater and tailwater conditions. Use of those curves ensures high velocity jets are broken up and hydraulic jumps take place on the concrete apron.

Incorrect operations of water control structures for the purpose of avoiding harm to manatees, without regard to maximum allowable gate opening (MAGO) curves could subject the structures to damaging erosion and ultimately jeopardize the structures' safety. Spillway operations will be accomplished only by qualified operators, through on-the-job training, who are able to perform the standard operation procedures for manatee protection.

General Rule for Operating Water Control Structures to Minimize Harm to Manatees

The standard operating procedures are described in Appendix C, Draft Manatee Protection Plan for Water Control Structures Operated by the USACE, Jacksonville District. This discussion applies only to those procedures which are for structures within the scope of this study. The procedures are designed to allow manatees to pass under the gates. The prescribed minimum

opening for any gate under the "less than or equal to 3.0 feet of head" condition is 2.5 feet.

Single-Gate Operations

Prolonged uneven gate openings against heads greater than 3.0 feet should not be permitted. Field investigations with gate openings of 2.5 feet and heads greater than three feet produced discernable unstable flow conditions well beyond the end of the concrete apron. Compressed jets and highly turbulent boils were detected. Those conditions can produce excessive local velocities and very high lift forces which displace rip rap protection. Subsequent erosion of exposed soil on the channel bottom could cause excessive erosion and structure undermining.

Multiple-gate Operations

Procedures for multiple gate operations are similar to those for single-gate operations. Discharges requiring several gate openings at multiple-gated structures would be made by adjusting all required gate openings to similar levels. If prolonged unequal gate openings against heads greater than 3.0 feet should occur, irregular flow patterns and locally high velocities could develop downstream causing damaging erosion to rip rap in the downstream channel. In extreme cases, erosion could progress to a point where the structure itself could be in danger of failure.

Discussions with field operation personnel and a review of discharge records at S-26 have revealed that gate restrictions in accordance with MAGO curves after the initial 2.5 foot gate opening have occasionally not been complied with. Often the water surface elevations react so quickly to gate openings that little time is available to adjust the gates. Extensive erosion has occurred at S-26 in spite of the "rock" upon which it is founded. This is due to a vertical vortex action which occurs over the "jet" of flow produced by partial gate openings under highly submerged conditions. Prolonged discharge can result in compression of the jet producing high velocities.

High Velocity Energy Dissipation on Stilling Basin Aprons

It should be noted that gate velocities can range around 10 feet per second under conditions of 2.5-foot gate openings and a head of three feet. Even higher velocities ranging over 20 feet per second are reached during higher head conditions. Vertical gate structures have a concrete apron downstream of the gates which have been fitted with concrete baffle blocks.

The shape, size and layout of the blocks are designed to dissipate high velocity energy of the flow stream by impacting that flow on the surface of the blocks.

Consideration must be given to the relative shape of the flow "jet" which will remain virtually intact until flow impacts on the baffle block energy dissipators. Any large object (such as a manatee) is likely to strike a baffle block with almost the same speed as the discharge jet. Table 5 shows expected velocities of the discharge flow stream with gates open 2.5 feet and headwater and tailwater stages at optimum and design conditions.

Table 5 also shows minimum tailwater elevations and corresponding maximum head water elevations for which 2.5 foot gate openings should not be allowed. In that case, MAGO curves must be followed until adequate tailwater elevations are reached to allow larger gate openings. Discharges through 2.5 foot gate openings, below those elevations, would result in highly erosive velocities on the rip rap protection.

TABLE 5
MANATEE PROTECTION ANALYSIS
(with 2.5 foot gate openings)

Spillways Structures	Maximum Velocity (fps)	Optimum Headwater (ft)	Optimum Tailwater (ft)	Optimum Head (ft)	Design Headwater (ft)	Design Tailwater (ft)	Design Head (ft)	*** Minimum Tailwater Headwater (ft)	*** Minimum Tailwater Tailwater (ft)	*** Minimum Tailwater Head (ft)
S-29	4.26				2.4	1.9	0.5	2.4	-1.2	3.6
	7.37	2.5	1	1.5						
	10.92	2.5	-0.8	3.3						
S-13	2.69				2.4	2.2	0.2	1	-2	3
S-308C	7.85				24.9	23.2	1.7	24.9	9.5	15.4
	8.51	17.5	15.5	2						
**	19.41	24.9	14.5	10.4						
S-44	13.59				9	3.9	5.1	3.4	-1.1	4.5
	20.94				9	-3.1	12.1			
	16.04	7.1	0	7.1						
S-77	10.93				16.4	13.1	3.3	15	8	7
	13.86	16.4	11.1	5.3						
**	20.85	23.5	11.5	12						
S-78	9.7				10.6	8	2.6	14.1	2	12.1
	17.13	11.1	3	8.1						
S-79	4.26				4.4	3.9	0.5	5.8	-1.3	7.1
	6.59	4.2	3	1.2						
S-80	13.72				12	6.8	5.2	-1.1	1.5	0.4
	22.92	14.5	0	14.5						
**	23.7	15.5	0	15.5						
S-28	4.26				2.2	1.7	0.5	2.2	-2.5	4.7
	8.07	1.8	0	1.8						
S-26	4.26				4.4	3.9	0.5	4.4	-1.5	5.9
	9.52	2.5	0	2.5						
S-33	4.26				5.1	4.6	0.5	0.5	0	0.5
	9.52	3.5	0	3.5						
S-21	4.26				1.9	1.4	0.5	2.8	-0.2	3
	7.37	1.5	0	1.5						
	8.3	1.9	0	1.9						
S-25B	3.3				4.4	4.1	0.3	4.7	-1.5	6.2
	10.07	2.8	0	2.8						
S-22	4.26				3.2	2.7	0.5	3.5	0	3.5
	10.25	2.9	0	2.9						
S-20G	4.26				2	1.5	0.5	3	-2	5
	6.59	2	0	2						
	8.51	1.2	0	1.2						
S-21A	4.26				2.1	1.6	0.5	3	-2	5
	6.59	1.2	0	1.2						
	8.51	2	0	2						
S-20F	4.26				1.9	1.4	0.5	3	-2	5
	6.59	1.2	0	1.2						
	8.51	2	0	2						
S-123	4.26				1.5	1	0.5	3.8	0	3.8
	8.51	2	0	2						
	13.46	5	0	5						

** *NOTE: These are the maximum head conditions where the gates would be opened to 2.5 ft.*
*** *The gates at these structures will be opened to 2.5 feet under these worst case conditions with the minimum tailwater conditions. The maximum allowable head under the condition is shown.*

WATER MANAGEMENT

Most of the multiple-gate water control structures constructed by the USACE have been designed to be opened and set at balanced openings when passing discharges. The Jacksonville District's experience indicates that generally the maximum unbalanced differential gate opening should not exceed one foot at S-308C, S-77, and S-79. The USACE's policy regarding the 2.5 foot gate opening has been as follows: the gate is initially opened 2.5 feet for 1 minute, then set at the desired setting. Misoperations of water control structures, with uneven gate openings and without regard to maximum allowable gate opening (MAGO) curves, could subject the structures to damaging erosion and jeopardize the structures' safety. For instance, large gate openings, like the 2.5-foot minimum, can cause compressed jets which can result in reverse flow. In turn, reverse flow causes vortexing which can move riprap around and form scour holes. This action causes erosion that could eventually undermine the structure. Also, until recently, in some cases where a smaller gate opening is called for, it has been considered impractical to open the gates to 2.5 feet for more than a very short time.

Analytical techniques for determination of maximum permissible unbalanced gate openings are not available. These criteria are based on experience or physical model tests, and can vary from spillway to spillway.

It has been established that manatees have been killed at spillway structures in southern Florida as a result of gate operating requirements. Consequently, although it was a departure from required operation based on design, the USACE, Jacksonville District developed the policy that a gate at a spillway may be opened 2.5 feet for 1 minute and then closed to the desired opening in accordance with the MAGO curves. The rationale for this is that if a manatee(s) is resting against, or near, the gate when it is opened, it would be flushed downstream without harm. It is recognized, however, that a manatee(s) upstream of the structure could swim or drift downstream close to a gate setting smaller than a 2.5 foot opening; and the forces of high velocity water discharging through the opening could pin the manatee against the opening and cause drowning. Also, when the gate is being closed to a smaller opening, a manatee could be crushed between the gate's lip and the weir's crest.

The SFWMD, in a letter dated August 16, 1993, presented data indicating that, at low-head coastal structures, unbalanced gate openings on the order of 2.5 feet are not damaging to the structures. Such gate openings

are believed to be beneficial in the effort to protect manatees. In the above letter, the SFWMD pointed to operating experience which often required unbalanced gate openings at multiple gated structures. These gate openings approximated the condition in which one gate is open 2.5 feet, while the rest of the gates are closed. Upstream elevations (all elevations are referenced to NGVD) ranged from 2.0 to 3.5 feet while the gates were open, and the tidal downstream elevations normally ranged from 0 to 2.5 feet with an average of roughly 1.0 feet. The SFWMD presented an assessment of observed erosion for ten multiple-gated structures operated under the above conditions, and noted that no erosion attributed to the 2.5 foot gate openings had been observed after several years of operation. The SFWMD also cited "rather strong indirect evidence that operating under minimum 2.5 foot gate openings has had a major impact on reducing manatee fatalities."

The SFWMD stated that it "supports the Manatee Task Force in asking that the USACE reconsider modifying the current manatee gate policy at the low-head structures, S-308, S-77, and S-79." The requested modifications were to operate these low-head spillways with minimum 2.5 foot gate openings, in spite of unbalanced conditions, when the head differentials across the spillways are less than 3.0 feet.

Based on the above data, it appears that one gate at a multiple-gated spillway can be safely opened 2.5 feet under a headwater/tailwater differential of as much as 3.5 feet. In a letter from the USACE to SFWMD dated February 23, 1994, this office concurred with SFWMD's conclusion that the gates at certain low-head coastal structures, and certain Okeechobee Waterway structures, can be safely set at unbalanced openings up to 2.5 feet for head differentials of up to 3.0 feet. This policy was applied only to the following structures:

South Florida Coastal	Okeechobee Waterway
S-29	S-308C
S-28	S-77
S-27	S-79
S-26	
S-25B	
S-22	
S-123	
S-21	
S-21A	
S-20F	

The question was raised as to whether the above 2.5 foot gate openings for head differentials of up to 3.0 feet should be permitted only for single gate openings or for multiple gate openings as well. During a recent site visit to S-308 spillway, 2.5-foot gate openings of 1, 2, 3, and 4 gates were performed, regardless of unbalanced conditions. Before beginning these gate openings, the head differential across the structure was approximately 2.6 feet. The gates central to the structure were opened before the outer gates, and gates were opened on alternating sides of the structure. During this exercise, no significant adverse hydraulic effects were observed. In contrast, a 2.5-foot gate opening was performed at S-77 spillway the same day, where the head differential was about 6.0 feet. There, adverse hydraulic effects were observed such as turbulence beyond the spillway apron and no further 2.5-foot gate openings were attempted.

In light of the results of the above gate opening exercises, the 2.5-foot unbalanced gate opening policy will apply to both single and multiple-gates. This policy will also be extended to certain other structures not listed above, but which are also low head structures and are included in the scope of this study. Those structures are: S-13, S-20G, and S-25.

The procedures by which the minimum 2.5 foot gate opening policy is to be implemented are contained in Appendix C, Manatee Protection Plan for Water Control Structures.

The automatic operation of the proposed pressure sensitive devices at South Florida coastal spillways and at the three vertical lift-gate locks on Lake Okeechobee is expected to trigger 2.5 foot gate openings only occasionally. Generally, gate openings due to activation of manatee sensor devices will occur under head differentials not greater than 3.0 feet. Even if the head differential should exceed 3.0 feet, the resulting gate openings will usually be of short duration. It is recognized that there will probably be cases in which, under head differentials exceeding 3.0 feet, the manatee sensors cause 2.5 foot gate openings. Head differentials above 3.0 feet are expected fairly regularly at S-33, with its optimum headwater elevation of 3.5 feet and tidal tailwater. Another problem is that if activation of the manatee sensor devices at a structure allows a large object to become stuck beneath the gate when the head differential is above 3.0 feet, erosive velocities could occur for a prolonged period of time. In view of these potential problems, and other possible though more rare situations, the following recommendation is made: Periodic surveys should be conducted at all South Florida coastal structures so that scouring and movement of riprap over time can be detected and, where necessary,

repaired. Initial, pre-project surveys should be conducted so that erosion due to implementation of this project can be distinguished from erosion which occurred earlier. Operating procedures and use of the PSD's should be reassessed as necessary, depending on the amount of erosion detected and the amount of maintenance required. Provided that these recommendations are followed, installation of the pressure sensitive devices is not expected to adversely impact existing water management plans. Installation of these devices is not expected to cause significant deviations from maximum allowable gate opening criteria.

The proposed installation of pressure sensitive devices at certain Okeechobee Waterway spillways will result in gates ceasing to move upon detection of a manatee, and the triggering of an audio/video alarm. These occurrences do not entail the automatic raising or lowering of gates. Once a gate is stopped, the decision to raise or lower it is left to the spillway operator, who must follow criteria set forth in the Water Control Plans and Manuals. Therefore, the proposed installation of pressure sensitive devices at Okeechobee Waterway spillways is not expected to cause adverse effects to existing water management plans or significant deviations from maximum allowable gate opening criteria. However, in view of the adoption of the 2.5 foot minimum gate opening policy for head differentials of less than 3.0 feet at low head spillways, the initial and periodic surveys described above for South Florida coastal structures should also be conducted for the structures S-308, S-77, and S-79.

The above analysis, for all proposed manatee sensor devices, assumes that the dewatering and scheduling constraints imposed to meet water management needs will be adhered to.

GEOTECHNICAL

The recommended plan will have no adverse effects from a geotechnical perspective.

MECHANICAL AND ELECTRICAL

The recommended plan will have minimal impact on the existing mechanical and electrical systems at spillways and lock structures. The main operating machinery, and the electrical power and distribution system will remain the same. The main change will be in the electrical control circuit for the 2.5 feet gate closing zone as explained in DESCRIPTION OF

ALTERNATIVES. The operation of locks and USACE operated spillways will change as explained in SELECTED PLAN.

The location of all structures is shown on plate ME-1 in Appendix D. Further, Table 1 of Appendix D gives the gate dimensions, number of gates and operational features. The existing mechanical and electrical machinery and plunger systems for each structure are explained in Appendix D. Information on the piezo-electric film sensor system can be found in Appendix I.

STRUCTURAL

The structural effects associated with attaching the pressure sensitive device system on vertical lift gates will be minimal. The attachment will primarily be accomplished through the use of bolted connections. Stainless steel bolts will be used to help facilitate any future removal that may be required for maintenance and repair. Typical connections for the plunger system are shown on plates ME-2 and ME-4 in Appendix D.

REAL ESTATE

The recommended plan will have no adverse effects from a real estate perspective. Due to the requirements of this project, there is no scheduled acquisition of real estate.

WATER QUALITY

The proposed project will have no adverse effects on the water quality at each of the 20 project sites. There will be no impact on the substrate adjacent to each lock and spillway since device installation will occur on a previously constructed spillway gate. Dewatering will be required at several structures, but will most likely be coordinated during annual maintenance periods. Temporary dewatering (estimated to take one month) will have no adverse effects on the water quality of the OWW or the East Coast Canal system. Standard Water Quality conditions will apply to this project.

FISH AND WILDLIFE

There will be no adverse effects to the fish and wildlife resources as a result of this project. Dewatering for the installation of the sensing devices will displace fish and wildlife species temporarily, but the habitat area will be restored within one month. Fish and wildlife species are expected to utilize the lock and spillway areas immediately after restoration.

THREATENED AND ENDANGERED SPECIES

Although many endangered and threatened species are present in the OWW and the C&SF project areas, the only species the project could impact is the Florida manatee. Manatees utilize both the OWW and the C&SF project area for travel, resting, and foraging routes. Their presence in the project locations has necessitated the implementation of this project. Many measures (i.e. contingency planning, model testing, dry testing, monitoring, etc.) will be implemented to ensure that no adverse effects to the manatee will result from this project.

During the construction period, a 24 hour manatee watch will be followed. Before dewatering is initiated or structures are modified, the area will be checked for manatees. Standard State and Federal manatee construction precautions will be instituted.

Following the installation of the devices, dry testing of the system with manatee models will be required of the Contractor by the government. Models will be situated along gate edges and the sensors verified by activating the gate closing operation. Once the dry testing is complete, testing of the system will be included in the daily operational instructions at each structure. Reliability testing of each system on a biannual basis (or other required intervals) will be performed. Regularly scheduled O&M will involve repairing/replacing the system parts which are subject to wear to ensure the system is functional to provide for the consistent protection of manatees.

In order to protect the manatee population should a system fail, both the USACE and SFWMD have developed Operating Contingency Plans for the operation of their respective structures. Both plans are detailed in section 6.0 of the Environmental Assessment and are included as Appendix C in the main document. These plans provide policies, guidelines, and operating procedures for the effective long-term management and operation of water control structures to minimize manatee mortality. These procedures will be strictly followed if a Pressure Sensitive Device fails at a structure.

There will be no adverse effects to the manatee as a result of the implementation of this project. The project will, in fact, improve the manatee's ability to navigate within its natural habitat without harm.

CULTURAL RESOURCES

It is the Jacksonville District's determination that significant cultural resources will not be adversely affected by the installation of the manatee protection devices, as proposed. This determination was coordinated with the Florida State Historic Preservation Officer (SHPO). In a November 1, 1994 letter, the SHPO concurred with the District determination.

AESTHETIC ASSESSMENT

During modification of the structures to install the manatee protection devices, the gates at the locks will be de-watered. De-watering occurs intermittently during scheduled maintenance on these structures. Therefore, de-watering will not be an unusual event and will not take any longer to accomplish than routine maintenance. No unusual noise, air quality or water quality conditions will exist during the time the structures are de-watered. Once the project modifications have been completed, only close observation will detect the manatee protection devices in place. Therefore, the devices will have no impact on the aesthetics of the area. Almost all of the protection devices will be located below the water surface at the gate structures and will not be visible.

CONCLUSIONS

The five alternatives selected for study were evaluated on the basis of environmental benefits and project goals met. Plans 1, 2, 3, and 5 were eliminated due to structural problems and lack of feasibility. Plan 4 was determined to be the most effective plan producing the greatest environmental benefits, as required under Federal guidelines for water resources development.

Plan 4 consists of the implementation of operational changes and the phased installation of a manatee protection system on selected spillway and lock vertical lift gates at twenty water control structures in Central and Southern Florida. In the recommended plan, an operational protocol was devised for locks and spillways as specified in the Manatee Protection Plan for Water Control Structures; and a pressure sensitive device system was selected to be installed on selected water control structure gates. This device will immediately reverse the lowering of a vertical water control gate when an object is detected under a closing gate. The device consists of a series of pressure sensitive devices on the bottom of the water control gate which transmit a signal used to reverse the gate direction when resistance is encountered. When the gate sensors are activated by an object or manatee, the gate will open. At this time, a manatee will be able to travel under the gate. After the gate opens, it will fully close unless an object remains under the gate. Then, the opening process will repeat the cycle if the sensors are activated again.

This plan is in the best overall public interest and is the most beneficial environmental plan for implementation. Since the second highest source of human-related manatee mortality was attributable to water control structures, the project will promote the recovery of the endangered species. There will be substantial environmental benefits by protecting manatees and reducing manatee injury and mortality at vertical lift gate water control structures.

This plan meets the designated criteria for participation by the Federal Government in project modifications for improving the quality of the environment. It also conforms to the guidelines for Federal water resource project development as provided under the Principles and Guidelines. There are no identified plans which are more cost efficient, address the primary study objectives, and achieve significant manatee protection at the selected navigation and water control structures. The effects of the proposed plan are

deemed beneficial overall and the plan is considered to be in full compliance with all pertinent environmental statutes as well as other Federal laws and directives regarding water resource project development.

Pertinent economic cost estimates for the recommended plan are as follows:

Estimated Federal Cost	$1,993,000
Estimated Non-Federal Cost	$419,000
Total Estimated Cost:	$2,412,000

Based on an analysis of overall economic, environmental, and social aspects, the above plan was found to be in the Federal interest and justified for implementation. Therefore, this project modification plan for manatee protection at selected navigation and water control structures is recommended for approval for Federal construction.

RECOMMENDATIONS

I have weighed the accomplishments to be obtained from the proposed project modification manatee protection plan at select navigation and water control structures in the Central and Southern Florida Project area against project costs and have considered the alternatives, effects, and scope of the proposed project. In my judgement, the proposed project is a justified expenditure of Federal funds. I recommend that the Secretary of the Army approve the Manatee Protection Plan, Part I. The total estimated cost of the project is $2,412,000 (of which $1,993,000 would be the Federal cost). The remaining $419,000 would be non-Federal funds provided by South Florida Water Management District. I further recommend that funds be allocated to initiate preparation of plans and specifications.

The sharing of costs between the Federal Government and non-Federal interests for the recommended plan is contained in the authorization of Section 203 of the Flood Control Act of 1948 and Section 203 of the Flood Control Act of 1958. The above recommendations are made with the provision that prior to project implementation, the non-Federal sponsor shall enter into a binding agreement with the Secretary of the Army or his designated representative to provide 15 Percent of the total project costs for modifications to structures S-13, S-22, S-26, S-27, S-28, S-29, S-33, and S-77 and 20 Percent of the total project costs for the modifications to structures S-20F, S-20G, S-21, S-21A, S-25, S-25B, S-79, S-123, S-127, S-131, S-135, and S-308, as further specified below:

Provide all land, easements, and rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the implementation, operation, and maintenance of the Project Modification.

For so long as the Project Modification remains authorized, operate, maintain, repair, replace, and rehabilitate the completed Project Modification, or functional portion of the Project Modification at structures operated by the non-Federal sponsor, at no cost to the Federal Government, in a manner compatible with the Project Modification's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor, now or hereafter, owns or controls for access to the Project Modification for the purpose of inspection, and, if necessary after failure to perform by the non-Federal sponsor for the purpose of completing, operating, maintaining, replacing, or rehabilitating the Project Modification. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall operate to relieve the non-Federal sponsor of responsibility to meet the non-Federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance.

Hold and save the United States free from all damages arising from the implementation, operation, maintenance repair, replacement, and rehabilitation of the Project Modification and any Project Modification-related betterment, except for damages due to the fault or negligence of the United States or its contractors.

Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the Project Modification in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20.

Perform, or cause to be performed, any investigations for hazardous substances as are deemed necessary to identify the existence and extent of hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the implementation, operation, and maintenance of the Project Modification, except for any such lands, easements, or rights-of-way that are owned by the United States and administered by the Federal Government, and except for any such lands that the Federal Government determines to be subject to the navigation servitude. The Government shall perform, or cause to be performed, all investigations on lands, easements, or rights-of-way that are owned by the United States and administered by the Federal Government. For lands that the Federal Government determines to be subject to navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which

case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the implementation, operation, or maintenance of the Project Modification, except for any such lands, easements, or rights-of-way owned by the United States and administered by the Federal Government.

As between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the Project Modification for the purpose of CERCLA liability. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the Project Modification in a manner that will not cause liability to arise under CERCLA.

Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the implementation, operation, and maintenance of the Project Modification, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

Provide 25 percent of that portion of total historic preservation mitigation and data recovery costs attributable to the Project Modification that are in excess of one percent of the total amount authorized to be appropriated for the Project Modification.

The recommendations contained herein reflect information available at this time and current Departmental policies governing formulation of individual projects. Consequently, the recommendations may be modified before they are approved for implementation.

Terry L. Rice
Colonel, U.S. Army
District Engineer

September 1995

PROJECT MODIFICATION REPORT
MANATEE PROTECTION AT
SELECTED NAVIGATION AND WATER CONTROL
STRUCTURES IN CENTRAL AND SOUTHERN FLORIDA
PART I

ENVIRONMENTAL ASSESSMENT
AND FINDING OF NO
SIGNIFICANT IMPACT

US Army Corps
of Engineers
Jacksonville District
South Atlantic Division

MANATEE PROTECTION PLAN AT SELECTED NAVIGATION AND WATER CONTROL STRUCTURES IN CENTRAL AND SOUTHERN FLORIDA

PART I

FINDING OF NO SIGNIFICANT IMPACT

I have reviewed the planning document and the Environmental Assessment of the proposed action. Based on the information analyzed in the Environmental Assessment, reflecting pertinent data obtained from cooperating Federal and State agencies having jurisdiction by law and/or special expertise, and from the interested public, I conclude that the considered action will have no significant impact on the quality of the human environment.

In summary, the reasons for this conclusion are as follows:

a. Protection of the Florida manatee from risk and mortalities associated with the operation of the water control structures in the study;

b. Water quality of the Okeechobee Waterway and the East Coast Canal system of the Central and Southern Florida Project area will not be degraded;

c. Site survey and coordination have determined that the planned action will not adversely impact historical or archeological resources.

d. In the vicinity of each installation site, there is no potential for the presence of hazardous, toxic, or radiological waste materials;

e. No documented adverse impacts to public facilities and services or to the human and natural environment.

In consideration of the information summarized, I find that the proposed action does not require the preparation of an Environmental Impact Statement.

3 OCT 95

Date

Terry L. Rice
Colonel, U.S. Army
District Engineer

EXECUTIVE SUMMARY

This Environmental Assessment has been prepared by the Jacksonville District, U.S. Army Corps of Engineers (Corps) to document the feasibility phase of a study that is in partial response to authorization and appropriations provided in the Energy and Water Development Appropriation Act of 1994 (P.L. 103-126). The local sponsor for this study is the South Florida Water Management District. Part I of the study addresses manatee protection at vertical lift gates of selected water control structures. Pressure sensitive devices (PSDs) are recommended as a protection measure in accordance with the study authority to employ "relatively low-cost innovative solutions" to protect manatees at these gates. Twenty water control structures are addressed in Part I. Part II of the study will address manatee protection at seven sector-gated locks. Currently under development, a separate Environmental Assessment will be developed for Part Two and its recommendations.[1]

The Florida manatee is listed as endangered by the U.S. Department of the Interior (USDI). Mortalities of manatees occur at both spillways and locks, with the majority of mortalities linked to the operation of spillway structures. Structures addressed in the study were selected based on their history of manatee mortality and their potential to cause future mortalities. An evaluation was made of the existing environmental resources and the probable environmental consequences of the alternatives discussed in the Project Modification Report (PMR). Contingency Plans have been developed by both the Corps and SFWMD to properly protect manatees during an emergency PSD system failure. Extensive testing and monitoring is planned by both SFWMD the Corps to ensure the system's effectiveness. Installation of the PSDs is being coordinated so the structures with the worst mortality records will be retrofitted first. Monitoring of retrofitted structures and the effectiveness of the PSDs will transpire prior to further installations. Flexible scheduling is stressed to avoid peak manatee aggregation and travel times through Dade county during the months of November through May.

Information on natural and man-made resources of the study area was obtained from existing data sources, scoping responses from State and Federal resource agencies, and the local sponsor. Coordination with the USDI Fish and Wildlife Service, South Florida Water Management District, and interested resource agencies and parties has occurred during the development of the alternatives and the selected plan. This document was coordinated with the public for a period of 45 days. Comments from this coordination period have been incorporated in the Final

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[1]Revised March 1996.

Report and this Environmental Assessment. A Finding of No Significant Impact (FONSI) is attached to this Environmental Assessment.

TABLE OF CONTENTS

LIST OF ATTACHMENTS

ATTACHMENT

1.0 PURPOSE AND NEED FOR ACTION

The purpose of the Project Modification Report (PMR) is to develop innovative and relatively low cost "pass-through" gates for manatees on selected Central and Southern Florida flood protection structures. This effort is expected to reduce risk, injury and mortality of the Florida manatee caused by the operation of vertical lift gated-structures.

1.1 BACKGROUND

1.11 Biological Information. The West Indian manatee is a large herbivorous aquatic mammal which predominantly occurs in subtropical or tropical waters in coastal, estuarine, and riverine habitats. The Florida species of the West Indian manatee, (*Trichechus manatus latirostris*), can be found throughout Florida and Georgia's southern coast and feeds primarily on submerged, emergent, and overhanging vegetation. The habitat requirements for this species include access to shallow channels, freshwater sources, aquatic vegetation, and warm water refugia in the colder months of the year.

An estimated 1,856 Florida manatees inhabit the waters of the contiguous United States, according to aerial surveys conducted in January 1992. The population of the Florida manatee (hereafter referred to as manatee) is almost equally divided between the east and west coasts of peninsular Florida.

Manatees are seasonally distributed due to their intolerance for cold temperatures. During the warmer months of the year (April through October) they range further north to the Carolinas. Historically, manatees have remained in areas south of Sebastian Inlet on Florida's east coast and south of Charlotte Harbor on the west coast during the colder months of the year (November through March). The proliferation of artificial warm water effluents associated with power plants and paper mills has expanded this wintering range of manatees further north and west. Manatees aggregate at these artificial warm water refugia as well as at natural warm water springs to avoid cold stress (and possible death) associated with ambient water temperatures below 68 degrees Fahrenheit. The most common wintering areas include Homosassa River, Crystal River, Titusville, Port Everglades, Fort Myers, and Tampa Bay.

1.12 Listing. The Florida manatee is listed as Endangered throughout its range by the U.S. Department of the Interior (Federal Register, July 22, 1985. Vol 50 (140): 29900-29909). The threats to the Florida manatee, as documented in the "Florida Manatee Recovery Plan", are predominantly human-related. The most common causes of death are perinatal mortality, collisions with watercraft, crushing by water

control structures, and entanglement in crab lines and fishing nets. Other sources of mortality include poaching, red tides, cold stress, and natural causes.

1.2 Mortality and Water Control Structures. Deaths of manatees are associated with water control structures if a carcass is recovered at or near a structure with one or more of the following indicators; External scrapes, bruises, impressions, massive internal trauma, and/or drowning with an absence or hemorrhaging. Possible causes of these injuries are speculated to be pinning against gates resulting in drowning, and/or entrapment of an animal in a closing gate resulting in internal trauma. Manatees are also speculated to become trapped in floor depressions and lock recesses during gate motion. Each carcass, when reported, is examined for causes of death and a necropsy is performed by the Florida Marine Research Institute (FMRI) in cooperation with the Florida Department of Environmental Protection. Other agencies involved (depending on the responsible structure) investigate the mortality and prepare a report concerning the incident. Mortality determinations are based on a mutual agreement of agencies based on necropsy reports, the observations of lock and water control structure operators, unusual circumstances, equipment failure, and other structure specific monitoring data.

From 1974 through 1994, 110 manatee mortalities were attributed to the operation of water control structures in Florida. Mortalities associated with navigation locks and spillways are the second leading cause of human-related manatee mortality. In 1994, 16 manatee mortalities were caused by water control structures. Consequently, 1994 was chronicled as the worst year of structure related deaths since record-keeping began twenty years ago. It has been speculated that the increase in mortalities in 1994 was a result of unusually high flood stages in the Central and Southern Florida Project area necessitating increased flood gate and lock operations. For the period from January 1, 1995 through July 1, 1995, only one manatee mortality was attributed to the operation of a water control structure. Appendix G of the main report indicates each structure addressed in the study and the manatee mortalities associated with its operation.

1.21 Past Initiatives to Reduce Mortalities. Over the past ten years, both the Corps and the SFWMD field offices have made operational improvements and structural modifications to place the manatee at less risk when encountering water control structures. Each is described briefly below. Please see the main report for more detailed information on each of the past Corps and SFWMD initiatives to reduce manatee mortalities at their structures.

SFWMD installed a prototype Pressure Sensitive Device (PSD) on two of its vertical lift gates, S-27 and S-29. This sensor system consists of a multi-plunger system which activates a switch when depressed by a passing manatee. When initially installed, this system was not completely successful in protecting manatees. Three deaths occurred at S-27 since the PSD's initial installation; however, several testing

procedures were developed to evaluate the system and replace a faulty limit switch. Since this last design iteration, S-29 was retrofitted on both the upstream and downstream locations with the new version of the PSD Plunger system. These system revisions have been highly successful in protecting manatee populations. There have been no deaths associated with the operation of S-27 and S-29 since these design revisions were implemented in March of 1995.

Other efforts to protect manatees at water control structures have included installing iron grate barriers in front of spillways and developing standard operating procedures for lock and dam operators. SFWMD installed Manatee protection circuits at their structures to automatically hold gate openings at 2.5 feet. This operating protocol has allowed for the unobstructed passage of manatees through spillways. Since these structures are operated by telemetry to remote locations, providing safe passage for manatees (large enough openings) was a concern.

The Corps adopted a similar protocol to raise spillway gates to 2.5 feet for one minute prior to setting it at the required opening level. This allows any manatees near the gates to pass through the structure before a small opening could trap them. Undoubtedly, these past initiatives have aided in the protection of the manatee.

1.3 Study Location. The water control structures selected for this study are all located in the Central and Southern Florida Project area (C&SF). Within this region, the project addresses structures located in two areas: The East Coast Canal (ECC) System and the Okeechobee Waterway (OWW).

The Central and Southern Florida Project area is a comprehensive plan of water management for flood control, drainage, water supply and other purposes. This project involves an area of over 16,000 square miles including 16 counties. The C&SF area includes Agricultural and Conservation Areas, the Kissimmee River Basin, the Upper St. John's River Basin, Lake Okeechobee, the East Coast Canals, and other tributaries and outlets. It originates just south of Orlando and extends southward through the Kissimmee River Basin to Everglades National Park.

Fourteen structures addressed in this Report are located within the East Coast Canal System of the C&SF Project Area. Operated by the SFWMD, all of these structures in this region are spillway structures located in Dade and Broward counties (refer to table EA-B-1). These spillway structures prevent salt water intrusion from the Atlantic Ocean and control the release of flood waters. Please see the section of the Main Report entitled "Description of Water Control Structures" for more information on the structures in the East Coast Canal system.

The remainder of the structures addressed in this report (six) are located along the Okeechobee Waterway (OWW) in the counties of Glades, Hendry, Martin, Lee, and Okeechobee (see table EA-B-2). The OWW is a 152 mile inland navigation

system across the Florida peninsula. The OWW consists of the St. Lucie Canal, Lake Okeechobee, and the Caloosahatchee River. The purposes of this Federal Project include navigation, flood control, recreation, water supply, and fish and wildlife management. This lake is a main source of water supply in the C&SF Project area providing fresh water to agricultural areas as well as urban areas in southern Florida. The levee and canal system encircling the lake were completed in 1937 to better control the release of flood waters and to promote interstate shipping. The Corps, in conjunction with SFWMD, subsequently developed a complex water management system with which to manage this network of levees and waterways and by which to control flooding and to protect water supplies. Water control structures within the OWW typically involve both locks and spillways.

2.0 ALTERNATIVE ANALYSIS

2.1 Alternative 1. This alternative is entitled the "No Action" alternative. It proposes to eliminate any modifications to water control structures for manatee protection. This alternative is not a practical solution. Manatees will, according to the USFWS, continue using both the OWW and the C&SF area as travel, foraging, and resting habitat now and into the foreseeable future. Mathematical models suggest that increases in manatee mortality by even a few individuals could have a significant, adverse affect on the future of the manatee.

2.2 Alternative 2. The Bubble Curtain is a tube which emits a wall of pressurized air to discourage manatees from entering operational areas when locks and/or gates are closing. This system has been used previously at the W.P. Franklin lock to control salt water intrusion. The lock operators found it effective, particularly in its first few months of use. It was observed by lock operators, however, that manatee populations became increasingly adapted to the presence of the Bubble Curtain. Animals were observed cavorting in the pressurized air bubbles. Although once thought to be a viable protection measure, the Bubble Curtain concept was abandoned for this project due to its inability to confidently and consistently protect manatees at the structures in the study. In areas where high head differentials are present (and thus, high water velocities), this system would be ineffective for manatee protection.

2.3 Alternative 3. This alternative consists of fabricating and installing folding screens made with a plastic or PVC frame. The screens, when installed in front of a structure, would eliminate manatees from entering an operational gate area. When raised during a gate opening, the screen would allow water to flow through the structures, but would prevent manatee travel through the open gates. When the gates are closed, the screen would remain flat to the channel bottom. This alternative was discarded based on both biological and economical evaluations. If a malfunction occurred or if a manatee slipped passed the screen when raised, the animal could be trapped between the structure and the screen. Once a manatee was trapped in this area, a lowering screen (as the gate moves into a closed position) could then drown an

animal. In addition, designing and fitting each screen to the exact specifications of each channel would be very costly. Maintenance of the screen would also be exorbitant due to the potential destruction of the screens (as they lat flat on the channel bottom) by passing barges and other large vessels.

2.4 Alternative 4. Alternative 4 consists of a variety of Pressure Sensitive Devices (PSDs) which when attached to a gate in some fashion, will either reverse a closing spillway gate or activate an alarm when a manatee comes into contact with it. The following pressure sensitive devices have been investigated:

2.41 The Plunger System. This manatee protection device utilizes a series of plungers which reverse a closing gate when one or more of the plungers is depressed by a passing manatee or object. Assemblies of plungers are bolted to the upstream and downstream edges of the vertical lift gates identified in this study. Two variations of the plunger system have been detailed for this study. In principle, the systems are identical. Both systems are activated by pressure being applied to the plungers which activates an electrical switch. The activated switch generates a signal which modifies the gate open/close circuit accordingly. The difference between the two systems is the selected activation switch.

A. The Magnetic Plunger/Reed Switch system consists of plastic plungers which are spaced at six-inch intervals along upstream and downstream gate edges. When depressed, the plungers activate a manatee protection circuit. Each plunger contains a solid, cylindrical magnet which energizes a reed switch bank. Once triggered by the reed switch back, the circuit will reverse and/or stop a lowering gate. The reed switch bank consists of three switches in parallel per plunger. Each of the three activation switches for each plunger can activate the manatee protection circuit independent of the other switches. The three switches were designed to provide redundancy in the system. Please see the main report for further details on this system in the Section entitled "Alternatives".

The Magnetic Plunger/Reed Switch has both advantages and disadvantages associated with its use. The following are some advantages of the system; a) the plastic pieces are corrosive free; b) the plunger mechanism conforms to the manatee body surface closely; c) replacement of the system can be accomplished without dewatering a structure and; d) the system has been field tested and evaluated at S-27 and S-29. The disadvantages of the system include; a) production of parts is labor intensive; b) very few "pre-made" parts are available; c) testing for fault sources is very maintenance intensive; and d) biofouling is caused by the growth of organisms on the plunger portion of the devices.

B. The Plunger/Sensi-Switch system also consists of plungers placed at six-inch intervals along the upstream and downstream edges of vertical lift gates. When depressed, the plungers activate a sensi-switch which is in the form of a strip

that will reverse and/or stop a closing gate. The sensi-switch consists of a strip of urethane rubber, half-round form enclosing continuous lengths of stainless steel foil tape. Compression of the urethane completes contact of the foil tape to activate the connected electronics to modify the gate open/close circuit.

The advantages of the sensi-switch include all of those listed for the Magnetic Plunger/Reed Switch system. In addition to those advantages, the Plunger Sensi-Switch can be furnished in any length and is less maintenance intensive than the Magnetic Reed Switch system. The sensi-switch eliminates the extensive wiring system to each reed switch by replacing it with an uniform "off-the-shelf" part. Because its parts are less maintenance intensive, when a device fails it can also be replaced more quickly. In addition, this design lends itself easily to the addition of backup devices on the gate for predictable and consistent protection of the manatee. The disadvantage of this system includes that extensive field testing has not yet been completed on its effectiveness and maintenance of the plungers would still be necessary.

2.42 The Collapsible Tube Switch. This system operates similar to pressure sensors on automatic elevator doors. When depressed, the tube compresses air and activates a sensitive pressure switch and circuitry which stops the door and reverses its action. The technology to apply this system to an underwater environment has not been developed to date. A manufacturer could not be located who would recommend this product in a marine environment at lock and spillway structures.

2.43 The Piezo Switch. The Piezo Switch consists of an electrical film manufactured from polyvinylidene fluoride plastic. The Switch converts mechanical energy to an electrical response. In current field tests, the piezo switch can be used in a variety of fashions in conjunction with sector gates and possibly vertical lift gates. Because this is currently under development by Harborbranch Oceanographic Institute (HBOI), the effectiveness of this system is unknown. In the next few months, the results of further testing will determine if this PSD is a feasible alternative for vertical lift gates.

2.5 Alternative 5. Developing "Over the top structures" is another alternative for manatee protection at water control structures. This alternative recommends completely redesigning and constructing new navigation locks and spillways to pass water over the top of the structure. The redesign and construction of 20 new structures is outside the study authority. This study, according to the wording of the authorization, must focus on "relatively low cost" modifications to structures or to the permanent operation of those structures. The recommended modifications, according to the authorization must be limited to a five million dollar limit. Replacing even one structure would exceed that limit. The Corps will be investigating other avenues of funding such as the Flood Control Act of 1944 and the Water Resources Development Act of 1986 to study redesign of structures.

3.0 SELECTED PLAN

The selected plan consists of equipping all vertical lift gates at the selected study structures with a Pressure Sensitive Device (Alternative 4). After analysis, the other alternatives did not prove to be viable and/or consistent in their protection of manatees at water control structures. At present, the Corps is applying value engineering and adaptive management in order to have the ability to shift its focus as more efficient and economical PSD technologies become available. Testing will continue on both variations of the Plunger system (the Magnetic Reed Switch and the Sensi Switch) as well as with the Piezo Switch. Following further field testing, a specific PSD will be chosen and refined for installation at one structure. After six months of intense field testing and evaluation at one structure, the other structures will be equipped with the refined device in a phased approach.

The PSD will be installed on the leading and trailing edges of the gate contact area to offer protection to manatees interacting with water control structures. In order to install the device, each structure will be dewatered, when practicable. Once attached, the devices will be inspected so that they are secured properly. Divers will be used whenever possible to expedite the installation and limit the amount of time the aquatic environment will be disturbed.

While each structure is dewatered, the PSD system will be operationally tested and evaluated. Furthermore, testing with manatee models will also be conducted to ensure the system is working properly. Manatee models will be situated along gate edges and the sensors verified by activating the gate closing operation. Once dry testing is complete, testing of the system will be included in the daily operational instructions at each structure. Reliability testing of each system on a biannual basis (or other required intervals) will also be performed. Regularly scheduled O&M will involve repairing/replacing the system parts which are subject to wear. All of these measures will ensure the sensor devices are functioning properly so that manatees will be protected at the selected structures.

In order to protect the manatee population should a system fail, both the Corps and SFWMD have developed Operating Contingency Plans for their respective structures. Both plans are summarized in Section 6.0 of this Environmental Assessment and are included as Appendix C in the main document. The Corps' plan provides policies, guidelines, and operating procedures for the effective long-term management and operation of water control structures to minimize manatee mortality. SFWMD's plan establishes inspection and maintenance procedures for the manatee protection device to ensure the proper functioning of the devices to protect manatees at SFWMD structures.

4.0 AFFECTED ENVIRONMENT

The study area is divided into two geographical locations; the Okeechobee Waterway (OWW) and the East Coast Canal system (ECC). The proposed project will impact the following counties within the Okeechobee Waterway area: Glades, Okeechobee, Martin, Hendry and Lee counties. In the ECC system, structures in Dade and Broward counties will be impacted by the implementation of the proposed project.

4.01 Air Quality. Air quality in both the OWW and the ECC System is generally good. There are no non-attainment areas within the vicinity of each installation site.

4.02 Water Quality. The water quality of Lake Okeechobee is classified as Class I by the State of Florida. This classification identifies Lake Okeechobee as a potable water supply. Canals in Broward and Dade counties are classified as Class III by the State of Florida. This classification identifies the ECC system as suitable for general recreation and fishing.

4.03 Cultural, Historic and Archeological Resources. All of the structures which will be modified under the proposed plan are located along the OWW and the ECC system of the C&SF Project area. The majority of the twenty structures were built within the last 35 years; however, S-77 was constructed more than 50 years ago. This historic structure contributes to the significance of the OWW and is eligible for inclusion in the National Register of Historic Places as part of the OWW.

4.04 Aesthetic Resources. Aesthetic resources are defined as "those resources and cultural features of the environment that elicit a pleasurable response" in the observer, most notably from the visual sense. The vast majority of structures proposed for modification for manatee protection devices are located in a rural setting with little or no additional development around them. The main locks on the OWW are the primary exception to this rural setting. These locks are usually found in an area with additional development in the close proximity. These man-made structures contrast with and provide a human scale to the water bodies and vegetation provided by nature.

4.05 Hazardous, Toxic, and Radiological Wastes. In the vicinity of each of the installation sites, there is no potential for hazardous, toxic, or radiological wastes.

4.06 Fish and Wildlife Resources. In the Okeechobee Waterway, a variety of fish and wildlife species are expected to be found at the project locations. Typical fish found in the OWW include those usually found in freshwater lakes and streams in Florida: Bass, crappie catfish, sunfish, gar, shad and shiners. A wide variety of bird species inhabit Lake Okeechobee. Wading birds such as herons, egrets, various ibis

species, wood storks, bald eagles and many others are also common in the vicinity of the project sites.

In the East Coast Canal system, the man-made canals along the lower east coast of Florida represent a unique aquatic ecosystem. The canals are relatively deep and narrow and sustain intermittent high water flows during the rainy season. These canals provide habitat for various species of fish, birds, reptiles, amphibians, small mammals, benthic organisms, and aquatic and terrestrial plant species. Common fish in the salt water canals include striped mullet, sea catfish, and needle fish. In the freshwater canals, common fish include bluegills and sunfish. Frequently observed birds include the brown pelican, anhinga, great blue heron, various egret species, osprey, vulture species, ibis species, and various waterfowl species.

4.07 Endangered and Threatened Species. Endangered and threatened species occurring in and around Lake Okeechobee include the bald eagle, wood stork, Everglades kite, Okeechobee gourd, and Florida manatee. The main species of concern for effects from the proposed project is the Florida manatee (*Trichechus manatus latirostris*). The Florida manatee, due to its habitat requirements, can be found in the vicinity of all of the structures addressed in the study.

Okeechobee Waterway (OWW) - Lake Okeechobee lies at the center of the Okeechobee Waterway. Access to this lake is provided by the St. Lucie Canal, the West Palm Beach Canal, the Hillsborough Canal, the North New River Canal, and the Miami Canal on the east and by the Industrial Canal, the Caloosahatchee River, Fisheating Creek, the Harney Pond Canal, the Indian Prairie Canal, the Kissimmee River and Taylor Creek on the east and to the north. Much of what is known about manatee use of this waterway is restricted to the coastal reaches of this system.

In Martin and Palm Beach counties, manatees are seasonally abundant. Peak numbers are present during the winter season. Winter use patterns are typified by an initial southerly influx of manatees from the north to warm water refugia in south Florida. Manatees wintering at FPL's Riviera Plant in Palm Beach County generally use the plant during cold days and shift to waters along the Intracoastal Waterway in Martin County on warmer days to forage. In Martin County, based on mortality records, manatees are present year-round; the St. Lucie River and Canal are used throughout the year. Manatees are also present throughout the year in Palm Beach County.

On Florida's west coast, the Caloosahatchee River traverses Lee, Hendry, and Glades counties between Lake Okeechobee and Matlacha Pass in coastal Lee County. Manatee use of this river occurs throughout the year. Manatee numbers peak during the winter when manatee activity focuses on FPL's Fort Myers Plant near the junction of the Orange River and the Caloosahatchee River. Manatees appear at this warm water refugia primarily from sites located either in coastal Lee County or from areas

to the north. The Franklin Locks upriver of the plant are known to offer refuge to wintering manatees. Manatees occasionally seek refuge near the Franklin Lock where deep waters cool more slowly than waters in the lower Caloosahatchee River in colder times of the year. Subsequent to this event, manatees are occasionally seen resting in the general area of the locks during the winter.

Manatee distribution, abundance, and activity patterns are relatively unknown within the inner reaches of the Okeechobee Waterway. Aerial surveys were flown intermittently over the last 15 years documenting the presence of manatees in the northwest reaches of the Rim Canal in Lake Okeechobee, in the Caloosahatchee River between Moore Haven and La Belle, the upper Caloosahatchee, and at the mouth of Lake Hicpochee.

East Coast Canal System (ECC) - In the ECC project area, the two counties within which modifications are planned are at spillway structures in Broward and Dade Counties. Manatee numbers peak during the colder months of the year in these counties and decline in the warmer months. A frequent aggregation site during the cold months is the Florida Power and Light's (FPL) Port Everglades Plant and Lauderdale Plant in Broward County. The upper reaches of various small canals (usually warmer than more shallow bays) and Coral Gables Waterway in Dade County also act as warm water refugia for manatees during extreme cold weather. Dade County's canal system is expected to be utilized by at least 90 manatees.

Dumfoundling Bay and Virginia Key in Dade County offer foraging areas for manatees. In Broward County, Lake Worth in Palm Beach provides opportunities for foraging as well. Manatees can also be found foraging throughout rivers and canals where vegetation can accumulate in mats or be located on shoreline fringes. Other feeding sites identified include Dania Cut-off Canal, the New River, and the North and South New River Canals.

Manatees are found within the vicinity of water control structures in order to obtain needed freshwater sources. Water control structures are an important source of freshwater within the East Coast Canal system of the C&SF project area. The structures regulate large volumes of freshwater into brackish water systems. When the spillways are closed, small amounts of freshwater leak through the structure and attract manatees. These leaks are known to attract manatees on a routine basis for drinking. Canals, rivers, and streams managed by water control structures are an integral component of the manatee's habitat in Broward and Dade counties. Manatees have been known to ascend all the canals of the C&SF Flood Control Project. The water bodies provide winter refugia, foraging sites, watering sites, and access to and from open bays and waterways.

4.08 Public Facilities and Services. Each of the selected structures in the study provide functions and services to the public. The fourteen structures located in the

ECC (in Dade and Broward Counties) primarily prevent salt water intrusion from the Atlantic Ocean and control the release of flood waters.

The structures found in the OWW all contribute to the overall project purposes of the OWW. Examples of public services that the structures provide include: navigation, flood control, recreation, water supply, and fish and wildlife management. Adjacent to S-77, S-79, and S-308C exist public recreation facilities for outdoor enjoyment and camping.

5.0 ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION

5.01 Unavoidable Adverse Effects. There are no unavoidable adverse effects.

5.02 Relationship Between Short-term uses of the human environment and maintenance and enhancement of the long term productivity. The environment at all of the project locations is being protected for long-term use. The proposed action will not have any adverse effects on the long term productivity of the sites.

5.03 Irreversible or Irretrievable Commitments of Resources. No environmental resources will be permanently removed or altered by the proposed action.

5.04 Possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (including Indian tribes) Land Use Plans, Policies, and Controls for the Study Area. No conflicts will result from the implementation of this project. The proposed modifications are in accordance with the planned land use of each project location.

5.05 Community Growth, Cohesion, and Displacement of People and Businesses. There will be no adverse effects on the community or economy from the implementation of this project.

5.06 Air Quality. The proposed project will have no impact on the air quality in the respective project areas. A temporary increase in emissions will occur due to the mobilization of increased personnel for the installation and monitoring of the structures and devices.

5.07 Water Quality. The proposed project will have no adverse effects on the water quality at each of the 20 project sites. There will be no impact on the substrate adjacent to each lock and spillway since device installation will occur on a previously constructed spillway gate. Dewatering will be required at several structures, but will most likely be coordinated during annual maintenance periods. Temporary dewatering (estimated to take one month) will have no adverse effects on the water quality of the OWW or the East Coast Canal system.

5.08 Cultural, Historic, and Archeological Resources. Pressure Sensitive Devices will be added to the existing gates and spillways. No historic material will be removed or altered by the installation. It is the Jacksonville District's determination that significant cultural resources will not be adversely affected by the installation of the manatee protection devices, as proposed. This determination was coordinated with the Florida State Historic Preservation Officer (SHPO). In a November 1, 1994 letter, the SHPO concurred with the District determination. A copy of this letter is included in Attachment EA-C of this document.

5.09 Aesthetic Resources. During modification of the structures to install the Pressure Sensitive Devices, the gate areas will be dewatered. Dewatering occurs intermittently during scheduled maintenance on these structures. Therefore, dewatering will not be an unusual event and will not take any longer to accomplish than routine maintenance. No unusual noise, air quality or water quality conditions will exist during the time the structures are dewatered. Almost all of the protection devices will be located below the water surface at the gate structures and will not be visible. Once the project modifications have been completed, only close observation will detect the manatee protection devices in place. Therefore, the devices will have no impact upon the aesthetics of the area.

5.10 Hazardous, Toxic, and Radiological Wastes. There is no potential for any effects on the environment from Hazardous, Toxic and Radiological Wastes. Toxic and Radiological wastes will not be used in the construction of the project and are not present at any of the installation sites. Hazardous material use will be minimal (limited to items such as gasoline for the trucks carrying construction personnel, any metal shavings from drilling, etc). All material will be segregated and handled in accordance with the Site Safety and Health Plan (SSHP).

5.11 Fish and Wildlife Resources. There will be no adverse effects to the fish and wildlife resources as a result of this project. Dewatering for the installation of the PSDs will displace fish and wildlife species temporarily; however, the habitat area will be restored within one month. Fish and wildlife species are expected to reinhabit the lock and spillway areas immediately after restoration. The implementation of this plan is expected to improve the habitat of the Florida manatee.

5.12 Endangered and Threatened Species. Although many endangered and threatened species are present in the OWW and the East Coast Canal system, the only species the project could potentially affect is the manatee. Manatees utilize both the OWW and the East Coast Canals for travel, resting, and foraging routes. Their presence in the project locations has necessitated the implementation of this project. Many measures (i.e. Contingency planning, model testing, dry testing, monitoring, etc.) will be implemented by the Corps and SFWMD to ensure that no adverse effects to the manatee will result from this project. The Federal and State "Standard Manatee Construction Conditions" will be strictly followed. This project is expected to

improve the manatee's ability to travel through the OWW and the C&SF Project area unharmed. The PSDs to be installed at the selected structures in this study were designed specifically to decrease risk and mortalities of manatees at water control structures.

5.13 Public Facilities and Services. Public services provided by the canal systems and the spillways will not be adversely impacted by the project. Temporary closure of these structures (estimated at one month per structure) will occur in order to install the PSDs. The closure of each structure will not permanently impact the water supply or flood control functions that each provide. Boaters will be routed through other canals and rivers while each structure is retrofitted. Use of recreational areas adjacent to the S-77, S-79, and S-308C will not be curtailed unless the area is required for temporary staging of construction material. In most cases, if staging is necessary in these areas, only a portion of the recreational area will be closed.

5.14 Cumulative Effects. There will be no cumulative adverse effects expected from the proposed project. The installation of PSDs at all the structures in the study is expected to have an overall positive effect on manatee populations. Manatees will be able to reproduce, travel, feed, and cavort in their habitat without risk of mortality caused by water control structures.

6.0 CONTINGENCY PLAN

Contingency Plans were developed by both the Corps and SFWMD to protect manatee populations found near water control structures should a sensing device fail. Although these documents are in draft form, they are dynamic and will change as new mortality issues are identified and new testing/evaluation procedures for spillway structures are developed.

6.01 Corps Structures. The Corps developed a "Manatee Protection Plan" under which their structures are currently operating. The purpose of the plan is to provide policies, guidelines, and operating procedures for the effective long-term management and operation of water control structures to minimize risks to the Florida manatee. The plan is Appendix C of the Main document. Included in the plan are corrective action plans, operating protocols, safety precautions, reporting and sighting requirements, investigation procedures, and general policies.

6.02 SFWMD Structures. The SFWMD has developed a plan entitled "Manatee Protection Device Inspection/Maintenance Procedures". This draft document provides South Florida Water Management District with a standardized method of insuring the proper operation of the PSDs. These procedures also develop a standard protocol for inspecting and maintaining the PSDs and all associated hardware. The draft procedures are located in Appendix C of the main report. The implementation of these procedures will protect manatee populations by establishing a set of guidelines

to be followed in emergency situations which will eliminate any time loss to repair the selected PSD system.

7.0 COORDINATION

The Corps, Jacksonville District, had the primary responsibility of developing the Project Modification Report. The local sponsor, the SFWMD, coordinated and conducted the research and development of sensor devices and other alternate protection devices.

The Jacksonville District furnished a scoping letter to appropriate Federal, State, and local agencies. A scoping letter was also sent to private and non-profit interest groups, as well as interested parties. The purpose of the scoping letter is to identify potential problems concerning policy and the acceptability of the project as early as possible in the planning process. The scoping component satisfies National Environmental Policy Act (NEPA) scoping requirements and is a source of communicating the Corp's study with interested persons. Scoping also enables the Corps to receive valuable feedback on its coordination effort and to seek additional alternatives or comments on a concept set forth. Responses to the scoping letters were received and incorporated into the plan formulation process. These letters and the Corps' responses are found as Attachment C of this Environmental Assessment.

An Interagency Task Force was established in 1991 to recommend measures to reduce water control structure related manatee mortality. Members include Dade County Department of Environmental Resources Management, Florida Department of Environmental Protection, South Florida Water Management District, U.S. Army Corps of Engineers Jacksonville District, and the U.S. Fish and Wildlife Service. Throughout this study, the Jacksonville District attended Manatee Task Force meetings and maintained contact with members of the Task Force concerning issues and developments of this study. The Manatee Task Force was instrumental in providing information pertaining to manatees and the selection of alternatives.

During each field trial and testing procedure of the various PSDs, the Jacksonville Office of the Fish and Wildlife Service as well as the Bureau of Protected Species Management of the Florida Department of Environmental Protection were contacted and coordinated with for their comments and suggestions. Informal consultation under Section 7 of the Endangered Species Act was conducted for any PSD tested in the aquatic environment.

8.0 LIST OF PREPARERS

The following persons were responsible for the evaluation and contents of this Environmental Assessment:

Preparer's Name	Expertise	Responsibility
Kimberly C. Koelsch	Biologist	EA preparation Principle Compiler
Amy Hill	Civil Engineer	Study Manager
Janice Adams	Archeologist	Cultural Resources
Annon Bozeman	Outdoor Recreation Planner	Aesthetics, Recreation
Eric Holland	Hydraulic Engineer	Hydrology and Hydraulics
Adam Stuart	Hydraulic Engineer	Analysis of Water Management Effects Manatee Protection Plan

9.0 SUMMARY OF COMPLIANCE WITH APPLICABLE ENVIRONMENTAL REQUIREMENTS

9.01 Archeological Resources Preservation Act, as amended. 1974. (ARPA, also called the Archeological Data Recovery Act, the Reservoir Salvage Act of 1960 as amended and the Moss-Bennett Act) This Act requires agencies to notify the Secretary of the Interior with their actions that will cause the loss or destruction of archeological data. The agency can then either recover such data itself or cooperate with the Secretary, and transfer up to one percent of project funds to the Secretary, in order to carry out data recovery.

Compliance with ARPA will be coordinated for each structure during the Plans and Specification phase of the project.

9.02 Clean Air Act, as amended. 42 U.S.C. 7401 et seq. Any official of a Federal agency having jurisdiction over any property or facility constituting an emissions source shall be subject to and comply with Federal, state, interstate or local requirements respecting control and abatement of pollution. All Federal projects, licenses, permits, financial assistance and other activities must conform to EPA approved or promulgated state implementation plans. The assurance of such

conformity is an affirmative responsibility of the head of the Federal agency involved. Sections 118, 176(c), and 309, 42 U.S.C. Executive Order 12088, Federal Compliance with Pollution Control Standards, 13 October 1978.

The only project-related sources of such emissions would be the motorized construction equipment. All vehicles, generators, pumps and construction-related engines will conform to State of Florida emissions standards. The project is not expected to cause significant new atmospheric emissions. Applicable air quality regulations will be strictly followed.

9.03 Clean Water Act (Federal Water Pollution Control Act), as amended. 33 U.S.C. 1251 et seq. (PL 92-500). Any official of a Federal agency having jurisdiction over any property or facility or engaged in any activity that may result in the discharge or runoff of pollutants shall be subject to, and shall comply with federal, state, interstate and local requirements, both substantive and procedural, respecting control and abatement of pollution. Federal agencies are not exempt from the requirement to obtain certification from the state or interstate agency for any discharge into navigable waters (except as provided in Section 404(r)). Executive Order 12088, 13 October 1978. EPA guidelines, 33 U.S.C. 1344b. CEQ Memorandum 17 Nov 80, guidance to apply Sec. 404(r) to a Federal project.

These proposed actions will not result in runoff or discharge of fill or pollutants into water bodies. Temporary dewatering will occur but will not result in any long-term adverse effects on the water column and its composition.

9.04 Coastal Barrier Resources Act. The Act prohibits certain types of development on designated coastal barrier islands or portions thereof (CBRA units) and requires that a project locate in a CBRA unit be subjected to comments by the Secretary of the Interior.

None of the 20 project locations are located in a designated CBRA unit.

9.05 Coastal Zone Management Act of 1972, as amended. 16 U.S.C. 1451 et seq. Any activity that a Federal agency conducts or supports that directly affects the coastal zone, and any development project in the coastal zone, shall be, to the maximum extent practicable, consistent with approved state management programs. NOAA Regulations, 15 CFR Part 930 revised 15 June 1979, 44 F.R. 37142.

In a letter dated August 4, 1994, the State of Florida Department of Community Affairs deemed this project consistent with the Coastal Zone Management Act. The state concurred that the project would not significantly affect the coastal waters and adjacent shorelines of the state.

9.06 Endangered Species Act of 1973, as amended. 16 U.S.C. 1531 et seq. Federal agencies shall, in consultation with and with the assistance of the Secretary (Interior or Commerce), utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of listed endangered and threatened species and by taking such action as necessary to insure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of such endangered or threatened species or result in the destruction or modification of habitat of such species which the Secretary, after consultation as appropriate with the affected States, has determined to be critical. USDI and USDC, NOAA, Rules on Endangered Species Exemption Applications, 50 CFR Parts 451, 45 F.R. 8264 (8 Feb 80), and 50 CFR Parts 450, 451, 452 and 453, 45 F.R. 23354 and 49083.

The nature of this project focuses on the protection of an endangered species, the Florida manatee (*Trichechus manatus latirostris*). Coordination under the Endangered Species Act with the U.S. Fish and Wildlife Service (USFWS) has occurred throughout the lifetime of this project. Formal Section 7 consultation with the USFWS will be initiated once the plans and specifications phase of the project has begun, upon their request. The USFWS's informal comments on this project can be found as the Coordination Act Report in Attachment A of this document. It is the Corps's opinion that the project will not adversely impact the Florida manatee. The project will, in fact, improve the manatees ability to navigate within its habitat without harm. Protective measures, testing procedures, phased installation, and contingency planning have all been designed to implement this project without adversely impacting the manatee.

9.07 Estuary Protection Act. 16 U.S.C. 1221 et seq. (PL 9454, 3 August 1968). In planning for use or development of water and land resources, all Federal Agencies shall give consideration to estuaries and their natural resources, and their importance for commercial and industrial developments. All project plans and reports affecting estuaries and their natural resources that are submitted to Congress shall contain a discussion by the Secretary of the Interior concerning the estuaries and their resources and effects of the project on them and his recommendation thereon.

This law provides for Federal designation of Estuaries of National Significance, and consultation with the Secretary of the Interior for projects that may impact such estuaries. The structures are not part of such a designated area.

9.08 Federal Water Project Recreation Act, as amended. 16 U.S.C. 4601-12 et seq. Any Federal navigation, flood control, hydroelectric, or multipurpose project planning shall include full consideration of opportunities afforded by the project for outdoor recreation and fish and wildlife enhancement.

No new recreational opportunities were identified as being potentially generated by the proposed project.

9.09 Fish and Wildlife Coordination Act, as amended. 16 U.S.C. 661 et seq. For any proposal or Federal work affecting any stream or other body of water, the Federal agency proposing such work must first consult with the Fish and Wildlife Service and state wildlife agency with a view to preventing losses and damages to wildlife resources and to providing for development and improvement of wildlife resources. Reports of the Secretary of the Interior and state wildlife agency shall be an integral part of any report to Congress. No implementing directives.

The proposed project has been coordinated with the Jacksonville Field Office and the Vero Beach Office of the U.S. Fish and Wildlife Service. A Coordination Act Report (CAR) is attached to this Environmental Assessment as Attachment A. The CAR recommends the installation of the sensing devices, with a caveat to continue searching for additional protection strategies at water control structures. The Corps is exploring other protection measures, as recommended by the USFWS, such as hydroacoustic technologies, barriers, new operational protocols, and future PSDs. In addition, USAE Waterways Experiment Station was tasked with various monitoring and development projects to further evaluate protection of manatees at water control structures. The USFWS's recommendation to install the devices on a few structures and monitor them for effectiveness will be implemented. The Corps concurs with this strategy to ensure the effectiveness of the devices to prevent future manatee mortalities.

9.10 Land and Water Conservation Fund Act of 1965, as amended. 16 U.S.C. 4601-4 et seq. No financial assistance may be given under any other Federal program for any project with respect to which such assistance to a state has been given or promised under this statute. No property acquired or developed with assistance from the Land and Water Conservation Fund shall, without the approval of the Secretary of the Interior, be converted to other than outdoor recreation uses. No implementing directives.

This legislation is not applicable to the project.

9.11 Marine Protection, Research, and Sanctuaries Act of 1972, as amended. 33 U.S.C. 1401 et seq. In connection with Federal projects involving dredged material, the Secretary of the Army may issue permits for the ocean discharge of dredged material, applying the same criteria which apply to EPA issuance of permits for ocean dumping of other material. Executive Order 12088, Federal Compliance with Pollution Control Standards, 13 Oct 78.

Ocean disposal of dredged material is not proposed. No properties affected by this act are involved in the recommended project area.

9.12 National Environmental Policy Act of 1969, as amended. 42 U.S.C. 4231 et seq. PL 91-190, as amended. All Federal agencies shall perform a detailed analysis

early in the planning process to help develop and evaluate alternatives for all major federal actions. The resulting analysis may be in the form of a Categorical Exclusion, an Environmental Assessment, and/or an Environmental Impact Statement, depending upon the significance of the expected impacts of a project. This analysis ensures that a federal agency in reaching its decisions, will have available and will carefully consider detailed information concerning significant environmental impacts. This relevant information may then be provided to a larger audience that may also play a role in the decision-making process and in the implementation of that decision. The nature of the scoping process involves pertinent federal, state and local agencies, as well as associations, and interested citizens in the development of the document as a decision-making tool. Executive Order 11593, 13 May 71; E.O. 11988, 24 May 77; E.O. 1990, 24 May 1977; E.L. 11991, 24 May 77; E.L. 12088, 13 Oct 78; E.L. 12114, 4 Jan 79; CEQ Regulations 40 CFR Parts 1500-1508, 29 Nov 78; CEQ Memorandum 30 Aug 76.

In consultation with the State of Florida and the U.S. Fish and Wildlife Service we have made a determination that the proposed major Federal action will not significantly affect the human environment. The Project Modification Report and EA have been submitted to the responsible Federal, State and local officials for comment. The comments were reviewed and considered during the process of project finalization and prior to authorizing a Finding of No Significant Impact. The result of a Finding of No Significant Impact is the conclusion that an EIS is not required.

9.13 National Historic Preservation Act of 1966, as amended. 16 U.S.C. 470 et seq., as amended by PL 102-575, 2 Nov 92. The head of any Federal agency having direct or indirect jurisdiction over a proposed Federal or Federally assisted undertaking shall, prior to approving expenditure of any Federal funds on that undertaking, take into account its effect on any district, site, building, structure, or Places. The head of the Federal agency shall afford the Advisory Council on Historic Preservation a reasonable opportunity to comment with regard to such undertaking. Advisory Council on Historic Preservation Regulations, 36 CFR Part 800, 44 F.R. 6068, 30 Jan 79.

In-house cultural resource analysis and coordination with the Florida State Preservation Officer (SHPO) were completed according to the requirements established in the National Historic Preservation Act, the Archeological and Historic Preservation Act, and 36 CFR Part 800. Coordination of the District's no adverse effect determination is documented in a November 1, 1994 letter from the SHPO, a copy of which was included in Attachment EA-C of this Environmental Assessment.

10.0 REFERENCES CITED

DRAFT WATER CONTROL MANUAL, EAST COAST CANALS. Central and Southern Florida Project for Flood Control and Other Purposes. U.S. Army Corps of Engineers, Jacksonville District, June 1992.

FINAL ENVIRONMENTAL IMPACT STATEMENT SOUTH DADE CONVEYANCE CANALS AND EAST COAST BACKPUMPING (CENTRAL AND SOUTHERN FLORIDA). U.S. Army Corps of Engineers, Jacksonville District, June 1975.

LAKE OKEECHOBEE IMPLEMENTATION OF 15.65 TO 16.75 (RUN 25) REGULATION SCHEDULE. Environmental Assessment, U.S. Army Corps of Engineers, Jacksonville District, September 1994.

MANATEE RECOVERY PLAN. U.S. Fish and Wildlife Service, Atlanta, Georgia, 1989.

RARE AND ENDANGERED BIOTA OF FLORIDA Vol.I Mammals ed. by Stephen R. Humphrey, University Press of Florida Gainesville, 1992.

FINAL
ENVIRONMENTAL ASSESSMENT

MANATEE PROTECTION PLAN AT SELECTED NAVIGATION AND WATER CONTROL STRUCTURES IN CENTRAL AND SOUTHERN FLORIDA PART I

ATTACHMENT A

USFWS COORDINATION ACT REPORT

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE, DISTRICT

SEPTEMBER 1995

United States Department of the Interior

FISH AND WILDLIFE SERVICE
6620 Southpoint Drive South
Suite 310
Jacksonville, Florida 32216-0912

OCT 23 1996

Mr. A. J. Salem
Chief, Planning Division
Environmental Studies Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

The Draft Project Modification Report and Environmental Assessment, Manatee Protection Plan (Part 1) At Selected Navigation and Water Control Structures in Central and Southern Florida contains the final version of the U. S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act Report (CAR). It appears that the Service's transmittal letter which accompanied the draft CAR was inadvertently retained in the draft report.

While not addressed in the CAR, the Service believes that the proposed project will not impact fisheries known to occur in the project area. The installation and operation of manatee protection devices on navigation and water control structures will not require equipment or practices known to adversely affect these fisheries.

Thank you for the opportunity to clarify your concerns.

Sincerely,

Don Palmer

for Michael M. Bentzien
Assistant Field Supervisor

Enclosure

MANATEE PROTECTION AT WATER CONTROL STRUCTURES

Fish and Wildlife
Coordination Act Report

Prepared by:

Department of the Interior
U.S. Fish and Wildlife Service
Jacksonville Field Office
Jacksonville, Florida

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia
November, 1994

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1.0 Introduction

The West Indian manatee (*Trichechus manatus latirostris*) is an endangered species protected under the Endangered Species Act of 1973, as amended (Act). The Act promotes actions necessary to recover endangered species. Actions specific to manatees are outlined in the "Florida Manatee (*Trichechus manatus latirostris*) Recovery Plan" (Plan) (U.S. Fish and Wildlife Service, 1989). The Plan delineates and schedules actions necessary to restore the manatee as a "viable self-sustaining element of its ecosystem".

To document causes of manatee mortality in Florida, a manatee carcass recovery program was initiated in 1974 (O'Shea *et al.* 1985). This program identified the various ways by which manatees die and demonstrated that a significant number of manatees die as a result of human activities. Between 1974 and 1992, 2074 manatee deaths were documented; 673 (or 32.4%) died from human-related causes. The majority of these deaths were caused by watercraft (522). The second highest source of human-related manatee mortality was attributable to water control structures (89) (Ackerman *et al.*, 1994).

The Plan promotes the recovery of the manatee through actions which will result in the reduction of manatee mortality and the protection of manatee habitat. Task 13 specifically seeks to minimize manatee mortality caused by water control structures. Efforts to reduce this source of mortality began in 1979 when the U.S. Fish and Wildlife Service (Service), the U.S. Army Corps of Engineers (Corps), the South Florida Water Management District (SFWMD) and the University of Miami met to review these deaths and to make recommendations by which to reduce these mortalities (Oberheu, 1979). A task force was developed as a result of these efforts. The task force reviews water control structure-related deaths and develops and implements strategies to reduce such mortality.

The Corps is an active member of the interagency task force and participates in the development and implementation of manatee protection strategies at water control structures. The Corps is currently involved in a study authorized under Section 1135(b) of the Water Resources Development Act of 1986, as amended. The study seeks "to design manatee protective structures or operational modifications at selected navigation locks and water control structures in the Okeechobee Waterway and Central and Southern Florida Flood Control Projects" (Salem, 1994). (Table 1).

This Fish and Wildlife Coordination Act Report summarizes information about manatee use of waterways regulated by water control structures and reviews water control structure-related manatee mortality and methods by which to minimize mortality.

NOTE: Since submittal of this report, the study authorization has changed. This report is in partial response to authorization and appropriations provided in the Energy and Water Development Appropriations Act of 1994 (P.L. 103-126).

Table 1.

Section 1135 Manatee Protection Study Structures

The affected structures are located in the Okeechobee Waterway and Central and Southern Florida Flood Control Project, as indicated in the table below.

Structure	Location	Date Constructed	Manatee Deaths (1974 - 1993)
S-27	Dade Co.	1958	13[1]
S-29	Dade Co.	1953	12[1]
St. Lucie Lock/ S-80 Spillway	Martin Co	1941/1944	9
Ortona Lock/ S-78 Spillway	Glades Co.	1937	7
S-22	Dade Co.	1956	6
S-193	Okeechobee Co.	1973	4
Port Mayaca Lock/ S-308C Spillway	Martin Co.	1977	4
S-28	Dade Co.	1962	3
S-13	Broward Co.	1954	3
S-25B	Dade Co.	1976	3
S-26	Dade Co.	1974	3
Moore Haven Lock/ S-77 Spillway	Glades Co.	1935/1966	2
S-20F	Dade Co.	1967	1
S-135	Martin Co.	1969	1
S-33	Broward Co.	1954	1
S-25	Dade Co.	1976	1
S-21	Dade Co.	1961	0
S-21A	Dade Co.	1966	0
S-20G	Dade Co.	1966	0
S-79	Lee Co.	1965	0
S-127	Glades Co.	1963	0
S-310	Hendry Co.	1980	0
S-131	Glades Co.	1963	0

Footnote (1): These structures are operated by the South Florida Water Management District. They have already been modified by installation of plunger-type mechanical sensing devices along the lower edge of the vertically-closing gates which can reverse gate closure automatically. The effectiveness of the modifications is still under evaluation.

Data on manatee mortality were furnished by the Florida Department of Environmental Protection, Authorized Purposes: Navigation, Flood Control, Water Supply.

2.0 Site Description

The twenty-three water control structures selected for this study are located in the Okeechobee Waterway and in the Central and Southern Florida Flood Control Project area. The Okeechobee Waterway structures are found in Martin, Okeechobee, Glades, Hendry and Lee counties in south central Florida. Flood Control Project sites are located in Broward and Dade counties on the southeast coast of Florida (Map 1).

South central and southeast Florida lie at the northern edge of the subtropics. The study site locations involve a variety of habitats, inclusive of but not limited to coastal marshes, dry prairies, flatwoods, and significantly, freshwater marshes, lakes and riverine systems (Ward, 1979). These habitats were altered primarily for agricultural purposes (Ewel, 1990).

Habitats were initially altered in the 1880's when a series of canals and dikes were built to create fast land for farming purposes. Lands were further converted in the early 1900's and late 1920's for the purpose of building roads and controlling flood waters (Ewel, 1990). The Corps completed the Okeechobee Waterway in 1937 to better control the release of flood waters and to promote interstate shipping. The Corps, in conjunction with SFWMD, subsequently developed a complex water management system to manage this network of dikes and waterways, control flooding, and protect water supplies (U.S. Army Corps of Engineers, undated).

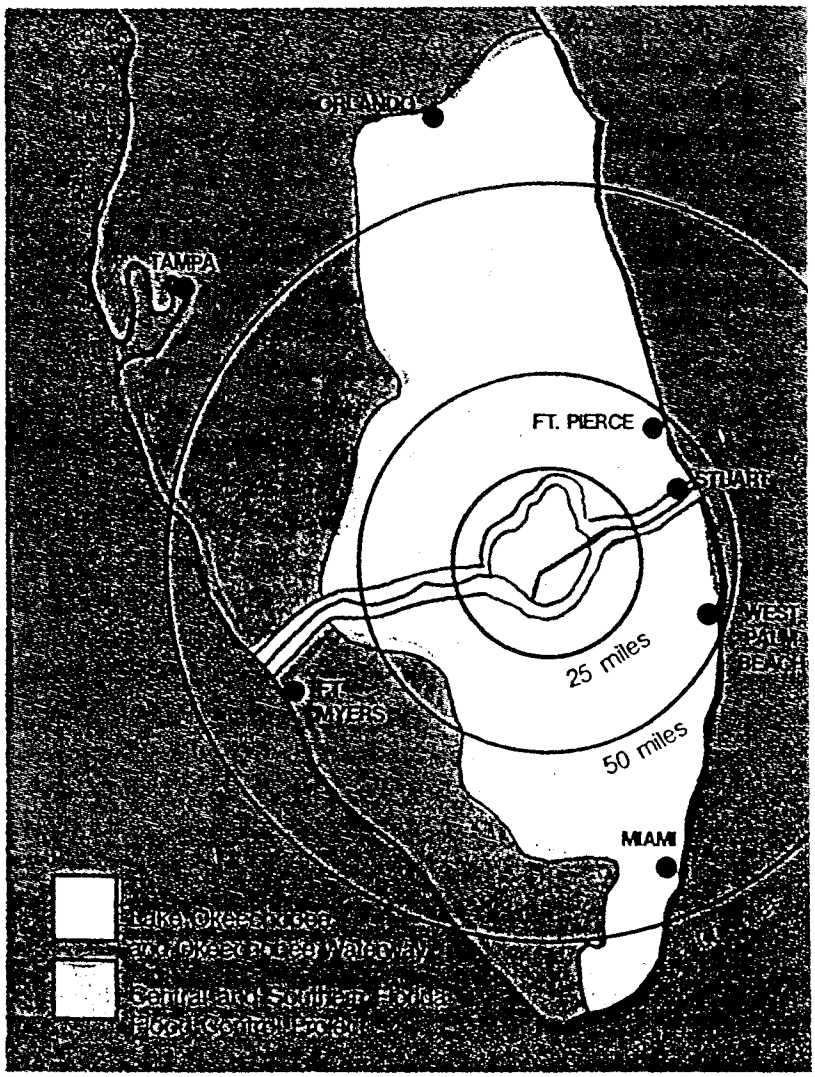
Ten of the twenty-three water control structures are located within the 152-mile-long Okeechobee Waterway. Water control structures within the Waterway typically involve both locks and spillways. The thirteen remaining structures in Dade and Broward counties are spillways.

3.0 Biological Background

The Florida manatee is one of two subspecies of manatee commonly referred to as the West Indian manatee. The Florida manatee (hereafter referred to as manatee) typically ranges throughout Florida and southern Georgia. The population is thought to be almost equally divided between the east and west coasts of peninsular Florida. While there has been no definitive count of the number of manatees found in this area, aerial surveys conducted in January, 1992, confirmed the presence of at least 1,856 manatees (Ackerman, 1992). Subsequent surveys completed in February, 1995, counted 1,822 manatees.

Manatees are seasonally distributed. This pattern reflects an intolerance for cold temperatures. Historically, manatees ranged to their northern limit during warmer times of the year. Conversely, during colder times of the year, manatees were restricted in their

Map 1. Location of Lake Okeechobee, the Okeechobee Waterway and the Central and Southern Florida Flood Control Project sites.



range to those areas south of Sebastian Inlet on Florida's east coast and south of Charlotte Harbor on the west coast (Moore, 1951). These wintering areas were complemented by several natural, warm water springs in northern areas. While historical distribution patterns persist, the number of wintering sites has increased in recent times due to the proliferation of artificial warm water effluents associated with power generating plants and paper mills (Beeler and O'Shea, 1988).

During warmer months, manatees disperse and may travel as far north as the Carolinas. Typically, female manatees remain within a given area for some time during the summer. Males will travel from female to female, presumably to ascertain the reproductive status of these individuals (Bengston, 1981). A female in estrus will mate several times with different males. A pregnant manatee will carry a calf for approximately 13 months. The calf is dependent upon the mother for a period of about two years (Rathbun *et al.*, 1992).

Assessments of manatee abundance, distribution, and behavior have demonstrated "that manatees exhibit both opportunism and independence in their distribution and movement [patterns]" (U.S. Fish and Wildlife Service, 1994). Manatees have readily adapted to the presence of man-made systems including artificial warm water refugia, freshwater discharges, water control structures, and navigation locks. Their presence at water control structures and navigation locks has been primarily documented through anecdotal sighting reports and the manatee carcass recovery program.

3.1 Manatee Use of the Southern and Central Flood Control Project Area

(The Southern and Central Flood Control Project Area includes that area on Florida's east coast from Volusia County to Dade County. The following discussion is restricted to Broward and Dade counties, where the study-selected water control structures are located).

Manatees can be found in Broward and Dade counties throughout the year. Manatee numbers peak during the winter season and small numbers remain during warmer times of the year (Dade County, 1994). Manatee use of warm water refugia is restricted primarily to periods following the passage of severe cold fronts. As temperatures increase, manatees leave these sites to forage and to engage in other activities. Wintering manatees in these counties use Florida Power & Light's (FPL) Port Everglades Plant and Lauderdale Plant in Broward County and the upstream reaches of numerous small rivers and canals in Dade County. Both site-fidelity and movements in-between wintering sites are known to occur (Reid *et al.*,1991; Sirenia Project, 1993). Water temperatures in the deeper rivers and canals are usually warmer than temperatures found in open shallow bay waters (Dade County, 1994). Dade County's canal system is used by as many as 90 different manatees (Markley *et al.*, 1994). In Dade County, the Coral Gables Waterway is commonly used during the winter by manatees (Beeler and O'Shea, 1988).

Foraging sites in Broward and Dade counties include areas noted for the presence of submerged, emergent, and overhanging vegetation. In particular, Dumfoundling Bay, northern Biscayne Bay, and Virginia Key in Dade County attract large numbers of manatees because of the presence of seagrass beds (Dade County, 1994). Animals wintering in Broward County will travel to Lake Worth in Palm Beach County to feed on seagrasses found there (Broward County, 1991). Manatees also forage in rivers and canals, areas which provide vegetation either from shoreline fringes or from mats of accumulated floating vegetative debris (Hartman, 1974; Curtin, pers. comm., 1994). Beeler and O'Shea (1988) identified feeding sites in Broward County; these sites include the Dania Cut-Off Canal, the New River, and the North and South New River Canals. They further speculate that Hillsboro and Pompano Canals may afford manatees with feeding sites. Some manatees travel upstream of salinity control structures into fresh water canal/lake systems to feed on fresh water vegetation (Dade County, 1994).

"A daily pattern has been observed by manatee trackers in Dade [County] during cold weather months: many manatees leave Biscayne Bay in the morning and travel up rivers and canals to salinity control structures where they drink fresh water. They may rest in these areas occasionally feeding on shoreline vegetation, or move to a nearby open area to rest, play, mate, or nurse. In the latter part of the afternoon, many manatees head downstream into Biscayne Bay where they feed in seagrass beds during the evening". (Dade County, 1994).

Manatees in marine or estuarine environments are attracted to fresh water. Sources include fresh water creeks and rivers, sewage outfalls, water hoses, artesian springs, culverts and other sources of surface water runoff (O'Shea and Kochman, 1990). The Black Point Marina basin in Dade County is typical of those sites which attract manatees to freshwater. Water control structures are an important source of freshwater within the Flood Control Project area. These structures regulate large volume flows of fresh water into brackish water systems; when closed, small amounts of fresh water leak through the structures. Manatees are attracted to these fresh water sources and are known to use them on a routine basis (Dade County, 1994).

Travel corridors have been identified in Broward County's "Manatee Protection & Boating Safety Plan" (1991) and in Dade County's ""Draft Dade County Manatee Protection Plan" (1994). In Broward County, the New River system, the Dania Cut-Off Canal, and the Intracoastal Waterway are used as primary manatee travel corridors. In Dade County, the county plan identifies the channel area within the Intracoastal Waterway as being the primary manatee travel corridor in that county; the plan further describes preferred travel paths on the west side of Biscayne Bay and mentions daily east-west travel in major rivers and canals.

Canals, rivers, and streams managed by water control structures are an integral part of manatee habitat in Broward and Dade counties. Hartman (1974) states that manatees "are known to ascend all the canals of the Southern and Central Flood Control [Project Area]." These waterbodies provide manatees with winter refugia, foraging sites, watering sites, and access to and from open bays and waterways. They are found at these locations throughout the year, albeit primarily during the cold weather months. Specific sites are listed in Table 2. These canals and their respective water control structures have altered manatee distribution and movement patterns and the structures have become a significant source of mortality (Ackerman *et al.*, 1994).

3.2 Manatee Use of the Okeechobee Waterway

Lake Okeechobee lies at the center of the Okeechobee Waterway. Lake Okeechobee drainages are provided by the St. Lucie, West Palm Beach, Hillsboro, North New River, and Miami Canals on the east and by the Industrial Canal, the Caloosahatchee River, Fisheating Creek, Harney Pond Canal, Indian Prairie Canal, Kissimmee River, and Taylor Creek on the east and north. Much of what is known about manatee use of this waterway is restricted to the coastal reaches of this system. (Manatee use of the coastal reaches of the Hillsboro, North New River, and Miami Canals has been described in the previous section.)

The St. Lucie Canal originates in Martin County and runs between Lake Okeechobee and the south fork of the St. Lucie River. The West Palm Beach Canal is found in Palm Beach County and crosses between Lake Okeechobee and the Intracoastal Waterway south of Lake Worth. In Martin and Palm Beach counties, manatees are seasonally abundant. Peak numbers are present during the winter season. Winter use patterns are typified by an initial southerly influx of manatees from the north to warm water refugia in south Florida (Reid, *et al.*, 1991; Sirenia Project, 1993). Manatees wintering at FPL's Riviera Plant in Palm Beach County generally use the plant during cold days and shift to waters along the Intracoastal Waterway in Palm Beach and Martin counties on warmer days to forage; others continue their migration south to Port Everglades. In Martin County, based on mortality records, manatees are present year-round; the St. Lucie River and Canal are used throughout the year. Manatees are also present throughout the year in Palm Beach County (Beeler and O'Shea, 1988). Beeler and O'Shea (1988) listed specific locations where manatees had been seen in these counties. These lists include canals and waterways controlled by water control structures (Table 3).

On Florida's west coast, the Caloosahatchee River traverses Lee, Hendry, and Glades counties between Lake Okeechobee and Matlacha Pass in coastal Lee County. Manatee use of this river occurs throughout the year. Manatee numbers peak during the winter when manatee activity focuses on FPL's Fort Myers Plant near the junction of the Orange River and the Caloosahatchee River. Manatees appear at this warm water refugia

Table 2. Manatee sighting locations from Broward and Dade counties (within the South and Central Florida Flood Control Project area). Selected water control structures associated with sighting locations appear in ( ). (Adapted from Beeler and O'Shea, 1988)

- Broward County
  - Hillsboro River (Intracoastal Waterway)
    - Hillsboro Canal
    - Lake Santa Barbara
      - Cypress Creek (aka Pompano) Canal
    - Middle River
      - North Fork
      - South Fork
        - Middle River (aka Midriver or Oakland Park) Canal
    - New River
      - North Fork **(S-33)**
        - North New River Canal
      - South Fork (site of the Lauderdale Plant)
        - South Fork New River (aka South New River) Canal
    - Lake Mabel (site of Port Everglades and the Port Everglades Plant)
      - Inlet, Port Everglades
      - Nova University Boat Basin
      - US Coast Guard Station
  - Intracoastal Waterway
    - Dania Cut-Off Canal **(S-11)**
- Dade County
  - Intracoastal Waterway (continued)
    - Golden Beach
    - Dumfoundling Bay
      - Canal between Dumfoundling Bay and Maule Lake
    - Maule Lake
      - Snake Creek (aka Royal Glades or Greynolds Park) Canal **(S-29)**
      - Oleta River
    - Bal Harbour
    - New Arch Creek
    - Indian Creek
    - Arch Creek
    - Biscayne Bay
      - Biscayne Canal **(S-28)**
      - Little River **(S-27)**
        - Little River Canal
        - Surprise Lake (aka Lake Surprise)

Table 2. Manatee sighting locations from Broward and Dade counties (within the South and Central Florida Flood Control Project area). Selected water control structures associated with sighting locations appear in ( ). Continued.

- Dade County (continued)
  - Intracoastal Waterway
    - Biscayne Bay
      - Dodge Island (Port of Miami)
      - Virginia Key
      - Bear Cut
      - Coral Gables Canal (aka Coral Gables Waterway)
      - Snapper Creek Canal (S-22)
      - Biscayne Canal
      - Kings Bay
      - Cutler Ridge Plant
      - Black Creek Canal
      - Goulds Canal (S-21)
      - Canal C-102 (S-21A)
      - Military Canal (S-20G)
      - Mowry Canal (aka C-102) (S-20F)
      - Miami River
        - Wagner Creek (aka Seybold Channel) (S-25)
        - South Fork (S-25B)
          - Blue Lagoon
          - Tamiami Canal
        - North Fork (S-26)
          - Miami Canal

Table 3. Manatee sighting locations from Martin, Okeechobee, Glades, Hendry, and Lee counties (within the region of the Okeechobee Waterway). Selected water control structures associated with sighting locations appear in ( ). (Adapted from Beeler and O'Shea, 1988)

- Martin County
  - St. Lucie Inlet
  - Indian River
  - Intracoastal Waterway
  - St. Lucie River
    - Sewall Point
    - Hell Gate
    - Hooker Cove
    - A1A Bridge
    - Warner Creek
    - Roosevelt Bridge (Highway 5)
    - North Fork, St. Lucie River
      - Lighthouse Point Canals
      - Bessey Creek
    - South Fork, St. Lucie River
      - Palm City Bridge (Highway 314)
      - St. Lucie Canal **(St. Lucie Lock/S-80 Spillway and Port Mayaca Lock/S-308C Spillway)**
        - Indiantown
  - Lake Okeechobee **(S-135)**
- Okeechobee County
  - Lake Okeechobee
    - Henry Creek
    - Nubbin Slough
    - Taylor Creek **(S-193)**
    - Kissimmee River
    - Coe's Cove
- Glades County
  - Lake Okeechobee
    - Indian Prairie (aka C-40) Canal
    - Harney Pond (aka C-41) Canal
    - Fisheating Bay
    - Fisheating Creek
    - LD-3 Canal
    - Old Moore Haven Canal
      - Caloosahatchee River
        - Moore Haven **(Moore Haven Lock/S-77 Spillway)**
        - Lake Hicpochee
        - Ortona **(Ortona Lock/S-78 Spillway)**
        - LaBelle
    - Rim Canal

Table 3. Manatee sighting locations from Martin, Okeechobee, Glades, Hendry, and Lee counties (within the region of the Okeechobee Waterway). Selected water control structures associated with sighting locations appear in ( ). Continued.

- Hendry County
  - Lake Okeechobee
    - Rim Canal
  - Caloosahatchee River
    - Fort Denaud
- Lee County
  - Caloosahatchee River
    - Cape Coral
      - Piney Point
      - Redfish Cove
      - Yuma Lake
      - Cape Coral Bridge
    - Fort Myers
      - Iona Point
      - Shell Point Village
      - Deep Lagoon
      - Whiskey (aka Wyomi) Creek
      - Peppertree Point
    - North Fort Myers
      - Hancock Creek
      - Powell Creek
      - Daughtrey Creek
    - Beautiful Island
    - Orange River
      - Orange Harbor
      - Fort Myers Plant
    - Owl Creek
    - Olga
    - **Franklin Lock/S-79 Spillway**
    - Alva Bridge

primarily from sites located either in coastal Lee County or from areas to the north (Beeler and O'Shea, 1988). The Franklin Locks upriver of the plant are known to offer refuge to wintering manatees. During the winter of 1985 the Fort Myers Plant did not generate warm water; manatees normally seeking refuge at this site sought refuge near the Franklin Locks where deep waters cool more slowly than waters in the lower Caloosahatchee River (Packard *et al.*, 1985). Manatees are occasionally seen resting in the general area of the locks throughout the year (Beeler and O'Shea, 1988; Reid, pers. comm.).

Manatee distribution, abundance, and activity patterns within the inner reaches of the Okeechobee Waterway are poorly known. Aerial surveys were flown over Florida's southwest coast from July through December 1979, inclusive of the Caloosahatchee River (Irvine *et al.*, 1982). The Florida Game and Fresh Water Fish Commission (GFC) flew surveys from the mouth of the St. Lucie River to Fort Myers on the Caloosahatchee River. These surveys were conducted from September to December 1981, January to June 1982, April to December 1983, January to November 1984, and in March 1985 (Beeler and O'Shea, 1988). Irvine sighted three manatee aggregations in the upper Caloosahatchee River, all in November (Irvine *et al.*, 1982). The GFC surveys documented the presence of manatees in the northwest reaches of the Rim Canal in Lake Okeechobee, in the Caloosahatchee River between Moore Haven and La Belle, and at the mouth of Lake Hicpochee. A total of 16 manatees were sighted during these surveys and sightings occurred throughout the course of the year (Beeler and O'Shea, 1988). A Service sponsored write-in sightings program received sighting reports from various locations within the Okeechobee Waterway; lock tenders participated in this program and maintained sighting logs (Beeler and O'Shea, 1988), (Table 3). Additional information has been obtained from the manatee carcass recovery program.

3.3 Manatee Mortality Associated With Water Control Structures

The carcass recovery program has identified water control structures which cause manatee mortality and identified structures responsible for the majority of such deaths. By analyzing this mortality database, seasonal trends, age patterns, and sex ratios have been determined. A review of manatee activity at the structures and of trauma associated with manatee carcasses has led to the development of theories describing how manatees are killed in water control structures.

