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TO: Principals of the Consent Decree

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FROM: Representatives on the Technical Oversight Committee

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Date: February 24, 2005

**Progress Report on Remedial Measures to Control Phosphorus Inputs to
the A.R.M. Loxahatchee National Wildlife Refuge**

The TOC met in special session on November 8, 2004 to discuss the circumstances of an August 2004 exceedance of the Interim Phosphorus Levels in the Refuge. This meeting provided an opportunity to review all relevant information on external and internal factors involved in phosphorus levels in the Refuge and potentially having some role in exceedances of the Interim Phosphorus Levels. While TOC representatives can agree on the suite of potential causes of the exceedances, the TOC also finds that there is not definitive information or agreement on the relative importance of these factors. As a result, the TOC and Settling Parties find it more appropriate and effective to focus on the remedy rather than to continue debating the which factor may have been most involved in a particular exceedance.

Following the November 8, 2004 TOC meeting, the Principals of the Consent Decree met and provided guidance to the TOC in a letter dated November 9, 2004. They recognized that TOC had invested substantial effort to arrive at consensus recommendations in response to the 2002/2003 exceedance of the Interim Phosphorus Levels, culminating in a letter agreement dated April 2, 2004. The agreement supports remedial and monitoring measures in response to the 2002/2003 exceedance, based on the detailed TOC recommendations dated July 24, 2003. Most of these measures are contained in the District's Long-Term Plan and in the letter of November 9, 2004, the Principals re-affirmed the suite of actions being taken based on the April 2, 2004 agreement. Absent extenuating circumstances, they indicated that the Settling Parties should allow sufficient time for those measures to be completed before imposing additional remedies.

The Principals requested that the additional measures being put in place by the State beyond those of the April 2, 2004 agreement should be discussed at the November 30, 2004 TOC meeting, along with possible water management

actions to further reduce phosphorus loads and levels. They anticipate recommendations based on these discussions. Further, they request a report on progress to date implementing the April 2, 2004 agreement. In this summary of progress, they expect an update on: 1) actions being taken to control phosphorus loads to the Refuge, 2) enhancing monitoring of the Refuge and 3) modeling of the Refuge. These are the three general categories of recommendations submitted by the TOC in their letter of July 24, 2003.

Introduction to the Progress Report

The Settling Parties have identified several factors that could contribute to or potentially cause the exceedances of the Interim Phosphorus Levels in the Refuge. However, genuine differences of professional opinion exist as to the relative weight of various factors in affecting phosphorus levels in the Refuge, generally and in causing the exceedances, specifically. To move constructively forward, a three-prong remedy was devised by the TOC (July 24, 2003) and approved by the Principals (April 2, 2004) to address multiple sources of phosphorus to the Refuge and to provide additional information through monitoring and modeling. The following summary uses the three-prong outline and titles of the July 24, 2003 recommendations from the TOC to the Principals while referencing specific activities described in the November 2004 version of the Long-Term Plan.

The following paragraphs and appendices constitute the requested progress report to the Principals. The report was discussed in detail at the January 24, 2005 Special Session of the TOC and approved at the quarterly meeting of the TOC on February 25, 2005.

A. Controlling Phosphorus Loads to the Refuge

Background of the Phosphorus Control Program

The overall remedy considered by the Principals and the TOC in relation to controlling phosphorus loads to the Refuge (Category A TOC recommendations) is embodied by the organizational framework of the Long-Term Plan for Achieving Water Quality Goals, or Long-Term Plan (LTP). The LTP includes projects and activities spanning years of planning and derived from three different sources. As reflected in the Principals letter agreement of April 2, 2004, one important source of projects is the existing phosphorus control measures established by the Settlement – the STAs and BMP Program. Prepared by the Water Management District over a more two years, the Plan contains a major series of activities involving the installation of physical improvements or upgrades to the existing STAs to improve their performance. Updates on specific activities being executed under the Plan and recommended by the TOC are provided below. At the time of the April 2, 2004 agreement of the Settling Parties, improvements of the Long-Term Plan had been finalized and were being implemented. In formulating their remedy to the Refuge exceedances, the Settling Parties recognized the obvious benefits of using the organizational

structure and detail of the plan to assure that appropriate actions were being taken and progress could be tracked and reported.