From April 1974 through December 31, 1994, 110 manatees were killed by water control structures in Florida. Water control structures used for flood and salinity control and navigational purposes have been involved in these deaths . The majority of these structures are located within the area of the South and Central Florida Flood Control Project and within the Okeechobee Waterway. Other structures can be found in Brevard County, Putnam County, Citrus County, Levy County and in Hillsborough County. Ackerman *et al.* (1994) analyzed FDEP's manatee mortality database for the period 1974

Table 4

S nary (1974 to 1994) of Monthly Water Control Structure-related Ma e Mortality from Study Selected Water Control Structures.

Structure	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Broward County													
S-13	0	0	1	0	0	1	0	0	0	0	1	0	3
S-33	0	0	0	0	0	1	0	0	0	0	0	0	1
Dade County													
S-20	0	0	0	0	0	0	0	0	0	0	1	2	3
S-22	0	0	0	0	0	3	0	0	0	1	2	0	6
S-25B	0	0	0	0	1	0	0	0	4	1	1	0	7
S-27	4	1	1	0	2	1	0	1	2	0	3	0	15
S-28	0	0	0	0	0	1	1	0	0	0	0	1	3
S-29	0	0	0	0	1	3	1	0	3	1	3	0	12
Glades County													
S-77	0	1	1	0	0	1	0	0	0	0	0	1	4
S-78	0	0	2	2	1	1	0	2	0	2	1	3	14
Martin County													
S-80	1	1	1	1	3	0	1	0	1	0	0	2	11
S-135	0	0	0	0	0	0	1	0	0	0	0	0	1
S-308	1	0	1	0	1	0	1	1	0	0	0	0	5
Okeechobee County													
Henry Creek	0	0	0	0	0	0	0	0	0	0	0	1	1
S-193	0	0	0	0	0	2	1	1	0	3	0	0	7
Total	6	3	7	3	9	14	6	5	10	8	12	10	93

to 1992. He noted the preponderance of manatee deaths associated with water control structures in southeast Florida and associated that number with the high density of such structures within this geographic area and with spring and fall migrations.

Ackerman's review of water control structure-related mortality trends and patterns demonstrated a tendency for such deaths to occur more frequently in the spring and fall, (Table 4). As discussed in Odell and Reynolds (1979), these periods coincide with periods of greatest rainfall in this area and, similarly, with greatest water control structure activity. Ackerman *et al.* (1994) also concluded that, in comparison with other causes of death, water control structure-related mortality included significantly more adults than did other causes. Furthermore, more males died in these structures than did females. These conclusions are generally consistent with observations made during earlier reviews of the mortality databases (Ackerman *et al.*, 1992; O'Shea *et al.*, 1985; Odell and Reynolds, 1979).

Researchers with the manatee carcass recovery program attribute manatee deaths to water control structures if the carcass was recovered at or near a water control structure and one or more of the following criteria apply:

1. External scrapes, impressions, and bruises may be present anywhere on the body, particularly if concrete walls, bottoms, or sills are present. Distinct impressions of gate edges are sometimes present (Bonde *et al.,* 1983).

2. Massive internal trauma involving broken and/or disarticulated ribs and shock syndrome (*eg.*, infiltration of blood vessels, haemotomas, and ischemia) may be present (O'Shea, 1983). Internal trauma may be coincident with external traumatic findings.

3. Drowning and an absence of hemorrhaging (Bonde *et al.*, 1983).

While these deaths have been carefully documented, the circumstances by which these manatees have died are not completely known. Reynolds and Odell (1979) theorized that manatees upstream of the water control structures become entrained by strong water currents which develop when structure gates open. The entrainment may draw the animal against the gate and then downward to the gate opening. If the opening is too narrow for the manatee to pass through, the manatee would be pinned in the opening, thus drowning the animal. A carcass pinned against a gate opening often displays scrapes, impressions, and/or bruises consistent with concrete walls, bottoms or sills, if present. Reynolds and Odell (1979) further postulated that crushing may be a secondary event, occurring after a manatee had been trapped and drowned. (Dade County [1994] reported that approximately 15% of water control structure-related mortality known to have taken place in Dade County was attributable solely to drowning).

The passage of manatees through closing structures may also result in manatees becoming entrapped and drowned. Reynolds and Odell (1979) stated that when the downstream current was weak, manatees were observed to swim upstream through a wide open gate. They also described the passage of a female downstream through a gate, an event motivated by the separation of that animal from its calf. Mobley (1994) described the passage of a large manatee through a closing gate. This manatee was pursuing two smaller manatees and went through a gate opening estimated at 20 inches. The manatee apparently turned sideways and pushed through, as evidenced by black markings observed on its flanks. Given such actions, manatees appear to be susceptible to entrapment while swimming through closing gates.

Navigation locks utilize paired doors (sector gates) which, when opened, withdraw into recesses built into the lock bulkheads. Interviews with Corps' personnel have demonstrated that these recesses accumulate floating vegetation and are prone to algal growth. Manatees have been seen foraging within the recesses and have been seen moving about within these structures (Gren, 1981). When the doors close, the doors press against the bulkheads and may crush animals found within the recesses. Closing lock doors may entrap and entrain manatees in a fashion similar to that postulated for gate structures (Frohlich and Bonde, 1983).

Within Broward and Dade Counties, 50 manatees have been killed in water control structures during the 1974 through September 30, 1994 period. Structures S-27 and S-29, on the Miami and Little Rivers respectively, have been implicated in the deaths of 27 manatees. Other structures accounting for more than 5 deaths per structure include S-22 and S-25B in Dade County. These deaths have occurred throughout the year, with most deaths during spring and fall, (Table 5).

Water control structures within the Okeechobee Waterway have killed 43 manatees during the same period. Heaviest mortality has been associated with the St. Lucie Lock and S-80 Spillway and with the Ortona Lock and S-78 Spillway (11 and 14 mortalities, respectively). The Port Mayaca Lock and S-308C Spillway and the Moore Haven Lock and S-77 Spillway have also caused manatee deaths. Deaths within these waterways have occurred throughout the year and are known to peak during the spring and fall, (Table 6).

4.0 Mortality Reduction Strategies

Subsequent to the 1979 meeting, agencies and researchers have been involved in numerous efforts to reduce mortality associated with water control structures. Mortality reduction strategies have included efforts to delay gate operations, "shooing" manatees away from structures, and deployment of remotely operated reversal mechanisms. Water control structure-related mortality declined during the mid-1980's. It was thought that this decline

Table 5. **Annual Water Control Structure-related Mortality (1974 through December 31, 1994) at Selected Water Control Structures within the South and Central Florida Flood Control Project Area (Broward and Dade counties).**

Broward County

Structure	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	T
S-13	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	3
S-33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

Dade County

Structure																						
S-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	3
S-22	0	0	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
S-25B	0	0	1	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	7
S-27	0	0	0	1	0	0	1	0	1	0	0	1	0	1	6	0	1	0	0	1	2	15
S-28	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
S-29	0	0	1	3	2	4	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	12

Table 6. **Annual Water Control Structure-Related Mortality (1974 through December 31, 1994) at Selected Structures within the Okeechobee Waterway area (Martin, Okeechobee, and Glades counties).**

Martin County

Structure	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	T
S-80	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	2	0	1	1	1	1	11
S-135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
S-308	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	5

Okeechobee County

Structure																						
Henry	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
S-193	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	2	7

Glades County

Structure																						
S-77	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	3	5
S-78	0	0	0	0	0	0	1	1	0	2	1	0	0	1	1	0	0	0	0	1	6	14

had been brought about by the implementation of successful mortality reduction efforts. However, despite this brief lull, mortality associated with water control structures persists.

4.1 Deterrents

In order to distract manatees from gates and doors, agencies and researchers have tested and implemented a variety of "disturbance" techniques. Initial efforts to drive manatees away from the structures were "not very successful" (precise methods used are unknown)(Mierau, 1991). Bubble screens were reviewed by both the Service and the Corps as a possible method by which to "scare" manatees away from gates and doors.

Brownell *et al.* (1981), Odell and Reynolds (1979), and Kinnaird (1983) theorized that, inasmuch as some manatees demonstrate a fear response to bubbles generated by SCUBA regulators, a bubble screen may provide an effective means with which to repel manatees from certain areas. The Corps installed bubble screens at the Franklin Locks (Lee County) and at the Buckman Locks (Putnam County) (Milleson, 1985; Bowman, 1991). The bubble screens were made up of dispersion tubes with holes in them; an air compressor was used to force air through the tubes. At the Buckman Locks, the screens were activated prior to lock operations.

The Corps, citing observations made by lock operators, determined that these devices were not an effective deterrent. Some operators thought that manatees "played" in the bubbles and that they were thus attracted to them. Other operators concluded that manatees were alerted by the bubbles to door operations and that it brought manatees to the doors. Bowman (1991) cited a perceived decrease in the number of manatees in Lake Ocklawaha and the number of manatees locking through the Buckman Locks; he speculated that this decrease may be attributable to the bubble screens.

Kinnaird (1983) and Brownell *et al.* (1981) considered the use of sound as an acoustic repellent. The broadcasting of high intensity sounds above a certain threshold is known to elicit avoidance response in certain marine mammals. The effectiveness of such methods is highly variable among species. Cursory efforts were made to investigate the effect of high intensity sounds on manatees (Kinnaird, 1983). These initial investigations elicited no response from the manatees. Further investigation into manatee hearing capacities has been conducted by Gerstein *et al.* (1994). Hearing ranges were determined for a single manatee. The manatee appeared to be sensitive to high frequency sound. This sensitivity may provide an opportunity with which to deter manatees from fixed locations such as canals and water control structures. The effectiveness of this method will require additional research.

4.2 Barriers

The use of fixed barriers to restrict manatees from specific sites has been reviewed and implemented by various agencies and researchers. Fixed barriers keep manatees from reaching certain sites. The permanent exclusion of manatees from certain habitats has been cited as a concern with these structures. Other difficulties associated with these barriers are primarily related to maintenance and cost.

An initial assessment of these structures was conducted by Odell and Reynolds (1979), who evaluated a mechanical barrier placed downstream of a water control structure in Dade County. The barrier was effective in preventing manatees from accessing the structure. However, despite the barrier's self-cleaning design, the barrier accumulated large amounts of trash which threatened gate operations. Other designs such as that at the Moore Haven water control structure experience similar problems, particularly with the accumulation of vegetative debris (Holand, 1994). Navigation lock door recesses have been successfully screened to keep manatees from accessing these sites. Barriers designed to preclude manatees from power plants, mill effluents and drainage pipes have failed due to bars and screens having rusted out (Valade, pers. obs.).

Redesigning water control structures to discharge water over the top of a gate may also effectively preclude manatees from accessing water control structures and upstream areas. Costs associated with the design, demolition of existing structures, and construction of these new structures are thought to be prohibitive (Mierau, 1994).

Barriers, if properly maintained, are effective in their ability to exclude manatees from certain areas. Barriers will prevent manatees from being killed in water control structures. These devices will need to placed at some structures in order to fully eliminate this source of mortality. The resultant loss of habitat will need to be weighed against the benefit of eliminating mortality.

4.3 Operating procedures

To avoid the entrainment of manatees against water control structure gates, gates at various structures have been programmed to open to an initial height of 2.5 feet. It is believed that, with an opening of this height, manatees will be swept through the structure without being held against the opening. Water control structure-related mortality declined after this strategy was employed; these procedures were thought to be an effective mortality reduction strategy. However, mortality subsequently increased. It was initially thought that a "yo-yo" effect (i.e., an increase in the number of openings and closings) was responsible for these increases in mortality. To minimize the number of operations, a computer algorithm was designed to decrease the number of oscillations and, thereby, the degree of risk to manatees travelling through the structures. While these algorithms have

minimized the number of gate operations, the algorithms did not effectively reduce mortality (Markley *et al,*. 1994).

The Corps has developed a draft "Manatee Protection Plan for Water Control Structures Operated by the Jacksonville District, U.S. Army Corps of Engineers" (1994). This draft provides "policies, guidelines, and operating procedures for the effective long-range management of water control structures ... to minimize manatee risk." Operating procedures described in this plan require close visual monitoring of structures for manatees by lock tenders and the implementation of avoidance strategies, as needed.

4.4 Detection devices

Detection methods have been evaluated as a means by which to locate and to prevent injury and death to manatees. Such methods include the use of sonar to locate manatees and the use of remotely operated reversal mechanisms to sense the presence of manatees.

A variety of sonar devices have been evaluated for their potential to detect manatees. Kinnaird (1983) stated that such units were highly variable in their ability to locate manatees. Kinnaird's review summarized the findings of three investigators, one of whom reported the "reliable and successful detection of manatees" and two others who, using the same unit, could not detect manatees. Kinnaird further investigated a separate unit with similar, mixed results. In 1983, Kinnaird stated that "this technology does not appear to be a viable or practical management option." She additionally stated that "new, more sophisticated units that may be developed in the future" will warrant additional testing and consideration. SFWMD subsequently tested a sonar device. Test results were once again inconclusive, although the device's inability to operate in turbulence was of particular note (Mobley, 1994).

To avoid crushing manatees in water control structures, reversal mechanisms have been deployed with mixed results. These devices rely upon a pressure switch which, when triggered by the presence of an object such as a manatee, cause structure gates to open and to avoid crushing the object. Some navigation lock doors have an automatic shut-off switch that stops the doors when they meet resistance. Testing of these switches has demonstrated that these switch sensitivities are inadequate to prevent the crushing of manatees (Frohlich and Bonde, 1983). SFWMD has developed and deployed pressure sensitive devices. These pressure sensitive devices are more sensitive than the lock door switches and have been observed to open gates when they encounter manatees (Mobley, 1994). Subsequent to the installment of these devices on the S-27 water control structure in 1992, two manatees have been crushed, thus raising questions about the effectiveness of these devices, or at least the current design.

5.0 Selected plans

For the purposes of the 1135(b) study, the Corps reviewed several mortality reduction strategies as possible solutions to the problem of water control structure-related manatee mortality. The Corps considered deterrents (bubble curtains), barriers (folding screens and over the top control gate structures), and detection devices (including reversal mechanisms). The Corps elected to pursue the installation of reversal mechanisms at both gates and doors of selected water control structures, (Table 1).

The reversal mechanism selected for this study involves a variation on SFWMD's pressure sensitive device. Instead of using reed switches, the Corps proposes to use a urethane enclosed foil strip to activate a manatee protection circuit. The activated circuit will cause a lowering gate or closing door to reverse and/or trigger an audio/visual alarm when a manatee is present.

Automated vertical gates will open to 2.5 feet when triggered and will continue to open and close until the manatee either passes through the gate or when the gate closing reaches 2". A manually operated gate will stop when the device is triggered; the gate operator will then control the closure. When a manatee comes in contact with a closing navigation lock door, a switch will be triggered, alerting the lock operator to increase the door aperture as needed.

The Corps proposes to initially dry test each of the installations. Operational checks will then be conducted daily as part of the Draft Manatee Plan for Water Control Structures. Biannual maintenance will then occur and the structures will be monitored for effectiveness.

6.0 Review of selected plans

In order to eliminate water control structure-related manatee mortality, the Corps has elected to install reversal mechanisms on structures associated with manatee mortalities. This technology may prove to be an effective means by which to reduce or eliminate this cause of mortality. However, because mortality has been associated with structures outfitted with a current version of this device, consideration of this device as the only solution to this problem may be unrealistic. Other strategies may offer alternatives to these devices. Serious consideration should be given to the development and construction of barriers at selected water control structures where manatees will not be restricted from accessing important habitat.

7.0 Recommendations

1. While there are problems associated with the current reversal mechanism prototype, it is apparent that such devices have the potential to reduce manatee mortality. While the Corps has proposed to fit all selected structures with these devices, it may be prudent to install these mechanisms on a limited number of structures and to thoroughly test and monitor their effectiveness prior to installation on all structures.

2. In its selection of this plan, the Corps reviewed and elected not to pursue alternative plans and methodologies. The Service recommends that the Corps investigate other mortality reduction methods and that the Corps implement these as appropriate. Consideration should be given to building permanent barriers, such as those proposed on an emergency basis for the Ortona Spillway, at other similar structures. Acoustical deterrents should also be re-evaluated, particularly in light of recent studies which have better assessed manatee hearing capabilities. New advancements in sonar or other passive underwater detection methods may warrant further investigation (Dickerson, 1994).

3. Certain navigation lock structure recesses have been screened to prevent manatee access. While most structures have been screened, the status of each should be reviewed and, in the event that screening is absent or in need of repair, new screening should be installed.

4. The Corps selected 23 water control structures for this study. Chosen sites reflected incidences of manatee mortality or structural similarities with structures known to have killed manatees. The Henry Creek Lock, a structure located on the northeastern shore of Lake Okeechobee, is known to have killed a manatee in 1985. This structure should be included in this study.

5. While not addressed in this review, manatees are known to have been killed by watercraft operating in the vicinity of water control structures. Speed zones have been established at some of the structures. Caution signs have also been posted near certain structures and awareness materials are being distributed to alert watercraft operators of the presence of manatees. These efforts should be reviewed and, if needed, supplemented to further reduce manatee mortality.

6. Any construction activity associated with this effort should follow the Standard Manatee Construction Precaution Guidelines.

8.0 Conclusions

Water control structures are a significant source of manatee mortality. While there have been numerous efforts to reduce the number of structure-related deaths, these deaths continue to occur. Mathematical models suggest that increases in manatee mortality by even a few individuals could easily have a significant, adverse effect on the future of the manatee (Marmontel, 1994). By eliminating this source of mortality, the future of the manatee will be on a more secure footing. The Section 1135(b) study proposed by the Corps is a means by which to reduce or eliminate water control structure-related mortality. The installation of pressure-sensitive devices on selected structures may provide a partial solution to this problem. Other alternatives should be considered and additionally implemented, if appropriate. The Service recommends that permanent barriers be installed on all structures where the installation will not restrict the manatee's access to essential habitat.

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FINAL
ENVIRONMENTAL ASSESSMENT

MANATEE PROTECTION PLAN AT SELECTED NAVIGATION AND WATER CONTROL STRUCTURES IN CENTRAL AND SOUTHERN FLORIDA PART I

ATTACHMENT B

TABLES

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE, DISTRICT

SEPTEMBER 1995

CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL PROJECT AREA (TABLE EA-B-1)

STRUCTURE	LOCATION	OPERATED BY/ DATE CONSTRUCTED	GATE TYPE
S-27	Dade Co.	SFWMD/1958	VERTICAL
S-29	Dade Co.	SFWMD/1953	VERTICAL
S-22	Dade Co.	SFWMD/1956	VERTICAL
S-28	Dade Co.	SFWMD/1962	VERTICAL
S-13	Broward Co.	SFWMD/1954	VERTICAL
S-25B	Dade Co.	SFWMD/1976	VERTICAL
S-26	Dade Co.	SFWMD/1974	VERTICAL
S-20F	Dade Co.	SFWMD/1967	VERTICAL
S-33	Broward Co.	SFWMD/1954	VERTICAL
S-25	Dade Co.	SFWMD/1976	VERTICAL
S-21	Dade Co.	SFWMD/1961	VERTICAL
S-21A	Dade Co.	SFWMD/1966	VERTICAL
S-20G	Dade Co.	SFWMD/1966	VERTICAL
S-123	Dade Co.	SFWMD/1963	VERTICAL

OKEECHOBEE WATERWAY STRUCTURES (TABLE EA-B-2)

STRUCTURE	LOCATION	OPERATED BY/ DATE CONSTRUCTED	GATE TYPE
S-308C Spillway	Martin Co.	CESAJ/1977	VERTICAL
S-77 Spillway	Glades Co.	CESAJ/1935	VERTICAL
S-135	Martin Co.	SFWMD/1969	VERTICAL
S-79 Spillway	Lee Co.	CESAJ/1965	VERTICAL
S-127	Glades Co.	SFWMD/1963	VERTICAL
S-131	Glades Co.	SFWMD/1963	VERTICAL

FINAL
ENVIRONMENTAL ASSESSMENT

MANATEE PROTECTION PLAN AT SELECTED NAVIGATION AND WATER CONTROL STRUCTURES IN CENTRAL AND SOUTHERN FLORIDA PART I

ATTACHMENT C

COMMENTS AND RESPONSES

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE, DISTRICT

SEPTEMBER 1995

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702

May 30, 1995

Colonel Terry Rice
District Engineer, Jacksonville District
Department of the Army, Corps of Engineers
ATTN: CESAJ-PD-PF
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Rice:

This responds to your letter, dated May 5, 1995, requesting comments regarding the Draft Project Modification Report and Environmental Assessment (EA) for Manatee Protection Plan (Part 1) at selected Okeechobee Waterway and Central and Southern Florida navigation locks and water control structures.

1. The National Marine Fisheries Service (NMFS) has reviewed the document. In our assessment of the project, coordinated with the U.S. Fish and Wildlife Service (FWS), we have concluded that the work could adversely impact fishery resources for which the National Marine Fisheries Service (NMFS) is responsible. Therefore, comments and recommendations submitted to you by the FWS also represent those of the NMFS.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

cc:
Mr. A. J. Salem
Chief, Planning Division
Department of the Army, Corps of Engineers
Flood Control and Flood Plain Management
P.O. Box 4970
Jacksonville, Florida 32232-0019

F/SEO2
F/SEO23-MIAMI

CORPS RESPONSE:

1. Comments and recommendations by the U.S. Fish and Wildlife Service (USFWS) were incorporated into the document throughout its development. Because this is an endangered species issue, every facet of this report and its implementation will continue to involve close coordination with the USFWS.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1875 Century Boulevard
Atlanta, Georgia 30345

JUN 30 1995

Mr. A. J. Salem
Chief, Planning Division
Environmental Studies Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

The Fish and Wildlife Service (Service) has reviewed the Draft Project Modification Report and Environmental Assessment, Manatee Protection Plan (Part 1) At Selected Navigation and Water Control Structures in Central and Southern Florida.

Water control structures are a significant cause of human-related manatee deaths, second only to those caused by watercraft. We commend the Army Corps of Engineers (Corps) for reviewing alternate ways to reduce the number of deaths associated with these structures through the Section 1135(b) process of the Water Resources Development Act of 1986.

We support the Corps' efforts to reduce manatee mortality associated with water control structures. The design, construction, and deployment of the selected devices together with implementation of proposed operational protocols should significantly reduce manatee deaths. This is consistent with the recovery goal for the endangered Florida manatee in the Service's Florida Manatee Recovery Plan.

We offer the following comments and recommendations for your consideration:

1. The number of structures identified in this report (20) represents a decrease in the number of structures identified in your initial letter (23). In our Coordination Act Report dated January 24, 1995, we recommended that the Henry Creek Lock, a structure identified as a source of mortality, be included in the list. This would bring the list of structures to be studied to 24.

2. We recommend that the use of lock structure recess screens (a mortality reduction device) and their repair, maintenance, and installation be included as an alternative.

3. The report should address the status of speed restrictions and signage at the locks as a means to further reduce mortality.

4. The report addresses the use of permanent barriers as a possible alternative in its discussion of "Related Project Conditions." In "Project Conditions," where previous operational improvements and modifications are described, the report states that a barrier prototype was abandoned because it interfered with manatee travel and habitat use patterns. However, it is our understanding that the prototype was discarded because of problems associated with debris collecting on the barrier. Although there are some problems associated with permanent barriers, it should be noted that these devices will eliminate the possibility of manatee mortality at water control structures in which they are installed by preventing manatees from reaching gate mechanisms. The Service encourages the use of barriers at locations where they will not prohibit manatee access to essential habitat.

5. The "Project Operations Manatee Protection Plan" describes operating protocols for the Franklin Lock bubbler curtains. Bubbler curtains are discounted as a viable manatee deterrent in the "Selection Process/Alternative Evaluation" section. This protocol should be eliminated from the operations plan.

6. In the reports' stated purpose, the Service's Florida Manatee Recovery Plan is described as a requirement of the Marine Mammal Protection Act. The recovery plan is a requirement of the Endangered Species Act of 1973, as amended.

Thank you for the opportunity to review and comment on this important proposal.

Sincerely yours,

Noreen K. Clough

Noreen K. Clough
Regional Director

CORPS RESPONSE:

Because of duplicate comments, all U.S. Fish and Wildlife Service comments are addressed on page EA-C-4.

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

July 6, 1995

ER-95/362

Mr. A. J. Salem
Chief, Planning Division
Environmental Studies Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

The U. S. Department of the Interior has reviewed the Draft Project Modification Report and Environmental Assessment, Manatee Protection Plan (Part 1) At Selected Navigation and Water Control Structures in Central and Southern Florida as requested.

Water control structures are a significant cause of human related manatee deaths, second only to those caused by watercraft. As noted in the subject document there have been 16 manatee deaths attributed to water control structures in 1994, making that year the worst since record keeping began in 1974. The 1994 mortality attributed to water control structures is a 220% increase over the previous year. We encourage the efforts of the U.S. Army Corps of Engineers (Corps) to review alternative ways to reduce the number of deaths associated with these structures through the Section 1135(b) process of the Water Resources Development Act of 1986.

We support the Corps' efforts to reduce manatee mortality associated with water control structures. The design, construction, and deployment of the selected devices together with the implementation of proposed operational protocols should significantly reduce manatee deaths. This is consistent with the recovery goal for the endangered Florida manatee in the Fish and Wildlife Service's Florida Manatee Recovery Plan.

We offer the following comments and recommendations for your consideration:

The number of structures identified in this report (20) represents a decrease in the number of structures identified in your initial letter (23). In the Fish and Wildlife Service Coordination Act Report dated January 24, 1995, it was recommended that the Henry Creek Lock, a structure identified as a source of mortality, be included in the list. This would bring the list of structures to be studied to 24.

2. We recommend that the use of lock structure recess screens (a mortality reduction device) and their repair, maintenance, and installation be included as an alternative. This would more fully address the range of alternatives available to the Corps in their efforts to reduce manatee mortality.

3. The report should address the status of speed restrictions and signage at the locks as a means to further reduce mortality.

4. The report addresses the use of permanent barriers as a possible alternative in the discussion of "Related Project Conditions." In "Project Conditions," where previous operational improvements and modifications are described, the report states that a barrier prototype was abandoned because it interfered with manatee travel and habitat use patterns. However, it is our understanding that the prototype was discarded because of problems associated with debris collecting on the barrier. Although there are some problems associated with permanent barriers, it should be noted that these devices will eliminate the possibility of manatee mortality at water control structures in which they are installed by preventing manatees from reaching gate mechanisms. The Service encourages the use of barriers at locations where they will not prohibit manatee access to essential habitat.

5. The "Project Operations Manatee Protection Plan" describes operating protocols for the Franklin Lock bubbler curtains. Bubbler curtains are discounted as a viable manatee deterrent in the "Selection Process/Alterative Evaluation" section. This protocol should be eliminated from the operations plan.

6. In the stated purpose of the report, the Service's Florida Manatee Recovery plan is described as a requirement of the Marine Mammal Protection Act. The recovery plan is a requirement of the Endangered Species Act of 1973, as amended.

7. We agree that pressure sensitive gate reversal devices may be the most effective means of reducing or eliminating mortality at water control structures. Since some mortality has been associated with these devices we recommend that a limited number of these gates be installed and tested before wide application.

8. We disagree with the proposal for construction from November 1 through May 31. In some locations (Dade County) manatee activity peaks during this period. The timing of installation should determined on a site by site basis to avoid locations and times of peak manatee activity.

9. The current proposal does not include enough objective information on flood constraints, gate operations, costs and engineering limitations to dismiss an "over the top" discharge alternative. If the current study authorization does not permit consideration of such an alternative then we recommend a separate or modified study authorization. In accordance with Council on Environmental Quality guidelines on alternatives (40 CFR, Section 1502.14) agencies are required to provide for development and review of reasonable alternatives including those not currently within agency jurisdiction.

10. We suggest that the Corps include in the document a discussion of the opportunities and limitations for eliminating structure caused manatee deaths that may result from the Central and South Florida Comprehensive Restudy. While the study is far from complete, a recurring theme has been to redesign and operate in such a manner as to keep water in the system and minimize loss to tide. This suggests a future reduction in structure activity and a potential concomitant reduction in structure related mortality.

We request that you add the following to your mailing list:

Superintendent
Biscayne National Park
P. O. Box 1369
Homestead, FL 33090

Thank you for the opportunity to review and comment on this important proposal.

Sincerely,

James H. Lee
Regional Environmental Officer

CORPS RESPONSE:

1. The total number of structures selected for study is twenty-seven. Twenty vertical lift structures are addressed in Part I and seven sector-gated structures are addressed in Part II. The total number of structures is actually an increase from the originally authorized twenty-three structures. The Henry Creek Lock was deleted from the study because it was neither operated nor constructed with federal funds at any time in the past. The Section 1135 authorization for the construction phase of this project clearly states that the funding is only for structural changes to a "federal" project for environmental restoration.

2. The lock structure recess screens are used exclusively on sector-gated structures. We concur that these screens be listed as an alternative in the Part II report which identifies manatee protection measures at sector-gated locks.

3. A short section on speed restrictions was added to the report. Although our established "No Wake" zones in the vicinity of our locks and spillways benefit manatees, these zones were established for public safety. Because the Corps has no regulatory guidance to establish and police manatee zones, we did not address this issue further in the report.

4. The Corps is committed to investigating the use of spillway barriers at locations where the barriers would not impede manatee access to essential habitat. At present, all spillways (consisting of vertical lift gates) with adjacent Navigation locks are being investigated for the feasibility of barriers. S-78 and S-80 (Ortona and St. Lucie locks respectively) have both been investigated and a feasible design was developed for implementation. The further installation of barriers at other applicable structures will be coordinated in the near future.

5. We concur with this recommendation and have eliminated the bubble curtain from the Operations plan.

6. We concur with this recommendation and the appropriate revisions have been incorporated into the document.

CORPS RESPONSES CONTINUED:

7. The Corps concurs with this comment and will install the Pressure Sensitive Devices in a cautious, phased approach. Extensive testing will transpire prior to the final selection of the switch; and once installation begins, a few select gates will be retrofitted prior to a wider installation of the devices.

*8. There will be a **flexible** implementation schedule for the installation of the PSDs on the spillway structures. Despite the plan for implementation in the report, the Corps is committed to being sensitive to important manatee aggregation periods during the winter months to avoid risk and injury to manatees as a consequence of construction activities.*

9. "Over the Top" structures have been investigated preliminarily for this study. The documentation can be found in the "Description of Alternatives" section of the main report. Past experience has presented many engineering challenges to utilizing these type of structures in Central and Southern Florida (C&SF). Further detailed analysis on "Over the Top" structures, if deemed appropriate, will be conducted at a later date under a separate study authority. In the future, the Corps will be investigating other avenues of funding to redesign structures in C&SF.

10. The C&SF Comprehensive Review Study will not specifically evaluate the elimination or modification of water control structures for the purpose of eliminating manatee incidents. This Manatee Protection Project Modification Report was authorized for that purpose. In the C&SF Comprehensive Review Study, the modifications in the operation of certain structures may reduce the potential for incidents involving manatees. All recommendations and plans resulting from this Manatee Protection Study (which will be completed well in advance of the C&SF Comprehensive Review Study) will be incorporated into the C&SF Comprehensive Review Study.

South
Florida
Regional
Planning
Council

June 2, 1995

A. J. Salem, Chief
Planning Division, Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019
Attention: CESAJ-PD-PF

RE: SFRPC #95-0527, USACE request for public comments regarding the implementation of a proposed Manatee Protection Plan at selected (20) navigation and water control structures, Central and Southern Florida.

Dear Mr. Salem:

We have reviewed the above-referenced plan and have the following comments:

- Council staff has reviewed the completed Draft Section 1135 Project Modification Report and Environmental Assessment. Staff continues to be supportive of efforts intended to reduce manatee mortality rates related to the operation of navigation and drainage structures, as well as other human activities. We would therefore be interested in participating and assisting in coordination efforts within our region. The program goals and objectives stated in the Project Modification Report are generally consistent with the goals and policies included in our Regional Plan.

- The goals and policies of the *Regional Plan for South Florida*, specifically pertaining to the proposed Manatee Protection Plan, are provided below for your information.

GOAL 10.1 Beginning in 1991, maintain or increase the percentage of the area of natural systems in the Region based on the area documented in local government comprehensive plans.

Policy 10.1.6 Maintain or enhance existing upland buffers along the Region's waterways to provide wildlife corridors, prevent erosion, filter runoff, and preserve natural aesthetics.

Policy 10.1.7 Discourage incompatible development and human encroachment in and around areas that have been identified as unique and important natural plant or animal communities.

GOAL 10.3 To improve the status of five percent of the threatened and endangered species reduce the number of species becoming extinct in the Region by 1995.

Policy 10.3.1 Discourage activity reducing or adversely altering the habitat of an endangered or threatened species or species of special concern.

Policy 10.3.4 Coordinate the efforts of agencies involved in regulation of endangered species programs to ensure the survival of threatened and endangered species.

3440 Hollywood Boulevard, Suite 140, Hollywood, Florida 33021
Broward (305) 985-4416, Area Codes 305 and 407 (800) 985-4416
SunCom 473-4416, FAX (305) 985-4417, SunCom FAX 473-4417

Policy 10.3.5 Develop public education programs regarding habitat and behavior of endangered and threatened species to inform the public of potential hazardous actions to these organisms.

Policy 10.3.8 In the review process, developments which contain potentially significant habitat or species shall, at a minimum, be required to:

a) inventory the site with an approved methodology and provide the results of the survey to reviewing agencies; and

b) either preserve the habitat of the species with appropriate buffers or relocate the species and habitat if determined acceptable by the U.S. Fish and Wildlife Service and the Florida Game and Freshwater Fish Commission.

All inventories must occur during the time of year that the anticipated species or plant community may be observed.

GOAL 10.4 By 1995, reduce man-induced manatee deaths by 25 percent.

Policy 10.4.1 Local, regional, state and federal agencies should coordinate the approval of development and the formulation of resource protection plans to reduce human-related manatee mortality and prevent the continuing loss or degradation of manatee habitat.

Policy 10.4.2 Use data from aerial surveys and other monitoring programs to develop site-specific vessel speed restrictions to protect manatees.

Policy 10.4.3 Investigate structural, operational, or other methods for reducing manatee mortality caused by flood control structures and locks.

Policy 10.4.4 Assist in the development and distribution of public education materials including brochures, charts, public service announcements, signs, and K-12 school lesson plans.

Policy 10.4.5 Any activity that has an adverse impact on manatees or their habitat shall be prohibited or mitigate their impacts.

Thank you for the opportunity to comment. We would appreciate being kept informed on the progress of this plan and results of its implementation. Should you need any further assistance, please do not hesitate to call us.

Very truly yours,

Gerson M. Garcia

Gerson M. Garcia, AICP
Regional Planner

GMG/mj

STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

2740 CENTERVIEW DRIVE • TALLAHASSEE, FLORIDA 32399-2100

LAWTON CHILES
Governor

LINDA LOOMIS SHELLE
Secreta

July 28, 1995

Mr. A. J. Salem
Department of the Army
Corps of Engineers
Jacksonville District
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: Endangered Species Protection - Manatee Protection Plan (Part 1) - Draft Project Modification Report and Environmental Assessment - Florida
SAI: FL9505080422C

Dear Mr. Salem:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Governor's Executive Order 93-194, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.

The Department of Environmental Protection (DEP) recommends that the final report include a detailed plan for testing the manatee protection devices and an analysis of the potential impacts to manatees from the entire flood control structure operating system. The DEP also suggests a flexible time table for construction. Please refer to the enclosed DEP comments for further details.

The South Florida Water Management District (SFWMD) recommends that permanent barriers and pressure sensing devices (PSDs) be further evaluated as alternatives for manatee protection. The PSDs should be subjected to additional field testing prior to large-scale installation. In addition, the SFWMD recommends an implementation schedule that includes work during the wet season. Please refer to the enclosed SFWMD comments for further details.

EMERGENCY MANAGEMENT • HOUSING AND COMMUNITY DEVELOPMENT • RESOURCE PLANNING AND MANAGEMEI

Based on the information contained in the above-referenced document and the enclosed comments provided by our reviewing agencies, the state has determined that the above-referenced project is consistent with the Florida Coastal Management Program. Please be advised that any additional comments which may be provided by our reviewing agencies will be forwarded to you as soon as they are received.

Very truly yours,

for Linda Loomis Shelley
Secretary

LLS/rk

Enclosures

cc: Susan Goggin, Department of Environmental Protection
Frank Lund, South Florida Water Management District
George Percy, Department of State
Wynnelle Wilson, Department of Commerce

CORPS RESPONSE:

1. Comments from State agencies are included separately from this letter in order to respond in more detail to specific comments by each organization. Please refer to the specific letters contained in this Comment & Responses section for the Corps' response.

Department of
Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

14 June 1995

RECEIVED
JUN 16 1995
Florida Coastal
Management Program

Suzanne Traub-Metlay
State Clearinghouse
Office of Planning & Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399-0001

RE: USCOE/Manatee Protection Plan (Part 1), Draft Modification Report and Environmental Assessment
SAI: FL9505080422C

Dear Ms. Traub-Metlay.

The Department has reviewed the proposed Manatee Protection Plan (Part 1) as proposed by the U.S. Army Corps of Engineers (Corps), and we find it consistent with our authorities in the Florida Coastal Management Program. Staff of the Department's Office of Protected Species Management (OPSM) have been actively involved in this project for a number of years. Kipp Frohlich serves as the DEP representative on an interagency task force created to solve the problem of structure-caused manatee mortality. He indicates that the subject draft report is a very thorough presentation of information on the water control structures in South Florida as well as a compilation of manatee related data. While overall the project as outlined in the subject document is a sound approach to reaching the goal of zero structure-caused mortality, OPSM staff offer the following comments and recommendations on the draft Plan:

1. We believe that pressure sensitive devices that will reverse the direction of a closing gate hold the most promise in our efforts to eliminate structure-caused manatee mortality. However, they are not a proven solution. As is mentioned in the report, there have been manatees killed at some structures equipped with these devices. The report needs to go into greater detail assessing why the pressure sensitive devices have failed in the past and should provide recommendations on what steps should be taken to correct problems with the system. Past experience has shown problems with the plungers, but also in other components of the system. The report needs to carefully examine the entire flood control structure operating system including the telemetry system, the control switches and logic switches in the control house, control room protocols, as well as

any overrides. In addition, the report should evaluate how power outages or loss of communication in the telemetry system could possibly affect performance.

2. Because this technology is experimental, it needs to be rigorously tested. The most significant shortcoming in the 1135 proposal is that it inadequately addresses testing of the manatee protection devices. The report should outline in detail the types of tests that will be performed to document that the pressure sensitive devices are working satisfactorily. Testing should be done in actual field conditions with the gate fully operational. A mechanical test procedure should be developed; that is, a procedure where the plungers are physically depressed in a normal operating mode. This needs to be a procedure that is repeatable and that can be done by field staff. The report should describe in detail how these tests will be performed and should recommend a suitable test schedule. The draft test procedures as contained in Appendix C are a start but are inadequate.

3. We do not agree that construction should be limited to November 1 through May 31 for water control structures and between May and September for navigation structures. We believe that a flexible implementation schedule should be developed that would allow gates or locks to be worked on any time during the year, as weather and water level conditions permit.

We appreciate the opportunity to provide comments on the Draft Modification Report and Environmental Assessment of the Manatee Protection Plan. Questions regarding these comments should be directed to Kipp Frohlich, OPSM, at (904)922-4330. If I may be of further assistance, please call me at 487-2231.

Sincerely,

Susan Goggin

Susan Goggin
Environmental Specialist, MS 47
Office of Intergovernmental Programs

KF/seg
cc: Kipp Frohlich, OPSM
Linda McCarthy, SFWMD
Fritz Wettstein, Marine Resources
Herb Zebuth, DEP Southeast District

FLORIDA DEPARTMENT OF STATE
Sandra B. Mortham
Secretary of State
DIVISION OF HISTORICAL RESOURCES
R.A. Gray Building
500 South Bronough Street
Tallahassee, Florida 32399-0250
Director's Office (904 488-1480
Telecopier Number (FAX) (904) 488-3353

June 6, 1995

Ms. Suzanne Traub-Metlay
State Clearinghouse
Executive Office of the Governor
Room 1603, The Capitol
Tallahassee, Florida 32399-0001

In Reply Refer To:
Robin D. Jackson
Historic Sites Specialist
(904) 487-2333
Project File No. 951770

RE: Cultural Resource Assessment Request
SAI# FL9505080422C
Manatee Protection Plan (Part 1) at Selected Navigation and Water Control Structures in Central and Southern Florida
Draft Project Modification Report and Environmental Assessment

Dear Ms. Traub-Metlay:

In accordance with the provisions of Florida's Coastal Zone Management Act and Chapter 267, Florida Statutes, as well as the procedures contained in 36 C.F.R., Part 800 ("Protection of Historic Properties"), we have reviewed the referenced project(s) for possible impact to historic properties listed, or eligible for listing, in the National Register of Historic Places, or otherwise of historical or architectural value.

A review of the Florida Site File indicates that no significant archaeological or historical sites are recorded for or likely to be present within the project area. Furthermore, because of the project location and/or nature it is unlikely that any such sites will be affected. Therefore, it is the opinion of this office that the proposed project will have no effect on historic properties listed, or eligible for listing, in the National Register of Historic Places, or otherwise of historical or architectural value. The project is also consistent with the historic preservation laws of Florida's Coastal Management Program.

If you have any questions concerning our comments, please do not hesitate to contact us. Your interest in protecting Florida's historic properties is appreciated.

Sincerely,

Laura A. Kammerer
for George W. Percy, Director
Division of Historical Resources
and
State Historic Preservation Officer

GWP/Jrj
xc: Jasmin Raffington, FCMP-DCA

STATE OF FLORIDA DEPARTMENT OF COMMERCE

Division of Economic Development

May 26, 1995

Ms. Janice L. Hatter, Director
State Clearinghouse
Office of Planning and Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399-0001

RE: SAI# FL 95 05 08 0422C (Manatee/P.M.R/E.A./C.O.E.)

Dear Ms. Hatter:

Thank you for asking the Florida Department of Commerce to conduct a consistency review of this Draft Project Modification Report (PMR) and Environmental Assessment (EA) on the Manatee Protection Plan from the U.S. Army Corps of Engineers (COE). The modification involves spending $2,409,000 on mechanical gates for locks and spillways which are designend to protect Manatee.

Based on those portions of the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.) and the Florida Coastal Management Program (Secs. 380.19-33, F.S.) for which the Department of Commerce has responsibility, we believe that the proposed plans and actions are consistent with criteria in Chapter 288, Florida Statutes: (1) no negative impacts on income and employment; (2) social costs are less than social benefits; (3) no adverse effects on any key Florida industry; and (4) official local agency support for the project.

Very respectfully,

Wynnelle Wilson
Economic Development Policy Coordinator
Bureau of Economic Analysis

WW/rdp

COLLINS BUILDING TALLAHASSEE, FLORIDA 32399-2000 TELEX 510/6002141 FL TRADE TAS

COUNTY: [illegible]

5/24/95

CLEARANCE DUE DATE: 7/7/95

SAI#: FL9505080422C

STATE AGENCIES	LOCAL/OTHER	OPB POLICY UNITS
Agriculture	Northwest Florida Water Manag. District	Education
✓Commerce	✓South Florida Water Manag. District	Environmental Policy/C & ED
Commission for Transport. Disadv	✓Southwest Florida Water Manag. District	General Government
✓Community Affairs	✓St. Johns River Water Manag. District	Health & Human Services
Corrections	Suwannee River Water Manag. District	Public Safety
Education		
Elder Affairs		
Environmental Protection		
✓Game and Fresh Water Fish Comm		
Health and Rehabilitative Services		
Highway Safety and Motor Vehicles		
Insurance		
Juvenile Justice		
Labor and Employment Security		
Law Enforcement		
✓Marine Fisheries Commission		
State		
✓Transportation		

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evaluation and is categorized as one of the following:

- Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.
- ✓ Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.
- Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.
- Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

RECEIVED
MAY 31 1995
Florida Coastal Management Program

FOR CONSISTENCY PROJECTS, SEE REVERSE SIDE FOR INSTRUCTIONS.

To: State Clearinghouse
Executive Office of the Governor -OPB
Room 1603, The Capitol
Tallahassee, FL 32399-0001
(904) 488-8114 (SC 278-8114)

Florida Coastal Management Program
Department of Community Affairs
Suite 305, Rhyne Building
2740 Centerview Drive
Tallahassee, FL 32399-2100
(904) 922-5438 (SC 292-5438)

EO. 12372/NEPA
- ☐ No Comment
- ☐ Comments Attached
- ☐ Not Applicable

Federal Consistency
- ☐ No Comment/Consistent
- ☒ Consistent/Comments Attached
- ☐ Inconsistent/Comments Attached
- ☐ Not Applicable

From: Florida Department of Commerce
Division of Economic Development
Division/Bureau: Bureau of Economic Analysis

Reviewer: R Peterson

Date: May 26, 1995

South Florida Water Management District

3301 Gun Club Road, West Palm Beach, Florida 33406 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 38-20

July 24, 1995

Mr. A. J. Salem, Chief
Planning Division
U. S. Army Corps of Engineers
Jacksonville District
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

Subject: Draft Manatee Protection Plan (Part 1) - Section 1135 Project Modification

We have reviewed the draft Manatee Protection Plan (Part I), and wish to compliment your staff on their efforts in developing this document. It represents an excellent summary of both C&SF Project-related manatee mortality problems and water control structure operations. In reviewing the Recommended Plan we would offer the following general comments and recommendations:

1. We note that the U.S. Fish and Wildlife Service (USFWS) Coordination Report requests that consideration be given to permanent barriers where access to essential habitat would not be denied. Our past efforts have been directed at alternatives which would permit access through all structures. This has been due to the nonsuccess of our previous barrier designs and the belief that open access was preferred for biological reasons. In view of the recommendation from USFWS, and the Corps' apparent success with barriers at Ortona, we also request that barriers be evaluated as a project alternative for sites determined to be nonessential for manatee access. We suggest that potential barrier sites be identified by the Manatee Interagency Task Force for further evaluation in the Protection Plan. The Plan should include an assessment of the relative merits of permanent barriers, consider specific site feasibility, determine the degree of manatee protection, and estimate total cost. The barrier alternative may then be compared to the proposed pressure sensing device (PSD) alternative to determine the best option at each of these structures.

2. We concur that pressure sensitive devices (PSDs) appear the most promising alternative for spillway gates which must be protected. However, as noted in the USCOE Plan and the USFWS Coordination Report, the current generation of PSDs should not be installed without

Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680

additional testing and refinement. Field testing has improved the reliability and effectiveness of these systems, but we remain concerned that their relative complexity may still require significant maintenance efforts. The proposed sensi-switch alternative has yet to be subjected to any field testing. The further evaluation of alternatives, such as the sensi switch, under prolonged field conditions is essential before we commit to an installation program on 20 or more structures. Ideally, the Part 1 Report could identify the optimum solution and a detailed implementation timeline; however, we agree that the current situation regarding reliability of any PSD alternative necessitates a more phased approach. We suggest that the plan be further clarified to note that no alternative will be selected for large-scale implementation without at least six months of field testing on a representative structure.

3. The Implementation Schedule proposed in this draft plan is somewhat vague with respect to timelines and specific installation sequencing. We strongly concur that installations should be given priority based upon relative threat to manatees; however, the relationship of this criteria to the three geographic contracts proposed, and the need for additional testing time, makes the actual project timeline unclear to us. We suggest that after candidates for structural barriers are identified, a more detailed work plan be developed for all structures. We appreciate that the draft document recognizes the necessity of insuring that this program does not disrupt critical maintenance obligations. We also believe that we can coordinate these two efforts at certain structures to both expedite manatee protection and minimize costs. Our Operations and Maintenance staff will be happy to assist your staff in developing a more detailed work plan.

4. We suggest that the Part I Report define the general timelines for testing, as well as, structure priorities and timelines. Detailed scheduling could be reserved for the Project Cost Agreement process and the results of further alternative testing. The Part I Report could be revised to reflect this sequence.

5. With respect to actual implementation scheduling, we urge that wet season work on multi-gate coastal structures be allowed. We have previously worked on our manatee systems during the summer months and have temporarily removed individual gates from active service, exercising care

to not compromise immediate flood control capabilities. If specific wet season conditions did permit PSD (or barrier) installation, this option might allow protection of Dade structures prior to arrival of a wintering manatee population. Limited wet season work might also avoid a possible 12-month delay in protecting some structures. PSD installation on single gated structures should be reserved for the dry season.

6. We examined the estimated costs for the PSD alternatives included in the draft plan. The estimated costs for the Reed switch system appears a reasonable projection based upon our experience with the system. In reviewing the estimated cost for the Sensi-switch system, we are uncertain if this estimate represents two strips, or only a single strip, on each gate. Based upon our experiences at S-27 and S-29, we strongly recommend the installation of two banks of switches on each gate. Our experience has shown that redundancy is essential in these systems for long-term reliability. We ask that the plan be clarified regarding this issue and estimated costs adjusted, if necessary.

7. In addition to the installation costs, life cycle costs of the selected alternative should include appropriate maintenance costs. As the local sponsor, we are obligated for these costs. The draft Plan largely focuses upon installation costs to be paid by the USCOE. We request that additional language be inserted in the draft Plan to make it clear that the selected alternative will be chosen based upon expected total life cycle costs, not solely installation expense.

We recognize that these are only preliminary cost estimates and acknowledge that the figures will be further adjusted as the selected alternative systems are tested and refined. However, the estimated project costs included in this plan fall well below the cost ceiling established by our Governing Board in May 1993, when they gave conceptual approval to acting as the local sponsor for this project. Based upon our previous Governing Board action and the information contained in the draft plan, we will proceed immediately with providing a Letter of Intent to participate in this project.

We hope these comments are helpful to your efforts. We sincerely appreciate the coordination efforts your staff have undertaken with our District staff in developing this document, and believe that it represents a critical step toward eliminating all C&SF Project-related manatee mortality.

Please contact Mr. Frank Lund, our Manatee Project Coordinator, if we can provide further assistance to your staff in revising the draft Manatee Protection Plan. We look forward to participating in the successful implementation of this program.

Sincerely,

Joseph A. Schweigart, P.E.
Director
Operations and Maintenance Department

c: Frank Lund
Kipp Frohlich, FDEP
Susan Markley, Dade DERM
Robert Turner, USFWS

CORPS RESPONSE:

1. At the last Interagency Task Force Meeting on Manatee Protection at Water Control Structures on September 7, 1995, the concept of installing barriers on additional vertical lift structures was discussed. At this time, the USFWS, DEP, and DERM would not commit to establishing any nonessential habitat for manatees in central and southern Florida. The Task Force preliminarily agreed at this meeting that all the canals and waterways are "essential" to the manatee. Further research by DEP staff will investigate limiting habitat or determining certain waterways "non-essential". In the near future it was agreed that the barriers would only be considered for vertical lift structures which were adjacent to Navigation Locks. This will ensure that manatees can continue travel and foraging routes even if access to the spillway is restricted.

2. We concur with this recommendation and it will be reflected in the Implementation Schedule in the Main Report.

CORPS RESPONSES CONTINUED:

*3. We concur with your comment. There will be a **flexible** implementation schedule for the installation of the PSDs on the spillway structures. Despite the plan for implementation in the report, the Corps is committed to being sensitive to important manatee aggregation periods during the winter months to avoid risk and injury to manatees as a consequence of construction activities. At the same time, we also wish to complete the installation in an efficient and economical fashion. The Implementation Schedule will remain flexible and dynamic throughout the study process to merge these two important priorities.*

4. We concur with your comment and have incorporated general timelines in the report. Once the report is approved by USACE Headquarters, the Corps will coordinate both the Implementation Plan and the Testing Timelines on a more detailed basis with SFWMD.

5. We concur with your comment and wish to stress that the Implementation Schedule will be flexible in order to accommodate changing water conditions, the wet season, peak manatee activity, and annual maintenance schedules.

6. The Corps also stresses the use of two banks of strips for the Sensi-Switch system on each gate to confidently protect manatees. The estimated costs listed in the report do reflect the costs of this redundancy feature.

7. We concur with your comment and have incorporated the appropriate wording into the document. The Corps' sleection of a recommended plan is based on a variety of factors, of which one is expected life cycle costs.

Department of
Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

June 8, 1995

Mr. A. J. Salem
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019
Attention: CESAJ-PD-PF

RE: Review SAI 95-0422C
Manatee Protection Plan (Part 1) at Selected Navigation & Water Control Structures in Central and Southern Florida

Dear Mr. Salem:

The Bureau of Protected Species Management has reviewed the subject report and finds it consistent with the Florida Coastal Management Program, the U.S. Fish and Wildlife Service Manatee Recovery Plan, and the Department of Environmental Protection's goals for manatee recovery.

The Department of Environmental Protection has been actively involved in this project for a number of years. We participate in the interagency task force created to solve the problem of structure-caused manatee mortality and we have had an active role in the development of this 1135 project.

I commend you and your staff in preparing a very thorough presentation of information on the water control structures in South Florida as well as a good compilation of manatee related data. The background information contained in this report is very valuable and will no doubt be used as a reference by a number of agencies in the future.

While overall I believe the project as outlined in the subject documents is a sound approach to reaching the goal of zero structure-caused mortality, I offer the following points as suggestions for improving this draft.

I believe that pressure sensitive devices that will reverse the direction of a closing gate hold the most promise in our efforts to eliminate structure-caused manatee mortality.

1. However, they are not a proven solution. As is mentioned in the report, there have been manatees killed at some structures equipped with such devices. The report needs to go into greater detail assessing why the pressure sensitive plungers at S-27 have failed and should provide recommendations on what steps should be taken to correct problems with the system. Past experience has shown problems with the plungers themselves, but also in other components of the system. The report needs to carefully examine the entire flood control structure operating system including the telemetry system, control switches and logic switches in the control house, control room protocols, as well as various overrides. In addition, the report should evaluate how power outages or loss of communication in the telemetry system could possibly affect performance.

2. Because this technology is experimental, it needs to be rigorously tested. The most significant shortcoming in the 1135 proposal is that it inadequately addresses testing of the manatee protection devices. The report should outline in detail the types of tests that will be performed to document the pressure sensitive devices are working satisfactory. Testing should be done in actual field conditions with the gate fully operational. A mechanical test procedure should be developed: that is, a procedure where the plungers are physically depressed in a normal operating mode. This needs to be a procedure that is repeatable and that can be done by field staff. The report should describe in detail how these tests will be performed and should recommend a suitable test schedule. The draft test procedures as contained in appendix C are a start but are inadequate.

3. We do not agree that construction should be limited to November 1 through May 31 for water control structures and between May and September for navigation structures. We believe that a flexible implementation schedule should be developed that would allow gates or locks to be worked on any time during the year, as weather and water level condition permits.

4. Finally, we believe while the Corps of Engineers should continue to move forward on refinements and installation of the pressure sensitive devices, attention should also be given to other possible manatee protection systems. The use of sonar appears to hold some promise and we are pleased that the Waterways Experimental Station is researching this technology. While the 1135 report dismissed over-the-top type water control structures, we believe that this concept merits more in-depth review.

Thank you for the opportunity to comment on this draft document. We look forward to working with the Corps of Engineers in implementing solutions to this problem in the future.

Sincerely,

R. Kipp Frohlich
Biological Administrator
Bureau of Protected Species Management

RKF/kw

CORPS RESPONSE:

1. More details on the manatee mortalities and electrical/mechanical difficulties at S-27 can be found in Appendix G of the main report. In this appendix, a mortality report details the specifics concerning the gate malfunction. Information on the operation of flood control structures can be found in Appendix D of the Main Report, entitled "Mechanical and Electrical Description of Vertical Lift Gated Structures".

2. Basic testing procedures have been established, i.e. using mock manatees, electrical protocols, etc. Additional testing procedures will be developed during the Plans and Specifications phase; after the PSDs have been evaluated for a longer period in the study phase. This knowledge will allow the Corps to learn more about the challenges of employing the PSDs and thus contrive more appropriate and meaningful testing procedures. All procedures will be coordinated with DEP and the USFWS through the Interagency Task Force on Manatee Protection at Water Control Structures to ensure that the utmost protection of the manatee is guaranteed.

3. There will be a flexible implementation schedule for the installation of the PSDs on the spillway structures. Despite the plan for implementation in the report, the Corps is committed to being sensitive to important manatee aggregation periods during the winter months to avoid risk and injury to manatees as a consequence of construction activities.

4. This Project Modification Report is a dynamic document. Should technology become available to achieve the goal of zero structure-related manatee mortality, the Corps will investigate it for application to its structures. Other technologies being evaluated exclusive of this report include other PSD configurations, barriers, and hydroacoustic detection technologies. In addition, protection measures specifically for sector-gated locks will be investigated in Part II of the report, which is currently in the developmental stage. The Corps will be investigating other avenues of funding to redesign structures in C&SF for "Over the Top" structures.

METROPOLITAN DADE COUNTY, FLORIDA

METRODADE

DERM

ENVIRONMENTAL RESOURCES MANAGEMENT
33 S.W. 2nd AVENUE
MIAMI, FLORIDA 33130-1540
(305) 372-6789

May 31, 1995

Attention: CESAJ-PD-PF
c/o A.J. Salem
Department of the Army
Jacksonville District Corps of Engineers
P.O.Box 4970
Jacksonville, Florida 32232-0019

RE: Draft 1135 report on modification of navigation locks and water control gates for manatee protection

Dear Mr. Salem:

This office has reviewed the subject draft report and would like to commend your staff and their colleagues at the U.S. Fish and Wildlife Service (USFWS), who have compiled a thorough review of manatee mortality related to water control structures and locks. It is particularly helpful to have the background information regarding dates of gate/lock construction and modifications as collected for this document. I am certain that this report will become a useful reference for many, especially those involved with the Interagency Task Force to eliminate manatee mortalities at flood gates and locks.

1. We generally agree with the U.S. Army Corps of Engineers conclusion that pressure-sensitive gate reversal devices provide the most promise at this time for reducing manatee mortality in water control gates, and therefore, should be the primary focus of the future implementation phase of the 1135 project. We strongly recommend that sections on testing and monitoring, inspection, operation and maintenance be strengthened to include mechanical testing. Protocols described in the appendix for periodic electrical inspections are a good beginning for assessing integrity of circuitry and telemetry, but a test is needed, particularly for evaluation of new or modified designs, to determine whether a device will actually be triggered and reverse if an object enters the gate opening during wet operation. With regard to the implementation schedule (page 26), we strongly disagree with the proposal that construction should occur from November 1 through May 31. Although we understand and agree that flood protection should not be compromised, fall and winter months are the peak season for manatee activity at Dade County structures. Many mortalities have occurred during these months also. We recommend that timing of installation should be determined on a site-by-site basis after consideration of typical rainfall patterns and manatee activities. For structures such as S-27 or S-25b, late March through June may be a more suitable period for construction. All required federal, state, and local permits or approvals should be obtained, and construction plans and schedules should be reviewed by the members of the Interagency Manatee Task Force as they are developed.

2. Because mortalities continue, even in gates that have been modified with prototype reversal devices, Dade County DERM staff and the citizen's advisory committee reviewing our draft Manatee Protection Plan strongly believe that multiple methods for manatee protection at flood gates and locks should be examined. As we have suggested in previous correspondence, it is important to have at least one back-up plan underway to implement in case the primary plan fails to prove successful. We therefore agree with recommendations in the USFWS coordination report in the Environmental Assessment section that several alternatives should receive further consideration. In particular, we suggest that acoustic detection may provide a back-up method of triggering gate reversal or for monitoring manatee behavior so as to improve effectiveness of protection strategies. Acoustic devices are apparently being considered in connection with structures not included in this report (page 14) and may be promising for water control gates as well. We also concur with the USFWS that more consideration should be given to use of barriers at selected structures, if habitat access is not an overwhelming concern. Further review of manatee mortality, distribution, tracking and related habitat data will be required to refine recommendations in this regard.

3. We continue to recommend that a thorough assessment of "over-the-top" discharge alternatives should be included in this report. Many interest groups, including boating and conservation organizations, believe that this concept represents a simple solution to the manatee mortality problem. Your staff has included a brief review of some engineering constraints, but does not recommend further assessment primarily due to concerns related to cost, limiting access to potential habitat, and limitations of the scope of the 1135 study. We understand that replacement structures may not be constructed, or perhaps even designed, under the 1135 authorization or budget. However, we suggest that a more thorough assessment of this option be included in this report, if it is to be eliminated from further consideration. More objective information on flood protection constraints, gate operations, costs, and engineering limitations should be provided to help reviewers

understand why this option is infeasible. For example, it is not clear why slot gates are found to be structurally problematic (page 22-23), if indeed many gates were originally equipped with them (page 10). If a separate feasibility study authorization, or modification of an existing authorization is necessary, it would be appropriate for the present 1135 study report to include such a recommendation. In this regard, your staff has suggested that such work might be possible under the "Biscayne Bay Survey Review" project, currently being developed by your staff and Dade County. The authorizing language for this study involves determining whether modifications of federal projects are warranted in connection with "Biscayne Bay and improvement of water quality in the bay," and the outline of the scope of work for the project involves development of a hydrologic model which can assess water quality and quantity issues. With a budget of only $700,000 federal and $700,000 non-federal funds and services, we regretfully conclude that the scope and revenue constraints are more limiting than in the 1135 project.

We have made some minor corrections to the manuscript and suggested revisions to your mailing list, which we have provided separately to your staff. In particular, we recommend you send a copy of the draft report as soon as possible to Representative Carrie Meek, since we believe she was strongly involved in obtaining funding for many water resources projects in Florida. Thank you for the opportunity to review and comment on the draft 1135 report. We look forward to continuing to work with your staff.

Sincerely,

Susan Markley, PH.D., Chief
Natural Resources Division

CORPS RESPONSE:

1. Basic testing procedures have been established i.e using mock manatees, electrical protocols, etc. Additional testing procedures will be developed during the Plans and Specifications phase after the PSDs have been evaluated for a longer period in the study phase. This knowledge will allow the Corps to learn more about the challenges of employing the PSDs and thus contrive more appropriate and meaningful testing procedures. All procedures will be coordinated with DEP and the USFWS through the Interagency Task Force on Manatee Protection at Water Control Structures to ensure that the utmost protection of manatees is guaranteed. There will be a flexible implementation schedule for the installation of the PSDs on the structures. The Corps is targeting the highest risk structures first but will be sensitive to important manatee aggregation periods during the winter months to avoid risk to manatees. The Interagency Task Force will also have the opportunity to comment on the construction plans and schedules.

2. The Corps is committed to a comprehensive approach to manatee protection. Should technology become available to achieve the goal of zero structure-related manatee mortality, the Corps will investigate it for application to its structures. The Corps strategy for protecting manatees is dynamic. Multiple technologies are being evaluated exclusive of this report including other PSD configurations, barriers, and hydroacoustic detection technologies. Other various protection measures will be investigated in Part II of this report which will be completed in FY96. In addition, barriers have been installed at some Corps spillway structures to prevent future manatee mortalities. Most of these locations have a navigation lock adjacent to the spillway to allow manatees to continue travel and foraging routes. In Dade and Broward counties, the spillway structures are the only means by which manatees can travel down a canal or waterway. Once USFWS and DEP determine which waterways and canals are not essential to the manatee population, the Corps will investigate the feasibility of installing barriers at those corresponding spillways.

3. "Over the Top" structures have been investigated preliminarily for this study. The documentation can be found in the "Description of Alternatives" section of the main report. Past experience has presented many engineering challenges to utilizing these type of structures. Further detailed analysis on "Over the Top" structures, if deemed appropriate, will be conducted at a later date under a separate study authority. In the future, the Corps will be investigating other avenues of funding to redesign structures in C&SF.

MARINE MAMMAL COMMISSION
1825 CONNECTICUT AVENUE, N.W. #512
WASHINGTON, DC 20009

20 June 1995
By facsimile

Mr. A. J. Salem
Chief, Planning Division
Attn: CESAJ-PD-PF
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

Thank you for your 5 May 1995 letter forwarding a copy of the "Draft Project Modification Report and Environmental Assessment" on altering 20 water control structures in central and southern Florida. The purpose of the planned work is to fit pressure sensitive devices on these structures to reduce the likelihood that they could crush and/or drown endangered manatees trying to pass through them. The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the document and offers the following comments.

Crushing and drowning in flood gates and navigation locks is the second largest cause of human-related manatee mortality in Florida. The number of such deaths has increased significantly in recent years. To address the problem, the Corps of Engineers, in cooperation with the South Florida Water Management District, has designed, tested, and refined pressure sensitive mechanisms that can be affixed to gate doors to reverse the direction of closing gates should a manatee become caught as a door shuts. The draft project report indicates that the proposed action would involve retrofitting the new technology at 20 water control structures that have killed or potentially could kill manatees and that the total cost of the project is $2,409,000.

The Commission applauds the Corps for its efforts to develop the technology and apply it to problem water control structures. The pressure sensitive mechanisms appear to be an innovative, well-suited approach that would be an important, timely contribution to the manatee recovery program. The Marine Mammal Commission commends the Corps for its continuing attention to this urgent conservation need.

1. With regard to the design of the new pressure sensitive devices, we understand that initial testing revealed several design flaws, and that while these problems appear to have been

resolved, experience with the improved mechanisms is still limited. It seems possible, therefore, that further technical refinements may yet be needed or may soon become apparent. In view of the limited experience with the new mechanisms and the importance of implementing effective manatee protection measures as quickly as possible, the Marine Mammal Commission recommends that the Corps of Engineers adopt a flexible approach in implementing its proposed plan such that construction schedules may be altered if experience gained as new devices come on line should indicate that additional technical modifications appear warranted.

Once again, the Commission commends the Corps for its initiative in trying to solve this serious and all-too-often fatal problem for manatees.

We hope these comments are helpful.

Sincerely,

John R. Twiss, Jr.
Executive Director

cc Mr. Samuel E. Pool, III, Executive Director, South Florida Water Management District
Lance D. Wood, Esq., Assistant Chief Council, Environmental Law and Regulatory Programs, Corps of Engineers

CORPS RESPONSE:

1. The Corps agrees with this comment and has adopted a flexible approach in choosing the proper Pressure Sensitive Device (PSD). Further testing and modeling will continue so that the device which provides the most consistent protection of manatees will be installed at our structures. The PSD assembly will be employed at one structure and tested rigorously for six months in the field. Following successful field testing, it will then installed at the other structures in a phased approach.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

MAY 30 1995

District Engineer, Jacksonville
P.O. Box 4970
Jacksonville, FL 32232

Attn: Mr. A.J. Salem (CESAJ-PD-~~PF~~)
Chief, Planning Division

Subject: Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for Modifications to Selected Water Control Structures for the Protection of the Florida Manatee

Dear Sir:

Pursuant to Section 309 of the Clean Air Act, EPA, Region 4 has reviewed the subject document which discusses the consequences of equipping vertical lift gates at the selected study structures with a pressure sensitive (Plunger Option 4) device which should offer protection to manatees traversing from upstream and downstream locations. This device will be tested (upon installation and biannually) with manatee models to ensure the system is working properly and/or if additional modification is necessary.

From the information in the text it does not look as if the proposal will adversely affect the natural environment and hopefully will significantly reduce manatee mortality from locking operations. Therefore, we have no significant objections to the use of an EA as the evaluation model rather than the more comprehensive environmental impact statement format.

Thank you for the opportunity to comment on this action. If we can be of further assistance in this matter, Dr. Gerald Miller (404-347-3776) will serve as initial point of contact.

Sincerely,

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

APPENDIX A

TABLE A-1
ESTIMATED COST FOR PLANS & SPECIFICATIONS

ITEM	ESTIMATED COST
Hydrologic and Hydraulic Design	$22,000
Structures	$28,000
Mechanical and Electrical	$98,000
Specifications	$91,500
Geotechnical	$5,000
Cost Engineering	$22,500
Office of Counsel - LCA	$2,500
Planning	$21,000
Total, Plans & Specifications	$290,500

APPENDIX B

REED TYPE

MANATEE PROTECTION
CENTRAL AND SOUTH FLORIDA

Designed By: JACKSONVILLE DISTRICT OFFICE
Estimated By: E.P.C.

Prepared By: E.P.CAMPA

Preparation Date: 08/30/94
Effective Date of Pricing: 08/30/94

Sales Tax: 6.00%

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** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
04 Contract 02 REED TYPE ALT 2		1,994,548	299,182	2,293,730	
TOTAL MANATEE PROTECTION		1,994,548	299,182	2,293,730	

** PROJECT OWNER SUMMARY - UserDefi **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
04 Contract 02 REED TYPE ALT 2					
04- A Construction Cost					
04- A/05 Locks					
04- A/05.00 Locks					
04- A/05.00.57 Lock Gates & Operate Machine U/L					
04- A/05.00.57/01 S-13		17,422	2,613	20,036	
04- A/05.00.57/02 S-20F		63,205	9,481	72,686	
04- A/05.00.57/03 S-20G		31,540	4,731	36,271	
04- A/05.00.57/04 S-21		84,915	12,737	97,652	
04- A/05.00.57/05 S-21A		53,946	8,092	62,037	
04- A/05.00.57/06 S-22		51,861	7,779	59,640	
04- A/05.00.57/07 S-25		22,645	3,397	26,042	
04- A/05.00.57/08 S-25B		51,249	7,687	58,937	
04- A/05.00.57/09 S-26		61,065	9,160	70,225	
04- A/05.00.57/10 S-28		56,407	8,461	64,868	
04- A/05.00.57/11 S-33		30,921	4,638	35,559	
04- A/05.00.57/12 S-77		90,717	13,608	104,325	
04- A/05.00.57/16 S-79		297,723	44,659	342,382	
04- A/05.00.57/17 S-308C		97,277	14,592	111,869	
04- A/05.00.57/18 S-127		50,863	7,629	58,492	
04- A/05.00.57/19 S-131		50,863	7,629	58,492	
04- A/05.00.57/20 S-135		50,863	7,629	58,492	
04- A/05.00.57/21 S-27		67,172	10,076	77,248	
04- A/05.00.57/22 S-29		133,422	20,013	153,436	
04- A/05.00.57/23 S-123		45,747	6,862	52,609	
04- A/05.00.57/24 BULKHEAD BEAMS FOR DEWATERING	50742.00 LBS	32,277	4,842	37,119	0.73
04- A/05.00.57/25 NEEDLE BEAMS FOR DEWATERING	26196.00 BF	101,646	15,247	116,893	4.46
TOTAL Lock Gates & Operate Machine U/L		1,543,748	231,562	1,775,310	
TOTAL Locks		1,543,748	231,562	1,775,310	
TOTAL Locks	1.00 EA	1,543,748	231,562	1,775,310	1775310
TOTAL Construction Cost		1,543,748	231,562	1,775,310	
04- B Non-Construction Cost					
04- B/01 Lands and Damages		2,500	375	2,875	
04- B/30 Planning, Engineering and Design		199,244	29,887	229,131	
04- B/31 Construction Management (S&I)		249,056	37,358	286,414	
TOTAL Non-Construction Cost		450,800	67,620	518,420	

** PROJECT OWNER SUMMARY - UserDefi **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
TOTAL Contract 02 REED TYPE ALT 2		1,994,548	299,182	2,293,730	
TOTAL MANATEE PROTECTION		1,994,548	299,182	2,293,730	

** PROJECT INDIRECT SUMMARY - Contract **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OF	PROFIT	BOND	TOTAL COST	UNIT COST
04 Contract 02 REED TYPE ALT 2		1,664,247	97,076	91,737	126203	15285	1,994,548	
MANATEE PROTECTION		1,664,247	97,076	91,737	126203	15285	1,994,548	
CONTING							299,182	
TOTAL INCL OWNER COSTS							2,293,730	

** PROJECT INDIRECT SUMMARY - UserDefi **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OF	PROFIT	BOND	TOTAL COST	UNIT COST
04 Contract 02 REED TYPE ALT 2								
04- A Construction Cost								
04- A/05 Locks								
04- A/05.00 Locks								
04- A/05.00.57 Lock Gates & Operate Machine U/L								
04- A/05.00.57/01 S-13		13,695	1,096	1,035	1,424	172	17,422	
04- A/05.00.57/02 S-20F		49,682	3,975	3,756	5,167	626	63,205	
04- A/05.00.57/03 S-20G		24,792	1,983	1,874	2,578	312	31,540	
04- A/05.00.57/04 S-21		66,747	5,340	5,046	6,942	841	84,915	
04- A/05.00.57/05 S-21A		42,403	3,392	3,206	4,410	534	53,946	
04- A/05.00.57/06 S-22		40,765	3,261	3,082	4,240	513	51,861	
04- A/05.00.57/07 S-25		17,800	1,424	1,346	1,851	224	22,645	
04- A/05.00.57/08 S-25B		40,284	3,223	3,045	4,190	507	51,249	
04- A/05.00.57/09 S-26		48,000	3,840	3,629	4,992	605	61,065	
04- A/05.00.57/10 S-28		44,338	3,547	3,352	4,611	558	56,407	
04- A/05.00.57/11 S-33		24,305	1,944	1,837	2,528	306	30,921	
04- A/05.00.57/12 S-77		71,307	5,705	5,391	7,416	898	90,717	
04- A/05.00.57/16 S-79		234,022	18,722	17,692	24,339	2,948	297,723	
04- A/05.00.57/17 S-308C		76,464	6,117	5,781	7,953	963	97,277	
04- A/05.00.57/18 S-127		39,980	3,198	3,023	4,158	504	50,863	
04- A/05.00.57/19 S-131		39,980	3,198	3,023	4,158	504	50,863	
04- A/05.00.57/20 S-135		39,980	3,198	3,023	4,158	504	50,863	
04- A/05.00.57/21 S-27		52,800	4,224	3,992	5,491	665	67,172	
04- A/05.00.57/22 S-29		104,875	8,390	7,929	10,907	1,321	133,422	
04- A/05.00.57/23 S-123		35,959	2,877	2,719	3,740	453	45,747	
04- A/05.00.57/24 BULKHEAD BEAMS FOR DEWATERING	50742.00 LBS	25,371	2,030	1,918	2,639	320	32,277	0.64
04- A/05.00.57/25 NEEDLE BEAMS FOR DEWATERING	26196.00 BF	79,898	6,392	6,040	8,310	1,006	101,646	3.88
TOTAL Lock Gates & Operate Machine U		1,213,447	97,076	91,737	126203	15285	1,543,748	
TOTAL Locks		1,213,447	97,076	91,737	126203	15285	1,543,748	
TOTAL Locks	1.00 EA	1,213,447	97,076	91,737	126203	15285	1,543,748	1543748
TOTAL Construction Cost		1,213,447	97,076	91,737	126203	15285	1,543,748	
04- B Non-Construction Cost								
04- B/01 Lands and Damages		2,500	0	0	0	0	2,500	
04- B/30 Planning, Engineering and Design		199,244	0	0	0	0	199,244	
04- B/31 Construction Management (S&I)		249,056	0	0	0	0	249,056	
TOTAL Non-Construction Cost		450,800	0	0	0	0	450,800	

** PROJECT INDIRECT SUMMARY - UserDefi **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OF	PROFIT	BOND	TOTAL COST	UNIT COST
TOTAL Contract 02 REED TYPE ALT 2		1,664,247	97,076	91,737	126203	15285	1,994,548	
TOTAL MANATEE PROTECTION		1,664,247	97,076	91,737	126203	15285	1,994,548	
CONTING							299,182	
TOTAL INCL OWNER COSTS							2,293,730	

** PROJECT DIRECT SUMMARY - Contract **

	QUANTITY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
04 Contract 02 REED TYPE ALT 2		778,682	0	434,765	450,800	1,664,247	
MANATEE PROTECTION		778,682	0	434,765	450,800	1,664,247	
OVERHEAD						97,076	
SUBTOTAL						1,761,323	
HOME OFC						91,737	
SUBTOTAL						1,853,060	
PROFIT						126,203	
SUBTOTAL						1,979,263	
BOND						15,285	
TOTAL INCL INDIRECTS						1,994,548	
CONTING						299,182	
TOTAL INCL OWNER COSTS						2,293,730	

** PROJECT DIRECT SUMMARY - UserDefi **

	QUANTITY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
04 Contract 02 REED TYPE ALT 2							
04- A Construction Cost							
04- A/05 Locks							
04- A/05.00 Locks							
04- A/05.00.57 Lock Gates & Operate Machine U/L							
04- A/05.00.57/01 S-13		9,965	0	3,730	0	13,695	
04- A/05.00.57/02 S-20F		36,660	0	13,022	0	49,682	
04- A/05.00.57/03 S-20G		18,220	0	6,572	0	24,792	
04- A/05.00.57/04 S-21		46,387	0	20,359	0	66,747	
04- A/05.00.57/05 S-21A		31,053	0	11,351	0	42,403	
04- A/05.00.57/06 S-22		29,995	0	10,770	0	40,765	
04- A/05.00.57/07 S-25		15,476	0	2,323	0	17,800	
04- A/05.00.57/08 S-25B		28,003	0	12,281	0	40,284	
04- A/05.00.57/09 S-26		34,407	0	13,592	0	48,000	
04- A/05.00.57/10 S-28		30,801	0	13,537	0	44,338	
04- A/05.00.57/11 S-33		18,481	0	5,824	0	24,305	
04- A/05.00.57/12 S-77		48,834	0	22,474	0	71,307	
04- A/05.00.57/16 S-79		146,060	0	87,963	0	234,022	
04- A/05.00.57/17 S-308C		51,238	0	25,226	0	76,464	
04- A/05.00.57/18 S-127		31,432	0	8,548	0	39,980	
04- A/05.00.57/19 S-131		31,432	0	8,548	0	39,980	
04- A/05.00.57/20 S-135		31,432	0	8,548	0	39,980	
04- A/05.00.57/21 S-27		39,105	0	13,695	0	52,800	
04- A/05.00.57/22 S-29		72,685	0	32,190	0	104,875	
04- A/05.00.57/23 S-123		27,017	0	8,942	0	35,959	
04- A/05.00.57/24 BULKHEAD BEAMS FOR DEWATERING	50742.00 LBS	0	0	25,371	0	25,371	0.50
04- A/05.00.57/25 NEEDLE BEAMS FOR DEWATERING	26196.00 BF	0	0	79,898	0	79,898	3.05
TOTAL Lock Gates & Operate Machine U/L		778,682	0	434,765	0	1,213,447	
TOTAL Locks		778,682	0	434,765	0	1,213,447	
TOTAL Locks	1.00 EA	778,682	0	434,765	0	1,213,447	1213447
TOTAL Construction Cost		778,682	0	434,765	0	1,213,447	
04- B Non-Construction Cost							
04- B/01 Lands and Damages		0	0	0	2,500	2,500	
04- B/30 Planning, Engineering and Design		0	0	0	199,244	199,244	
04- B/31 Construction Management (S&I)		0	0	0	249,056	249,056	
TOTAL Non-Construction Cost		0	0	0	450,800	450,800	

** PROJECT DIRECT SUMMARY - UserDefi **

	QUANTITY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Contract 02 REED TYPE ALT 2		778,682	0	434,765	450,800	1,664,247	
TOTAL MANATEE PROTECTION		778,682	0	434,765	450,800	1,664,247	
OVERHEAD						97,076	
SUBTOTAL						1,761,323	
HOME OFC						91,737	
SUBTOTAL						1,853,060	
PROFIT						126,203	
SUBTOTAL						1,979,263	
BOND						15,285	
TOTAL INCL INDIRECTS						1,994,548	
CONTING						299,182	
TOTAL INCL OWNER COSTS						2,293,730	

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
04. Contract 02 REED TYPE ALT 2										
04- A. Construction Cost										
04- A/05. Locks										
04- A/05.00. Locks										
04- A/05.00.57. Lock Gates & Operate Machine U/L										
04- A/05.00.57/01. S-13										
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T DN	16.00	LF		0.00	1,328	0	1,272	0	2,600	162.50
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	16.00	LF		0.00	1,328	0	1,272	0	2,600	162.50
USR AA CONDUIT 1/2 S.S.					3.58	0.00	2.89	0.00	6.47	
	240.00	LF		0.00	859	0	695	0	1,554	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	2.00	EA		0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL					2.44	0.00	1.33	0.00	3.77	
ROOM	36.00	LF		0.00	88	0	48	0	136	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	108.00	LF		0.00	22	0	9	0	31	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	4.00	EA		0.00	80	0	106	0	186	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	3.00	EA		0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	1.00	EA		0.00	20	0	27	0	47	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	1.00	EA		0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCHING					0.00	0.00	0.00	0.00	0.00	
	1.00	EA		0.00	0	0	0	0	0	0.00

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA TRENCHING					0.00	0.00	0.00	0.00	0.00	
	1.00	EA		0.00	0	0	0	0	0	0.00
TOTAL S-13					9,965	0	3,730	0	13,695	
04- A/05.00.57/02. S-20F										
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T DN	36.00	LF		0.00	2,988	0	2,862	0	5,850	162.50
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	36.00	LF		0.00	2,988	0	2,862	0	5,850	162.50
USR AA CONDUIT 1/2" S.S.					3.58	0.00	2.89	0.00	6.47	
	2160.00	LF		0.00	7,733	0	6,251	0	13,983	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	4.00	EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL					2.44	0.00	1.33	0.00	3.77	
ROOM	76.00	LF		0.00	185	0	101	0	286	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	228.00	LF		0.00	46	0	19	0	65	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	12.00	EA		0.00	240	0	318	0	558	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	3.00	EA		0.00	60	0	80	0	140	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	3.00	EA		0.00	18,000	0	0	0	18,000	6000.00
USR AA TRENCHING					100.00	0.00	0.00	0.00	100.00	
	40.00	LF		0.00	4,000	0	0	0	4,000	100.00
TOTAL S-20F					36,660	0	13,022	0	49,682	

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
04- A/05.00.57/03. S-20G								
AA REED ASSEM S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	25.00 LF	0.00	2,075	0	1,988	0	4,063	162.50
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T UP	25.00 LF	0.00	2,075	0	1,988	0	4,063	162.50
USR AA CONDUIT 1/2" S.S.			3.58	0.00	2.89	0.00	6.47	
	720.00 LF	0.00	2,578	0	2,084	0	4,661	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	2.00 EA	0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL			2.44	0.00	1.33	0.00	3.77	
ROOM	50.00 LF	0.00	122	0	66	0	188	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	150.00 LF	0.00	30	0	13	0	43	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	4.00 EA	0.00	80	0	106	0	186	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	3.00 EA	0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	1.00 EA	0.00	20	0	27	0	47	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	1.00 EA	0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	50.00 LF	0.00	5,000	0	0	0	5,000	100.00
TOTAL S-20G			18,220	0	6,572	0	24,792	
04- A/05.00.57/04. S-21								
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	81.00 LF	0.00	6,723	0	6,440	0	13,163	162.50

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	81.00	LF		0.00	6,723	0	6,440	0	13,163	162.50
USR AA CONDUIT 1/2" S.S.					3.58	0.00	2.89	0.00	6.47	
	2160.00	LF		0.00	7,733	0	6,251	0	13,983	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	4.00	EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL					2.44	0.00	1.33	0.00	3.77	
ROOM	141.00	LF		0.00	344	0	187	0	531	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	423.00	LF		0.00	85	0	36	0	120	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	12.00	EA		0.00	240	0	318	0	558	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	9.00	EA		0.00	180	0	239	0	419	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	3.00	EA		0.00	60	0	80	0	140	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	3.00	EA		0.00	18,000	0	0	0	18,000	6000.00
USR AA TRENCHING					100.00	0.00	0.00	0.00	100.00	
	60.00	LF		0.00	6,000	0	0	0	6,000	100.00
TOTAL S-21					46,387	0	20,359	0	66,747	

04- A/05.00.57/05. S-21A

USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T DN	40.00	LF		0.00	3,320	0	3,180	0	6,500	162.50
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	40.00	LF		0.00	3,320	0	3,180	0	6,500	162.50
USR AA CONDUIT 1/2"S.S.					3.58	0.00	2.89	0.00	6.47	
	1440.00	LF		0.00	5,155	0	4,167	0	9,322	6.47

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	3.00 EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM			2.44	0.00	1.33	0.00	3.77	
	65.00 LF	0.00	159	0	86	0	245	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	195.00 LF	0.00	39	0	17	0	56	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	8.00 EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	6.00 EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	2.00 EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	65.00 LF	0.00	6,500	0	0	0	6,500	100.00
TOTAL S-21A			31,053	0	11,351	0	42,403	

04- A/05.00.57/06. S-22

USR AA REED ASSEM W/ S.S.BRACKET DN			83.00	0.00	79.50	0.00	162.50	
	36.00 LF	0.00	2,988	0	2,862	0	5,850	162.50
USR AA REED ASSEM W/ S.S.BRACKET UP			83.00	0.00	79.50	0.00	162.50	
	36.00 LF	0.00	2,988	0	2,862	0	5,850	162.50
USR AA CONDUIT 1/2" S.S.			3.58	0.00	2.89	0.00	6.47	
	1440.00 LF	0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	3.00 EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM			2.44	0.00	1.33	0.00	3.77	
	100.00 LF	0.00	244	0	133	0	377	3.77

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	300.00 LF	0.00	60	0	25	0	85	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	8.00 EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	6.00 EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	2.00 EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	60.00 LF	0.00	6,000	0	0	0	6,000	100.00
TOTAL S-22			29,995	0	10,770	0	40,765	

04- A/05.00.57/07. S-25

USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	9.00 LF	0.00	747	0	716	0	1,463	162.50
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T UP	9.00 LF	0.00	747	0	716	0	1,463	162.50
USR AA CONDUIT 1/2" S.S.			3.58	0.00	2.89	0.00	6.47	
	120.00 LF	0.00	430	0	347	0	777	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	2.00 EA	0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL			2.44	0.00	1.33	0.00	3.77	
ROOM	70.00 LF	0.00	171	0	93	0	264	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	210.00 LF	0.00	42	0	18	0	60	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20

04- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	4.00	EA	0.00	80	0	106	0	186	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	3.00	EA	0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	1.00	EA	0.00	20	0	27	0	47	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	1.00	EA	0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCHING				100.00	0.00	0.00	0.00	100.00	
	70.00	LF	0.00	7,000	0	0	0	7,000	100.00
TOTAL S-25				15,476	0	2,323	0	17,800	
04- A/05.00.57/08. S-25B									
USR AA REED ASSEM W/ S.S.BRACKE T DN	46.00	LF	0.00	83.00 3,818	0.00 0	79.50 3,657	0.00 0	162.50 7,475	162.50
USR AA REED ASSEM W/ S.S.BRACKE T UP	46.00	LF	0.00	83.00 3,818	0.00 0	79.50 3,657	0.00 0	162.50 7,475	162.50
USR AA CONDUIT 1/2" S.S.				3.58	0.00	2.89	0.00	6.47	
	1440.00	LF	0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	3.00	EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM	50.00	LF	0.00	2.44 122	0.00 0	1.33 66	0.00 0	3.77 188	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	150.00	LF	0.00	30	0	13	0	43	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00	EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	8.00	EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	6.00	EA	0.00	120	0	159	0	279	46.50

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	2.00 EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	25.00 LF	0.00	2,500	0	0	0	2,500	100.00
TOTAL S-25B			28,003	0	12,281	0	40,284	
04- A/05.00.57/09. S-26								
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	54.00 LF	0.00	4,482	0	4,293	0	8,775	162.50
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T UP	54.00 LF	0.00	4,482	0	4,293	0	8,775	162.50
USR AA CONDUIT 1/2" S.S.			3.58	0.00	2.89	0.00	6.47	
	1440.00 LF	0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	3.00 EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL			2.44	0.00	1.33	0.00	3.77	
ROOM	75.00 LF	0.00	183	0	99	0	282	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	225.00 LF	0.00	45	0	19	0	64	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	8.00 EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	6.00 EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	2.00 EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA	0.00	12,000	0	0	0	12,000	6000.00

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	75.00 LF	0.00	7,500	0	0	0	7,500	100.00
TOTAL S-26			34,407	0	13,592	0	48,000	
04- A/05.00.57/10. S-28								
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	54.00 LF	0.00	4,482	0	4,293	0	8,775	162.50
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T UP	54.00 LF	0.00	4,482	0	4,293	0	8,775	162.50
USR AA CONDUIT 1/2" S.S.			3.58	0.00	2.89	0.00	6.47	
	1440.00 LF	0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	3.00 EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL			2.44	0.00	1.33	0.00	3.77	
ROOM	40.00 LF	0.00	98	0	53	0	151	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	120.00 LF	0.00	24	0	10	0	34	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	8.00 EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	6.00 EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	2.00 EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	40.00 LF	0.00	4,000	0	0	0	4,000	100.00
TOTAL S-28			30,801	0	13,537	0	44,338	

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
04- A/05.00.57/11. S-33								
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	20.00 LF	0.00	1,660	0	1,590	0	3,250	162.50
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T UP	20.00 LF	0.00	1,660	0	1,590	0	3,250	162.50
USR AA CONDUIT 1/2" S.S.			3.58	0.00	2.89	0.00	6.47	
	720.00 LF	0.00	2,578	0	2,084	0	4,661	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	2.00 EA	0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL			2.44	0.00	1.33	0.00	3.77	
ROOM	80.00 LF	0.00	195	0	106	0	301	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	240.00 LF	0.00	48	0	20	0	68	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	4.00 EA	0.00	80	0	106	0	186	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	3.00 EA	0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	1.00 EA	0.00	20	0	27	0	47	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	1.00 EA	0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	60.00 LF	0.00	6,000	0	0	0	6,000	100.00
TOTAL S-33			18,481	0	5,824	0	24,305	
04- A/05.00.57/12. S-77								
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	80.00 LF	0.00	6,640	0	6,360	0	13,000	162.50

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	80.00	LF		0.00	6,640	0	6,360	0	13,000	162.50
USR AA CONDUIT 1/2" S.S.					3.58	0.00	2.89	0.00	6.47	
	2880.00	LF		0.00	10,310	0	8,334	0	18,645	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	5.00	EA		0.00	300	0	371	0	671	134.20
USR AA 1/2" CONDUIT TO CONTROL					2.44	0.00	1.33	0.00	3.77	
ROOM	80.00	LF		0.00	195	0	106	0	301	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	240.00	LF		0.00	48	0	20	0	68	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	16.00	EA		0.00	320	0	424	0	744	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	12.00	EA		0.00	240	0	318	0	558	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	4.00	EA		0.00	80	0	106	0	186	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	4.00	EA		0.00	24,000	0	0	0	24,000	6000.00
TOTAL S-77					48,834	0	22,474	0	71,307	

04- A/05.00.57/16. S-79

USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T DN	325.00	LF		0.00	26,975	0	25,838	0	52,813	162.50
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	325.00	LF		0.00	26,975	0	25,838	0	52,813	162.50
USR AA CONDUIT 1/2" S.S.					3.58	0.00	2.89	0.00	6.47	
	11520	LF		0.00	41,242	0	33,337	0	74,578	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	9.00	EA		0.00	540	0	668	0	1,208	134.20

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 1/2" CONDUIT TO CONTROL				2.44	0.00	1.33	0.00	3.77	
ROOM	325.00	LF	0.00	793	0	431	0	1,224	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	975.00	LF	0.00	195	0	83	0	278	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00	EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	32.00	EA	0.00	640	0	848	0	1,488	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	24.00	EA	0.00	480	0	636	0	1,116	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	8.00	EA	0.00	160	0	212	0	372	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	8.00	EA	0.00	48,000	0	0	0	48,000	6000.00
TOTAL S-79				146,060	0	87,963	0	234,022	

04- A/05.00.57/17. S-308C

USR AA REED ASSEM W/ S.S.BRACKE				83.00	0.00	79.50	0.00	162.50	
T DN	116.00	LF	0.00	9,628	0	9,222	0	18,850	162.50
USR AA REED ASSEM W/ S.S.BRACKE				83.00	0.00	79.50	0.00	162.50	
T UP	116.00	LF	0.00	9,628	0	9,222	0	18,850	162.50
USR AA CONDUIT 1/2" S.S.				3.58	0.00	2.89	0.00	6.47	
	1800.00	LF	0.00	6,444	0	5,209	0	11,653	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	5.00	EA	0.00	300	0	371	0	671	134.20
USR AA 1/2" CONDUIT TO CONTROL				2.44	0.00	1.33	0.00	3.77	
ROOM	177.00	LF	0.00	432	0	235	0	666	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	531.00	LF	0.00	106	0	45	0	151	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00	EA	0.00	60	0	74	0	134	134.20

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	16.00	EA		0.00	320	0	424	0	744	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	12.00	EA		0.00	240	0	318	0	558	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	4.00	EA		0.00	80	0	106	0	186	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	4.00	EA		0.00	24,000	0	0	0	24,000	6000.00
TOTAL S-308C					51,238	0	25,226	0	76,464	

04- A/05.00.57/18. S-127

USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T DN	30.00	LF		0.00	2,490	0	2,385	0	4,875	162.50
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	30.00	LF		0.00	2,490	0	2,385	0	4,875	162.50
USR AA CONDUIT 1/2" S.S.					3.58	0.00	2.89	0.00	6.47	
	960.00	LF		0.00	3,437	0	2,778	0	6,215	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	4.00	EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL					2.44	0.00	1.33	0.00	3.77	
ROOM	130.00	LF		0.00	317	0	172	0	489	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	390.00	LF		0.00	78	0	33	0	111	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	100.00 LF	0.00	10,000	0	0	0	10,000	100.00
TOTAL S-127			31,432	0	8,548	0	39,980	
04- A/05.00.57/19. S-131								
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T DN	30.00 LF	0.00	2,490	0	2,385	0	4,875	162.50
USR AA REED ASSEM W/ S.S.BRACKE			83.00	0.00	79.50	0.00	162.50	
T UP	30.00 LF	0.00	2,490	0	2,385	0	4,875	162.50
USR AA CONDUIT 1/2" S.S.			3.58	0.00	2.89	0.00	6.47	
	960.00 LF	0.00	3,437	0	2,778	0	6,215	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	4.00 EA	0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL			2.44	0.00	1.33	0.00	3.77	
ROOM	130.00 LF	0.00	317	0	172	0	489	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	390.00 LF	0.00	78	0	33	0	111	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	8.00 EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	6.00 EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	2.00 EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING			100.00	0.00	0.00	0.00	100.00	
	100.00 LF	0.00	10,000	0	0	0	10,000	100.00

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL S-131				31,432	0	8,548	0	39,980	
04- A/05.00.57/20. S-135									
USR AA REED ASSEM W/ S.S.BRACKE				83.00	0.00	79.50	0.00	162.50	
T DN	30.00 LF		0.00	2,490	0	2,385	0	4,875	162.50
USR AA REED ASSEM W/ S.S.BRACKE				83.00	0.00	79.50	0.00	162.50	
T UP	30.00 LF		0.00	2,490	0	2,385	0	4,875	162.50
USR AA CONDUIT 1/2" S.S.				3.58	0.00	2.89	0.00	6.47	
	960.00 LF		0.00	3,437	0	2,778	0	6,215	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	4.00 EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL				2.44	0.00	1.33	0.00	3.77	
ROOM	130.00 LF		0.00	317	0	172	0	489	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	390.00 LF		0.00	78	0	33	0	111	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00 EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	8.00 EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	6.00 EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	2.00 EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	2.00 EA		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING				100.00	0.00	0.00	0.00	100.00	
	100.00 LF		0.00	10,000	0	0	0	10,000	100.00
TOTAL S-135				31,432	0	8,548	0	39,980	

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
04- A/05.00.57/21. S-27									
USR AA REED ASSEM W/ S.S.BRACKE				83.00	0.00	79.50	0.00	162.50	
T DN	54.00	LF	0.00	4,482	0	4,293	0	8,775	162.50
USR AA REED ASSEM W/ S.S.BRACKE				83.00	0.00	79.50	0.00	162.50	
T UP	54.00	LF	0.00	4,482	0	4,293	0	8,775	162.50
USR AA CONDUIT 1/2" S.S.				3.58	0.00	2.89	0.00	6.47	
	1440.00	LF	0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	3.00	EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL				2.44	0.00	1.33	0.00	3.77	
ROOM	140.00	LF	0.00	342	0	186	0	527	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	420.00	LF	0.00	84	0	36	0	120	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00	EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	8.00	EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	6.00	EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	2.00	EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	2.00	EA	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING				100.00	0.00	0.00	0.00	100.00	
	120.00	LF	0.00	12,000	0	0	0	12,000	100.00
TOTAL S-27				39,105	0	13,695	0	52,800	
04- A/05.00.57/22. S-29									
USR AA REED ASSEM W/ S.S.BRACKE				83.00	0.00	79.50	0.00	162.50	
T DN	88.00	LF	0.00	7,304	0	6,996	0	14,300	162.50

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	88.00	LF		0.00	7,304	0	6,996	0	14,300	162.50
USR AA CONDUIT 1/2" S.S.					3.58	0.00	2.89	0.00	6.47	
	5760.00	LF		0.00	20,621	0	16,668	0	37,289	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	5.00	EA		0.00	300	0	371	0	671	134.20
USR AA 1/2" CONDUIT TO CONTROL					2.44	0.00	1.33	0.00	3.77	
ROOM	150.00	LF		0.00	366	0	199	0	565	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	450.00	LF		0.00	90	0	38	0	128	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	16.00	EA		0.00	320	0	424	0	744	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	12.00	EA		0.00	240	0	318	0	558	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	4.00	EA		0.00	80	0	106	0	186	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	4.00	EA		0.00	24,000	0	0	0	24,000	6000.00
USR AA TRENCHING					100.00	0.00	0.00	0.00	100.00	
	120.00	LF		0.00	12,000	0	0	0	12,000	100.00
TOTAL S-29					72,685	0	32,190	0	104,875	
04- A/05.00.57/23. S-123										
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T DN	25.00	LF		0.00	2,075	0	1,988	0	4,063	162.50
USR AA REED ASSEM W/ S.S.BRACKE					83.00	0.00	79.50	0.00	162.50	
T UP	25.00	LF		0.00	2,075	0	1,988	0	4,063	162.50
USR AA CONDUIT 1/2" S.S.					3.58	0.00	2.89	0.00	6.47	
	1440.00	LF		0.00	5,155	0	4,167	0	9,322	6.47

04. Contract 02 REED TYPE ALT 2

04- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	3.00	EA		0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL					2.44	0.00	1.33	0.00	3.77	
ROOM	50.00	LF		0.00	122	0	66	0	188	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	150.00	LF		0.00	30	0	13	0	43	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	EA		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCHING					100.00	0.00	0.00	0.00	100.00	
	50.00	LF		0.00	5,000	0	0	0	5,000	100.00
TOTAL S-123					27,017	0	8,942	0	35,959	
TOTAL BULKHEAD BEAMS FOR DEWAT	50742	LBS			0	0	25,371	0	25,371	0.50
TOTAL NEEDLE BEAMS FOR DEWATER	26196	BF			0	0	79,898	0	79,898	3.05
TOTAL Lock Gates & Operate Mac					778,682	0	434,765	0	1,213,447	
TOTAL Locks					778,682	0	434,765	0	1,213,447	
TOTAL Locks	1.00	EA			778,682	0	434,765	0	1,213,447	1213447
TOTAL Construction Cost					778,682	0	434,765	0	1,213,447	
04- B. Non-Construction Cost										
TOTAL Lands and Damages					0	0	0	2,500	2,500	
TOTAL Planning, Engineering an					0	0	0	199,244	199,244	

04. Contract 02 REED TYPE ALT 2

04- B. Non-Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Construction Management					0	0	0	249,056	249,056	
TOTAL Non-Construction Cost					0	0	0	450,800	450,800	
TOTAL Contract 02 REED TYPE					778,682	0	434,765	450,800	1,664,247	
TOTAL MANATEE PROTECTION					778,682	0	434,765	450,800	1,664,247	

STRIP TYPE

MANATEE PROTECTION
CENTRAL AND SOUTH FLORIDA

Designed By: JACKSONVILLE DISTRICT OFFICE
Estimated By: E.P.C.

Prepared By: E.P.CAMPA

Preparation Date: 08/30/94
Effective Date of Pricing: 08/30/94

Sales Tax: 6.00%

FOR OFFICIAL USE ONLY

SUMMARY REPORTS SUMMARY PAGE

DETAILED ESTIMATE DETAIL PAGE

No Backup Reports...

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** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
01 Contract 01 STRIP TYPE ALT 1		1,801,682	270,252	2,071,934	
TOTAL MANATEE PROTECTION		1,801,682	270,252	2,071,934	

** PROJECT OWNER SUMMARY - UserDefi **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
01 Contract 01 STRIP TYPE ALT 1					
01- A Construction Cost					
01- A/05 Locks					
01- A/05.00 Locks					
01- A/05.00.57 Lock Gates & Operate Machine U/L					
01- A/05.00.57/01 S-13		14,370	2,155	16,525	
01- A/05.00.57/02 S-20F		56,663	8,499	65,163	
01- A/05.00.57/03 S-20G		27,178	4,077	31,254	
01- A/05.00.57/04 S-21		69,951	10,493	80,443	
01- A/05.00.57/05 S-21A		46,844	7,027	53,870	
01- A/05.00.57/06 S-22		53,115	7,967	61,082	
01- A/05.00.57/07 S-25		21,498	3,225	24,723	
01- A/05.00.57/08 S-25B		42,677	6,402	49,079	
01- A/05.00.57/09 S-26		51,374	7,706	59,080	
01- A/05.00.57/10 S-28		46,430	6,965	53,395	
01- A/05.00.57/11 S-33		27,594	4,139	31,733	
01- A/05.00.57/12 S-77		75,455	11,318	86,773	
01- A/05.00.57/14 S-79		427,634	64,145	491,779	
01- A/05.00.57/15 S-308C		75,147	11,272	86,419	
01- A/05.00.57/16 S-127		45,954	6,893	52,847	
01- A/05.00.57/17 S-131		45,954	6,893	52,847	
01- A/05.00.57/18 S-135		45,954	6,893	52,847	
01- A/05.00.57/20 S-27		57,847	8,677	66,524	
01- A/05.00.57/21 S-29		117,611	17,642	135,252	
01- A/05.00.57/22 S-123		41,555	6,233	47,789	
01- A/05.00.57/23 STEEL BULKHEADS FOR DEWATERING	50742.00 LBS	32,277	4,842	37,119	0.73
01- A/05.00.57/24 NEEDLE BEAMS FOR DEWATERING	26196.00 BF	101,646	15,247	116,893	4.46
TOTAL Lock Gates & Operate Machine U/L		1,524,726	228,709	1,753,435	
TOTAL Locks		1,524,726	228,709	1,753,435	
TOTAL Locks	1.00 EA	1,524,726	228,709	1,753,435	1753435
TOTAL Construction Cost		1,524,726	228,709	1,753,435	
01- B Non-Construction Cost					
01- B/01 Lands and Damages		2,500	375	2,875	
01- B/30 Planning, Engineering and Design		121,978	18,297	140,275	
01- B/31 Construction Management (S&I)		152,478	22,872	175,350	
TOTAL Non-Construction Cost		276,956	41,543	318,499	

** PROJECT OWNER SUMMARY - UserDefi **

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
TOTAL Contract 01 STRIP TYPE ALT 1			1,801,682	270,252	2,071,934	
TOTAL MANATEE PROTECTION			1,801,682	270,252	2,071,934	

** PROJECT INDIRECT SUMMARY - Contract **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OF	PROFIT	BOND	TOTAL COST	UNIT COST
01 Contract 01 STRIP TYPE ALT 1		1,475,451	95,880	90,606	124648	15096	1,801,682	
MANATEE PROTECTION		1,475,451	95,880	90,606	124648	15096	1,801,682	
CONTING							270,252	
TOTAL INCL OWNER COSTS							2,071,934	

** PROJECT INDIRECT SUMMARY - UserDefi **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OF	PROFIT	BOND	TOTAL COST	UNIT COST
01 Contract 01 STRIP TYPE ALT 1								
01- A Construction Cost								
01- A/05 Locks								
01- A/05.00 Locks								
01- A/05.00.57 Lock Gates & Operate Machine U/L								
01- A/05.00.57/01 S-13		11,295	904	854	1,175	142	14,370	
01- A/05.00.57/02 S-20F		44,539	3,563	3,367	4,632	561	56,663	
01- A/05.00.57/03 S-20G		21,363	1,709	1,615	2,222	269	27,178	
01- A/05.00.57/04 S-21		54,984	4,399	4,157	5,719	693	69,951	
01- A/05.00.57/05 S-21A		36,821	2,946	2,784	3,830	464	46,844	
01- A/05.00.57/06 S-22		41,750	3,340	3,156	4,342	526	53,115	
01- A/05.00.57/07 S-25		16,898	1,352	1,278	1,757	213	21,498	
01- A/05.00.57/08 S-25B		33,546	2,684	2,536	3,489	423	42,677	
01- A/05.00.57/09 S-26		40,382	3,231	3,053	4,200	509	51,374	
01- A/05.00.57/10 S-28		36,496	2,920	2,759	3,796	460	46,430	
01- A/05.00.57/11 S-33		21,690	1,735	1,640	2,256	273	27,594	
01- A/05.00.57/12 S-77		59,310	4,745	4,484	6,169	747	75,455	
01- A/05.00.57/14 S-79		336,137	26,891	25,412	34,960	4,234	427,634	
01- A/05.00.57/15 S-308C		59,068	4,725	4,466	6,143	744	75,147	
01- A/05.00.57/16 S-127		36,122	2,890	2,731	3,757	455	45,954	
01- A/05.00.57/17 S-131		36,122	2,890	2,731	3,757	455	45,954	
01- A/05.00.57/18 S-135		36,122	2,890	2,731	3,757	455	45,954	
01- A/05.00.57/20 S-27		45,470	3,638	3,438	4,729	573	57,847	
01- A/05.00.57/21 S-29		92,447	7,396	6,989	9,615	1,164	117,611	
01- A/05.00.57/22 S-123		32,664	2,613	2,469	3,397	411	41,555	
01- A/05.00.57/23 STEEL BULKHEADS FOR DEWATERING	50742.00 LBS	25,371	2,030	1,918	2,639	320	32,277	0.64
01- A/05.00.57/24 NEEDLE BEAMS FOR DEWATERING	26196.00 BF	79,898	6,392	6,040	8,310	1,006	101,646	3.88
TOTAL Lock Gates & Operate Machine U		1,198,495	95,880	90,606	124648	15096	1,524,726	
TOTAL Locks		1,198,495	95,880	90,606	124648	15096	1,524,726	
TOTAL Locks	1.00 EA	1,198,495	95,880	90,606	124648	15096	1,524,726	1524726
TOTAL Construction Cost		1,198,495	95,880	90,606	124648	15096	1,524,726	
01- B Non-Construction Cost								
01- B/01 Lands and Damages		2,500	0	0	0	0	2,500	
01- B/30 Planning, Engineering and Design		121,978	0	0	0	0	121,978	
01- B/31 Construction Management (S&I)		152,478	0	0	0	0	152,478	
TOTAL Non-Construction Cost		276,956	0	0	0	0	276,956	

** PROJECT INDIRECT SUMMARY - UserDefi **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OF	PROFIT	BOND	TOTAL COST	UNIT COST
TOTAL Contract 01 STRIP TYPE ALT		1,475,451	95,880	90,606	124648	15096	1,801,682	
TOTAL MANATEE PROTECTION		1,475,451	95,880	90,606	124648	15096	1,801,682	
CONTING							270,252	
TOTAL INCL OWNER COSTS							2,071,934	

** PROJECT DIRECT SUMMARY - Contract **

	QUANTITY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
01 Contract 01 STRIP TYPE ALT 1		645,646	0	552,849	276,956	1,475,451	
MANATEE PROTECTION		645,646	0	552,849	276,956	1,475,451	
OVERHEAD						95,880	
SUBTOTAL						1,571,331	
HOME OFC						90,606	
SUBTOTAL						1,661,937	
PROFIT						124,648	
SUBTOTAL						1,786,585	
BOND						15,096	
TOTAL INCL INDIRECTS						1,801,682	
CONTING						270,252	
TOTAL INCL OWNER COSTS						2,071,934	

** PROJECT DIRECT SUMMARY - UserDefi **

	QUANTITY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
01 Contract 01 STRIP TYPE ALT 1							
01- A Construction Cost							
01- A/05 Locks							
01- A/05.00 Locks							
01- A/05.00.57 Lock Gates & Operate Machine U/L							
01- A/05.00.57/01 S-13		8,685	0	2,611	0	11,295	
01- A/05.00.57/02 S-20F		29,796	0	14,744	0	44,539	
01- A/05.00.57/03 S-20G		11,240	0	10,123	0	21,363	
01- A/05.00.57/04 S-21		33,931	0	21,053	0	54,984	
01- A/05.00.57/05 S-21A		21,379	0	15,442	0	36,821	
01- A/05.00.57/06 S-22		27,139	0	14,611	0	41,750	
01- A/05.00.57/07 S-25		7,784	0	9,114	0	16,898	
01- A/05.00.57/08 S-25B		21,833	0	11,713	0	33,546	
01- A/05.00.57/09 S-26		22,617	0	17,764	0	40,382	
01- A/05.00.57/10 S-28		22,497	0	13,999	0	36,496	
01- A/05.00.57/11 S-33		10,905	0	10,785	0	21,690	
01- A/05.00.57/12 S-77		42,434	0	16,877	0	59,310	
01- A/05.00.57/14 S-79		189,610	0	146,528	0	336,137	
01- A/05.00.57/15 S-308C		41,958	0	17,110	0	59,068	
01- A/05.00.57/16 S-127		19,072	0	17,050	0	36,122	
01- A/05.00.57/17 S-131		19,072	0	17,050	0	36,122	
01- A/05.00.57/18 S-135		19,072	0	17,050	0	36,122	
01- A/05.00.57/20 S-27		22,833	0	22,637	0	45,470	
01- A/05.00.57/21 S-29		53,693	0	38,754	0	92,447	
01- A/05.00.57/22 S-123		20,097	0	12,567	0	32,664	
01- A/05.00.57/23 STEEL BULKHEADS FOR DEWATERING	50742.00 LBS	0	0	25,371	0	25,371	0.50
01- A/05.00.57/24 NEEDLE BEAMS FOR DEWATERING	26196.00 BF	0	0	79,898	0	79,898	3.05
TOTAL Lock Gates & Operate Machine U/L		645,646	0	552,849	0	1,198,495	
TOTAL Locks		645,646	0	552,849	0	1,198,495	
TOTAL Locks	1.00 EA	645,646	0	552,849	0	1,198,495	1198495
TOTAL Construction Cost		645,646	0	552,849	0	1,198,495	
01- B Non-Construction Cost							
01- B/01 Lands and Damages		0	0	0	2,500	2,500	
01- B/30 Planning, Engineering and Design		0	0	0	121,978	121,978	
01- B/31 Construction Management (S&I)		0	0	0	152,478	152,478	
TOTAL Non-Construction Cost		0	0	0	276,956	276,956	

** PROJECT DIRECT SUMMARY - UserDefi **

	QUANTITY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Contract 01 STRIP TYPE ALT 1		645,646	0	552,849	276,956	1,475,451	
TOTAL MANATEE PROTECTION		645,646	0	552,849	276,956	1,475,451	
OVERHEAD						95,880	
SUBTOTAL						1,571,331	
HOME OFC						90,606	
SUBTOTAL						1,661,937	
PROFIT						124,648	
SUBTOTAL						1,786,585	
BOND						15,096	
TOTAL INCL INDIRECTS						1,801,682	
CONTING						270,252	
TOTAL INCL OWNER COSTS						2,071,934	

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
01. Contract 01 STRIP TYPE ALT 1										
01- A. Construction Cost										
01- A/05. Locks										
01- A/05.00. Locks										
01- A/05.00.57. Lock Gates & Operate Machine U/L										
01- A/05.00.57/01. S-13										
USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	16.00	LF		0.00	688	0	712	0	1,400	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	16.00	LF		0.00	688	0	712	0	1,400	87.52
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	240.00	LF		0.00	859	0	695	0	1,554	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	2.00	EA		0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	36.00	LF		0.00	88	0	48	0	136	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	108.00	LF		0.00	22	0	9	0	31	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	4.00	EA		0.00	80	0	106	0	186	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	3.00	EA		0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	1.00	EA		0.00	20	0	27	0	47	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	1.00	LS		0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.00	0.00	0.00	0.00	0.00	
	1.00	LS		0.00	0	0	0	0	0	0.00
TOTAL S-13					8,685	0	2,611	0	11,295	

01. Contract 01 STRIP TYPE ` ALT 1

01- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
01- A/05.00.57/02. S-20F								
USR AA SWITCH ASSEM UPSTREAM			43.00	0.00	44.52	0.00	87.52	
	36.00 LF	0.00	1,548	0	1,603	0	3,151	87.52
USR AA SWITCH ASSEM DOWNSTREAM			43.00	0.00	44.52	0.00	87.52	
	36.00 LF	0.00	1,548	0	1,603	0	3,151	87.52
USR AA 1/2" CONDUIT S.S.			3.58	0.00	2.89	0.00	6.47	
	2160.00 LF	0.00	7,733	0	6,251	0	13,983	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	4.00 EA	0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM			2.44	0.00	1.33	0.00	3.77	
	76.00 LF	0.00	185	0	101	0	286	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	228.00 LF	0.00	46	0	19	0	65	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	12.00 EA	0.00	240	0	318	0	558	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	6.00 EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	3.00 EA	0.00	60	0	80	0	140	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	3.00 LS	0.00	18,000	0	0	0	18,000	6000.00
USR AA TRENCH TO CONTROL ROOM			0.40	0.00	106.00	0.00	106.40	
	40.00 LF	0.00	16	0	4,240	0	4,256	106.40
TOTAL S-20F			29,796	0	14,744	0	44,539	
01- A/05.00.57/03. S-20G								
USR AA SWITCH ASSEM UPSTREAM			43.00	0.00	44.52	0.00	87.52	
	25.00 LF	0.00	1,075	0	1,113	0	2,188	87.52
USR AA SWITCH ASSEM DOWNSTREAM			43.00	0.00	44.52	0.00	87.52	
	25.00 LF	0.00	1,075	0	1,113	0	2,188	87.52

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 1/2" CONDUIT S.S.				3.58	0.00	2.89	0.00	6.47	
	720.00	LF	0.00	2,578	0	2,084	0	4,661	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	2.00	EA	0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM				2.44	0.00	1.33	0.00	3.77	
	50.00	LF	0.00	122	0	66	0	188	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	150.00	LF	0.00	30	0	13	0	43	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00	EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	4.00	EA	0.00	80	0	106	0	186	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	3.00	EA	0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	1.00	EA	0.00	20	0	27	0	47	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	1.00	LS	0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCH TO CONTROL ROOM				0.40	0.00	106.00	0.00	106.40	
	50.00	LF	0.00	20	0	5,300	0	5,320	106.40
TOTAL S-20G				11,240	0	10,123	0	21,363	

01- A/05.00.57/04. S-21

USR AA SWITCH ASSEM UPSTREAM				43.00	0.00	44.52	0.00	87.52	
	81.00	LF	0.00	3,483	0	3,606	0	7,089	87.52
USR AA SWITCH ASSEM DOWNSTREAM				43.00	0.00	44.52	0.00	87.52	
	81.00	LF	0.00	3,483	0	3,606	0	7,089	87.52
USR AA 1/2" CONDUIT S.S.				3.58	0.00	2.89	0.00	6.47	
	2160.00	LF	0.00	7,733	0	6,251	0	13,983	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	4.00	EA	0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM				2.44	0.00	1.33	0.00	3.77	
	141.00	LF	0.00	344	0	187	0	531	3.77

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	423.00 LF	0.00	85	0	36	0	120	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	12.00 EA	0.00	240	0	318	0	558	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	9.00 EA	0.00	180	0	239	0	419	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	3.00 EA	0.00	60	0	80	0	140	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	3.00 LS	0.00	18,000	0	0	0	18,000	6000.00
USR AA TRENCH TO CONTROL ROOM			0.40	0.00	106.00	0.00	106.40	
	60.00 LF	0.00	24	0	6,360	0	6,384	106.40
TOTAL S-21			33,931	0	21,053	0	54,984	

01- A/05.00.57/05. S-21A

USR AA SWITCH ASSEM UPSTREAM			43.00	0.00	44.52	0.00	87.52	
	40.00 LF	0.00	1,720	0	1,781	0	3,501	87.52
USR AA SWITCH ASSEM DOWNSTREAM			43.00	0.00	44.52	0.00	87.52	
	40.00 LF	0.00	1,720	0	1,781	0	3,501	87.52
USR AA 1/2" CONDUIT S.S.			3.58	0.00	2.89	0.00	6.47	
	1440.00 LF	0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	3.00 EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL			2.44	0.00	1.33	0.00	3.77	
ROOM	65.00 LF	0.00	159	0	86	0	245	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	195.00 LF	0.00	39	0	17	0	56	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	8.00 EA	0.00	160	0	212	0	372	46.50

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	6.00	EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	2.00	EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS	0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM				0.40	0.00	106.00	0.00	106.40	
	65.00	LF	0.00	26	0	6,890	0	6,916	106.40
TOTAL S-21A				21,379	0	15,442	0	36,821	
01- A/05.00.57/06. S-22									
USR AA SWITCH ASSEM UPSTREAM				43.00	0.00	44.52	0.00	87.52	
	36.00	LF	0.00	1,548	0	1,603	0	3,151	87.52
USR AA SWITCH ASSEM DOWNSTREAM				43.00	0.00	44.52	0.00	87.52	
	36.00	LF	0.00	1,548	0	1,603	0	3,151	87.52
USR AA 1/2" CONDUIT S.S.				3.58	0.00	2.89	0.00	6.47	
	1440.00	LF	0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	3.00	EA	0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM				2.44	0.00	1.33	0.00	3.77	
	100.00	LF	0.00	244	0	133	0	377	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	300.00	LF	0.00	60	0	25	0	85	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00	EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	8.00	EA	0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	6.00	EA	0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	2.00	EA	0.00	40	0	53	0	93	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	3.00	LS	0.00	18,000	0	0	0	18,000	6000.00

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA TRENCH TO CONTROL ROOM			0.40	0.00	106.00	0.00	106.40	
	60.00 LF	0.00	24	0	6,360	0	6,384	106.40
TOTAL S-22			27,139	0	14,611	0	41,750	
01- A/05.00.57/07. S-25								
USR AA SWITCH ASSEM UPSTREAM			43.00	0.00	44.52	0.00	87.52	
	9.00 LF	0.00	387	0	401	0	788	87.52
USR AA SWITCH ASSEM DOWNSTREAM			43.00	0.00	44.52	0.00	87.52	
	9.00 LF	0.00	387	0	401	0	788	87.52
USR AA 1/2" CONDUIT S.S.			3.58	0.00	2.89	0.00	6.47	
	120.00 LF	0.00	430	0	347	0	777	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	2.00 EA	0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM			2.44	0.00	1.33	0.00	3.77	
	70.00 LF	0.00	171	0	93	0	264	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	210.00 LF	0.00	42	0	18	0	60	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	4.00 EA	0.00	80	0	106	0	186	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	3.00 EA	0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	1.00 EA	0.00	20	0	27	0	47	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	1.00 LS	0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCH TO CONTROL ROOM			0.40	0.00	106.00	0.00	106.40	
	70.00 LF	0.00	28	0	7,420	0	7,448	106.40
TOTAL S-25			7,784	0	9,114	0	16,898	

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
01- A/05.00.57/08. S-25B										
USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	46.00	LF		0.00	1,978	0	2,048	0	4,026	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	46.00	LF		0.00	1,978	0	2,048	0	4,026	87.52
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	1440.00	LF		0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	3.00	EA		0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	50.00	LF		0.00	122	0	66	0	188	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	150.00	LF		0.00	30	0	13	0	43	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	25.00	LF		0.00	10	0	2,650	0	2,660	106.40
TOTAL S-25B					21,833	0	11,713	0	33,546	
01- A/05.00.57/09. S-26										
USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	54.00	LF		0.00	2,322	0	2,404	0	4,726	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	54.00	LF		0.00	2,322	0	2,404	0	4,726	87.52

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	1440.00	LF		0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	3.00	EA		0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	75.00	LF		0.00	183	0	99	0	282	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	225.00	LF		0.00	45	0	19	0	64	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	75.00	LF		0.00	30	0	7,950	0	7,980	106.40
TOTAL S-26					22,617	0	17,764	0	40,382	

01- A/05.00.57/10. S-28

USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	54.00	LF		0.00	2,322	0	2,404	0	4,726	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	54.00	LF		0.00	2,322	0	2,404	0	4,726	87.52
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	1440.00	LF		0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	3.00	EA		0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	40.00	LF		0.00	98	0	53	0	151	3.77

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	120.00 LF		0.00	24	0	10	0	34	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00 EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	8.00 EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	6.00 EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	2.00 EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	2.00 LS		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM				0.40	0.00	106.00	0.00	106.40	
	40.00 LF		0.00	16	0	4,240	0	4,256	106.40
TOTAL S-28				22,497	0	13,999	0	36,496	

01- A/05.00.57/11. S-33

USR AA SWITCH ASSEM UPSTREAM				43.00	0.00	44.52	0.00	87.52	
	20.00 LF		0.00	860	0	890	0	1,750	87.52
USR AA SWITCH ASSEM DOWNSTREAM				43.00	0.00	44.52	0.00	87.52	
	20.00 LF		0.00	860	0	890	0	1,750	87.52
USR AA 1/2" CONDUIT S.S.				3.58	0.00	2.89	0.00	6.47	
	720.00 LF		0.00	2,578	0	2,084	0	4,661	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	2.00 EA		0.00	120	0	148	0	268	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM				2.44	0.00	1.33	0.00	3.77	
	80.00 LF		0.00	195	0	106	0	301	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	240.00 LF		0.00	48	0	20	0	68	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00 EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	4.00 EA		0.00	80	0	106	0	186	46.50

No errors detected...

* * * END OF ERROR REPORT * * *

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	3.00	EA		0.00	60	0	80	0	140	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	1.00	EA		0.00	20	0	27	0	47	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	1.00	LS		0.00	6,000	0	0	0	6,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	60.00	LF		0.00	24	0	6,360	0	6,384	106.40
TOTAL S-33					10,905	0	10,785	0	21,690	
01- A/05.00.57/12. S-77										
USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	80.00	LF		0.00	3,440	0	3,562	0	7,002	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	80.00	LF		0.00	3,440	0	3,562	0	7,002	87.52
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	2880.00	LF		0.00	10,310	0	8,334	0	18,645	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	5.00	EA		0.00	300	0	371	0	671	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	80.00	LF		0.00	195	0	106	0	301	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	240.00	LF		0.00	48	0	20	0	68	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	16.00	EA		0.00	320	0	424	0	744	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	12.00	EA		0.00	240	0	318	0	558	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	4.00	EA		0.00	80	0	106	0	186	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	4.00	LS		0.00	24,000	0	0	0	24,000	6000.00

01- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL S-77				42,434	0	16,877	0	59,310	
01- A/05.00.57/14. S-79									
USR AA SWITCH ASSEM UPSTREAM				150.00	0.00	169.60	0.00	319.60	
	325.00 LF		0.00	48,750	0	55,120	0	103,870	319.60
USR AA SWITCH ASSEM DOWNSTREAM				150.00	0.00	169.60	0.00	319.60	
	325.00 LF		0.00	48,750	0	55,120	0	103,870	319.60
USR AA 1/2" CONDUIT S.S.				3.58	0.00	2.89	0.00	6.47	
	11520 LF		0.00	41,242	0	33,337	0	74,578	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	9.00 EA		0.00	540	0	668	0	1,208	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM				2.44	0.00	1.33	0.00	3.77	
	325.00 LF		0.00	793	0	431	0	1,224	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	975.00 LF		0.00	195	0	83	0	278	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00 EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	32.00 EA		0.00	640	0	848	0	1,488	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	24.00 EA		0.00	480	0	636	0	1,116	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	8.00 EA		0.00	160	0	212	0	372	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	8.00 LS		0.00	48,000	0	0	0	48,000	6000.00
TOTAL S-79				189,610	0	146,528	0	336,137	
01- A/05.00.57/15. S-308C									
USR AA SWITCH ASSEM UPSTREAM				43.00	0.00	44.52	0.00	87.52	
	116.00 LF		0.00	4,988	0	5,164	0	10,152	87.52
USR AA SWITCH ASSEM DOWNSTREAM				43.00	0.00	44.52	0.00	87.52	
	116.00 LF		0.00	4,988	0	5,164	0	10,152	87.52

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 1/2" CONDUIT S.S.				3.58	0.00	2.89	0.00	6.47	
	1800.00 LF		0.00	6,444	0	5,209	0	11,653	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	5.00 EA		0.00	300	0	371	0	671	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM				2.44	0.00	1.33	0.00	3.77	
	177.00 LF		0.00	432	0	235	0	666	3.77
USR AA 3#12 WIRE				0.20	0.00	0.08	0.00	0.28	
	531.00 LF		0.00	106	0	45	0	151	0.28
USR AA CONTROL BOX				60.00	0.00	74.20	0.00	134.20	
	1.00 EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS				20.00	0.00	26.50	0.00	46.50	
	16.00 EA		0.00	320	0	424	0	744	46.50
USR AA LIMIT SWITCHS				20.00	0.00	26.50	0.00	46.50	
	12.00 EA		0.00	240	0	318	0	558	46.50
USR AA STOP SWITCH				20.00	0.00	26.50	0.00	46.50	
	4.00 EA		0.00	80	0	106	0	186	46.50
USR AA DEWATER				6000.00	0.00	0.00	0.00	6000.00	
	4.00 LS		0.00	24,000	0	0	0	24,000	6000.00
TOTAL S-308C				41,958	0	17,110	0	59,068	

01- A/05.00.57/16. S-127

USR AA SWITCH ASSEM UPSTREAM				43.00	0.00	44.52	0.00	87.52	
	30.00 LF		0.00	1,290	0	1,336	0	2,626	87.52
USR AA SWITCH ASSEM DOWNSTREAM				43.00	0.00	44.52	0.00	87.52	
	30.00 LF		0.00	1,290	0	1,336	0	2,626	87.52
USR AA 1/2" CONDUIT S.S.				3.58	0.00	2.89	0.00	6.47	
	960.00 LF		0.00	3,437	0	2,778	0	6,215	6.47
USR AA JUNCTION BOX				60.00	0.00	74.20	0.00	134.20	
	4.00 EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM				2.44	0.00	1.33	0.00	3.77	
	130.00 LF		0.00	317	0	172	0	489	3.77

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	390.00	LF		0.00	78	0	33	0	111	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	100.00	LF		0.00	40	0	10,600	0	10,640	106.40
TOTAL S-127					19,072	0	17,050	0	36,122	
01- A/05.00.57/17. S-131										
USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	30.00	LF		0.00	1,290	0	1,336	0	2,626	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	30.00	LF		0.00	1,290	0	1,336	0	2,626	87.52
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	960.00	LF		0.00	3,437	0	2,778	0	6,215	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	4.00	EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	130.00	LF		0.00	317	0	172	0	489	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	390.00	LF		0.00	78	0	33	0	111	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	100.00	LF		0.00	40	0	10,600	0	10,640	106.40
TOTAL S-131					19,072	0	17,050	0	36,122	

01- A/05.00.57/18. S-135

USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	30.00	LF		0.00	1,290	0	1,336	0	2,626	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	30.00	LF		0.00	1,290	0	1,336	0	2,626	87.52
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	960.00	LF		0.00	3,437	0	2,778	0	6,215	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	4.00	EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM	130.00	LF		0.00	2.44 317	0.00 0	1.33 172	0.00 0	3.77 489	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	390.00	LF		0.00	78	0	33	0	111	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS		0.00	12,000	0	0	0	12,000	6000.00

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	100.00	LF		0.00	40	0	10,600	0	10,640	106.40
TOTAL S-135					19,072	0	17,050	0	36,122	
01- A/05.00.57/20. S-27										
USR AA SWITCH ASSEM UPSTREAM					43.00	0.00	44.52	0.00	87.52	
	54.00	LF		0.00	2,322	0	2,404	0	4,726	87.52
USR AA SWITCH ASSEM DOWNSTREAM					43.00	0.00	44.52	0.00	87.52	
	54.00	LF		0.00	2,322	0	2,404	0	4,726	87.52
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	1440.00	LF		0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	3.00	EA		0.00	180	0	223	0	403	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	140.00	LF		0.00	342	0	186	0	527	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	420.00	LF		0.00	84	0	36	0	120	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	120.00	LF		0.00	48	0	12,720	0	12,768	106.40
TOTAL S-27					22,833	0	22,637	0	45,470	

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY UOM CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
01- A/05.00.57/21. S-29								
USR AA SWITCH ASSEM UPSTREAM			43.00	0.00	44.52	0.00	87.52	
	88.00 LF	0.00	3,784	0	3,918	0	7,702	87.52
USR AA SWITCH ASSEM DOWNSTREAM			43.00	0.00	44.52	0.00	87.52	
	88.00 LF	0.00	3,784	0	3,918	0	7,702	87.52
USR AA 1/2" CONDUIT S.S.			3.58	0.00	2.89	0.00	6.47	
	5760.00 LF	0.00	20,621	0	16,668	0	37,289	6.47
USR AA JUNCTION BOX			60.00	0.00	74.20	0.00	134.20	
	5.00 EA	0.00	300	0	371	0	671	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM			2.44	0.00	1.33	0.00	3.77	
	150.00 LF	0.00	366	0	199	0	565	3.77
USR AA 3#12 WIRE			0.20	0.00	0.08	0.00	0.28	
	450.00 LF	0.00	90	0	38	0	128	0.28
USR AA CONTROL BOX			60.00	0.00	74.20	0.00	134.20	
	1.00 EA	0.00	60	0	74	0	134	134.20
USR AA RELAYS			20.00	0.00	26.50	0.00	46.50	
	16.00 EA	0.00	320	0	424	0	744	46.50
USR AA LIMIT SWITCHS			20.00	0.00	26.50	0.00	46.50	
	12.00 EA	0.00	240	0	318	0	558	46.50
USR AA STOP SWITCH			20.00	0.00	26.50	0.00	46.50	
	4.00 EA	0.00	80	0	106	0	186	46.50
USR AA DEWATER			6000.00	0.00	0.00	0.00	6000.00	
	4.00 LS	0.00	24,000	0	0	0	24,000	6000.00
USR AA TRENCH TO CONTROL ROOM			0.40	0.00	106.00	0.00	106.40	
	120.00 LF	0.00	48	0	12,720	0	12,768	106.40
TOTAL S-29			53,693	0	38,754	0	92,447	
01- A/05.00.57/22. S-123								
USR AA SWITCH ASSEM UPSTREAM			43.00	0.00	44.52	0.00	87.52	
	25.00 LF	0.00	1,075	0	1,113	0	2,188	87.52
USR AA SWITCH ASSEM DOWNSTREAM			43.00	0.00	44.52	0.00	87.52	
	25.00 LF	0.00	1,075	0	1,113	0	2,188	87.52

01. Contract 01 STRIP TYPE ALT 1

01- A. Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
USR AA 1/2" CONDUIT S.S.					3.58	0.00	2.89	0.00	6.47	
	1440.00	LF		0.00	5,155	0	4,167	0	9,322	6.47
USR AA JUNCTION BOX					60.00	0.00	74.20	0.00	134.20	
	4.00	EA		0.00	240	0	297	0	537	134.20
USR AA 1/2" CONDUIT TO CONTROL ROOM					2.44	0.00	1.33	0.00	3.77	
	50.00	LF		0.00	122	0	66	0	188	3.77
USR AA 3#12 WIRE					0.20	0.00	0.08	0.00	0.28	
	150.00	LF		0.00	30	0	13	0	43	0.28
USR AA CONTROL BOX					60.00	0.00	74.20	0.00	134.20	
	1.00	EA		0.00	60	0	74	0	134	134.20
USR AA RELAYS					20.00	0.00	26.50	0.00	46.50	
	8.00	EA		0.00	160	0	212	0	372	46.50
USR AA LIMIT SWITCHS					20.00	0.00	26.50	0.00	46.50	
	6.00	EA		0.00	120	0	159	0	279	46.50
USR AA STOP SWITCH					20.00	0.00	26.50	0.00	46.50	
	2.00	EA		0.00	40	0	53	0	93	46.50
USR AA DEWATER					6000.00	0.00	0.00	0.00	6000.00	
	2.00	LS		0.00	12,000	0	0	0	12,000	6000.00
USR AA TRENCH TO CONTROL ROOM					0.40	0.00	106.00	0.00	106.40	
	50.00	LF		0.00	20	0	5,300	0	5,320	106.40
TOTAL S-123					20,097	0	12,567	0	32,664	
TOTAL STEEL BULKHEADS FOR DEWA	50742	LBS			0	0	25,371	0	25,371	0.50
TOTAL NEEDLE BEAMS FOR DEWATER	26196	BF			0	0	79,898	0	79,898	3.05
TOTAL Lock Gates & Operate Mac					645,646	0	552,849	0	1,198,495	
TOTAL Locks					645,646	0	552,849	0	1,198,495	
TOTAL Locks	1.00	EA			645,646	0	552,849	0	1,198,495	1198495
TOTAL Construction Cost					645,646	0	552,849	0	1,198,495	

01. Contract 01 STRIP TYPE ALT 1

01- B. Non-Construction Cost	QUANTY	UOM	CREW ID	OUTPUT	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
01- B. Non-Construction Cost										
TOTAL Lands and Damages					0	0	0	2,500	2,500	
TOTAL Planning, Engineering an					0	0	0	121,978	121,978	
TOTAL Construction Management					0	0	0	152,478	152,478	
TOTAL Non-Construction Cost					0	0	0	276,956	276,956	
TOTAL Contract 01 STRIP TYPE					645,646	0	552,849	276,956	1,475,451	
TOTAL MANATEE PROTECTION					645,646	0	552,849	276,956	1,475,451	

No errors detected...

* * * END OF ERROR REPORT * * *

APPENDIX C

DEPARTMENT OF THE ARMY
Jacksonville District, Corps of Engineers
CESAJ-CO-OR P.O. Box 4970
Jacksonville, Florida 32232-0019

CESAJ SOP No. 1130-2-3 DATE

Project Operations
MANATEE PROTECTION PLAN
FOR WATER CONTROL STRUCTURES
OPERATED BY THE JACKSONVILLE DISTRICT
U.S. ARMY CORPS OF ENGINEERS

1. Authority and Applicability.

The Project Operations Manatee Protection Plan for the Jacksonville District is prepared in accordance with ER 1130-2-400, Management of Natural Resources and Outdoor Recreation at Civil Works Water Resource Projects, 1 June 1986; the Florida Manatee Recovery Plan, revised 24 July 1989; the Marine Mammal Protection Act of 1972; and the Endangered Species Act of 1973, as amended; and the approved water control plans and manuals for Central and Southern Florida Project; and is applicable to all Jacksonville District Field Operating Activities, (FOA), having Civil Works water control structure responsibilities.

2. Purpose and Objectives.

The purpose of this plan is to provide policies, guidelines, and operating procedures for the effective long-range management and operation of water control structures to minimize manatee risk. Water control structure-related manatee deaths (navigation structures, floodgates, culverts, and other structures) are second only to boat and barge collisions as an identified source of human-caused mortality. This plan will serve to address operational tasks identified in the Florida Manatee Recovery Plan, prepared by the Florida Manatee Recovery Team, in order to meet our objective.

The objective is to eliminate U.S. Army Corps of Engineers water control structure-related manatee mortality by:

a. Identifying problem structures through site-specific structure-related mortality investigations.

b. Testing and implementing alternative operational methods, schedules, and/or partial or complete structural modifications.

c. Following proper operational protocol and procedures for assuring that the manatee receives safety consideration when in the vicinity of a U.S. Army Corps of Engineers water control structure.

3. Background.

The U.S. Army Corps of Engineers is enjoined under Section 2 of the Endangered Species Act of 1973, as amended (the Act) to seek to conserve endangered species and threatened species. The Jacksonville District, U.S. Army Corps of Engineers, is a partner with the U.S. Fish and Wildlife Service and other Federal, State and local agencies to provide for an environment whereby the Florida subspecies of the West Indian Manatee is assured consideration regarding safety and recovery. The Corps has accepted this challenge and many manatee protection tasks have already been completed by our project operations offices. These actions include screens placed on lock gates to prevent manatee access to sector gate recesses, reduced lock gate closure speeds, and establishment of flood gate operational protocols. These innovative actions have resulted in less risk to the manatee. As a partner in the Florida Manatee Recovery Plan, the Jacksonville District is committed to meeting its charge under Section 7 of the Act by reducing manatee risk caused by Corps water control structures.

4. Policies and Procedures.

It is the policy of the Jacksonville District to investigate specific cases of reported structure-related mortality by conducting site-specific studies to identify the precise problem(s) at structures; to comply with established procedures as set forth in this plan for lock, flood gate, culvert and/or other structure operations; and to comply with District reporting requirements.

a. Investigate specific cases of reported structure-related mortality by conducting site-specific studies to identify the precise problem(s) at structures.

(1) Upon official notification by the Florida Department of Environmental Protection (FDEP), and/or the U.S. Fish and Wildlife Service (FWS), the U.S. Army Corps of Engineers (COE), with the assistance of both FDNR and FWS, will conduct investigations of reported structure-related mortality to identify the precise problem at structures.

(2) Operations Branch, Project Operations Section will provide Planning Division, Environmental Studies Section (the District Point of contact for endangered species and a District representative on the Manatee Protection Task Force), Engineering Division, Water Management and Meteorology Section (also a

District representative on the Manatee Protection Task Force) and the affected FOA, a copy of the official FDEP notification. Planning Division, Environmental Studies Section, upon receipt of a manatee necropsy report attributing a manatee death to a Jacksonville District water control structure, will provide a copy of said report to Operations Branch, Project Operations Section. (See Appendix A, Manatee Protection Plan Point of Contact List)

(3) The FOA will conduct a preliminary onsite investigation of the incident.

(4) Upon completion of the preliminary onsite investigation, a written report including an analysis of the incident and recommendations for corrective actions will be completed by the FOA and forwarded through Operations Branch, Project Operations Section and coordinated with both Engineering and Planning Divisions prior to submittal to FDEP and FWS. (See Appendix B, Sample Jacksonville District Manatee Mortality Investigation Report)

(5) When a structure has been identified as a responsible agent in a manatee mortality, the affected FOA will test and/or implement the corrective action plan as soon as it is reasonably possible.

(6) When it has been determined that the corrective action is beneficial to the safety of the manatee, does not adversely affect the structural integrity of the structure, and does not alter the water management function of the structure, modifications will be made permanent as soon as possible within the scope of authorities and funding. All similar structures posing an immediate risk will be similarly modified within a period of twelve months, if possible.

b. Operational protocol for locks, flood control/spillway gates, culverts and/or other structures.

Safety consideration will be given to manatees that come near COE navigation locks, flood control spillways, culverts and other water control structures. Each lock, spillway and culvert structure may differ due to design and water elevations. The following procedures are designed to place the manatee at less risk when in the vicinity of these systems.

(1) Lock Operations.

The following standard operating procedures are in effect for safely locking manatees at Canaveral Lock, St. Lucie Lock, Port Mayaca Lock, Moore Haven Lock, Ortona Lock and W.P. Franklin Lock:

(a) Lock operators will be attentive as to the location and number of manatees in the lock chamber and approaches at all times, as well as aware that manatees may be present even if not visible.

(b) Manatee sightings will be recorded on a Florida Department of Environmental Protection Manatee Sighting Form. These forms are to be submitted monthly to the Florida Department of Environmental Protection, Office of Protected Species Management, 3900 Commonwealth Boulevard, MS 245, Tallahassee, Florida, 32399-3000, with the FOA retaining a file copy for record.

(c) Every effort will be made to avoid hindering the passage of manatees through the locks and to assure their safety around vessels. Special lockages will be provided for manatees that demonstrate a desire to pass in a particular direction. According to the judgement of the lock operator on duty, vessels may be locked with manatees or delayed until the next lockage. At the W.P. Franklin Lock it will be necessary to turn off the bubbler system to allow manatees to enter and exit the lock chamber.

(d) When manatees are first observed in the lock area, lock operators will inform approaching vessels of any manatees in the area and their locations, so craft can use extra caution. Lock operators will then assure that vessels are at idle speed upon entering the approach channels and inform vessels of any manatee movements necessary to their safety.

(e) Every effort will be made not to crowd manatees in the lock chamber, especially with barges and tugs. Sufficient distance between vessels and gates will be maintained at all times.

(f) Precautions will be made to assure manatee safety around sector gates. Operate sector gates at slowest speeds possible for the first minute to avoid manatees being trapped in strong currents. Operate both sector gates simultaneously; leaving one gate closed for any reason other than an emergency or malfunction should be avoided. However, at Canaveral Lock one sector gate may be left closed when not needed for lockage.

(g) Delay vessels or lockage temporarily if imminent danger to a manatee exists by continuing operations. When locking manatees and vessels together delay vessels after lockage to assure manatees enough time to clear the area and gain access to safe water. Vessel operators should then be warned to proceed with caution at idle speed. If there is doubt that the manatee has exited the chamber, the gates shall be left open to assure safe passage.

(h) The FOA will perform inspections of manatee exclusion screening devices on lock gates every 6 months and any time damage is suspected. Deficiencies will be corrected as soon as possible.

(2) Flood Control/Spillway Gate Operations.

The following standard operating procedures, in conjunction with the operating criteria contained in the approved water control plans and manuals for the Central and Southern Florida Project, are designed to reduce manatee risk during spillway operations. These procedures, however, are not intended for use at structures where manatee barriers (whether temporary or permanent) prevent manatee access to the spillway gates. The procedures below should only be used at spillways without barriers, or at spillways where barriers have been removed or are otherwise not fully functional. At spillways where barriers are functional and prevent manatee access to the spillway gates, gates should be operated in accordance with the operating criteria set forth in the water control plans and manuals.

(a) Standard operating procedure for S-78, Ortona; and S-80, St. Lucie.

The following procedures are designed to put the manatee at less risk during spillway operations and are based on the water surface profile (difference between the upper and lower pools) of the S-78 spillway (9' to 11') and S-80 spillway (12' to 14').

(1) On initial gate openings stop gate for 30 second period upon first sign of water movement. (Approximately .01 to .03 feet).

(2) Stop at .05' increments for 30 seconds until a .3' opening is acquired. Observe for a continuous flow across the full gate width at each increment.

(3) Continue opening gate in increments not to exceed .3' until gate is at desired opening. Operator will continuously observe for obstructions in gate opening during this procedure.

(4) If voids appear (interruptions of even water flow across the full gate width) the operator will determine to the best of his/her ability the source of the voids and make the following decision.

(a) If it appears to be trash or debris that is caught in the gate (aquatic plants, trees or other such debris) the operator will continue to open the gate at .3' increments at 30 second periods until the debris has passed

through the gate and then lower the gate at .3' increments at 30 second periods until the desired gate setting is obtained.

(b) If it appears that a manatee has been entrapped, the gate should be operated as follows: If the current gate opening is less than or equal to 0.6 feet, the gate is to be closed to a height of 0.3 feet so that the manatee will be able to free itself. The gate may then be raised to the desired opening; this raising should be done in increments not to exceed 0.3 feet and with continual observations for obstructions. However, if the current gate opening is greater than 0.6 feet, then the gate should be immediately opened to allow the manatee to be washed through (up to a maximum of 2.5 feet) and then adjusted to the desired opening.

(5) Gates will always be maintained at the smallest possible opening across all gates. The minimum gate opening when more than 1 gate is in operation, will be .5 feet. This will allow debris to be flushed through the gate without being caught. The maximum single gate openings will be .9 feet.

(6) Spillway operations will be accomplished only by qualified operators, through on-the-job training, who are able to perform the standard operation procedures for manatee protection described herein.

(b) General rule for operating SINGLE OR MULTIPLE GATES at S-77, Moore Haven; S-79, W.P. Franklin; S-308, Port Mayaca; S-351; S-352; and S-354, when the difference between headwater and tailwater elevations, or head, across these structures is less than or equal to 3.0 feet.

(1) To allow manatees to pass under the gates, the minimum opening for any gate under the "less than or equal to 3.0 feet of head" condition is 2.5 feet. One or more gates may be opened to 2.5 feet, subject to the following constraints: The operator should open the more central gates of the structure first, proceeding outward to those gates further from the center. The operator should also open gates on alternating sides of the structure. Thus, if there are four gates numbered 1-4 from left to right, a correct sequence for opening them would be: Gates 2, 3, 1, and 4. An equally correct sequence would be: Gates 3, 2, 4, and 1. Gates should be closed in reverse order.

(2) Gate openings greater than 2.5 feet should not be made until all gates have been opened to 2.5 feet, at which time additional gate openings may be made as follows: The operator may increase each gate opening in equal increments, in turn, in accordance with the Maximum Allowable Gate Opening (MAGO) curves until the predetermined opening is attained. At the end of the gate opening sequence, all of the gates must be

set at approximately equal gate openings, all in accordance with the MAGO curves. As a practical consideration the spillway gates should not be adjusted such that gate openings differ by more than one foot.

(3) This procedure should be used at S-77 only if the tail water is above +9.0 feet, NGVD; and at S-79 only if the tail water is above -2.0 feet, NGVD. In other words, in the rare event that these conditions are not met, do not exceed the maximum allowable gate opening criteria.

(4) Gate openings greater than 2.5 feet shall be accomplished according to the operational criteria specified in the approved water control plans and manuals for the Central and Southern Florida Project.

(5) Spillway operations will be accomplished only by qualified operators, through on-the-job training, who are able to perform the standard operating procedures for manatee protection as described herein.

(6) The procedures above are only applicable for heads less than or equal to 3.0 feet. Procedures for heads exceeding 3.0 feet are described in the paragraphs that follow. If, while operating under the low head procedures above, the head across the structure should exceed 3.0 feet, the following steps should be taken: The gates should be closed, in reverse order, to openings permitted by the Maximum Allowable Gate Opening (MAGO) curves. The operating procedures applicable to heads greater than 3.0 feet should then be used.

(c) General rule for operating a SINGLE GATE at S-77, S-79, S-308, S-351, S-352, and S-354, provided that the difference between headwater and tailwater elevations, or head, across these structures is greater than 3.0 feet.

(1) If it is predetermined that an opening smaller than or equal to 2.5 feet would be needed for the gate:

The gate may be initially opened to a maximum of 2.5 feet and held at that opening for up to one (1) minute. Forces of the water should "flush-through" any manatee that may be resting against the gate or in the immediate vicinity while the gate is at the 2.5-foot opening. Within the one minute period, the gate must be closed to the predetermined opening. If the predetermined opening is not permitted by the Maximum Allowable Gate Opening (MAGO) curves, the operator must close the gate to a permitted opening and wait until the discharge raises the tailwater elevation so that the opening can be increased to the predetermined opening in accordance with the MAGO curves.

(2) If it is predetermined that an opening larger than 2.5 feet would be needed for the gate:

The gate may be initially opened to a predetermined opening larger than 2.5 feet, provided that such an opening would be permitted by the Maximum Allowable Gate Opening (MAGO) curves. If the predetermined opening would not be permitted by the MAGO curves, the gate may be initially opened to 2.5 feet and held at that opening for up to one (1) minute. Forces of the water should "flush-through" any manatee that may be resting against the gate or in the immediate vicinity while the gate is at the 2.5-foot opening. Within the one minute period, the operator must close the gate to a permitted opening in accordance with the MAGO curves and wait until the discharge raises the tailwater elevation. As the tailwater rises, the gate opening may be increased to the predetermined opening in accordance with the MAGO curves.

(3) This procedure should be used at S-77 only if the tail water is above +9.0 feet, NGVD; and at S-79 only if the tail water is above -2.0 feet, NGVD. In other words, do not exceed the maximum allowable gate opening criteria in the rare event that these conditions are not met.

(4) Gate openings greater than 2.5 feet shall be accomplished according to the operational criteria specified in the approved water control plans and manuals for the Central and Southern Florida Project.

(5) Spillway operations will be accomplished only by qualified operators, through on-the-job training, who are able to perform the standard operating procedures for manatee protection as described herein.

(d) <u>General rule for operating MULTIPLE GATES at S-77, S-79, S-308, S-351, S-352, and S-354, provided that the difference between headwater and tailwater elevations, or head, across these structures is greater than 3.0 feet</u>.

(1) If it is predetermined that an opening smaller than or equal to 2.5 feet would be needed for the gates:

One gate may be initially opened to a maximum of 2.5 feet and held at that opening for up to one (1) minute. Forces of the water should "flush-through" any manatee that may be resting against the gate or in the immediate vicinity of the gate. Within the one-minute period, the gate must be closed to the predetermined setting. If the predetermined opening would not be permitted by the Maximum Allowable Gate Opening (MAGO) curves, then the operator must lower the gate to a permitted smaller opening. This same procedure would then be repeated for opening the remaining gates. As the tailwater rises because of the

discharge, the operator may increase each gate opening in equal increments, in turn, in accordance with the MAGO curves until the predetermined opening is attained. At the end of the gate opening sequence, all of the gates must be set at approximately equal gate openings, all in accordance with the MAGO curves. As a practical consideration the spillway gates should not be adjusted such that gate openings differ by more than one foot.

(2) If it is predetermined that an opening larger than 2.5 feet would be needed for the gates:

One gate may be initially opened to a predetermined opening larger than 2.5 feet, if such an opening would be permitted by the Maximum Allowable Gate Opening (MAGO) curves. The remaining gates must also be opened to the same opening. If the MAGO curves do not permit a 2.5-foot opening, one gate may be opened to 2.5 feet and then closed to a permitted opening within a maximum period of one (1) minute. Forces of the water should "flush-through" any manatee that may be resting against the gate or in the immediate vicinity while the gate is at 2.5-foot opening. This same procedure must be repeated for opening the remaining gates. As the tailwater rises because of the discharge, the operator may increase each gate opening in equal increments, in turn, in accordance with the MAGO curves until the predetermined opening is attained. At the end of the gate opening sequence, all of the gates must be set at approximately equal gate openings, all in accordance with the MAGO curves. As a practical consideration the spillway gates should not be adjusted such that gate openings differ by more than one foot.

(3) This procedure should be used at S-77 only if the tail water is above +9.0 feet, NGVD; and at S-79 only if the tail water is above -2.0 feet, NGVD. In other words, do not exceed the maximum allowable gate opening criteria in the rare event that these conditions are not met.

(4) Gate openings greater than 2.5 feet shall be accomplished according to the operational criteria specified in the approved water control plans and manuals for the Central and Southern Florida Project.

(5) Spillway operations will be accomplished only by qualified operators, through on-the-job training, who are able to perform the standard operating procedures for manatee protection as described herein.

(3) Culvert Operations.

The following standard operating procedures are in effect to reduce manatee risk at H.H. Dike and these extension levee culverts; 1, 1-A, 2, 3, 4-A, 5, 5-A, 6, 7, 8, 9, 10, 10-A, 11, 12, 12-A, 13, 14, 16, and the following pipe culverts 1 (L-

50); 1, 2, 3, 4, 5, 6 (Harney Pond Canal); 1, 2, 3 (Indian Prairie Canal); 1, 2, 3, 4 (Kissimmee River) and (50) pipe culverts on C-43, Caloosahatchee River, C.M.P. with risers.

(a) When the vertical lift gates are being opened from the closed position, they will be raised to an initial opening of 2.5 feet and then closed to the desired setting. This will allow a resting manatee to be flushed through the culvert rather than being pinned and drowned at the point of the gate opening.

(b) When the flap gate culverts are being opened by winch or crane, the shape of the flap gate and the slow operation will alert the manatee to move before a strong current could trap it at the point of the gate opening.

(c) If manatees are observed during culvert operations, they will be discouraged from passing through to the smaller canal system in order to prevent entrapment in shallow water, possible harassment in developed areas and potential starvation.

c. <u>District and interagency reporting requirements</u>.

(1) Sightings of dead, injured, sick or newly calved manatees, as well as sightings of manatees in smaller, shallower canal systems associated with Corps water control structures but outside Lake Okeechobee and Okeechobee Waterway, will be immediately reported to the Manatee Hotline at 800 DIAL-FMP (342-5367). It will be the responsibility of the FOA to promptly notify the Jacksonville District Office, Operations Branch, Project Operations Section. (See Appendix A, Manatee Protection Plan Point of Contact List)

(2) Prior to FDEP manatee rescue operations or investigations requiring diving by any agency at U.S. Army Corps of Engineers structures, coordination of dive plans will be submitted by the requesting agency through the FOA to the Jacksonville District Office, Operations Branch, Plant Section. (See Appendix A, Manatee Protection Plan Point of Contact List)

(3) The COE (Operations Branch, Project Operations Section) will notify FDEP and FWS well in advance of scheduled maintenance construction.

(4) The COE (Operations Branch, Project Operations Section) will provide an annual report NLT 31 January to FDEP and FWS that outlines the previous years structural and operational changes and goals for the upcoming year.

5. Summary.

This project operations manatee protection plan was developed to provide policy and procedure for the effective long-range management and operation of water control structures to minimize and reduce manatee risk at such structures. We believe this plan accurately addresses structure-related problem areas, and presents workable standard operating procedures to assist in the recovery of the Florida Manatee. In order to meet the objective of this plan, all involved must continually monitor and recommend any necessary revisions for update that will minimize conflicts between the manatee and the intended uses of these structures.

FOR THE COMMANDER:

JAMES A. CONNELL
LTC, Corps of Engineers
Deputy Commander

2 APPENDICES
APP A - Manatee Protection Plan Point of Contact List
APP B - Sample Jacksonville District Manatee Mortality Investigation Report

APPENDIX A

Manatee Protection Plan Point of Contact List

Florida Department of Environmental Protection
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399

Mr. Pat Rose (904) 922-4330
Mr. Kipp R. Frohlich (904) 922-4330

U.S. Fish and Wildlife Service
6620 Southpoint Dr., South
Suite 310
Jacksonville, FL 32216

Mr. Robert Turner (904) 232-2580
Mr. Jim Valade (904) 232-2580

South Florida Water Management District
Post Office Box 24680
West Palm Beach, FL 33416

Mr. Frank Lund (407) 687-6631
Mr. Robert Chamberlain (407) 338-1668

U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232

Planning Division, Environmental Studies Section, (CESAJ-PD-ES)
Mr. Elmar Kurzbach (904) 232-2325
Ms. Kim Koelsch (904) 232-3332

Engineering Division, Water Management and Meteorology Section, (CESAJ-EN-HW)
Mr. James Vearil (904) 232-2142
Mr. Adam Stuart (904) 232-2116

Mechanical and Electrical Section, (CESAJ-EN-DM)
Ms. Shashi Makker (904) 232-1112

Operations Branch, Project Operations Section, (CESAJ-CO-OR)
Mr. Bill Zattau (904) 232-2215
Mr. Donnie Kinard (904) 232-2255

South Florida Operations Office (CESAJ-CO-S)
525 Ridgelawn Road
Clewiston, FL 33440
Mr. Pete Milam (813) 983-8101
Mr. Ron Miedema (813) 983-8101

APPENDIX B

Sample
Jacksonville District
Manatee Mortality Investigation Report

REPORT DATE: (Date report is prepared)

CASE/LOCATION: (Field ID number from FDNR necropsy report and location of incident)

DESCRIPTION: (Description of incident from FDNR official letter of notification/necropsy report. Include reported cause of death and any other pertinent information.)

PERSONAL ACCOUNTS: (Document any actions and/or observations by lock personnel, others, etc.)

EQUIPMENT MALFUNCTIONS or UNUSUAL MANATEE OBSERVATIONS: (Document any equipment malfunctions or unusual manatee observations, etc, that may have bearing on the incident.)

C&SF WATER CONDITIONS SUMMARY (NUMBER OF GATE CHANGES AND LOCKAGES) FOR PERIOD OF / / - / / : (Provide dates for period.)

DATE	UPPER	LOWER	WINDS	RAINFALL	S-__ SPILLWAY	LOCKAGES
6/16	1454	1159	CALM	2.93	CLO	20

(An analysis of openings and closings for both the navigation lock and the water control structure should be provided for the week prior to the carcass recovery as shown in the above example.)

SUMMARY: (Provide findings, conclusions and recommendations regarding the reported incident.)

REPORT FILED BY: (Name of individual completing report, office symbol, and telephone number).

MANATEE PROTECTION DEVICE INSPECTION/MAINTENANCE PROCEDURES

DRAFT

PURPOSE: The purpose of the manatee protection device inspection and maintenance procedures is to provide the South Florida Water Management District with a standardized method of insuring the operation of the protection devices.

GOAL: Develop a District wide standard procedure for inspecting and maintaining the pressure sensitive devices and all associated hardware. It is the intent to develop procedures that provides the needed information in an efficient manner.

OBJECTIVES: The following list contains the objectives needed to provide efficient inspection/maintenance procedures

1. Provide routine scheduled inspection intervals.

2. Develop a standardized inspection procedures.

3. Develop methods that are quick, minimizing the on site time as much as possible.

4. Develop a user friendly procedure, that involves simple and quick operations.

5. Insure that all data gathered is required.

6. Develop a notification list for required maintenance/repairs.

7. Develop a user friendly checklist, to document inspection/maintenance

These seven objectives should yield a procedure that will provide the District with assurance that the manatee protection devices are functioning as intended.

WHERE WE ARE

DRAFT

The Engineering Unit of the Operations and Maintenance Department has formed a committee to develop a standard operating procedure for the inspection and maintenance of the manatee protection devices (MPD).

The first objective was what level(s) of inspection and maintenance are required to insure the reliability of the MPD. Past experience has indicated that a weekly check was necessary. This will be followed by a more comprehensive quarterly inspection. The final would be a semi-annual inspection/maintenance procedure.

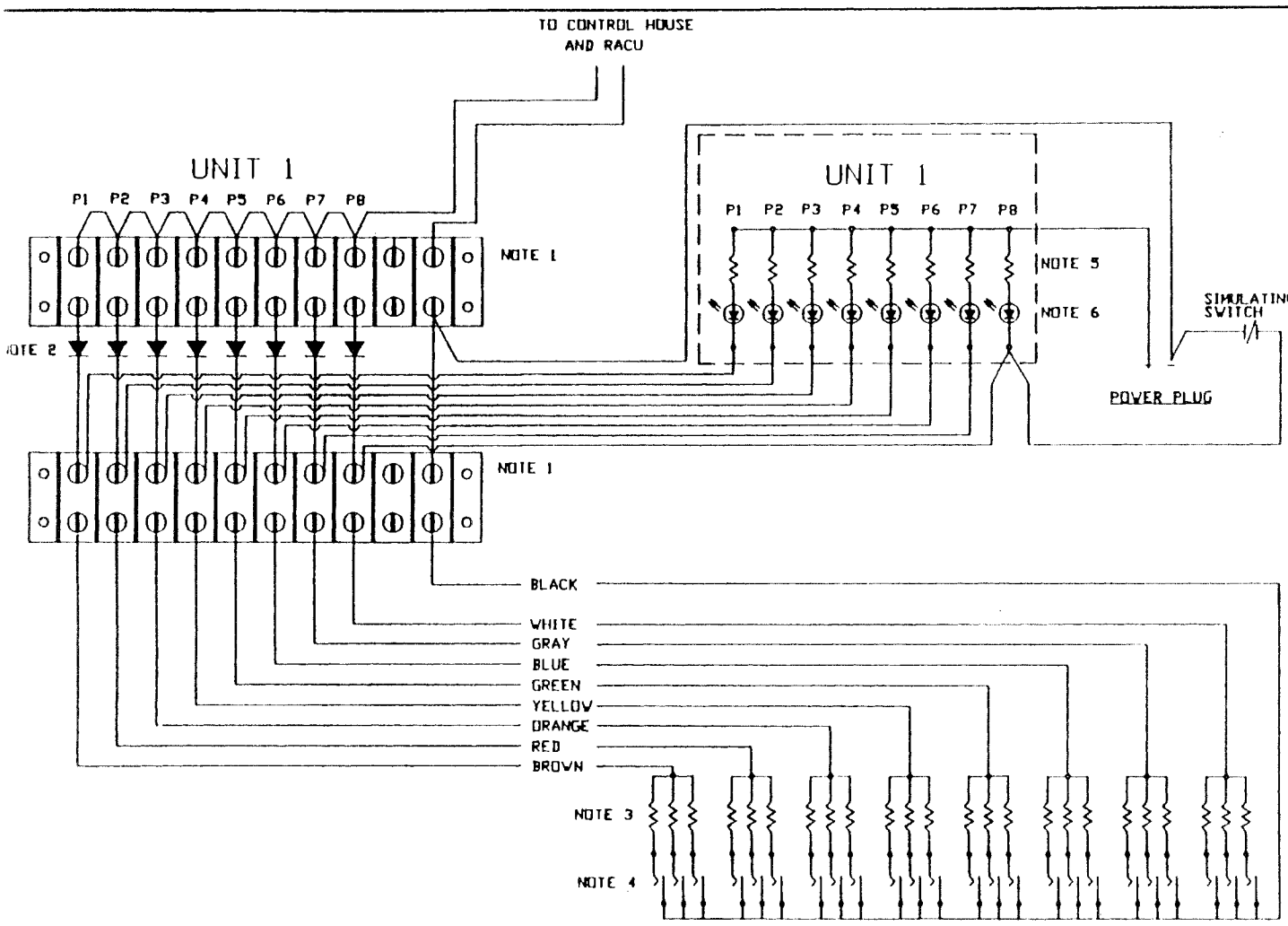
Due to increasing number of sites it was concluded that the weekly inspection should be made as least time consuming as possible.The present method consist of taking ohm meter readings on each pressure sensitive device (PSD). This method was viewed as time consuming. It was felt that a visual aid might be more fitting for the weekly inspection. The committee agreed to investigate this idea. Since that time the idea of installing a panel with indicator lights showing that each PSD is working. A working schematic has been developed and a prototype panel is in progress. It is planned to also install a simulation circuit to test the system. This system will allow for a fast and easy review of the system. Reducing time and technical skill level required.

The quarterly inspection will be more involved than the weekly. This inspection will check all three switches in a single plunger. This will require the use of an ohm meter. The difference in these two inspection is that the weekly tells if the PSD is working, the quarterly identifies each switch, 3 per plunger, is working.

The semi-annual inspection will be subsurface, to visually inspect each PSD and remove any marine growth that may hamper operation.

It is viewed that these three levels of inspection will insure the reliability of the manatee protection devices.

DRAFT



NOTE:

1. TERMINAL BLOCK
2. RECTIFIER 1N4001
3. RESISTOR 10 OHM 1% IRC METAL FILM 1/8 WATT
4. REED SWITCH MDRR-4-185
5. RESISTOR 1.5K
6. LED HLMP-4700

SOUTH FLORIDA WATER MANAGEMENT DISTRICT	
DESIGNED BY VCM DRAWN BY VCM CK NO. TESTING DATE 02-17-95	MANATEE PROJECT STRUCTURE 27 & 29 TEST PANEL FOR PSD UNITS
FILE NO. 001-27-01 SHEET OF SCALE	

MANATEE PROTECTION DEVICE INSPECTION/MAINTENANCE PROCEDURES

DRAFT

All vertical lift water control structures and navigation locks having a pressure sensitive manatee protection device installed on the gates will follow the proscribed procedures.

WEEKLY INSPECTION PROCEDURE:

1. Notify control room of intended gate operation(s)

2. Open panel, plug in power supply, visually check that all indicator lights are on. Record finding. If a indicator light fails to respond initiate maintenance procedures. Disconnect power supply.

3. Open gate to 2.5 feet, if water level permits, a minimum of .5 feet must be obtained. Manatee override push button must be activated to limit gate travel below 2.5 feet.

4. Start gate into the close position.

5. Push manatee simulation button.

6. If gate fails to reverse operation, initiate maintenance procedure.

7. Re-initiate gate to the close position.

8. Document all gate/manatee protection functions.

9. File report in local history file.

10. Repeat steps 1-9 for each gate.

11. Notify control room when complete. Verify that they received a manatee signal.

QUARTERLY INSPECTION PROCEDURE:

1. Perform steps 1-10 of the weekly inspection.

2. Take ohm meter readings of magnetic switches.

3. Visually inspect exterior equipment box wiring.

4. Visually inspect interior equipment box wiring.

5. Document inspection results and file in local history file, send a copy to the appropriate person.

6. Notify control room of completion.

SEMI-ANNUAL INSPECTION PROCEDURE:

1. Perform a subsurface inspection on all PSDs and associate hardware.

2. Clean any marine growth on hardware.

3. Document inspection and file in local history file.

APPENDIX D

APPENDIX D

Mechanical & Electrical Description of Vertical Lift Gated Structures.

1. SFWMD STRUCTURES:

A. Spillways

a. General: Three basic operating systems are used throughout the spillways managed by SFWMD. They are as follows:

i. Hydraulic System: Each vertical lift gate is raised and lowered either by a two- or four-part wire rope block and tackle arrangement with the lead line end of the two ropes attached to the top of the gate and the sheave-block cross-head assembly directly connected to the piston rod of the actuating horizontal trunnion-mounted hydraulic cylinder. Thus, the movement of this piston with the double-block effects movement of the gate in a ratio of 1 to 2 respectively. The gates can be operated from the push button at the service bridge and at the control room. The mechanism is located on the operating platform above the service bridge. The four-way valves are solenoid actuated. The following structures fall within this category:

(1) S-20F Spillway. (Single-gated structure serviced by the Homestead Field Station).

(2) S-20G Spillway. (Three-gated structure serviced by the Homestead Field Station).

(3) S-21A Spillway. (Two-gated structure serviced by the Homestead Field Station).

(4) S-25 Culvert. (Single-gated structure serviced by the Miami Field Station). This structure has a single gate operated by a vertically installed hydraulic cylinder. There is no mechanical disadvantage in the system as the cylinder rod is directly connected to the gate.

(5) S-25B Spillway. (Two-gated structure serviced by the Miami Field Station).

(6) S-26 Spillway. (Two-gated structure serviced by the Miami Field Station).

(7) S-123 Spillway. (Two-gated structure serviced by the Miami Field Station).

ii. Electric Motor/Chain Sprockets/Reduction Gear System: Power from the electric motor is transmitted to a set of roller chain sprockets through a special shear pin hub and into the helical worm gear speed reducer. Each of the two output

shafts from the reducer connects directly to a wire rope drum which reels in or out the wire rope connected to the lower end of the gate, thereby causing the gate to raise or lower. A visual position indicator is mounted directly on the face of the gate and is graduated in feet to show any position of gate opening from full up to full down. The shear pin hub is incorporated into the hoist design as a means of protecting the entire assembly against possible damage from overload. The operating mechanism is located at service bridge elevation. The gates can be operated from the push button at the service bridge and at the control room. The following structures fall within this category:

(1) S-22 Spillway. (Two-gated structure serviced by the Miami Field Station). This structure has a new control house.

(2) S-29 Spillway. (Four-gated structure serviced by the Miami Field Station).

(3) S-33 Spillway. (Single-gated structure serviced by the Ft. Lauderdale Field Station). This structure controls water from different storm sewers and collects it into a small canal. If the gate stays open too long, a rapid canal drawdown occurs. Therefore, in order to protect the manatees without emptying the canal, the gate is opened up to 2-1/2 feet on 6-inch increments.

iii. Electric Motor/Reduction Gear System: Same as ii. above except that power from the electric motor is directly transmitted into the helical worm gear speed reducer. The following structures fall within this category:

(1) S-13 Spillway. (Single-gated structure serviced by the Ft. Lauderdale Field Station). Operating mechanism is located on the operating platform at an elevation higher than the service platform. The gate is connected to the operating mechanism through screw stems, one screw stem at each end of the gate. This gate is operated from the pumping station adjacent to it.

(2) S-21 Spillway. (Three-gated structure serviced by the Homestead Field Station). The electrical system on this structure was being changed to 3 phase. Mechanism is located on the operating platform above the service bridge.

(3) S-27 Spillway. (Two-gated structure serviced by the Miami Field Station). Operating mechanism is similar to that on S-13.

(4) S-28 Spillway. (Two-gated structure serviced by the Miami Field Station). Mechanism is located at service bridge elevation.

b. Electrical System: All structures have commercial power and stand-by LPG genset ranging in sizes from 7.5 to 15 KW. An automatic transfer switch (ATS) transfers operation from commercial power to emergency power as necessary. Except for structures S-21, S-22 and S-29 which have three phase electrical systems; all structures have single phase systems.

c. Stilling Wells: All structures have three stilling wells. Two of those stilling wells are used for water level indication. Mercury switches mounted on a pedestal next to the third well are used to control the opening and closing of the gate(s). A float down in the well is connected through a metal tape to a wheel on the side of the pedestal. The side wheel turns the mercury switches inside the pedestal through a bevel gear system. A new control house was built next to S-22. This control house is not shown on the as-built drawings. The water level stilling wells have been equipped with new depth probes as part of the telemetry system. These probes are several feet long and are installed as a single unit. Due to their length and the need to install them as a single unit, they were installed through a hole cut on the control house roof.

d. Manatee Protection: Except for S-27 and S-29 which have an improved design in manatee protection, and S-20G, S-25 and S-33 which do not have any provisions at all to protect the manatees; all SFWMD structures have been retrofitted with a simple manatee protection system. The so called "old manatee" protection system opens the gate to 2-1/2 feet every time the gate is opened. It closes the gate to fully close position every time it is closed. The system does not allow the gate to stop at any position between those predetermined elevations. Gate opening to 2-1/2 feet is delimited by either a limit switch (plunger or rotary type) mounted on the operating mechanism or electronically through a process timer.

e. Telemetry System: All structures are retrofitted with telemetry system.

B. Locks:

a. General: All the locks are manually operated. The basic operating system used the vertical lift gated locks managed by SFWMD is as follows:

i. Electric Motor/Reduction Gear System (Vertical Lift Gates: The lock consists of one vertical lift gate on the upstream side and another vertical lift gate on the downstream side. One control room located at an equidistance from the gates, houses the main distribution panel, electrical equipment and the gates control panel. Power from the electric motor is transmitted into the helical worm gear speed reducer. Each of the two output shafts from the reducer connects directly to a wire rope drum which reels in or out the wire rope causing the

gate to raise or lower. The mechanism is located on the operating platform above the service bridge and is similar to mechanism on structure S-21. The gates can be operated from the push button at the service bridge and at the control room. The following structures fall within this category:

(1) Buckhead Ridge Lock S-127 (Two-gated structure).

(2) Lakeport Lock at S-131 (Two-gated structure).

(3) Lock at S-135 (Two-gated structure).

2. COE STRUCTURES:

Spillways

a. General: One basic operating system is used throughout the spillways managed by COE for this project. They are as follows:

i. Hydraulic System: System is identical to hydraulic system as described on paragraph 1.A.a.i. above, except that not all the structure gates can be opened from the service bridge and that some of the four-way valves are not solenoid actuated. The following structures fall within this category:

(1) S-77 (Moore Haven)* (Four-gated structure).

(2) S-79 (W.P. Franklin)* - (Eight-gated structure).

(3) S-308C (Port Mayaca)* - (Four-gated structure)

* - Operation of the gates is from the operating platform. Design does not allow remote operation of the gates from the service bridge. Hydraulic controls are manual levers.

b. Electrical System: All COE structures have commercial power and stand-by genset. In case operation is transferred from commercial power to emergency power by means of a transfer switch as necessary.

c. Manatee Protection: None of the COE managed structures have been retrofitted with manatee protection system.

d. Stilling Wells: All COE structures have stilling wells.

TABLE 1 SUMMARY OF VERTICAL GATED WATER CONTROL STRUCTURES

STRUCTURE #/NAME	TYPE	(NO.) & SIZE OF LIFT GATES, FT X FT	SECTOR GATES HEIGHT & (LOCK WIDTH)	PROPSD. OPERAT.	OPRTD. BY
S-13	SPLLWY.	(1)16 X 11.33	N/A	1/	SFWMD
S-20F	"	(3)25 X 13	N/A	"	"
S-20G	"	(1)25 X 12.3	N/A	"	"
S-21	"	(3)27 X 10.7	N/A	"	"
S-21A	"	(2)20 X 11.8	N/A	"	"
S-22	"	(2)18 X 15	N/A	"	"
S-25	CULVERT	(0)*	N/A	"	"
S-25B	SPLLWY.	(2)22 X 11.9	N/A	"	"
S-26	"	(2)26 X 14.1	N/A	"	"
S-27	"	(2)27 X 15	N/A	"	"
S-28	"	(2)27 X 17.5	N/A	"	"
S-29	"	(4)22 X 15	N/A	"	"
S-33	"	(1)20 X 9.75	N/A	"	"
S-123	"	(2)25 X 12.7	N/A	"	"
S-127	LOCK	15 X 19.9 U.S. 15 X 14 D.S.	N/A (15')	"	"
S-131	"	15 X 19.9 U.S. 15 X 14 D.S.	N/A (15')	"	"
S-77	SPLLWY.	(4)20 X 12.42	N/A	2/	COE
S-135	LOCK	(2)15 X 19.9	N/A	1/	SFWMD
S-79	"	(8)38 X 19.2	N/A	2/	COE
S-308C	"	(4)29 X 17.38	N/A	2/	"

TABLE 1 NOTES:

* - S-25 culvert has a 96-inch dia. sluice gate. Approximate dimensions are 110-inch X 110-inch.
1/ - At manatee detection, gate opening and closing is automatic.
2/ - After presence of a manatee is detected and an alarm goes off alerting the operator, operation of gates will be done manually by the operator.

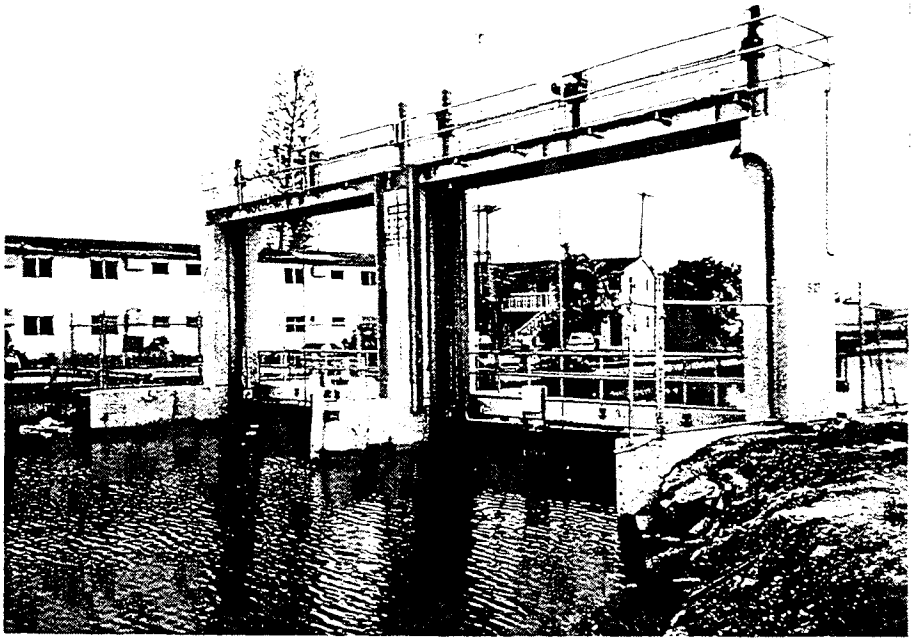


Photo I. Structure 27

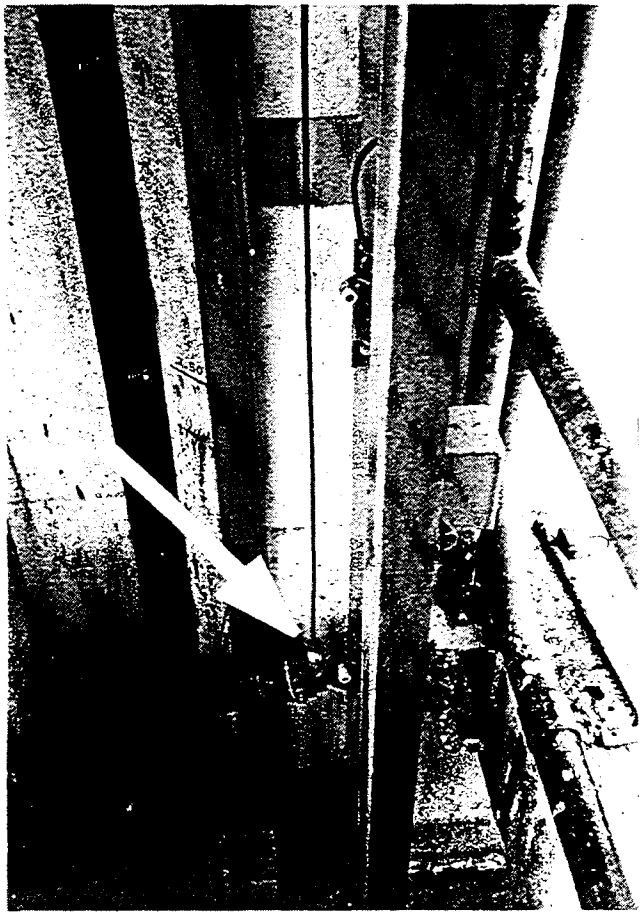


Photo II. Gate Position
Limit Switch & Wiring

Photo III. Structure 27
Manatee Circuit Distribution Box

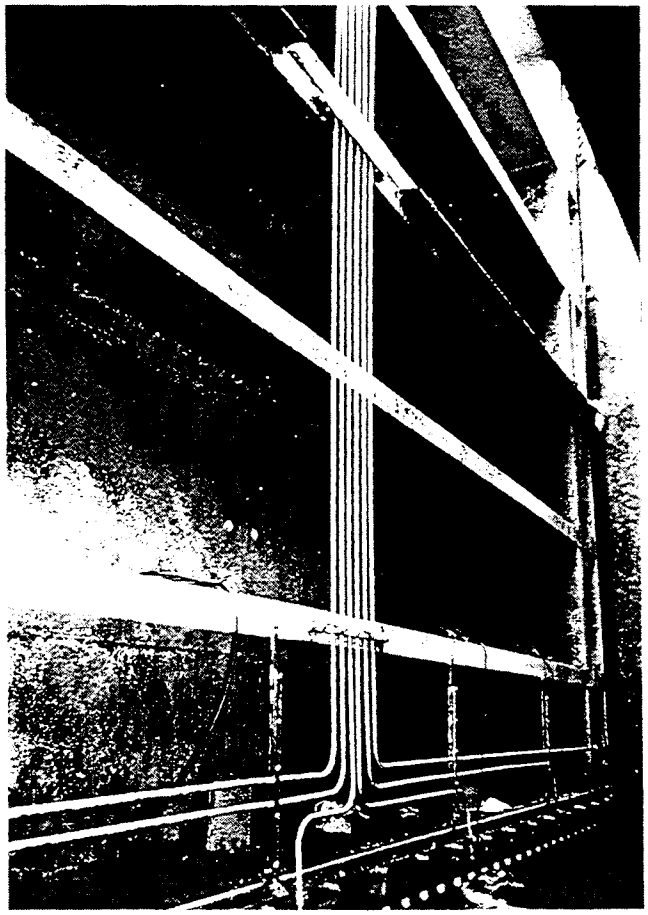


Photo IV. Sensor Wiring
and Conduit from
Plungers to Box

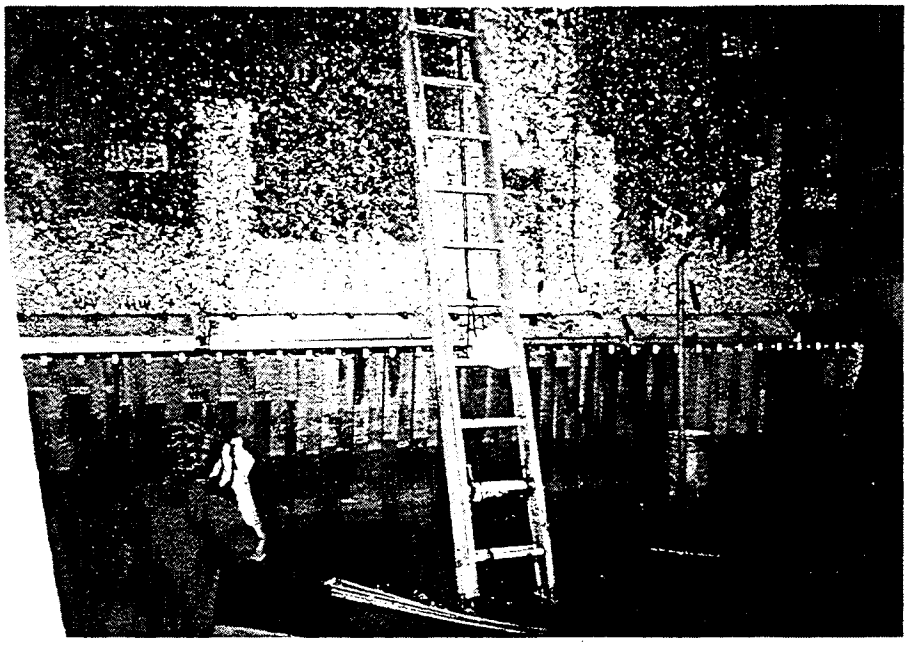


Photo V. Structure 29
Reed and Plunger Installation

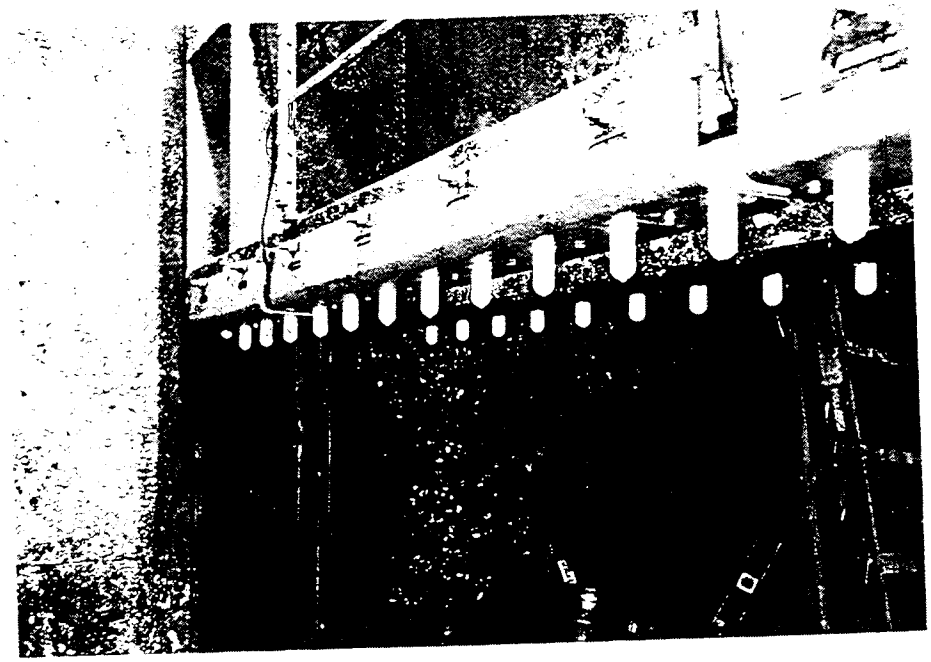


Photo VI. Structure 29
Gate and Plunger Location

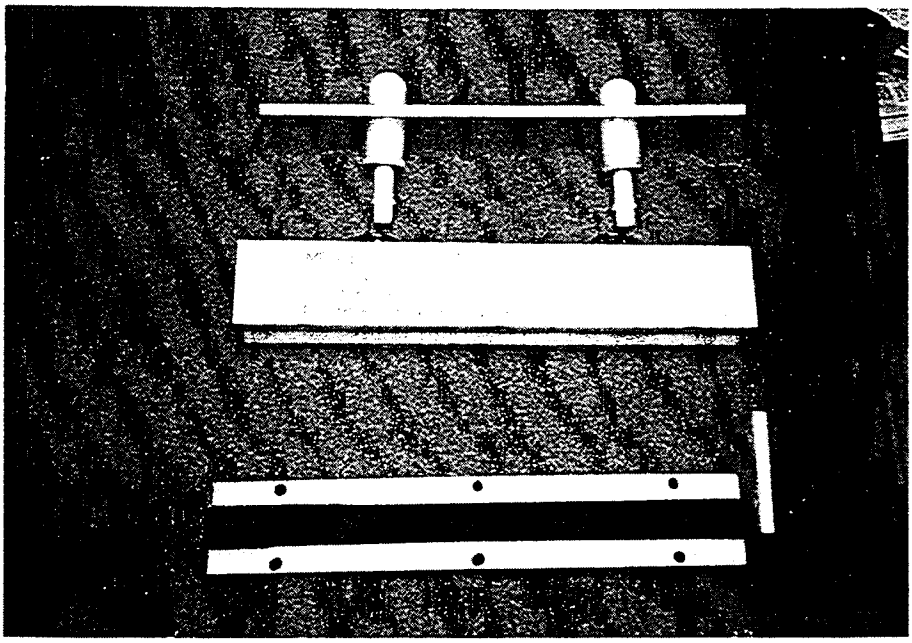
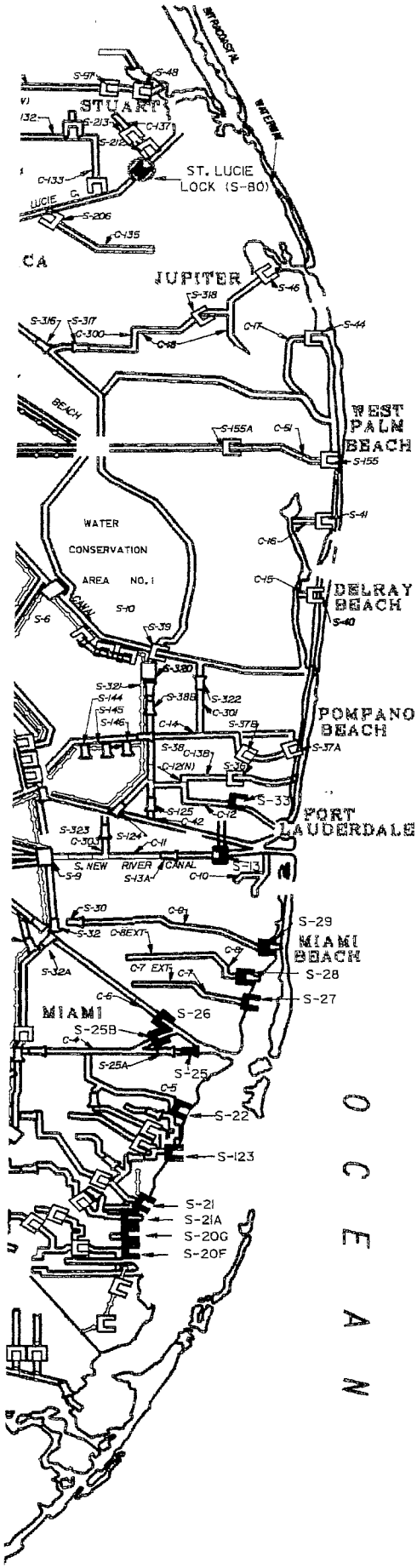


Photo VII. Prototype
Sensi-Strip Plunger Device



N

LEGEND

CANAL	
LEVEE	
PUMPING STATION	
CULVERT	
SPILLWAY	
* SPILLWAY (SFWMD OPERATED)	
* LOCK & SPILLWAY (COE OPERATED)	
* LOCK (SFWMD OPERATED)	

COE= CORPS OF ENGINEERS

SFWMD= SOUTH FLORIDA WATER MANAGEMENT DISTRICT

* INDENTIFIES SELECTED LOCKS AND SPILLWAYS OPERATED BY COE AND SFWMD FOR MANATEE PROTECTION PURPOSES.