The second major component of the P control program is a series of operational refinements and research projects initiated since the original Long-Term Plan was drafted to further improve STA performance and otherwise reduce phosphorus levels. These are generally set forth in the TOC's recommendations of July 24, 2003, which were approved by the Settling Parties. The Settling Parties recognize that there is a great amount of uncertainty associated with all of the phosphorus control programs set into motion under the Settlement and EFA, and as a result, we must constantly re-evaluate that remedy in an adaptive manner.

The third group of projects for P control is several recent initiatives by the State in conjunction with the Army Corps of Engineers, a combined effort known as 'Acceler8'. First in relation to P control to the Everglades, the State is committed to building approximately 18,000 additional acres of STAs in the EAA, about a 40% increase from the current size. This project will substantially improve water quality in the Everglades. Second, the State and the Corps are expediting construction of several CERP projects that will also help improvement.

The following paragraphs update progress on projects and activities in the LTP originating from the Settlement Agreement, the first version of the LTP and the Acceler8 initiative.

A. 1. Continue to develop and implement strategies to operate the STAs within their design range. That should include review of baseline hydrologic data sets used for STA design and updating to reflect current regional water management.

A.1.a. Operate the STAs within their design range

1. Project: Flow-through operation of STA-1E.

- a. **Purpose:** Until STA-1E is in flow-through operation, there will likely be continued diversion of untreated water to the Refuge, as STA-1W was designed to work in concert with STA-1E, by sharing the flows from S-5A basin.
- b. **Status:** The Corps determined that STA-1E construction was substantially complete in June 2004. Since that time, the District has been implementing vegetation management activities in all cells except Cell 2, which the Corps is maintaining control over as the location of their proposed PSTA demonstration project. The FDEP is in the process of issuing operational permits for the STA.

2. Project: Minimize Lake Okeechobee regulatory releases to the Refuge

- a. **Purpose:** STA-1W was not designed to treat regulatory releases from Lake Okeechobee, hence sending these water to STA-1W may result in flow and phosphorus loads in excess of the STA

design quantities. Minimizing these releases will reduce P loads to the Refuge.

- b. **Status:** In February 2003, the District terminated the delivery of regulatory releases to STA-1W from Lake Okeechobee, which was above its regulation schedule. STA-3/4 was designed to treat these regulatory releases and it is now operational and has been receiving regulatory discharges.

3. Project: Delivery of water around the Refuge instead of through the Refuge

- a. **Purpose:** To minimize the delivery of water supply make-up water (and associated P loads) to the Refuge without compromising downstream water supply needs.
- b. **Status:** The District and local water supply district have experimented with delivery of water around the Refuge instead of through the Refuge. A maximum of 500 cfs can be delivered in this manner when conditions in the C-51 West Basin are amenable.

4. Project: Develop and implement operational tool to ensure STAs are operated within their design range

- a. **Purpose:** To avoid overloading the STAs
- b. **Status:** The District developed an operational tool to track actual vs. anticipated design range for flow and phosphorus. This tool is used in weekly meetings with Operations staff.

5. Project: G-341 divide structure

- a. **Purpose:** to minimize water and associated P loads to STA-1W that should go to STA-2
- b. **Status:** Construction is underway on the divide structure in the Ocean Canal.

6. Project: Temporary deviation from Refuge regulation schedule

- c. **Purpose:** to minimize water quality impacts to the Refuge associated with the current regulation schedule
- d. **Status:** On January 6, 2005, the District requested a temporary deviation for the regulation schedule of the Refuge from the USACOE, Jacksonville. The District asked for the removal of the condition requiring water supply releases be balanced by deliveries when the Refuge stage is less than one foot above the stage of Lake Okeechobee. By removing this condition, water supply deliveries from the Lake would not be required at high stages. Removing this requirement will decrease the potential for the penetration of canal water into the interior areas of the Refuge. This is one step in the direction of decreasing water quality impacts to the Refuge through changes in regional water management.