NOTE:

THIS MAP SHOWS PARTS 1 AND 2 FOR THE MANATEE PROTECTION STRUCTURES. PART 1 STRUCTURES ARE LISTED IN TABLE 1.

MANATEE PROTECTION
AT SELECTED LOCKS AND SPILLWAYS
PROJECT MODIFICATION REPORT

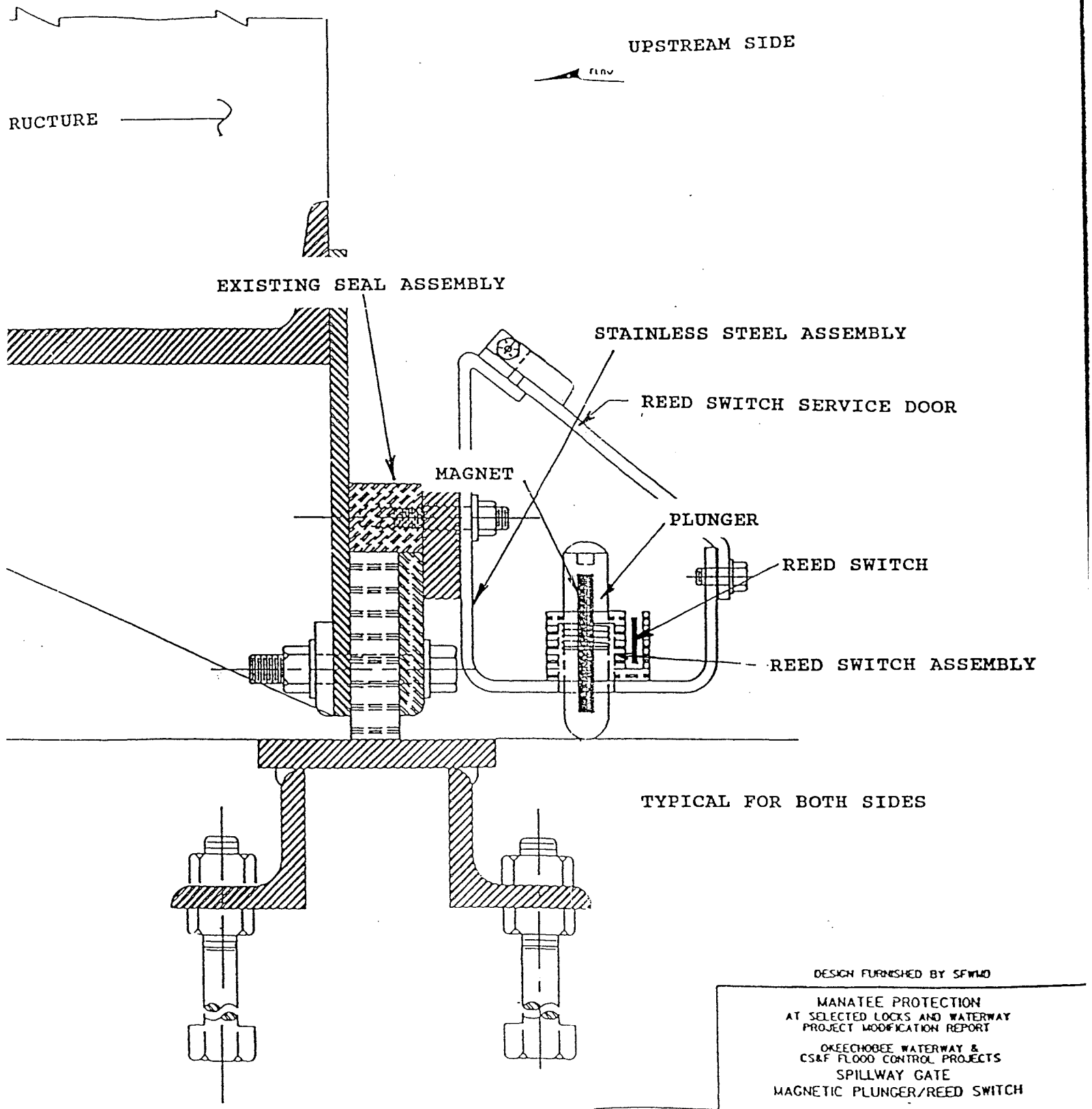
OKEECHOBEE WATERWAY &
CS&F FLOOD CONTROL PROJECTS

STRUCTURE LOCATION MAP

SCALE AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DESIGN ENG.: SM/JB
DWN. BY: JB
CKD. BY: SM
DATED:
D.O. FILE NO.

PLATE ME-1



DESIGN FURNISHED BY SFWMD

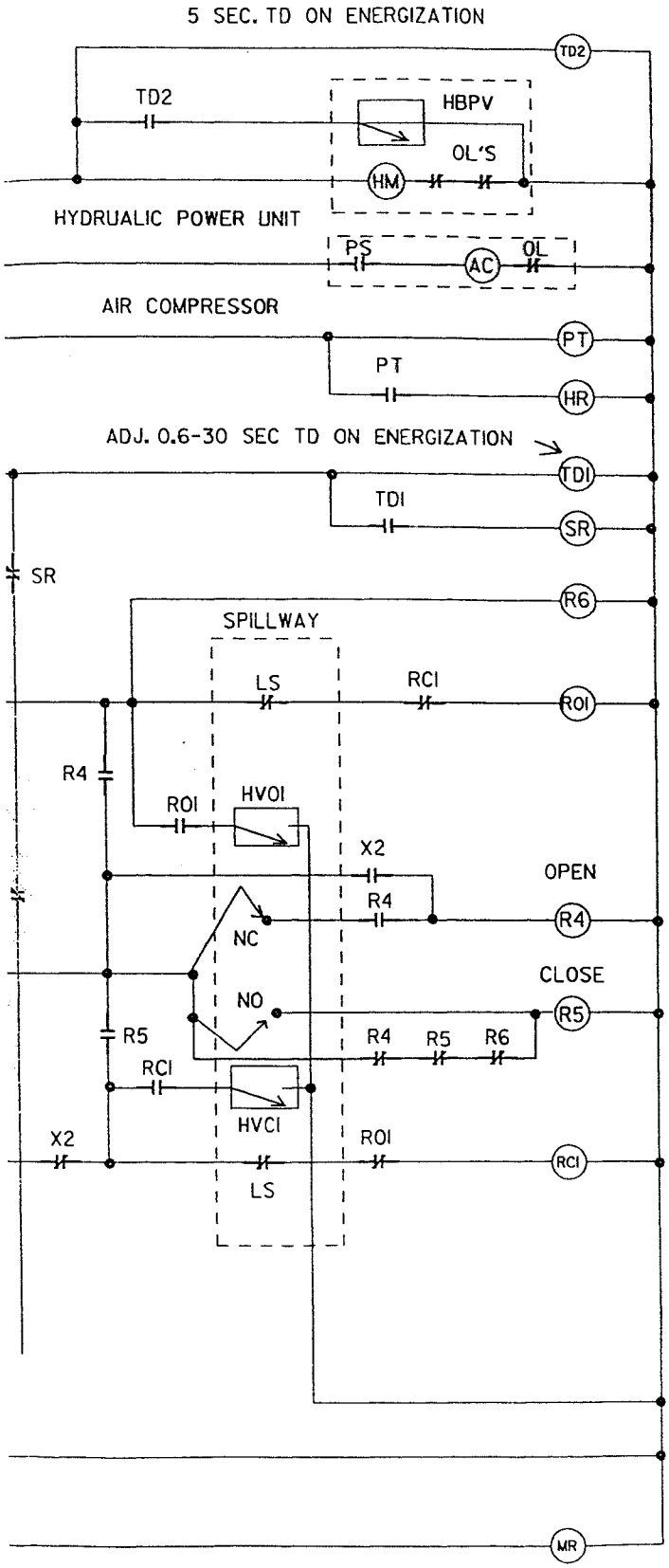
MANATEE PROTECTION
AT SELECTED LOCKS AND WATERWAY
PROJECT MODIFICATION REPORT

OKEECHOBEE WATERWAY &
CS&F FLOOD CONTROL PROJECTS
SPILLWAY GATE
MAGNETIC PLUNGER/REED SWITCH

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DESIGN ENG
DRAWN BY:
CHECKED BY:
DATE:
D.O. FILE NO.

PLATE: ME-2



MANATEE PROTECTION
AT SELECTED LOCKS AND WATERWAY
PROJECT MODIFICATION REPORT

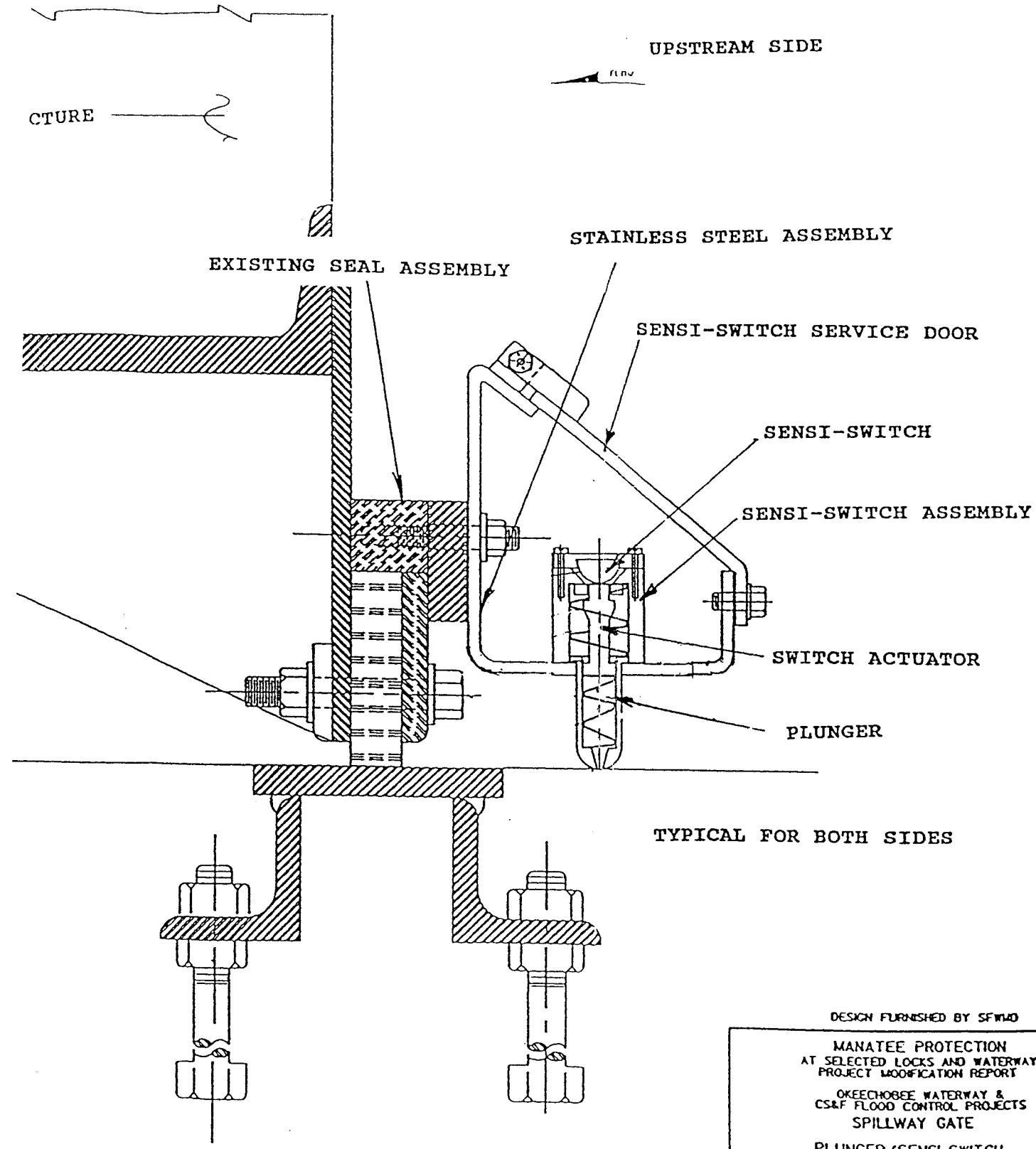
OKEECHOBEE WATERWAY &
CS&F FLOOD CONTROL PROJECTS

MANATEE PROTECTION CIRCUIT
ELECTRICAL CONTROL DIAGRAM
SPILLWAY
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DESIGN ENG	
SM	
DRAWN BY:	CHECKED BY:

DATE: D.O. FILE NO.

PLATE: ME-3



DESIGN FURNISHED BY SFWMD

MANATEE PROTECTION
AT SELECTED LOCKS AND WATERWAY
PROJECT MODIFICATION REPORT

OKEECHOBEE WATERWAY &
CS&F FLOOD CONTROL PROJECTS

SPILLWAY GATE

PLUNGER/SENSI-SWITCH

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

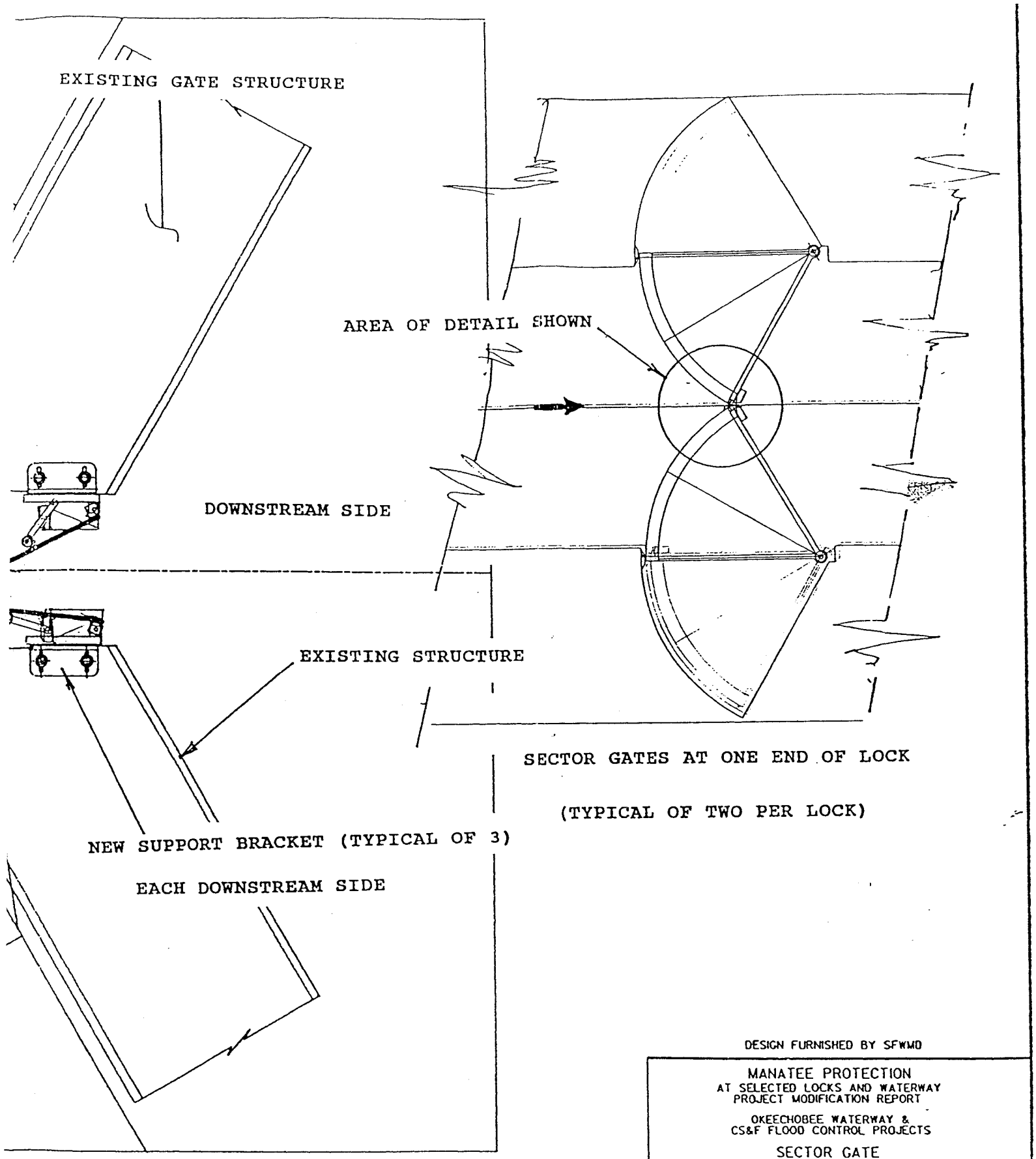
DESIGN ENG

DRAWN BY: | CHECKED BY:

DATE:

O.D. FILE NO.

PLATE ME-4



DESIGN FURNISHED BY SFWMD

MANATEE PROTECTION
AT SELECTED LOCKS AND WATERWAY
PROJECT MODIFICATION REPORT

OKEECHOBEE WATERWAY &
CS&F FLOOD CONTROL PROJECTS

SECTOR GATE

HINGED PLATE ASSEMBLY

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DESIGN ENG

DRAWN BY: CHECKED BY:

DATE: D.O. FILE NO.

PLATE: ME-5

APPENDIX E

GENERAL DESCRIPTION OF LOCK AND SPILLWAY OPERATIONS

This section provides a basic description of the types of gates found at locks and spillways in central and southern Florida. This description facilitates an understanding of the physical characteristics of gates and their operations. Such an understanding will aid in properly evaluating the measures being proposed for preventing manatee fatalities at water control structures.

A. Spillways. The basic purpose of a spillway is to convey large floods through a project area without incurring unacceptable damage either upstream or downstream from the spillway. Project spillways also release water for other purposes such as water supply and navigation. Generally, spillways in central and southern Florida have gates which can be used to control the flow of water over a concrete spillway crest. Although other types of gates exist, the two types of gates used within the area of the project are tainter gates and vertical lift gates. Tainter gates and tainter gated spillways are described for information purposes only.

(1) Tainter Gated Spillways. The conventional tainter gate consists of a steel "skin plate" and a framework of horizontal and vertical members all of which are formed to a segment of a cylinder. This cylindrical or "pie" segment is held in place by radial struts that converge downstream to a central location called the trunnion. The tainter gate is raised and lowered by chains or wire rope attached at both ends.

Figure 1 shows a cross section of St. Lucie (S-80) spillway, a typical tainter gate in the closed position. Photographs A and B show the S-78 spillway at Ortona, two of whose gates are tainter gates. Photographs C and D show closer views of a tainter gate. S-80 has seven tainter gates; S-78 has two tainter gates along with two vertical lift gates. The tainter gates at S-80 spillway are 20 feet in length and 10.5 feet high. The tainter gates at S-78 spillway are 20 feet wide and 8.5 feet along the curved skin plate.

(2) Vertical Lift Gated Spillways. The typical vertical lift gate is rectangular in shape and slides up and down (vertically), allowing water to pass beneath it when open and resting upon the spillway crest when closed. The gate consists of a structural frame to which a flat skin plate is attached, normally on the upstream face. On the gate bottom there is a hard rubber seal which seals on the spillway crest. The vertical-lift gate, like the tainter gate, must be hoisted at both ends, and the entire weight is suspended from the hoisting cables. Piers extend to a considerable height above high water in order to provide guide slots for the gate in the fully raised position. These piers support an operating platform, and together they form part of the spillway's concrete superstructure. Figure 2 shows Port Mayaca spillway, a typical

vertical lift gate in the closed position. Photographs A and B show, in addition to the two tainter gates mentioned above, the two vertical lift gates at S-78 spillway. Photograph E shows a closer view of one of these vertical lift gates.

All of the spillway gates within the scope of this part of the project are vertical lift gates. The nominal width of these vertical lift gates (the width not including that of the guide slots, which usually adds another 0.8 feet to the nominal width) varies from 15 feet to 38 feet wide. The height of these gates varies from 9.75 to 19.2 feet.

Vertical lift gates at structures within the scope of this project were designed to raise and lower at a rate not to exceed 6 inches/minute.

B. Locks. A navigation lock can be thought of as a kind of "boat elevator", into which a boat enters through one side and exits through the other side. The bodies of water immediately upstream and downstream of a lock are referred to as the upper and lower pools, respectively. The lock chamber lies between the two pools. A lock allows a boat to "step" from the water level in the lower pool to the water level in the upper pool, or vice versa. Closure gates are required at both ends of the lock chamber so that the water level inside the lock chamber can be varied to coincide with the water levels in the upper and lower pools. The sequence of "locking" a vessel upstream is: first, lower the water level in the lock chamber to the downstream water level; second, open the lower gate and move the vessel into the lock chamber; third, close the lower gate and fill the lock chamber to the level of the upper pool; and finally, open the upstream gate and move the vessel out of the lock. Lockage of a vessel downstream involves a similar sequence in reverse order.

(1) Sector-Gated Lock. A sector gate is a pie slice- or wedge-shaped gate similar to a tainter gate, except that it is oriented to rotate horizontally (i.e., about a vertical axis). Sector gates are used in pairs, meeting at the center of the lock when in the closed position and swinging into recesses in the lock walls for the open position. Figure 3 shows Moore Haven Lock, a typical lock with sector gates. Photographs F, G, H, and I show sector gates at sector-gated locks. Photographs J, K, and L contain close-up views of the locations where sector gates meet when closed and where, correspondingly, manatees can be injured.

Locks S-310 and S-193, and all Okeechobee Waterway locks (St. Lucie, Port Mayaca, Moore Haven, Ortona, and W.P. Franklin), are sector-gated locks. The lock chambers are all either 50 or 56 feet wide. The sector gate heights vary from 20 feet to 35 feet, and sometimes the upper gates differ in height from that of the lower gates. Sector gates have two speed settings, a low and a high speed, at which they operate. As the gate swings from the fully open position to the closed position, it begins moving at the low speed and soon changes to the high speed. The gate

continues most of its motion at the high speed setting, slowing down to the low speed 18 inches on each side of the closure point before reaching the point of gate closure. The gates travel at the low speed until they finally meet.

Another danger to manatees at sector-gated locks is the possibility that manatees could swim into the sector gate recesses and be crushed. Access has been possible either through the "sides" of the sector gate wedge, or through depressions in the floor of the lock chamber. Screens have been installed on the side and bottom of the gates at certain structures to prevent manatees from swimming into the sector gate recesses.

(2) Vertical Lift-Gated Lock. Instead of a pair of sector gates, this type of lock has a single vertical lift gate on each end. These vertical lift gates are similar to the spillway vertical lift gates described above.

The only vertical lift-gated locks within the scope of this project are at S-127, S-131, and S-135. All of their gates have a nominal width of 15 ft. The height of the upstream gates is 19.9 ft. while the height of the downstream gates varies from 14 to 19.9 ft. As with vertical lift gated spillways, these locks' gates were originally designed to raise and lower at rates not exceeding 6 inches per minute. As for stopping time, the gates are designed to stop moving almost immediately.

LAKE OKEECHOBEE AND OKEECHOBEE WATERWAY STRUCTURES

Lake Okeechobee, a natural lake, is located about 30 miles from the Atlantic coast and 60 miles from the Gulf of Mexico in south central Florida. Local flood protection levees of the C&SF Project completely encircle the lake, forming a major multi-purpose reservoir. The lake is regulated to provide flood control; navigation; water supply for agricultural irrigation, municipalities and industry, Everglades National Park; regional groundwater control and salinity control; enhancement of fish and wildlife; and recreation. The drainage area, including the lake area, is about 5,600 square miles. The Okeechobee Waterway, which crosses the lake, is 154.6 miles long and 8 feet deep from Fort Myers on the west coast to the Intracoastal Waterway near Stuart on the east coast. Table 1 contains the optimum water control elevations for the project structures in this study. Below are general descriptions of these structures. In Table 1 and in the general descriptions, data on structures S-78 and S-80 and the locks adjacent to all of the Okeechobee Waterway spillways is provided for information purposes only.

A. Structure 80 (St. Lucie Lock and Dam). S-80 is located in Martin County along the St. Lucie Canal (C-44) approximately 15.5 miles above the intersection of the St. Lucie River with the Intracoastal Waterway. The lock serves the purpose of navigation and as an emergency flood control facility. The connecting

spillway structure is a control structure for flood control and for regulatory control of flow through the St. Lucie Canal for control of the level of water in Lake Okeechobee. The first lock was built at this site by the Everglades Drainage District in 1925 and is hereby referred to as the old lock. The new lock was completed by the Corps of Engineers in 1941 at which time the old lock became designated as an auxiliary lock. The main spillway with temporary wooden flashboards was completed in 1944, and in 1950 seven steel tainter gates were installed. The Flood Control Act of 1948 authorized an enlarging of the discharge capacity of the spillway and was assigned the project name of S-80. The enlargement of the spillway was later deleted from the project in connection with the 1968 Water Resources Plan, but the name (S-80) remains in use to describe the lock and spillway structures. The spillway is a concrete structure having an overall width between abutment piers of 170 feet. It is provided with 7 electrically-operated structural steel tainter gates, each having a length of 20 feet and a height of 10.5 feet. The sill is at elevation 0.56 ft., NGVD. The lock is a sector gate type lock, providing 50-foot clear navigation width and a 250-foot usable length of lock chamber. Upper and lower sills are at NGVD elevations of -0.94 and -12.44 feet, respectively, providing 10-foot navigable depth at extreme low water.

B. Structure 308B and C (Port Mayaca Lock and Spillway). S-308B and C are located in Martin County, in Lake Okeechobee at Port Mayaca. Their purpose is to permit the raising of regulatory levels in Lake Okeechobee and to mitigate the effects of higher lake stages along the St. Lucie Canal (C-44). The spillway, S-308C, is required in the St. Lucie Canal to regulate water levels in the lake and to pass normal and standard project flood (SPF) discharges at non-eroding velocities. The structure consists of a reinforced concrete ogee-type spillway with 4 vertical lift steel gates and a horizontal stilling basin with end sill and one row of baffle blocks. An 11-foot reinforced concrete breastwall with a crest elevation of 40.0 ft., NGVD, provides protection from a hurricane for the area downstream of the structure. The design discharge is 14,800 cfs with a headwater elevation of 24.9 ft., NGVD, and a tailwater elevation of 23.2 feet,NGVD. The purpose of the lock, S-308B, is to permit use of the federal navigation project by navigation interests. The lock is 56 feet wide and 400 feet long (usable dimensions). The upstream and downstream sill elevation is -3.5 ft., NGVD, which provides a depth of 14.0 feet at the minimum lake stage of 10.5 ft., NGVD.

C. Structure 77 and Moore Haven Lock. Spillway S-77 is located on the Caloosahatchee River (C-43), in Levee D3 about 530 feet east of the Moore Haven Lock, near the town of Moore Haven in Glades County, Florida. Hurricane Gate Structure No. 1 (HGS-1) was built at Moore Haven in 1935. S-77 was built in 1966, at which time HGS-1 was converted into Moore Haven Lock. The spillway provides control of regulatory discharge from Lake Okeechobee to the Caloosahatchee River; restricts discharge

during floods to that which will not cause damaging velocities or stages downstream; passes sufficient discharge during low-flow periods to maintain stages and satisfy irrigation demands downstream. It is a 4-bay reinforced-concrete ogee-type spillway, provided with 20.0 feet wide by 11.9 feet high vertical lift steel gates. Each gate is operated by a hydraulically operated cable hoist mounted on a reinforced concrete operating platform. The design capacity of this structure is 9,300 cfs when there is no local inflow into the canal downstream. Discharges should be controlled to prevent the tailwater from exceeding 13.1 ft., NGVD. The navigation lock, 56 feet wide by 400 feet in usable length, is of reinforced concrete rigid-frame type construction containing upper and lower sector gates. The sill elevation is -14 ft., NGVD, at both the upper and lower sills.

D. Structure 78 and Ortona Lock. S-78 is located on the Caloosahatchee River (Canal 43) in Glades County, near Ortona, Florida. It is on the existing by-pass channel around Ortona Lock, which is a navigation link of the Okeechobee Waterway, about 15.5 miles below Moore Haven. The spillway provides water control in the areas upstream; to control discharges during 30 percent standard project flood without exceeding desirable stages; to restrict discharge during floods to that which will not cause damaging velocities downstream; to pass the Lake regulation discharge of 9,300 cfs without exceeding desirable stages or velocities. No discharge would be passed through the lock. The structure is a 4-bay spillway, two bays of which are controlled by means of electric-motor-operated taintor gates; flow through the remaining two bays is controlled by electro-hydraulically operated vertical-lift gates. The navigation lock and spillway with two taintor gates were built in 1937; the two vertical lift gates were added in 1964. During periods of regulatory discharge from Lake Okeechobee, (up to 8,660 cfs under ultimate conditions) the spillway will be operated to maintain a headwater elevation of 10.6 ft., NGVD. The navigation lock, 56 feet wide by 400 feet useable length, is of reinforced concrete rigid-frame type construction containing upper and lower sector gates.

E. Structure 79 (W.P. Franklin Lock and Dam). This lock and spillway structure is located on the Caloosahatchee River (Canal 43) approximately 10 miles upstream from Fort Myers in Lee County, Florida. It is along the navigation canal of the Okeechobee Waterway between State Roads 78 and 80 immediately above Olga. The purpose of the S-79 spillway structure is to provide salinity and water control to lands adjacent to the Caloosahatchee River, prevent excessive depletion of ground water during normal or dry periods, and to provide regulatory discharge capacity for Lake Okeechobee. S-79 will pass all discharges up to the design capacity of 30% of the Standard Project Flood, or 28,000 cfs, without exceeding the design stage of 4.4 feet, MSL. The structure will also restrict discharges during larger-than-design floods to 28,900 cfs without causing damaging velocities

downstream. The purpose of the lock is to permit use of the Federal navigation interests. An earthen dam is to the north of the spillway and was constructed to serve as the closure for the existing river and also to provide roadway access to the spillway and lock from the north. The spillway consists of 8 gated, reinforced concrete units located north of the lock, opposite the upper sector gate of the lock. The gates, 38 feet by 19.2 feet, are structural steel vertical lift type. The two outer gates function as skimmer gates while one of the center gates is provided with an automatic control. The automatic control allows water passage while regulating the headwater and stabilizes discharge by rising and falling with the tide. The spillway has a design discharge of 28,900 cfs and a weir elevation of -15.0 ft., NGVD. The navigation lock, 56 feet wide by 400 feet useable length, is of reinforced concrete rigid-frame type construction containing upper and lower sector gates. The sill elevation is -14 ft.,NGVD, at both the upper and lower sills.

F. S-127 Buckhead Ridge Lock. The S-127 lock is located next to the Pumping Station 127 located in L-48 on the northwest shore of Lake Okeechobee, just southeast of State Road 78, and approximately twelve miles southwest of the town of Okeechobee. S-127 is a 15 x 50-foot vertical-lift type navigation lock which provides water access between the lake and housing developments landward of the levee.

G. S-131 Lakeport Lock. The S-131 lock is located just to the east of the Pumping Station 131 in L-50 on the northwest shore of Lake Okeechobee, just off of State Road 721, southeast of State Road 78, and approximately 27 miles southwest of the town of Okeechobee. S-131 is a 15 x 50-foot vertical-lift type navigation lock. The lock provides water access between the lake and housing developments landward of the levee.

H. S-135 and Lock. The lock at S-135 is a small boat navigation lock adjacent to the south side of the pumping station at Chancy Bay in L-47. A 15 by 50 foot operating chamber is created between two vertical lift gates. Bottom elevation of the lock chamber is at elevation 8 feet, NGVD. Protection grade on the lake side is 37.5 feet, NGVD. The lock was provided at local interest expense to provide riparian access to the lake.

EAST COAST CANAL STRUCTURES

The facilities designated the East Coast Canals (ECC) component of the C&SF Flood Control Project, are the flood control and outlet works from St. Lucie County (northeast of Lake Okeechobee) southward through Martin, Palm Beach and Broward Counties to Dade County, a distance along the Atlantic Coast of about 170 miles (the ECC also drain a small portion of Okeechobee County). The ECC portion of the C&SF Flood Control Project encompasses the majority of the canals and water control structures located along the lower east coast of Florida, with a

few exceptions. The exceptions include the St. Lucie Canal system (Canal 44) and several non-C&SF canals which are operated and maintained by SFWMD. The East Coast Canals portion of the project is designed for the following purposes: flood protection for agricultural and urban activities within the area; provide water supply for agriculture; groundwater control and supply for the region; and to prevention of salinity encroachment. Table 2 contains the optimum water control elevations for the project structures in this study. Below are general descriptions of these structures.

A. Pumping Station 13. S-13, located in C-11, 300 feet west of U.S. Highway 441 and 5.5 miles southwest of Fort Lauderdale, is a reinforced-concrete structure and concrete-block superstructure, with three vertical propeller pumps (540 cfs total capacity) and a spillway with an automatically controlled vertical-lift gate. The purpose of S-13 is to release runoff from, prevent overdrainage of, and prevent saltwater intrusion into the agricultural area west of S-13.

B. Structure 20F. S-20F is a reinforced concrete, trapezoidal weir, with U-shaped spillways and provided with automatically-controlled vertical lift gates. S-20F is a three-bay spillway which maintains desirable water control stages in C-103 upstream of S-20F and prevents salt water intrusion into C-103.

C. Structure 20G. S-20G, located about 18 miles south of Miami in Section 2 of L-31E at Military Canal, is a reinforced-concrete trapezoidal weir spillway with a hydraulically-operated vertical-lift gate. The purpose of S-20G is to maintain desirable water stages upstream of the structure, pass all discharges up to the design capacity without exceeding desirable stages and restrict discharge during floods to that which will not cause damaging stages or velocities downstream.

D. Structure 21. S-21, 0.7 miles upstream of Biscayne Bay and east of U.S. Highway 1, is a three-bay reinforced-concrete gated spillway with steel sheet-piling wing walls and automatic gate controls. Under design conditions, S-21 passes about 2,560 cfs. The purpose of S-21 is to permit release of flood runoff from the tributary basin, prevent overdrainage and saltwater intrusion.

E. Structure 21A. S-21A is about one mile west of the shoreline at Biscayne Bay on C-102. S-21A is a two-bay spillway with vertical lift gates. The spillway maintains desirable water control stages in C-102 upstream of S-21A during low flow periods, passes all discharges up to design capacity without exceeding desirable stages, restricts discharge during floods to that which will not cause damaging velocities, and prevents salt water intrusion into C-102.

F. Structure 22. S-22 was constructed at the site of a

temporary salinity and water control structure. S-22 (C-2 Station 599+00), about 7,000 feet above the mouth at Biscayne Bay and about 10 miles southwesterly of downtown Miami, is a two-bay, reinforced-concrete gated spillway with head and wing walls, riprap, operating platform and two roller gates. S-22 permits release of flood runoff and prevents overdrainage and salt water intrusion in C-2. The design discharge of S-22 and C-2 is 1905 cfs (100 percent of SPF).

G. Structure 25. S-25 is a one-barrel, gated culvert in C-5. The SPF discharge is 320 cfs. The purpose of S-25 is to permit release of local flood runoff and to serve as a salinity control structure to prevent overdrainage and saltwater intrusion upstream of S-25 in C-5.

H. Structure 25B. S-25B, in C-4 just downstream of Northwest 42nd Avenue (LeJeune Road) and just south of Northwest 21st Street, is a two-bay reinforced-concrete, U-shaped, gated trapezoidal-weir spillway with automatically-controlled vertical-lift gates. The purpose of S-25B is to release flood runoff and serve as a salinity control structure to prevent overdrainage and saltwater intrusion upstream of S-25B in C-4. The design discharge is 2,000 cfs (100% of SPF).

I. Structure 26. S-26, in C-6, is a two-bay spillway with vertical-lift gates. The purpose of S-26 is to release flood runoff up to 2,470 cfs (100% of SPF) to prevent overdrainage and saltwater intrusion.

J. Structure 27. S-27 permits release of flood runoff and prevents overdrainage and salt water intrusion through C-7. S-27, located at C-7 Station 75+00, northwest of the intersection of N.E. 4th Place and N.E. 82nd Street in Miami, is a reinforced concrete spillway with steel sheet pile wing-walls, operating platform, and two roller gates. S-27 has a design discharge of 2,800 cfs (75 percent of SPF or 3,070 cfs).

K. Structure 28. S-28, located on C-8 between F.E.C. Railway Bridge and N.E. 107th Street and on the Miami Shores golf course, is a vertical lift, two gate, reinforced concrete spillway with steel sheet piling wing walls. The purpose of S-28 is to permit release of flood runoff from the tributary basin, prevent overdrainage and saltwater intrusion. Design discharge is 3,220 cfs.

L. Structure 29. S-29, on C-9 in North Miami Beach about 400 feet east of U.S. Highway 1, is a reinforced-concrete spillway with head and wing walls, operating platform, and four roller gates. Under SPF conditions, S-29 will pass about 4,700 cfs. The purpose of S-29 is to permit release of flood runoff and prevent overdrainage and saltwater intrusion of C-9.

M. Structure 33. Spillway S-33, in C-12 about 3 miles west of Fort Lauderdale, is a reinforced-concrete spillway with head

and wing walls, operating platform, riprap reinforcement, and one roller gate. Under design flow conditions, S-33 will pass about 620 cfs. The purpose of S-33 is to permit release of runoff and prevent overdrainage and salt water intrusion of the agricultural area served by C-12 west of S-33.

N. Structure 123. S-123 is on the original portion of C-100 about 1,800 feet west of the easterly limits. S-123 is a trapezoidal crest spillway with two vertical lift gates. The purpose of S-123 is to maintain optimum water control stages upstream in C-100 and C-100B, pass up to 40 percent SPF without exceeding desirable stages, restrict discharge during floods to that which will not cause damaging velocities or stages downstream, and pass sufficient discharge during low flow periods to maintain stages downstream.

TABLE 1

Optimum Water Control Elevations For
Okeechobee Waterway and Lake Okeechobee (1)

Structure	Optimum Water Surface Elevation (ft)		Notes
	Headwater	Tailwater	
S-77 Spillway and Moore Haven Lock	See Note 2	11.1	
S-78 Spillway and Ortona Lock	11.1	3.0	
S-79 Spillway and W.P. Franklin Lock	3.0	Tidal	
S-80 Spillway and St. Lucie Lock	14.0-14.5	Tidal	
S-308 Spillway and Port Mayaca Lock	See Note 2	14.0-14.5	
	Landside	Lake	
S-127 Lock	14.0	See Note 2	(3)
S-131 Lock	13.5	See Note 2	(4)
S-135 Lock	14.0	See Note 2	(3)

TABLE 1 (Continued)

Optimum Water Control Elevations For
Okeechobee Waterway and Lake Okeechobee

Notes:

(1) Optimum water control elevations have been developed through operating experience. All elevations are referenced to National Geodetic Vertical Datum 1929.

(2) The current Lake regulation schedule ranges from 15.65 to 16.75 feet with multiple operation zones which vary flood releases over a wide range before reaching maximum release rates. The purpose of the 15.65 to 16.75 foot regulation schedule is to reduce damaging flows to the nearby St. Lucie Canal and Caloosahatchee River estuaries without sacrificing the flood control or water supply benefits derived from the Lake. In Zone D discharges may be made to the estuaries for extended periods of time when the stage is rising. In Zone C, discharges are made at the same rate as Zone B of the current regulation schedule. In Zone B, discharges up to 6500 cfs at S-77 and 3500 cfs at S-80 can be made. When lake stages reach the levels defined for Zone A, maximum discharges are made through the major lake outlets after the removal of local runoff.

This schedule does not significantly impact water supply, or lake stages but it does reduce the occurrence of large discharges to the estuaries. It is similar to the 1978 Regulation Schedule (previous regulation schedule) in that regulatory releases occur at relatively high lake stages from 15.65 ft. to 16.75 ft. compared to 15.5 to 17.5 ft. The largest difference between the current regulation schedule and the 1978 Regulation Schedule is that regulatory releases to the estuaries occur in a more graduated fashion. The first zone of releases (Zone D) incorporates pulse releases to the estuaries. Pulse releases are low level releases that mimic the natural runoff from a rainstorm event. Zone D releases to the estuaries and flows to the Water Conservation Areas have been successfully used several times in the past to avoid larger regulatory releases. Even though these releases are low in volume compared to other flood control releases, they may cause problems in the estuaries if used too frequently. However, it is still an environmentally sensitive approach to release water to these ecosystems and provides a compromise that can possibly avoid more harmful larger releases.

Lake stages can occur outside the regulation schedule. The minimum Lake elevation is 9.5 ft., NGVD. The 30-day average SPF stage is 24.8 ft., NGVD.

(3) Whenever the lake stage is below 14.0 feet, the lock remains full open. When the lake exceeds this stage the lock is operable seven days a week between 5:30 am and 8:00 pm and the lock is fully closed between 8:00 pm and 5:30 am.

(4) Whenever the lake stage is below 13.5 feet, the lock remains full open. When the lake exceeds this stage the lock is operable seven days a week between 5:30 am and 8:00 pm and the lock is fully closed between 8:00 pm and 5:30 am.

Table 2

Optimum Water Control Elevations
For East Coast Canal Structures (1)

			Headwater Elevation Auto Gate Operation (ft)			
Structure	Canal	Range	Open	Optimum	Close	Notes
S-13	C-11	All	---	2.5	---	
S-20F	C-103	High Low	2.2 1.4	2.0 1.2	1.8 1.0	(2,4)
S-20G	L-31	High Low	2.2 1.4	2.0 1.2	1.8 1.0	(2,4)
S-21	C-1	High Low	2.4 2.0	1.9 1.5	1.5 1.0	(2,4)
S-21A	C-102	High Low	2.2 1.4	2.0 1.2	1.8 1.0	(2,4)
S-22	C-2	All	3.5	2.9	2.5	(2)
S-25	C-5	All	2.2	2.0	1.8	(2)
S-25B	C-4	All	3.0	2.8	2.0	(2)
S-26	C-6	All	2.8	2.5	2.3	(2)
S-27	C-7	All	1.9	1.7	1.6	(2)
S-28	C-8	All	2.1	1.8	1.5	(2)
S-29	C-9	All	2.5	2.0	1.5	(2)
S-33	C-12	All	4.0	3.5	2.5	(5)
S-123	C-100	High Low	3.5 2.4	3.0 2.4	2.5 1.4	(3,4)

Notes:
(1) Optimum water control elevations and gate operating criteria have been developed through operating experience. All elevations are with reference to the National Geodetic Vertical Datum of 1929.

(2) The gates will close or remain closed should the headwater-tailwater differential be less than 0.2 feet.

(3) The gates will remain closed when the headwater-tailwater differential is less than 0.3 feet.

(4) Selection of an operating range depends on field conditions and agricultural needs.

(5) Total capacity is 920 cfs which includes 300 cfs added for Old Plantation Pump station at the west end of C-12; water levels listed are based on increased flows and channel size.

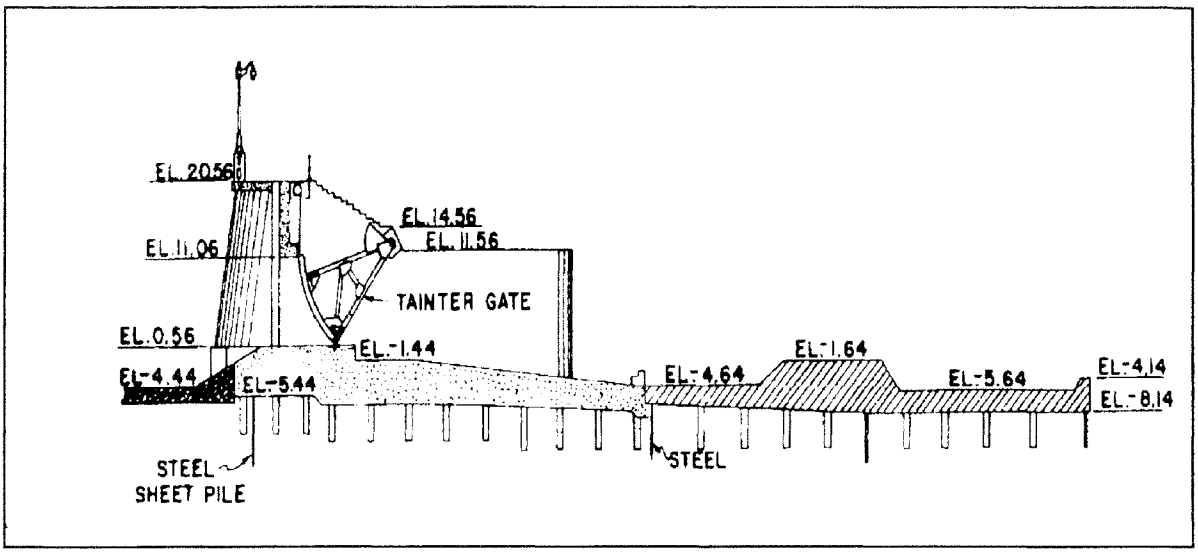


Figure 1: Cross section of St. Lucie Spillway. A typical tainter gate.

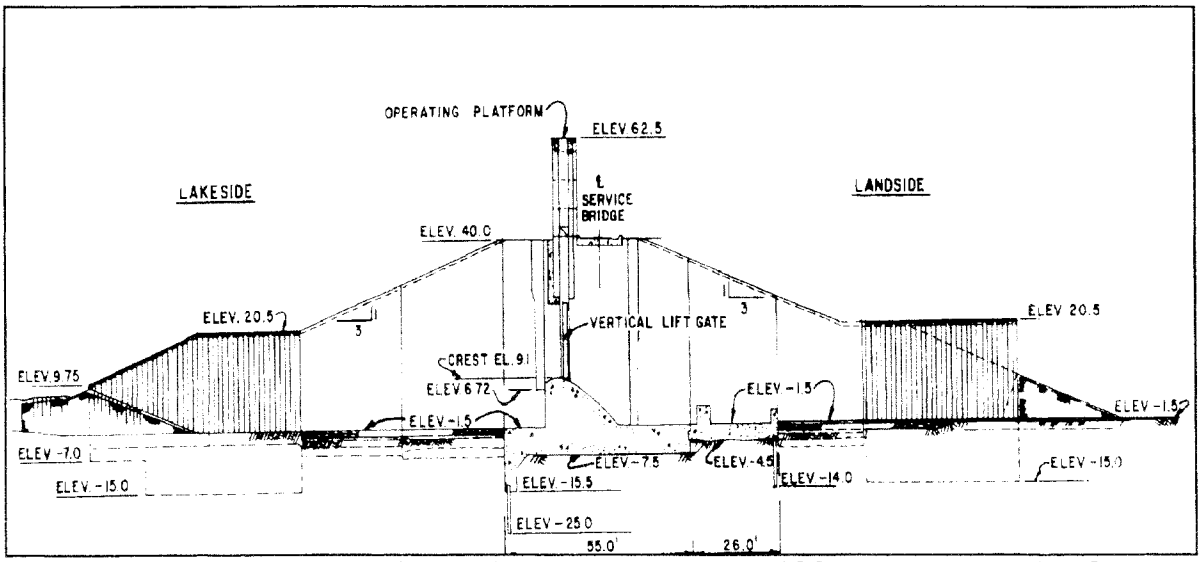


Figure 2: Cross section of Port Mayaca Spillway. A typical vertical gate.

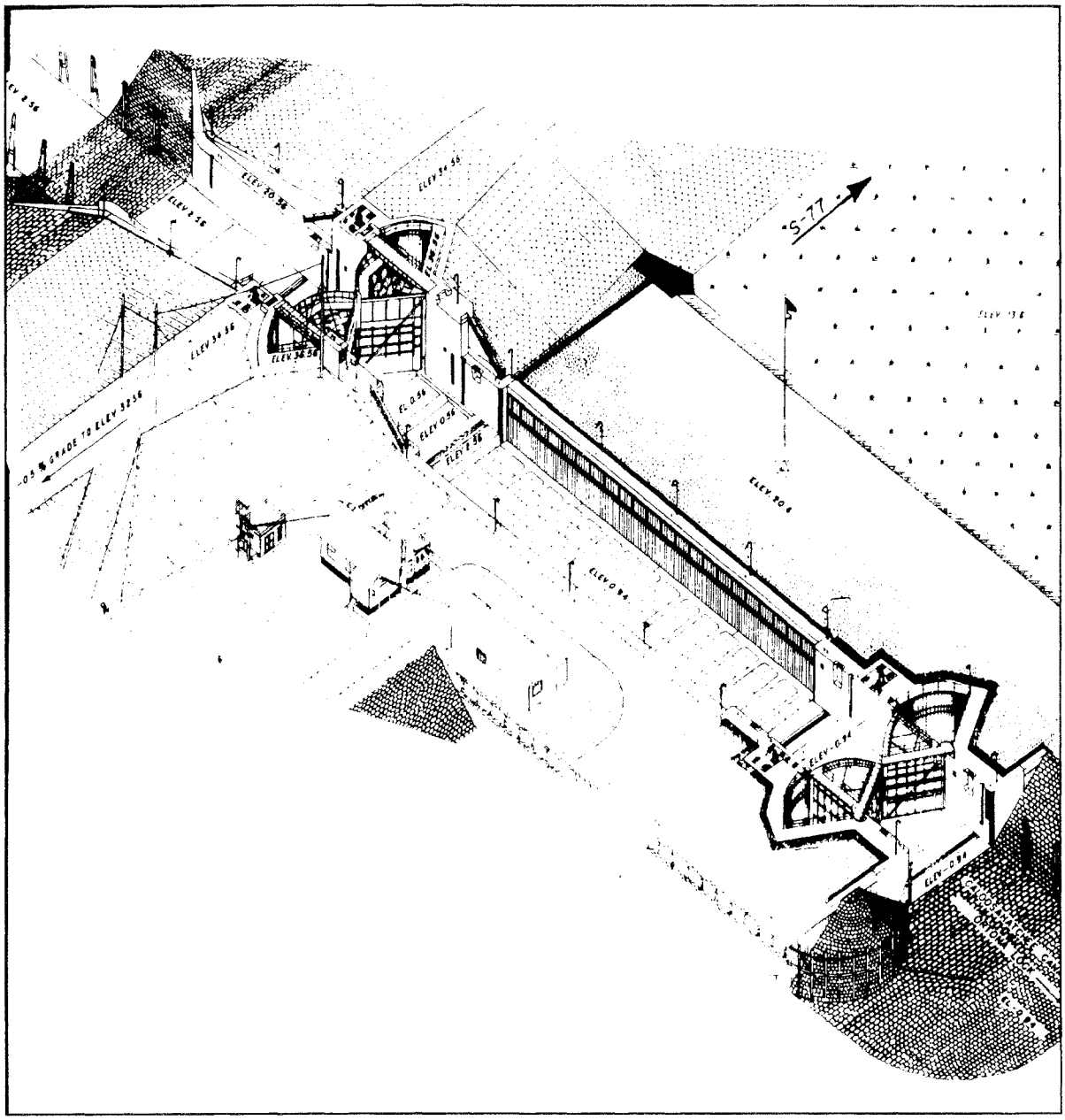
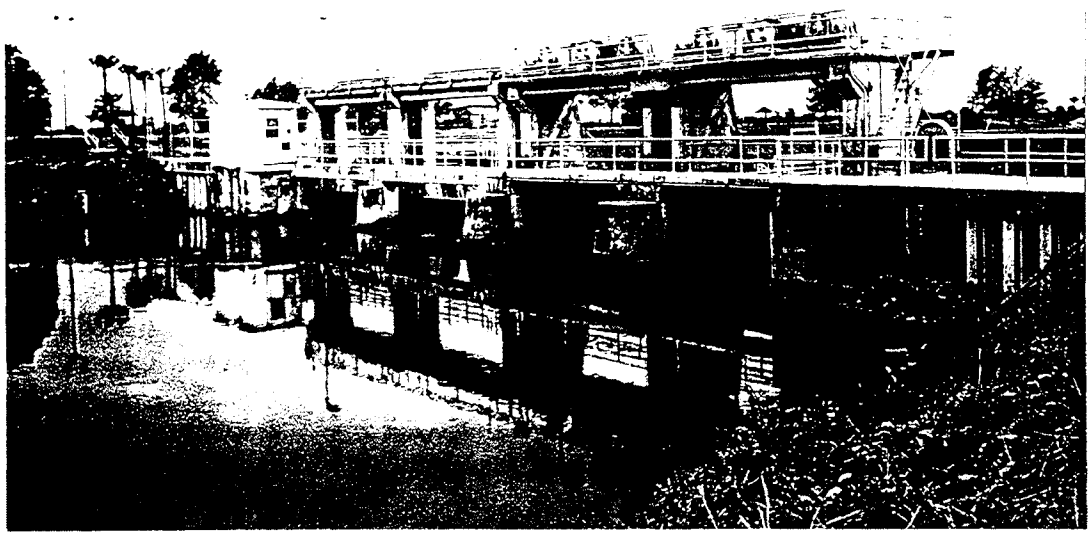
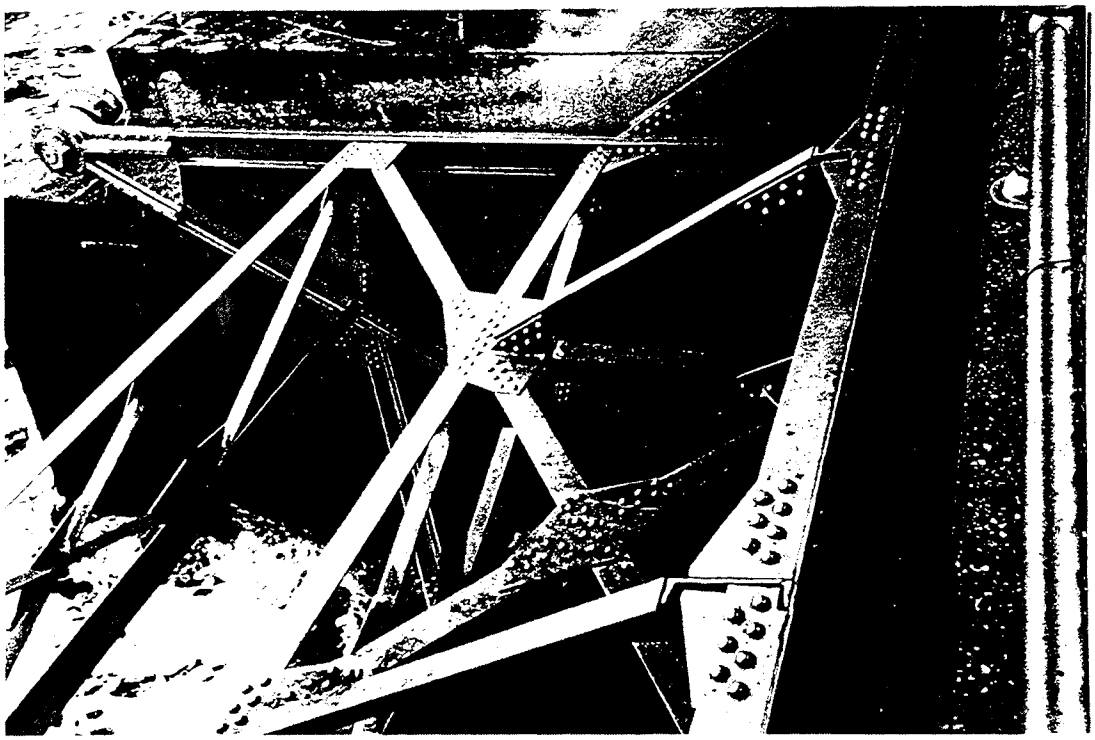


Figure 3: Moore Haven Lock- typical lock with sector gates.

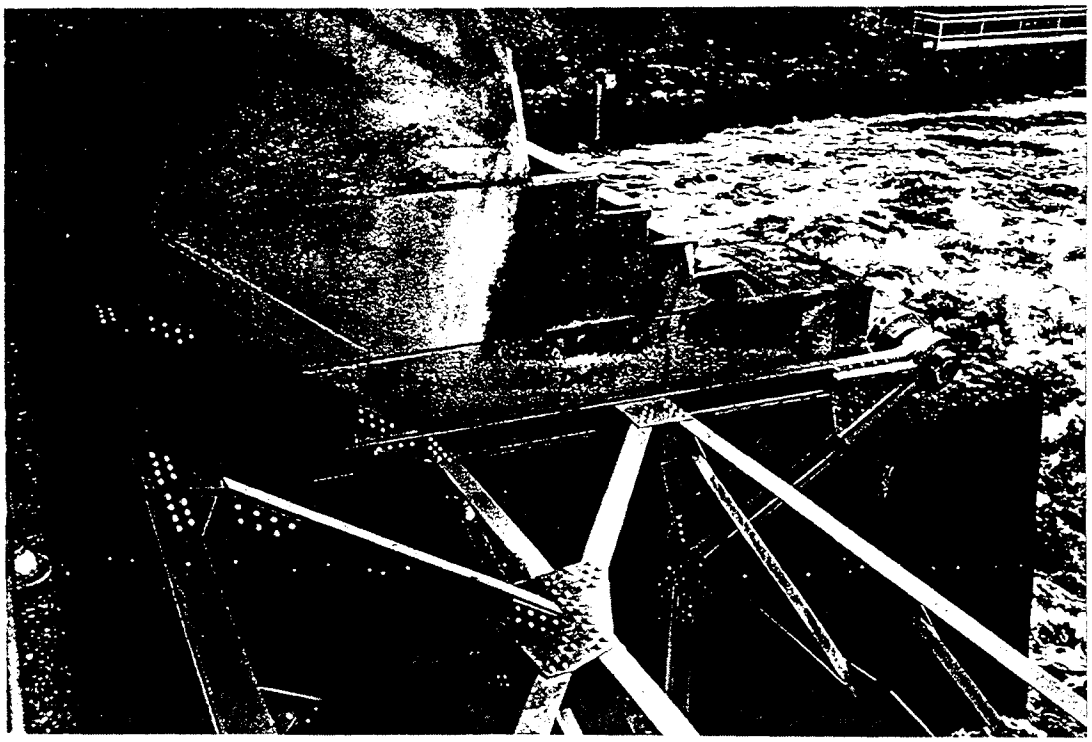


Photograph A. S-78 Spillway, upstream side. The two gates to the right are tainter gates; the two gates to the left are vertical lift gates.

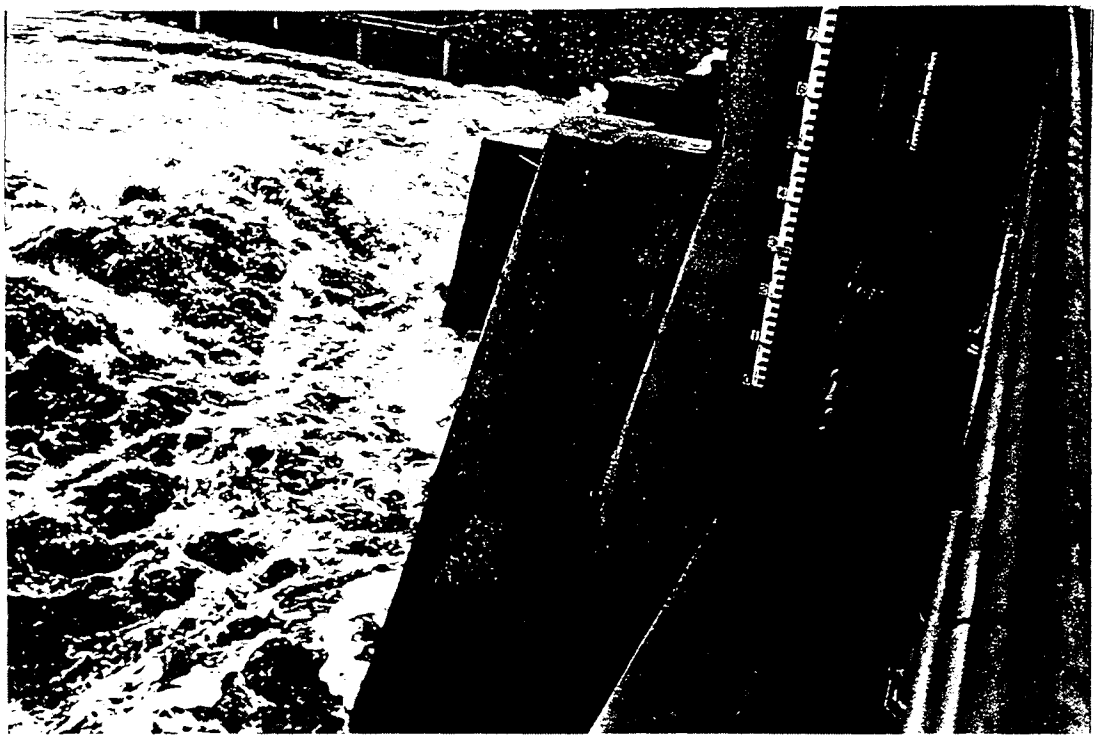
Photograph B. S-78 Spillway, downstream side. The two tainter gates are on the left; the two vertical lift gates are on the right.



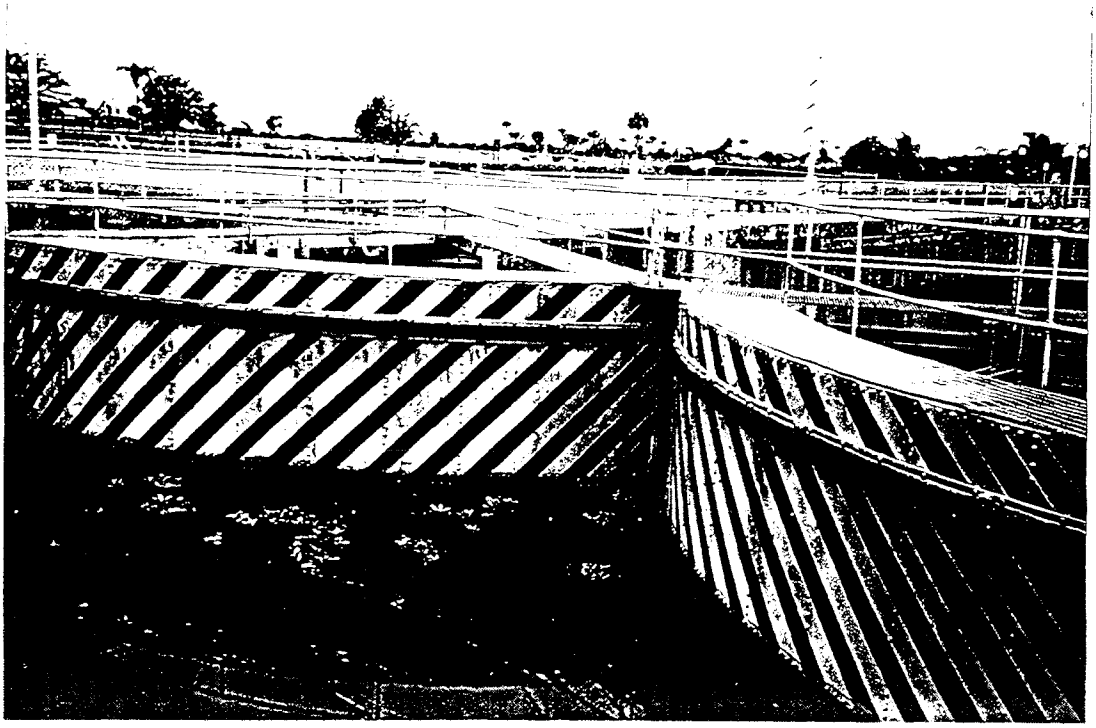
Photograph C. S-78 Spillway, tainter gate. Upstream is to the right. Note that a tainter gate is a segment of a cylinder mounted on radial arms which rotate about trunnions, one of which is visible in the upper left corner.



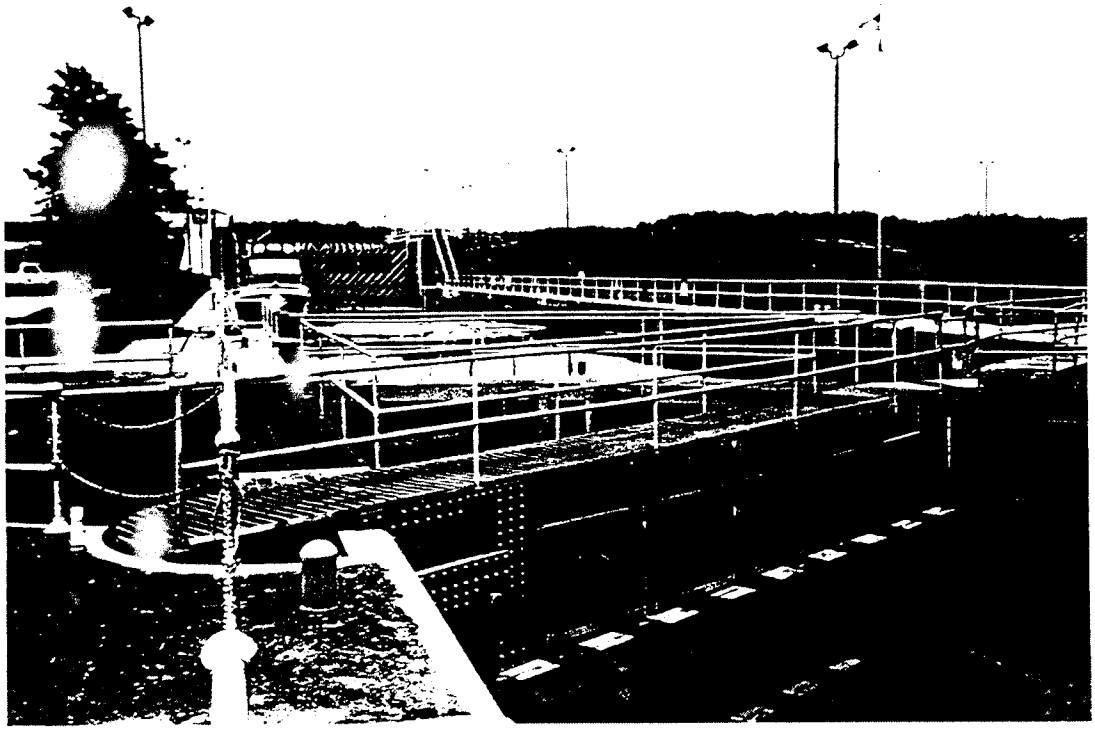
Photograph D. S-78 spillway, tainter gate. In this picture upstream is to the left. One of the hoist chains and the 3 ft. gate setting can be discerned (upper left).



Photograph E. S-78 spillway, vertical lift gate. Upstream is to the right. One of the hoist cables, as well as the 3 ft. gate setting, can be seen (right). Most of the spillway gates in Central and Southern Florida are vertical lift gates.

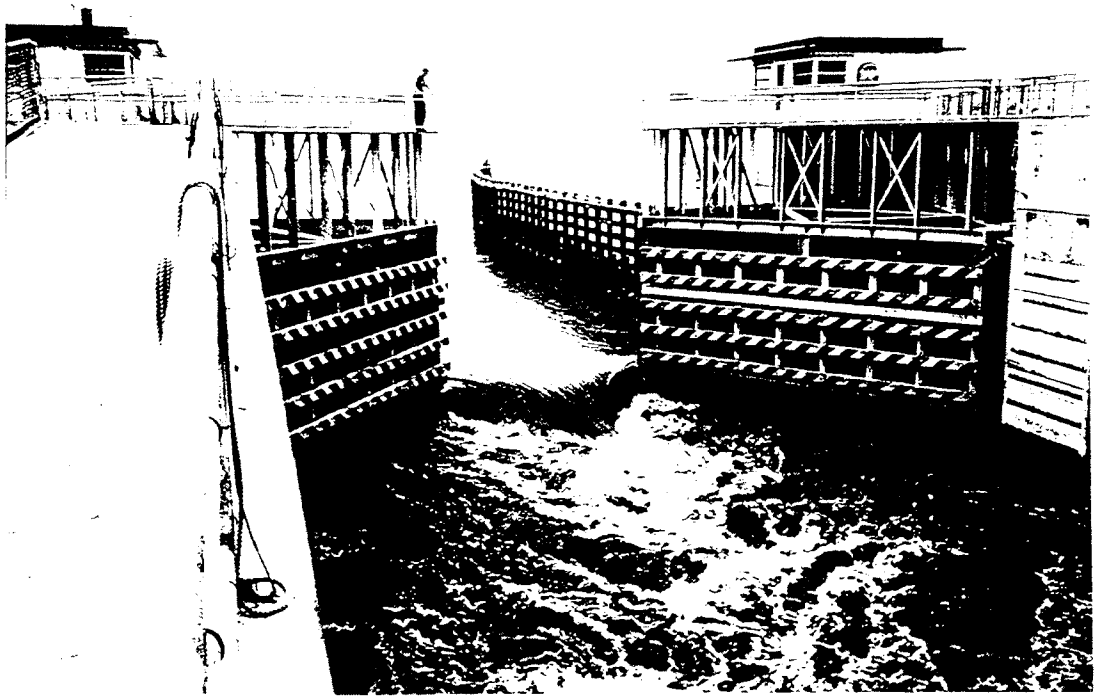


Photograph F. Ortona Lock, upstream sector gates. This photograph was taken standing upstream of the lock chamber.

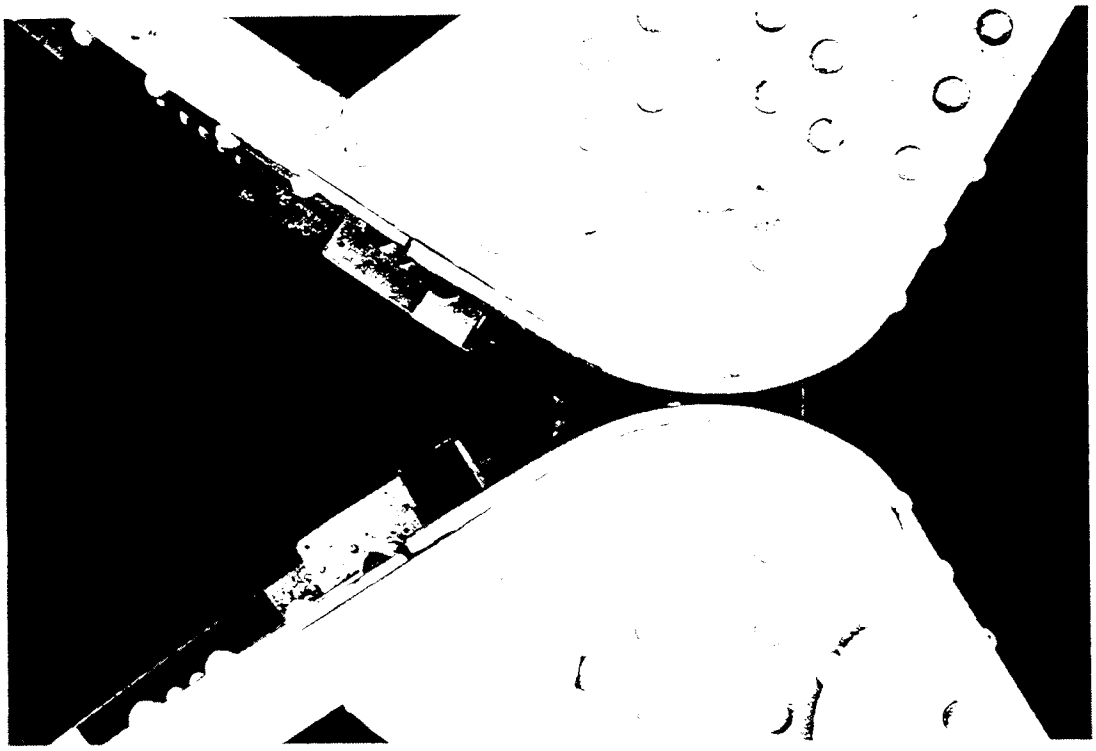


Photograph G. Moore Haven Lock, facing upstream. The two sector gates in the foreground are the downstream gates, and the two sector gates in the background are the upstream gates. In this photograph the viewer is facing the flat sides of the sector gates and not their curved skin plates, which face upstream. Note the boat moored along the left side of the lock chamber. While the upstream sector gates are closed, the downstream gates are open slightly in order to lower the water level inside the lock chamber to the level of the lower pool. When the level of the lower pool is reached, the downstream gates are opened fully and the boat may pass through.

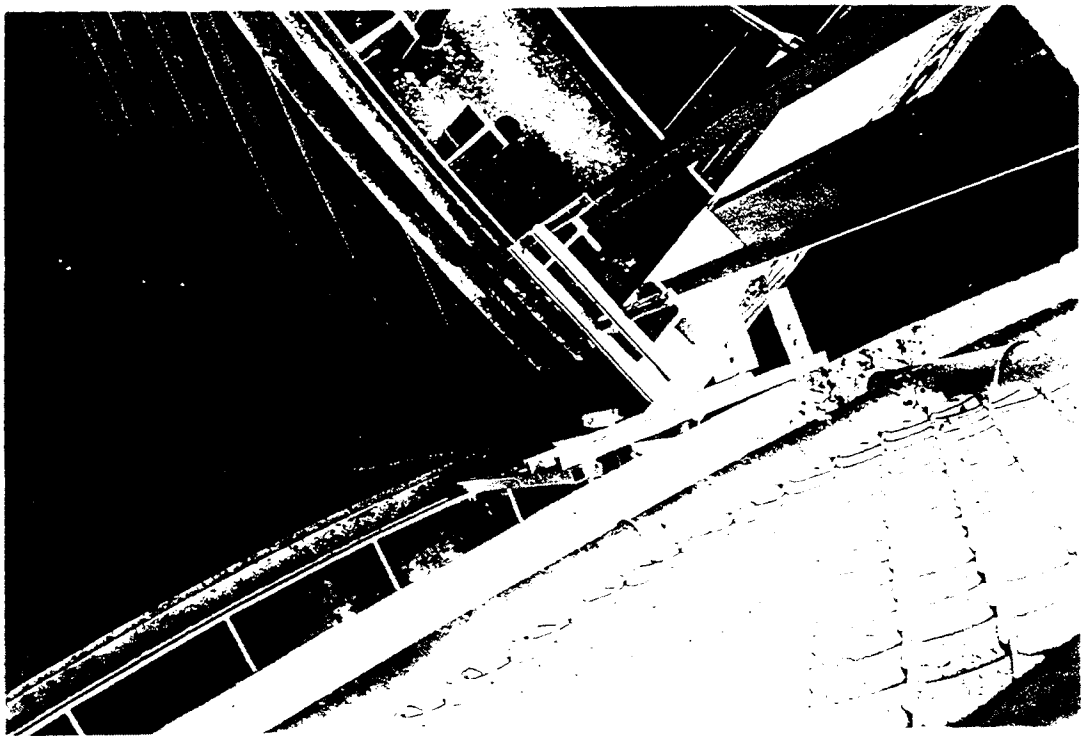
Photograph H. Port Mayaca Lock, facing downstream towards the St. Lucie Canal. This photograph, which shows the downstream sector gates, was taken from a point near the upstream sector gates; thus, the upstream gates cannot be seen in this picture.



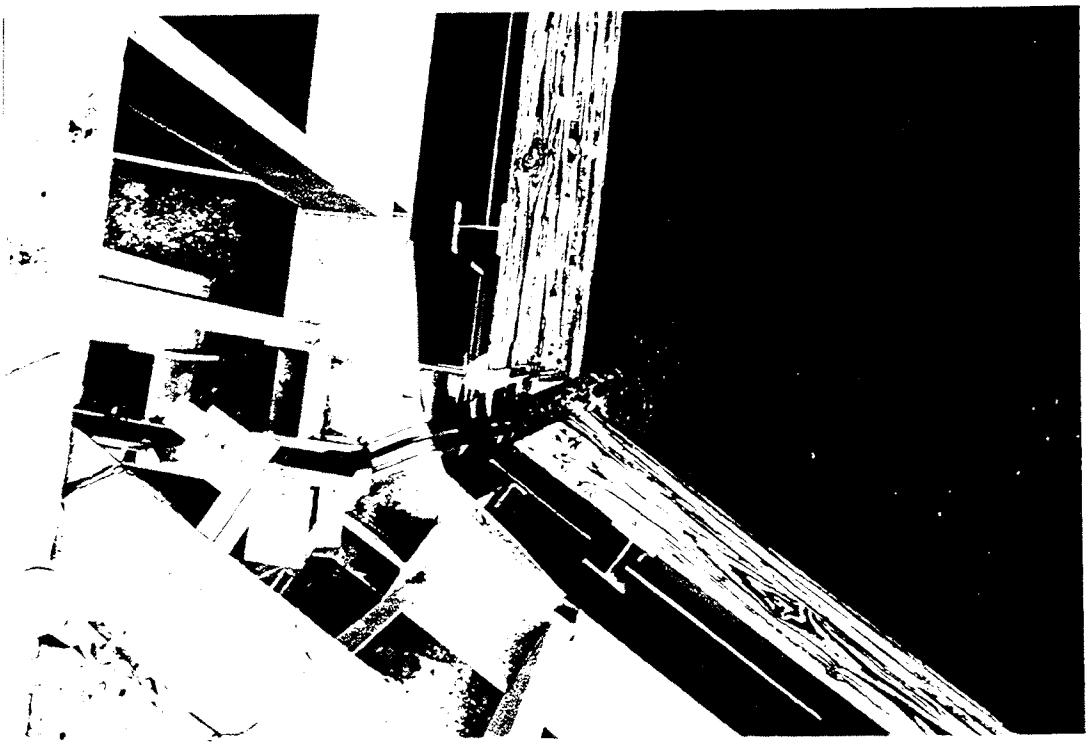
Photograph I. Port Mayaca Lock, facing upstream towards Lake Okeechobee from inside the lock chamber.



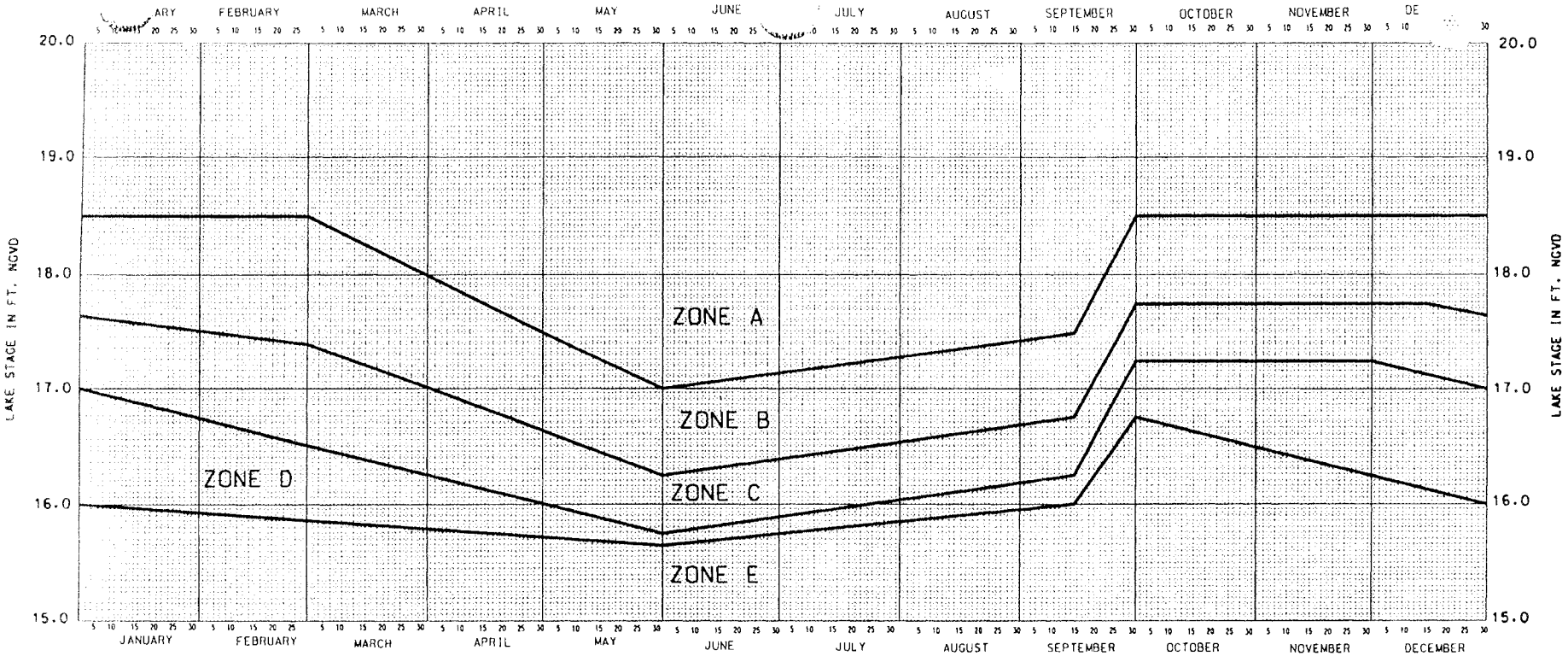
Photograph J. Moore Haven Lock. The vicinity where the two upstream sector gates meet when closed.



Photograph K. Port Mayaca Lock, upstream sector gates. The viewer is looking down just to the left of the point of gate closure. The lock chamber is to the right.



Photograph L. Port Mayaca Lock, upstream sector gates. Looking down, just to the right of the point of gate closure. The water on the right is in the lock chamber.



RELEASE THROUGH OUTLETS AS INDICATED

ZONE	AGRICULTURAL CANALS (2)	CALOOSAHATCHEE RIVER (2)	ST. LUCIE CANAL
A	PUMP MAXIMUM PRACTICABLE TO WCA'S	UP TO MAXIMUM CAPACITY AT S-77	UP TO MAXIMUM CAPACITY AT S-80
B (1)	MAXIMUM PRACTICABLE TO WCA'S	6500 CFS AT S-77	3500 CFS AT S-80 (3)
C (1)	MAXIMUM PRACTICABLE TO WCA'S	UP TO 4500 CFS AT S-77	UP TO 4500 CFS AT S-80 (3)
D	MAXIMUM PRACTICABLE TO WCA'S	MAXIMUM NON-HARMFUL DISCHARGES TO ESTUARY WHEN STAGE RISING	MAXIMUM NON-HARMFUL DISCHARGES TO ESTUARY WHEN STAGE RISING
E	NO REGULATORY DISCHARGE	NO REGULATORY DISCHARGE	NO REGULATORY DISCHARGE

NOTES: (1) RELEASES THROUGH VARIOUS OUTLETS MAY BE MODIFIED TO MINIMIZE DAMAGES OR OBTAIN ADDITIONAL BENEFITS.

(2) SUBJECT TO FIRST REMOVAL OF LOCAL RUNOFF.

(3) EXCEPT WHEN EXCEEDED BY LOCAL INFLOW.

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE

LAKE OKEECHOBEE

DEPARTMENT OF THE ARMY, JACKSONVILLE DISTRICT
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

DATED: 11 MAY 1992

FIGURE 4

RUN 25

APPENDIX F

MAINTENANCE AND INSPECTION SCHEDULE FOR LOCKS & SPILLWAYS
FY 1995 - 2004

STRUCTURE	LAST SB&P	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05
St.Lucie Lock	1994		M,P		I			P	I			
Pt. Mayaca Lock	1991		P		I			P	M			
Moore Haven Lock	1988		P		I		M	P			I	
Ortona Lock	1985		M,P				I	P			I	
WP Franklin Lock	1993		I,P				I	P			M	
Canaveral Lock	1992	I			P	I				M,P		
St. Lucie Spillway	1988		P			M		P				
Mayaca Spillway	1992		P					P				
Moore Haven Spillway	1994		P					P				
Ortona Spillway	1985	I	P	M				P				
Franklin Spillway	1985		I,M,P					P				
S-351 Spillway	1989	P		P		I, P	M	~~M~~	~~P~~			P
S-352 Spillway	1988	P		P		P	I ~~M~~	M	~~P~~			P
S-354 Spillway	1990	P		P		P		I	M, ~~P~~			P
S-10 Spillway	1994	P					P					
S-11 Spillway	1994	P					P					
S-12 Spillway	1994	P					P					
Palm Valley Bridge	1982	M,P	P	P	P	P	P	P	P	P	P	P

M DENOTES SCHEDULED <u>MAINTENANCE</u> FOR SANDBLASTING & PAINTING INCLUDING MECHANICAL AND ELECTRICAL REPAIRS. SCHEDULED AT 12 YEAR INTERVALS.

I DENOTES SCHEDULED DEWATERING FOR <u>INSPECTION</u> AND MINOR MAINTENANCE, IF NEEDED, OF SEALS, MANATEE SCREENS, TOUCH-UP PAINTING. SCHEDULED AT 4 YEAR INTERVALS.

P DENOTES <u>PERIODIC</u> INSPECTION WITHOUT DEWATERING.

08/23/94

Rev 1/13/95

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Lock Overhaul and Inspection Schedule

Structure	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01
S-193								
Design & Spec.								
Construction								
5 Year Inspection								
S-310								
Design & Spec.								
Construction								
5 Year Inspection								
S-65E								
Design & Spec.								
Construction								
5 Year Inspection								
S-65D								
Design & Spec.								
Construction								
5 Year Inspection								
S-65								
Design & Spec.								
Construction								
5 Year Inspection								
S-61								
Design & Spec.								
Construction								
5 Year Inspection								
S-65A								
5 Year Inspection								
S-65B								
5 Year Inspection								
S-65C								
5 Year Inspection								

S-65B & C are not scheduled for overhaul due to possible removal.
Overhaul was performed at S-65A in FY93.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Vertical Lift Navigation Lock Overhaul and Inspection Schedule

Structure	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
S-131											
Overhaul											
5 Year Inspection											
S-127											
Overhaul											
5 Year Inspection											
G-36											
Overhaul											
5 Year Inspection											
S-135											
Overhaul											
5 Year Inspection											

Work performed by in-house forces.

INVENTORY OF JACKSONVILLE DISTRICT STOPLOGS
Bulkhead and Needle systems

Structures	Needles or Bulkheads	No. of Needles (Material)/Needle Beams (Material) No. of Bulkheads (Material)/Pickup Beams (Material)	Storage Location
LOCKS:			
Canaveral Lock 11-29,676 (40-44)	Needles	62 (timber)/2 (steel) with 2 tripod supports (steel)	Canaveral Lock
Ortona Lock Moore Haven Lock St. Lucie Lock	Needles	52* (aluminum)/2 (riveted steel built in 30's or 40's - 126-33,612, sht 1) or 52* (aluminum)/2 (welded steel built in 1972 - 120-31,384, sht 60)	Clewiston
Port Mayaca Lock 400-32,596 (78-81) W.P. Franklin Lock 471-29,059 (53-55)	Bulkheads	12 (steel)/1 (steel)	Moore Haven Lock
SPILLWAYS:			
S-79 (Franklin) Spillway 471-29,059 (26-28)	Bulkheads	20 (steel)/2 (steel)	W.P. Franklin Lock and Spillway
Port Mayaca Spillway 400-32,596 (127-129)	Bulkheads	10 (steel)/1 (steel)	Port Mayaca Spillway
St. Lucie Spillway 131-12,234 (380/2-380/9A)	Bulkheads	3 (steel)/1 (steel)	St. Lucie Spillway
S-78 (Ortona) Spillway 471-28,941	Needles	10* (aluminum)/0 for tainter gates 12* (aluminum)/0 for vert lift gates	Clewiston
S-351 Spillway S-77 (Moore Haven) Spillway 471-28,862	Bulkheads	10 (steel)/1 (steel)	S-77 (Moore Haven) Spillway
S-10 Spillway 471-36,321 (3/9)	Needles	220 (timber)/4 (steel)	Clewiston
S-11 Spillway 422-22,351 (8)	Needles	56 (timber)/3 vertical (aluminum) or 12* (aluminum)/0	Clewiston
S-12 Spillway 472-28,223 (33 of 44)	Needles	56 (timber)/3 (aluminum) or 12* (aluminum)/0	Clewiston
S-352 Spillway S-354 Spillway 400-34,780 (6/10-6/12)	Bulkheads	8 (steel)/1 (steel)	S-354 Spillway

* aluminum needles were fabricated for the Government by Purchase Order in 1987

AS-BUILT INFORMATION ON NEEDLE DAM SYSTEMS AT SFWMD STRUCTURES			
STRUCTURE (AS-BUILT D.O. FILE NO.)	BAY WIDTH/ NUMBER	NEEDLE BEAMS PROVIDED BY STRUCTURE CONSTRUCTION CONTRACT	STOPLOGS PROVIDED BY STRUCTURE CONSTR. CONTRACT
PS-13 (423-22,836)	16'/1	NONE (CONCRETE BEAMS WERE BUILT AS PART OF THE STRUCTURE)	68 6X8 TIMBERS 16' LENGTH 2 4X8 TIMBERS 16' LENGTH
S-20F S-20G (420-30,225) S-123 (497-29,404)	 25'/1 25'/2	ONE SET IS SHARED 2 @ 33WF200 26'-11" LENGTH WITH 24" FLANGED ENDS (FROM S-71, 463-28,020, SHEET 27)	70 8X8 TIMBERS 16' LENGTH (FROM S-29)
S-21 (469-27,760)	27'/3	1 @ 24WF160 28'-11" LENGTH (FROM S-27) FOR U/S; CONCRETE BEAMS WERE BUILT AS PART OF THE SERVICE PLATFORM FOR THE D/S	44 6X8 TIMBERS 17'-6" LENGTH (FROM S-27) 74 6X8 TIMBERS (FROM S-22)
S-21A (501-30,084	20'/2	2 @ 24WF145 21'-10" LENGTH (FROM S-118)	70 8X8 TIMBERS 16' LENGTH (FROM S-29)
S-22 (452-23,978)	17'/2	2 @ 14WF78 18'-10" LENGTH	74 6X8 TIMBERS 17'-6" LENGTH
S-25 CULVERT (400-32,455)	96" DIA	COFFERDAM OR EARTH DIKE WILL BE REQUIRED	
S-25B (400-32,459)	22'/2	2 @ 14WF84 23'-10" LENGTH (FROM S-47D)	70 8X8 TIMBERS 16' LENGTH (FROM S-29)
S-26 (400-31,837)	26'/2	2 @ 27WF84 27'-11" WITH 18" FLANGED ENDS	26 12X12 TIMBERS 16'-8" LENGTH (FROM S-63) 31 12X12 TIMBERS 17'-8" LENGTH (FROM S-20A)
S-27 (454-27,175) S-28 (461-27,826)	27'/2 27'/2	ONE SET IS SHARED 2 @ 24WF160 28'-11" LENGTH (FROM S-27)	44 6X8 TIMBERS 17'-6" LENGTH (FROM S-27) 74 6X8 TIMBERS (FROM S-22) FOR S-28, ALINE NEEDLES SO THAT 8" NOMINAL DIMENSION IS IN DIRECTION OF FLOW

AS-BUILT INFORMATION ON NEEDLE DAM SYSTEMS AT SFWMD STRUCTURES			
STRUCTURE (AS-BUILT D.O. FILE NO.)	BAY WIDTH/ NUMBER	NEEDLE BEAMS PROVIDED BY STRUCTURE CONSTRUCTION CONTRACT	STOPLOGS PROVIDED BY STRUCTURE CONSTR. CONTRACT
S-29 (419-22,395)	22'/4	2 @ 24WF100 23'-11" LENGTH	70 8X8 TIMBERS 16' LENGTH
S-33 (440-22,676)	20'/1	2 @ 12WF40 21'-11" LENGTH	
S-310 LOCK S-193 LOCK	50'/2	CORPS OWNS FOUR 54' LONG BOX GIRDER NEEDLE BEAMS; THESE BEAMS ARE USED TO DEWATER CORPS STRUCTURES (MOORE HAVEN LOCK, ORTONA LOCK, ST. LUCIE LOCK)	CORPS OWNS TWELVE 3'X22' AND FORTY 4'X22' ALUMINUM NEEDLES (ENOUGH TO DEWATER TWO LOCKS CONCURRENTLY)
S-127 LOCK (477-28,725) S-131 LOCK (477-28,725) S-135 LOCK	15'/2 15'/2 15'/2 15'/2	NONE	24 10X10 TIMBERS 16'-2" LENGTH (FROM S-127 & 131)

NEEDLE DAM SYSTEMS USED AT SFWMD STRUCTURES			
STRUCTURE	FIELD STATION	ALUMINUM NEEDLES[1]	NEEDLE BEAMS[2]
PS-13	FT. LAUDERDALE	8 @ 4' WIDE	NONE
S-20F	HOMESTEAD	10 @ 4' WIDE 2 @ 3' WIDE 2 @ 2' WIDE	2 @ 33WF200 26'-11" WITH 24" FLANGED ENDS
S-20G	HOMESTEAD	10 @ 4' WIDE 2 @ 3' WIDE 2 @ 2' WIDE	2 @ 33WF200 26'-11" WITH 24" FLANGED ENDS
S-21	HOMESTEAD	12 @ 4' WIDE 2 @ 3' WIDE	1 @ 24WF160 28'-11"
S-21A	HOMESTEAD	10 @ 4' WIDE	2 @ 24WF145 21'-10"
S-22	MIAMI	8 @ 4' WIDE	2 @ 14WF78 18'-10"
S-25	MIAMI	NONE	NONE
S-25B	MIAMI	8 @ 4' WIDE 4 @ 3' WIDE	2 @ 14WF84 23'-10"
S-26	MIAMI	10 @ 4' WIDE 4 @ 3' WIDE	2 @ 27WF84 27'-11" WITH 18" FLANGED ENDS
S-27	MIAMI	12 @ 4' WIDE 2 @ 3' WIDE	2 @ 24WF160 28'-11"
S-28	MIAMI	12 @ 4' WIDE 2 @ 3' WIDE	2 @ 24WF160 29'-9 1/2"
S-29	MIAMI	10 @ 4' WIDE 2 @ 2' WIDE	2 @24WF100 23'-11"
S-33	FT. LAUDERDALE	10 @ 4' WIDE	2 @ 12WF40 21'-11"
S-123	MIAMI	5 @ 4' WIDE 1 @ 3' WIDE 1 @ 2' WIDE	2 @ 33WF200 26'-11" WITH 24" FLANGED ENDS

[1]Each field station has a set of aluminum dewatering needles.

[2]An expansion beam is also used to close the 10 to 12-inch gap which usually exists in the needle dam system after the needles are in place.

[3]The needles are supported at the top by the needle beam; the beams are either fabricated from structural steel shapes or concrete.

APPENDIX G

Table 1a. Manatee deaths (1974 through 28 February 1995) associated with Central and Southern Florida locks and water control structures.

Structure	Type	County Location	Operated By Date Constructed	Total Manatee Deaths*
S-27	Spillway	Dade	SFWMD/1958	15
S-29	Spillway	Dade	SFWMD/1953	12
S-80 St. Lucie	Spillway & Lock	Martin	CESAJ/1941, 1944	12
S-78 Ortona	Spillway & Lock	Glades	CESAJ/1937	14
S-22	Spillway	Dade	SFWMD/1956	6
S-193	Lock	Okeechobee	SFWMD/1973	7
S-308 C Pt. Mayaca	Spillway & Lock	Martin	CESAJ/1977	5
S-28	Spillway	Dade	SFWMD/1962	4
S-13	Spillway	Broward	SFWMD/1954	3
S-25B	Spillway	Dade	SFWMD/1976	5
S-26	Spillway	Dade	SFWMD/1974	2
S-77 Moore Haven	Spillway & Lock	Glades	CESAJ/1935, 1966	4
S-20F	Spillway	Dade	SFWMD/1967	2
S-135	Lock	Martin	SFWMD/1969	1
S-33	Spillway	Broward	SFWMD/1954	1
S-25	Culvert	Dade	SFWMD/1976	0
S-21	Spillway	Dade	SFWMD/1961	0
S-21A	Spillway	Dade	SFWMD/1966	0
S-20G	Spillway	Dade	SFWMD/1966	0
S-79 W.P. Franklin	Spillway & Lock	Lee	CESAJ/1965	0
S-127	Lock	Glades	SFWMD/1963	0
S-310	Lock	Hendry	SFWMD/1980	0
S-131	Lock	Glades	SFWMD/1963	0
S-123	Spillway	Dade	SFWMD/1966	0
			Total	**93**

*** (From FL Dept. of Env. Protect. data set)**

Table 1b. Additional manatee deaths (1974 through 28 February 1995) associated with Florida locks and water control structures other than Central and Southern Florida.

Structure	County Location	Manatee Deaths*
Canaveral	Brevard	6
Rodman	Putman	5
Buckman	Putnam	2
Rocky	Hillsborough	2
Inglis	Levy Citrus	1 1
Henry (G-36)	Okeechobee	1
		Total 18

*** (Data summary from FL Dept. of Env. Protect. data set)**

Table 2a. Yearly distribution of manatee mortality associated with central and southern Florida locks and water control structures. (Number in parenthesis indicates manatee record number. See Appendix A-D for additional individual information).

Structure	1975	1976	1977	1978	1979	1980	1981	Total
S-27			9 May (1)			4 Feb (2)		2
S-29		24 Nov (16)	28 Jun (17) 28 Jun (18) 23 Sep (19)	15 Sep (20) 13 Nov (21)	16 May (22) 1 Sep (23) 30 Oct (24) 15 Nov (25)			10
S-80					12 May (28)	11 Mar (29)		2
S-78						24 Dec (40)	23 May (41)	2
S-22		22 Nov (54) 29 Nov (55)	3 Jun (56)	18 Jun (57) 26 Jun (58) 26 Oct (59)				6
S-193				1 Jun (60)				1
S-308C					11 Jan (67)			1
S-28	27 Jun (72)			31 Dec (73)		23 Jul (74)		3
S-13						15 Jun (75)		1
S-25B				26 Sep (79) 12 Nov (80)				2
S-26		16 Sep (84)			10 Sep (85)			2
S-77								0
S-20F								0
S-135								0
S-33								0
S-21								0
S-21A								0
S-20G								0
S-79								0
S-127								0
S-310								0
S-131								0
S-123								0
Total	1	4	5	9	7	5	1	32

Table 2a. (Continued).

Structure	1982	1983	1984	1985	1986	1987	1988	Total
S-27	26 Aug (3)			23 Mar (4)		30 Nov (5)	11 Jan (6) 26 Jan (7) 16 May (8) 27 Jun (9) 2 Sep (10) 8 Sep (11)	9
S-29		21 Jun (26)				16 Jul (27)		2
S-80		20 Dec (30)	1 Jan (31)			15 Jul (32)		3
S-78		19 Mar (42) 28 Mar (43)	6 Dec (44)			3 Oct (45)	26 Dec (46)	5
S-22								0
S-193								0
S-308C						19 May (68)		1
S-28								0
S-13	30 Mar (77)			5 Nov (78)				2
S-25B	21 May (81)							1
S-26								0
S-77			16 Mar (86)					1
S-20F								0
S-135								0
S-33								0
S-21								0
S-21A								0
S-20G								0
S-79								0
S-127								0
S-310								0
S-131								0
S-123								0
Total	3	4	3	2	0	5	7	24

Table 2a. (Continued).

Structure	1989	1990	1991	1992	1993	1994	1995	Total
S-27		28 Nov (**12**)			25 Jan (**13**)	24 Jan (**14**) 5 Nov (**15**)		**4**
S-29								**0**
S-80	8 May (**33**) 21 May (**34**)		10 Apr (**35**)	22 Feb (**36**)	14 Dec (**37**)	25 Sep (**38**)	10 Feb (**39**)	**7**
S-78					30 Apr (**47**)	26 Apr (**48**) 16 Jun (**49**) 4 Aug (**50**) 31 Aug (**51**) 27 Oct (**52**) 6 Nov (**53**)		**7**
S-22								**0**
S-193			18 Oct (**61**) 31 Oct (**62**)	14 Jun (**63**)	19 Oct (**64**)	10 Jul (**65**) 27 Aug (**66**)		**6**
S-308C		23 Mar (**69**)	9 Aug (**70**)			18 Jul (**71**)		**3**
S-28						30 Dec (**75**)		**1**
S-13								**0**
S-25B				8 Oct (**82**)		20 Sep (**83**)		**2**
S-26								**0**
S-77				23 Jun (**87**)		20 Feb (**88**) 26 Dec (**89**)		**3**
S-20F			30 Nov (**90**)		29 Dec (**91**)			**2**
S-135				7 Jul (**92**)				**1**
S-33			13 Jun (**93**)					**1**
S-21								**0**
S-21A								**0**
S-20G								**0**
S-79								**0**
S-127								**0**
S-310								**0**
S-131								**0**
S-123								**0**
Total	**2**	**2**	**6**	**5**	**5**	**16**	**1**	**37**

Table 2b. Yearly distribution of additional manatee mortality associated with Florida locks and water control structures. (Number in parenthesis indicates manatee record number. See Appendix A-D for additional individual information).

Structure	1975	1976	1977	1978	1979	1980	1981	Total
Canaveral						20 Aug (95)	8 Nov (96)	2
Rodman					11 May (101)			1
Buckman			23 Oct (106)			30 Jun (107)		2
Rocky								0
Inglis						2 Nov (111)		1
Henry								0
Total	0	0	1	0	1	3	1	6

Structure	1982	1983	1984	1985	1986	1987	1988	Total
Canaveral								0
Rodman		22 Jun (102) 23 Jun (103) 8 Aug (104)						3
Buckman								0
Rocky					16 Jul (108) 24 Jul (109)			2
Inglis					8 Jul (110)			1
Henry				9 Dec (94)				1
Total	0	3	0	1	3	0	0	7

Structure	1989	1990	1991	1992	1993	1994	1995	Total	Total (All Years)
Canaveral	29 Apr (97)	12 Oct (98)	4 Jun (99) 21 Sep (100)					4	6
Rodman			24 Jun (105)					1	5
Buckman								0	2
Rocky								0	2
Inglis								0	2
Henry								0	1
Total	1	1	3	0	0	0	0	5	18

Table 3a. Monthly distribution of manatee mortality (1974 through 28 February 1995) associated with Central and Southern Florida locks and water control structures.

Structure	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
S-27	4	1	1	0	2	1	0	1	2	0	3	0	**15**
S-29	0	0	0	0	1	3	1	0	3	1	3	0	**12**
S-80	1	1	1	1	3	0	1	0	1	0	0	3	**12**
S-78	0	0	2	2	1	1	0	2	0	2	1	3	**14**
S-22	0	0	0	0	0	3	0	0	0	1	2	0	**6**
S-193	0	0	0	0	0	2	1	1	0	3	0	0	**7**
S-308C	1	0	1	0	1	0	1	1	0	0	0	0	**5**
S-28	0	0	0	0	0	1	1	0	0	0	0	2	**4**
S-13	0	0	1	0	0	1	0	0	0	0	1	0	**3**
S-25B	0	0	0	0	1	0	0	0	2	1	1	0	**5**
S-26	0	0	0	0	0	0	0	0	2	0	0	0	**2**
S-77	0	1	1	0	0	1	0	0	0	0	0	1	**4**
S-20F	0	0	0	0	0	0	0	0	0	0	1	1	**2**
S-135	0	0	0	0	0	0	1	0	0	0	0	0	**1**
S-33	0	0	0	0	0	1	0	0	0	0	0	0	**1**
S-21	0	0	0	0	0	0	0	0	0	0	0	0	**0**
S-21A	0	0	0	0	0	0	0	0	0	0	0	0	**0**
S-20G	0	0	0	0	0	0	0	0	0	0	0	0	**0**
S-79	0	0	0	0	0	0	0	0	0	0	0	0	**0**
S-127	0	0	0	0	0	0	0	0	0	0	0	0	**0**
S-310	0	0	0	0	0	0	0	0	0	0	0	0	**0**
S-131	0	0	0	0	0	0	0	0	0	0	0	0	**0**
S-123	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total	**6**	**3**	**7**	**3**	**9**	**14**	**6**	**5**	**10**	**8**	**12**	**10**	**93**

Table 3b. Monthly distribution of additional manatee mortality associated with Florida locks and water control structures.

Structure	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Canaveral	0	0	0	1	0	1	0	1	1	1	1	0	**6**
Rodman	0	0	0	0	1	3	0	1	0	0	0	0	**5**
Buckman	0	0	0	0	0	1	0	0	0	1	0	0	**2**
Rocky	0	0	0	0	0	0	2	0	0	0	0	0	**2**
Inglis	0	0	0	0	0	0	1	0	0	0	1	0	**2**
Henry	0	0	0	0	0	0	0	0	0	0	0	1	**1**
Total	**0**	**0**	**0**	**1**	**1**	**5**	**3**	**2**	**1**	**2**	**2**	**1**	**18**

Appendix A. Distribution of Manatee mortality by structure, county and waterway, to include date of mortality, sex identification and total body length (cm). (* Information not available)

Record #	Field ID #	Structure	County	Waterway	Date of Mortality	Sex	Total Length (cm)
1	M7716	S-27	Dade	Little River	9 May 77	M	267
2	M8006	S-27	Dade	Little River	4 Feb 80	M	291
3	M8252	S-27	Dade	Little River	26 Aug 82	M	300
4	M8514	S-27	Dade	Little River	23 Mar 85	M	303
5	M8718	S-27	Dade	Little River	30 Nov 87	F	214
6	MSW135	S-27	Dade	Little River	11 Jan 88	M	272
7	KDL8804	S-27	Dade	Little River	26 Jan 88	M	236
8	MSW148	S-27	Dade	Little River Canal	16 May 88	F	252
9	MSE8803	S-27	Dade	Little River	27 Jun 88	M	330
10	KDL8854	S-27	Dade	Little River	2 Sep 88	F	272
11	MSE8805	S-27	Dade	Little River	8 Sep 88	F	243
12	MSE9023	S-27	Dade	Little River	28 Nov 90	F	308
13	MSE9302	S-27	Dade	Little River	25 Jan 93	F	287
14	MSE9401	S-27	Dade	Little River	24 Jan 94	M	263
15	MSE9424	S-27	Dade	Little River	5 Nov 94	*	*
16	M7628	S-29	Dade	Snake Creek	24 Nov 76	M	278
17	M7720	S-29	Dade	Snake Creek	28 Jun 77	F	229
18	M7721	S-29	Dade	Snake Creek	28 Jun 77	M	295
19	M7729	S-29	Dade	Snake Creek	23 Sep 77	F	285
20	M7835	S-29	Dade	Snake Creek	15 Sep 78	M	257
21	M7842	S-29	Dade	Snake Creek	13 Nov 78	M	255
22	M7912	S-29	Dade	Snake Creek	16 May 79	F	331
23	M7919	S-29	Dade	Snake Creek	1 Sep 79	M	296
24	M7923	S-29	Dade	Snake Creek	30 Oct 79	M	263

Appendix A. (Continued)

Record #	Field ID #	Structure	County	Waterway	Date of Mortality	Sex	Total Length (cm)
25	M7924	S-29	Dade	Snake Creek	15 Nov 79	M	235
26*	M8327	S-29	Dade	Snake Creek	21 Jun 83	M	317
27	M8713	S-29	Dade	Snake Creek Canal	16 Jul 87	M	310
28	M150	S-80 St. Lucie	Martin	St. Lucie Canal	12 May 79	F	289
29	M8010	S-80 St. Lucie	Martin	St. Lucie Canal	11 Mar 80	M	324
30	M8340	S-80 St. Lucie	Martin	St. Lucie Canal	20 Dec 83	M	259
31	M8402	S-80 St. Lucie	Martin	St. Lucie Canal	1 Jan 84	M	288
32	KDL8736	S-80 St. Lucie	Martin	Okeechobee Waterway	15 Jul 87	F	280
33	MSE8906	S-80 St. Lucie	Martin	St. Lucie Canal	8 May 89	M	309
34	KDL8932	S-80 St. Lucie	Martin	St. Lucie Canal	21 May 89	M	320
35	MSE9106	S-80 St. Lucie	Martin	Okeechobee Canal	10 Apr 91	M	263
36	MSE9207	S-80 St. Lucie	Martin	St. Lucie Canal	22 Feb 92	M	271
37	MSE9320	S-80 St. Lucie	Martin	St. Lucie Lock	14 Dec 93	F	285
38	MSE9421	S-80 St. Lucie	Martin	St. Lucie Lock	25 Sep 94	*	*
39	MSE 9505	S-80 St. Lucie	Martin	St. Lucie Lock	10 Feb 95	M	297
40	M8028	S-78 Ortona	Glades	Okeechobee Waterway	24 Dec 80	M	250

Appendix A. (Continued)

Record #	Field ID #	Structure	County	Waterway	Date of Mortality	Sex	Total Length (cm)
41	M8152	S-78 Ortona	Glades	Caloosahatchee River	23 May 81	F	375
42	M8313	S-78 Ortona	Glades	Okeechobee	19 Mar 83	M	283
43	M8315	S-78 Ortona	Glades	Okeechobee Waterway	28 Mar 83	F	308
44	MSW038	S-78 Ortona	Glades	Okeechobee Waterway	6 Dec 84	M	239
45	MSW122	S-78 Ortona	Glades	Okeechobee Waterway	3 Oct 87	M	290
46	MSW184	S-78 Ortona	Glades	Okeechobee Waterway	26 Dec 88	F	302
47	MSW9316	S-78 Ortona	Glades	Okeechobee Waterway	30 Apr 93	M	331
48	MSW9416	S-78 Ortona	Glades	Okeechobee Waterway	26 Apr 94	M	349
49	MSW9433	S-78 Ortona	Glades	Okeechobee Waterway	16 Jun 94	F	271
50	MSW9443	S-78 Ortona	Glades	Okeechobee Waterway	4 Aug 94	M	282
51	MSW9451	S-78 Ortona	Glades	Okeechobee Waterway	31 Aug 94	M	271
52	MSW9462	S-78 Ortona	Glades	Okeechobee Waterway	27 Oct 94	*	*
53	MSW9464	S-78 Ortona	Glades	Okeechobee Waterway	6 Nov 94	*	*
54	M7626	S-22	Dade	Snapper Creek	22 Nov 76	M	142
55	M7629	S-22	Dade	Snapper Creek	29 Nov 76	F	335
56	M7719	S-22	Dade	Snapper Creek	3 Jun 77	M	353
57	M7830	S-22	Dade	Snapper Creek	18 Jun 78	F	245
58	M7832	S-22	Dade	Snapper Creek	26 Jun 78	M	285

Appendix A. (Continued)

Record #	Field ID #	Structure	County	Waterway	Date of Mortality	Sex	Total Length (cm)
59	M7839	S-22	Dade	Snapper Creek	26 Oct 78	F	300
60	M7829	S-193 Taylor	Okeechobee	Okeechobee Rim Canal	1 Jun 78	M	292
61	W9135	S-193 Taylor	Okeechobee	Lake Okeechobee	18 Oct 91	F	249
62	MSW9137	S-193 Taylor	Okeechobee	Lake Okeechobee	31 Oct 91	M	289
63	MSE9220	S-193 Taylor	Okeechobee	Taylor Creek	14 Jun 92	M	278
64	MSE9317	S-193 Taylor	Okeechobee	Taylor Creek	19 Oct 93	M	242
65	MSE9414	S-193 Taylor	Okeechobee	Taylor Creek	10 Jul 94	F	329
66	MSE9418	S-193 Taylor	Okeechobee	Taylor Creek	27 Aug 94	M	258
67	M7902	S-308 Pt. Mayac	Martin	St. Lucie Canal	11 Jan 79	M	202
68	M87[illegible]	S-308 Pt. Mayac	Martin	Lake Okeechobee	19 May 87	F	329
69	MSW262	S-308 Pt. Mayac	Martin	Lake Okeechobee	23 Mar 90	M	288
70	MSE9115	S-308 Pt. Mayac	Martin	Lake Okeechobee	9 Aug 91	M	292
71	MSE9416	S-308 Pt. Mayac	Martin	St. Lucie Canal	18 Jul 94	M	255
72	M7511	S-28	Dade	Biscayne Canal	27 Jun 75	F	310
73	M7844	S-28	Dade	Biscayne Canal	31 Dec 78	M	230
74	M8018	S-28	Dade	Biscayne Canal	23 Jul 80	M	305
75	MSE9430	S-28	Dade	Biscayne Canal	30 Dec 94	M	*

Appendix A. (Continued)

Record #	Field ID #	Structure	County	Waterway	Date of Mortality	Sex	Total Length (cm)
76	M8016	S-13	Broward	Dania Cutoff Canal	15 Jun 80	F	311
77	M8230	S-13	Broward	Dania Cutoff Canal	30 Mar 82	M	320
78	M8523	S-13	Broward	Dania Cutoff Canal	5 Nov 85	F	355
79	M7836	S-25B\	Dade	Miami River	26 Sep 78	F	360
80	M7841	S-25B	Dade	Tamiami Canal	12 Nov 78	F	302
81	M8238	S-25B	Dade	Tamiami Canal	21 May 82	M	245
82	MSE9229	S-25B	Dade	Tamiami Canal	8 Oct 92	M	269
83	*	S-25B	Dade	Tamiami Canal	20 Sep 94	*	*
84	M7621	S-26	Dade	Miami River	16 Sep 76	F	285
85	M7920	S-26	Dade	Miami River	10 Sep 79	F	326
86	MSW017	S-77 Moorehaven	Glades	Okeechobee Waterway	16 Mar 84	M	231
87	MSW9227	S-77 Moorehaven	Glades	Calooschatchee River	23 Jun 92	M	290
88	MSW9408	S-77 Moorehaven	Glades	Calooschatchee River	20 Feb 94	*	*
89	MSW9469	S-77 Moorehaven	Glades	Calooschatchee River	26 Dec 94	M	*
90	MSE9122	S-20F Mowry	Dade	Mowry Canal	30 Nov 91	M	315
91	MSE9323	S-20F Mowry	Dade	Biscayne Bay	29 Dec 93	F	321
92	MSE9223	S-135	Martin	Lake Okeechobee	7 Jul 92	F	264.8

Appendix A. (Continued)

Record #	Field ID #	Structure	County	Waterway	Date of Mortality	Sex	Total Length (cm)
93	MSE9111	S-33	Broward	C-12 Canal	13 Jun 91	F	299
94	M8525	Henry	Okeechobee	Okeechobee Rim Canal	9 Dec 85	F	350
95	M199	Canaveral	Brevard	Port Canaveral	20 Aug 80	F	294
96	M255	Canaveral	Brevard	Banana River	8 Nov 81	M	314
97	KDL8924	Canaveral	Breward	Banana River	29 Apr 89	M	323
98	UCF9058	Canaveral	Brevard	Banana River	12 Oct 90	F	290
99	UCF9120	Canaveral	Brevard	Banana River	4 Jun 91	M	310
100	UCF9134	Canaveral	Brevard	Banana River	21 Sep 91	M	335
101	M149	Rodman	Putnam	Rodman Dam	11 May 79	F	263
102	M338	Rodman	Putnam	Rodman Dam	22 Jun 83	F	340
103	M339	Rodman	Putnam	Rodman Dam	23 Jun 83	M	291
104	M344	Rodman	Putnam	Rodman Dam	8 Aug 83	F	310
105	MNE9113	Rodman	Putnam	Rodman Dam	24 Jun 91	M	275
106	M093	Buckman	Putnam	Cross Florida Barge Canal	23 Oct 77	M	310
107	M195	Buckman	Putnam	Cross Florida Barge Canal	30 Jun 80	F	276
108	SWFTM 8639	Rocky	Hillsborough	Old Tampa Bay	16 Jul 86	F	165
109	SWFTM 8642	Rocky	Hillsborough	Old Tampa Bay	24 Jul 86	F	279
110	SWFTM 8635	Inglis	Citrus	Withlacoochee River	8 Jul 86	F	343
111	M212	Inglis	Levy	Cross Florida Barge Canal	2 Nov 80	F	272

Appendix B. Distribution of localities for structure caused manatee mortality from 1974 through 28 February 1995.

Record #	Locality
1	Little River Flood Control Dam (S-27, C-4).
2	Miami, Little River at 79th Street, below flood control dam.
3	Miami, Little River, Flood control dam S-27, NE 82nd St. & 4th Avenue.
4	Little River flood control dam, S-27.
5	Miami, just downstream of SFWMD flood gate S-27 in the Little River.
6	Miami, S-27 dam, just below flood gates on Little River at 82nd St. NE.
7	Miami, behind 8240 N.E. 4th Place, just below S-27.
8	Miami, Little River Canal, Next to U.S. 1.
9	Miami, at N.E. 82nd St. and 4th Ct. just below S-27 floodgate.
10	Miami, in Little River Canal at S-27 floodgate.
11	Miami, fifty meters above floodgate S-27 in the Little River.
12	Miami, Little River Just E. of Biscayne Blvd. Bridge.
13	North Miami, north of C-7, S-27 flood control structure, behind Biscayne Shopping Center at NE 4th Court and 79th Street.
14	Miami, Just outside and South of the mouth of the Little River.
15	Little River
16	Canal near flood gate, Biscayne Blvd. and N.E. 169th Street. Gate S-29.
17	North Miami, Greynolds Park, flood control dam.
18	North Miami, Greynolds Park, flood control dam.
19	North Miami, Greynolds Park, flood control dam at Biscayne Blvd. and NE 169th St.
20	North Miami, Snake Creek (C-9), Greynolds Park Flood Dam (S-29).
21	North Miami, Snake Creek at flood control structure (S-29).
22	North Miami, in canal below Greynolds Park Flood Control structure, Maule Lake, NE 165 Street and 26 Avenue.
23	North Miami, 2919 Pt. East Drive, S-29 Greynolds Park Dam.
24	North Miami, Greynolds Park Flood Control Dam.
25	North Miami, Greynolds Park Flood Control Dam.

Appendix B. (Continued)

Record #	Locality
26	North Miami, Maule Lake, near flood dam S-29, Greynolds Park.
27	North Miami Beach, downstream of Greynolds Park flood control dam.
28	Stuart, St. Lucie Canal at buoy 50, near St. Lucie Lock (downstream).
29	St. Lucie Waterway at Phipps Park.
30	St. Lucie Canal, marker 47, just downstream of Locks.
31	St. Lucie Canal, just downstream of Lock\Dam structure.
32	Palm City, St. Lucie Lock and Dam, canal side of Okeechobee Waterway.
33	Stuart, just downstream (salt side) of the St. Lucie Locks.
34	Stuart, just downstream (salt side) of St. Lucie Locks.
35	Tropical Park, in Okeechobee Waterway just downstream of St. Lucie Lock and Dam near channel marker 34.
36	Tropical Farms, St. Lucie Locks. Inside the structure of the NW triangle section of the West gate. Gate S-80 Navigational Lock.
37	Tropical Farms, St. Lucie Canal (C-44), St. Lucie Lock, inside lock chamber.
38	St. Lucie Canal
39	St. Lucie Canal
40	Ortona Locks, by flood gate, west side.
41	Caloosahatchee River, 1/4 mile west of Ortona Locks
42	Caloosahatchee River, west (downstream) of Ortona Lock, 4 miles east of Port La Belle Marina, near mile markers 96 and 97.
43	Caloosahatchee River, 1.5 miles east of Port La Belle.
44	Down stream from Ortona Locks.
45	Ortona, downstream side of water control structure #2, trapped by eddy of flowing water.
46	Ortona, caught in NE gate of Ortona Locks.
47	Ortona Locks, Navigational Lock S-78, floating inside of lock chamber near E. gate.
48	Ortona Lock, floating on the down stream side of spillway gate #3, S-78
49	Ortona Lock, Just downstream of spillway #2

Appendix B. (Continued).

Record #	Locality
50	Ortona, floating against N. bank of Caloosahatchee Canal, approx. 1 mile downstream from the Ortona Locks.
51	Ortona Lock, S. bank approx. 500 feet downstream of the spillway.
52	Ortona Lock
53	Ortona Lock
54	Snapper Creek
55	Snapper Creek flood control dam.
56	Snapper Creek flood dam.
57	Snapper Creek flood control dam.
58	Snapper Creek automatic flood control dam.
59	Snapper Creek at Red Road and 112th Street S.W. by flood dam (S-22)
60	Taylor Creek, north end of Lake Okeechobee.
61	Okeechobee, just north of Lock at Taylor Creek.
62	Okeechobee, 100 yds. N. of Lock at Taylor Creek. At the convergence of Taylor Creek, Rim Canal, and Lake Okeechobee.
63	Okeechobee, at S-193 Navigational Lock. At the joining of Taylor Creek, Lake Okeechobee and the Rim Canal.
64	Okeechobee, S-193 navigational canal on Taylor Creek. Lock connects Taylor Creek to Lake Okeechobee.
65	Okeechobee, Just outside and E. of Taylor Creek in Lake Okeechobee (S-193).
66	Okeechobee, Just outside and N. of Taylor Creek Lock in Taylor Creek (S-193).
67	Port Mayaca Locks, St. Lucie Canal
68	Port Mayaca Lock between Okeechobee and St. Lucie Canal.
69	Port Mayaca, in lock canal.
70	Port Mayaca, just downstream from the canal locks.
71	Port Mayaca, St. Lucie Canal, Just outside and S. of Port Mayaca Lock #308.
72	Miami Shores, Biscayne Canal, just east of flood control dam.
73	Miami Shores, Biscayne Canal, downstream from dam (S-28), between NE 104 & 105 St

Appendix B. (Continued).

Record #	Locality
74	North Miami, canal between NE 90 Street, NE 91 Street, Miami Shores.
75	Biscayne Canal S-28
76	Dania Cutoff Canal at Florida Power and Light Plant.
77	Fort Lauderdale, Dania Cutoff Canal, New River Canal South, at Dam S-13.
78	Upstream side of pumping station S-13.
79	Miami River, flood control dam (S-25B) - downstream.
80	Tamiami Canal at flood dam (S-25B).
81	Miami River, South Branch, Tamiami Canal, downstream of flood control dam S-25B.
82	Miami, West Tamiami Canal, 0.25 mi.. E of water control structure S-25B, drop gate.
83	Tamiami Canal
84	Miami River at flood control dam near Lejeune Road, at airport.
85	Miami, in Miami River near Jones Boatyard.
86	Moore Haven, downstream of the Moore Haven Locks.
87	Moore Haven, on W. bank of river, 500 yds. SW of lock chamber (S-77), near intersection of River Road and Avenue 0.
88	Moore Haven approx. 2000 ft. W. of Moore Haven Lock, across the canal from Alvin E. Ward Memorial Boat Ramp.
89	Calooschatchee River Flood Gate, Glades County
90	Biscayne National Park, S.W. side of water control structure S-20F.
91	Homestead, just outside and E. of Mowry Canal in Biscayne Bay, N. of spoil island.
92	Port Mayaca, L-47 canal, E. of S-135 SFWMD water control structure drop gate. At the vegetation barrier.
93	Ft. Lauderdale, S-33 flood gate, just W. NW 34th Avenue and Sunrise Blvd. intersection.
94	Henry Creek Lock on east side of Lake Okeechobee
95	Port Canaveral, in canal Lock.
96	East shore Banana River, Port Canaveral, west end of canal Lock, on north side.
97	Cape Canaveral (5 km NW) in locks between Banana River and Canaveral Barge Canal at Port Canaveral.

Appendix B. (Continued)

Record #	Locality
98	Cape Canaveral, W. side of the Locks at Port Canaveral.
99	Cape Canaveral, approximately 0.8 km NW, small cove N. of SR A1A, just W. of Port Canaveral Locks.
100	Cape Canaveral, found near W. end of Port Canaveral Locks at Ski Island.
101	Stuart, St. Lucie Canal at buoy 50, near St. lucie Lock (downstream).
102	Rodman Dam, under flood gate.
103	Rodman Dam, under flood gate.
104	Rodman Dam, under flood gate.
105	Palatka, 1/2 mile downstream of Rodman Dam in overflow canal.
106	Buckman Locks at E. end of the Cross Florida Barge Canal.
107	Cross Florida Barge Canal, Buckman Lock,
108	Tampa, off Old Tampa Bay at flood gate at north end of Rocky Creek.
109	Tampa, off Old Tampa Bay in Rocky Creek east of bridge over Sheldon Road.
110	Near Inglis, in Withlacoochee River just east of US Highway 19 Bridge.
111	Inglis, Cross Florida Barge Canal, Inglis Lock, immediately downstream of west gate.

Appendix C. Distribution of probable cause of death for structure related manatee mortality from 1974 through 28 February 1995. (* Information not available)

Record #	Probable Cause of Death
1	Crushed in flood gate-thoracic and pleural cavity trauma. Gate marks.
2	Crushed in flood dam S-27
3	Crushed in flood gate - hemidiaphragms ruptured.
4	Crushed in flood gate
5	Flood gate impression on back parallel to body axis. Six left ribs broken; left lung lacerated.
6	Flood gate: animal found just below dam. External marks and internal damage indicates post-mortem crushing. Probably drowned prior to crushing.
7	Flood gate: both lungs punctured by broken ends of 9 ribs with associated hemorrhaging. 1/2 Liter of blood present in left pleural sac.
8	Fresh longitudinal impression on both sides of body. Left ribs 4-7 disarticulated or fractured, vertebrae at 4th and 5th rib separated.
9	Longitudinal impressions on dorsum, 9 fractured ribs. food present in mouth.
10	Killed by crushing blow to the chest. Multiple luxated ribs, separated spine, Lacerated lung and diaphragm, damage to mandible and teeth.
11	Disarticulated ribs, clotted blood around heart, two liters of food in stomach.
12	Severe trauma to heart, trachea, and adjacent organs; 3 anterior ribs disarticulated.
13	Animal appeared to have been caught by its head within the flood control structure. There was substantial cranial trauma along with a broken neck.
14	Flood gate, vertebral separation, 1 luxated & 6 broken ribs on L. side, 1 luxated and 4 subluxated ribs on R. side, L. lung torn, blood clots.
15	Crushed in flood control gate.
16	Crushed in flood control gate.
17	Crushed in flood gate.
18	Crushed in flood gate.
19	Crushed in flood gate - external gate marks present, no internal damage.
20	Crushed in flood control gate.
21	Crushed in flood control gate - gate marks on back, ribs broken.
22	Crushed/Drowned in flood control structure.

Appendix C. (Continued).

Record #	Probable Cause of Death
23	Crushed\Drowned in flood gate.
24	Crushed\Drowned in flood control dam, gate impressions on left side.
25	Crushed\Drowned in flood control dam.
26	Crushed in flood gate, gate impression across shoulders.
27	Crushed, gate mark across shoulders; tissue trauma; body cavity filled with clotted blood; no broken bones. Massive internal hemorrhage.
28	Crushed in canal lock - massive internal damage.
29	Crushed\Drowned in flood gate or canal lock. Rivet impressions on back.
30	Crushed in flood gate. Gate impression on left side. Left diaphragm ruptured.
31	Crushed\Drowned in flood gate - gate marks on left side, 7 left broken ribs.
32	Internal lesions indicate death from crushing. Stomach contents were pushed forward under the neck and chin. 10 cm separation of T-13 and T-14.
33	Fractured ribs, separation fracture of cervical spine.
34	Separation fracture of cervical vertebrae; severed trachea.
35	Abrasions on mid-dorsal and mid-ventral sides, Luxated ribs with damage to respiratory organs and abdominal aorta.
36	Canal lock, drowned\crushed. two small lacerations on the right dorsal lobe of the liver were present. Subdermal bruising and laceration on the head.
37	Trauma from navigational locks, torn right hemi-diaphragm, left lung completely collapsed from previous chronic infection.
38	*
39	Crushed in St. Lucie Flood Gate.
40	Crushed in flood gate - disarticulated ribs R 2-9, L 10, 12, 13, 14.
41	Crushed\Drowned in canal lock. Hematoma extending length of Left side of body.
42	Crushed in flood gate or canal lock. Intracerebral hemorrhage.
43	Crushed in flood gate or canal lock. Skull crushed.
44	Fresh scars indicative of being crushed in locks.
45	Carcass had pattern of bruises along both sides that appeared to be regularly spaced, corresponding to rivets or bolts on a lock structure.

Appendix C. (Continued).

Record #	Probable Cause of Death
46	Manatee died of severe internal trauma caused by being crushed between a navigational lock gate and its recessed concrete wall.
47	Complete vertebral separation at rib #7, Luxated ribs, black rubber marks around body on the ventral surface.
48	Bolt impressions along dorsal & lateral left side, blood clots throughout neck region, abdominal and pleural cavities, tear in GI Tract.
49	Exsanguination; subdermal hemorrhage on dorsal and left body, right side of head and jaw hemorrhagic.
50	Black mark and periodic scrape marks along entire left side, sternum, stomach, transverse colon, and right lung were pushed forward of normal location.
51	Black mark on left dorsum from neck to pedunele, torn stomach, subdermal hemorrhage above luxated ribs, left ribs # 2-5 luxated.
52	*
53	*
54	Crushed in flood control gate.
55	Crushed in flood control gate - gate marks across shoulders.
56	Crushed in flood gate.
57	Crushed in flood control gate - massive internal damage, marks from gate.
58	Crushed in flood control gate - imprint of gate on animal's back.
59	Crushed in flood control gate - stuck in dam.
60	Crush in flood control gate - internal damage.
61	Crushed, Left ribs all but one fractured, R rib 7 fractured, all but 3 luxated or sublaxated, massive damage to organs, blood clots free in abdomen.
62	Crushed in lock, massive damage to organs (especially to lower body).
63	Blood clots in neck region, dislocated and broken ribs, vertebral separation (3), severed heart and urinary bladder, fractured kidneys, displaced organs.
64	Multiple broken and luxated ribs, GI tract torn in several places, ruptured hemi-diaphragms, complete vertebral separation, both kidneys lacerated.
65	Blood clots in abdominal cavity, uterus & urinary bladder pinched, left and right ribs broken and luxated, muscle trauma along vertebral column.

Appendix C. (Continued).

Record #	Probable Cause of Death
66	Canal lock, black impressions and scrape marks externally, blood clots in abdomen, torn stomach, liver displaced, aorta severed, ribs broken/luxated.
67	Drowned in flood gate - flood gate mark parallel to body.
68	Crushed by canal lock. 3 left ribs disarticulated. Ruptured aorta. Right scapula broken. Pleural cavities filled with blood.
69	Ribs 4, 5, 6, and 7 disarticulated and pushed through lung and diaphragm, sternum fractured, hematoma just posterior to sternum.
70	Gate impressions on dorsal and ventral sides, luxated ribs, ruptured trachea, right lung collapsed.
71	Black marks and bolt impressions on dorsum and ventrum, gastric gland torn from stomach, lungs torn, vertebral separation, ribs luxated and broken.
72	Crushed in flood control gate.
73	Crushed in flood control gate - gate marks on back.
74	Crushed\Drowned in flood gate S-28 - flood gate impression marks on back.
75	Crushed\Drowned in flood gate S-28
76	Crushed in flood gate S-13.
77	Crushed in flood gate - head crushed.
78	Head caught in flood control gate and crushed.
79	Crushed in flood control gate.
80	Crushed in flood control gate - massive internal damage.
81	Crushed\Drowned in flood gate - flood dam gate marks across body.
82	Crushed in flood gate. Complete vertebral separation, and displacement, another partial vertebral separation, four severed ribs.
83	*
84	Crushed in flood control gate - several ribs broken.
85	Crushed\Drowned in flood control gate or canal lock - probable S-26
86	Crushed\Drowned in canal lock. Right ribs 5-13 broken. Large bruise on Rt. side.
87	Disarticulated ribs, separation in spinal column.
88	Vertebral separation, luxated and subluxated ribs on both sides, blood clots throughout neck region, abdominal and pleural cavities, tear in GI tract.

Appendix C. (Continued).

Record #	Probable Cause of Death
89	Crushed\Drowned in flood gate S-77
90	Separated vertebrae, 7 luxated ribs. Numerous pressure marks on external dorsal and ventral surface, including marks from Hex. bolts, gate seal.
91	Impression mark on dorsal body, blood clots in abdominal cavity, vertebral separation at rib #4, multiple broken and luxated ribs on both sides.
92	Crushed. A 64 cm impression on dorsum. Complete separation between 3-4 thoracic vertebra and left 1-3 thoracic rib and vertebra.
93	Eight luxated ribs on left side with associated damage to respiratory system, impressions dorsal side of right flank, abdominal cavity ruptured.
94	Animal caught mid-body by navigation lock. Vertebral column separated; aorta, vena cava, diaphragm ruptured. No external sign of injury.
95	Crushed in lock - trauma suggest animal was crushed in lock.
96	Crushed in canal lock - death due to acute massive pressure.
97	Multiple broken ribs and fractured ribs.
98	Bilateral rib injury, 2-8 luxated, vertebrate separation at 8, left rib #7 fractured at head.
99	Left ribs 13-15. Right 16 & 17, fractured, one lumbar vertebral process fractured. Bilateral injuries indicate animal was squeezed.
100	Vertebral separation between ribs 6-7, Left ribs 6, 7 luxated, Left rib 7 fractured, stomach ruptured, food and clotted blood throughout body cavity.
101	Crushed in flood gate - massive internal damage.
102	Crushed\Drowned in flood gate-fresh scrapes and rivet marks on body.
103	Crushed\Drowned in flood gate-fresh scraped and rivets marks on left side.
104	Crushed\Drowned in flood gate-fresh scrapes and rivet marks on body.
105	Animal died in the water control gates of the Rodman Dam. Distinctive marking on carcass corresponds to structures on the gates.
106	Probably caught in the lock - massive hemorrhaging in head and shoulder area.
107	Drowned in canal lock - scrape marks on skin suggest that manatee was pinned.
108	Extreme bruising in head and neck area indicated crushing injury although no fractures were observed.

Appendix C. (Continued).

109	Found just below flood gate with traumatic fracture of thoracic vertebrae 8 and 9.
110	Massive trauma to cranial vault and soft tissue damage around sternum suggest a 2 sided crushing injury.
111	Drowned in canal lock - parallel superficial scrapes present on body.

Appendix D. Listing of additional remarks about manatee carcasses referenced to structure caused mortality from 1974 through 28 February 1995.

Record #	Additional Remarks About Carcass
1	Stomach full, rapid death. No body fat, muscular fat yellow in color, about 1 cm thick. Photos taken. Deposited and necropsied at So. Dade Zoo. Wt. 626 Lbs.
2	Wedged in perpendicular to dam axis. Probably tried to get through and got stuck. No sperm in S. vesicles or epididymis.
3	GI tract full but little fat present. FMP Case No. 1003.
4	Known animal: RB310.
5	Heavy abdominal fat deposits. Stomach full of ingesta.
6	Although physical damage appeared to be post-mortem, robust health of the animal indicated by abundant fat deposits and full GI tract made disease seem unlikely. No bruising or blood clots observed
7	Trauma caused bilateral pneumothorax and total atelectasis of the lungs. Apparently healthy animal with fat deposits, full GI tract, and no signs of illness.
8	Necropsy was observed by Dr. Hunt Scheuerman, Lee County Examiners Office.
9	No Additional Comments.
10	No Additional Comments.
11	Right ribs 1 and 2 disarticulated, clotted blood around the heart, food in stomach; possible trauma around head and thorax.
12	Animal was lactating
13	Two pressure point injuries were observed on the ventral jaw area, a single pressure point injury was located on the cranium.
14	No Additional Comments
15	No Additional Comments
16	Entire carcass returned to RSMAS for necropsy. Tissue samples preserved. Entire skeleton saved. Sexually mature. Sperm in epididymis.
17	Stomach full. Weight: 450 pounds.
18	Stomach full. Weight: 950 pounds.
19	Entire carcass, skeleton, reproductive organs, stomach and GI tract contents.
20	Skeleton, GI tract, eyes, thyroid, spleen, adrenal, testes, epididymis, seminal vesicles and fluid, urine and histopath samples recovered. Died at 0700 hrs. - floating didn't sink.

Appendix D. (Continued).

Record #	Additional Remarks About Carcass
21	Skelton, reproductive tract, urine, seminal fluid, GI tract, data recovered. Prob. died 11 Nov. low numbers of sperm in seminal fluid. Photos taken. Organ weights available.
22	Yellow fluid in peritoneal cavity. Numerous healed prop. scars on body, none fresh. Blood and water flowed from nostrils.
23	Skull, thoracic rib, L. flipper. Carcass had drifted into Maule Lake at recovery time,
24	Monofilament line wrapped around L. flipper resulting in healed scar tissue under the line. Gut was full. Major organs unparasitized.
25	Right ribs 6-17 either disarticulated or broken. No sperm in epididymis.
26	FMP Case No. 1121.
27	Light nasal fluke infestation; field necropsy; animal could not be towed from site by boat.
28	Left ribs 10-14 disarticulated, right ribs 6-10 disarticulated, 11-16 broken. Thoracic 13 free. UF No. G79-80.
29	No nasal flukes.
30	Tissue beneath gate marks crushed/bruised. GI tract full, heavy fat deposits. FMP Case No. 1202.
31	Left lung punctured. Heavy fat deposits, GI tract full. FMP Case No. 1210.
32	16th right rib broken, dorsal arches of 16-17 thoracic vertebrae broken hemorrhage on ribs. Digestive tract filled with fresh blood indicating good health at the time of death.
33	No Additional Comments.
34	This is the second manatee killed in the St. Lucie Locks during May. This animal was a known animal DC03
35	Abundant fat and full GI tract.
36	External bruises and abrasions. Postmortem luxation of the Right 8th rib. Unilateral mild to moderate suppurative pneumonia, left side.
37	This animal appeared to have been caught in the navigational locks and was distended with gas; therefore, girths were not taken.
38	No Additional Comments
39	No Additional Comments.
40	Animal was very fat. Carcass was very dry, hardly messy at all. Blood and juices drained out.

Appendix D. (Continued).

Record #	Additional Remarks About Carcass
41	Musculature on left side noticeably more decomposed. Conditions suggest crushing. No reproductive organs found, sex determination based on absence of penis.
42	Right tympanic broken, middle ear filled with clotted blood. Skin abrasion at right ear. Numerous 1-2 mm subdermal abscesses. Heavy nematode infection in duodenum. FMP Case No. 1066
43	Left and right diaphragms ruptured at ribs 2-5, tissue at site necrotic. FMP Case No. 1073.
44	Carcass had fresh external scars indicative of being crushed in locks, internal damage of disarticulated right ribs # 7-11, and disarticulated vertebrae. No FMP Case #.
45	No Additional Comments.
46	Lockmaster found manatee after lock gate would not open completely. It is unclear how such a large manatee managed to get into the area behind the lock gate.
47	Found inside lock chamber. Lock tender reported having difficulty in closing lock. Game and Fish Commission # 93-1-937.
48	No blubber or girth measurements taken due to deomposition. Game and Fish Commission Case # 94-01-0855. Towed by GFC Officer Malone.
49	Animal slightly bloated, but measurements taken.
50	Carcass too decomposed, no girth or blubber measurements. Game and Fish Commission # 94-01-1607.
51	Carcass bloated, no girth\ blubber measurements taken. Towed by COE Ranger Sullivan
52	No Additional Comments.
53	No Additional Comments.
54	Possible drowning, trauma to head, neck, shoulder area. Ductus arteriosus open. Found near flood gate.
55	Head and two ribs collected. Animal not removed from site. Possible mother of 76-26 which was found in the same area on 22 Nov. 1976.
56	Head collected.
57	Head, reproductive tract, digestive tract, flippers and four ribs recovered for RSMAS, remainder to S. Dade Zoo. Very fat. Ribs on left side disarticulated.
58	Head and two ribs recovered, remainder disposed of. Fish hook, without line, caught in upper lip.
59	Entire carcass and caecum contents recovered. Stomach empty. Dead several days. Photos taken.

Appendix D. (Continued).

Record #	Additional Remarks About Carcass
60	Entire carcass recovered. Killed at approx 0730 hrs, on 1 Jun in Taylor Creek Lock. Organ weights available.
61	20 cm wide (est.) black marks around body about 50 cm caudal to pectoral flippers.
62	Numerous sets of black marks around body. Lock tender reported problems closing lock gates previous evening.
63	There were distinct marks on the carcass that corresponded to the lock gates leading edges.
64	Carcass weight 674 pounds.
65	Culture results revealed no growth at 48 hours.
66	No Additional Comments
67	Dam closed approx 1200 hrs, 10 Jan had been opened 6 in. St. Lucie (combination lock and flood control). No scars C. Dennis FGFWFC observed necropsy.
68	Light fluke infestation in caecum/upper lower intestine. No stomach nematodes. No nasal flukes. GI tract full of vegetation. Old white prop. wound on right caudal peduncle.
69	No Additional Comments.
70	No Additional Comments.
71	No Additional Comments.
72	Skull and two ribs recovered, post cranial skeleton buried. Scar pattern on back indicated crushing in gate. Right ribs were disarticulated and heads driven through lung, diaphragm and stomach.
73	Crushed carcass recovered. Photos taken. Data available.
74	Animal was probably killed at 104 street NE flood dam (S-28), and floated to recovery site after 3 or 4 days.
75	No Additional Comments
76	Animal very fat and digestive tract full. No parasites observed. Male fetus 112 cm long (m-80-16F), (fetus = UF 15194) evidence of crushing was noted in the right and left thorax, brachial area.
77	First flood dam fatality in approximately two years. FMP Case No. 872.
78	Anterior organs more decomposed than posterior, related to crushed head.
79	Skull recovered. Hydrilla leaves in mouth. Carcass taken to dump. Photos taken.

Appendix D. (continued).

Record #	Additional Remarks About Carcass
80	Entire skeleton and data recovered. Killed 11 Nov., 3 other manatees with it, one trying to copulate. Possible animal in estrus. Cervical trauma, cervical separated from skull. Hemorrhagic. Photos taken.
81	Typical flood dam gate marks across body. Ribs on right side broken.
82	External impression from drop gate seal, bolt marks, and 2 parallel lines perpendicular to the sea mark. Incidental to being crushed the manatee had an active infection.
83	No Additional Comments.
84	Head and three ribs collected. Animal originally reported on 6 Sep in same location. length estimated
85	Calf seen all day on 11 Sep with dead female. Miami seaquarium attempted rescue unsuccessfully. Calf was large enough (Approx. 4.5 feet) that survival is very possible.
86	Back bruised. Blood clots throughout pleural cavities. Three nails on each flipper. Left pelvic bone lost. FMP Case No. 1279
87	No Additional Comments.
88	No Additional Comments.
89	No Additional Comments.
90	Pressure marks present dorsally and ventrally on epidermis. Two of these were parallel and . exactly 45 cm. in length.
91	Manatee weight: 1560 pounds.
92	The primary bronchi of both lungs were filled with red fluid. The muscular tissue surrounding the trachea was torn, with separations observed on either side (approx. 16 cm each). Possible pregnancy.
93	GI tract full, uterus distended and ruptured. 83 cm fetus found at same location.
94	Right horn of uterus enlarged and filled with non-odorous gray mucous. Generally fresh but lung and liver decomposition enhanced by internal damage. Mammary gland enlarged but little milk. Heavy fat.
95	Fresh scrapes on left side, perpendicular to long axis of body. Heart ruptured. Left ribs 2, 3, 4, 5, disarticulated; Right ribs 1-11 broken.
96	Several bones fractured and vertebral column split between T13 and T14. Both hemidiaphragms ruptured. Left lung punctured. Inferior vena cava ruptured. 3 long bands of bruising along musculature.
97	Anterior face of scapula broken. Known as BC146.

Appendix D. (Continued).

Record #	Additional Remarks About Carcass
98	No Additional Comments.
99	Blood from genital opening, clotted blood in abdominal cavity. Large intestine, mesentery, small intestine and kidneys damaged.
100	Known animal: BC130.
101	Right ribs 8 & 9 broken. Left ribs 6-13 broken approx. 5 cm from proximal end. Break in Vert. column between thoracic 8 & 9. Pleural cavity full of clotted blood. Dermis in head and shoulder region hemorrhaging.
102	Dermis bruised. Lungs saturated with blood. GI tract full. Heavy fat deposits present. Three nails on each flipper. FMP Case No. 1122
103	Severe ante-mortem bruising of musculature on left side from flipper to mid-fluke. Lungs saturated with blood. GI tract full. Heavy fat deposits present. FMP Case No. 1126.
104	Massive ante-mortem bruising of musculature beneath scrapes. Left scapula broken, Large hematoma. Shock syndrome; ischemic kidneys, little blood in heart. Left flipper missing beyond humerus.
105	Game and Fish Commission number: 1240.
106	Scrapes marks on head
107	Manatee had scrape marks and concrete abrasions on body suggesting that it was pinned between lock gate and wall during gate opening. GI tract full. No broken bones or hemorrhagic tissue present.
108	GI tract contained ingesta; feces in colon.
109	No external lesions or wounds. GI tract full of ingesta. Ovaries contained many little follicles in various stages of maturity. Uterus slightly enlarged. Lumen contained grey fluid sectioned for histologic examination.
110	Focal uterine enlargement and presence of milk in the mammaries indicated calving in the near past. The canal lock at Lake Rousseau is suspected of crushing the animal during the operation on July 5th.
111	Pathological conditions indicate death due to shock resulting from trauma; massive hemorrhaging along ribs, patchy serosal hemorrhaging on intestinal walls, lungs dark and heavy, kidneys pale.

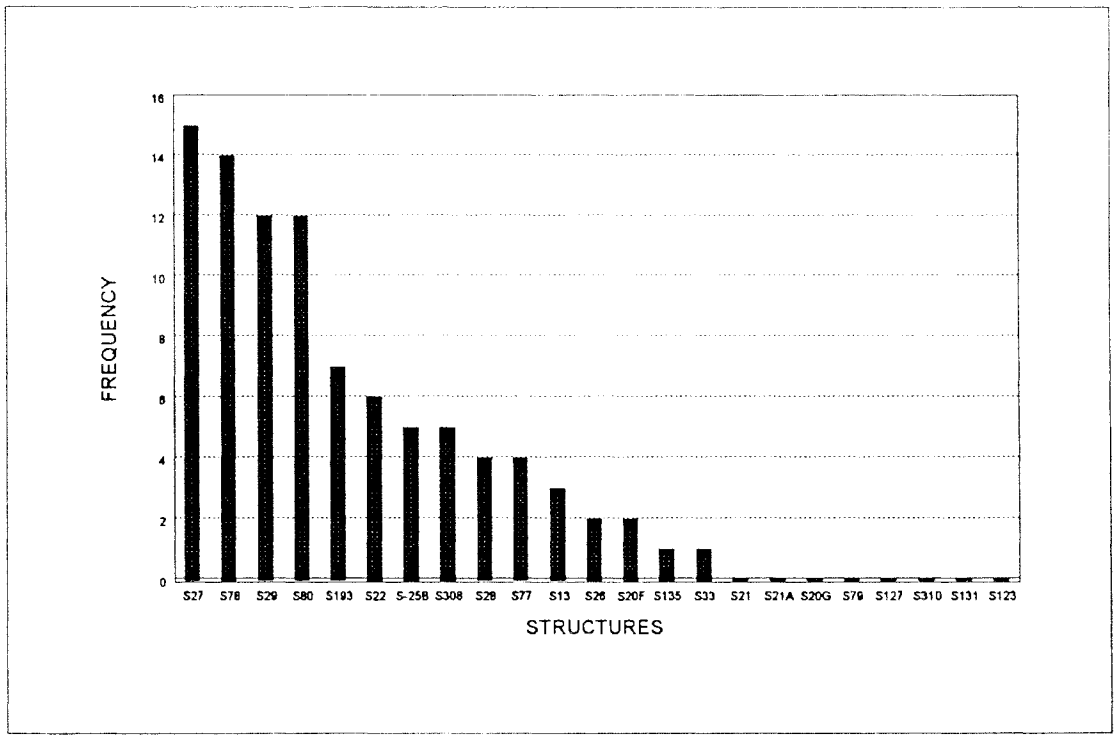


Figure 1a. Frequency of manatee mortality (1974 through 28 February 1995) associated with Central and Southern Florida locks and water control structures.

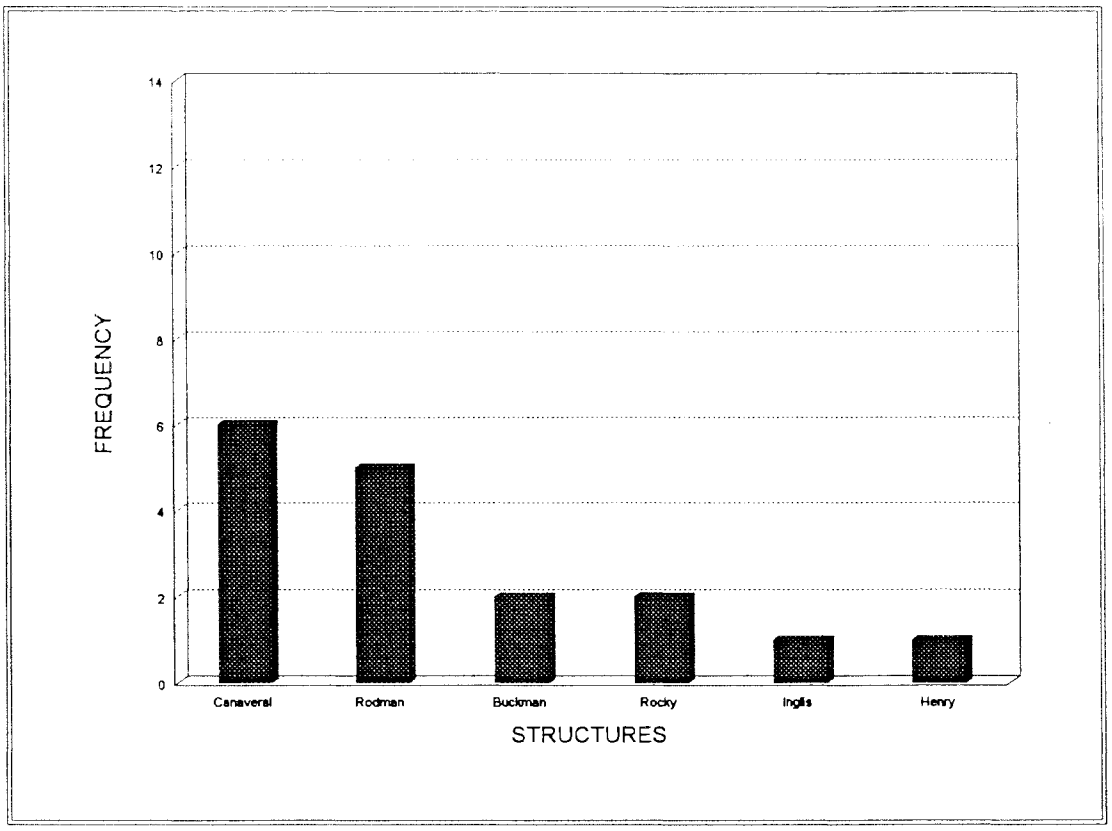


Figure 1b. Frequency of additional manatee mortality (1974 through 28 February 1995) associated with Florida locks and water control structures other than Central and Southern Florida.

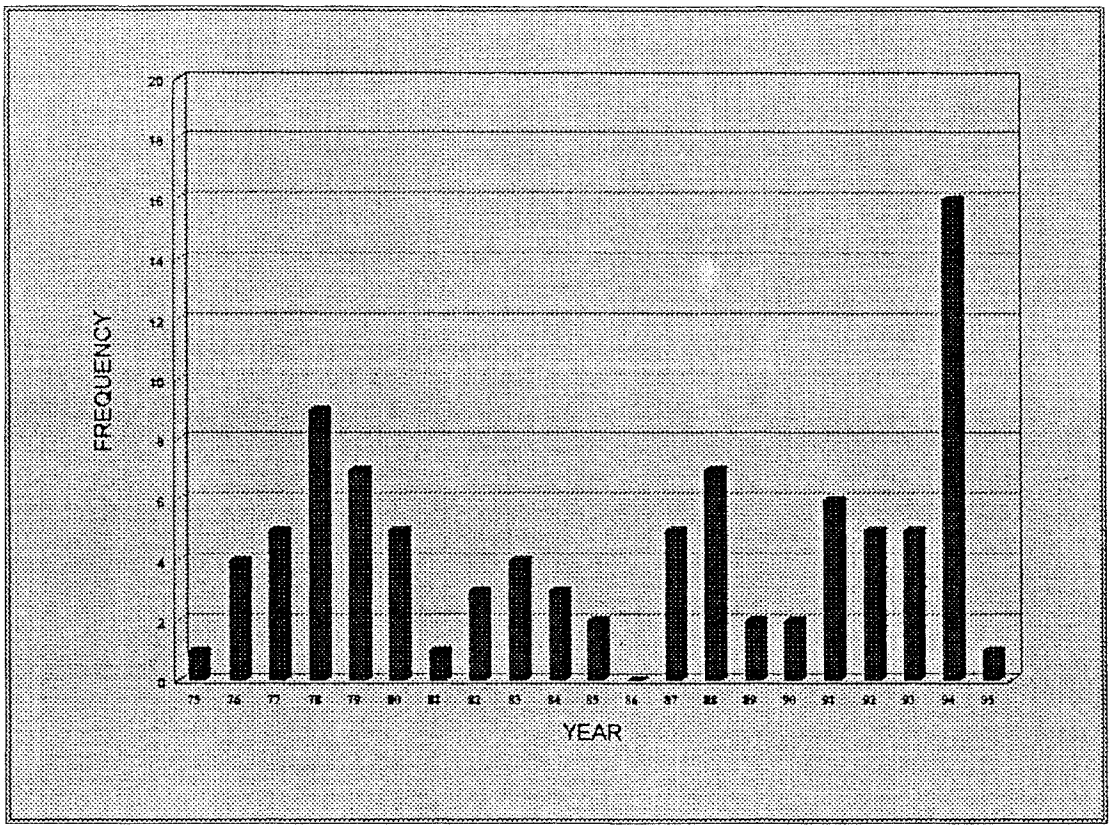


Figure 2a. Yearly distribution of manatee mortality (1974 through 28 February 1995) associated with Central and Southern Florida locks and water control structures.

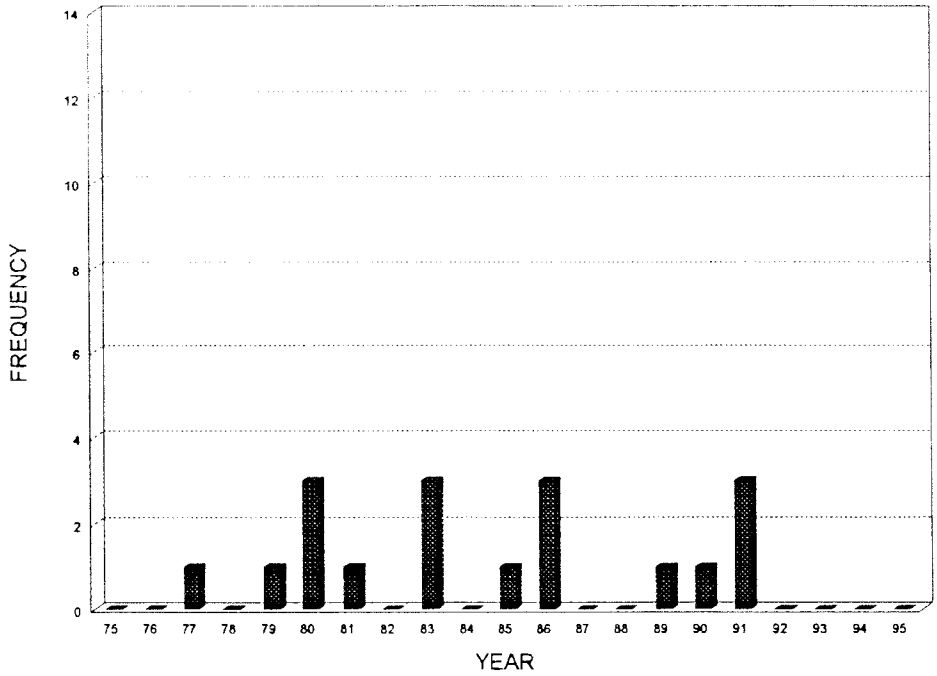


Figure 2b. Yearly distribution of additional manatee mortality (1974 through 28 February 1995) associated with Florida locks and water control structures other than Central and Southern Florida.

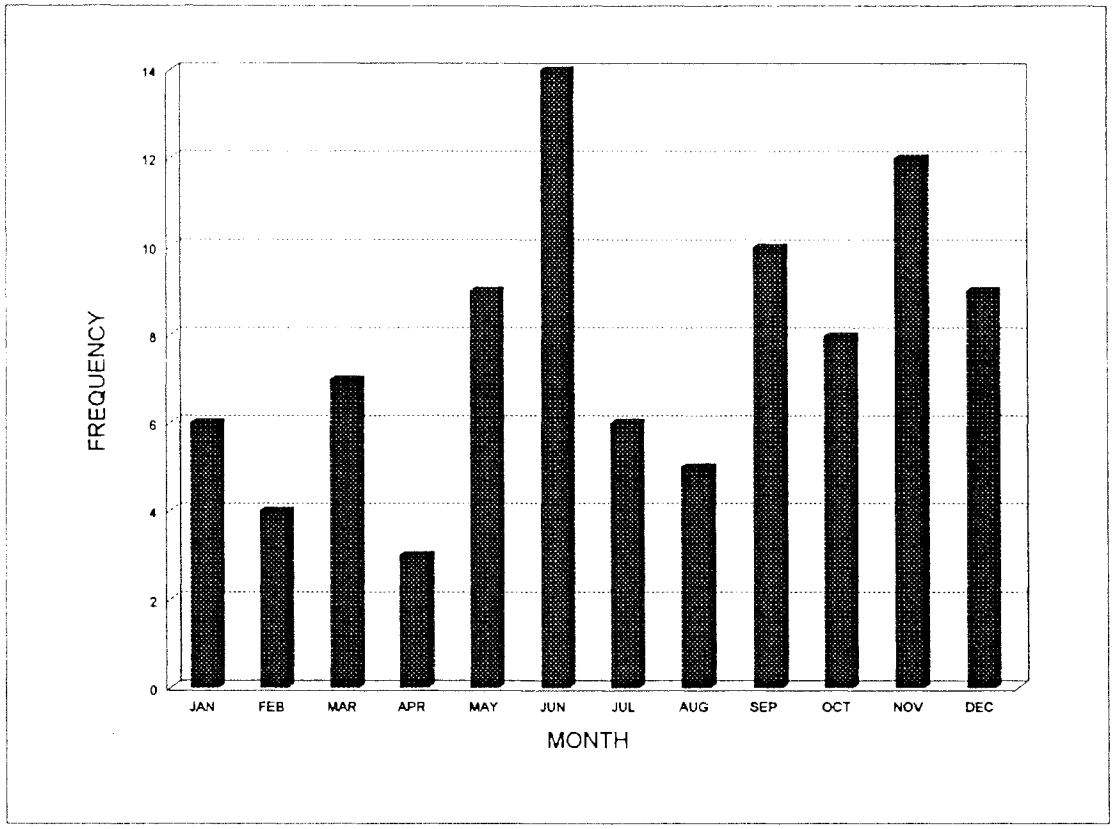


Figure 3a. Monthly distribution of manatee mortality (1974 through 28 February 1995) associated with Central and Southern Florida locks and water control structures.

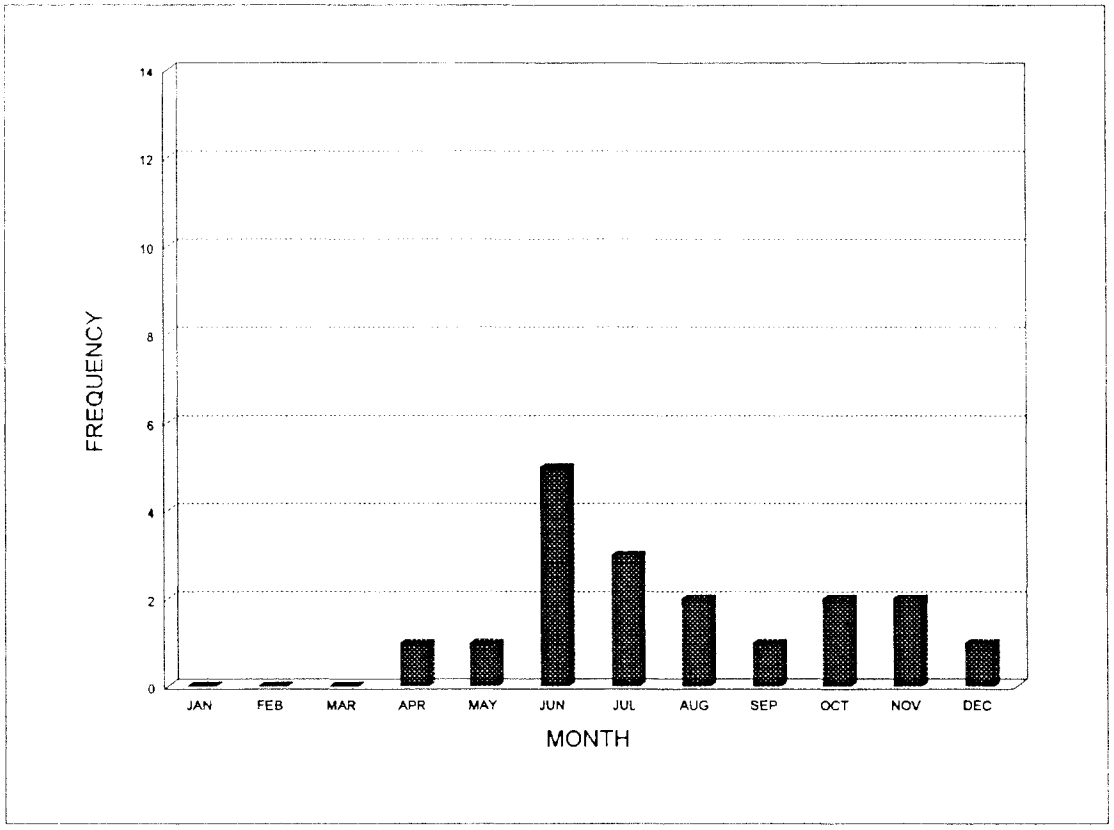


Figure 3b. Monthly distribution of additional manatee mortality (1974 through 28 February 1995) associated with Florida locks and water control structures other than Central and Southern Florida.

SFWMD MANATEE MORTALITY REPORT

Case : **MSE9424**

Date Prepared: March 5, 1995

I. INTRODUCTION/BACKGROUND

This report has been prepared for the Florida Department of Environmental Protection (FDEP) by the staff of the South Florida Water Management District. It has been drafted due to an incident of manatee mortality associated with one of the water control structures operated and maintained by the South Florida Water Management District. The document summarizes available information regarding structure operations with the objectives of 1) identifying the probable time and cause of the mortality,and; 2) identifying actions to eliminate further manatee mortality due to operation of this structure. The document is divided into the following sections; Introduction/Background, General Description of Structure, Structure Operations, Conclusions Regarding Manatee Mortality, and Recommendations.

This document has been prepared for FDEP Manatee Case MSE9424. On November 5, 1994, the Dade County Department of Environmental Resources Management (DERM) staff notified the SFWMD Operations Control Room that a manatee carcass had been found floating approximately 1/2 mile west of the mouth of the Little River, downstream of the S-27 structure. The SFWMD Control Room notified both Mr. Frank Lund, SFWMD Manatee Coordinator, and Mr. Clarence Teers, Asst. Director at the Ft. Lauderdale Field Station. Mr. Lund and Mr. Teers met FDEP and DERM personnel the following morning at which time the carcass was salvaged for FDEP necropsy. Examination of the carcass at the salvage site revealed a clearly discernible dorsal abrasion indicating contact with a water control gate. Additional disc-shaped abrasions suggested contact with the row of pressure sensing devices (PSDs) installed on the S-27 structure.

FDEP necropsy concluded that the animal was crushed in the water control structure. The SFWMD was provided with the necropsy report and a request for relevant information regarding this mortality on December 9, 1994.

II. GENERAL DESCRIPTION OF STRUCTURE

The S-27 structure (FIGURE 1) is located in the City of Miami near the mouth of Canal 7 (Little River Canal) about 700 feet from the shore of Biscayne Bay. The SFWMD assumed responsibility for the structure from the US Army Corps of Engineers in April 1959 as a component of the Central and South Florida Flood Control Project. The structure is a reinforced concrete, gated spillway, with discharge controlled by two stem operated, vertical lift gates. Each of the two vertical

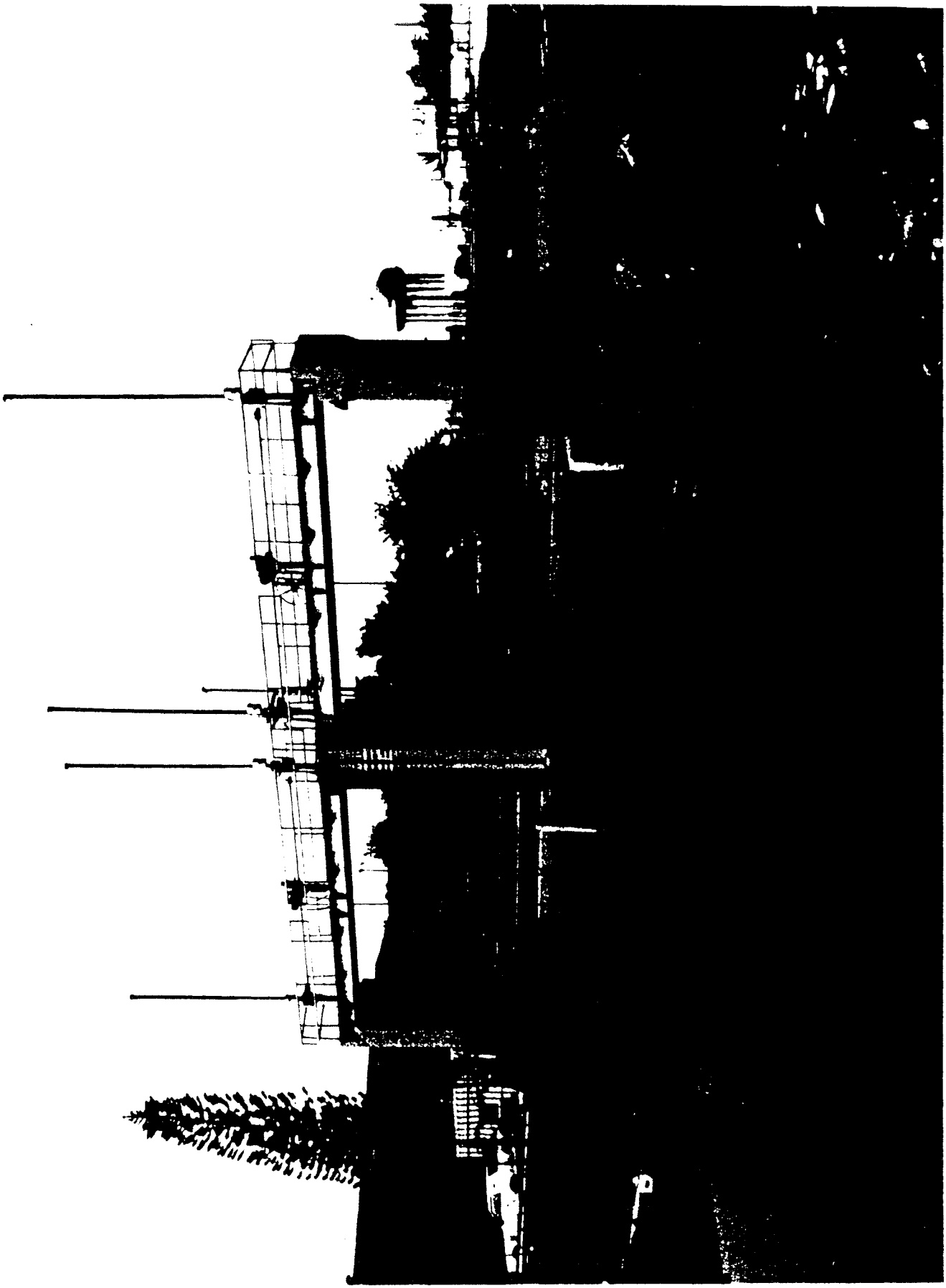


FIGURE 1. S-27 Structure

gates is approximately 15 feet high and 28 feet long (FIGURE 2). Bottom elevation of the gates is -11.0 feet. The gates are electrically operated, with back-up diesel generator power located on-site. The generator system engages automatically in the event of a power failure at the structure.

PURPOSE

The purpose of this structure is to: maintain optimum water control stages upstream in Canal 7, pass the design flood (75% of the Standard Project Flood) without exceeding upstream flood design stage, and prevent saline intrusion during high tide periods. It may also serve, during wet conditions, as a supplemental outlet for excess water from Water Conservation Area 3. This is accomplished by diverting water from the Miami Canal into the western end of C-7 via the G-72 structure.

OPERATION

The structure is not manned. It may be operated in four modes: 1) automatic remote computer control from the SFWMD Operations Control Room (The control program is called Data Derived Set Point or DDSP), 2) automatic local control utilizing structure headwater/tailwater sensors, 3) manual remote control from the SFWMD Control Room, and 4) local manual control at the structure. The structure is generally operated under remote computer control (DDSP). Manual control at the structure is used during repair and maintenance activities.

The optimum headwater elevation is 1.5 feet. The structures computer controls are programmed to automatically operate the gates so that headwater levels between 1.0 and 1.9 feet are maintained to the greatest extent possible.. The operating schedule is as follows:

* When the headwater elevation rises to 1.9 feet, the gate rises at a rate of 6 inches per minute. Computer algorithms slowly reduce the gate opening incrementally in relation to receding water levels.
* When the headwater falls to 1.5 feet, the gate will become stationary with an opening gap of 2.5 feet.
* When the headwater condition recedes to 1.0 feet, the gate will close completely.

This gate closing level was lowered from 1.6 to 1.0 feet in early summer 1990, to protect manatees by reducing the gate moving activity.

Modification of operating criteria to eliminate stationary flood control gate openings of less than 2.5 feet (for headwater/tailwater differentials of less than 3 feet), and permit unbalanced gate openings (i.e. the use of only one gate in a multi-gate system) were approved by the USCOE in February 1994. These changes were implemented on a trial basis in 1983 to eliminate the possibility of drowning manatees behind partially-opened gates, and to minimize the number of moving gates which might threaten manatees.

Both computerized and automatic local control initially open gate #2 to 2.5 feet when a gate opening is required. If the initial single gate opening is insufficient to manage water levels, then gate #1 is also opened to 2.5 feet. If these gate opening are still insufficient, then both gates open together in approximately 0.5 foot increments. If both gates are open, the gates will close under remote control incrementally until reaching, both gates close together incrementally until reaching 2.5 feet. Upon reaching 2.5 feet, the gates close completely without pausing. The rate of operation of the gates is approximately 6 inches per minute.

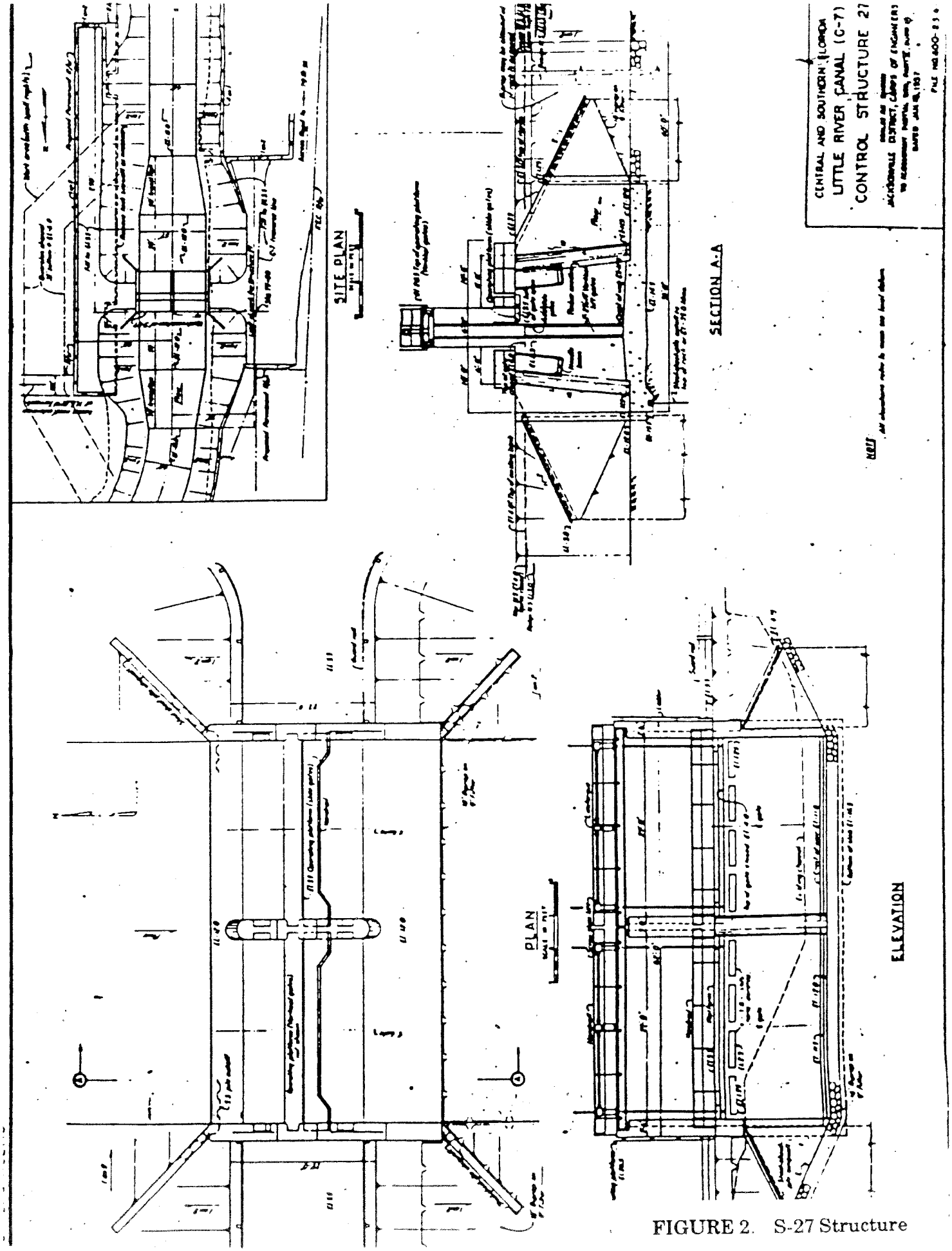


FIGURE 2. S-27 Structure

In addition to operating for control of upstream water level, the automatic local control system has an overriding control mechanism which closes the gate, regardless of the upstream level, when the difference between the headwater and tailwater becomes only 0.2 feet. The overiding control mechanism operates to prevent saltwater back-flow through the structure during high tides.

The structure may also be operated manually from the Control Room. Manual operation id often necessary during periods of high tide and heavy rainfall within the C-7 basin. The C-7 basin is highly urbanized, yet lies below, or only slightly above, the elevation of high tide. FIGURE 3 shows the general ground profiles along the canal across the C-7 basin. Manual operation of the S-27 structure is also utilized to preemptively reduce canal stages to minimal levels when SFWMD meteorologists forecast rainfall events deemed likely to exceed the discharge capacity of the system and cause flooding in the basin. The structure may also be operated manually from the control room when discharges are made into the western C-7 canal from the Miami canal. In this event a gate at S-27 may be fixed open while inflows are controlled from the western G-72 structure. Additionally, the control room may disengage the automatic computer operations and manually lock a gate either open (in excess of 2.5 feet) or completely closed if the manatee protection system is not operating properly.

Gate movement in all control modes is effected by an electric motor driving geared shafts to lift the gates with threaded stems in each end of the gate. The actual gate position is determined by the number of revolutions of the stem lift gears; a revolution counter system determines when the gate has returned to its zero position, then terminates electric power. In the event that a gate does not slide freely in its track, a backup torque limit switch terminates gate power under excessive load. Should the stems move down and the gate not close concurrently, stem limit switches on the gate terminate power to the motor. Upon termination of power, these switches reset. Computer control (DDSP) reverses the gate motion if the gate opening is less than 2.5 feet, resets the gate to 2.7 feet, and then returns to the previous command instructions. If a gate fails to operate as expected when under computer control (DDSP), error messages are automatically generated and logged. Examples include Normal Gate Termination, Abnormal Gate Termination, No Power Applied For Motion, Gate Lost Power, Improper Gate Motion, Setpoint Passed, etc.

Operations of the S-27 structure are typically based upon headwater and tailwater conditions at the structure. Headwater stage and tailwater stage are transmitted to the control room every three minutes via a remote telemetry network. Whenever the gates are in motion, the monitoring frequency is increased to once every minute and the actual gates settings are also monitored. All gate setting and water levels data is logged automatically into District computers. In the event that the telemetry signal is lost during the actual operation of a gate, gate motion will first terminate, then the computer control program will reopen a gate to 2.5 feet (if below that level when the monitoring signal was lost). When the telemetry signal is regained, (typically by the next 60 second sweep) the computer revaluates the situation and initiates the required gate motion.

The S-27 structure is fitted with the prototype manatee protection system. Each of the two gates is fitted with an single strip of pressure sensing devices (PSDs). The PSD has two components; a plastic plunger containing a magnet, and an adjacent circuit board containing reed switches activated by the movement of the magnet. The plungers are tensioned at approximately 5 pounds pressure with coil springs. When depressed, the magnet passes the reed switch, activates the switch and closes the

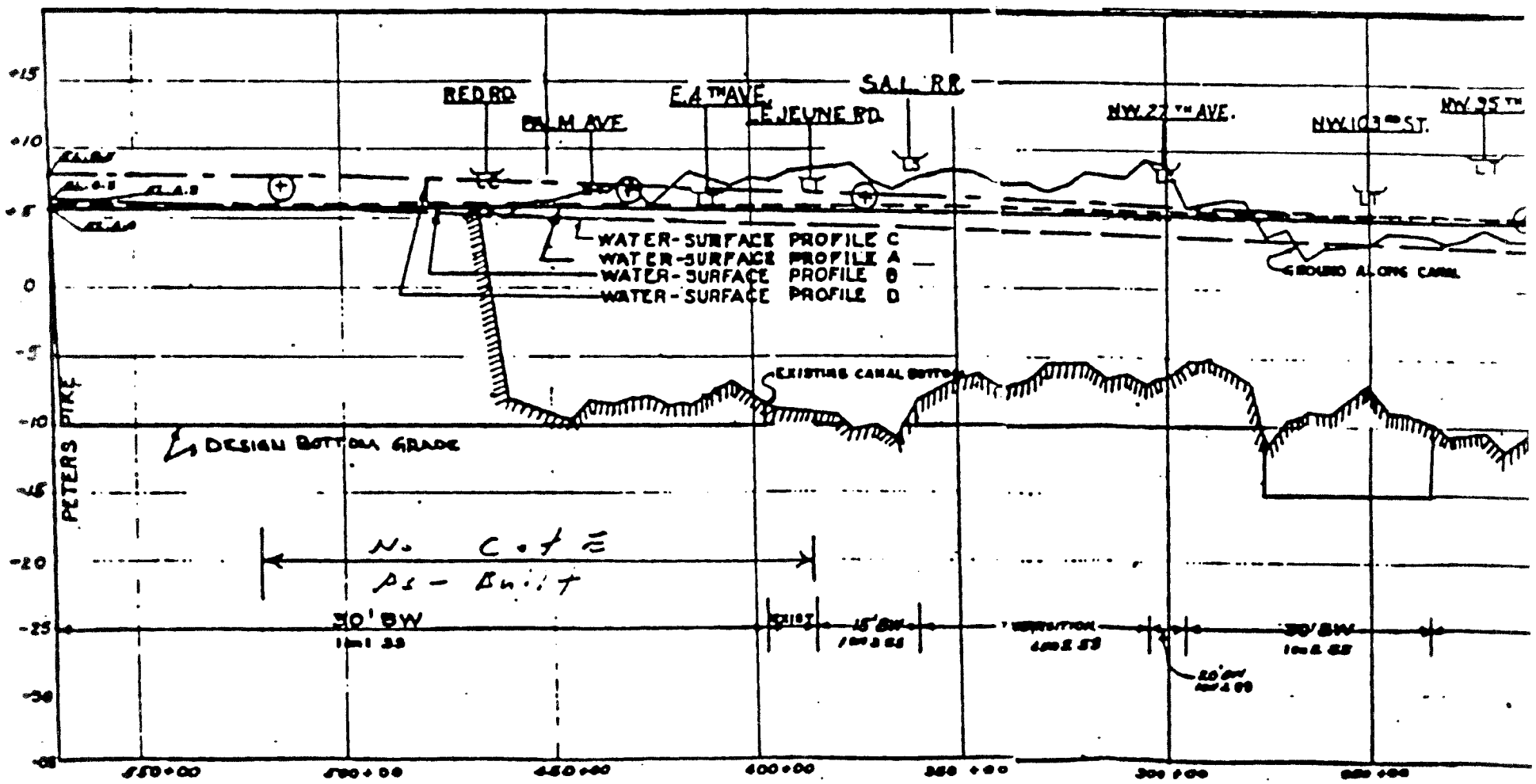
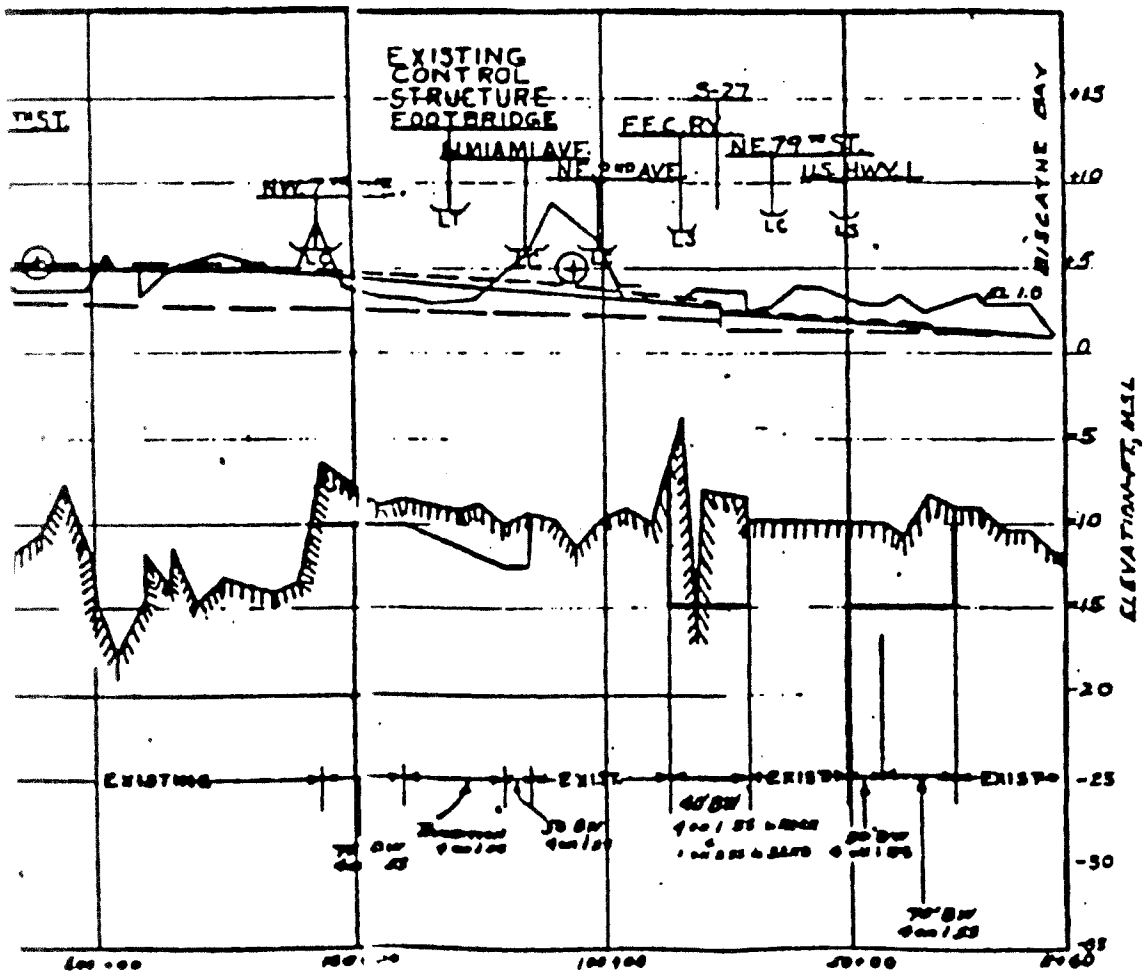


FIGURE 3. C-7 Basin Profile



(+) THE MINIMUM ALLOWABLE ELEVATION OF GROUND AND ROAD CROWN IN AREAS WHERE BUILDING PERMITS ARE TO BE ISSUED BY DADE COUNTY.

NOTES:

1. WATER-SURFACE PROFILE A IS THAT WHICH WOULD RESULT FROM THE PEAK RUNOFF RATE EQUAL TO 75 PERCENT OF THE STANDARD PROJECT FLOOD. (Design)
2. WATER-SURFACE PROFILE B IS THE CONDITION OF MAXIMUM OUTFLOW AT MOUTH OF CANAL DURING THE STANDARD PROJECT FLOOD.
3. WATER-SURFACE PROFILE C IS THE CONDITION OF MAXIMUM OUTFLOW FROM AREA B DURING THE STANDARD PROJECT FLOOD.
4. WATER-SURFACE PROFILE D REPRESENTS THE ESTIMATED MAXIMUM WATER-SURFACE FOR THE 1947 FLOOD.
5. DISCHARGES SHOWN ON FLOW DISTRIBUTION IN REACH 1 INCLUDE FLOW IN SOUTH FORK OF LITTLE RIVER.

FIGURE 3. C-7 Basin Profile

circuit. When pressure upon the plunger is released, the switch returns to the initial position and the circuit is again open. These plungers are placed six inches apart on the bottom edge of each of the gates. Each is independently wired such that a malfunction in one plunger circuit will not disable the entire array. Each plunger activates a dedicated set of three reed switches. The alarm system requires a signal only from one of the three reed switches, the three are included to provide redundancy in the system. The entire array of PSDs on each spillway gate are controlled by a single switch located atop each gate. This enable/disable switch arms the PSD array when the gates are open and at less than a 2.5 feet opening gap, and disarms the PSDs when the gate is completely closed or above 2.5 feet. The circuitry from the enable/disable switches passes to another switch in the structure control building which essentially disengages the manatee protection system when the gates are opening, and activates the entire system during the closing mode. When the manatee protection system is triggered by the PSDs, the gates stop closing and reopen to 2.7 feet. At that point, the final component of the system, a reversal switch, stops the upward motion of the gate, and initiates another gate closure cycle. As the gate passes 2.5 feet, the PSD system is again armed. If no PSD switches are triggered, the gate closes completely, if a switch is again activated, the gate opening cycle is repeated. When the manatee protection system terminates gate power, the gate motion ceases almost instantly with the signal; continued gate drift does not occur. An electronic relay allows several seconds delay before activating reverse gate motion. This insures that motor rotation has stopped completely before reversing power is applied.

The manatee protection system at S-27 overrides all four modes of gate control. It can only be deactivated in two ways; it must be specifically disarmed via special Control Room instruction, or disconnected via a special on-site disarming switch located in a lock-box on the S-27 structure. The on-site switch is used as a safety device by maintenance personnel to insure that an accidental triggering of the PSDs (such as during electrical testing) does not cause unexpected gate motions/motor operations which might pose a safety risk.

Any activation of the manatee protection system sends an alarm signal to the Control Room via the telemetry system. Manatee alarms are auto-logged in the Control Room computer system. Additionally, a desk-top log is maintained by the on-duty staff to alert supervisors and other shifts to the alarm events.

III. STRUCTURE OPERATIONS

This section of the report reviews operations of S-27 for the week preceding the manatee mortality. It attempts to provide a correlation between the observed mortality and specific operations of this water control structure. It also provides a general over-view of the structure operations during the preceding month (October), and during the same month from the previous year. It also includes any tests of the manatee protection system during for the relevant period.

The manatee carcass was recovered on November 6, 1994, approximately 1/2 mile downstream of the Little River structure (S-27). According to the subsequent FDEP necropsy report, death was due to crushing by this water control structure. A thick banded impression was distinguishable on the dorsum, with four circular impressions located approximately 12 inches posterior to the band. These impressions were

spaced approximately 4 inches apart. Three similar depressions were located on the ventral side, with a banded impression found directly across the ventral depressions.