A.1.b. Review and update the baseline data set

1. **Project: Review and update baseline data set**

a. **Purpose:** To update the anticipated flows and loads to the STAs for subsequent evaluation of potential regional modifications to optimize STA performance

b. **Status:** The STA performance measures in the Settlement Agreement assumed future flows would match the flows that occurred during the 10-yr base period (1979-88). It turns out that some of the actual flows are considerably higher than the Base Period. Of particular concern are flows from the upstream basins that contribute to STA-1W, which may be up to twice the anticipated amounts until future CERP projects are in place (e.g., the L-8 diversion project). The District's simulation model was re-calibrated using updated information. A review of the actual and anticipated flows and loads are underway at this time, with a target to complete this analysis by September 2005.

2. **Project: EAA Regional Feasibility Study**

a. **Purpose:** One major objective is to determine an optimal re-allocation of flows and loads to the STAs that will minimize overloading. A subsequent task is to identify the necessary revisions to the operational regime, or physical improvements to the conveyance system to implement the optimal re-distribution of flows and loads.

b. **Status:** The District has initiated a regional feasibility study for the EAA that will utilize the updated data sets. The feasibility study should be completed in the summer of 2005. (See further discussion of the regional feasibility study below.)

A.2. Review the Long-Term Plan to determine whether additional measures are appropriate for optimizing phosphorus reduction. Implement such measures as necessary to achieve the long-term levels.

In general, the STA enhancements contained in the Long-Term Plan include the following features:

- Conversion of emergent vegetation to submerged aquatic vegetation, which has been demonstrated to generally reduce phosphorus to lower levels than emergent vegetation.
- Construction of physical features to improve the movement of water within an STA, thereby allowing greater opportunity for the plants to remove phosphorus.
- Refinement of the operations of the STAs – including lowered depths which have been shown to improve phosphorus removal, and balance flows/loads among the cells within an STA, reducing loads has been shown to reduce p levels in discharge

The Long-Term Plan was reviewed and the following modifications were made:

1. Project: Review Long-Term Plan and revise to optimize phosphorus reduction

- a. **Purpose:** To optimize phosphorus reduction
- b. **Status:** The District added a water control structure and remotely operated gates to the plan of enhancements to STA-1W. The construction contract for the STA-1W enhancement was awarded in the fall of 2004 and work is underway. The target completion is December 2006. The result of these refinements to the Plan should be increased operational flexibility to move water among the treatment cells within an STA in order to balance the flows/loads better under the theory that balanced loads will improve performance

2. Project: Revise operations of STA

- a. **Purpose:** to optimize phosphorus reduction
- b. **Status:** The District has revised the operating depths within STA-1W in order to improve performance

A.3. Refine operational strategies to reduce short-term loads to and from the STAs.

This component of the remedy is based on the theory that by reducing the short-term phosphorus loads to the STAs, there will be better performance of the STAs due to reduced peaks – the result of more of an even inflow – therefore more opportunity for the plants to remove phosphorus. There is a similar theory that reducing short-term loads from the STAs (and therefore to the Refuge) there will be less penetration into the interior marsh.

1. Project: Use smaller pumps prior to the larger ones

- a. **Purpose:** To reduce short-term loads from the STAs to the Refuge
- b. **Status:** This is the standard operating protocol. The standard practice for the STA-1W outflow pump stations (G-251 and G-310) is to use the smaller (75 and 100 cfs) electric pumps first instead of the large diesel pumps (470 and 950 cfs).

2. Project: Revise operation of STA outflow pumps from 8-hr on/16-hour off to 24-hour on

- a. **Purpose:** To reduce short-term loads from the STAs to the Refuge
- b. **Status:** During 2004, The District began implementing 24-hr pumping of the STA-1W outflow pumps instead of the prior practice of pumping for 8-hr, then shutting down for 16 hours. This increases the cost to the District, but these expenses are warranted if this operational protocol reduces phosphorus levels into the Refuge.

3. Project: Revise operation of STA inflow pumps from 8-hr on/16-hour off to 24-hour on

- a. **Purpose:** To reduce short-term loads to the STAs
- b. **Status:** The District is investigating a similar continuous pumping protocol for the S-5A (inflow) pump station. Extensive coordination with the upstream landowners will be required, and an initial meeting with an industry representative has taken place.

4. Project: Increase conveyance capacity of L-40 canal downstream of STA-1E

- a. **Purpose:** to reduce short-term loads from STA-1E to the Refuge
- a. **Status:** As part of the STA-1E construction, the US Army COE has agreed to increase the conveyance capacity of the Refuge canal downstream of STA-1E. This should reduce the hydraulic penetration of STA-1E discharges into the interior marsh of the Refuge.