RELEVANT WEEK OPERATIONS

Gate operations for the seven days prior to the carcass recovery have been reviewed to determine the possible time of entrapment in the S-27 spillway gate. This analysis was conducted by first generating a graphic printout of all movements for both gates during the period October 31 through November 6. These printouts are based upon the SFWMD Data Management computer files of S-27 gate readings compiled during 3 minute intervals (gates stationary) and 1 minute (gate moving) intervals during these seven days. From these printouts, any instances where a gate failed to close without delay from the 2.5' setting were identified. The Control Room computer logs were then examined to detect any alarm messages relevant to incomplete gate closures.

The computer printouts of S-27 gate motions during this period are included as APPENDIX A. Six instances when gates failed to close completely before reopening are identifiable on these graphs. The time, gate setting, and alarm messages recorded for each of these incidents are shown in TABLE 1. Each of these incomplete gate closures are discussed in the following text.

TABLE 1. INCOMPLETE GATE CLOSURES AT S-27

	DATE /TIME	GATE NUMBER	GATE POSITION (feet)	SFWMD ALARM LOG
1	11/03/94 *06:33:15*	2	0.347	Manatee Moving gate
2	11/04/94 *07:24:04*	1	0.148	Manatee Moving Gate
3	11/04/94 *07:34:03*	1	0.273	Manatee Moving Gate
4	11/06/94 *02:50:17*	2	1.580	Failure To Communicate - Telemetry Signal Lost
5	11/06/94 *07:31:33*	2	0.697	Abnormal Gate Operation - Gate Lost Power
6	11/06/94 *12:40:42*	2	0.949	Abnormal Gate Operation - Gate Lost Power

The first instance when S-27 failed to complete a normal gate movement was on November 3 when the #2 gate failed to close completely. The SFWMD computer log recorded a manatee alarm triggered when the gate was approximately 4 inches from closure. Review of the initial gate position (see APPENDIX A) indicates that the gate had been open approximately 7.5 feet for a period of approximately 9 hours immediately preceding this closure. This position places the bottom of the gate within several feet of the headwater level. While it is possible that this manatee

alarm could have been triggered by a manatee tail beneath the gate, it is more likely that this alarm was triggered by debris or aquatic plants which became lodged against the gate face during the high gate opening. When the gate reopened to 2.7 feet on the manatee alarm signal, these materials could have been flushed from the gate face as the next closure attempt resulted in a normal gate termination. The C-7 canal typically carries a heavy trash load; floating material frequently lodges against the gates and is passed beneath them. The spillway gates in the S-27 structure are installed in the reverse of the typical pattern such that the exposed gate reinforcing frame beams are upstream and the smooth face ("skin plate") faces downstream. This enhances the ability of the gates to snag material as it is pulled down the face by discharge currents. Given the large opening gap (with concurrent large flow) and prolonged use period it seems likely that debris could have been entangled on the gate and was responsible for this alarm.

The second and third instance of incomplete gate closure occurred the following morning. These both happened at gate #1 The gate failed to close completely on two successive attempts; in each case the manatee alarm was triggered. The gates were open approximately 1.7 and 3.0 inches respectively when the alarms were generated. This gate had also been open to about 7.25 feet for about 9 hours immediately prior to these alarms. As with the incomplete closure of the other gate the previous morning, these two instances are believed to be due to debris entrapment beneath the gate which triggered the alarms On the third attempt the gate closed completely, presumably after flushing entrapped material.

The fourth instance of incomplete gate closure occurred about 2:50 am on November 6. Gate #2 was closing from a 2.5 foot setting. It reached about 1.6 feet when the telemetry signal from S-27 to the Control Room was lost . This caused the DDSP computer program to automatically reopen the gate to 2.7 feet and repeat the closure attempt. The telemetry signal was recaptured and the gate closed normally on the next attempt. Gate #1 was fully closed (it had not been in operation) at this time and was therefore unaffected by the telemetry signal loss. This loss of the telemetry signal was recorded in the Control Room computer log and was also verified in Data Management by missing headwater/tailwater and gate setting values in the telemetry data files. No manatee alarm, nor other warning alarms, were recorded at this time and this gate reversal is attributed solely to the momentary telemetry signal loss.

The final two occurrences of incomplete gate closure were both on November 6. These are discussed together due to the similarity of the events. The first was approximately 8:30 am, the second about four hours later. In both the cases gate #2 experienced a loss of power during the closing mode. Gate #1 was fully closed (not in operation) throughout this time period.

Gate power loss may occur due to loss of external power to the structure (i.e. power failure due to severe weather such as a lightning strike), or because of an on-site power loss associated with the electrical motor systems. External power failure is not believed to have occurred because the associated telemetry system recorded no concurrent loss of signal. Extended on-site loss did not occur; in both instances the gate was quickly repowered and the automatic generator system was not activated. Temporary gate power loss may be triggered by two safety systems described earlier; the torque limit switch and the stem limit switches. The former will terminate motor power when excessive torque against the gate motor is detected. This will occur if movement (typically downward) of the gate is impaired such that pressure builds against the threaded stems which link the gate to the drive motor. The second

system, the stem limit switches, are located atop the gate at the base of each gate stem. In the event that the gate does not settle in synchronization with the moving stems, the stems will trigger switches to terminate motor power. The purpose of these switches is to insure that, if the counter switch designed to terminate power when the gate reaches closure should fail, or if the torque limit switch should not become engaged, the stems will stop before extreme pressure can be applied to other components of the structure.

When gate power is terminated, torque pressure or stem pressure is relieved and the motor may then be reactivated. If continued motion in the previous direction is attempted, the switches may again terminate power, however if power to reverse the gate is applied, and the gate is free to move in the opposite direction, normal operation will resume.

When the first power loss happened, the Control Room staff noted the alarm and manually reopened the gate within approximately one minute. For the second instance, the gate remained stationary for approximately three minutes until the next sweep of the telemetry system recorded the static gate and the DDSP computer program automatically reopened the gate. Following both instances of power loss, normal gate cycles resumed (see Appendix A).

When gate power was lost, the gate openings were approximately 8 inches and 11 inches, respectively.

No manatee alarms were triggered during either of these events. Possible reasons for gate motor termination in these two instances appear to be limited to four possible explanations: 1.) a momentary loss of power within the electric motor circuit momentarily shut down the motor; 2.) the closing gates encountered debris which jammed the gate without touching any PSD switch and therefore triggering the manatee protection system and the torque limit or stem limit switches then terminated power; 3.) the closing gates encountered debris which triggered the PSDs, but the manatee protection system did not function to reverse the gates, and the torque limit or stem limit switches then terminated power; or 4) the closing gate encountered a manatee, the manatee protection system did not function, and the switches terminated gate power.

As will be discussed further in a following section, this manatee mortality is believed to be due to crushing during one of these two gate closings.

Examination of the general gate movements for this seven day interval reveals that prolonged (up to 10 hours), large (8.0 feet) gate openings occurred daily for both gates from October 3 until November 4. Gates remained closed for only 2-3 hours each day. Gate #2 frequently opened to 2.5 feet between the large-scale openings of both gates. During this period, the S-27 structure was operating with much higher gate frequency, and duration than normal in response to the exceptional rainfall which had been experienced in South Florida.

On all occasions when gates were opened, the minimal opening gap of at least 2.5 feet required as part of the manatee protection operating criteria was achieved.

OPERATIONS PREVIOUS MONTH

Further insight into the unusual operation of S-27 during late October may be obtained by examining the daily operations for the preceding month of October, as well as October of 1993. The computer printouts of these gate operations and headwater / tailwater conditions are provided in APPENDIX B and C.

Large gate openings and frequent use of the structure occurred from October 1 until October 9 in response to exceptional heavy rainfall and flood control demands. Operations became more normalized until more intensive operations resumed on October 31. District weather records for October indicate that the Lower East Coast recieved about 1" of rainfall on October 1. Thunderstorms during October 27-29 were followed by the arrival of a low pressure system on October 30. More than six inches of rain was recorded in Dade county from these storms. In addition to local runoff from these rainfall events, excess water from the Water Conservation Areas was also conveyed to tide through virtually all available coastal outlets.

In comparison to S-27 operation during October, 1994, the use of S-27 in October, 1993 required fewer high magnitude gate openings and in particular fewer frequent repetitive gate openings such as those associated with the flood control discharges during October 4 - 7, 1994.

IV. CONCLUSIONS REGARDING MANATEE MORTALITY

The recovered manatee carcass exhibits a lateral band and circular depressions indicative of the pattern of the S-27 rubber gate seal and the PSD switches. The spacing of these marks do not match precisely with the corresponding gate components, however this is presumed to be due to distortion of the carcass by the gate during the entrapment.

This mortality is believed to have been caused by crushing in gate #2 during one of the two partial gate closures which terminated in gate power loss on November 6. Which of the two partial closures is responsible cannot be determined. The cause of the other power failure cannot be attributed to this mortality inasmuch as only a single set of gate marks were present on the carcass. No conclusion regarding the cause of the other power failure can be provided.

The PSDs are located on the upstream side of the gate seal (FIGURE 4). Based upon the relative location of the presumed PSDs and gate seal imprints upon the dorsal side of the carcass, the manatee was moving downstream through the gate when killed.

The imprints upon the carcass indicate contact with at least four plungers (and therefore four switches) in the manatee protection system however no gate reversal or alarm was triggered.

The manatee protection system had functioned successfully on both gates preceding the probable mortality time. Gate#2 had been triggered approximately 72 hours earlier, and gate #1 PSDs were activated about 48 hours earlier.

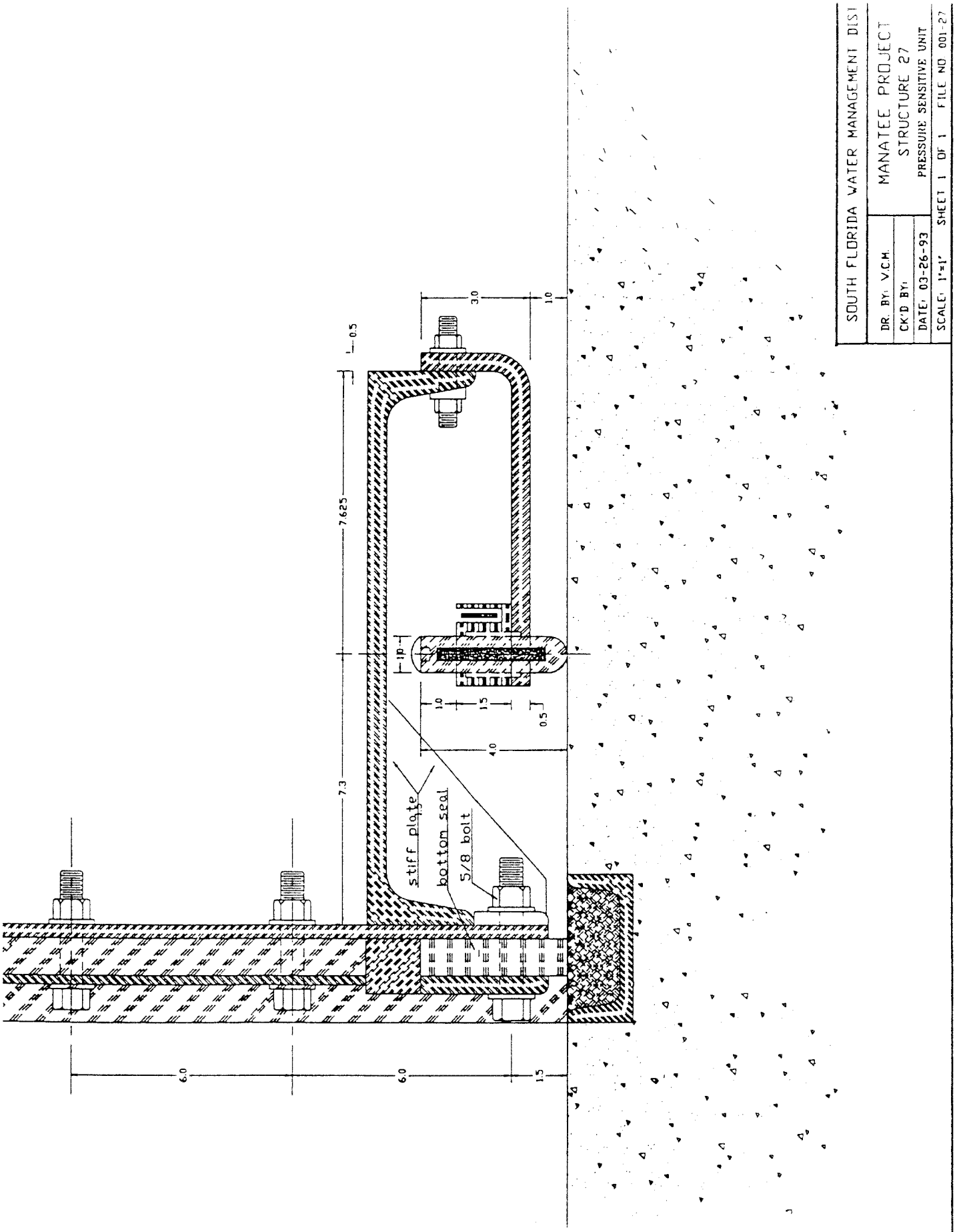


FIGURE 4. PSD Mounting Arrangement at S-27

Electricians from the District Field Station tested the PSD circuits on November 7 at 1400 hours and found all switches working properly.

Inasmuch as the PSD switches were functional both immediately prior to, and immediately following, this mortality, these switches are not believed to be responsible for the failure of the manatee protection system. Failure of the manatee protection system to be triggered by the manatee is believed to have been due to the failure of the system enable/disable switches (FIGURE 5) to be tripped by the closing gate. If the horizontal trip arm affixed atop the spillway (note black arm in FIGURE 5) gate does not engage and rotate the enabling switch mounted on the nearby structure sidewall as it passes during downward motion of the gate, the entire array of PSDs will remain shut off during gate closure. This is the most likely cause of the system failure associated with this mortality. Maintenance staff have experienced trouble adjusting these switches due to the excessive lateral gate movement at S-27. The excessive gate wobble could allow the trip arm to miss the enable switch if the gate is leaning upstream in the track. If adjusted to insure contact when at this extreme spacing, the trip arm subsequently may extend too far into the switch mounting during downstream drift of the gate and cause damage to the switch.

A recent incident at S-29 lends further support to this conclusion. Similar switches are used at S-29, although gate drift is not as severe at that site. Manatee alarms were recently triggered at S-29 when the lower disable switch was not tripped by the gate trip arm and the gate closed with the PSDs still armed. If the upper switch fails to enable the circuit there is no way to know that the circuit is not armed, however, as in this case, failure to trip the other half of the switch pair (the lower disable switch) means that the circuit remains armed. When the still-active PSDs contact the chamber floor, the manatee alarm is triggered.

IV. RECOMMENDATIONS

ISSUES TO BE ADDRESSED

Analysis conducted during the investigation of this mortality identified the following issues to be addressed:

+ Replacement of Current Enable/Disable Switch System
+ Formalized Manatee Protection System Testing and Reporting
+ Formalized Control Room Operator Manatee Alarm Log
+ Increased Manpower Allocation to SFWMD Manatee Program
+ Enhanced System Maintenance Capability
+ Field Testing of PSD System
+ Further Refinement of Gate Control Algorithms
+ Consideration of Additional Tension in PSD Trigger Springs
+ Inclusion of Additional Information in FDEP Mortality Reports

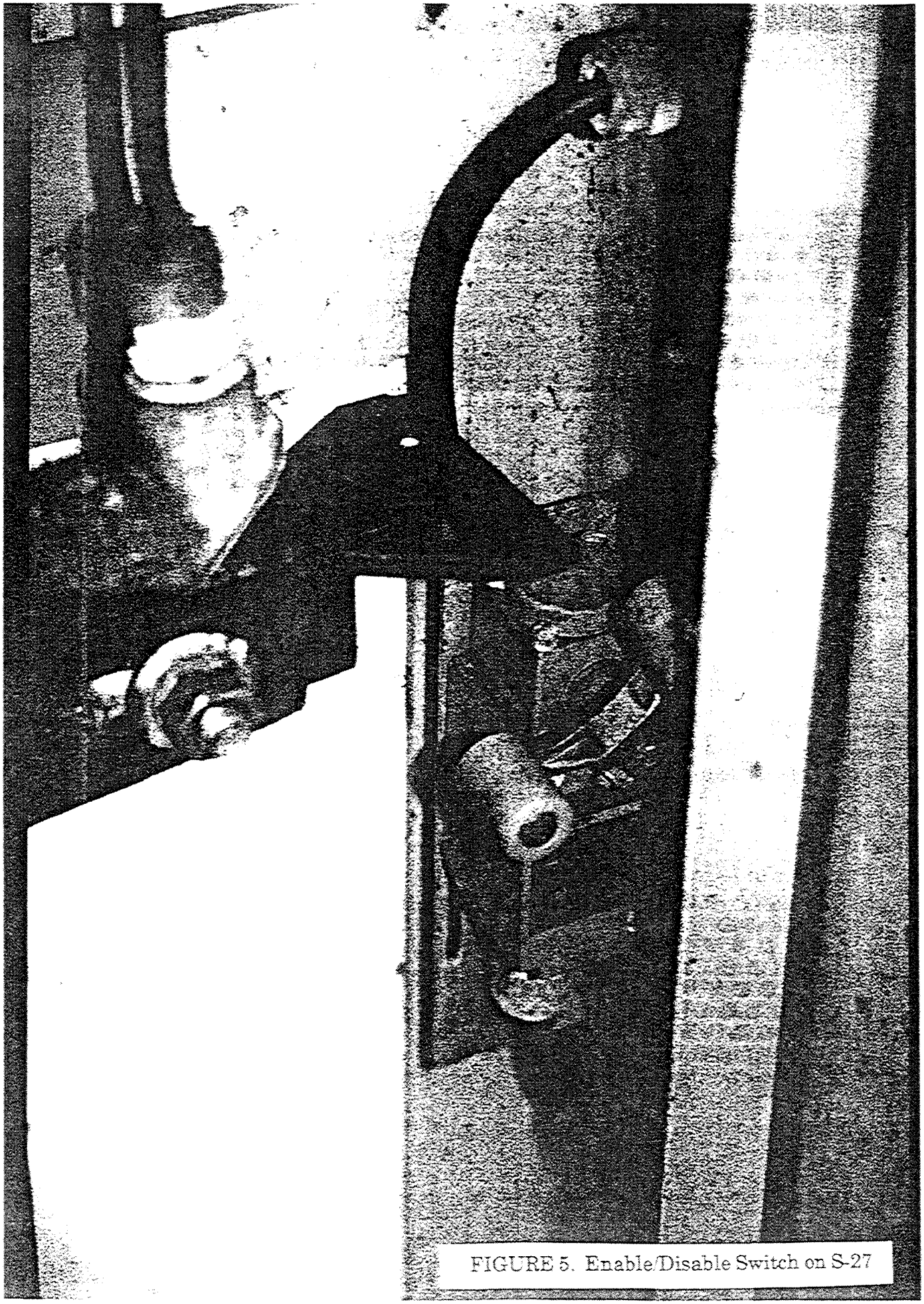


FIGURE 5. Enable/Disable Switch on S-27

Each of these issues and relevant proposed action items are discussed below:

Replacement of Current Enable/Disable Switch System

The toggle switch system used at S-27 to activate and deactivate the PSD array during each gate cycle is believed to be the cause of this mortality. Excessive lateral gate motion may result in failure of the gate trip arm to encounter this switch. The switch system on each gate is being replaced with a magnetic strip switch. This system uses a magnet moving in proximity to a metal circuit strip to activate the circuit. Switches have been ordered and received. Custom stainless steel mounting brackets have been fabricated. Installation of the switches on S-27 is scheduled for the week of March 6.

Formalized Manatee Protection System Testing and Reporting

The S-27 manatee protection system is transitioning from a research and development program to one with increasing emphasis upon operations and maintenance. Consistent, routine testing of the entire electerical circuit by Field Station personnel is required to insure optimum operation. To this time, electrical testing has been done by hand metering each individual PSD circuit. Testing has been done by District headquarters electronics staff.

An additional electronics person was recruited to the manatee project in February. His duties are to: 1.) assist in training field station electricians for subsequent routine manatee protection system testing, 2.) develop enhanced on-site testing capability of the PSDs by installing dedicated test circuits, and 3.) develop appropriate alarm test log sheets to be completed during weekly inspection of the manatee protection system.

The proposed testing sequence will entail testing in three steps: first, checking the inactive PSDs to insure that no circuits are shorted (such as by water seepage); second, testing the PSDs to insure that all switches will activate correctly, and finally, generating a test signal from the S-27 PSD circuit to the SFWMD Control Room to confirm that the alarm system is fully functional. An outline of the procedures to enact this test is currently being developed.

Formalized Control Room Operator Manatee Alarm Log

While the SFWMD computer system auto-logs all alarms and operations of the structure, the Control Room also maintains a hand-written desk log noting alarms and activities. This insures that supervisors and subsequent shift operators are aware of previous operational details. The log also serves as a convenient reference for initial review of previous gate activities prior to accessing the detailed computer files. A more formal log sheet, with a standardized format will be developed to optimize the usefulness of this log. These sheets will also include general recording of field station activities when relevant to the manatee protection system.

Increased Manpower Allocation to the Manatee Protection Program

Virtually all responsibility for design, testing, and maintenance of the prototype manatee protection system has rested with Mr. Vic Mobley. Field station personnel have assisted when available, however individuals have not been consistently assigned to this project.

In response to the increased progam demands, a general program coordinator (Frank Lund) was assigned in November, additionally, a project manager (Steve Ciulla) was redirected to the program in the Operations Department. Mr. Ciulla has identified the need for 1) additional electrician support, and 2) dedicated field station support. An additional electrician position has been advertised and was filled in February. Recent maintenance work on the S-27 system has provided the opportunity to train additional Miami field station personnel for operations and maintence support of the manatee protection system. Mr. Julio Fanjul, formerly the District's Dade County Intergovernmental Representative and a member of the Dade County DERM Manatee Protection Plan Review Committee, has recently become the Assistant Director at the Miami Field Station and is assisting in coordinating manatee protection efforts.

Enhanced System Maintenance Capability

Previous maintenance and repair has been handled by headquarters electrical staff; all replacement parts have been fabricated in West Palm Beach by District personnel and subsequently delivered to the appropriate structure.

To enhance the ability of the District to maintain the manatee protection systems installed on the water control structures, the Operations Department is decentralizing maintenance and repair activities and stockpiling replacement parts. A target goal of a 20% supply of replacement PSD switches has been set, with these switches to be catalogued and stored at the appropriate field station. A team at each field station will also be trained in PSD switch replacement such that only supervisory oversight from the headquarters building may be required.

Materials orders to establish the backup supply are currently being processed and storage/inventory control plans are under development. Additionally, the use of existing contract vendors to fabricate the units is currently being evaluated. The use of vendors should streamline the manufacture of spare systems

Field Testing of PSD System

Inasmuch as the PSD switches are located approximately 11 feet below the top of the gate, and typically are exposed to significant flow velocities, direct manual testing of the manatee protection system PSDs has not been undertaken.

Upon completion of current maintenance and upgrades to the S-27 manatee protection system, an on-site test using a sandbag system will be undertaken. Gates will be opened, soft obstructions place within the gate opening, and closure will then be initiated. Upon gate reopening (and presumed PSD triggering), District divers will inspect the obstructions to ascertain relative impacts.

Further Refinement of Gate Control Algorithms

Review of the gate movement printouts indicate that gate openings not critical to flood control still occur at S-27. These appear to be caused by the close headwater/tailwater conditions frequently existing at the structure.

District staff will investigate possible options to further reduce gate openings. It is recommended that this topic be scheduled for discussion at the next Interagency Task Force meeting.

Consideration of Additional Tension in PSD Trigger Springs

Currently, the PSDs may be triggered by applying approximately 5 pounds of lift pressure. It appears that some gate openings are the result of debris brushing against the switches during water flow beneath the gate.

As development of the optimum system to protect all water control structures proceeds, it is recommended that a slightly higher spring setting, perhaps 10 to 15 pounds, be considered. Any information regarding the pressure tolerance level of manatees would be helpful to this evaluation. This topic is suggested for discussion by the Interagency Task Force.

Additional FDEP Mortality Report Information

The FDEP mortality report for this manatee includes a description of both dorsal and ventral markings, and a descriptionof internal injuries. Dimensions for the surficial markings are also included.

In order to perhaps better understand the manner of entrapment, it would might be helpful if the relative location of major markings and injuries were provided. For example, is the ventral band directly beneath the dorsal band ? What is the location of the spinal separation in relation to the dorsal gate seal mark ?

Photographs of several crushed manatees were reviewed during preparation of this report. In each instance, associated gate impressions did not appear to reflect any twisting or rolling by the manatee, but rather a relatively static imprint. Any FDEP staff notations regarding details of carcass markings which might shed further light on manatee behavior beneath the gates would be appreciated.

APPENDIX H

BRIEF REAL ESTATE PLAN
MANATEE PROTECTION AT SELECTED
NAVIGATION & WATER CONTROL STRUCTURES
IN CENTRAL AND SOUTHERN FLORIDA
PART I

STATEMENT OF PURPOSE

This Real Estate Plan (REP) is tentative in nature for planning purposes only and both the final real property acquisition lines and the real estate cost estimates provided may be subject to change following approval of the Feasibility Report.

PROJECT AUTHORIZATION

Specific authorization and appropriations for this project are provided by the Energy and Water Development Appropriation Act of 1994 (P.L. 103-126).

PROJECT LOCATION

The project area consists of selected project structures located within the Okeechobee Waterway and Central and Southern Florida Flood Control Project, as identified below:

Structure	Location	Operator For Specific Structure
S-27	Dade Co.	Sponsor
S-29	Dade Co.	Sponsor
S-308C Spillway	Martin Co.	Government
S-123	Dade Co.	Sponsor
S-22	Dade Co.	Sponsor
S-28	Dade Co.	Sponsor
S-13	Broward Co.	Sponsor
S-25B	Dade Co.	Sponsor
S-26	Dade Co.	Sponsor
S-77 Spillway	Glades Co.	Government
S-20F	Dade Co.	Sponsor
S-135	Martin Co.	Sponsor
S-33	Broward Co.	Sponsor
S-25	Dade Co.	Sponsor
S-21	Dade Co.	Sponsor
S-21A	Dade Co.	Sponsor
S-20G	Dade Co.	Sponsor
S-79	Lee Co.	Government
S-127	Glades Co.	Sponsor
S-131	Glades Co.	Sponsor

Revised, March 1996

PROJECT DESCRIPTION

Structural modifications to selected Project structures are proposed to reduce Manatee risk and mortality. Automatic gate reverse sensor devices would be designed, constructed, and installed on vertical lift gates. The objective would be that whenever a closing structure gate comes into contact with a manatee, the gate would automatically stop and reverse to free the animal before it is injured.

GOVERNMENT-OWNED LAND

The Government owns the land, in fee, for those spillways and locks for which it has the responsibility of operating. Refer to chart under Project Location for individual identification.

SPONSOR-OWNED LAND

The Sponsor has easements for those spillways, culvert and locks for which it has the responsibility of operating. Refer to chart under Project Location for individual identification.

ATTITUDE OF OWNERS

All project lands are owned by the State or the Government which fully support the Project.

RELOCATION ASSISTANCE (PUBLIC LAW 91-646)

There are no persons or businesses that would be relocated due to project implementation.

RELOCATIONS (Utilities, Structures and Facilities, Cemeteries, and Towns)

There are no known utilities, structures and facilities, cemeteries, and towns to be affected as part of the federal project.

NON-FEDERAL OPERATION/MAINTENANCE RESPONSIBILITIES

OMRR&R requirements are consistent with the existing authorized project.

LOCAL SPONSOR'S AUTHORITY TO PARTICIPATE IN THE PROJECT

The Sponsor's authority to participate in the project is consistent with the Sponsor's existing authority, for the existing authorized project.

HAZARDOUS AND TOXIC WASTES (HTW)

There have not been any hazardous and toxic wastes identified within the project area.

RECREATION RESOURCES

There are no separable recreational lands identifies for the project.

CULTURAL RESOURCES

There are no known cultural resources that have been identified as being affected by the project.

OUTSTANDING RIGHTS

There are no known outstanding rights in the project area.

MINERALS

There exist no known minerals of value in the project area.

STANDING TIMBER AND VEGETATION COVERS

There exist no timber or unusual vegetative cover in the project area.

MITIGATION

There is no mitigation associated with this project.

APPRAISAL INFORMATION

The entire project will be implemented on existing project lands. No additional real estate interest will be required of the Sponsor to implement this project. No appraisal is to be requested or required for valuing of lands and damages associated with the proposed Project.

ESTIMATED COSTS OF LANDS, EASEMENTS, RIGHTS-OF-WAY AND RELOCATIONS

Lands and Damages	$ 0.00
Acquisition/Administrative Cost	
Federal	$ 1,000.00
Non Federal	$ 1,000.00
Public Law 91-646	$ 0.00
Contingencies (25%)	$ 500.00
Total Estimated Real Estate Cost	**$ 2,500.00**

REAL ESTATE ACQUISITION SCHEDULE

Due to the requirements of this Project, there is no scheduled acquisition of real estate.

APPENDIX I

MANATEE DETECTION SYSTEM
FOR
LAKE OKEECHOBEE
SECTOR GATES

Submitted by

Harbor Branch Oceanographic Institution, Inc.
5600 US 1 North
Ft. Pierce, Florida 34946

Prepared for

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

28 August 1995

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Harbor Branch Oceanographic Institution, Inc. (HBOI) was contracted by South Florida Water Management District (SFWMD) to evaluate the problem of manatee mortality at their Sector Gate 193 on Lake Okeechobee, Florida and propose a solution. HBOI identified a number of candidate technologies which could sense the presence of a manatee between closing gates. These technologies included; three different applications of Piezo-electric film, fiber optics and acoustical devices. Each of these sensor types underwent testing and evaluation at HBOI's laboratory. Described in the accompanying report are the data and findings of these tests. HBOI recommends the instrumentation of existing J-seals with Piezo-film. Included is a recommended design for the system with an estimated cost to implement of approximately $2,500 per gate in quantities. Also included is a proposed prototype and cost for a prototype system to be installed at Sector Gate 193.

1.0 BACKGROUND

Harbor Branch Oceanographic Institution, Inc. (HBOI) was contacted by the South Florida Water Management District (SFWMD) to evaluate sector gates at Lake Okeechobee as they relate to manatee mortality. On 4 May 1995, three HBOI engineers accompanied three SFWMD personnel to Sector Gate 193 to observe the geometry and operation of the lock system. On site were some prototype mechanical hinge/limit switch detectors put together by SFWMD. Their operation and installation was described to HBOI. A number of different potential approaches were discussed at the field site. During the HBOI site visit, a manatee was observed transiting the lock. On 9 May 1995, representatives of SFWMD traveled to HBOI's laboratories in Ft. Pierce to see firsthand some of the technologies discussed as possible solutions to the problem.

2.0 SCOPE

HBOI has conducted an intensive investigation to identify a manatee detection system for SFWMD's sector gates. The investigation focused on proven technologies with which the designers have substantial experience. Among the salient features of the candidates surveyed are:

- **Ruggedness.** Subject to submergence, impact from boats and debris, vandalism, lightening strikes and sedimentation.

- **Reliability.** Gates are operated sunrise to sunset, seven days per week. Assume MTBF > 1.8 M cycles.

- **Low Maintenance.** The system shall be designed in order to minimize the downtime and simplicity to repair with minimal diver effort.

- **Ease of Installation.** It is highly desirable to develop a system requiring minimal effort to install (i.e., not "drying-in" lock, etc.). Ideally, the installation would be a simple operation similar to present J-Seal replacement.

- **Ease of Operation.** The system must be sufficiently robust that it can be simply hardwired into the present gate closure circuitry. Presence of a manatee between the doors would trip-out the gate closure and activate the alarm, requiring no operator intervention.

- **Cost.** Cost is evaluated based on initial installation and life cycle.

- **Vertical Gates**

The District has requested that HBOI also provide an opinion as to the potential applicability of the studied technologies to vertical gates at coastal structures. It is preferred by the District that the system be non-mechanical (e.g., delete the use of the existing plunger system). The criteria for vertical gates is the same as previously listed.

The USACOE has recommended the use of a "strip switch" for vertical gate protection. The District provided this switch to HBOI for testing. HBOI has tested the switch for durability and resistance to leakage.

The switch was pressurized to 75 psig in fresh water for 30 minutes. No visible damage or water intrusion occurred as a result of pressure testing. The switch was found to still function, and maintained an open resistance of >2000 MΩ @ 100V.

Biofouling tests are presently underway, and the switches will be reevaluated at the end of the trial period. However, the effort required to activate the switch, without some sort of mechanical intensifier, is deemed unacceptable in terms of the force exerted on a manatee. In order to activate the switch, an excessive amount of force is required when distributed over an area representative of a manatee contact. Repeated deadweight tests performed on these switches indicate that they require a pressure of 45 lb./in^2 to sense the presence of contact. One potential application of the strip switch would be to place it behind the finger-like plungers currently used by the District on vertical gates, in place of the present magnetic flux/reed switches. However, there is presently no data to determine how well these switches would withstand the repeated point loadings requisite in this application. Without further testing, there is no indication that the strip switch would provide better reliability than the magnetic flux switches. Failures of the systems currently in the field are typically associated with the mechanical travel of the plungers, and adoption of the strip switch would not eliminate these problems.

The results of this investigation indicate that piezo film is an excellent candidate for the vertical gate application. The design proposed in Section 6.0 of this report would be readily adapted to the vertical gate application with very minor modification.

3.0 APPROACH

3.1 Study

HBOI has conducted a preliminary investigation to examine a number of candidate technologies and associated issues. Among them were:

- Piezo-electric film-contact sensor
- Piezo-electric spiral cable with mechanical amplification
- Fiber-optic strain/deformation sensor
- Acoustic emitter-receiver array

Based upon the results of this preliminary study and data obtained from SFWMD, it was determined that the Piezo-electric sensor approach is the best candidate for this application.

The investigation subsequently intensified the focus to include:

- Acquisition of drawings, general arrangements and operational considerations from SFWMD
- Literature survey including acquisition of sensor specifications, vendor sourcing, cost and delivery data
- CAD/CAM geometric model and analysis to determine "kill zones" and contact areas to be instrumented.
- Laboratory testing/analysis of sensor orientation and composition to optimize sensitivity and ruggedness.
- Design/fabrication instrumented mockups of Sector Gate 193 gates for test and analysis.
- Design/fabrication test apparatus to perform repeatable cyclic tests at very low loadings.
- Monitor, record, analyze excitation and response data from low-load cycles.
- Conduct in water testing of mockups to determine signal-to-noise, effect of moving water, etc.
- Monitor, record, analyze data from in water tests.

4. GEOMETRY CONSIDERATION

An engineering drawing package of Sector Gate 193 was obtained from the District. Dimensions from these drawings were used to develop a CAD/CAM computer model used to evaluate all the various possible geometries encountered during operation, e.g., two gates in motion in phase; two gates in motion out of phase; one gate fixed, one in motion; etc. Figure 1 is a partial view of one of the District provided drawings. The following figures in this section depict the "crush zones" or "kill zones" created by the different geometries. This analysis indicates that two areas of each gate must be instrumented; the J-seal as well as the flat bumper portion.

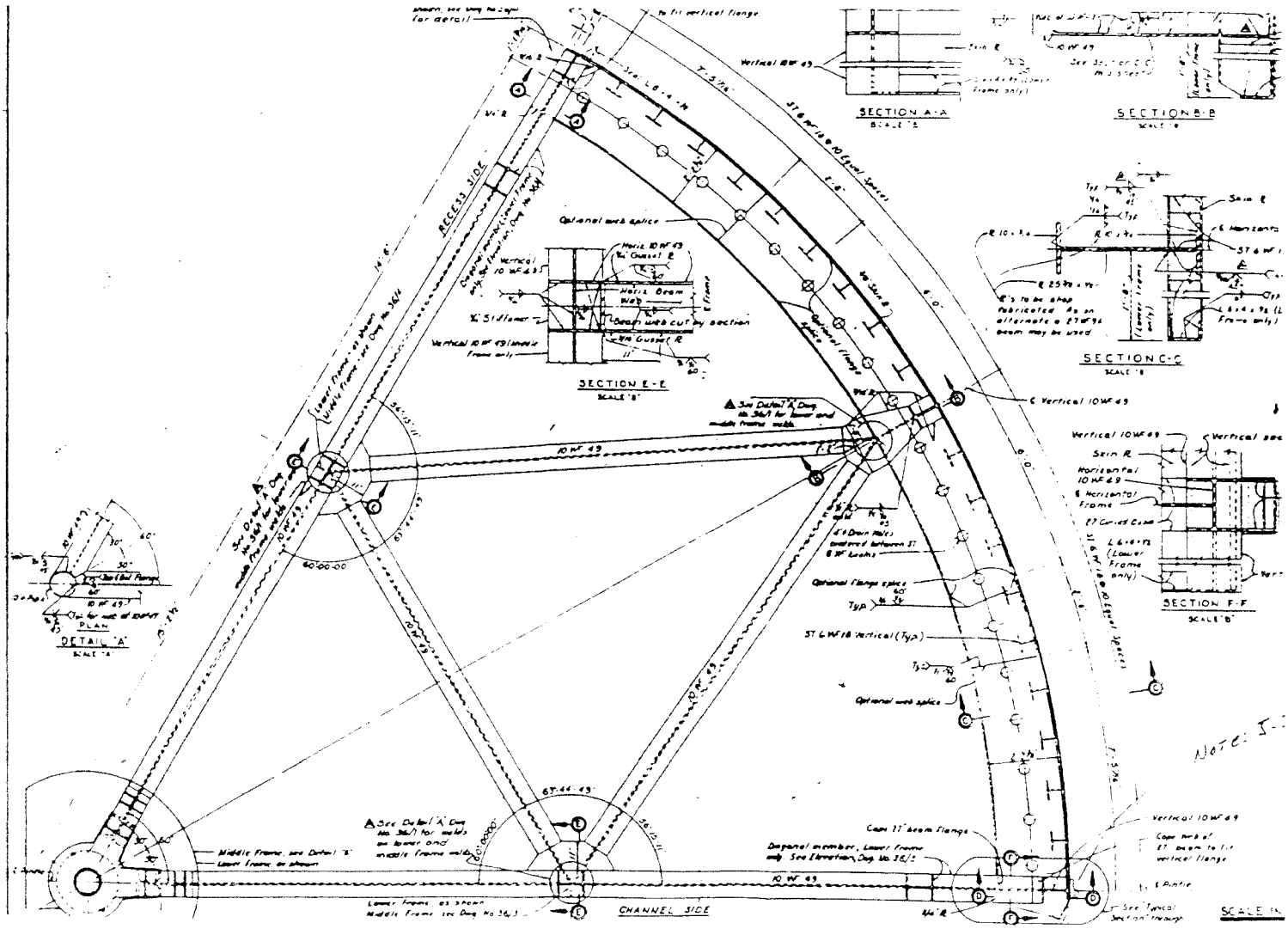
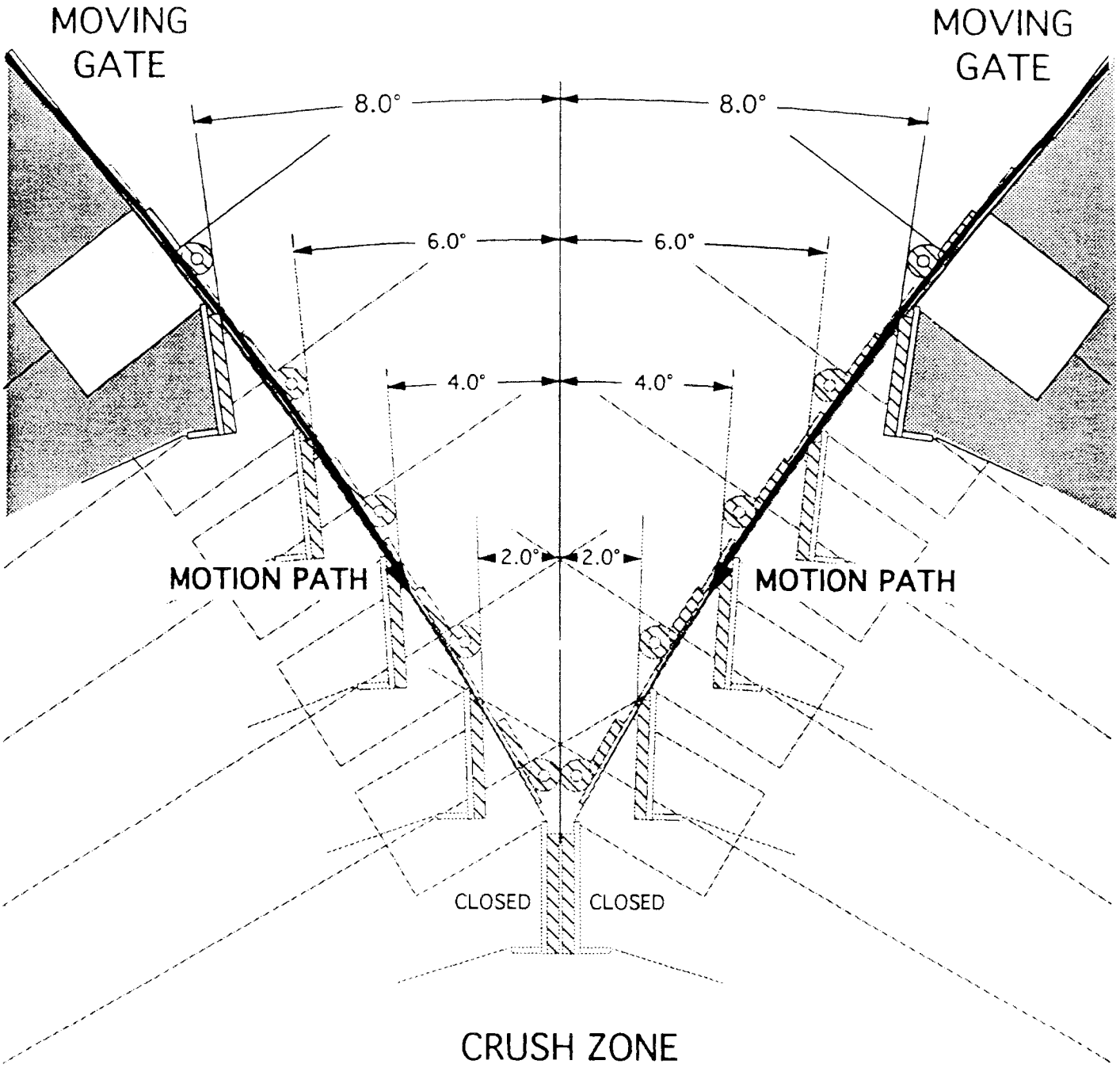
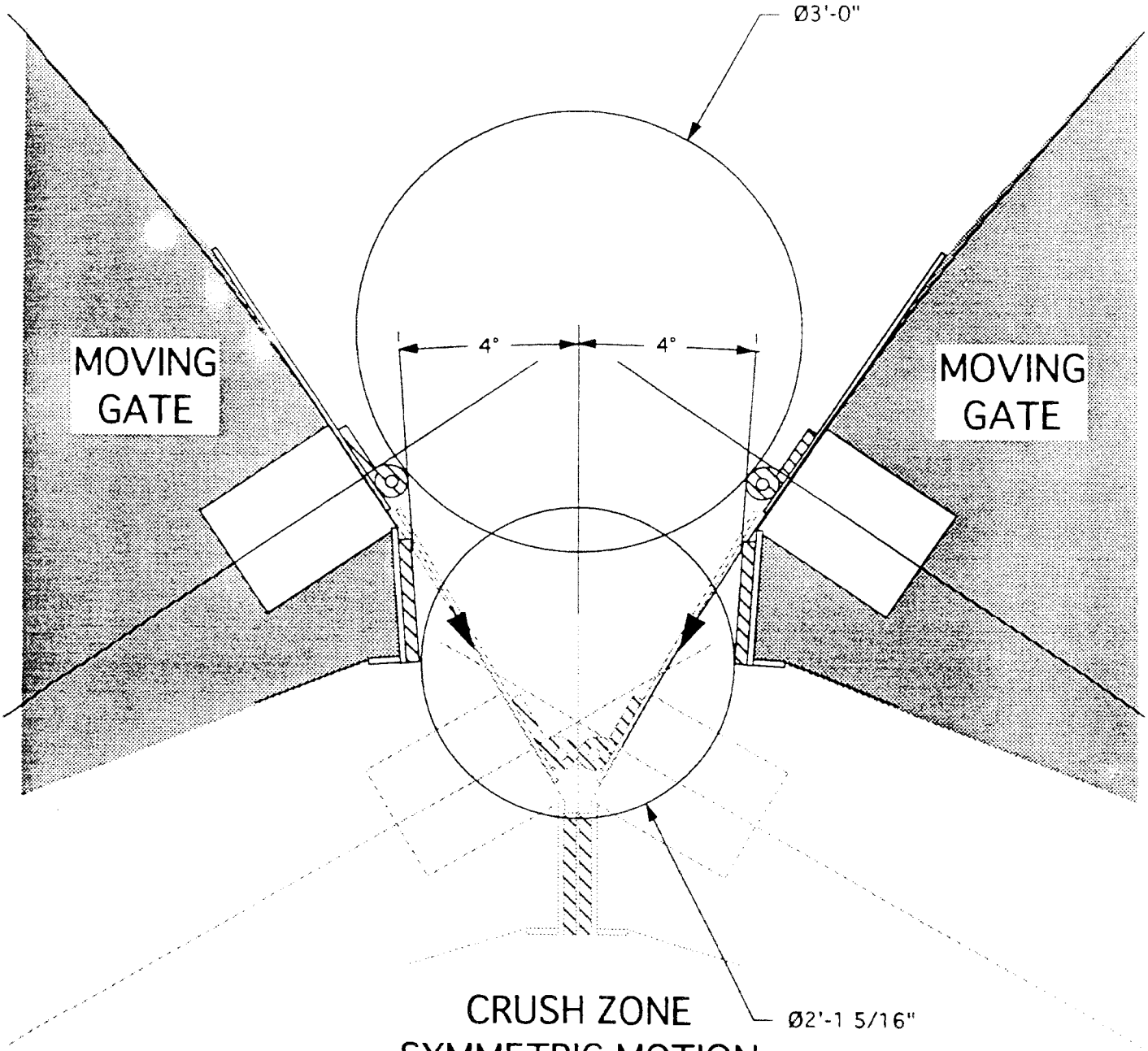


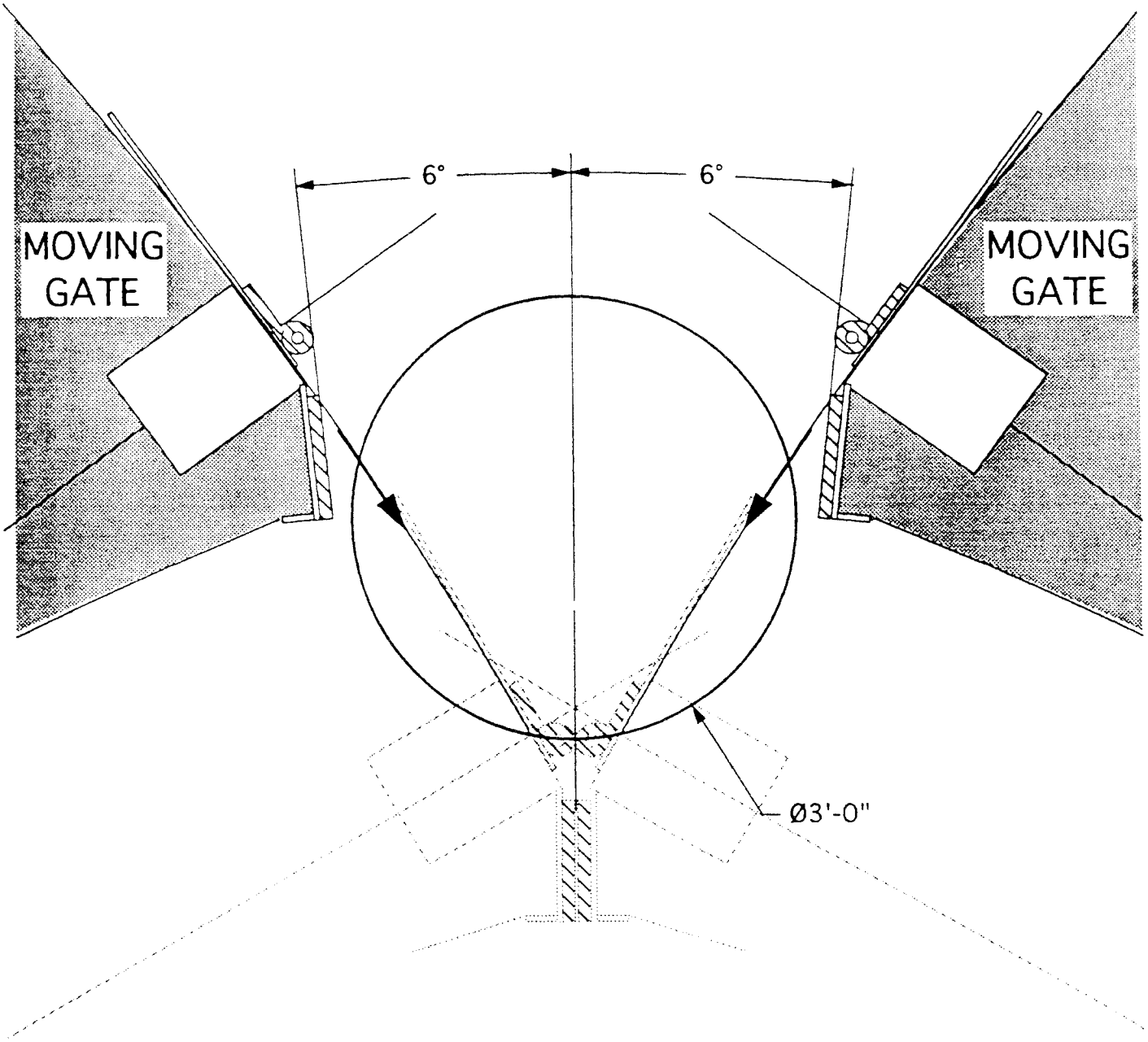
FIGURE 1



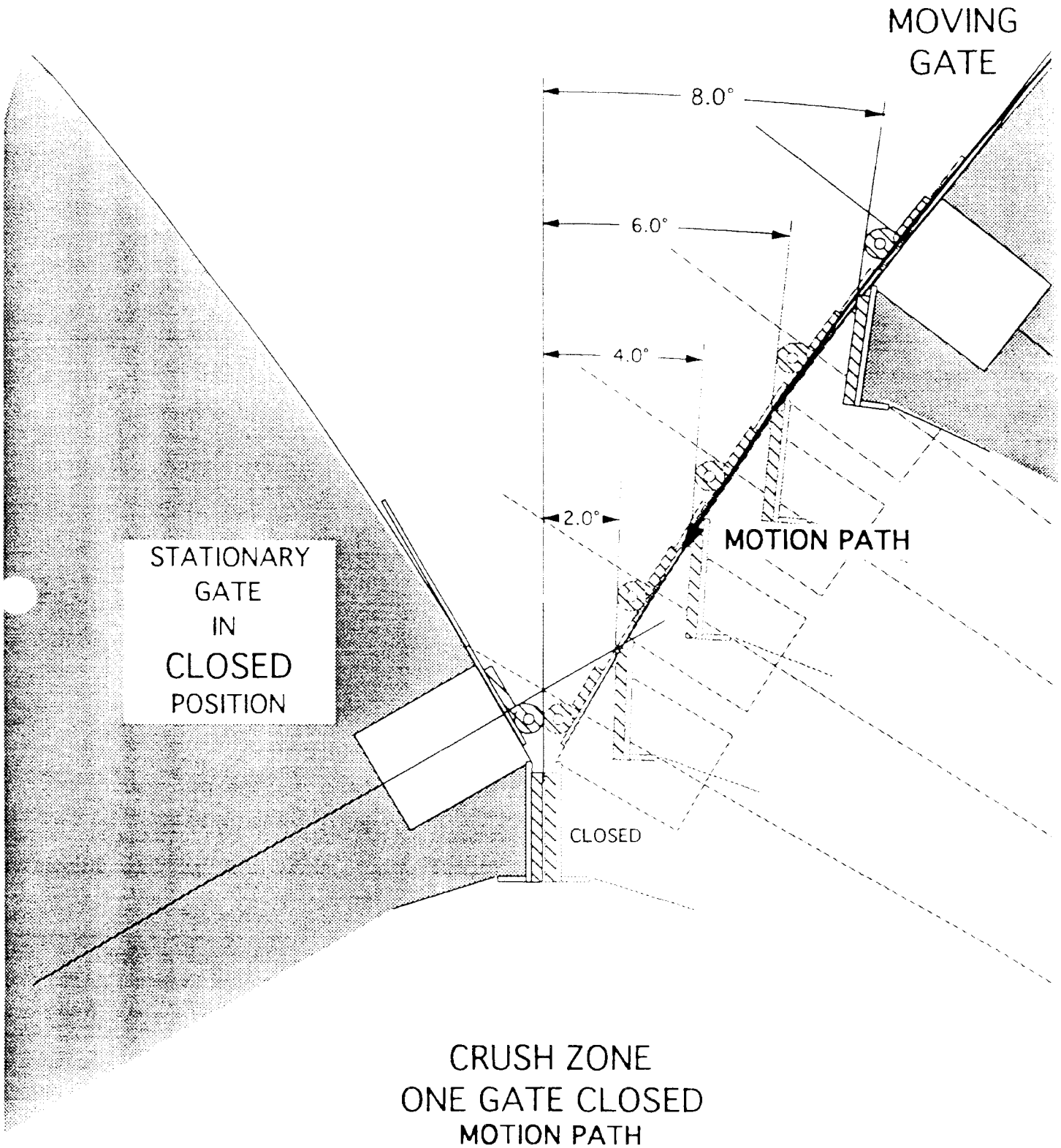
CRUSH ZONE
BOTH GATES IN MOTION
MOTION PATH
24 feet from base to Top of frame A



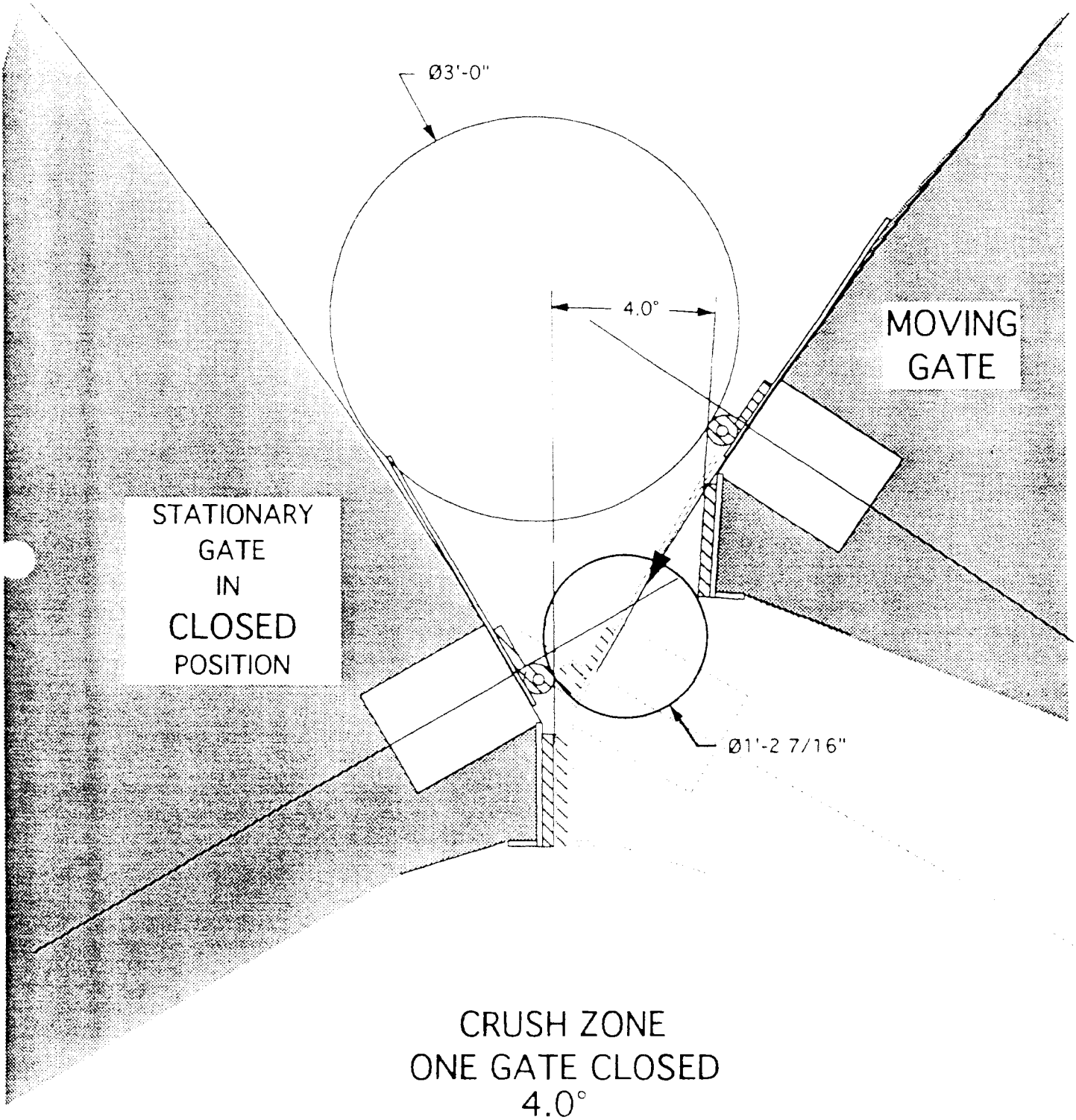
CRUSH ZONE
SYMMETRIC MOTION
BOTH GATES MOVING
4.0°-4.0°



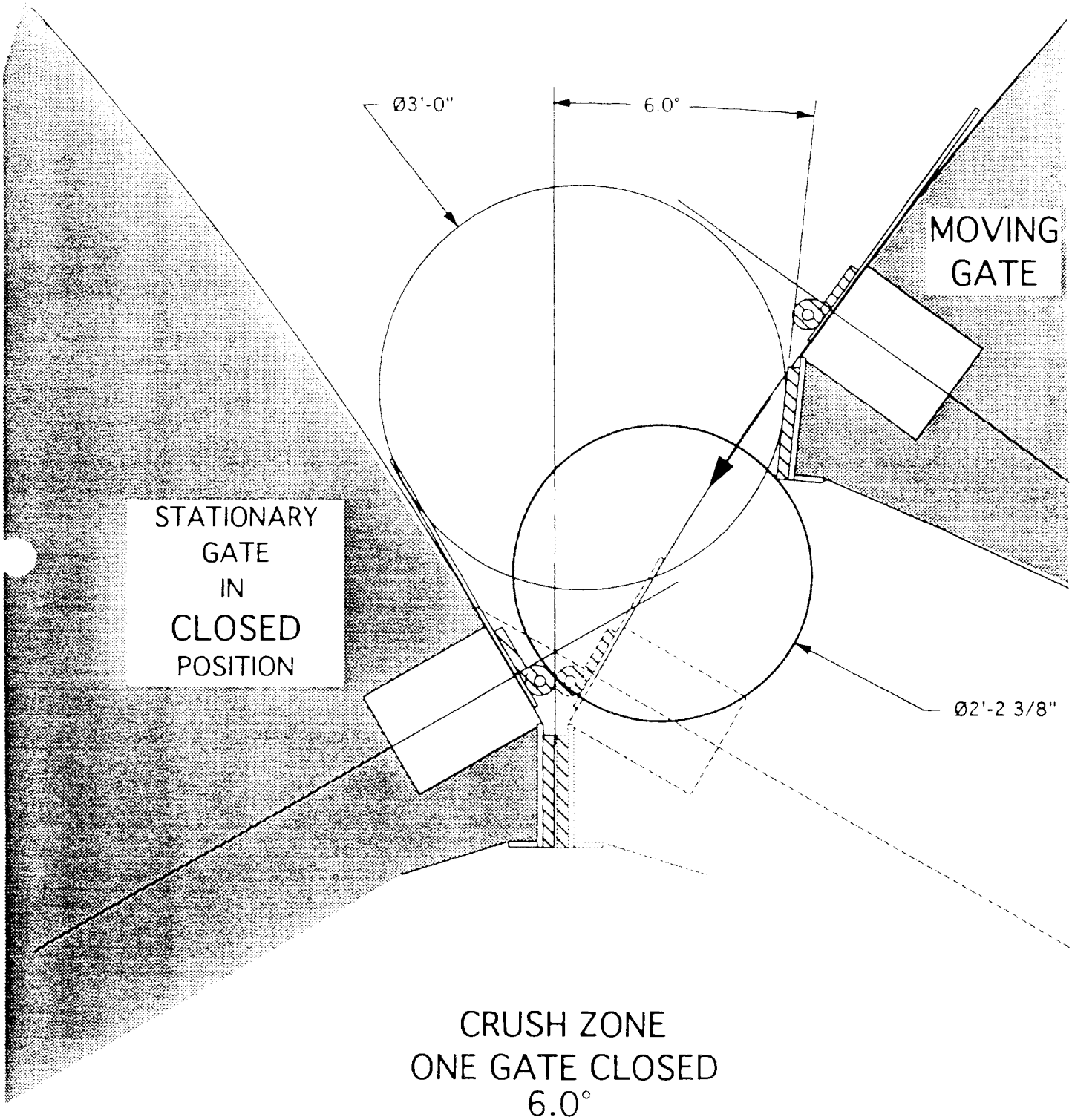
CRUSH ZONE
SYMMETRIC MOTION
BOTH GATES MOVING
6.0°-6.0°



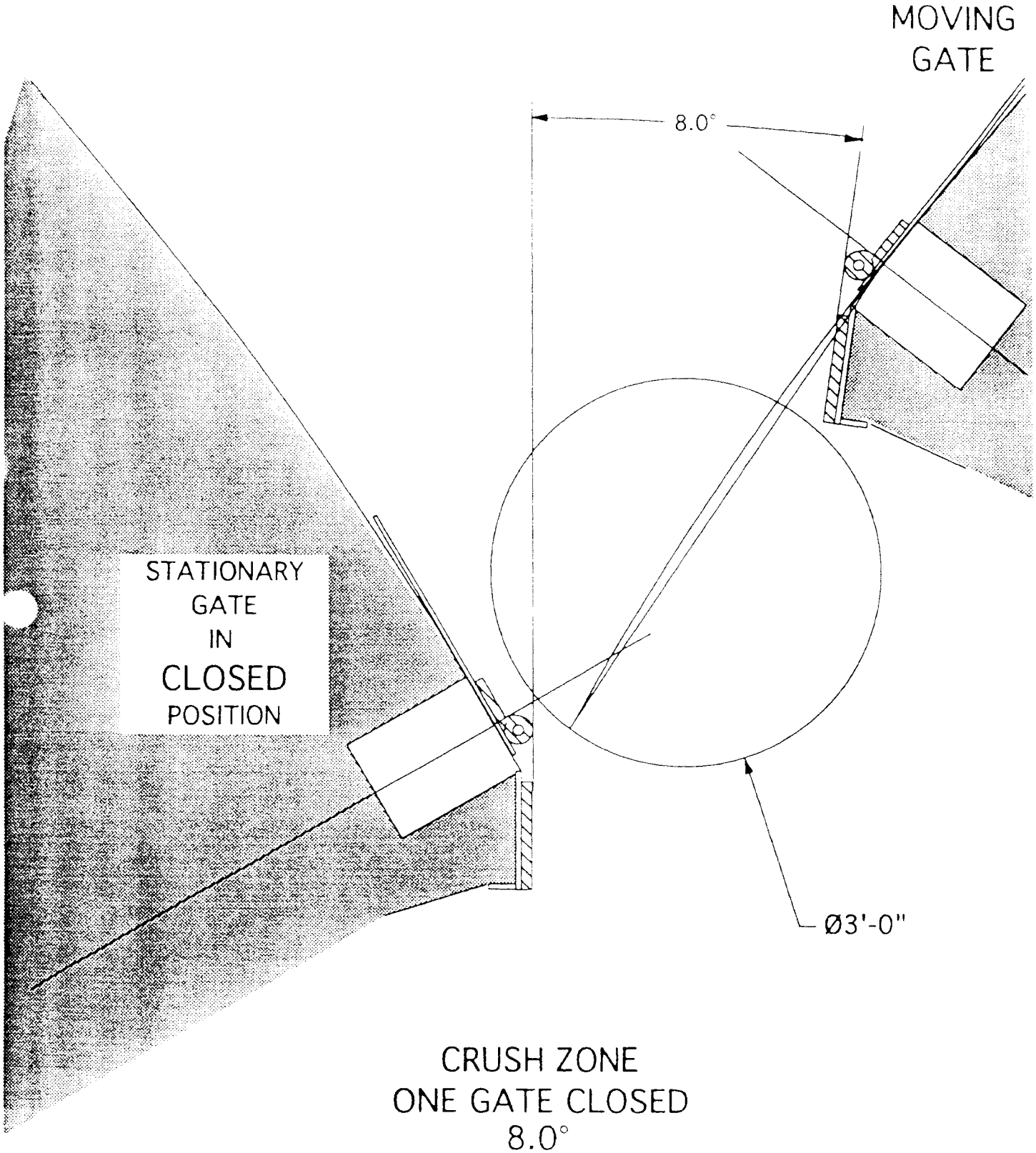
CRUSH ZONE
ONE GATE CLOSED
MOTION PATH



CRUSH ZONE
ONE GATE CLOSED
4.0°
24 feet from base to Top of frame A



CRUSH ZONE
ONE GATE CLOSED
6.0°



CRUSH ZONE
ONE GATE CLOSED
8.0°

5.0 Findings of Sensor Evaluation

Piezo-electric film based contact sensors are recommended for the implementation of the manatee detection system for SFWMD's sector gates. Information is provided on three piezo film based sensors constructed for testing. Section 6.0 describes in detail the design recommended for installation at Sector Gate 193.

Of the non-mechanical manatee sensing methods considered, four were deemed most practical, and chosen for demonstration. These sensing methods were: piezo-electric film based contact sensing, piezo-electric cable based contact sensing, acoustic beam interruption, and fiber optic cable based contact sensing. Of the above methods by far the most practical and robust are contact sensors based on piezo-film.

Information is provided in the Appendices on the three other methods of non-mechanical sensing that were built and demonstrated in Harbor Branch labs that could also be developed into workable solutions.

5.1 Piezo-electric Film Sensor Evaluation

Description and Operating Principle

Piezo film is a thin, tough, flexible material manufactured from polyvinylidene fluoride (PVDF) plastic. The PVDF is extruded, mechanically oriented by stretching, and polarized by exposure to an intense electric field. The resultant film, typically 1 or 2 thousandths of an inch thick, is then coated on both sides with a conductor to form the charge collecting electrodes.

Piezo film converts mechanical energy to electrical response. When the film is stressed, a charge is generated on the surface of the film proportional to the applied stress.

Piezo films are therefore very effective as dynamic strain sensors. They can cover large areas, require no external power source, and typically generate signals orders of magnitude greater than those from strain gages. Frequency response is thus free from limitations imposed by the need for the high gains required in conventional strain gage circuits. Piezo films respond only to time varying excitations, static excitation produces no response. Application of a constant stress will generate an initial level followed by an exponential decay of output signal.

A discussion of salient piezo-film properties is provided in Appendix 1

Sensor Development

Three approaches to manatee contact detection using piezo-electric film sensors were considered, designed, fabricated and subjected to preliminary testing. The three approaches were a hard-backed area contact sensor, a J Seal contact sensor, and a flat plate contact sensor. All three methods are intended to demonstrate a line sensor running along the edge of a gate. Various electrical contact and methods of water proofing were experimented with.

Hard-Backed Area Contact Sensor Proof of Concept

The sensor was fabricated from available neoprene rubber to save time, similar sensor performance is expected from the rubber used in the field. The sensor was fabricated in 3 layers, the hard-back, the ridge sheet, and the cover layer. The hard-back was fabricated from 3/4" 6061 T6 aluminum alloy plate to provide rigidity and a convenient mounting surface for testing. The ridge sheet, fabricated out of neoprene rubber, was bonded to the hard-back with contact cement. The 1 13/16" by 12 3/8" strip of 28 μm thick piezo-film was sandwiched between the ridge sheet and the cover layer. The piezo film is laid out so that its length direction, the 1 direction, is perpendicular to the ridges. The cover layer was fabricated from 3/8" neoprene sheet, and bonded to the stack with contact cement. A cross-section of the stack, dimensions, and film placement is shown in Figure 9 and Figure 10. Electrical connections to the silver ink electroded film surfaces were made with thin copper foil backed with conductive adhesive at the top 1/4" of the film strip. Output leads were soldered to the copper foil and brought out along the grooves of the ridged sheet.

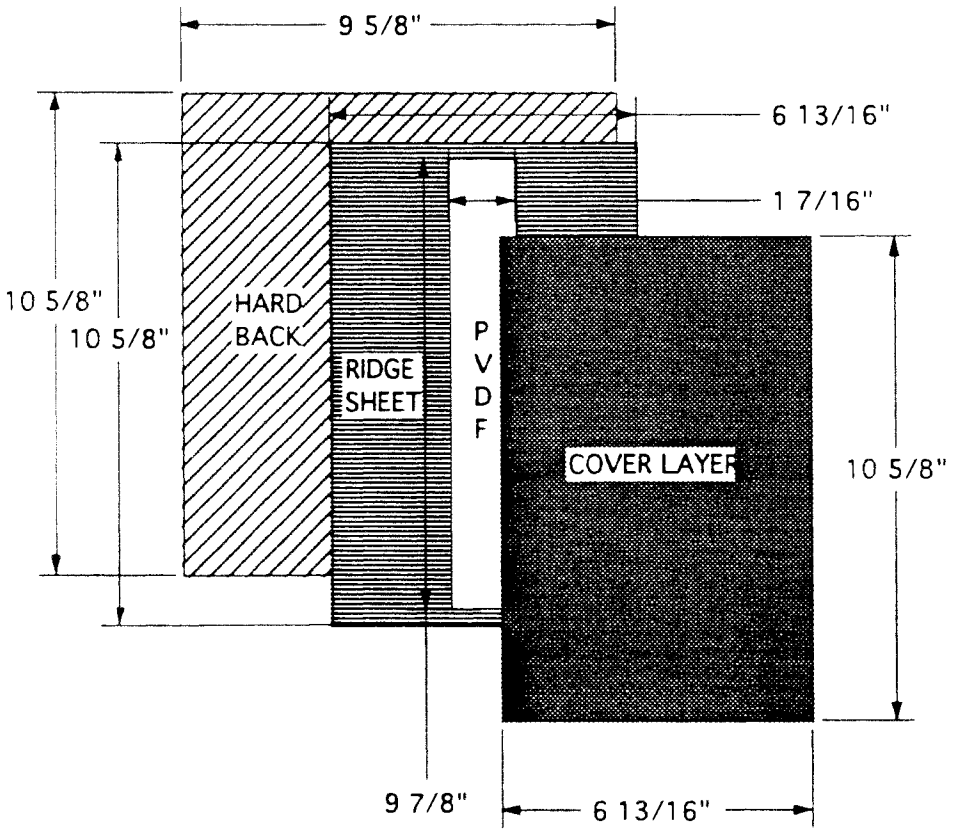


Figure 9: Hard Backed Sensor Components

Operation

When contact is made with the protective cover layer, the compliant cover is compressed against the ridges, which also deform, resulting in localized tension on the bottom surface of the cover layer. The compliant cover indents over the contact area on top of the ridges and bows down into the free span between them, both actions serving to stretch the bottom surface of the compliant cover layer in the direction perpendicular to the direction of the ridges. The piezo film, bonded to the bottom surface of the cover and clamped between the cover and the ridges, is positively stressed (tension) in the 1 direction, and negatively stressed (compression) in the 3 direction. As g_{33} is negative and g_{31} is positive, both conditions result in charge being generated on the electroded film surfaces, the 1 direction tension being the dominant charge generator, with a polarity opposite that of the poling voltage and proportional to stress and area of film under stress.

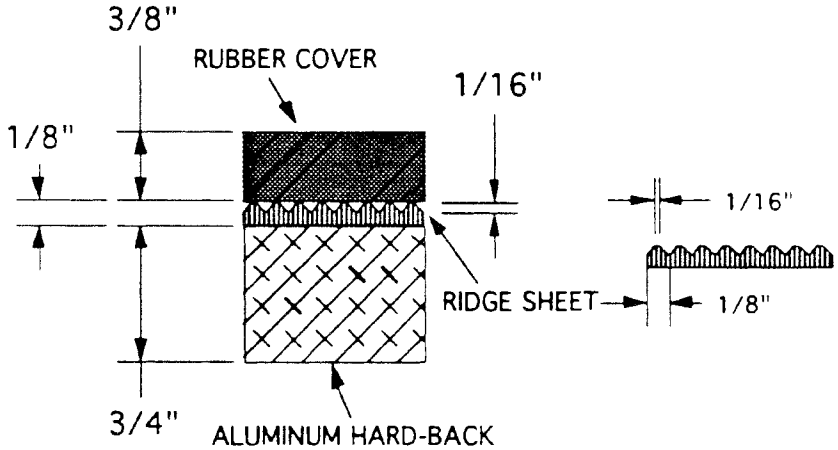


Figure 10: Cross section of Hard Backed Sensor

J-Seal Contact Sensor

The sensor was fabricated from a length of scrap J-seal. As this is the material actually used at present on the gates and is subject to routine periodic replacement, methods for gate installation are well established. The J seal served as the substrate on which various film mounting geometry's were tested. The film was sandwiched between the J -seal and a protective neoprene cover layer. Various arrangements of ridge sheets and cover layers were tested, and are shown in Figure 11.

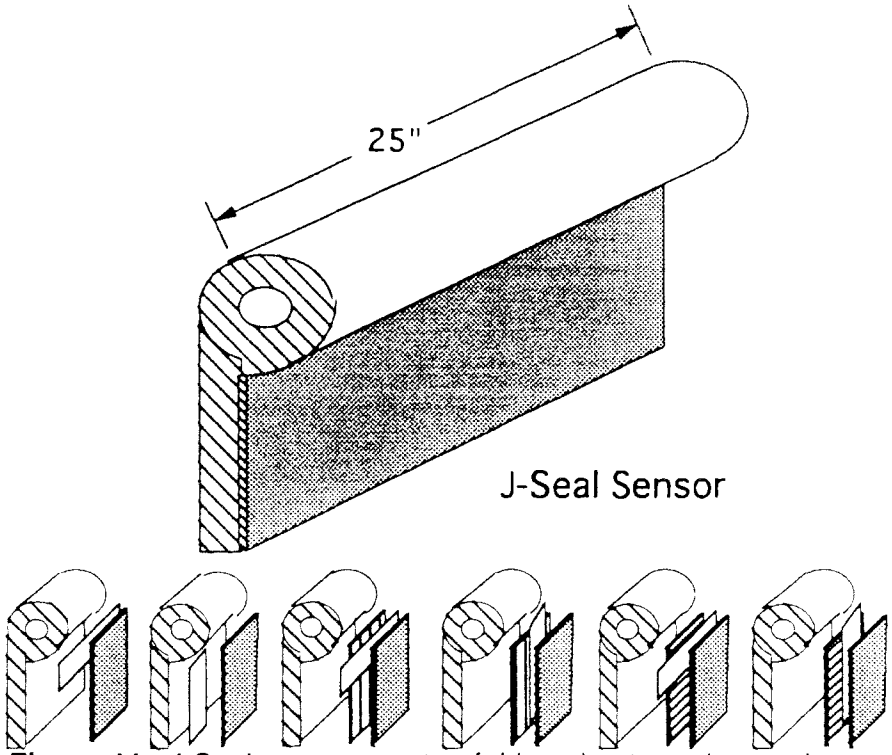
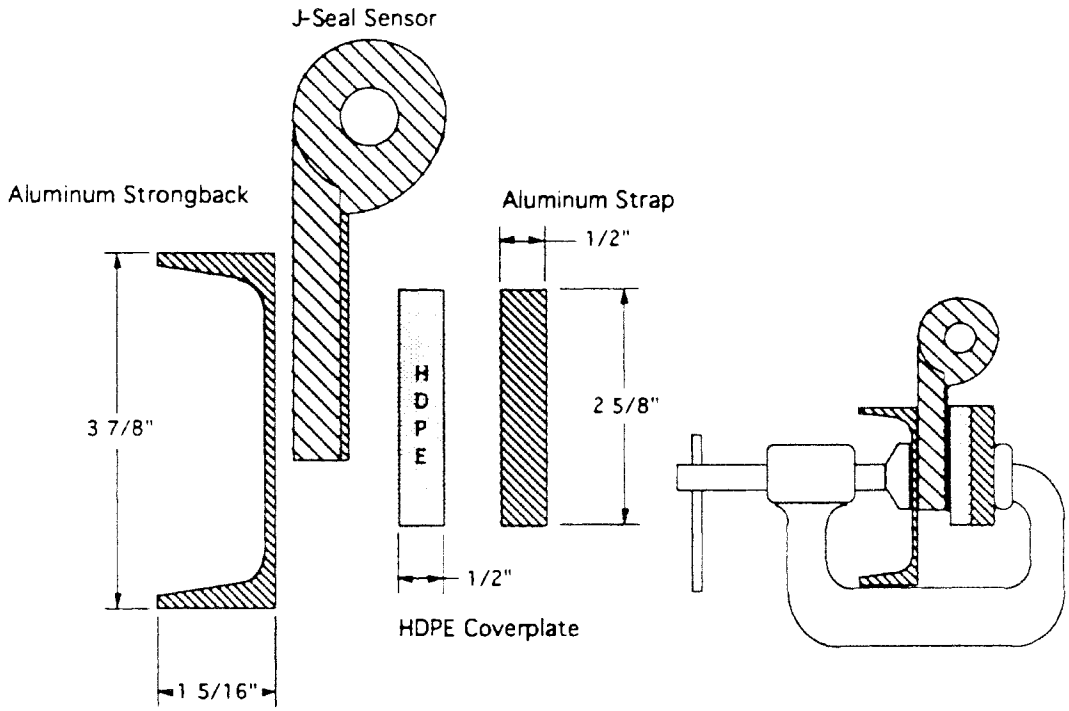


Figure 11: J-Seal arrangements of ridge sheets and cover layers

To facilitate changes in the film arrangement, adhesive bonding was not used, instead a simple clamped test set-up was employed and held together with C-clamps. This arrangement worked quite well, and allowed fairly easy modifications to the sensor. The test set-up, shown in Figure 12, consisted of a 6" extruded aluminum channel as the strong back, the J-seal sensor under test, a 1/2" thick HDPE cover plate, and a 1/2" thick aluminum strap. The stack was held together with C-clamps along the center line.



J-Seal Test Fixture

Figure 12: J-Seal test fixture setup

Operation

The design of the J-seal sensor exploits the geometry of the J-seal and it's positioning on the gate of the lock. When contact is made with the bulb of the J-seal, the contact force results in a negative bending moment at the position of the sensor proportional to the contact force and the separation distance (the bending moment increases along the length of the cantilever). This bending moment is converted by the thickness of the J-seal into a tensile stress at the piezo-film mounting point proportional to the magnitude of the bending moment, and the distance between the surface of the J-seal, where the piezo film is mounted, and the neutral axis of bending (about half the thickness). The piezo film bonded to the top surface of the J-seal, see Figure 11, is then positively stressed (tension) in the 1 direction, and to a lesser extent in the 2 direction. Both conditions result in charge being generated on the electroded film surfaces, the 1 direction tension being the dominant charge generator, with a polarity opposite that of the poling voltage and proportional to stress and area of film under stress. It is important to note that the clamping forces, being static, produce no response. This is a major advantage of the piezo-film approach as compared to conventional strain gages. Installation deformations and operational strains over time would render conventional strain gages out of range and useless, while piezo film can adjust to changes in a mater of minutes, without significant change in sensitivity.

Flat Plate Contact Sensor

The flat plate contact sensor was fabricated to simulate a section of an extrusion that would extend the length of the edge of the lock gate. The sensor was fabricated in three layers, a pedestal layer of 1/4" neoprene rubber, a flat plate of 2" rubber, and a cover layer of 3/8" neoprene. The 28 μm thick piezo film was mounted as shown in Figure 13 and Figure 14, sandwiched between the 3/8" cover layer and the 2" rubber plate. Electrical connections to the silver ink electroded film surfaces were backed with 5 mil mylar for reinforcement and riveted at the top 1/4" of the film strip. Output leads were brought out along grooves cut in the flat plate. Polyurethane electrical potting compound 3M2130 was used to bond and waterproof the cover layer to the 2" rubber plate, fully encapsulating the film, contacts, and leads.

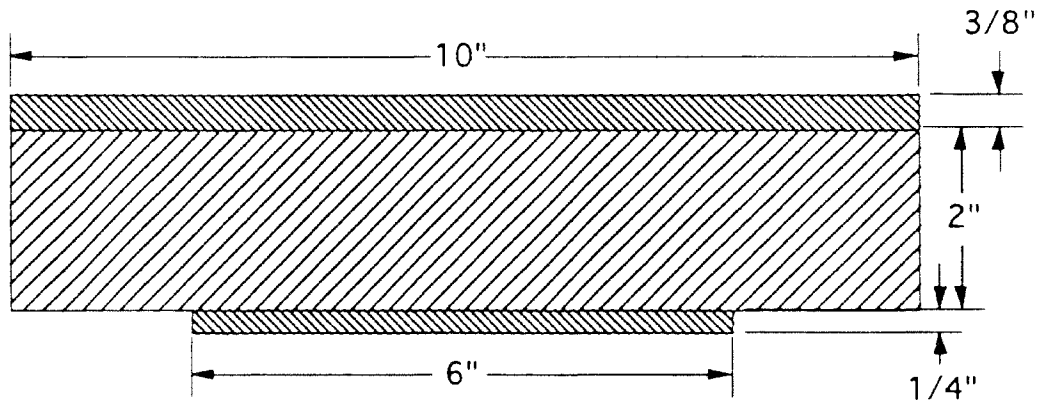


Figure 13: Top view of flat plate sensor

Operation

The flat plate contact sensor, similar to the J-seal contact sensor, utilizes mechanical amplification through the use of a cantilever. When contact is made with the plate, the contact force results in a negative bending moment at the position of the sensor proportional to the contact force and the separation distance (the bending moment increases along the length of the cantilever). This bending moment is converted by the thickness of the contact plate into a tensile stress at the piezo-film mounting point proportional to the magnitude of the bending moment, and the distance between the mounting plane of the piezo film, and the neutral axis of bending (about half the thickness of the plate). The piezo film is positioned to be positively stressed (tension) in the 1 direction, and to a lesser extent in the 2 direction. Both conditions result in charge being generated on the electroded film surfaces, the 1 direction tension being the dominant charge generator, with a polarity opposite that of the poling voltage and proportional to stress and area of film under stress.

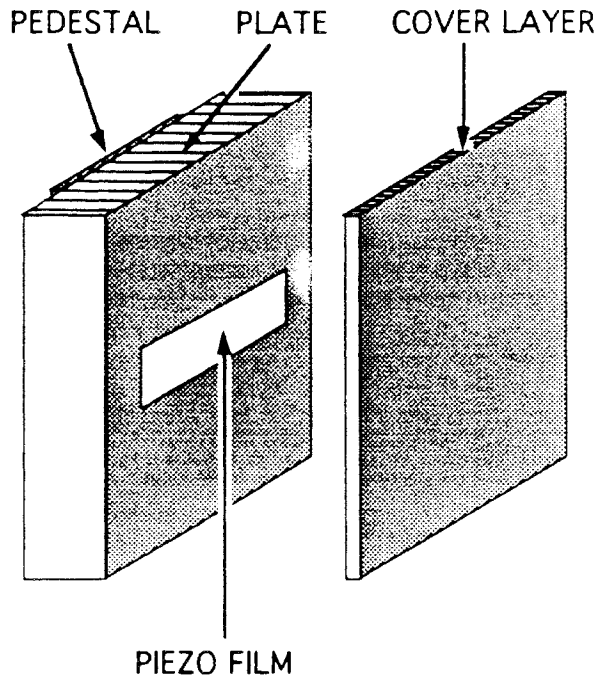


Figure 14: Flat plate sensor components

General Test Observations

Air Piston Tests

A simple air piston test set-up was used to provide mechanical stimulus to the sensors in the laboratory. The test set-up is shown in Figure 8. A foam padded plate is pushed against the sensor surface by a small air cylinder. The pressure in the air cylinder is monitored by an electronic pressure sensor. The pressure signal and sensor electrical response are measured and recorded with a digital storage oscilloscope. A valve and regulator system was used to vary the onset of load and peak load at the push plate. The system was used to provide two different mechanical loads; a high loading of 4.6 psi and a low loading of 0.8 psi, both with an onset of load of about a half second.

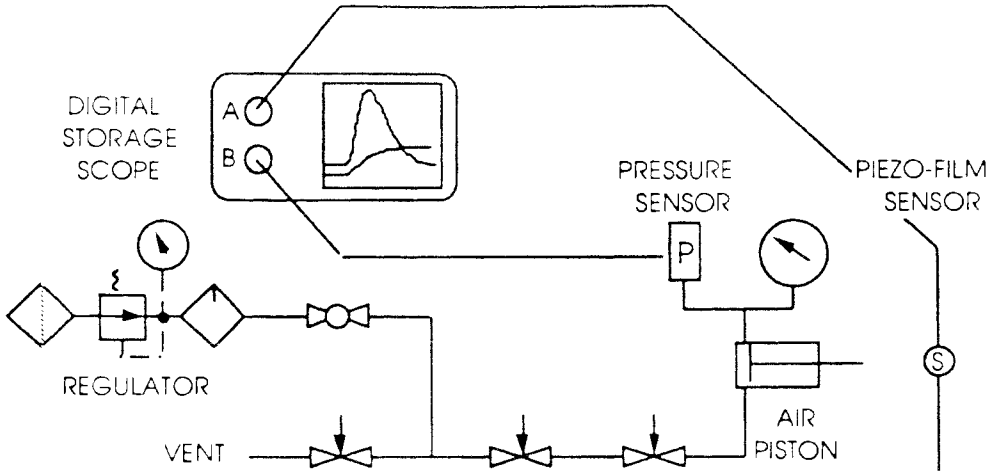


Figure 15: Air piston test set-up

Bias Force Test

The sensors were tested with and without a bias force to get an idea of the effects of installation distortions on performance. No perceivable difference was noted.

Flow Noise Test

A major initial concern to be addressed was the question of false triggering. Primary concerns addressed included impact from light debris and flow noise due the motion of the gate through the water during closing.

The signals produced by light debris are impulsive in nature, small, sharp, sudden impacts, with little energy content. By constructing the sensor of heavy sections of rubber, relatively little energy is transferred by these light impacts. The large film areas utilized to provide the required sensitivity also increase the capacitance of the sensor. This combination of mass, large film area, and capacitance result in a sensor with a long time constant that is relatively insensitive to small sharp local impacts, and yet is very sensitive to a broad shove or wiggle that a manatee would probably generate. A manatee, even an infant, would have a softer contact over a comparatively larger area, deforming a large area of film at a slower rate. This results in a broader, lower frequency signal that would be smoothed rather than filtered out. It should be noted that a large piece of debris in the same or higher mass range as a manatee would result in a trigger being generated to stop the gate. An object caught between the two gates would also result in a triggering event being generated.

When a gate is opening, large amounts of water can rush past the seals. When the gate is closing, the water is comparatively still, with the gate rotating slowly and steadily through the water. The unsupported drag area of the sensors are comparatively small, and the water velocity is low. This results in low drag forces. The sensors are designed for maximum sensitivity in the pinch direction. The drag forces are, for the most part, at right angles to the direction of pinch, reducing the sensors sensitivity to flow noise. At gate closing speeds, flow noise is not significant. Therefore, flow noise will not be a source of false triggering.

To quantify the flow noise generated by the sensor's movement in water, the flat plate contact sensor was mounted on a flat aluminum plate and moved through the water at approximately 1 m/s. The test set-up is shown in Figure 16. The sensor was moved both "edge to flow" and "face to flow".

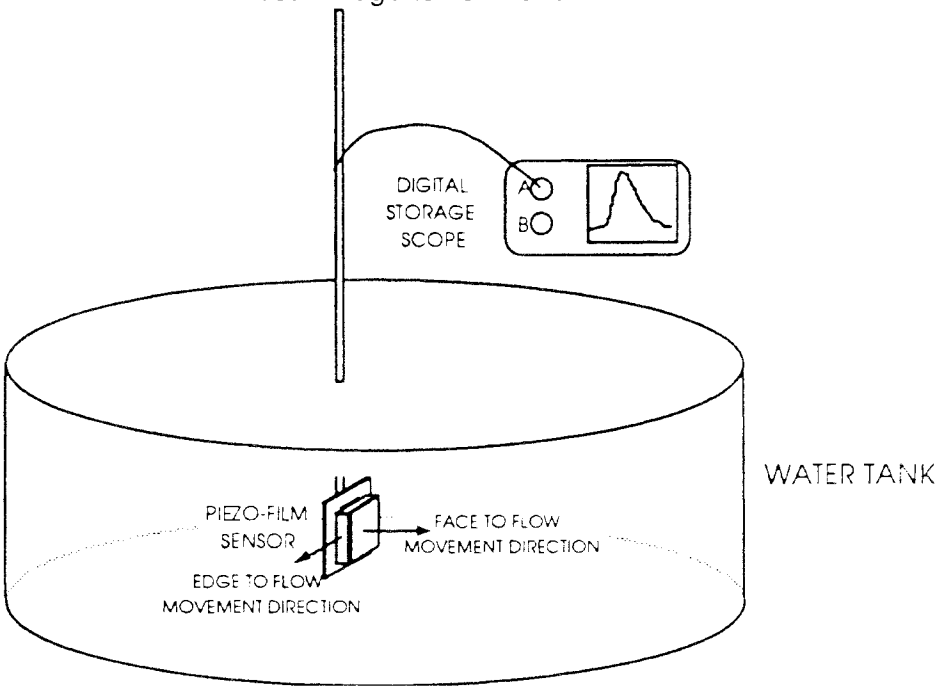


Figure 16: Flow noise and biologist impact test set-up

The flow noise signal was captured with a digital storage oscilloscope for observation. Flow noise plots are shown in Figures 17, 18, and, 19. The flow noise was somewhat lower than expected for an unshielded sensor, due in part to the rigidity of the backing plate. As the gate would provide backing in service, these levels are representative. The speed of slightly over 1 m/s was used for a worst case trial. At 1/4 m/s electrical noise was predominant. Edge to flow, (Figure 18), produced lower but similar levels of flow noise. CAD models show that the edge to flow will be encountered in service (see Figure 2). Figure 19 shows the flow noise plotted in the same scale as the signal response, 100mV/div, for ease of comparison. Testing verifies that flow noise due to the motion of the gate through the water during closing is not a significant source of noise, and is insignificant compared to the expected manatee contact signal (see Figures 19 and 20). Flow noise during closing will not be a source of false triggering.

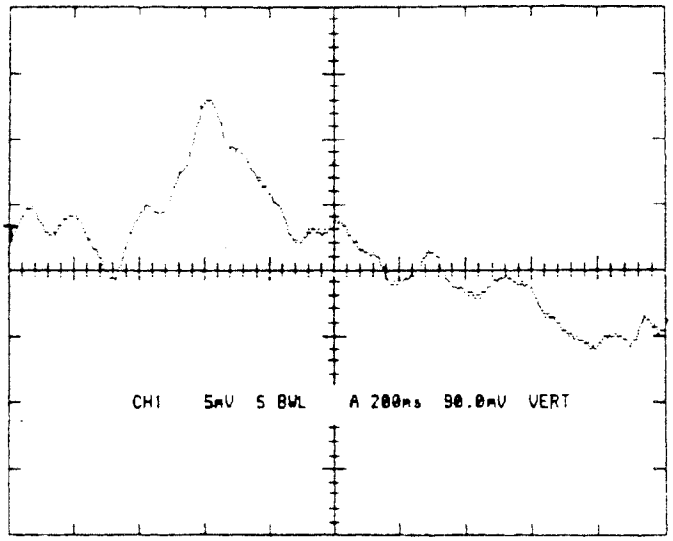


Figure 17: Amplified Flow Noise, 5mV/div, Face to Flow at >1 m/s

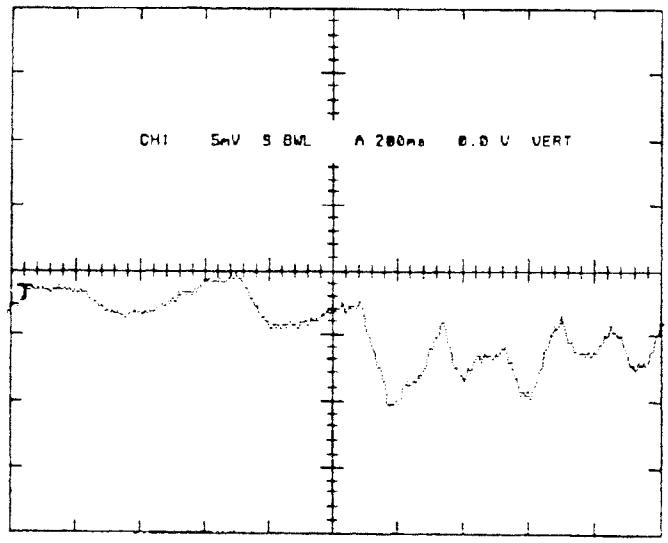
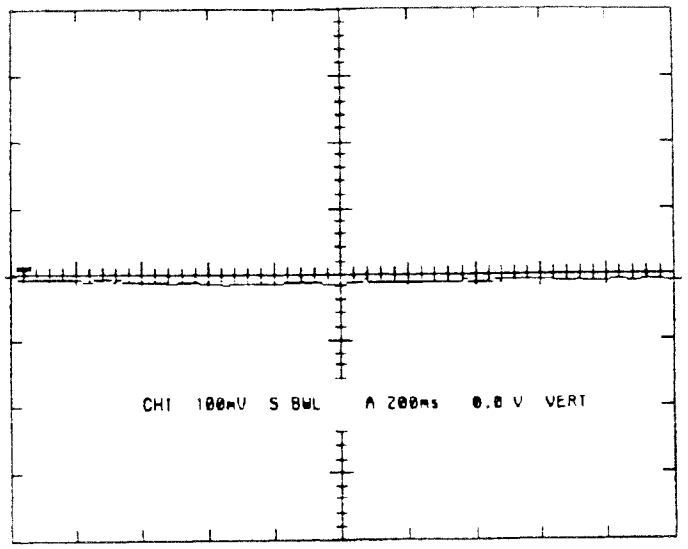


Figure 18: Amplified Flow Noise, 5mV/div, Edge to Flow at >1 m/s



Biologist Impact Flow Noise, 100mV/div, Edge to Flow at >1 m/s

Soft Body Impact In Water

To gain a qualitative feel for the response of the sensor in service, the sensor was moved through the water, face to flow, at about 1/4 m/s and run into a 185 lb. floating biologist in a fetal position to provide a soft body impact. The resulting soft body impact signal was captured with a digital storage oscilloscope for observation, and is presented in Figure 20.

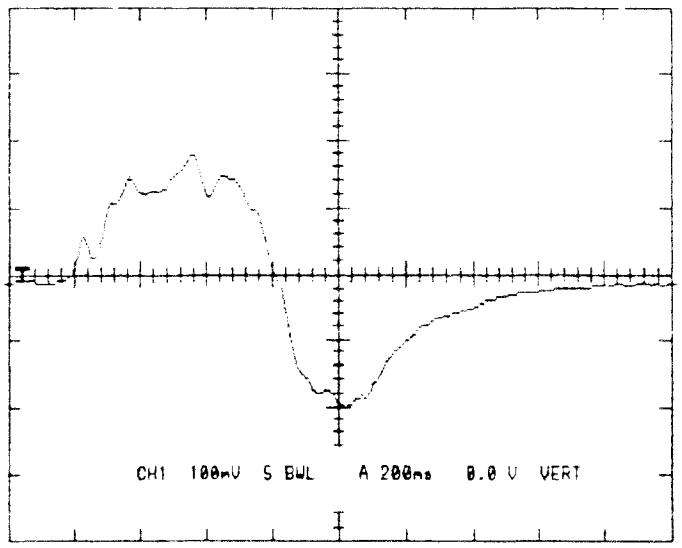


Figure 20: Trigger event signal, 100 mV/div, 200mS/div
Soft Body Impact, floating biologist, fetal position, fleshy region.

Evaluation Criteria

- **Ruggedness**

The piezo film based manatee contact sensor would be a solid monolithic block of tough, compliant rubber. It has no moving parts, no electronic components, and has a simple uncomplicated design.

Submergence

The piezo film and associated wiring on the gate will be solidly potted in a tough, flexible, elastic plastic, probably polyurethane, selected for environmental resistance. The years of experience HBOI has gained in the solid compliant encapsulation of electrical systems and devices designed for submergence in thousands of feet of seawater will be applied to the design and encapsulation of the manatee contact sensors. Testing of the water proofing method and materials selected can be carried out using the HBOI high pressure test facility.

Impact from Boats and Debris

The sensors are fabricated from heavy sections of solid, durable, rubber. The rubber and potting serve to protect the piezo film from abrasion and moisture. As the piezo film is a tough, flexible, elastic plastic, the sensors should be able to handle boat impacts and compression about as well as the existing gate seals.

Vandalism

The sensors should be fairly resistant to vandalism. Sledge hammers would have little or no effect, similarly, they should be resistant to hydrostatic shock from underwater explosives, unless the explosives are placed in close or direct contact with the surface of the sensor. Pry bars could be used to separate the sensor from the gate edge, or damage cable runs. Cutting torches or fire bombs could destroy or damage the sensor severely. Probably the greatest protection the sensors have from vandalism is that they will be unobtrusive. Fabricated from similar looking materials as the existing gate seals, and attached in a similar manner, they should attract little or no attention, and blend into the existing structure in a way that the change would not be readily apparent to the casual observer.

Lightning Strikes

The sensor itself should be fairly resistant to damage due to lightning. As the sensor contains no electronics, the isolation provided by the thick rubber, shielding, and simple circuit protection, as well as the mounting position on the steel gate, should prove effective against most disturbances short of a direct strike. Special care will be taken in the design and construction of the electronic signal conditioner to reduce lightning damage as well. The signal conditioner will be designed as a junction box module to allow replacement without disturbing the sensor or entering the water.

Sedimentation

The vertical orientation of the sensors place them, for the most part, above the sediment layer. As the sensor has no moving parts, "binding" by settling sediment is eliminated.

- **Reliability**

The simplicity of the approach, the ability of the sensors to null out stresses, the lack of any moving parts, and the innate toughness of the sensors themselves, should provide years of trouble free service. Continuous sunrise to sunset operation 365 days a year should be practical. The MTBF>1.8 M seems readily achievable.

- **Low Maintenance**

The sensor itself is simple in construction, and should be able to handle the same kind of service conditions as the existing gate seals. Little or no maintenance beyond that normally employed for the existing gate seals is expected.

Minimize Downtime

A simple, modular, functional block approach to the design is used to minimizes down time, in the rare event of system failure, to the replacement of failed modules. The exception to this would be the cable runs. Cable runs accidentally damaged or cut could be spliced, or redundant runs installed.

Ease of Repair

Parts of the system that could be damaged; the signal conditioners, relays and indicator lamps, would be designed for high reliability and ease of maintenance. Redundant indicator lamps would be designed for easy replacement, as well as socketed relays, and surge protection components.

- **Ease of Installation**

Installation of the sensor on the gate edge is anticipated to be essentially the same procedure as is currently employed for the existing J-seals. The electrical installation would consist of a junction box and cable run to the control room, a control room indicator lamp/bell, and necessary connections to the gate control switches.

- **Ease of Operation**

Presence of a manatee between the doors would trip-out the gate closure and activate the alarm, requiring no operator intervention.

6.0 Proposed Design

Based on our investigations and our experience with the design, fabrication, operation, and maintenance of high reliability underwater systems, we recommend contact sensors based on piezo film for the instrumentation of the sector gates at Lake Okeechobee. Piezo-film contact sensors offer the best mix of salient features of the candidates surveyed, the technology is well established, relatively low cost, and the components are available now.

In any system selected, installation, and in particular, maintenance, must involve minimal diver effort. Reliability and maintainability is a key concern for all components. Dry components are designed for simple modular replacement with minimal effort. Wet component reliability is crucial. Repairs requiring the scheduling and utilization of divers would be expensive and inevitably result in downtime. The part that goes in the water must be tough enough to handle the rough service environment of the locks. This is a principle advantage of the piezo film sensor based system: the contact sensor that goes in the water is a solid monolithic block of tough, compliant rubber. It has no moving parts, no electronic components, and has a simple uncomplicated design.

A defining feature of film based sensors is their ability to null out stresses. Deformations will inevitably occur. Whether the deformations occur during the installation process, or are due to other factors such as thermal expansion and contraction, collisions, or just due to the passage of the years, the ability of the sensors to naturally adapt without requiring recalibration or adjustment, is a major maintenance and reliability advantage.

A schematic of the proposed system is shown in Figure 21. Sensor construction details are provided in Figures 22 and 23. Each Sector gate would have the contact sensors in the water, mounted on the gate at the pinch point. The sensor would be of the J-Seal type, replacing the original J-Seal. The sensor would connect to a Junction Box accessibly mounted on the gate. The Junction Box would contain the sensor conditioner module used to report contacts over the cable run to the control room. The cable runs would connect each gate sensor Junction Box to a Junction Box in the control room. The control room Junction Box would contain the gate trip and alarm connections, and the hardwired connections to the present gate closure circuitry.

The presence of a manatee between the doors would trip-out the gate closure and activate the alarm, requiring no operator intervention. An override switch will allow the system to be bypassed and restore operator control in the event that it is necessary.

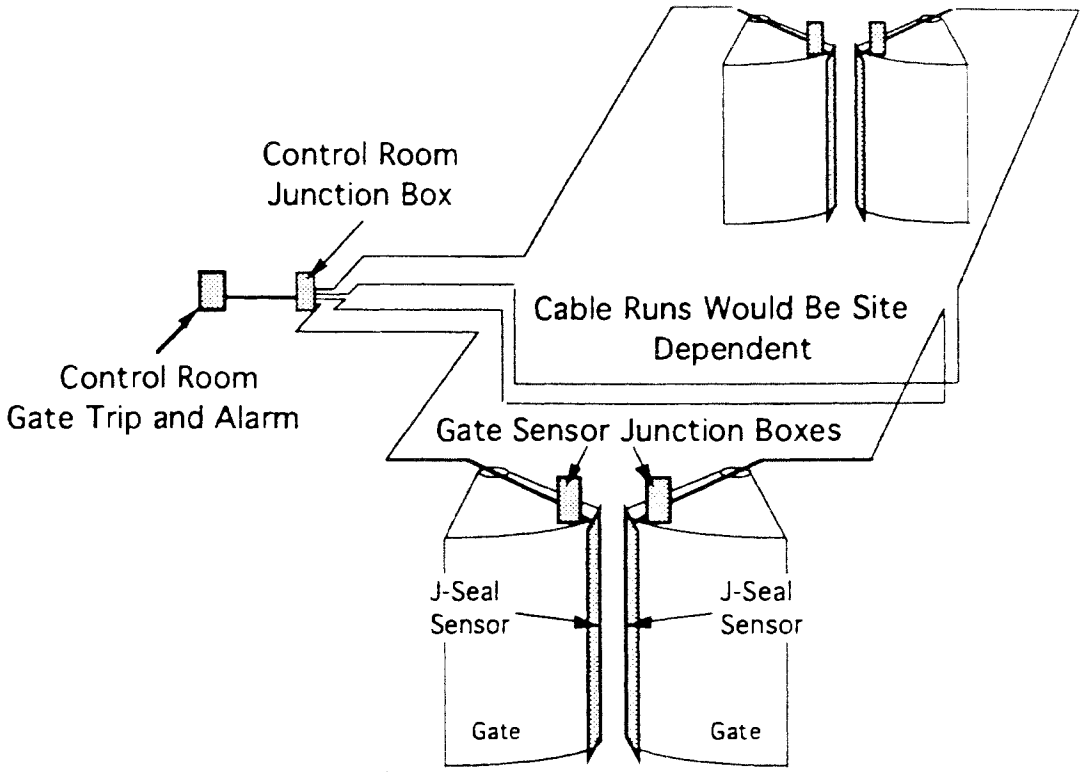


Figure 21: Outline view of the proposed manatee detection system for Lake Okeechobee sector gates.

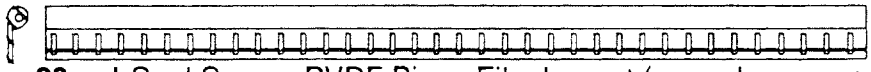


Figure 22:: J-Seal Sensor PVDF Piezo-Film Layout (cover layer removed)

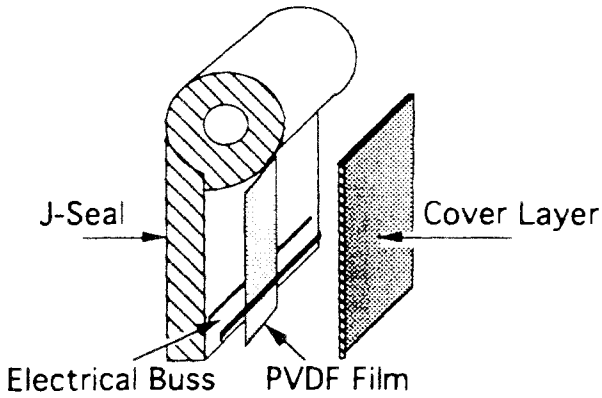


Figure 23: Section view of J-Seal Sensor

7. COST

7.1 Installation

7.1.1 First Prototype System

Due to the initial research, development and manufacturer's setup charges, the cost for the first two J-seal prototypes and control system at Sector Gate 193 is unrepresentatively high. It should not be extrapolated as a unit cost for multiple installations, primarily due to the high labor costs required in developing the initial prototype.

Materials			
Piezo-Sensors			
Manufacturer's setup charges			$2,500
Film (for 2 J-seals)			4,000
Polyurethane potting compound (for 2 J-seals)			900
Electrical sensor cable			160
Cable connectors			800
Sensor conditioner module (2)			2,745
Cable to control room (1000-ft. spool)			1,650
Cable ties, fittings, etc.			500
Control room relays, box, etc.			750
			14,005
Labor	**Rate**	**Hours**	
Sr. R&D Engineer	60	100	6,000
Engineer	40	300	12,000
Technician	35	200	7,000
			25,000
			39,005
5% institutional overhead			1,950
			$40,955

7.1.2 **Estimate for Production Runs**

8 J-SEALS PER LOCATION

Materials	
Piezo-Film	
Manufacturer's setup charges	N/A
Film (for 8 J-seals)	$ 5,000
Polyurethane potting compound (for 8 J-seals)	1,200
Electrical sensor cable	220
Cable connectors	1,600
Sensor conditioner module (8)	2,920
Cable to control room (1000-ft. spool)	1,120
Cable ties, fittings, etc.	750
Control room relays, box, etc.	750
	13,560
Labor	
Assembly (8)	7,000
Total for 8 instrumented J-seals and control system	$20,560

7.2 **Life Cycle Costs**

There is no periodic maintenance required for the instrumented J-seals and, therefore, no recurring maintenance costs. Considerable effort has been taken to ensure a very simple, rugged and robust system. However, as with any electrical system some failures may occur. Each controller is modular to facilitate rapid remove/replace maintenance methodology. At a cost of less than $400 each, this represents a component which may be practically inventoried in an on site spares locker. If the system were to take a direct lightening strike, many or all components might be damaged. However, as discussed in the Evaluation Criteria Section, special attention was directed during the design to harden the system against this damage. The instrumented J-seal itself is impervious to impact, even from large masses (barges, etc.).

Not included in the sensor costs above are the costs for a standard J-Seal, since these are required for the operation of the Sector Gate with or without the detector system. Presumably, these are periodically replaced as routine maintenance. HBOI has obtained a quote for J-Seals from the District's current vendor of approximately $360 each in quantities of 40 (see Appendix). It is presumed that J-Seal replacements are already included in the Life Cycle Costs of operating these Sector Gates.

Appendices

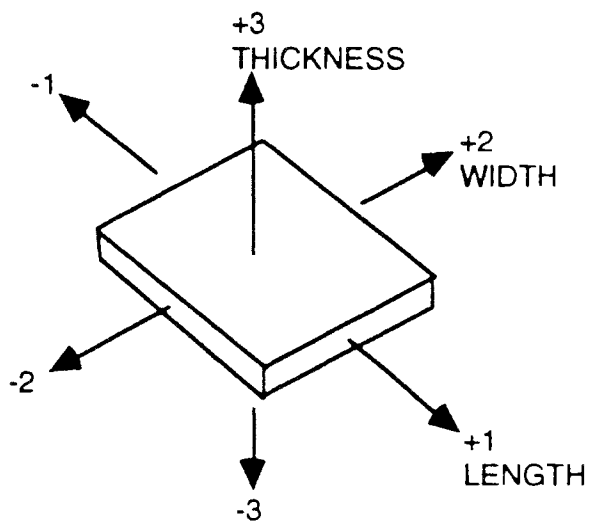
Appendix 1 Piezo-Electric Film

Description

Piezo film sensors are manufactured from polyvinylidene fluoride (PVDF) plastic. The PVDF is extruded, mechanically oriented by stretching, and polarized by exposure to an intense electric field. The resultant film, typically 1 or 2 thousandths of an inch thick, is then coated on both sides with a conductor to form the charge collecting electrodes.

Operating Principle

Piezo film converts mechanical energy to electrical response. When the film is stressed, a charge is generated on the surface of the film proportional to the applied stress. The electrical response is anisotropic, that is, the developed charge depends on both the magnitude of the stress and the direction in which the stress is applied. A two digit subscript numbering system is used to denote the piezo-electric constants in terms of the relevant film directions, or axes. These axis are shown below.



NUMBERED AXES

The piezo film is uniaxially oriented, stretched in only one direction, called the length direction, or machine axis, defined as the 1 axis. The 2 axis is transverse to the stretch direction, and is called the width direction. The 3 axis is called the thickness direction. Polarization is applied in the thickness (3) direction using the faces of the film as the poling surfaces; the electric field is parallel to the 3 axis, positive poling potential in the +3 direction. In standard two subscript notation, the first number indicates the polarization axis, 3, and the second number indicates the axis of mechanical stimulation.

Compressive stress or strain is defined as negative, and tension defined as positive. The piezoelectric stress constant, "g", varies considerably with direction. In the 3 direction g_{33} is negative and for the 1 direction g_{31} is positive. The material has the lowest stress constant in the 2 axis, width direction; typically g_{32} is only a few percent of g_{31}. Typical values are:

$$g_{31} = 216 \cdot 10^{-3}\ V/m/N/m^2$$

$$g_{33} = -339 \cdot 10^{-3}\ V/m/N/m^2$$

The low thickness of the film results in a low cross sectional area, causing relatively small longitudinal forces to create very large stresses in the material. This effect tends to predominate in most circumstances, resulting in the ratio of effective sensitivity in the 1 and 3 directions typically being 1000 to 1. The resulting open circuit voltage for the 1 direction is given by:

$$v = g_{31}\, T\, t$$

v = resulting open circuit voltage
g_{31} = piezoelectric stress constant in the 1 (machine) direction
T = applied stress
t = thickness of the piezo film

Piezo films are therefore very effective as dynamic strain sensors. They can cover large areas, require no external power source, and typically generate signals orders of magnitude greater than those from strain gages. Frequency response is thus free from limitations imposed by the need for the high gains required in conventional strain gage circuits. Piezo films respond only to time varying excitations, static excitation produces no response. Application of a constant stress will generate an initial level followed by an exponential decay of output signal.

Appendix 2 Piezo-Electric Spiral Cable

Description

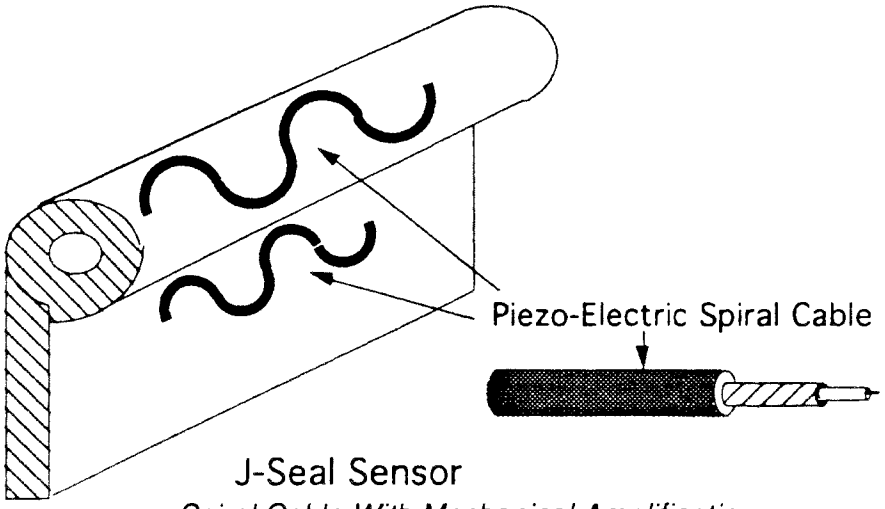
Piezo-electric sensor cable looks like standard coaxial cable, but is constructed with a piezoelectric polymer insulation layer between the copper braided inner conductor and the outer shield. The cable is protected by a polyurethane jacket.

Operating Principle

Separating the cable from the axis of bending provides mechanical amplification of strain, increasing the deformation of the cable. When the cable is deformed, it generates a charge proportional to the deformation. The generated charge is then detected and amplified by an electrometer to provide the signal output.

Sensor Demonstration

A length of piezo-cable was attached to a section of bumper material. Sinusoidal layout was used to increase the bending coverage and length of the cable. A high input impedance digital volt meter was used to monitor the sensor response. Characteristic wave forms were observed on an oscilloscope at 10 MΩ.



Spiral Cable With Mechanical Amplification

Evaluation Criteria

At present the signal levels obtained from the present available piezo-cables are marginal for detection purposes using the heavy sections of rubber used in the gate seal. A piezo-cable sensor would be ideal in an application involving greater compressive deformations at a faster rate. Development is continuing on these sensors.

- **Ruggedness / Reliability.** One of the great advantages of piezo-cable is its ruggedness and simplicity. The cables tough polyurethane jacket has good adherence to polyurethane and other rubber potting compounds, and

excellent water resistance. Impact from boats or barges would have no effect other than to generate a large signal. Lightning strikes are a particular hazard to the sensitive pre-amplifier electronics, but the fact that the cable is coaxial shielded cable would reduce signal pickup. Sedimentation, and biofouling are not expected to have any effect on sensor performance. The ability of piezo cable to self adjust to installation or other deformations and still maintain full sensitivity, as is the case with piezo-film, is a great advantage.

- **Ease of Installation / Maintenance / Operation.** Modular design, incorporating simple bolt-on assemblies, would be used to limit down time and minimize diver effort in the installation and replacement of sensors. The cables advantages of low cost, very good uniformity, and ability to be produced in long lengths, simplify both manufacture and maintenance. Operation would be automatic, the system would be hardwired into the existing gate closure circuitry. Presence of a manatee between the doors would trip-out the gate closure and activated the alarm, requiring no operator intervention.
- **Cost.** Much development work needs to be done, but the potential cost savings are worth considering. Although piezo cable will never achieve the sensitivity or directional selectivity of piezo film, development of piezo-cable sensors promise low cost, extreme simplicity, long life, and superb environmental durability.

Appendix 3 Fiber Optic Strain/Deformation Sensor

Description

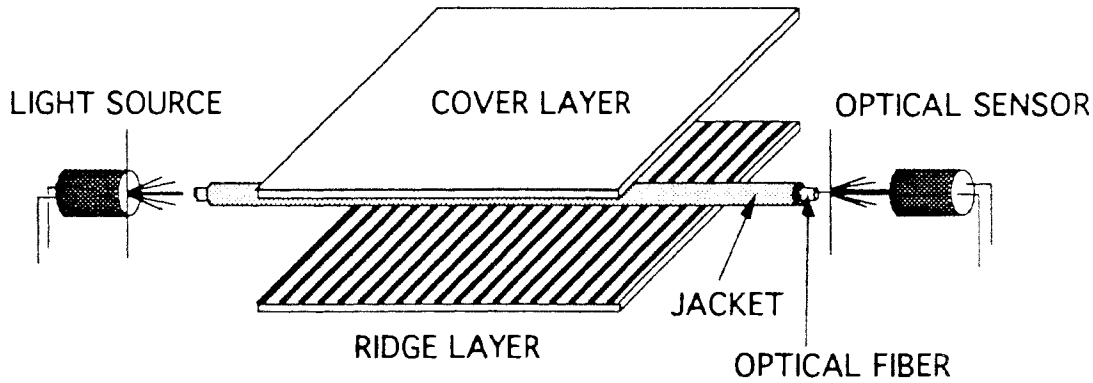
A unique multi-mode optical fiber made out of compliant optical rubber jacketed in polyurethane was selected for strain recovery characteristics. The compliant nature of the optical fiber makes it all but unbreakable in embedded applications.

Operating Principle

When an optical fiber is locally deformed, the resulting optical discontinuity results in increased light loss from the fiber in the region of the discontinuity. Two methods for the detection of the local deformation were considered, optical time domain reflectometry (OTDR), and a change total optical loss. The OTDR approach involves mapping the optical fiber over its length for discontinuities, and then looking for changes in the map. Due to the expense of OTDR equipment, and the limitations that are imposed on fiber selection, OTDR methods were discounted for the present. The optical loss method is both simple and practical, comparing the input power to the fiber with the output power to determine the loss.

Sensor Demonstration

A length of optical fiber was sandwiched between two layers of ridged rubber sheet. A LED light source was used to inject light into one end of the fiber, and a PIN diode optical sensor used to detect the output at the other end. The input light level, the stability of the LED light source was considered sufficient for the laboratory demonstration. Observations consisted of observing changes in output level on an oscilloscope from an established baseline. The compliant fiber optic rubber used shows excellent recovery effects, however permanent changes in baseline under large loads was observed.



Fiber Optic Area Contact Sensor

Evaluation Criteria

A working manatee optical strain sensor or area contact sensor could be built, but as the optical loss is a function of deformation, and not the rate of change of deformation, it does not have self nulling characteristics. Null would have to be accomplished in the control system by variation of the light source

intensity, or establishing reference levels used as adjustable baselines, or a combination of both methods.

- **Raggedness / Reliability.** Due to the reliability of properly designed modern low power solid state electronics, not subjected to extremes of temperature, failure is expected to be the result of external factors. Submergence in fresh or salt water is not expected to pose a problem. Impact from boats or barges could damage glass optical fibers, or permanently deform plastic fibers, resulting in transducer failure. Lightning strikes pose no EMP hazard to fiber optic sensors due to the absence of a conductor. Sedimentation, and biofouling in certain locations in particular, could degrade sensor performance by introducing permanent strains that would have to be nulled out electrically. Each of the above concerns would have to be carefully addressed and verified by testing and field trials to meet the MTBF > 1.8M requirement.
- **Ease of Installation / Maintenance / Operation.** Modular design, incorporating simple bolt-on assemblies, would be used to limit down time and minimize diver effort in the installation and replacement of sensors. Care would be required in the installation not to introduce strains that could not be nulled out after installation. Maintenance would consist of periodic loss checks and replacement of the fiber optic light source. Operation would be automatic, the system would be hardwired into the existing gate closure circuitry. Presence of a manatee between the doors would trip-out the gate closure and activated the alarm, requiring no operator intervention.
- **Cost.** Costs, particularly development costs, could be high. The best fiber identified so far, and used in the demonstration sensor, is a jacketed fiber optic rubber, available in limited quantities from the national laboratories, but not at present in production. The development of the control, signal processing, discrimination, and decision making system would require significant effort, with the bulk of the work in coding.

Appendix 4 Acoustic Emitter-Receiver Array

Description

The use of sound waves is perhaps the first method that comes to mind for the non-contact detection of objects under water. The manatee, due to it's size and the air volume of it's lungs, is well suited to acoustic detection in the close proximity environment of the locks. Methods divide into passive and active schemes with attention focused on active methods employing a sound source (transducer) and a sound receiver (hydrophone). Passive methods were not considered for this application due to the perceived complexities of the signal processing and lack of hard information on manatee acoustic emissions. Active methods considered included imaging and non-imaging systems. There is no doubt that a trained operator with a modern high frequency short range imaging sonar could accurately detect, and probably characterize as well, a manatee in the lock region. Attention focused instead on autonomous, comparatively low cost, methods that do not depend on the vigilance, training, and recognition memory of a human operator. These methods include field disturbance sensors, interrupted beam sensors, and ranging sensors. Field disturbance sensors employ a broad transmission and sense a change in the acoustic environment. Due to the movement of the gates, the presence and variety of barges and of boats, field disturbance sensors are unsuited for this application. Interrupted beam sensors, similar in nature to the electric eye sensors on garage doors, would detect the presence of a manatee between an acoustic source (transducer) and a receiver (hydrophone). Ranging sensors, similar to common fish finders, would detect the presence of a manatee based on the reflection (signal return) of the manatees body.

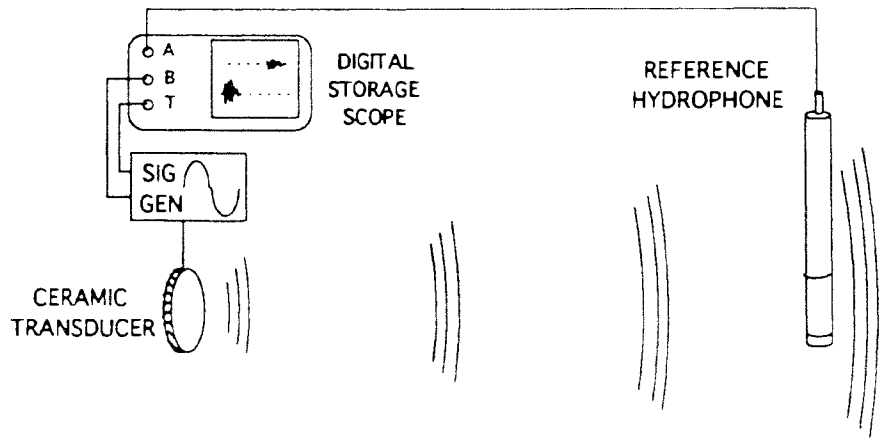
Operating Principle

Interrupted beam sensors can be continuous wave (modulated or unmodulated), or pulsed. Continuos wave sensors typically sense the presence of an obstruction by detecting a change in relative amplitude, a change in phase, or a combination of both. Problems with continuous wave sensors in the lock acoustic environment involve multipath effects resulting in signal interference. Solutions involve various modulation methods and the use of ultrasonic frequencies to increase attenuation. Pulsed interrupted beam sensors emit a short burst of sound at a fixed pulse repetition rate. This allows the receiver to be gated on only during the first reception of the pulse, reducing the effects of multipaths.

Sensor Demonstration

A simple emitter-detector pair was set up in a tank of water. The transducer was excited with continuos wave and pulsed repetition rate acoustic signals over the range 5 KHz- 500 KHz. Signals were received by a hydrophone placed 2 feet away from the transducer. The acoustic path was then interrupted by placing a hand or small block of foam in the middle between the transducer and hydrophone. The received hydrophone signal was observed with an

oscilloscope. A delayed trigger, triggered off of the signal to the transducer, simulated a gated receiver. In the water tank used, multipaths resulted in poor performance below 100KHz for the pulsed transducer, and poor performance at all tested frequencies for the continuous wave demonstration.



Acoustic Emitter-Receiver Array Sensor

Evaluation Criteria

A working manatee acoustic emitter-receiver array sensor could be built, operating in the frequency range of 500 KHz to 10 MHz. A possible geometry would employ small, high frequency transducers, acting as both emitters and receivers, mounted in a string about 6" to 12" apart, along the edge of each gate.

- **Ruggedness / Reliability.** Due to the reliability of properly designed modern low power solid state electronics, not subjected to extremes of temperature, failure is expected to be the result of external factors. Submergence in fresh or salt water is not expected to pose a problem as long as the encapsulant remains intact. Impact from boats or barges could damage the transducers mechanically, by crushing, cracking, debonding electrical connections, or damaging the encapsulant, resulting in transducer failure. Lightning strikes are a particular hazard to the sensitive pre-amplifier electronics. Sedimentation, and biofouling in certain locations in particular, could degrade sensor performance. Each of the above concerns would have to be carefully addressed and verified by testing and field trials to meet the MTBF > 1.8M requirement.
- **Ease of Installation / Maintenance / Operation.** Modular design, incorporating simple bolt-on assemblies, would be used to limit down time and minimize diver effort in the installation and replacement of sensors. The shop repair of failed encapsulated components would be labor intensive due to the difficulties involved in digging assemblies out of the potting compound. Operation would be automatic, the system would be hardwired into the existing gate closure circuitry. Presence of a manatee between the doors would trip-out the gate closure and activated the alarm, requiring no operator intervention.

- **Cost.** Costs, particularly development costs, could be high. For best performance, a separate driver/receiver pre-amp package, in close proximity, would be required for each transducer. The development of the control, signal processing, discrimination, and decision making system would require significant effort, with the bulk of the work in coding.

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HARBOR BRANCH

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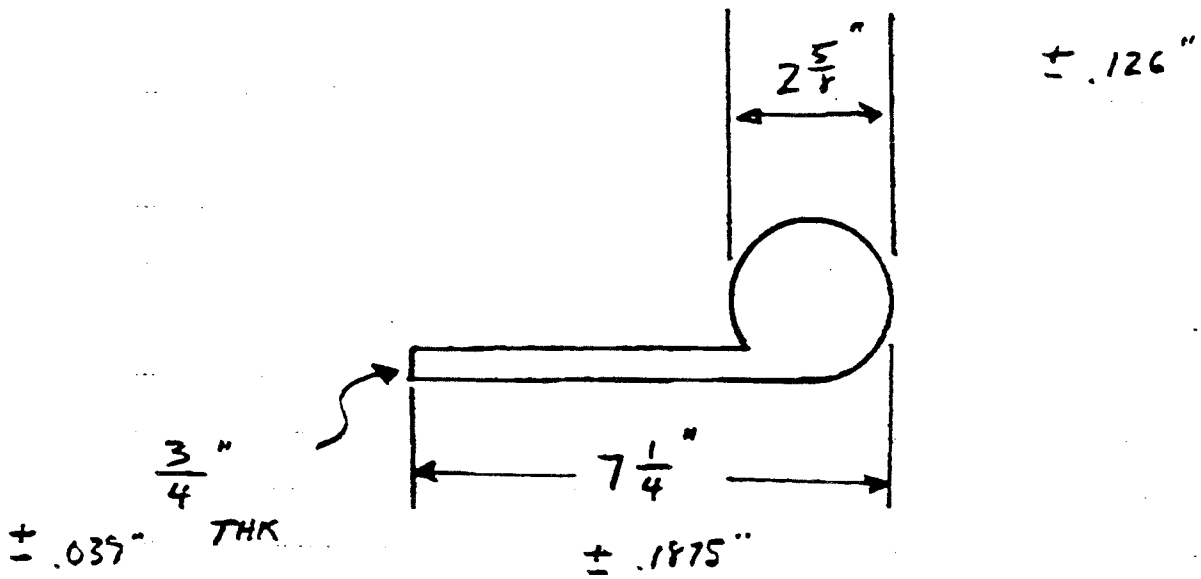

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BY: C. Cot

APPENDIX J

STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

2740 CENTERVIEW DRIVE • TALLAHASSEE, FLORIDA 32399-2100

LAWTON CHILES
Governor

LINDA LOOMIS SHELLEY
Secretary

July 28, 1995

Mr. A. J. Salem
Department of the Army
Corps of Engineers
Jacksonville District
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: Endangered Species Protection - Manatee Protection Plan (Part 1) - Draft Project Modification Report and Environmental Assessment - Florida
SAI: FL9505080422C

Dear Mr. Salem:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Governor's Executive Order 93-194, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.

The Department of Environmental Protection (DEP) recommends that the final report include a detailed plan for testing the manatee protection devices and an analysis of the potential impacts to manatees from the entire flood control structure operating system. The DEP also suggests a flexible time table for construction. Please refer to the enclosed DEP comments for further details.

The South Florida Water Management District (SFWMD) recommends that permanent barriers and pressure sensing devices (PSDs) be further evaluated as alternatives for manatee protection. The PSDs should be subjected to additional field testing prior to large-scale installation. In addition, the SFWMD recommends an implementation schedule that includes work during the wet season. Please refer to the enclosed SFWMD comments for further details.

Based on the information contained in the above-referenced document and the enclosed comments provided by our reviewing agencies, the state has determined that the above-referenced project is consistent with the Florida Coastal Management Program. Please be advised that any additional comments which may be provided by our reviewing agencies will be forwarded to you as soon as they are received.

Very truly yours,

for Linda Loomis Shelley
Secretary

LLS/rk

Enclosures

cc: Susan Goggin, Department of Environmental Protection
Frank Lund, South Florida Water Management District
George Percy, Department of State
Wynnelle Wilson, Department of Commerce

Department of
Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

14 June 1995

RECEIVED
JUN 16 1995
Florida Coastal
Management Program

Suzanne Traub-Metlay
State Clearinghouse
Office of Planning & Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399-0001

RE: USCOE/Manatee Protection Plan (Part 1), Draft Modification Report and Environmental Assessment
SAI: FL9505080422C

Dear Ms. Traub-Metlay.

The Department has reviewed the proposed Manatee Protection Plan (Part 1) as proposed by the U.S. Army Corps of Engineers (Corps), and we find it consistent with our authorities in the Florida Coastal Management Program. Staff of the Department's Office of Protected Species Management (OPSM) have been actively involved in this project for a number of years. Kipp Frohlich serves as the DEP representative on an interagency task force created to solve the problem of structure-caused manatee mortality. He indicates that the subject draft report is a very thorough presentation of information on the water control structures in South Florida as well as a compilation of manatee related data. While overall the project as outlined in the subject document is a sound approach to reaching the goal of zero structure-caused mortality, OPSM staff offer the following comments and recommendations on the draft Plan:

1. We believe that pressure sensitive devices that will reverse the direction of a closing gate hold the most promise in our efforts to eliminate structure-caused manatee mortality. However, they are not a proven solution. As is mentioned in the report, there have been manatees killed at some structures equipped with these devices. The report needs to go into greater detail assessing why the pressure sensitive devices have failed in the past and should provide recommendations on what steps should be taken to correct problems with the system. Past experience has shown problems with the plungers, but also in other components of the system. The report needs to carefully examine the entire flood control structure operating system including the telemetry system, the control switches and logic switches in the control house, control room protocols, as well as

any overrides. In addition, the report should evaluate how power outages or loss of communication in the telemetry system could possibly affect performance.

2. Because this technology is experimental, it needs to be rigorously tested. The most significant shortcoming in the 1135 proposal is that it inadequately addresses testing of the manatee protection devices. The report should outline in detail the types of tests that will be performed to document that the pressure sensitive devices are working satisfactorily. Testing should be done in actual field conditions with the gate fully operational. A mechanical test procedure should be developed; that is, a procedure where the plungers are physically depressed in a normal operating mode. This needs to be a procedure that is repeatable and that can be done by field staff. The report should describe in detail how these tests will be performed and should recommend a suitable test schedule. The draft test procedures as contained in Appendix C are a start but are inadequate.

3. We do not agree that construction should be limited to November 1 through May 31 for water control structures and between May and September for navigation structures. We believe that a flexible implementation schedule should be developed that would allow gates or locks to be worked on any time during the year, as weather and water level conditions permit.

We appreciate the opportunity to provide comments on the Draft Modification Report and Environmental Assessment of the Manatee Protection Plan. Questions regarding these comments should be directed to Kipp Frohlich, OPSM, at (904)922-4330. If I may be of further assistance, please call me at 487-2231.

Sincerely,

Susan Goggin

Susan Goggin
Environmental Specialist, MS 47
Office of Intergovernmental Programs

KF/seg
cc: Kipp Frohlich, OPSM
Linda McCarthy, SFWMD
Fritz Wettstein, Marine Resources
Herb Zebuth, DEP Southeast District

South Florida Water Management District

3301 Gun Club Road, West Palm Beach, Florida 33406 • (407) 686-8800 • FLWATS 1-800-432-2045

GOV 04

July 24, 1995

Ms Suzanne Traub-Metlay
State Clearinghouse
Office of Planning and Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399 -0001

Dear Ms. Traub-Metlay:

Subject: **USCOE Manatee Protection Plan (Part I), Draft Modification Report and Environmental Assessment**

SAI# 9505080422C

The South Florida Water Management District has reviewed the proposed Manatee Protection Plan (Part I) drafted by the U.S. Army Corps of Engineers. This plan represents a proposed joint effort with our District to eliminate manatee mortality associated with structural components of the Central and South Florida Flood Control Project. In May 1993 our Governing Board granted conceptual approval to participate as the local sponsor in this project, and the Corps has coordinated the development of this draft plan with our staff.

We have provided the following comments to the Corps regarding the draft plan:

1. We note that the US Fish and Wildlife Service Coordination Report requests that consideration be given to permanent barriers where access to essential habitat would not be denied. Our past efforts have been directed at alternatives which would permit access through all structures. This has been due to the nonsuccess of our previous barrier designs and the belief that open access was preferred for biological reasons. In view of the recommendation from USFWS, and the Corps apparent success with barriers at Ortona, we would also request that barriers be evaluated as a project alternative for sites determined to be nonessential for manatee access. We would suggest that potential barrier sites be identified by the Manatee Interagency Task Force for further evaluation in the Protection Plan. The Plan should include an assessment of the relative merits of permanent barriers, consider specific site feasibility, determine the degree of manatee protection, and estimate total cost. The barrier alternative may then be compared to the proposed pressure sensing device (PSD) alternative to determine the best option at each of these structures.

Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680

2. We concur that pressure sensitive devices (PSDs) appear the most promising alternative for spillway gates which must be protected. However, as noted in the USCOE Plan and the USFWS Coordination Report, the current generation of PSDs should not be installed without additional testing and refinement. Field testing has improved the reliability and effectiveness of these systems, but we remain concerned that their relative complexity may still require significant maintenance efforts. The proposed sensi-switch alternative has yet to be subjected to any field testing. The further evaluation of alternatives, such as the sensi switch, under prolonged field conditions is essential before we commit to an installation program on 20 or more structures. Ideally, the Part I Plan could identify the optimum solution and a detailed implementation timeline, however we agree that the current situation regarding reliability of any PSD alternative necessitates a more phased approach. We would suggest that the plan be further clarified to note that no alternative will be selected for large-scale implementation without at least six months of field testing on a representative structure.

The Implementation Schedule proposed in this draft plan is somewhat vague with respect to timelines and specific installation sequencing. We strongly concur that installations should be given priority based upon relative threat to manatees. However, the relationship of this criteria to the three geographic contracts proposed, and the need for additional testing time, makes the actual project timeline unclear to us. We suggest that after candidates for structural barriers are identified, a more detailed work plan be developed for all structures. We appreciate that the draft document recognizes the necessity of insuring that this program does not disrupt critical maintenance obligations. We also believe that we can coordinate these two efforts at certain structures to both expedite manatee protection and minimize costs.

We suggest that the Part I Report define the general timelines for testing as well as structure priorities and timelines. Detailed scheduling could be reserved for the USCOE Project Cost Agreement implementation process and the results of further alternative testing. The Part I Report could be revised to reflect this sequence.

With respect to actual implementation scheduling, we would urge that wet season work on multi-gate coastal structures be allowed. We have previously worked on our manatee systems during the summer months and have temporarily removed individual gates from active service exercising care to not compromise immediate flood control capabilities. If specific wet season conditions did permit PSD (or barrier) installation, this option might allow protection of Dade structures prior to arrival of a wintering manatee population. Limited wet season work might also avoid a possible 12-month delay in protecting some structures. PSD installation on single gate structures might be reserved for the dry season.

3. We examined the estimated costs for the PSD alternatives included in the draft plan. The estimated costs for the Reed switch system appears a reasonable projection based upon our experience with the system. In reviewing the estimated cost for the Sensi-switch system, we are uncertain if this estimate represents two strips, or only a single strip, on each gate. Based upon our experiences at S-27 and S-29, we strongly recommend the installation of two banks of switches on each gate. Our experience has shown that redundancy is essential in these systems for long-term reliability. We ask that the plan be clarified regarding this issue, and estimated costs adjusted if necessary.

   In addition to the installation costs, life cycle costs of the selected alternative should include appropriate maintenance costs. As the local sponsor, we are obligated for these costs. The draft Plan largely focuses upon installation costs to be paid by the USCOE. We request that additional language be inserted in the draft Plan to make it clear that the selected alternative will be chosen based upon expected total life cycle costs, not solely installation expense.

   We recognize that these are only preliminary cost estimates and acknowledge that the figures will be further adjusted as the selected alternative systems are tested and refined. However, the estimated project costs included in this plan fall well below the cost ceiling established by our Governing Board in May 1993 when they gave conceptual approval to act as the local sponsor for this project. Based upon our previous Governing Board action and the information contained in the draft plan, we will proceed with providing a Letter of Intent to the USCOE to participate in this project.

If you have any questions regarding the information provided or if I can be of any additional assistance, please call me at (407) 687-6631.

Sincerely,

Frank Lund

Frank Lund
Manatee Program Coordinator
Lower West Coast/Special Projects Division
Planning Department

FL/mh

bc: Mike Slayton, EXO
Dan Cary, PLD
Joe Schweigart, OMD

FLORIDA DEPARTMENT OF STATE
Sandra B. Mortham
Secretary of State
DIVISION OF HISTORICAL RESOURCES
R.A. Gray Building
500 South Bronough Street
Tallahassee, Florida 32399-0250

Director's Office (904 488-1480
Telecopier Number (FAX) (904) 488-3353

June 6, 1995

Ms. Suzanne Traub-Metlay
State Clearinghouse
Executive Office of the Governor
Room 1603, The Capitol
Tallahassee, Florida 32399-0001

In Reply Refer To:
Robin D. Jackson
Historic Sites
Specialist
(904) 487-2333
Project File No. 951770

RE: Cultural Resource Assessment Request
SAI# FL9505080422C
Manatee Protection Plan (Part 1) at Selected Navigation and Water Control Structures in Central and Southern Florida
Draft Project Modification Report and Environmental Assessment

Dear Ms. Traub-Metlay:

In accordance with the provisions of Florida's Coastal Zone Management Act and Chapter 267, Florida Statutes, as well as the procedures contained in 36 C.F.R., Part 800 ("Protection of Historic Properties"), we have reviewed the referenced project(s) for possible impact to historic properties listed, or eligible for listing, in the National Register of Historic Places, or otherwise of historical or architectural value.

A review of the Florida Site File indicates that no significant archaeological or historical sites are recorded for or likely to be present within the project area. Furthermore, because of the project location and/or nature it is unlikely that any such sites will be affected. Therefore, it is the opinion of this office that the proposed project will have no effect on historic properties listed, or eligible for listing, in the National Register of Historic Places, or otherwise of historical or architectural value. The project is also consistent with the historic preservation laws of Florida's Coastal Management Program.

If you have any questions concerning our comments, please do not hesitate to contact us. Your interest in protecting Florida's historic properties is appreciated.

Sincerely,

Laura A. Kammerer

for George W. Percy, Director
Division of Historical Resources
and
State Historic Preservation Officer

GWP/Jrj
xc: Jasmin Raffington, FCMP-DCA

CLEARANCE DUE DATE: 7/7/95

SAI#: FL9505080422

5/24/95

STATE AGENCIES	LOCAL/OTHER	OPB POLICY UNITS
Agriculture	Northwest Florida Water Manag. District	Education
✓ Commerce	✓ South Florida Water Manag. District	Environmental Policy/C & ED
Commission for Transport. Disadv.	✓ Southwest Florida Water Manag. District	General Government
✓ Community Affairs	✓ St. Johns River Water Manag. District	Health & Human Services
Corrections	Suwannee River Water Manag. District	Public Safety
Education		
Elder Affairs		
✓ Environmental Protection		
✓ Game and Fresh Water Fish Comm		
Health and Rehabilitative Services		
Highway Safety and Motor Vehicles		
Insurance		
Juvenile Justice		
Labor and Employment Security		
Law Enforcement		
✓ Marine Fisheries Commission		
✓ State		
✓ Transportation		

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

___ Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.

✓ Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.

___ Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.

___ Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

RECEIVED
MAY 31 1995
Florida Coastal Management Program

FOR CONSISTENCY PROJECTS, SEE REVERSE SIDE FOR INSTRUCTIONS.

To: State Clearinghouse
Executive Office of the Governor -OPB
Room 1603, The Capitol
Tallahassee, FL 32399-0001
(904) 488-8114 (SC 278-8114)

Florida Coastal Management Program
Department of Community Affairs
Suite 305, Rhyne Building
2740 Centerview Drive
Tallahassee, FL 32399-2100
(904) 922-5438 (SC 292-5438)

EO. 12372/NEPA
- ☐ No Comment
- ☐ Comments Attached
- ☐ Not Applicable

Federal Consistency
- ☐ No Comment/Consistent
- ☒ Consistent/Comments Attached
- ☐ Inconsistent/Comments Attached
- ☐ Not Applicable

From:
Division/Bureau: Florida Department of Commerce, Division of Economic Development, Bureau of Economic Analysis

Reviewer: R Peterson

Date: May 26, 1995

STATE OF FLORIDA DEPARTMENT OF COMMERCE

Division of Economic Development

May 26, 1995

Ms. Janice L. Hatter, Director
State Clearinghouse
Office of Planning and Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399-0001

RE: SAI# FL 95 05 08 0422C (Manatee/P.M.R/E.A./C.O.E.)

Dear Ms. Hatter:

Thank you for asking the Florida Department of Commerce to conduct a consistency review of this Draft Project Modification Report (PMR) and Environmental Assessment (EA) on the Manatee Protection Plan from the U.S. Army Corps of Engineers (COE). The modification involves spending $2,409,000 on mechanical gates for locks and spillways which are designend to protect Manatee.

Based on those portions of the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.) and the Florida Coastal Management Program (Secs. 380.19-33, F.S.) for which the Department of Commerce has responsibility, we believe that the proposed plans and actions are **consistent** with criteria in Chapter 288, Florida Statutes: (1) no negative impacts on income and employment; (2) social costs are less than social benefits; (3) no adverse effects on any key Florida industry; and (4) official local agency support for the project.

Very respectfully,

Wynnelle Wilson
Economic Development Policy Coordinator
Bureau of Economic Analysis

WW/rdp

South Florida Water Management District

3301 Gun Club Road, West Palm Beach, Florida 33406 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 38-20

August 8, 1995

Mr. A. J. Salem, Chief
Planning Division
U. S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem: Eddie

Subject: Draft Manatee Protection Plan (Part 1) - Section 1135 Project Modification - Letter of Intent

We reviewed the draft Manatee Protection Plan (Part I) and previously provided our staff comments for your consideration in completing the final report. We remain committed to continuing our joint efforts to eliminate all manatee mortality at Central and Southern Florida Flood Control Project structures; and view this document as a significant milestone in that effort.

In May 1993 our Governing Board gave conceptual approval to act as local sponsor in a joint 1135 effort. Their approval was conditioned upon total project costs not exceeding $5,000,000 and the District cost-share not exceeding 25%. The draft document details that the proposed project remains within those guidelines. We recognize that further adjustment of the project costs will occur with refinement of the selected alternative; however, it is appropriate to express our continued project support at this time.

By this letter we wish to notify you of our intent to enter into an agreement to participate in, and share the costs of, implementation of structural modifications as described in the draft Manatee Protection Plan (Part I). Our ultimate commitment to participate will, of course, require the approval of a Project Cost Agreement (PCA) by our Governing Board.

This project represents a multi-year effort of testing, refinement, and operational application of new technology to address the problem of structure-related manatee mortality. Program implementation without disruption of other critical C&SF project responsibilities will require innovative scheduling, phasing, and funding. We look forward to assisting you in developing a more detailed work plan to address these challenges in the near future.

Mr. Frank Lund, our Manatee Project Coordinator, will remain our point of contact relative to this project. I appreciate the efforts of your staff in coordinating with us in the development of the Manatee Protection Plan and look forward to successful program implementation.

Sincerely,

Samuel E. Poole III
Executive Director

SEP/js

c: F. Lund

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

July 6, 1995

ER-95/362

Mr. A. J. Salem
Chief, Planning Division
Environmental Studies Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

The U. S. Department of the Interior has reviewed the Draft Project Modification Report and Environmental Assessment, Manatee Protection Plan (Part 1) At Selected Navigation and Water Control Structures in Central and Southern Florida as requested.

Water control structures are a significant cause of human related manatee deaths, second only to those caused by watercraft. As noted in the subject document there have been 16 manatee deaths attributed to water control structures in 1994, making that year the worst since record keeping began in 1974. The 1994 mortality attributed to water control structures is a 220% increase over the previous year. We encourage the efforts of the U.S. Army Corps of Engineers (Corps) to review alternative ways to reduce the number of deaths associated with these structures through the Section 1135(b) process of the Water Resources Development Act of 1986.

We support the Corps' efforts to reduce manatee mortality associated with water control structures. The design, construction, and deployment of the selected devices together with the implementation of proposed operational protocols should significantly reduce manatee deaths. This is consistent with the recovery goal for the endangered Florida manatee in the Fish and Wildlife Service's Florida Manatee Recovery Plan.

We offer the following comments and recommendations for your consideration:

The number of structures identified in this report (20) represents a decrease in the number of structures identified in your initial letter (23). In the Fish and Wildlife Service Coordination Act Report dated January 24, 1995, it was recommended that the Henry

Creek Lock, a structure identified as a source of mortality, be included in the list. This would bring the list of structures to be studied to 24.

We recommend that the use of lock structure recess screens (a mortality reduction device) and their repair, maintenance, and installation be included as an alternative. This would more fully address the range of alternatives available to the Corps in their efforts to reduce manatee mortality.

The report should address the status of speed restrictions and signage at the locks as a means to further reduce mortality.

The report addresses the use of permanent barriers as a possible alternative in the discussion of "Related Project Conditions." In "Project Conditions," where previous operational improvements and modifications are described, the report states that a barrier prototype was abandoned because it interfered with manatee travel and habitat use patterns. However, it is our understanding that the prototype was discarded because of problems associated with debris collecting on the barrier. Although there are some problems associated with permanent barriers, it should be noted that these devices will eliminate the possibility of manatee mortality at water control structures in which they are installed by preventing manatees from reaching gate mechanisms. The Service encourages the use of barriers at locations where they will not prohibit manatee access to essential habitat.

The "Project Operations Manatee Protection Plan" describes operating protocols for the Franklin Lock bubbler curtains. Bubbler curtains are discounted as a viable manatee deterrent in the "Selection Process/Alterative Evaluation" section. This protocol should be eliminated from the operations plan.

In the stated purpose of the report, the Service's Florida Manatee Recovery plan is described as a requirement of the Marine Mammal Protection Act. The recovery plan is a requirement of the Endangered Species Act of 1973, as amended.

We agree that pressure sensitive gate reversal devices may be the most effective means of reducing or eliminating mortality at water control structures. Since some mortality has been associated with these devices we recommend that a limited number of these gates be installed and tested before wide application.

We disagree with the proposal for construction from November 1 through May 31. In some locations (Dade County) manatee activity peaks during this period. The timing of installation should determined on a site by site basis to avoid locations and times of peak manatee activity.

The current proposal does not include enough objective information on flood constraints, gate operations, costs and engineering limitations to dismiss an "over the top" discharge alternative. If the current study authorization does not permit consideration of such an alternative then we recommend a separate or modified study authorization. In accordance with Council on Environmental Quality guidelines on alternatives (40 CFR, Section 1502.14) agencies are required to provide for development and review of reasonable alternatives including those not currently within agency jurisdiction.

We suggest that the Corps include in the document a discussion of the opportunities and limitations for eliminating structure caused manatee deaths that may result from the Central and South Florida Comprehensive Restudy. While the study is far from complete, a recurring theme has been to redesign and operate in such a manner as to keep water in the system and minimize loss to tide. This suggests a future reduction in structure activity and a potential concomitant reduction in structure related mortality.

We request that you add the following to your mailing list:

Superintendent
Biscayne National Park
P. O. Box 1369
Homestead, FL 33090

Thank you for the opportunity to review and comment on this important proposal.

Sincerely,

James H. Lee

James H. Lee
Regional Environmental Officer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1875 Century Boulevard
Atlanta, Georgia 30345

IN REPLY REFER TO:

JUN 30 1995

Mr. A. J. Salem
Chief, Planning Division
Environmental Studies Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

The Fish and Wildlife Service (Service) has reviewed the Draft Project Modification Report and Environmental Assessment, Manatee Protection Plan (Part 1) At Selected Navigation and Water Control Structures in Central and Southern Florida.

Water control structures are a significant cause of human-related manatee deaths, second only to those caused by watercraft. We commend the Army Corps of Engineers (Corps) for reviewing alternate ways to reduce the number of deaths associated with these structures through the Section 1135(b) process of the Water Resources Development Act of 1986.

We support the Corps' efforts to reduce manatee mortality associated with water control structures. The design, construction, and deployment of the selected devices together with implementation of proposed operational protocols should significantly reduce manatee deaths. This is consistent with the recovery goal for the endangered Florida manatee in the Service's Florida Manatee Recovery Plan.

We offer the following comments and recommendations for your consideration:

1. The number of structures identified in this report (20) represents a decrease in the number of structures identified in your initial letter (23). In our Coordination Act Report dated January 24, 1995, we recommended that the Henry Creek Lock, a structure identified as a source of mortality, be included in the list. This would bring the list of structures to be studied to 24.

2. We recommend that the use of lock structure recess screens (a mortality reduction device) and their repair, maintenance, and installation be included as an alternative.

3. The report should address the status of speed restrictions and signage at the locks as a means to further reduce mortality.

4. The report addresses the use of permanent barriers as a possible alternative in its discussion of "Related Project Conditions." In "Project Conditions," where previous operational improvements and modifications are described, the report states that a barrier prototype was abandoned because it interfered with manatee travel and habitat use patterns. However, it is our understanding that the prototype was discarded because of problems associated with debris collecting on the barrier. Although there are some problems associated with permanent barriers, it should be noted that these devices will eliminate the possibility of manatee mortality at water control structures in which they are installed by preventing manatees from reaching gate mechanisms. The Service encourages the use of barriers at locations where they will not prohibit manatee access to essential habitat.

5. The "Project Operations Manatee Protection Plan" describes operating protocols for the Franklin Lock bubbler curtains. Bubbler curtains are discounted as a viable manatee deterrent in the "Selection Process/Alternative Evaluation" section. This protocol should be eliminated from the operations plan.

6. In the reports' stated purpose, the Service's Florida Manatee Recovery Plan is described as a requirement of the Marine Mammal Protection Act. The recovery plan is a requirement of the Endangered Species Act of 1973, as amended.

Thank you for the opportunity to review and comment on this important proposal.

Sincerely yours,

Noreen K. Clough

Noreen K. Clough
Regional Director

MARINE MAMMAL COMMISSION
1825 CONNECTICUT AVENUE, N.W. #512
WASHINGTON, DC 20009

20 June 1995
By facsimile

Mr. A. J. Salem
Chief, Planning Division
Attn: CESAJ-PD-PF
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

Thank you for your 5 May 1995 letter forwarding a copy of the "Draft Project Modification Report and Environmental Assessment" on altering 20 water control structures in central and southern Florida. The purpose of the planned work is to fit pressure sensitive devices on these structures to reduce the likelihood that they could crush and/or drown endangered manatees trying to pass through them. The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the document and offers the following comments.

Crushing and drowning in flood gates and navigation locks is the second largest cause of human-related manatee mortality in Florida. The number of such deaths has increased significantly in recent years. To address the problem, the Corps of Engineers, in cooperation with the South Florida Water Management District, has designed, tested, and refined pressure sensitive mechanisms that can be affixed to gate doors to reverse the direction of closing gates should a manatee become caught as a door shuts. The draft project report indicates that the proposed action would involve retrofitting the new technology at 20 water control structures that have killed or potentially could kill manatees and that the total cost of the project is $2,409,000.

The Commission applauds the Corps for its efforts to develop the technology and apply it to problem water control structures. The pressure sensitive mechanisms appear to be an innovative, well-suited approach that would be an important, timely contribution to the manatee recovery program. The Marine Mammal Commission commends the Corps for its continuing attention to this urgent conservation need.

With regard to the design of the new pressure sensitive devices, we understand that initial testing revealed several design flaws, and that while these problems appear to have been

resolved, experience with the improved mechanisms is still limited. It seems possible, therefore, that further technical refinements may yet be needed or may soon become apparent. In view of the limited experience with the new mechanisms and the importance of implementing effective manatee protection measures as quickly as possible, the Marine Mammal Commission recommends that the Corps of Engineers adopt a flexible approach in implementing its proposed plan such that construction schedules may be altered if experience gained as new devices come on line should indicate that additional technical modifications appear warranted.

Once again, the Commission commends the Corps for its initiative in trying to solve this serious and all-too-often fatal problem for manatees.

We hope these comments are helpful.

Sincerely,

John R. Twiss, Jr.
Executive Director

cc Mr. Samuel E. Pool, III, Executive Director, South Florida Water Management District
Lance D. Wood, Esq., Assistant Chief Council, Environmental Law and Regulatory Programs, Corps of Engineers

Department of
Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

June 8, 1995

Mr. A. J. Salem
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019
Attention: CESAJ-PD-PF

RE: Review SAI 95-0422C
Manatee Protection Plan (Part 1) at Selected Navigation & Water Control Structures in Central and Southern Florida

Dear Mr. Salem:

The Bureau of Protected Species Management has reviewed the subject report and finds it consistent with the Florida Coastal Management Program, the U.S. Fish and Wildlife Service Manatee Recovery Plan, and the Department of Environmental Protection's goals for manatee recovery.

The Department of Environmental Protection has been actively involved in this project for a number of years. We participate in the interagency task force created to solve the problem of structure-caused manatee mortality and we have had an active role in the development of this 1135 project.

I commend you and your staff in preparing a very thorough presentation of information on the water control structures in South Florida as well as a good compilation of manatee related data. The background information contained in this report is very valuable and will no doubt be used as a reference by a number of agencies in the future.

While overall I believe the project as outlined in the subject documents is a sound approach to reaching the goal of zero structure-caused mortality, I offer the following points as suggestions for improving this draft.

I believe that pressure sensitive devices that will reverse the direction of a closing gate hold the most promise in our efforts to eliminate structure-caused manatee mortality.

However, they are not a proven solution. As is mentioned in the report, there have been manatees killed at some structures equipped with such devices. The report needs to go into greater detail assessing why the pressure sensitive plungers at S-27 have failed and should provide recommendations on what steps should be taken to correct problems with the system. Past experience has shown problems with the plungers themselves, but also in other components of the system. The report needs to carefully examine the entire flood control structure operating system including the telemetry system, control switches and logic switches in the control house, control room protocols, as well as various overrides. In addition, the report should evaluate how power outages or loss of communication in the telemetry system could possibly affect performance.

Because this technology is experimental, it needs to be rigorously tested. The most significant shortcoming in the 1135 proposal is that it inadequately addresses testing of the manatee protection devices. The report should outline in detail the types of tests that will be performed to document the pressure sensitive devices are working satisfactory. Testing should be done in actual field conditions with the gate fully operational. A mechanical test procedure should be developed: that is, a procedure where the plungers are physically depressed in a normal operating mode. This needs to be a procedure that is repeatable and that can be done by field staff. The report should describe in detail how these tests will be performed and should recommend a suitable test schedule. The draft test procedures as contained in appendix C are a start but are inadequate.

We do not agree that construction should be limited to November 1 through May 31 for water control structures and between May and September for navigation structures. We believe that a flexible implementation schedule should be developed that would allow gates or locks to be worked on any time during the year, as weather and water level condition permits.

Finally, we believe while the Corps of Engineers should continue to move forward on refinements and installation of the pressure sensitive devices, attention should also be given to other possible manatee protection systems. The use of sonar appears to hold some promise and we are pleased that the Waterways Experimental Station is researching this technology. While the 1135 report dismissed over-the-top type water control structures, we believe that this concept merits more in-depth review.

Thank you for the opportunity to comment on this draft document. We look forward to working with the Corps of Engineers in implementing solutions to this problem in the future.

Sincerely,

R. Kipp Frohlich
Biological Administrator
Bureau of Protected Species Management

RKF/kw

South
Florida
Regional
Planning
Council

June 2, 1995

A. J. Salem, Chief
Planning Division, Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019
Attention: CESAJ-PD-PF

RE: SFRPC #95-0527, USACE request for public comments regarding the implementation of a proposed Manatee Protection Plan at selected (20) navigation and water control structures, Central and Southern Florida.

Dear Mr. Salem:

We have reviewed the above-referenced plan and have the following comments:

- Council staff has reviewed the completed Draft Section 1135 Project Modification Report and Environmental Assessment. Staff continues to be supportive of efforts intended to reduce manatee mortality rates related to the operation of navigation and drainage structures, as well as other human activities. We would therefore be interested in participating and assisting in coordination efforts within our region. The program goals and objectives stated in the Project Modification Report are generally consistent with the goals and policies included in our Regional Plan.

- The goals and policies of the *Regional Plan for South Florida*, specifically pertaining to the proposed Manatee Protection Plan, are provided below for your information.

GOAL 10.1	Beginning in 1991, maintain or increase the percentage of the area of natural systems in the Region based on the area documented in local government comprehensive plans.
Policy 10.1.6	Maintain or enhance existing upland buffers along the Region's waterways to provide wildlife corridors, prevent erosion, filter runoff, and preserve natural aesthetics.
Policy 10.1.7	Discourage incompatible development and human encroachment in and around areas that have been identified as unique and important natural plant or animal communities.
GOAL 10.3	To improve the status of five percent of the threatened and endangered species reduce the number of species becoming extinct in the Region by 1995.
Policy 10.3.1	Discourage activity reducing or adversely altering the habitat of an endangered or threatened species or species of special concern.
Policy 10.3.4	Coordinate the efforts of agencies involved in regulation of endangered species programs to ensure the survival of threatened and endangered species.

3440 Hollywood Boulevard, Suite 140, Hollywood, Florida 33021
Broward (305) 985-4416, Area Codes 305 and 407 (800) 985-4416
SunCom 473-4416, FAX (305) 985-4417, SunCom FAX 473-4417

Policy 10.3.5 Develop public education programs regarding habitat and behavior of endangered and threatened species to inform the public of potential hazardous actions to these organisms.

Policy 10.3.8 In the review process, developments which contain potentially significant habitat or species shall, at a minimum, be required to:

a) inventory the site with an approved methodology and provide the results of the survey to reviewing agencies; and

b) either preserve the habitat of the species with appropriate buffers or relocate the species and habitat if determined acceptable by the U.S. Fish and Wildlife Service and the Florida Game and Freshwater Fish Commission.

All inventories must occur during the time of year that the anticipated species or plant community may be observed.

GOAL 10.4 By 1995, reduce man-induced manatee deaths by 25 percent.

Policy 10.4.1 Local, regional, state and federal agencies should coordinate the approval of development and the formulation of resource protection plans to reduce human-related manatee mortality and prevent the continuing loss or degradation of manatee habitat.

Policy 10.4.2 Use data from aerial surveys and other monitoring programs to develop site-specific vessel speed restrictions to protect manatees.

Policy 10.4.3 Investigate structural, operational, or other methods for reducing manatee mortality caused by flood control structures and locks.

Policy 10.4.4 Assist in the development and distribution of public education materials including brochures, charts, public service announcements, signs, and K-12 school lesson plans.

Policy 10.4.5 Any activity that has an adverse impact on manatees or their habitat shall be prohibited or mitigate their impacts.

Thank you for the opportunity to comment. We would appreciate being kept informed on the progress of this plan and results of its implementation. Should you need any further assistance, please do not hesitate to call us.

Very truly yours,

Gerson M. Garcia

Gerson M. Garcia, AICP
Regional Planner

GMG/mj

METROPOLITAN DADE COUNTY, FLORIDA

METRO-DADE

DERM

ENVIRONMENTAL RESOURCES MANAGEMENT
33 S.W. 2nd AVENUE
MIAMI, FLORIDA 33130-1540
(305) 372-6789

May 31, 1995

Attention: CESAJ-PD-PF
c/o A.J. Salem
Department of the Army
Jacksonville District Corps of Engineers
P.O.Box 4970
Jacksonville, Florida 32232-0019

RE: Draft 1135 report on modification of navigation locks and water control gates for manatee protection

Dear Mr. Salem:

This office has reviewed the subject draft report and would like to commend your staff and their colleagues at the U.S. Fish and Wildlife Service (USFWS), who have compiled a thorough review of manatee mortality related to water control structures and locks. It is particularly helpful to have the background information regarding dates of gate/lock construction and modifications as collected for this document. I am certain that this report will become a useful reference for many, especially those involved with the Interagency Task Force to eliminate manatee mortalities at flood gates and locks.

We generally agree with the U.S. Army Corps of Engineers conclusion that pressure-sensitive gate reversal devices provide the most promise at this time for reducing manatee mortality in water control gates, and therefore, should be the primary focus of the future implementation phase of the 1135 project. We strongly recommend that sections on testing and monitoring, inspection, operation and maintenance be strengthened to include mechanical testing. Protocols described in the appendix for periodic electrical inspections are a good beginning for assessing integrity of circuitry and telemetry, but a test is needed, particularly for evaluation of new or modified designs, to determine whether a device will actually be triggered and reverse if an object enters the gate opening during wet operation. With regard to the implementation schedule (page 26), we strongly disagree with the proposal that construction should occur from November 1 through May 31. Although we understand and agree that flood

protection should not be compromised, fall and winter months are the peak season for manatee activity at Dade County structures. Many mortalities have occurred during these months also. We recommend that timing of installation should be determined on a site-by-site basis after consideration of typical rainfall patterns **and** manatee activities. For structures such as S-27 or S-25b, late March through June may be a more suitable period for construction. All required federal, state, and local permits or approvals should be obtained, and construction plans and schedules should be reviewed by the members of the Interagency Manatee Task Force as they are developed.

Because mortalities continue, even in gates that have been modified with prototype reversal devices, Dade County DERM staff and the citizen's advisory committee reviewing our draft Manatee Protection Plan strongly believe that multiple methods for manatee protection at flood gates and locks should be examined. As we have suggested in previous correspondence, it is important to have at least one back-up plan underway to implement in case the primary plan fails to prove successful. We therefore agree with recommendations in the USFWS coordination report in the Environmental Assessment section that several alternatives should receive further consideration. In particular, we suggest that acoustic detection may provide a back-up method of triggering gate reversal or for monitoring manatee behavior so as to improve effectiveness of protection strategies. Acoustic devices are apparently being considered in connection with structures not included in this report (page 14) and may be promising for water control gates as well. We also concur with the USFWS that more consideration should be given to use of barriers at selected structures, if habitat access is not an overwhelming concern. Further review of manatee mortality, distribution, tracking and related habitat data will be required to refine recommendations in this regard.

We continue to recommend that a thorough assessment of "over-the-top" discharge alternatives should be included in this report. Many interest groups, including boating and conservation organizations, believe that this concept represents a simple solution to the manatee mortality problem. Your staff has included a brief review of some engineering constraints, but does not recommend further assessment primarily due to concerns related to cost, limiting access to potential habitat, and limitations of the scope of the 1135 study. We understand that replacement structures may not be constructed, or perhaps even designed, under the 1135 authorization or budget. However, we suggest that a more thorough assessment of this option be included in this report, if it is to be eliminated from further consideration. More objective information on flood protection constraints, gate operations, costs, and engineering limitations should be provided to help reviewers

understand why this option is infeasible. For example, it is not clear why slot gates are found to be structurally problematic (page 22-23), if indeed many gates were originally equipped with them (page 10). If a separate feasibility study authorization, or modification of an existing authorization is necessary, it would be appropriate for the present 1135 study report to include such a recommendation. In this regard, your staff has suggested that such work might be possible under the "Biscayne Bay Survey Review" project, currently being developed by your staff and Dade County. The authorizing language for this study involves determining whether modifications of federal projects are warranted in connection with "Biscayne Bay and improvement of water quality in the bay," and the outline of the scope of work for the project involves development of a hydrologic model which can assess water quality and quantity issues. With a budget of only $700,000 federal and $700,000 non-federal funds and services, we regretfully conclude that the scope and revenue constraints are more limiting than in the 1135 project.

We have made some minor corrections to the manuscript and suggested revisions to your mailing list, which we have provided separately to your staff. In particular, we recommend you send a copy of the draft report as soon as possible to Representative Carrie Meek, since we believe she was strongly involved in obtaining funding for many water resources projects in Florida. Thank you for the opportunity to review and comment on the draft 1135 report. We look forward to continuing to work with your staff.

Sincerely,

Susan Markley

Susan Markley, PH.D., Chief
Natural Resources Division

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 3
To A. J. Salem	From Dr. Susan Markley
Co. Dept. of the Army	Co. MDC DERM
Dept.	Phone # (305) 372-6863
Fax # (904) 232-3442	Fax # (305) 372-6630

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702

May 30, 1995

Colonel Terry Rice
District Engineer, Jacksonville District
Department of the Army, Corps of Engineers
ATTN: CESAJ-PD-PF
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Rice:

This responds to your letter, dated May 5, 1995, requesting comments regarding the Draft Project Modification Report and Environmental Assessment (EA) for Manatee Protection Plan (Part 1) at selected Okeechobee Waterway and Central and Southern Florida navigation locks and water control structures.

The National Marine Fisheries Service (NMFS) has reviewed the document. In our assessment of the project, coordinated with the U.S. Fish and Wildlife Service (FWS), we have concluded that the work could adversely impact fishery resources for which the National Marine Fisheries Service (NMFS) is responsible. Therefore, comments and recommendations submitted to you by the FWS also represent those of the NMFS.

Sincerely,

Edwin J. Kappenman

for Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

cc:
Mr. A. J. Salem
Chief, Planning Division
Department of the Army, Corps of Engineers
Flood Control and Flood Plain Management
P.O. Box 4970
Jacksonville, Florida 32232-0019

F/SEO2
F/SEO23-MIAMI

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

MAY 30 1995

District Engineer, Jacksonville
P.O. Box 4970
Jacksonville, FL 32232

Attn: Mr. A.J. Salem (CESAJ-PD-~~PF~~) PR - Amy Rec
Chief, Planning Division

Subject: Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for Modifications to Selected Water Control Structures for the Protection of the Florida Manatee

Dear Sir:

Pursuant to Section 309 of the Clean Air Act, EPA, Region 4 has reviewed the subject document which discusses the consequences of equipping vertical lift gates at the selected study structures with a pressure sensitive (Plunger Option 4) device which should offer protection to manatees traversing from upstream and downstream locations. This device will be tested (upon installation and biannually) with manatee models to ensure the system is working properly and/or if additional modification is necessary.

From the information in the text it does not look as if the proposal will adversely affect the natural environment and hopefully will significantly reduce manatee mortality from locking operations. Therefore, we have no significant objections to the use of an EA as the evaluation model rather than the more comprehensive environmental impact statement format.

Thank you for the opportunity to comment on this action. If we can be of further assistance in this matter, Dr. Gerald Miller (404-347-3776) will serve as initial point of contact.

Sincerely,

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

FLORIDA

Department of
Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

January 26, 1995

Mr. A. J. Salem, Chief
Planning Division
Jacksonville District
Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: **Manatees and Water Control Structures**

Dear Mr. Salem:

Thank you for your letter requesting my input on research needs regarding manatees and water control structures.

The Department of Environmental Protection (DEP) is primarily involved in this issue on two fronts. First, we are responsible for the state-wide manatee carcass salvage program and accordingly retrieve carcasses recovered throughout Florida including those found in or near water control structures. In addition to collecting as much biological information as possible, our pathologist also makes a determination of the cause of death when the evidence is conclusive. It is through this research activity that the problem of structure-caused manatee deaths was first discovered almost 20 years ago. The salvage program keeps statistics on the numbers and locations of these manatee deaths and these data have been made available to the Corp of Engineers (COE) on a regular basis.

Our second major area of involvement is in addressing management solutions to this long standing problem. As you know, Kipp Frohlich of my staff has been actively involved with the interagency task force that was created to eliminate structure-caused manatee deaths. We will continue to work with all involved agencies to reach our mutual goals of zero structure-caused manatee mortalities.

In addition to these major activities, the Department has also been involved in other less intensive research and management activities relevant to manatees and water control structures. Our biologists maintain and update a manatee scar photo identification catalog, focusing attention on manatees along the west coast of Florida. At times this research brings biologists to structures to photograph uniquely scarred manatees. Our staff also coordinated a survey of navigation lock tenders and compiled the results of this survey. This report was previously provided to the COE but is attached for your convenience.

There continues to be a need for additional information concerning manatees and water control structures. Last year's record high of 16 manatee deaths from this cause is evidence that this problem is far from solved. A better understanding of the extent of manatee use of the canal systems and how frequently they use the structures would be beneficial. While the COE currently has lock tenders recording manatee sightings, additional research using photo identification or radio telemetry would be beneficial. Another avenue of possible research would involve behavioral observations of manatees that frequent the structures. In particular our knowledge of how manatees interact with the structure components is lacking, since in most cases this occurs in deep, turbid water. Perhaps research using underwater video or sonar might shed some light on how manatees are passing through the structures, and thereby help engineers to design safer structures.

I hope these ideas are useful to you. Kipp Frohlich will be attending the next interagency task force meeting and will be happy to discuss this topic in more detail.

Sincerely,

Edwin J. Conklin, Director
Division of Marine Resources

EJC\kfw
Attachment

SURVEY OF LOCK TENDERS ON MANATEE USE OF SELECTED LOCK STRUCTURES

R. Kipp Frohlich
Florida Department of Environmental Protection
Office of Protected Species Management

3900 Commonwealth Boulevard
Tallahassee, Florida
32399

March 1994

INTRODUCTION

It has been recognized for some time that manatees (Trichechus manatus) in Florida are killed in navigation lock structures (Odell and Reynolds 1979, O'Shea et al. 1985, Beeler and O'Shea 1988). Locks have been responsible for at least 40 manatee deaths during the period 1974 - 1993 (Department of Environmental Protection manatee mortality data base). In order to deal with the problem of structure-caused manatee mortality, an interagency working group was formed in 1991. This group consists of representatives from the South Florida Water Management District (SFWMD), the U.S. Fish and Wildlife Service (FWS), the U.S. Army Corps of Engineers (COE), Dade County Division of Environmental Resource Management (DERM), and the Florida Department of Environmental Protection (DEP, formerly the Department of Natural Resources, DNR).

One of the recommendations that this group agreed upon was that additional information about manatee behavior and activities around navigation locks might prove useful in our attempt to both understand the nature of the problem and also devise a successful solution.

A survey was developed by DEP staff (Appendix 1.) and was given to both the COE and SFWMD for distribution. The following is a summary of those surveys.

RESULTS

Twenty one surveys were received by DEP; 14 submitted by the COE and 7 by SFWMD. Two of the surveys submitted by SFWMD were for water control structures (S-127 and S-131). No manatees were seen at those structures, therefore they were not included in this summary. The structures covered in this summary are shown in Table 1.

As a group, the survey respondents were fairly experienced in terms of logging manatee sightings; 13 (68%) indicated they had participated in manatee sightings in the past. Of the nineteen respondents, 1 indicated seeing manatees "most of the time" and 1 indicated never having seen manatees. Eight respondents (42%) indicated they see manatees frequently, and 7 (37%) occasionally, while 2 (11%) see manatees hardly ever. Thirteen (13, 68%) indicated they were able to identify manatees by scar patterns, but only 3 (16%) indicated they photographed or sketched a scar pattern. Those responding differed on whether manatees seen were residents or migrants. Six (6, 40%) indicated the manatees were migrants, 5 (33%) indicated they were residents, and 4 (27%) thought the manatees they see are both residents and migrants. Only 4 respondents indicated they had seen a manatee towing a radio transmitter.

The survey asked during what season lock tenders most frequently saw manatees. Choices were "Spring", "Summer", "Fall", "Winter", and "Equally Throughout the Year". Respondents did not limit their answers to just one choice so the totals for this question were greater than 19. The most frequently selected answer was "equally throughout the year." Eight (8)

individuals responded this way. Spring and summer were both indicated 7 times as being the season during which most manatees were seen, while winter and fall were only selected 3 and 2 times respectively. The lock tenders were asked to indicate which months in particular manatees were most often seen. There was no overall pattern to these answers and they varied considerably between individuals and locations.

The respondents were about evenly split in their opinion on the threat locks pose to manatees with 10 indicating they believed the locks were a threat and 9 indicating they did not believe that locks posed a threat. Only two of the respondents indicated they had seen a manatee being crushed by a lock door. The respondents were asked if the structure at which they worked had "manatee fencing" installed across the face of the gates. These fences are intended to keep the manatees from entering the gate wells. They were also asked if they had seen manatees entering the gate wells and if such observations had been made after the fencing was attached. The responses to these questions are presented in Table 2. According to the respondents, the fencing is not working as designed and manatees continue to enter the gate wells after manatee exclusion fences have been attached.

The survey was also designed to determine the maximum duration that locks tenders had observed manatees remaining in the lock chamber. Answers varied widely. To summarize, we divided up the possible answers into five categories which are shown in Table 3. Eight respondents indicated that the maximum time manatees were in the chamber was more than 12 hours while five respondents indicated that manatees were in the chamber less than 1 hour.

Seventeen respondents answered the question regarding seeing manatees in close proximity to water control structures that are associated with the locks. Of those, 11 (64%) indicated that they see manatees in close proximity to water control gates. Only 6 (35%) thought manatees passed under these gates, and only 3, (18%) thought these water control gates were a threat to manatees.

All but one of the respondents answered the question "Do you think boats are a threat to manatees in or adjacent to locks." They were fairly evenly divided with 8 (44%) thinking boats were a threat and 10 (55%) of the opinion that they were not a threat. Seven (39%) respondents indicated that there were speed limits adjacent to the locks and 11 (61%) indicated that there are no speed limits close by their structures. Of the 11 people who responded to the question regarding compliance with posted speed limits, 7 (63%) indicated that compliance was good while 4 (36%) indicate that it was inadequate. These results are displayed in Table 4.

Only single response forms were obtained from the majority (7 of 12) of the lock facilities surveyed (see table 1). To ascertain how responses might differ from individual to individual at the same lock, we examined at the responses received from Port Canaveral (3) and Port Mayaca (4) to the following questions:

How often are manatees seen?
What season are they most often seen?

The three respondents differed in their answers to these questions at the Canaveral Lock. One respondent indicated that manatees were seen most of the time, another said frequently, while the third only occasionally. Responses as to the time of year of manatee sightings also differed. One indicated that manatees were seen year round, one thought they were seen mostly during the winter, while another respondent indicated they were seen most often during the summer. The responses from Port Mayaca on the other hand were much more consistent. All four respondents indicated that they saw manatees frequently, and all indicated that they saw them year round. One of the respondent also checked summer as the time of year most often seen.

Some of the questions asked were not entered into the data base but rather were read individually and are summarized below.

Q. HAVE YOU NOTICED A PATTERN TO MANATEE MOVEMENTS?

Most respondents did not notice any type of movement pattern. Some indicated that weather played a significant part in such patterns and that either manatee movements were more likely during a change in weather, or that they were moving in response to the presence of cold fronts. One individual indicated that manatees may be moving through the Canaveral Locks in order to gain access to fresh water, and another indicated that they appeared to return to the river (Canaveral Locks) in the evening. The respondent from St. Lucie lock indicated that, at least on one occasion when manatees were not being seen at St. Lucie, they were seen at Port Mayaca.

Q. ARE THERE CERTAIN CONDITIONS THAT MAKE MANATEES MORE LIKELY TO PASS THROUGH A LOCK?

Many respondents mentioned vegetation. It was not always clear how they thought vegetation influenced manatee behavior. Some respondents indicated that manatees may move through locks to feed on plant material on the other side of the structure, after which they move back through the lock gates. One suggested that when the water hyacinths are "stacked up" at the lock, manatees are more likely to be there. Others answered much like the responses to the previous question, that weather played an important role in influencing manatee movement through the lock. Boating activity also plays a part according to some of the respondents. Some indicated that manatees most often "lock through" as boats are locking through, and one respondent suggested that by moving away from oncoming boats, manatees might actually be influenced to enter locks. One respondent indicted that "vegetation, mating, feeding and just sunning" are all factors stimulating manatees to enter locks.

Q. WHAT HAVE BEEN YOUR OBSERVATIONS OF HOW MANATEES REACT TO AN OPENING OR CLOSING LOCK GATE?

Many respondents indicated how adept they thought manatees seem to be at "knowing" how to pass through the gates, basically "like humans". They indicated that manatees heard the machinery or would look and see the gate opening. One respondent indicated that manatees usually waited until the gate was fully open, and did not pass through until the force of the passing

water had diminished. Some indicated that manatees will wait "with their noses pressed against" the gate until it opens. One respondent indicated that manatees move in and out of the locks before boats do so. Others indicated that manatees move with the boats. One respondent indicated that manatees almost always enter locks submerged.

Q. WHAT DO MANATEES DO IN THE CHAMBER?
Most of the responses indicate that manatee basically "just act like manatees" swimming, floating, breathing, etc. Many respondents indicated that the manatees usually travel to the opposite end and wait for the next gate to open so they can continue on, while one respondent indicated that manatees swim back and forth until they feel a current, and that they keep away from motor noises. One person said they sometimes stay within the chamber for hours and continue feeding, mating, and laying in sun, while another said they tend to stay under water, coming to the surface only for air, then submerging again.

Q. HOW DO MANATEES RESPOND TO THE PRESENCE OF BOATS IN THE LOCK CHAMBER?
The group was divided in their perception of how manatees respond to boats. Most respondents indicated that manatees try to avoid boats, either staying submerged, or moving away from them in the chamber. But quite a few had the opposite opinion, that manatees either ignored boats, have no fear of boats, or that they sometimes are attracted to boats, rubbing up against them intentionally at times.

Q. HOW DO BOATERS RESPOND TO THE PRESENCE OF MANATEES?
The majority of respondents indicated that most boaters, when they learn of the presence of a manatee are excited and pleased, very careful, and cooperative. A few respondents indicated that at least some of the boaters get impatient if there are delays and that other boaters don't seem to care or want to go slow.

Q. IF YOU BELIEVE THAT BOATS ARE A THREAT TO MANATEES, DO YOU HAVE SUGGESTIONS OF HOW TO REDUCE THIS THREAT?

Most respondents indicated that posting speed limits and enforcing those limits would reduce the threats to manatees. Several noted that it is already Federal Regulations require boats to go at slow speed once they reach the arrival point, but most boaters are unaware of this and these regulations are not strictly enforced. They suggested that signs be erected at lock arrival points and that this Federal Regulation be enforced. Some wanted broader NO WAKE areas around locks. The use of underwater sounds to scare manatees away from boats was also suggested. Better boater education was suggested, as was the required use of prop guards.

DISCUSSION / CONCLUSIONS

The usefulness of anecdotal data such as that present in this report is limited. Different individuals, observing the same phenomena, describe it differently and reach varying conclusions. Casual observations by untrained observers are inherently vulnerable to a variety of biases and preconceived

notions. For example, several lock tenders have reported observations of manatee "families" ("bull, cow, and calf"). Their understanding and reporting of manatee behavior is influenced by their anthropomorphic assumption that manatees form a male/female bond and care for their young together -- which they do not. Other assumptions or misconceptions about manatees influence the public's perception, and ultimately the observations that they make and the conclusions that they reach concerning appropriate protection efforts for manatees.

The results of this survey support the conclusions reached by other observers that manatees are quite adept at going through locks, that they have learned to recognize when they can pass through, that they pass through locks regularly and frequently, and that most passages do not appear to stress or otherwise harm the manatees. It is most certainly true that the vast majority of manatees that pass through locks do so without injury. It is a relatively rare occurrence when one is crushed by a lock. Why this occasionally happens remains unknown.

Literature Cited

Beeler, I.E. and T.J. O'Shea. 1988. Distribution and mortality of the West Indian manatee (*Trichechus manatus*) in the Southeastern United States: a compilation and review of recent information. Natl. Tech. Inf. Ser., PB 88-207980/AS: Springfield, VA Two volumes, 613 pp.

Odell, D.K. and J. E. Reynolds, III. 1979. Observations on manatee mortality in South Florida. J. Wildl. Manage. 43:572-577.

O'Shea. T.J., C.A. Beck, R.K. Bonde, H.I. Kochman, and D.K. Odell. 1985. An analysis of manatee mortality patterns in Florida, 1976-81. J. Wildl. Manage. 49:1-11.

TABLE 1. Structures, structure number, responsible agency, and number of surveys received for each structure.

STRUCTURE NAME	STRUCTURE #	AGENCY	# SURVEYS
Port Canaveral		COE	3
Buckman		COE	2
Inglis		COE	1
St. Lucie	S-80	COE	1
Port Mayaca	S-308	COE	4
Moore Haven	S-77	COE	1
Ortona	S-78	COE	1
W.P. Franklin	S-79	COE	1
Taylor Creek	S-193	SFWMD	2
Henry Creek	G-36	SFWMD	1
	S-65E	SFWMD	1
	S-135	SFWMD	2
TOTAL			19

Table 2. Summary of responses concerning manatee fence installation and access into gate wells.

STRUCTURE	FENCE INSTALLED	SEEN MANATEES IN GATE WELLS	HAPPENED AFTER FENCE WAS INSTALLED
Port Canaveral	Y	3 YES	3 YES
Buckman	N	2 NO	-
Inglis	NO	1 NO	-
St. Lucie	YES	YES	YES
Mayaca	YES	2 NO, 1 YES	NO
Moore Haven	YES	YES	YES
Ortona	YES	NO	-
W.P. Franklin	YES	YES	YES
Taylor Creek	NO	2-NO	-
Henry Creek	-	-	-
S-65E	NO	NO	-
S-135	NO	NO	-

Table 3. Longest period of time manatees were seen in the lock chamber.

LONGEST PERIOD SEEN MANATEE IN CHAMBER	NUMBER OF RESPONDENTS
LESS THAN 1 HOUR	5
1-3 HOURS	2
4-8 HOURS	1
9-12 HOURS	0
MORE THAN 12 HOURS	8

Table 4. Evaluation of the threat boats pose to manatees, the presence of speed limits adjacent to the structures, and evaluation of boater compliance with speed limits.

STRUCTURE	BOATS A THREAT	SPEED LIMITS IN PLACE	SPEED LIMITS COMPLIED WITH
Port Canaveral	2-YES, 1-NO	2-NO, 1 YES	1-YES, 1-NO
Buckman	2-NO	2-YES	2-YES
Inglis	NO	NO	-
St. Lucie	NO	YES	YES
Mayaca	1-YES, 3-NO	4-NO	1-NO
Moore Haven	NO	NO	NO
Ortona	YES	NO	YES
W.P. Franklin	YES	YES	YES
Taylor Creek	1-YES, 1-NO	2-YES	1-YES, 1-NO
Henry Creek	-	-	-
S-65E	YES	NO	-
135	YES	NO	-

APPENDIX I.

ATTENTION NAVIGATION LOCK TENDERS!!!!!

The Manatee Needs Your Help. Please take the time to read the following information and fill out the attached form. This information will be used to further our understanding of this unique animal.

Most lock tenders are very aware of the manatee situation and many have participated in recording manatee sightings to contribute to our ongoing research. Because lock tenders have the opportunity to observe hundreds of passages of manatees, you may have learned a great deal about how manatees cope with these structures. Pleas take the time to share the wealth of your experience to help us further understand the problem so that together we can work to eliminate structure-caused manatee deaths.

The manatee is distributed throughout Florida and inhabits nearly all coastal areas, bays, sounds, rivers, and canals. The manatee has adapted to changes in Florida's waterways and frequently utilizes dredged canals, and other man made waters. Manatees have learned that they can pass through navigation locks and many kinds of water control structures. As a result they have access to the miles of water control canals in south Florida as well as Lake Okeechobee.

The vast majority of these manatees pass unharmed through locks and water control structures each year. Regrettably, not all are so fortunate. Since 1974, 85 manatees have been verified to have died as a result of being crushed or trapped by locks or water control structures. There are many other manatee carcasses that have been recovered in the immediate vicinity of the structures, but because the carcasses are badly decomposed, no conclusive cause of death can be determined. It is likely that the actual number of manatees that have died as a result of structures is higher.

Nearly every of a manatee being killed by a structure is quite different. The size of the manatee, the time of year the incident occurred, the type of injuries to the animal all vary. For a few cases there is some information regarding seeing the manatee prior to its death; but for the most part the first indication of a problem is when the carcass is found, often days after the event.

NAME _____

PRESENT DUTY STATION _____
OTHER LOCKS THAT YOU HAVE WORKED AT:
LOCATION_____ DATES: _____
_____ _____
_____ _____

WORK PHONE NUMBER _____

HAVE YOU PARTICIPATED IN LOGGING MANATEE SIGHTINGS IN THE PAST? YES NO

HOW OFTEN DO YOU SEE MANATEES WHILE YOU ARE ON DUTY?
NEVER - HARDLY EVER - OCCASIONALLY - FREQUENTLY - MOST OF THE TIME

WHAT SEASON DO YOU MOST FREQUENTLY SEE MANATEES?
SPRING SUMMER FALL WINTER
EQUALLY THROUGHOUT THE YEAR

ARE THERE PARTICULAR MONTHS WHEN YOU MOST OFTEN SEE MANATEES?
IF SO WHICH MONTHS? _____

HAVE YOU NOTICED A PATTERN TO MANATEE MOVEMENTS? FOR EXAMPLE ARE THEY PREDOMINATELY MOVING A PARTICULAR DIRECTION (UPSTREAM, DOWNSTREAM) DURING A PARTICULAR TIME OF THE YEAR?

_____
_____
_____
_____

DO YOU THINK YOU SEE DIFFERENT MANATEES MIGRATING THROUGH THE LOCKS, OR THE SAME "RESIDENT" MANATEES REPEATEDLY?
MIGRATING RESIDENT BOTH

CAN YOU IDENTIFY INDIVIDUALS MANATEES BY SCAR PATTERNS? YES NO

HAVE YOU PHOTOGRAPHED OR SKETCHED SCAR PATTERNS AND KEPT A RECORD OF INDIVIDUAL MANATEES?

ARE THESE AVAILABLE FOR MANATEE RESEARCHERS TO EXAMINE?

HAVE YOU SEEN MANATEES THAT ARE TOWING RADIO TRANSMITTERS OR THAT HAVE A BELT ATTACHED AROUND THE NARROW PART OF THE TAIL? IF SO PLEASE DESCRIBE.

_____
_____
_____
_____

ARE THERE CERTAIN CONDITIONS THAT MAKE MANATEES MORE LIKELY TO PASS THROUGH A LOCK? THESE MIGHT INCLUDE TIDES, BOAT TRAFFIC, TIME OF DAY, PRESENCE OF VEGETATION, WEATHER AND SO FORTH.