A.4. Review of regional water management decisions affecting STA operations and performance.

1. Project: Review of regional water management decisions affecting STA operations and performance

- a. **Purpose:** To identify regional decisions that may be adversely affecting STA operations and performance
- b. **Status:** Susan Sylvester of the COE is leading the effort to review the Lake Okeechobee and WCA regulation schedules at the request of the TOC.

The Refuge has identified several areas of concern or interest relative to regional water management and its influence on water quality (via Matt Harwell, 1/18/05; *District suggestions are in italics*):

1. Investigate in general the relationship between water supply operations and water quality. Evaluate feasibility of diverting water supply release from LO around refuge. *The operational aspect of this issue has been addressed in Section A.1.a.#3*
2. Avoid water supply releases in the periods when the regulation schedule is increasing. This practice forces replenishment of the release by new inflows from the rim canal in order to satisfy the regulation schedule. *In Section A.1.a.#6., an update was given on the request for a temporary deviation from the Regulation Schedule.*
- 3) Refuge's Regulation Schedule: A few things:
 - a. Consider deferring the seasonal increase in stage until later in the wet season? The objective would be to "rinse" the marsh fringe areas with rainfall for a period of time and export the initial flush of elevated P water to the rim canal (vs. interior marsh). *The Refuge should work with the CORPS and other others to request deviation or modification of the Regulation Schedule. The same applies to the next two issues in this set.*
 - b. Explore developing a rain-driven regulation schedule, under which the seasonal maximum stage would be related to rainfall (vs. fixed). A fixed stage requires more inflow from the rim canal in dry years, whereas rainfall satisfies more of the demand in wet years. This is probably the only way to deal with marsh water quality impacts associated with hardness, chloride, and other conservative substances that cannot be reduced by BMP's or STA's.
 - c. Avoid "double hitches" in the stage. In some years (1999, for one), the stage was suddenly dropped during a period with the regulation schedule was still increasing and then subsequently increased back to the original stage to satisfy the schedule. This could effectively double the intrusion of canal water in some years. The reasons for this are unclear (possibly draw-down in anticipation of large storm events so that the Refuge can function as a flood storage facility?).

B. Enhancing Monitoring of the Refuge

B.1. Design and implement an enhanced monitoring program to improve spatial and temporal understanding of factors related to phosphorus dynamics.
(contributed by Matt Harwell, 1/18/05)

An expanded water quality monitoring network (a combination of transects and individual sites) has been designed and established (Fig. 1). With the rise in water levels, complete sampling of the network occurred in September, October, and November (Figs. 2-4). This provides us a full quarter of data to begin preliminary analysis and interpretation. The results of these analyses will be presented at future TOC meetings. Final data for monthly samples continue to be publicly posted on DBHYDRO by the SFWMD.

The monitoring transects are also being equipped with water conductivity data loggers to collect conductivity and temperature data. This information can

then be used to understand and refine operations, when possible, to minimize canal water intrusion into the interior marsh. Four of these transects have been instrumented and, in cooperation with the USGS, we plan to deploy additional instruments within the next few months. Conductivity sonde deployment information for 2004 is presented in Table 1.

In September, three hurricanes passed through the region: Hurricane Frances (September 4), remnants of Hurricane Ivan (September 20-21), and Hurricane Jeanne (September 25). The Refuge's Enhanced Water Quality Monitoring sampling occurred 14-16 September and 4-7 October. We hope to utilize information from our water quality monitoring network to gain insights from these storms.

Enhanced Monitoring, Status

- Sampling in December included 39 stations
- Conductivity sondes were deployed in January at XXX stations from Table 1 of the Nov update (don't have this in front of me)
- Don't have the monthly sampling station maps (from previous updates) available at this point (but will soon)
- Sampling in January included 36 stations
- Conductivity sondes were deployed in January at XXX stations from Table 1 of the Nov update (don't have this in front of me)
- Don't have the monthly sampling station maps (from previous updates) available at this point (but will soon)

As part of a larger discussion on "L-40 enhancements" related to STA-1E construction activities, the Refuge put forth (11 January, 2005 meeting of Corps, SFWMD, FDEP, & Refuge) strawman "performance measures" related to better characterization/understanding of potential STA-1E impacts, specifically as it relates to L-40 enhancement activities.

C. Modeling of the Refuge

(Contributed by Matt Harwell, 1/18/05)

C.1. Develop a water quality / hydraulic model for the Refuge with a phosphorus cycling component.

C.3. Develop and track a simple phosphorus mass-balance for the Refuge.

A contract has been established with Dr. Ehab Meselhe (University of Louisiana – Lafayette) for the development of these modeling tools for the Refuge. The first phase of this effort involves a model selection process.

Current Status:

- Dr. Meselhe made initial visit to Refuge
- Model selection process in progress
- The first phase of Dr. Meselhe's model selection project is nearing conclusion with the meeting of the External Technical Panel (chaired by Dr. Neary) on 28 January, 2005.

- Finally, below is a brief list of some of the next steps that are critical for the implementation of this project:
 - Complete personnel actions necessary to complete the project. Upcoming hires include a water quality technician and a water quality ecologist.
 - Develop database management approach for data from the project
 - Refine information presentation approaches
 - Ongoing data analysis
 - The monitoring program will be presented at the 1st Nat. Conf. on Ecosystem Restoration in Orlando (Dec. 5-9th)

Separately, a contract has been established with Dr. Vince Neary (Tennessee Technological University) to establish an external technical panel to provide review of the model selection process and the development of the modeling tool(s) over time.

Current Status:

- Technical Panel members identified.
- Initial panel meeting targeted for January 2005.

C. Modeling of the Refuge

C.2. Evaluate issues associated with phosphorus loads and transports within the L-40 and L-7 canals.

A canal monitoring contract has been established with Dr. Samira Daroub (UF – IFAS) to conduct canal hydrographic surveys and synoptic water quality surveys.

Current Status:

- Survey protocols and plans are currently being developed.
- The sediment survey component will begin by end of CY 04.
- The canal water quality survey component will begin in early CY 05.

Progress Report to Principals of the Consent Decree, February 24, 2005

Additional Measures to Reduce Phosphorus Loads to the Refuge besides the ones recommended by the TOC in their July 24, 2003 memo. At its November 30, 2004, the TOC discussed several additional measures being undertaken to decrease phosphorus (P) imports to the Refuge beyond those measures considered in the July 24, 2003 TOC recommendations.

1. Project: Acceler8

- a. **Purpose:** Multi-purpose; Four Acceler8 projects will provide direct benefits to the Refuge. Three benefits will be derived from these Acceler8 projects:

- i. The primary and most direct benefit will be a reduction in phosphorus entering the Everglades.
 - ii. A second benefit will be improved timing and distribution of water to the Everglades – more closely reproducing the historic flow patterns.
 - iii. A third benefit is the additional operational flexibility provided by more storage and treatment areas.
- b. **Status:** Recently, the District, the State of Florida and the federal government initiated a major effort, referred to as Acceler8 that will provide significant benefits to the Everglades.
- i. Design is underway for an **18,000-acre expansion of the STAs**. Approximately 9,000 acres adjacent will be adjacent to STA-2, and as such, will be located close enough to STA-1W that it could receive a portion of the flows and loads that are currently entering the Refuge through STA-1W. Another approximately 9,000 acres of expanded treatment area will be located between STA-5 and STA-6.
 - ii. **Diversion of Acme Basin B discharges.** Currently, discharges from Wellington Acme Basin B go untreated directly to the Refuge. As part of Acceler8, these discharges will be terminated, and the water directed to STA-1E for treatment.
 - iii. **EAA Regional feasibility study** – As described in section A.1.b.#2 above, one objective of this project is to balance the flows and loads among the STAs, potentially enlarging canals to allow this interbasin transfer from the east to the west where these new areas are located. There is even one scope item that will look at enlarging the treatment area serving the Refuge if the 18,000 acres are not sufficient to meet the long-term water quality goals.
 - iv. **Everglades Agricultural Area Reservoir – Phase 1 with Bolles and Cross Canals Improvement.** This project will construct any necessary refinements to the existing canal system to be used to convey water from STA-1W to the expanded STA adjacent to STA-2. In addition, the additional storage to be provided in the reservoir will increase operational flexibility in the EAA canal network, which could lead to optimized performance of the STAs.