_____
_____

WHAT HAVE BEEN YOUR OBSERVATIONS OF HOW MANATEES REACT TO AN OPENING OR CLOSING LOCK GATE? ARE THEY ALL THE SAME OR ARE THERE MAJOR DIFFERENCE BETWEEN INDIVIDUALS?

WHAT DO MANATEES USUALLY DO ONCE IN THE LOCK CHAMBER?

WHAT IS THE LONGEST PERIOD OF TIME YOU HAVE SEEN A MANATEE REMAIN IN THE LOCK CHAMBER?

HOW DO MANATEES RESPOND TO THE PRESENCE OF BOATS IN AND AROUND THE LOCK?

HOW DO BOATERS RESPOND TO THE PRESENCE OF MANATEES?

DO YOU THINK BOATS ARE A THREAT TO MANATEES IN OR ADJACENT TO LOCKS?
YES NO

ARE THERE POSTED SPEED LIMITS ADJACENT TO THE LOCKS? YES NO

IF THERE ARE POSTED SPEED LIMITS, DO THE MAJORITY OF BOATERS OBEY THEM? YES NO

IF YOU BELIEVE THAT BOATS ARE A THREAT TO MANATEES, DO YOU HAVE SUGGESTIONS OF HOW TO REDUCE THIS THREAT?

ARE THE GATE WELLS (RECESSED AREA THAT THE GATE ROTATES INTO WHEN OPENING) EQUIPPED WITH "MANATEE FENCING" TO PREVENT THE MANATEES FROM GETTING BACK INTO THE RECESSES? YES NO

HAVE YOU EVER SEEN MANATEES GETTING INTO THE GATE WELLS?> YES NO

WAS THAT WITH THE MANATEE FENCING IN PLACE OR BEFORE INSTALLED?

HAVE YOU OBSERVED MANATEES IN CLOSE PROXIMITY TO THE WATER CONTROL DAMS SOMETIMES ASSOCIATED WITH NAVIGATION LOCKS? YES NO

DO YOU BELIEVE MANATEES PASS UNDER THESE WATER CONTROL GATES? YES NO

DO YOU BELIEVE THESE GATES ARE A THREAT TO MANATEES? YES NO

IF SO HOW, AND HOW COULD THEY BE IMPROVED TO ELIMINATE THE THREAT?

_____

_____

_____

_____

HAVE YOU EVER SEEN A MANATEE TRAPPED OR CRUSHED BY A THE DOORS OF A LOCK? YES NO

IF SO PLEASE DESCRIBE THE INCIDENT

_____

_____

_____

_____

_____

DO YOU THINK LOCKS POSE A THREAT TO MANATEES ? YES NO

IF SO, DESCRIBE WHAT YOU THINK HAPPENS WHEN A MANATEE GETS CAUGHT IN A LOCK.

_____

_____

_____

_____

_____

HAVE STEPS BEEN TAKEN AT YOUR LOCK TO REDUCE OR ELIMINATE THE DANGER THE LOCK POSE TO MANATEES? YES NO

WHAT ARE THEY?

_____

_____

_____

WHAT IF ANY ADDITIONAL STEPS WOULD RECOMMEND TO FURTHER REDUCE THE THREAT OF LOCKS TO MANATEES.

_____

_____

_____

_____

South Florida Water Management District

3301 Gun Club Road, West Palm Beach, Florida 33406 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 38 06 RF: 95065

November 28, 1994

Mr. A. J. Salem
Chief, Planning Division
Jacksonville District
US Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL 32232

Dear Mr. Salem: Eddie

Thank you for your invitation to attend the meeting held last Friday in your offices regarding manatee protection efforts in the St. Lucie canal and Caloosahatchee River. Ms. Kim Koelsch of your staff had been kind enough to contact us in advance of your letter so that Mr. Frank Lund, our Manatee Coordinator, could attend.

As the new Executive Director at the South Florida Water Management District, I would like to take the opportunity to express my strong commitment to achieving our zero manatee mortality goal as quickly as possible. As you are aware, we have had additional deaths at the S-27 structure despite the installation of the prototype PSDs, as well as further losses at the Taylor Creek lock. I recently asked Mr. Lund to assume responsibility for expediting and coordinating our efforts to address these problems.

We appreciate the technical assistance that has been provided by your staff as we have developed the initial PSDs, and hope that we can cooperatively find solutions to the problems with both locks and spillgates. I encourage you to contact Mr. Lund at (407) 687-6631 if we can be of any assistance to your efforts at Ortona and St. Lucie locks.

Sincerely,

Samuel E. Poole III
Executive Director

SEP/kh

Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680

FLORIDA DEPARTMENT OF STATE
Jim Smith
Secretary of State
DIVISION OF HISTORICAL RESOURCES
R.A. Gray Building
500 South Bronough
Tallahassee, Florida 32399-0250
Director's Office (904) 488-1480
Telecopier Number (FAX) (904) 488-3353

November 1, 1994

Mr. A. J. Salem
Planning Division
Environmental Branch
Department of the Army
Jacksonville District Corps
of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

In Reply Refer To:
Robin D. Jackson
Historic Sites
Specialist
(904) 487-2333
Project File No. 943667

RE: Cultural Resource Assessment Request
Manatee Protection Devices at Selected
Navigational Locks and Water Control Structures
Okeechobee Waterway and Central and
Southern Florida Flood Control Project

Dear Mr. Salem:

In accordance with the procedures contained in 36 C.F.R., Part 800 ("Protection of Historic Properties"), we have reviewed the referenced project(s) for possible impact to historic properties listed, or eligible for listing, in the National Register of Historic Places. The authority for this procedure is the National Historic Preservation Act of 1966 (Public Law 89-665), as amended.

A review of the Florida Site File indicates that no significant archaeological or historical sites are recorded for or likely to be present within the project areas. Furthermore, because of the project location and/or nature it is unlikely that any such sites will be affected. Therefore, it is the opinion of this office that the proposed projects will have no effect on historic properties listed, or eligible for listing, in the National Register of Historic Places, or otherwise of historical or architectural value.

If you have any questions concerning our comments, please do not hesitate to contact us. Your interest in protecting Florida's historic properties is appreciated.

Sincerely,

Laura A. Kammerer

for George W. Percy, Director
Division of Historical Resources
and
State Historic Preservation Officer

GWP/Jrj

METROPOLITAN DADE COUNTY, FLORIDA

METRODADE

DERM

ENVIRONMENTAL RESOURCES MANAGEMENT
33 S.W. 2nd AVENUE
MIAMI, FLORIDA 33130-1540
(305) 372-6789

September 12, 1994

Ms. Kim Brooks-Hall
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

RE: Dade County Manatee Mortalities at Flood Gates

Dear Kim,

Thank you for the update on the status of the Corps of Engineers review of solutions to the manatee mortality problem at flood gates and locks, provided in our recent telephone conversation. As I mentioned, more manatees have been killed in flood gates (salinity control structures) in Dade County than from any other identifiable cause of death, including vessel collisions. Dade has more manatee mortalities from flood gates than any other county in Florida. From 1974 to date, 43 manatee mortalities have been confirmed from flood gate drowning and/or crushing in Dade (27 vessel collision mortalities were confirmed during the same period).

I am enclosing a chart indicating the number of manatees killed at each flood gate in Dade where mortalities have occurred. The maps you requested indicating DERM aerial manatee sighting locations in the vicinity of flood gates from manatee surveys conducted between 12/89 and 7/94, are also enclosed. These maps do not provide you with the number of manatees observed at each location (marked by a "+"), but you can get a general idea of where manatees may be repeatedly observed. The approximate flood gate locations are marked by a red line. I have requested a map from DEP indicating manatee carcass recovery sites from flood gate mortalities, and will forward a copy of that to you upon receipt.

DERM staff and a citizen's advisory committee that is reviewing our draft Manatee Protection Plan, strongly believe that a flood gate that drops down toward the canal bottom should be thoroughly investigated. This type of structure should totally eliminate the possibility of manatee mortality from flood gates. In any case, please keep me apprised of the status of your study. Kipp Frolich (DEP) indicated that he is attempting to arrange an interagency task force meeting

modification made to the Taylor Creek structure (S-193), scheduled later this month.

I hope this information is useful. If you have any questions regarding this material, please contact me at (305) 372-6866.

Sincerely,

Keven

Keven E. Mayo, Coordinator
Manatee Protection Program

enc.

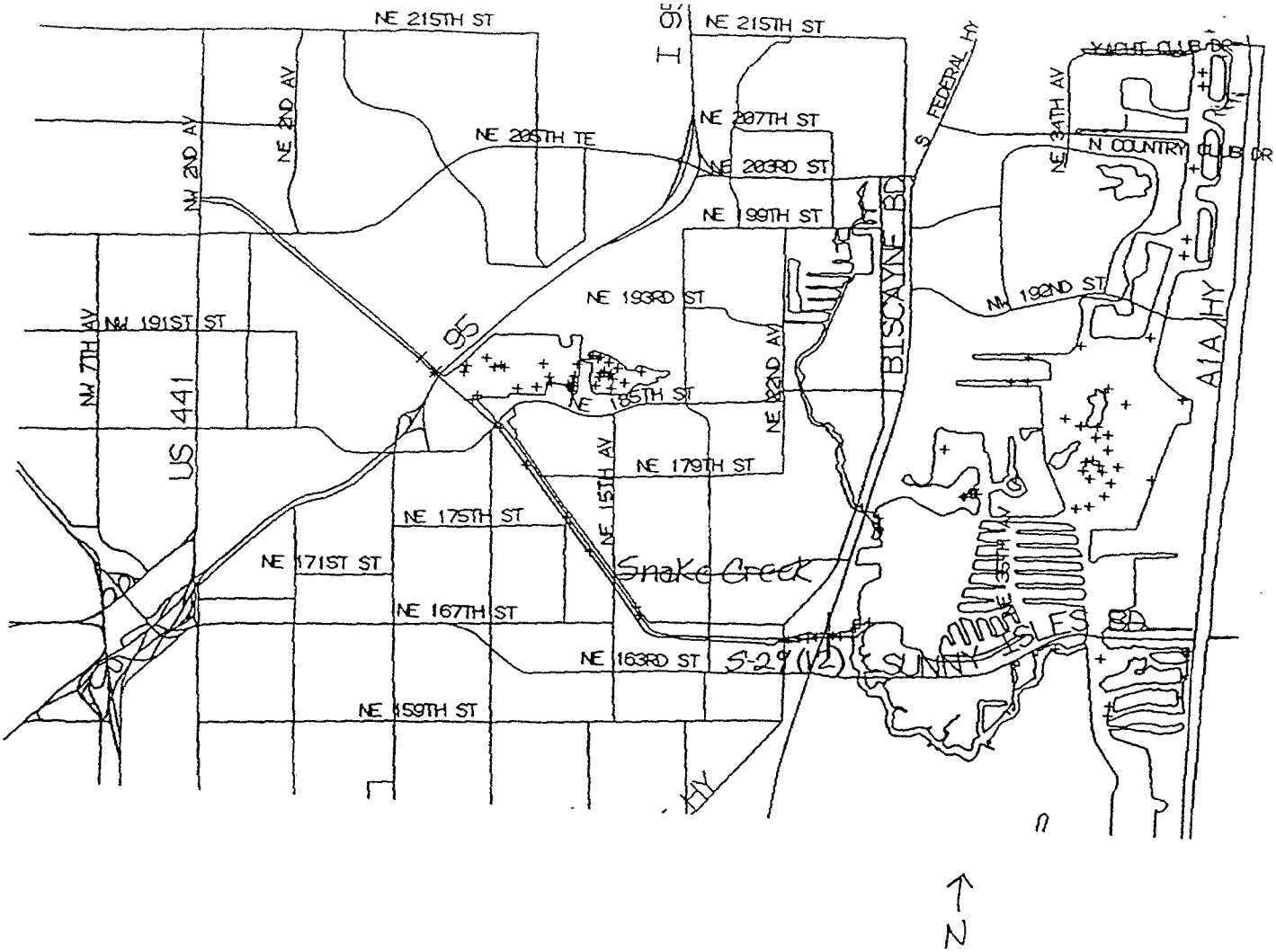
DADE COUNTY MANATEE MORTALITIES ATTRIBUTED TO FLOOD GATES

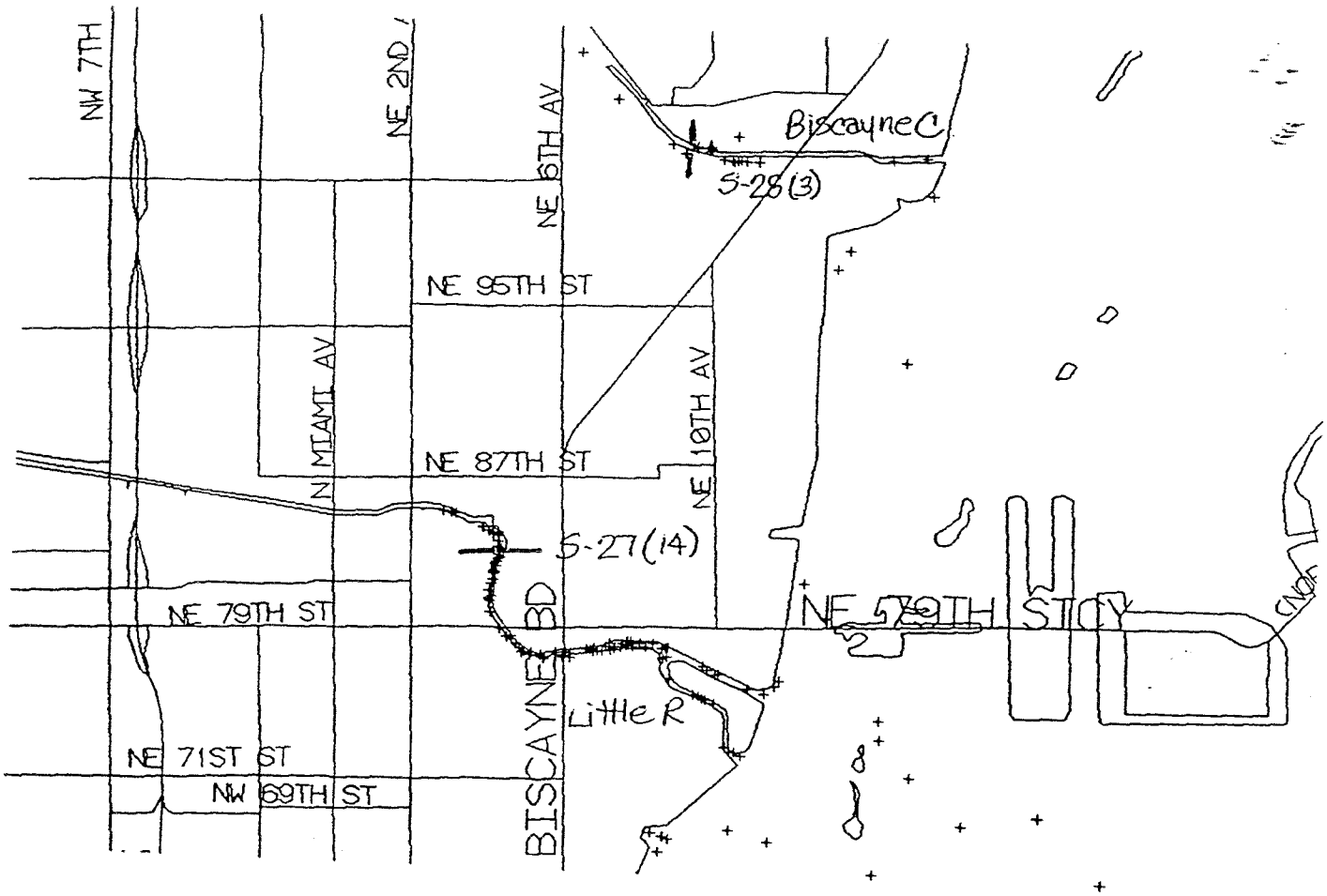
January 1974 through August 1994

1 S-27	2 S-29	3 S-22	4 S-25B
Little River	Snake Creek	Snapper Creek	Tamiami Canal
14 deaths	12 deaths	6 deaths	4 deaths
5/77	11/76	11/76	9/78
2/80	6/77	11/76	11/78
8/82	6/77	6/77	5/82
3/85	9/77	6/78	10/92
11/87	9/78	6/78	
1/88	11/78	10/78	
1/88	5/79		
5/88	9/79		
6/88	10/79		
9/88	11/79		
9/88	6/83		
11/90	6/87		
1/93			
1/94			

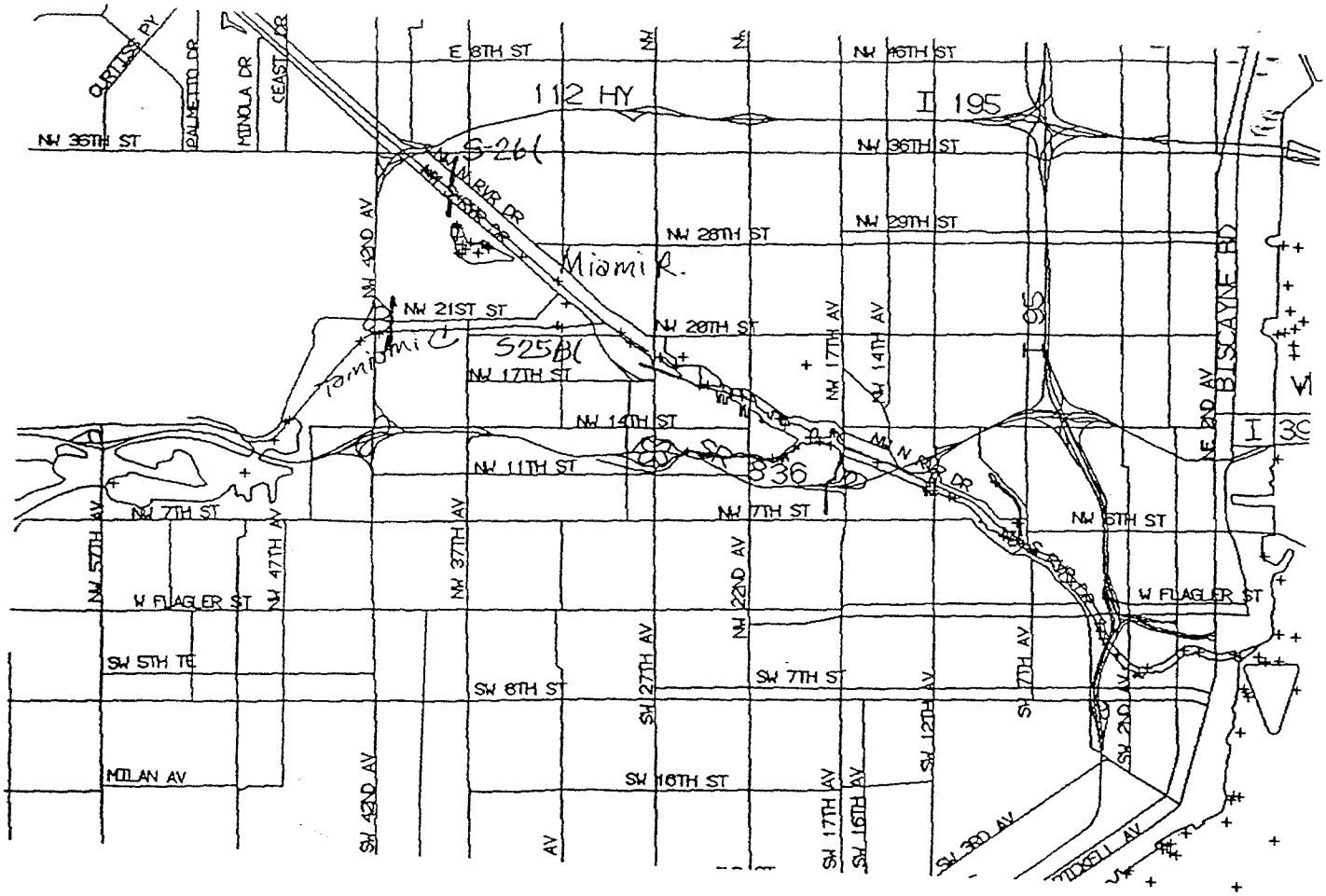
5 S-28	6 S-26	7 S-20F
Biscayne Canal	Miami River	Mowry Canal
3 deaths	2 deaths	2 deaths
6/75	9/76	12/91
12/78	9/79	12/93
7/80		

TOTAL: 43


NE 215TH ST
NE 215TH ST
NW 2ND AV
NE 2ND AV
NE 205TH TE
NE 207TH ST
NE 203RD ST
NE 199TH ST
NE 193RD ST
NW 191ST ST
NW 7TH AV
US 441
95
NE 185TH ST
NE 82ND AV
BISCAYNE BD
S FEDERAL HY
YACHT CLUB DR
NE 34TH AV
N COUNTRY CLUB DR
NE 192ND ST
A1A HY
NE 179TH ST
NE 15TH AV
NE 175TH ST
NE 171ST ST
Snake Creek
NE 167TH ST
NE 163RD ST
S-29 (12)
SUNNY ISLES BD
NE 159TH ST
N


NW 7TH
NE 2ND
NE 6TH AV
Biscayne C
S-28(3)
NE 95TH ST
N MIAMI AV
NE 10TH AV
NE 87TH ST
S-27(14)
NE 79TH ST
NE 79TH ST
BISCAYNE BD
Little R
NE 71ST ST
NW 69TH ST

N


CURTISS PY
PALMETTO DR
MINOLA DR
(EAST) DR
E 8TH ST
NW 46TH ST
112 HY
I 195
NW 36TH ST
S-26(
MIAMI RIVER DR
NW 42ND AV
NW 28TH ST
NW 29TH ST
Miami R.
NW 21ST ST
NW 20TH ST
NW 17TH AV
NW 14TH AV
I 95
BISCAYNE BD
NE 2ND AV
I 36
Tamiami C
S25B(
NW 17TH ST
NW 14TH ST
SR 836
NW 11TH ST
NW 7TH ST
NW 5TH ST
NW 57TH AV
NW 47TH AV
NW 37TH AV
NW 22ND AV
W FLAGLER ST
SW 5TH TE
SW 8TH ST
SW 7TH ST
SW 27TH AV
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SW 16TH ST
SW 17TH AV
SW 16TH AV
SW 3RD AV
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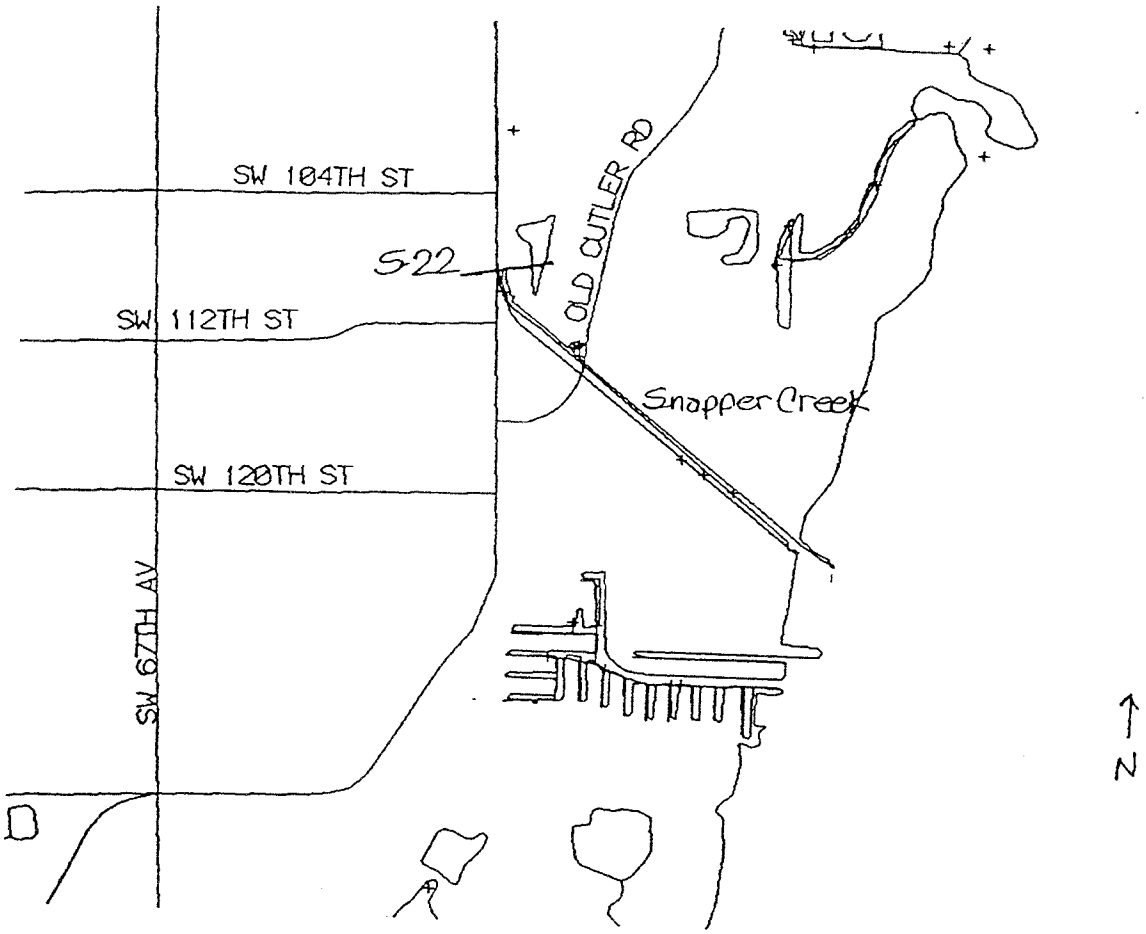
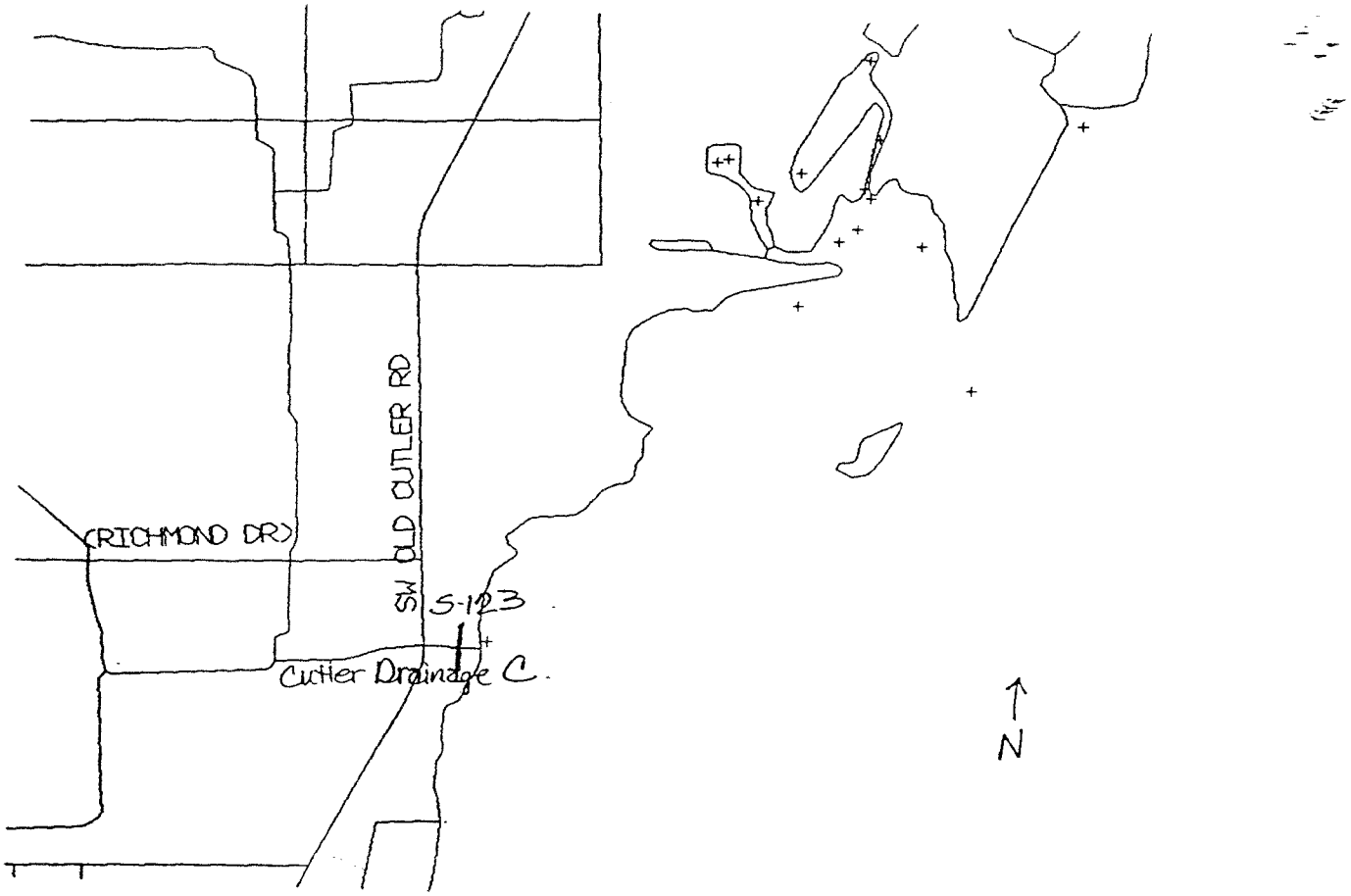

SW 104TH ST
SW 112TH ST
SW 120TH ST
SW 67TH AV
OLD CUTLER RD
S-22
Snapper Creek
N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(RICHMOND DR)
S-123
Cutler Drainage C.
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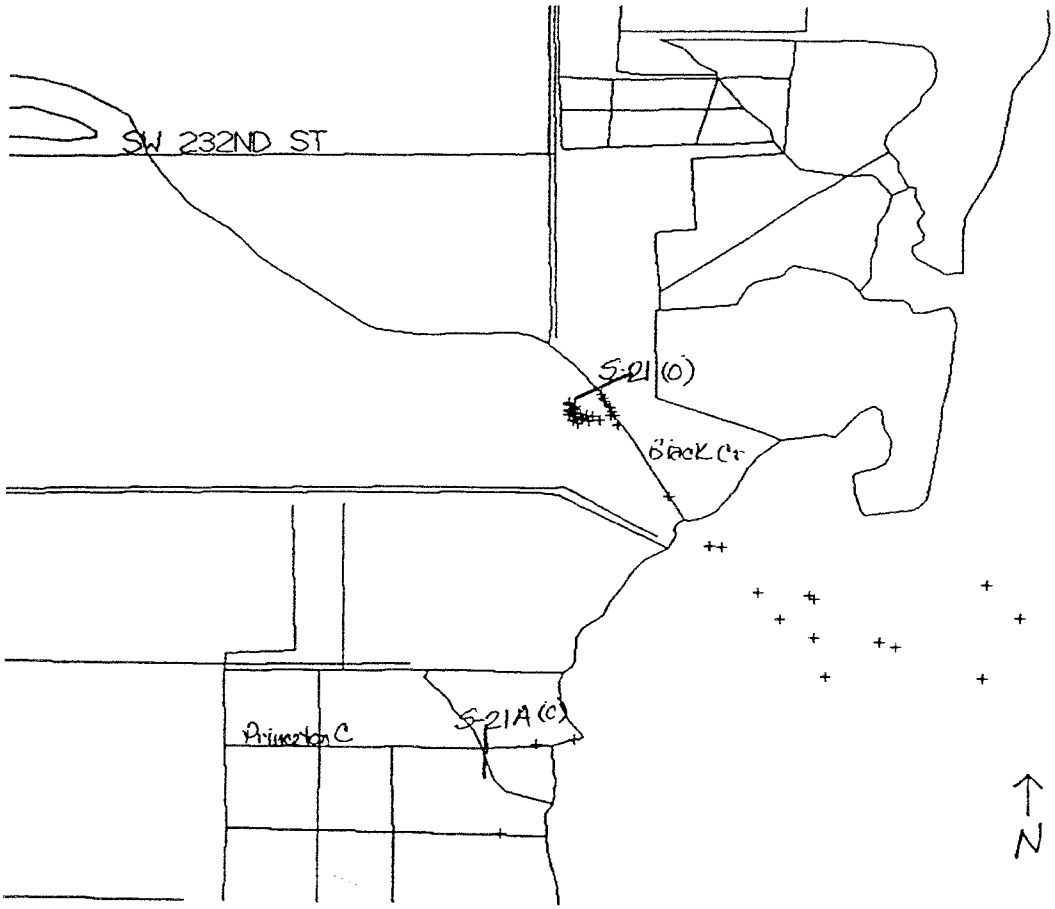
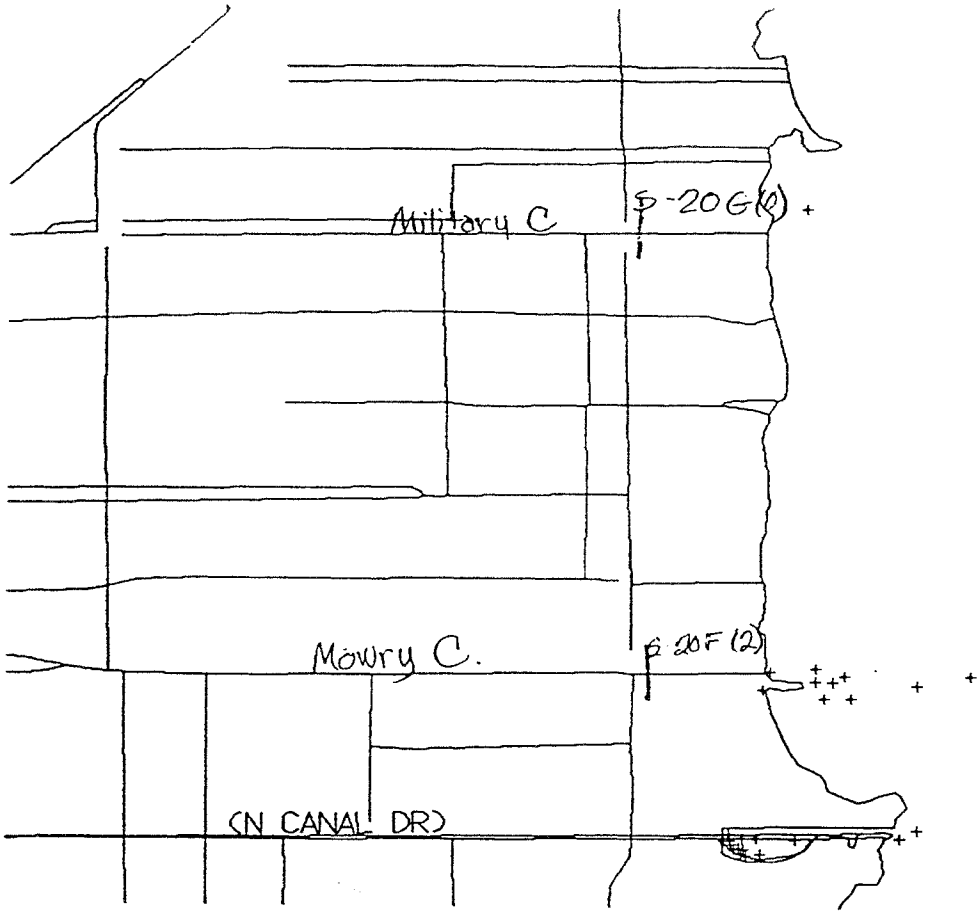

SW 232ND ST
S-21 (O)
Black Cr
Princeton C
S-21A (O)
N


Military C
P-20G(2)
Mowry C.
P 20F (2)
(N CANAL DR)
N

CECW-PE (CESAJ-PD-PF/14 JuN 93) (1105-2-10b) 2nd End
L. M. Lee/272-1721
SUBJECT: Initiation of Section 1135 Study, Manatee Protection at Selected Navigation Locks and Water Control Structures, Florida

HQ, U.S. Army Corps of Engineers, Washington, D. C. 20314-1000

FOR Commander, South Atlantic Division, ATTN: CESAD-PD 15 OCT 1993

The subject proposal is approved to proceed into the feasibility phase of planning. Please notify us by CORPSMAIL of the amount of funds needed to initiate the feasibility study.

Hugh E. Wright

wd encl

HUGH E. WRIGHT, P.E.
Acting Chief, Policy and
Planning Division
Directorate of Civil Works

South Florida Water Management District

3301 Gun Club Road • P.O. Box 24680 • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 38-06 RF: 94335

MEMORANDUM

TO: Nathaniel P. Reed, Governing Board Member

FROM: Tilford C. Creel, Executive Director

DATE: August 9, 1994

SUBJECT: Manatees - Section 1135 Update

The Corps of Engineers in a cooperative effort with the District has embarked on a three-year effort to modify 25 water control structures, primarily in Dade County but also including navigation locks, servicing Lake Okeechobee and the Okeechobee waterway, operated by the Corps. This work is being done under Public Law Section 1135.

The program will be funded through a 75/25% cost-share program, with the Federal government picking up the largest share of the cost. This funding arrangement was granted conceptual approval by the South Florida Water Management Governing Board in November 1993. A Feasibility study, which will determine the best conceptual approach and provide an environmental assessment which is required for the federal funding, will be completed in November 1994.

Detailed design and contract specifications will then be prepared to allow the contractual process to begin in July 1995. It is currently anticipated that all modifications will be in place by 1998. It is unlikely that large contractual expenditures will be made in FY 95. To provide more specifics in regard to federal funding, we have requested that the Corps of Engineers clarify their budget procedure in a separate response.

District staff recognizes the lengthy process which is required to get an innovative Federal program of this magnitude implemented. In order to partially offset the long implementation time, the District plans to continue to improve the pressure sensitive devices and adapt them to structures in Dade County which have the most severe manatee fatality problems.

Modifications to the two structures which historically had the largest number of manatee fatalities have been completed. These two structures (S-27 and S-29) together account for more than half of the fatalities attributed to water control structures within Dade County It is noteworthy that eyewitness accounts and water control structure gate dynamics observed by our control room personnel indicate that the pressure sensitive devices at these structures are working.

Work is currently in progress to adapt the pressure sensitive device to S-193, the navigation lock at Taylor Creek in Okeechobee which continues to prove hazardous to manatees which frequent the area. In addition, gratings are being installed to keep manatees out of hazardous sector gate recesses. An improved design modification which will allow adaptation of the pressure sensitive device to navigation lock sector gate configurations is currently being fabricated and should be complete in September.

District staff has proposed FY95 funding in the amount of $58,400 which will allow the pressure sensitive device to be implemented on two additional structures (S-25B and S-26) in Dade County, while the Corps is completing their design phase. The Corps has interacted closely with District staff over the last several months which has resulted in further improvements in the pressure device prototype. The attached chart provides information on Project water control structures slated for manatee protection modifications over the next three years.

Joe Schweigart, Director of Operations and Maintenance Department, will personally ensure that you and the other board members are kept informed of significant developments in our manatee protection efforts.

TCC/bj

c: ✓Kim Brooks-Hall, COE - JAX
Samuel E. Poole III
Carol Rist, MPPRC
Robert Turner, USF&WS
John Twiss, USDOI
Bernie Yokel, FAS
Judith Delaney Valley
Governing Board Members

downstream close to a gate setting smaller than a 2.5-foot opening; and the forces of high velocity water discharging through the opening could pin the manatee against the opening and cause drowning. Also, when the gate is being closed to a smaller opening, a manatee could be crushed between the gate's lip and the weir's crest.

As indicated in your letter, trial data that your office has collected since 1989 indicate that certain multiple-gated, low-head, coastal spillways with tidal tailwaters can be safely operated with only one gate opened up to 2.5 feet and set in that position while headwater elevations range from 2.0 to 3.5 feet, National Geodetic Vertical Datum of 1929 (NGVD), and concurrent tailwater elevations range from 0.0 to 2.5 feet, NGVD. Based on those data, it appears that one gate at a multiple-gated spillway can be safely opened 2.5 feet under a headwater/tailwater differential (ΔH) of as much as 3.5 feet. Therefore, this office concurs with your more conservative conclusion that the gates at certain low-head coastal structures, and certain Okeechobee Waterway structures, can be safely set at unbalanced openings up to 2.5 feet for ΔH's up to 3.0 feet. This policy applies only to those specific structures as follows:

South Florida Coastal Structures	Okeechobee Waterway Structures
S-29	S-308C
S-28	S-77
S-27	S-79
S-26	
S-25B	
S-22	
S-123	
S-21	
S-21A	
S-20F	

The "2.5-foot opening for 1-minute" procedure mentioned earlier, and as described in my letter of July 15, 1993, still applies to all other structures designed and constructed by this office. This same procedure also applies to those structures listed in the table above when they are to be operated under ΔH's greater than 3.0 feet.

Sincerely,

Edward E. Middleton, Ph.D., P.E.
Chief, Engineering Division

STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

2740 CENTERVIEW DRIVE • TALLAHASSEE, FLORIDA 32399-2100

LAWTON CHILES
Governor

LINDA LOOMIS SHELLEY
Secretary

August 4, 1994

Mr. A. J. Salem
Chief, Planning Division
Department of the Army
Corps of Engineers
Jacksonville District
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: Flood Control Projects - Development of Manatee Protection Modifications to Certain Water Control Structures in the Okeechobee Waterway and the Central and South Florida Project - Florida
SAI: FL9406080549C

Dear Mr. Salem:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Governor's Executive Order 93-194, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.

The Department of Environmental Protection (DEP) indicates that the Army Corps of Engineers is required to provide status reports on the study to the DEP's Office of Protected Species Management. Please refer to the enclosed DEP comments.

Although the applicant did not provide a federal consistency determination in accordance with the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, the state has determined, based on the enclosed comments of the reviewing agencies, that the referenced project will not significantly affect the coastal waters and adjacent shorelands of the state. Therefore, the project, at this stage, is consistent with the Florida Coastal Management Program. All subsequent environmental documents

prepared for this project will be reviewed to determine the project's continued consistency with the FCMP. The state's continued concurrence with the project will be based, in part, on the adequate resolution of issues identified during earlier reviews.

Very truly yours,

Mary Drue McMullen
for Linda Loomis Shelley
Secretary

LLS/rk

Enclosures

cc: Susan Goggin, Department of Environmental Protection
George Percy, Department of State

7-1
Ret to CESAJ-EN-HH

February 23, 1994

Engineering Division
Hydrology and Hydraulics Branch

Mr. Tilford C. Creel
Executive Director
South Florida Water Management District
Post Office Box 24680
West Palm Beach, Florida 33416-4680

Dear Mr. Creel:

Mr. Ron Mireau of your office attended and participated in a meeting in this office on February 3, 1994, concerning provisions for manatee protection at selected U.S. Army Corps of Engineers' navigation and water control structures. Attendees included representatives of various disciplines within this District Office, our South Atlantic Division Office (Mr. Jim Pace), and the Florida Department of Environmental Protection (Mr. Kipp Frohlich). At the close of the meeting, a separate discussion was held with Mr. Mireau, et al., concerning unbalanced gate operations at certain multiple-gated spillway type structures operated by your office. The discussion centered mainly around operations for those structures described in your letter of August 16, 1993 (subject: Unbalanced gate operation - Manatee Protection).

As you know, all slide-gated spillways constructed in your district by this office have been designed in accordance with standard U.S. Army Corps of Engineers criteria. These designs incorporate the conventional criterion that an even distribution of discharge through a spillway is necessary to obtain adequate energy dissipation without damaging erosion downstream. This requires that the gates at a multiple-gated spillway be raised (or lowered), in unison insofar as possible, to the same opening in accordance with maximum allowable gate opening (MAGO) curves provided by this office.

It has been established that manatees have been, and are occasionally being, killed at spillway structures in south Florida as a result of gate operating requirements. Consequently, although it was a departure from required operation based on design, this office developed a policy that a gate at a spillway may be opened 2.5 feet for 1 minute and then closed to the desired opening and/or in accordance with the MAGO curves. The rationale for this is that if a manatee(s) is resting against, or near, the gate when it is opened, it would be flushed downstream without harm. It is recognized, however, that a manatee(s) upstream of the structure could swim or drift

METROPOLITAN DADE COUNTY, FLORIDA

METRODADE

DERM

ENVIRONMENTAL RESOURCES MANAGEMENT
33 S.W. 2nd AVENUE
MIAMI, FLORIDA 33130-1540
(305) 372-6789

January 27, 1995

Mr. A. J. Salem
U. S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Salem:

I am responding to your recent letter to Mr. John Renfrow, Director of the Dade County Department of Environmental Resources Management (DERM), regarding manatees and flood control structures. As you are probably aware, DERM is in the final stages of developing a comprehensive manatee protection plan for Dade County. Since flood control structures historically have been the single leading cause of manatee mortality (and continue to cause manatee deaths) in Dade, we are most concerned about this issue and have spent considerable effort in identifying solutions. At least 46 animals have been killed in Dade structures, the majority of these by crushing. Our data and recommendations have been summarized in the draft Manatee Protection Plan, which has already been provided to your staff at a recent interagency meeting. However, we would be pleased to provide you more detailed information.

We have collected extensive data on manatee distribution and activities in Dade, primarily through aerial surveys and opportunistic sightings. This data has been compiled in a GIS data base and can be provided to your staff. DERM also has an extensive water quality data base for Biscayne Bay and the canal systems. Some stations have been monitored regularly since 1980. We also have received GIS data on manatee mortalities from the Florida Department of Environmental Protection, and tracking data from the U.S. Fish and Wildlife Service Sirenia Project. This information is also important in refining our understanding of manatee movement through the canal system in Dade and should receive further assessment. In an effort to understand structure-related mortality, we have considered seasonality, geographic location, gender of the animal killed, and similar factors. Although manatees have been killed during almost all months of the year, mortality is somewhat higher in the late fall-early winter. We are not aware of any calf deaths directly in structures, although some dependent calf deaths may be indirectly related to death or separation from the mother by a structure. Carcasses have been retrieved upstream and downstream of structures. In some, but not all, it is possible to determine from gate impressions on the animals' skin which direction it was heading with regard to the gate at the time it was crushed. With the assistance of the South Florida Water Management District, we have more recently been able to obtain records of gate operations during periods when a manatee has been killed and have been able to infer when

the animal may have been crushed. Because the number of such records is limited, we still do not know exactly how or when during discharge cycles manatees become entrapped and crushed in gates.

We believe that the Corps of Engineers is in the best position to evaluate design and operation of the structures and flood protection requirements, while state and federal wildlife agencies have the greatest expertise in manatee biology and behavior. We have urged the continuing assessment of the operational effectiveness of the prototype pressure-sensitive device, or other designs which would reverse the gate movement if it closes on an object. We strongly urge in-water testing under operational conditions of any prototype devices. We believe that further refinement of acoustic devices could not only be incorporated into a reversing mechanism, but would aid in general monitoring and understanding of the movements of animals through flood control structures and locks. Our local citizens advisory committee and DERM staff have requested additional assessment of structures that would discharge over the top or descend down into the water, instead of rising from the bottom. Such an assessment should take into consideration discharge required for adequate flood protection, as well as manatee biology. Manatee data, gate operation records and discharge data should be analyzed to determine if manatees movements or deaths occur more often during low flow or high flow conditions. Flow records should be assessed to determine what constitutes "normal" or typical operation for each structure where manatees are known to aggregate. Since redesign or operational modification of flood control canals may occur in connection with ongoing studies such as the Central and Southern Florida Project, manatee protection studies should be coordinated with these broader programs.

We strongly support your efforts to address manatee mortality in water control structures. We appreciate the opportunity to provide you with these comments and look forward to further discussion of this issue at the next Interagency Task Force or other meetings the Corps may be planning in connection with this study. Please contact me at (305)372-6863 should you require additional information.

Sincerely,

Susan M. Markley, PhD
Chief
Natural Resources Division

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

June 21, 1994

REPLY TO
ATTENTION OF
Planning Division
Environmental Branch

Mr. David J. Wesley, Supervisor
U.S. Fish and Wildlife Service
Jacksonville Field Office
Suite 310
6620 Southpoint Drive, South
Jacksonville, Florida 32216-0912

Dear Mr. Wesley:

The Jacksonville District, U.S. Army Corps of Engineers has initiated the feasibility phase of a study to design manatee protective structures or operational modifications at selected navigation locks and water control structures in the Okeechobee Waterway and Central and Southern Florida Flood Control Projects. The study is authorized under Section 1135(b) of the Water Resources Development Act (WRDA) of 1986, as amended. We enclose a list of structures under consideration. We have excluded the two structures already modified/undergoing modification by the South Florida Water Management District.

At this time we wish to initiate a cooperative study under the Fish and Wildlife Coordination Act, as amended, leading to a Coordination Act Report on West Indian Manatee interactions with water control structures. This information should help us to prioritize structures and operational methods for modification; make full utilization of research and management scientists' input on remote sensing, manatee learning and behavior, and other data applicable to proposed changes in structure and operations.

A proposed Scope of Work (SOW) and cost estimate for the CAR is enclosed along with a Form DD 448 transferring $10,500.00 to cover the cost of the work. Estimates of person-days and travel required are based on our telephone and facsimile communication with Mr. Jim Valade of your office. If the SOW is acceptable, please sign and return it to the Jacksonville District office and process the Form 448 to transfer funds.

Sincerely,

A. J. Salem

A. J. Salem
Chief, Planning Division

Enclosure

South
Florida
Regional
Planning
Council

June 20, 1994

Mr. A. J. Salem, Chief, Planning Division
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

RE: SFRPC #94-0609, - Feasibility-phase study of manatee protection at selected navigation locks and water control structures in South Florida..

Dear Mr. Salem:

- Council staff is supportive of efforts to reduce manatee mortality in drainage control structures. With sufficient peer review, the Army Corps of Engineers can develop a cost-effective and timely plan to accomplish this task.

- The goal of reducing manatee mortality is consistent with the goals and policies of the *Regional Plan for South Florida*, specifically:

GOAL 10.1	Beginning in 1991, maintain or increase the percentage of the area of natural systems in the Region based on the area documented in local government comprehensive plans.
Policy 10.1.7	Discourage incompatible development and human encroachment in and around areas that have been identified as unique and important natural plant or animal communities.
GOAL 10.2	By 1995, increase the effectiveness of regulations designed to protect and enhance the long-term productivity of natural systems.
Policy 10.2.1	Where feasible, degraded natural systems will be restored to a functional condition within a reasonable amount of time.
Policy 10.2.2	Encourage the maintenance and restoration of the natural vegetative wildlife habitat and hydrologic functions of the Everglades and Big Cypress Swamp.
Policy 10.2.3	Developments which are required to mitigate the impacts of their development through creation or enhancement programs, shall be required to maintain, monitor and report the status of those systems to the permitting agencies for a period of no less than five years.

3440 Hollywood Boulevard, Suite 140, Hollywood, Florida 33021
Broward (305) 961-2999, Dade and Monroe (305) 620-4266, FAX (305) 961-0322

Policy 10.2.4 The initiatives of the Save Our Everglades, Save our Keys, the East Everglades Resource Planning and Management Committee Implementation, Lake Okeechobee Everglades and Biscayne Bay SWIM plans and other resource protection plans shall be considered in land and water planning by local, regional and state agencies.

GOAL 10.3 To improve the status of five percent of the threatened and endangered species reduce the number of species becoming extinct in the Region by 1995.

Policy 10.3.1 Discourage activity reducing or adversely altering the habitat of an endangered or threatened species or species of special concern.

Policy 10.3.3 Encourage the development and maintenance of wildlife corridors.

Policy 10.3.4 Coordinate the efforts of agencies involved in regulation of endangered species programs to ensure the survival of threatened and endangered species.

Policy 10.3.5 Develop public education programs regarding habitat and behavior of endangered and threatened species to inform the public of potential hazardous actions to these organisms.

Policy 10.3.8 In the review process, developments which contain potentially significant habitat or species shall, at a minimum, be required to:

a) inventory the site with an approved methodology and provide the results of the survey to reviewing agencies; and

b) either preserve the habitat of the species with appropriate buffers or relocate the species and habitat if determined acceptable by the U.S. Fish and Wildlife Service and the Florida Game and Freshwater Fish Commission.

All inventories must occur during the time of year that the anticipated species or plant community may be observed.

GOAL 10.4 By 1995, reduce man-induced manatee deaths by 25 percent.

Policy 10.4.1 Local, regional, state and federal agencies should coordinate the approval of development and the formulation of resource protection plans to reduce human-related manatee mortality and prevent the continuing loss or degradation of manatee habitat.

Policy 10.4.3 Investigate structural, operational, or other methods for reducing manatee mortality caused by flood control structures and locks.

Policy 10.4.5 Any activity that has an adverse impact on manatees or their habitat shall be prohibited or mitigate their impacts.

GOAL 10.5 By 1995, identify lands and develop land acquisition and management practices in the Region which integrate and provide a sufficient water supply and protect wildlife and natural resources.

Thank you for the opportunity to comment. We would appreciate being kept informed of further developments with regard to this project.

Sincerely,

John E. Hulsey
Regional Planner

JEH/kc

cc: Suzanne Traub-Metlay, State Clearinghouse.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
6620 Southpoint Drive, South
Suite 310
Jacksonville, Florida 32216-0912

JUN 13 1994

Mr. A. J. Salem, Chief
Planning Division
Environmental Studies Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

The U. S. Fish and Wildlife Service (Service) has received your request for information regarding issues and concerns pertinent to the development of manatee protection modifications to certain water control structures in the Okeechobee Waterway and the Central and South Florida Project.

The proposed project will consider the feasibility of installing structural modifications to flood control gates for the purpose of reducing manatee injury and mortality. As described in your request, the Service will be preparing a Coordination Act Report for the project.

The Service looks forward to working with you and your staff in the review, assessment, and development of modifications to the described structures for the purpose of safeguarding manatees. Thank you.

Sincerely,

David L. Martin for

Michael M. Bentzien
Acting Field Supervisor

South Florida Water Management District

3301 Gun Club Road • P.O. Box 24680 • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 38-06 RF: 94253

April 27, 1994

Mr. A. J. Salem
Chief, Planning Division
U.S. Army Corps of Engineers
Jacksonville District
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem/ Eddie

Subject: Section 1135 Study for Manatee Protection

Thank you very much for your letter of April 7, 1994 giving us the status of your Section 1135 study for Manatee Protection at Navigational Locks and Water Control Structures.

We would like to provide special encouragement to your efforts in developing the sonar manatee detection system. We agree that this effort should be conducted outside the scope of the current 1135 manatee program. Please let us know if we can be of further assistance in this effort.

Sincerely,

Tilford C. Creel
Executive Director

TCC/bj

United States Department of the Interior

FISH AND WILDLIFE SERVICE
6620 Southpoint Drive, South
Suite 310
Jacksonville, Florida 32216-0912

FEB 2 9 1994

A. J. Salem, Chief
Planning Division
Flood Control and Flood Plain Management Section
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

I have received your letter of February 9, 1994, in which you requested comments addressing the alternatives concepts developed by the Section 1135 study team. In reviewing the concepts set forth for alternatives analysis, I believe that the selected alternatives provide a good basis for review and possible implementation.

In the Memorandum for Record enclosed with your letter, mention was made of a handout describing past efforts, a list of manatee alarm concepts and available assembly drawings of the S-29 PSD installation. It would be most helpful if we could be provided with copies of these materials.

While we regret not having been able to attend your initial meeting, the Service would like to be actively involved as planning progresses. Jim Valade of my staff should be your point of contact for the Service's involvement in this project. Please direct meeting notices and materials to his attention at this office.

We look forward to working with you.

Sincerely,

Robert O. Turner
Manatee Coordinator

cc: Kipp Frohlich, DEP, Tallahassee

South Florida Water Management District

3301 Gun Club Road • P.O. Box 24680 • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 38-06

May 26, 1993

Mr. A.J.Salem
Planning Division
Flood Control and Flood Plain Management Section
CESAJ-PD
Jacksonville District
U.S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

We are pleased to accept your proposal regarding Section 1135 - funding for Manatee Protection devices. Your response was very helpful in clarifying the scope of our proposed program.

The governing board of the South Florida Water Management District granted conceptual approval to act as local sponsor for installation of the proposed manatee protection devices on 25 structures within the South Florida Water Management District at its May 13, 1993 meeting. As detailed in your previous proposal, the South Florida Water Management District's share will be 25% of an amount not to exceed $5,000,000. Implementation details and refined cost estimates will be established as a part of an initial feasibility study and project report.

The enclosed list of 25 structures includes the 15 structures listed in your initial proposal and 10 other structures where manatee fatalities are likely. This second group was referenced in our letter of March 12 and your reply of April 6, 1993.

Please contact Mr. Ronald Mierau, Director of Operations, at (407) 687-6107, if you have further questions or need additional information.

Sincerely,

T. MacVicar

Thomas K. MacVicar
Deputy Executive Director

TKM/bj
Enclosure

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3100 University Blvd. South
Suite 120
Jacksonville, Florida 32216

TAKE PRIDE IN AMERICA

MAR 24 1993

Mr. Eddy Salem
CESAJ-PD
400 W. Bay St.
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Salem,

The U.S. Fish and Wildlife Service is pleased that the Corps of Engineers is seeking Water Resources Development Act Section 1135 funds in order to modify their navigation locks and water control structures in Florida for manatee protection.

Manatee deaths from these structures has been an ongoing problem. Since record-keeping began in 1974, 72 manatees have been killed by Corps of Engineers' constructed structures in Florida. The Manatee Recovery Team has determined that preventing further deaths by modifying these structures is a Priority 1 Task in the federal Manatee Recovery Plan. The Team represents a task force made up of 17 federal, state, private, and conservation agencies and groups who are dedicated to protecting manatees.

The Corps has already made significant contributions towards manatee safety at these structures. They have modified their gate opening procedures to reduce the risk to manatees. By fencing off recesses at navigation locks, manatees will be less likely to be crushed by retracting gates. These tasks were accomplished without additional funding. The Corps is currently preparing regulations to reduce boat speeds in the vicinity of locks, which will allow manatees to more easily avoid being struck by boats. This, too, is being accomplished with present funding. However, after viewing the prototype model of the Pressure Sensor Devices that the South Florida Water Management District is developing, the Service is convinced that these devices will be crucial to the attainment of our goal of "zero mortality" from locks and other water control structures. Funding will be necessary to modify and install these devices on all Corps structures in manatee habitat. The Service strongly urges that Section 1135 funds be made available for this important and timely project.

If you have any questions, please do not hesitate to call me at (904) 232-2580. Thank you.

Sincerely yours,

Robert O. Turner
Manatee Coordinator

cc: FWE, Vero
FWE, Atlanta
FWE, Washington, DC
Pete Milam, COE Jax
Patti Thompson, SMC
Mr. David Laist. MMC
Ms. Lizabeth Manners, COE
Ms. Gina M. Ruiz, Center for Marine Conservation

South Florida Water Management District

3301 Gun Club Road • P.O. Box 24680 • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 38-06 RF:93381

August 16, 1993

Edward E. Middleton, Ph.D., P.E.
Chief, Engineering Division
CESAJ-EN
U.S. Army Corps of Engineers
Jacksonville District
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Dr. Middleton:

Subject: Unbalanced gate operation - Manatee Protection

Thank you for your letter of July 15, 1993 explaining your position toward unbalanced gate openings. Experience at the South Florida Water Management District indicates that unbalanced gate openings on the order of 2.5 feet at low-head coastal structures are not damaging to the structure and can have significant benefits in the protection of the endangered manatee. Common sense and limited model studies do indicate that it is advisable to keep tighter tolerance on unbalanced gate operation under higher head conditions.

We concur that the analytical techniques for determination of maximum permissible unbalanced gate openings are not currently available and we support the improved design criteria described in your correspondence. We can, however, point to substantial operating experience for manatee protection which frequently required unbalanced gate opening conditions approximating one gate open at 2.5 feet while the remainder of the gates on multiple gate structures remained closed. It should be pointed out that all structures operating under these conditions operate under low head conditions. Upstream elevations range from 2.0 to 3.5 feet while gates are open. Downstream water elevations are tidal and normally range from 0 to 2.5 feet with an average of roughly 1.0 feet. (All water elevation referenced to NGVD). It should be noted that structures are never routinely operated in a manner to violate maximum allowable gate opening curves. Should such operation be called for due to unique and unforeseen circumstances, a deliberate consideration of benefits and risks associated with such action is undertaken including consultation with the Corps in each separate case.

Attached is a table presenting multi-gated structures operated under the manatee criteria with an assessment of observed erosion downstream of the structure. It may be noted that no erosion attributed to the 2.5 foot minimum gate openings has been observed at any of these ten sites after several years of operation under our continuous 2.5 foot minimum gate criteria. It should also

be noted that all of these sites operate under low-head conditions and conclusions may not be valid for structures with higher heads or significantly different structural configurations.

There is rather strong indirect evidence that operating under minimum 2.5 foot gate openings has had a major impact on reducing manatee fatalities. The attached figure indicates that in Dade County the implementation of 2.5 foot initial gate openings had a significant positive effect on the relative number of fatalities associated with water control gates (15% reduction) but that in order to achieve the full 30% reduction in fatalities, total elimination of small gate openings is required.

The South Florida Water Management District supports the Manatee Task Force in asking that the Corps reconsider modifying the current manatee gate policy at the low-head structures, S-308, S-77, and S-79. These structures should be operated with minimum of 2.5 foot gate openings in spite of unbalanced gate conditions when head differences across the spillways are less than 3.0 feet. It is realized that at high-head structures, such as S-80 and S-78, the minimum gate opening policy may be inadvisable.

Thank your for your cooperation. The point of contact on manatee operations and gate considerations for the South Florida Water Management District is Ronald Mierau, Director of Operations. He may be reached at (407) 687-6107.

Sincerely,

Tilford C. Creel
Executive Director

TCC/bj
Attachments

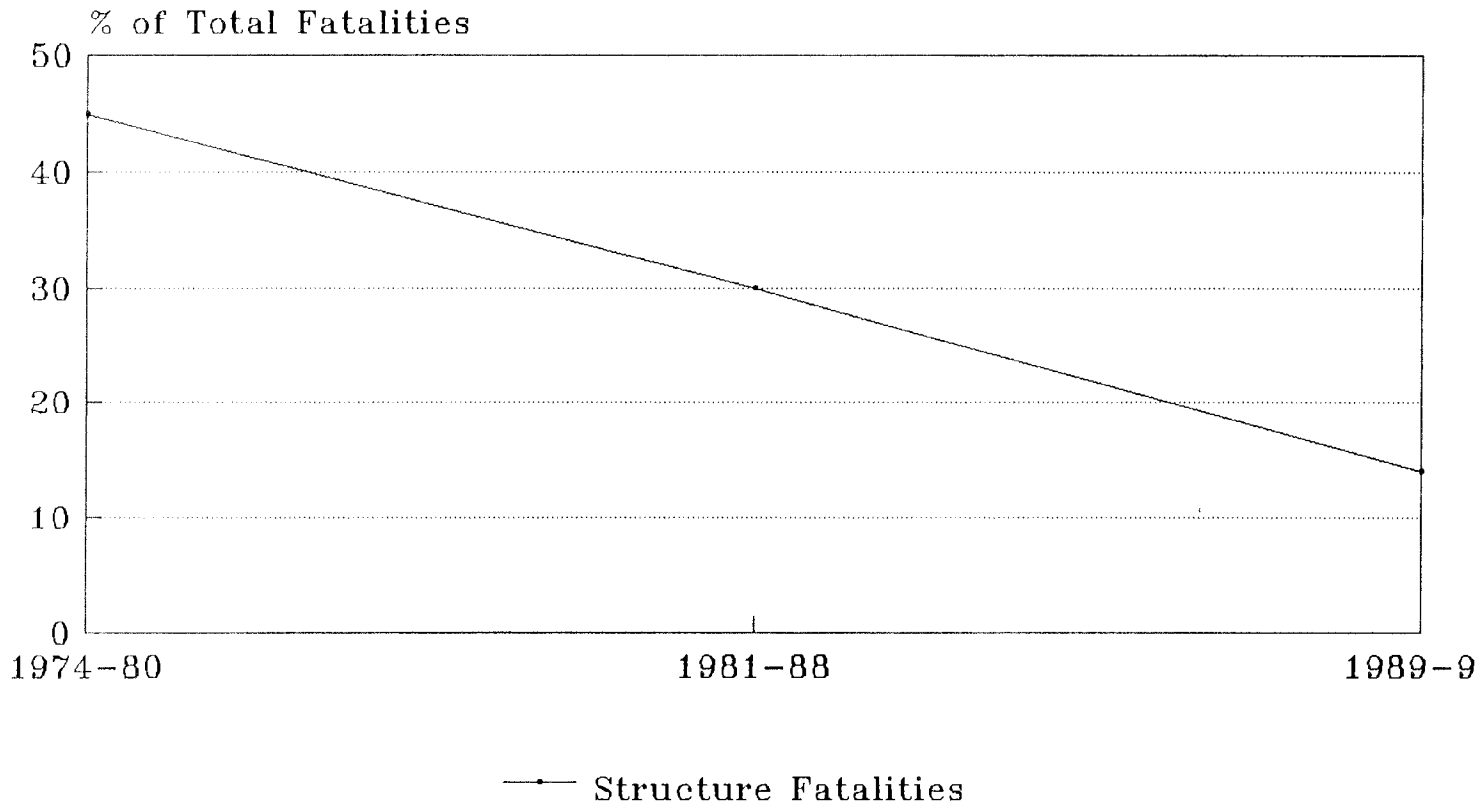
c: Jim Vearil, C.O.E.

SITE	GATE	STILLING Basin	CONTROL STAGE	AVE HEAD	Start Date[2]	EROSION
S-29	4	flat apron	2.5-1.5	1.0	1989	no
S-28	2	flat apron	2.1-1.5	0.8	1989	no
S-27	2	flat apron	1.9-1.0	0.5	1989	no
S-26	2	none	2.8-2.3	1.5	1989	other[1]
S-25B	2	2 aprons with blocks and end sill	3.0-2.0	1.5	1989	no
S-22	2	flat apron	3.5-2.5	2.0	1989	no
S-123	2	flat apron	3.5-2.5	2.0	1991	Andrew
S-21	3	flat apron	2.4-1.5	1.0	1990	Andrew
S-21A	2	flat apron	2.2-1.8	1.0	1991	no
S-20F	3	flat apron	2.2-1.8	1.0	1990	Andrew & David

[1] Erosion was observed at this structure unrelated to manatee gate opening criteria. Erosion at S-26, unrelated to manatee gate opening criteria, was documented as early as 1986.

[2] Start Date is date at which current gate opening policy was implemented. The 2.5 foot initial gate opening was established at many of these sites in 1980.

DADE MANATEE FATALITIES
% Caused by Water Control Gates



2.5 INITIAL gate started in 1980
2.5 MINIMUM gate started in 1989

July 15, 1993

Engineering Division
Hydrology and Hydraulics Branch

Mr. Tilford C. Creel
Executive Director
South Florida Water Management District
Post Office Box 24680
West Palm Beach, Florida 33416-4680

Dear Mr. Creel:

In response to questions presented to us by the Manatee Task Force, we would like to clarify our policy regarding the use of the 2.5-foot minimum gate opening in relation to manatee protection. We are concerned with the possible effects of the 2.5-foot minimum gate opening policy that is currently in use at the Central and Southern Florida Project spillways operated by the South Florida Water Management District.

Most of the multiple-gate water control structures constructed by the U. S. Army Corps of Engineers have been designed to be opened and set at equal openings when passing discharges. Our experience indicates that generally the maximum unbalanced differential gate opening should not exceed one foot. Our policy regarding the 2.5-foot gate opening is as follows: the gate is initially opened 2.5 feet for 1 minute, then set at the desired setting. Misoperations of water control structures, with uneven gate openings and without regard to maximum allowable gate opening curves for the purpose of avoiding harm to manatees, could subject the structures to damaging erosion and jeopardize the structures' safety. For instance, large gate openings, like the 2.5-foot minimum, can cause compressed jets which can result in reverse flow. In turn, reverse flow causes vortexing which can move riprap around and form scour holes. This action causes the erosion that could eventually undermine the structure. Additionally, in some cases where a smaller gate opening is called for, it is impractical to open the gates to 2.5 feet for more than a very short time.

Current design criteria recognizes the importance of designing hydraulic structures that can safely operate with unbalanced gate openings as discussed in the enclosed excerpt from Engineer Manual 1110-2-1605. Existing multiple-gate water control structures can be modified to be safely operated with uneven gate openings. Depending upon the hydraulic regime that a structure is designed to operate under, and possibly other structural considerations, the pier(s) between the gates at the

structure can be extended downstream to its stilling basin's endsill. This would, in effect, convert an existing multiple-gate structure into a battery of single-gate structures placed side-by-side. The gate in each bay could then be operated independently of the adjacent bay(s). Information on some other techniques is contained in the enclosed REMR Bulletin.

Analytical techniques for determination of maximum permissible unbalanced gate openings are not available. These criteria are based on experience or physical model tests, and can vary from spillway to spillway. Please provide us with any information that you have regarding spillways along the coast that have been safely operated with 2.5-foot unbalanced gate openings.

Thank you for your cooperation. The point of contact is Mr. James Vearil at 904-232-2142.

Sincerely,

Edward E. Middleton, Ph.D., P.E.
Chief, Engineering Division

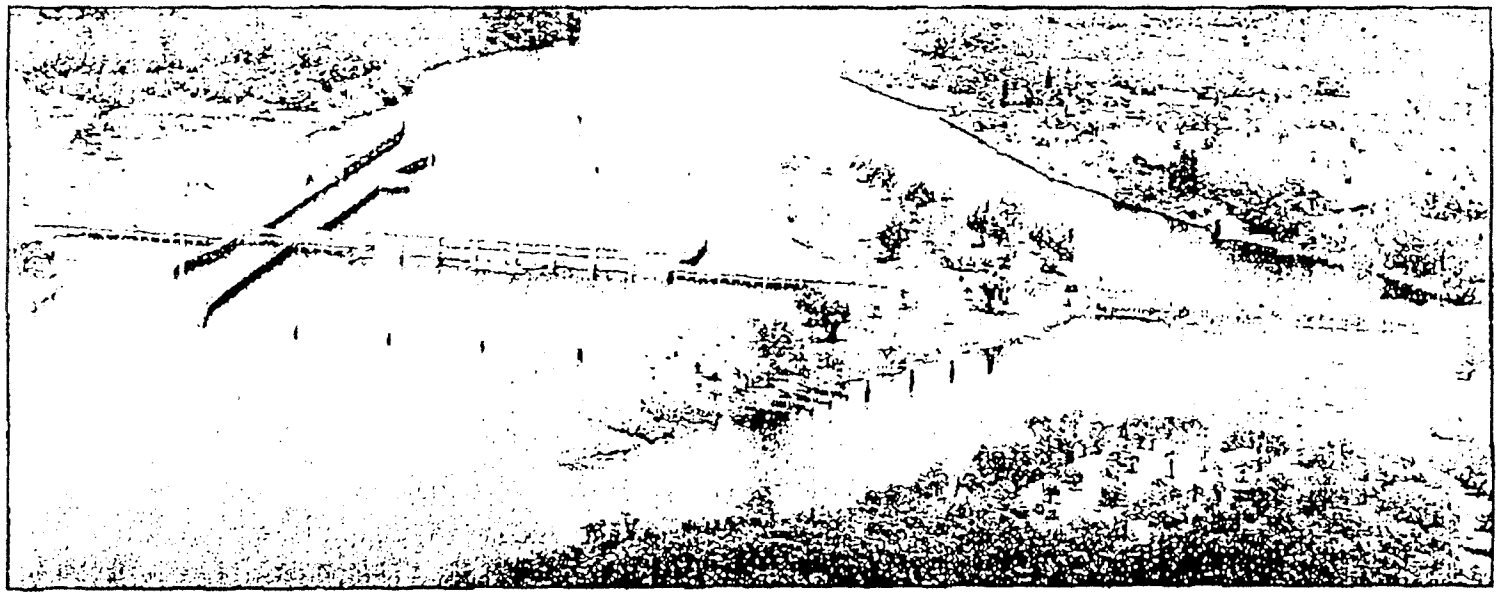
Enclosures

bcf (w/o encls):
CESAJ-CO-O
CESAJ-PD-E
CESAJ-EN-HH
CESAJ-DP-I

FILE MAINTAINED IN CESAJ-EN-HW

Sofia/CESAJ-EN-HW/fmj/1701
Vearil/CESAJ-EN-HW
Holand/CESAJ-EN-HH
Hilton/CESAJ-EN-H
DiChiara/CESAJ-CO
Salem/CESAJ-PD
Bonner/CESAJ-DP
Sanders/CESAJ-EN-A
Middleton/CESAJ-EN

UNINTERRUPTED FLOW



BRUCE FINE/News-Press

The Okeechobee Waterway is used by 75,000 boaters each year. Beginning Wednesday, the St. Lucie Lock will open their way to Stuart and the East Coast.

Unlocking the East

Gulf-to-Atlantic passage set to reopen for boaters

By BETSY CLAYTON
News-Press staff writer

The gate of the W.P. Franklin Lock slowly opened and Tom Craig eased in his 19-foot Bayliner.

The east Lee County man grabbed a rope from the lock chamber wall, cut the motor and waited for the lockmaster to work the gates. After the water level was adjusted, he motored out of the lock toward LaBelle for lunch.

Like 75,000 boaters a year, Craig uses the Okeechobee Waterway. But since June it has been impossible to take a through trip from the Gulf to the Atlantic. Now more than two months of construction at St. Lucie Lock is ending and the waterway will be open for traffic Wednesday.

Boaters west of Lake Okeechobee, such as Craig, have had nearly uninterrupted use of the locks all summer. But many Southwest Floridians have been waiting for access to the eastern locks to make the 152-mile trip from Fort Myers to Stuart.

Soon, like the car license plates from northern states on Cleveland Avenue, the sterns of boats passing through the locks will read of cities from up north.

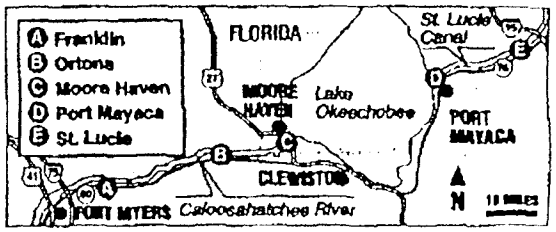
"Come the 31st we'll probably be swamped," said Ed Miller from his post east of LaBelle as lockmaster at Ortona Lock, where he's worked 10 years. "Then the Northerners will come and we'll be busier."

Miller estimated 90 percent of boaters he sees have already been through the Okeechobee Waterway locks. But even the experienced ones

See PASSAGE / 7C

■ Tips for passing through locks / 7C
■ Watersports calendar / 7C

OKEECHOBEE WATERWAY LOCKS



WATERWAY DISTANCES IN MILES

Gulf of Mexico Intracoastal to Franklin Lock	33.2
Franklin to Ortona Lock	27.9
Ortona to Moore Haven Lock	15.5
Moore Haven to Mayaca Lock – via open lake route	39.0
– via southern shore rim canal route	50.0
Port Mayaca to St. Lucie Lock	23.7
St. Lucie Lock to Atlantic Intracoastal	15.1

SOURCE: U.S. Army Corps of Engineers — News-Press

PASSAGE: Manatees gather at Franklin Lock

From Page 1C

sometimes get hung up — literally.

About twice a year, boaters who are locking down river tie off their craft instead of having the lines ready for an easy release. When the lower gate opens and the water exits by 8 feet, the inattentive boaters find themselves hanging on the wall.

Usually, Miller sees the disaster before it happens and can stop the mechanical lock to raise the water level. Or he cuts the line.

The more common problem boaters have in the locks is simply bumping into the chamber walls when they pull in, said officials with the U.S. Army Corps of Engineers, which manages the waterway.

They liken it to parking a car in a parking garage next to a concrete post.

Dawn DeSesa of Fort Myers is particularly careful to avoid the chamber wall when she rides her 6-month-old Yamaha Wave Raider through Franklin Lock on weekends.

"I stick out my leg because I don't want it banged up," said DeSesa, who usually tours on her personal watercraft with 10 friends. "But my one friend just pulls on in and hits hers every time."

After a few trips through the locks, most boaters get it down. Then they have time to do some nature scouting.

Franklin Lock is one of the best places in Lee County to see manatees, especially in early morning or early evening. Moore Haven Lock in Glades County also offers great viewing of the endangered marine mammals from land or boat.

A boater from Savannah who recently was locking through Moore Haven grabbed her camera while waiting in the lock chamber as four manatees swam by together.

LOCK OPENINGS

From west to east, opening years for Okeechobee Waterway locks:

■ Franklin Lock	1965
■ Ortona Lock	1937
■ Moore Haven Lock	1935
■ Port Mayaca Lock	1977
■ St. Lucie Lock	1946

(An earlier lock at St. Lucie was built in 1919.)

An estimated 1,600 manatees are locked through the waterway each year, said Eric Jeffcoat, assistant chief of the Corps South Florida Operations Office.

Alex Elkswick, 12, said going through Franklin Lock in his friend's boat always affords a spotting of a gator or turtle up close.

The North Fort Myers boy said besides nature watching, he observes the mechanics of the lock gates. "When it opens and the water rises up it looks sort of like a dam," he said.

In fact, it is. The Okeechobee Waterway is not just for transporting boats. Every lock is a dam — remember, a lock is merely a way to navigate around a dam — and the whole idea behind the waterway is flood control.

After two hurricanes devastated communities bordering Lake Okeechobee in the late 1920s, the Corps of Engineers got involved managing the waterway in 1937 — providing a way to release flood waters from the lake.

Maintenance and repairs on the locks are needed every so often. If the structure corrodes, metal fatigue develops and endangers the entire lock. A new Corps goal designed for convenience to boaters means individual locks will be closed for maintenance only every other year, rather than annually, Jeffcoat said.

The locks' appearance — lack of depth — often spurs questions to lockmasters from boating natives of the West Coast and North. The most typical: Why do you need the locks if the drop is so minimal? "Oh, to keep the lake from draining and the streets of LaBelle from flooding," Miller says whenever asked. Ortona Lock's 8-foot drop is the largest on the waterway west of Lake Okeechobee.

His answer usually convinces boaters the locks are necessary. But sometimes it's not easy to convince them the wait to be locked through is, Miller said.

At Ortona, it can take 20 minutes. If a boater arrives just as the gate is closing and someone on the other end needs to be locked through next, that boaters must wait 40 minutes.

"You're sitting out there in a hot boat in Florida weather and every minute can seem like an hour," he said.

Still, most boaters manage to be patient and not let tempers flare. Lockmasters estimate they have problems with fewer than 5 percent of all boaters.

Most remember the lockmasters are the equivalent to police officers once someone is using the locks, Jeffcoat said.

Craig agreed as he waited at Franklin Lock.

"It's very simple," he said. "He doesn't have to open the gate and he can write you a ticket."

LOCAL NEWS

Protecting manatees a lesson in trial and error

Researchers get good news from tests designed to protect the sea cows from water control structures.

By HEATHER GRAULICH
Palm Beach Post Staff Writer

Frustrating. Difficult. Trial ... and error.

Words commonly used in the world of research and development, but agonizing to biologists trying to save an endangered species.

Last week, researchers with the U.S. Army Corps of Engineers and the South Florida Water Management District got hopeful news from one in a series of tests on instruments designed to protect manatees from water control structures.

On Wednesday, a sonar device that can detect manatees in cloudy canal water worked perfectly during a test by the corps at Port Mayaca Lock in Martin County.

"We felt it was a very successful test," said Dena Dickerson, a research biologist with the Corps' Waterways Experiment Station in Mississippi. "We could see a manatee near the gates on the monitor as he swam around."

Since 1974, 89 manatees have been crushed or drowned in the two dozen navigational and flood control locks and spillway gates built by the corps and the district in South Florida. Since 1991, a task force of six state and federal agencies has worked to write a manatee protection plan to reduce these deaths.

"It's a frustrating process," said Frank Lund, manatee coordinator and a senior scientist with the district. "It seems so simple, but it's just damn difficult."

The problems with finding equipment that can detect and protect manatees as they pass through the structures are numerous. Strong water pressure, boat collisions and muck damaged a set of test hinge plates on the Taylor Creek lock in Okeechobee County and caused them to fail, Lund said.

It was hoped that the plates — mounted on either side of the swinging gates — would cause the gates to stop closing and reopen if a manatee was stuck in between.

Another blow to the program occurred at a spillway in Dade County earlier this year. The spillway's doors swayed from the force of tides, pushing a prototype manatee detection system off-track so that electronic sensors were not triggered. Two manatees later were crushed.

That system has since been fixed and no manatees have been killed, Lund said, but the hinge plates for the lock structures are still getting tweaked by the corps to see if they can be modified.

In the meantime, other safety equip-

Please see MANATEES/5B

Sonar tests show promise

MANATEES
From 1B

ment ideas are being developed.

One is an oil-filled plastic tube that would be mounted on the end of each lock gate and replace the hinge plates. A manatee caught between the gates would push on the tubes, causing the oil to rise and activate a switch to reopen the doors.

But the sonar system has been the most promising test yet, Dickerson said. Although it would not keep manatees from using the locks — places they seem to like to play around and use for traveling purposes — it could make them safer.

Sonar bounces sound waves off underwater objects. By watching a screen, a lock operator could check for manatees before opening or closing gates.

"The gate keepers are helpless because they just don't know the manatee is down there," Dickerson said. "Technically, it should be an easy problem to find a large mammal in what is the equivalent of a giant concrete bathtub. This works like a sound camera."

The next hurdle will be establishing protocol once a manatee is noticed. It could mean halting boat traffic and waiting for the manatee to move along.

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PALM BEACH POST
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MAY 28 1995

Protecting manatees a matter of trial, error

Researchers get good news from tests designed to protect the sea cows from water control structures.

By HEATHER GRAULICH
Palm Beach Post Staff Writer

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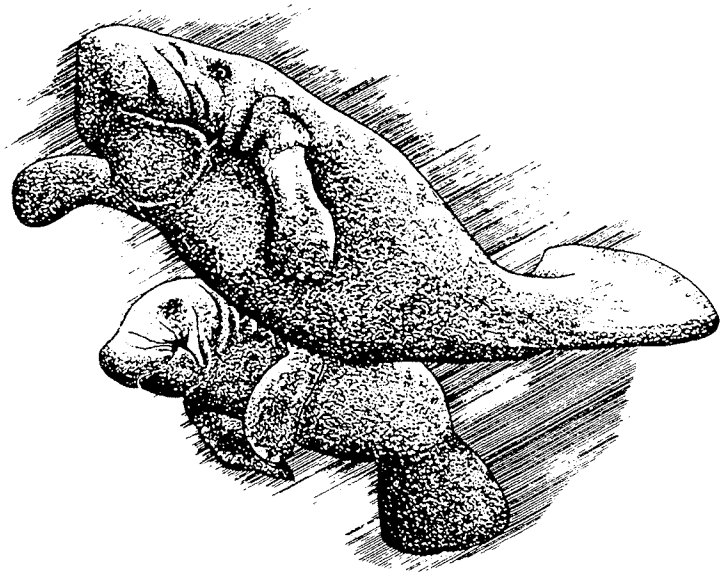
Attn: Ed Albanesi

Manatee Watch



Volunteer Watch Program Has Corps and Public Working Together to Save the Manatees

Story and Photos by Christina Plunkett

The Jacksonville District continually strives to develop programs that support environmental preservation and restoration goals throughout the nation. The uniqueness of a recent endeavor, the Volunteer Manatee Watch Program, shows the District's personal commitment to protecting endangered species.

Structure related manatee deaths recorded last year in Florida were the highest since record keeping began in 1975. Environmentalists believe the excessive amount of rain fall that caused heavy releases from water control structures in South Florida last year contributed to the deaths. The greatest number, six, were found near Ortona Lock and Dam. This sad discovery prompted a watch and data collection mission by the South Florida Operations Office (SFOO) in hopes of finding what the manatees' behavior pattern is around a water control structure.

The mission began last fall when the lock tenders at Ortona started conducting a round-the-clock watch of the structure. Around the same time, a special manatee protection barrier was installed in front of the spillway gates in order to keep the manatees from the possibility of becoming trapped and drowned.

The lock tenders watch became a volunteering opportunity in January when SFOO Manager Pete Milam came up with the idea to get the Ortono park visitors involved while, at the same time, educating them about the manatee. Park Ranger Stacy Amick took the concept and created the program, according to Milam.

Amick recruited volunteers through meetings and distributing flyers at the campground. Amick, along with Project Biologist Ron Miedema, also provided training on how and where to spot manatees at the Ortona Lock and Dam and how to record their behavior. Ortona campers traveling to other campgrounds also spread the word about the program. In less than a month, Amick's hard work paid off. The 24-hour watch is now completly manned by volunteers with a waiting list of potential volunteers.

"The whole volunteer program initiative, whether this program or others, such as Lake Okeechobee Cleanup Day, is to provide an opportunity for the public to work with the Corps and see what we do, as well as enhance our operations," explained Milam. "It's obvious from the campers' enthusiastic response that the public cares about the manatee's safety," Milam said.

Presently, nine couples are monitoring the manatees' behavior around the four gated spillways of the Ortona Dam. The participants not only observe manatee activity but look for any special identification marks. They also watch for any tagged manatees. Should a tagged manatee be observed, they are asked to call the toll free manatee hot-line which tracks manatee movement throughout its territorial range.

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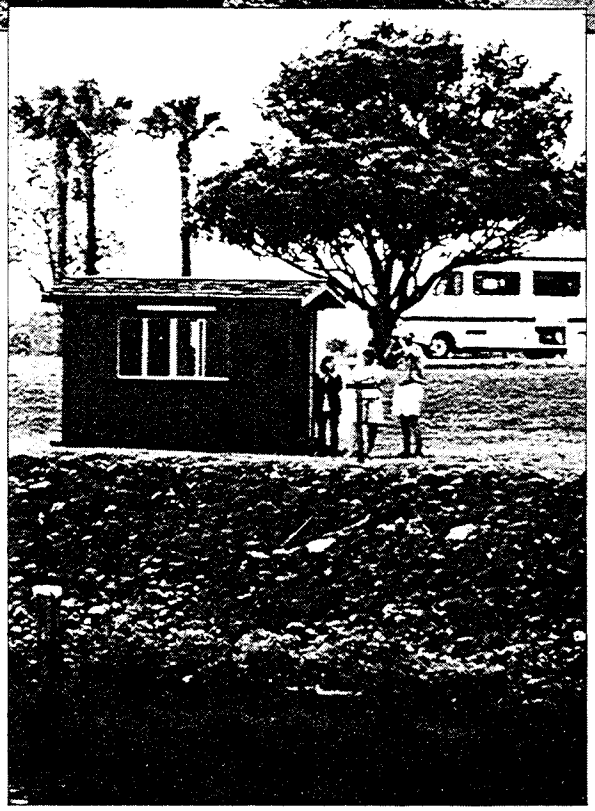
Because of unseasonably cold weather in February, only 17 manatees were spotted, with a cow and calf pair among them. From early to mid March, 12 were seen wading through the Ortona Lock.

As data is collected on the manatee's behavior around the structure, the District will decide how any determined risks could be removed from the dam to keep the manatees safe. Although six manatees were found dead downstream of the Ortona Lock, autopsies could not determine if the structure contributed to the deaths, according to Milam. It is still too early to determine if the gate barriers are helping to keep the manatees out of harm's way when the gates are closing. "We are still working on the design of the barriers because they collect a lot of debris," Milam said.

"It's obvious the volunteers monitoring Ortona's spillways feel good about what they are doing," Amick said. Enthusiasm in their contribution to this program is spreading throughout the campground as more and more park visitors stop and inquire about their activities, according to Amick. As a "thank you" to the volunteers, they are allowed to camp on the grounds for free. Because the nine couples are either golden age or golden access card holders, the cost to the Corps is nominal.

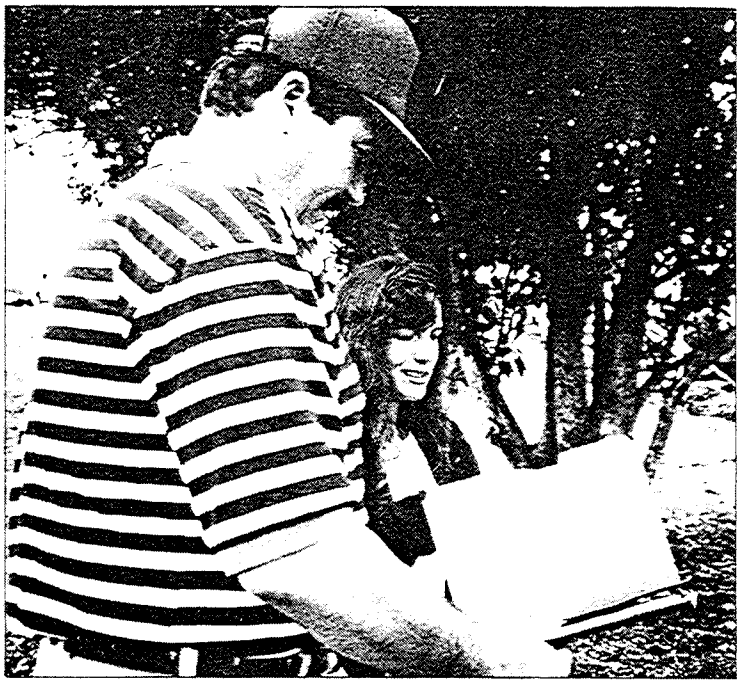
Because of the valuable information the program provides and the opportunity to educate and work with the public, the Manatee Watch Program has the potential of being a useful long-time program, according to Milam. "It's amazing how quickly the public responded to the need for volunteers, which made it possible for our lock tenders to go back to their regular duties," Milam said.❐

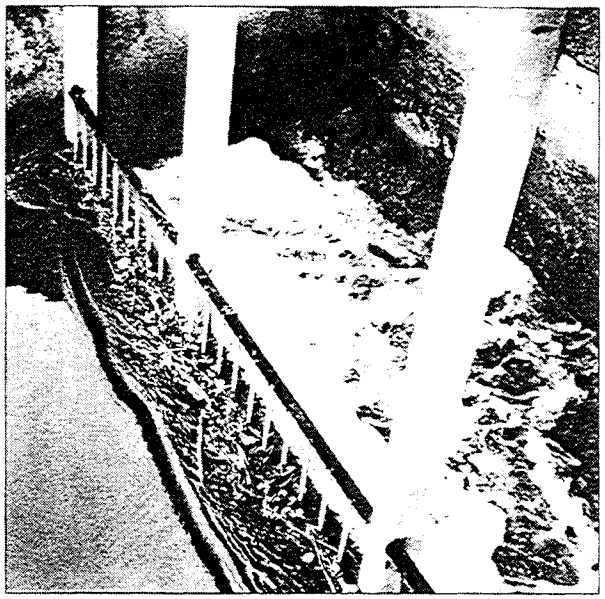
Col. Terry Rice borrows binoculars from a volunteer watcher to scan the manatee barriers in front of the spillway gates at Ortona Lock and Dam.



Volunteer manatee watchers keep a close eye on Ortona's spillway gates next to the building that was constructed to protect the volunteers from the weather.

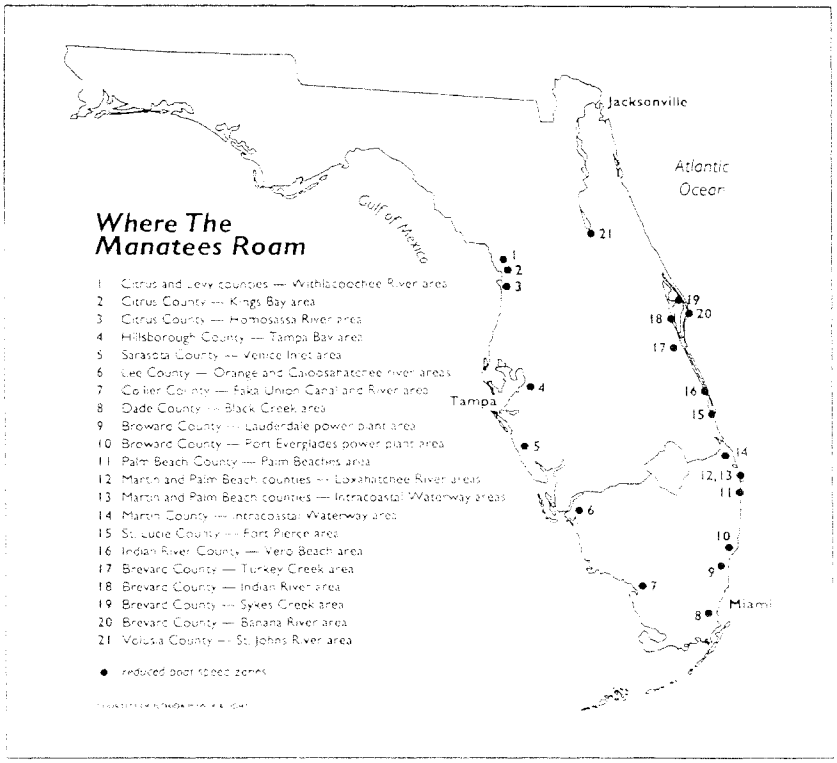
Manatee Watch *Continued*





A close up view of the manatee protection barrier that was installed last fall in front of the spillway gates at Ortona Lock and Dam to keep the manatees from being trapped.

Left: Pete Milam, SFOO Manager, and Deborah Elfindale, volunteer, look at the watch reports that show manatee behavior since last fall.



Manatee Alert

The slow-moving marine mammals are in Florida year-round, but their numbers swell in the winter, when many move to South Florida.

The Season
November 15 - March 31.

Boating Rules
Posted signs dictate slow or idle speed with no wake. A speeding violation in a manatee zone is a second-degree misdemeanor. The penalty: a fine of as much as $500 and up to 60 days in jail.

Don't Bother the Manatees
It's illegal to harass or molest a manatee under federal law. Potential penalty: up to $20,000 fine and a year in jail.

How You Can Help
If you spot an injured, harassed or dead manatee, call the Manatee Hotline any time at **1 - 800 - DIAL FMP.**