2. Possible water management practices related to water quality in the Refuge

(The following section was contributed by Mike Waldon, Refuge, on January 13, 2005, as a draft for TOC review. It is not clear from the Principals Nov. 9, 2004 letter whether this material is required in the Progress Report. However, it seems the Report is a timely and appropriate mechanism to communicate TOC recommendations requested by the Principals. gr)

In their letter of November 9, 2004, the principals of the consent decree requested information from the TOC including:

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“the TOC should analyze the relationship between the current water management practices and water quality compliance, as well as opportunities to alter water management to improve water quality while maintaining water quantity benefits. The Principals anticipate further recommendations from the TOC regarding these additional measures.”

Under oligotrophic conditions typical of the refuge, phosphorus is quickly sequestered into the biotic and abiotic pools. Significant reduction of water column phosphorus occurs within a few days under these low phosphorus conditions. Thus, it is reasonable to expect that when water that is high in phosphorus moves relatively rapidly toward the refuge interior, it may raise phosphorus concentrations within the plants and soil. This, in turn, can result in community change and eutrophic impacts.

Evidence from a number of lines of evidence and reasoning suggests that water operations within the refuge that cause water stage to rise then fall back to near initial levels over relatively short periods of a week or less may contribute to elevated phosphorus concentrations in the fringing, and possibly in the most interior marsh. The significance of the short-term stage fluctuations as a mechanism enhancing phosphorus impact relative to other mechanisms of movement of phosphorus (longer-term advective and dispersive transport) is not well understood at this time. However, in the absence of constraints or significant additional costs, it is prudent at this time to implement operational changes that minimize short-term stage fluctuations.

At the November 30 TOC meeting, three operational changes that should reduce these short-term stage fluctuations were proposed for further consideration:

1. Extend the daily duration of pumping to 24-hours

The G-310 and smaller G-251 pump stations at STA-1E deliver treated stormwater to the L-7 Canal within the refuge. The G-310 pump station houses two 10 cylinder, opposed piston, 2 cycle diesel engines, two 6 cylinder, opposed piston, 2 cycle diesel engines and two electric motors at 200 horsepower each. The 10 cylinder engines are capable of pumping 950 cubic feet of water per second (CFS), the 6 cylinder engines pump 470 CFS, and the electric motors pump 100 CFS (SFWMD 2004). The electric pumps are capable of remote operation without on-site staff. The diesel pumps, however, require on-site staff for operation.

Note - This item was addressed in section A.3.1 above.

In the past, routine STA discharge pumping operations have been limited, when feasible, to operations during the day work shift to minimize staffing requirements and costs. This daily on/off pump operation does cause a measurable fluctuation in canal stage over the period of each day of operation. Addressing the concerns described above, recent operational changes at the G-

310 pump station will reduce daily fluctuations in STA-1E discharge by increasing the use of the electric pumps and extending pumping hours.

Note - This item was addressed in section A.3.2 above.

2. Coordinate the operations of pumps and gates to minimize stage variation and intrusion

The major structures that release water from the refuge to the southern Everglades, the S-10 gates (Gates A, C, D and E), are located along the L-39 Levee and Canal. Staff from the Corps of Engineers Clewiston office manually operate the S-10A, S-10C, and S-10D gates. The smaller S-10E gate is not a Corp project, and is currently never open. Pumped inflow to the refuge is controlled by the SFWMD. It is conjectured that a more **predictive operation of the S-10 structures coordinated with pumping operations** could reduce fluctuations in the perimeter canal stage. More timely control of gate opening related to pumping events might require installation of equipment for remote operation at the S-10 gates. Coordination of gate operations and pumping will be discussed among agencies at the Quarterly Water Coordination Meeting (participating agencies include the A.R.M. Loxahatchee National Wildlife Refuge, Jacksonville District of the Corps of Engineers, South Florida Water Management district, and the Lake Worth Drainage District) to be held on January 19, 2005.

A related water quality/operations issue deals with the **distribution of flow through the individual S-10 gates**. Water quality monitoring in the headwater area of the gates reveals a strong gradient of total phosphorus often exists from the highest values at the more western S-10E and S-10D, to lowest values at the more eastern S-10A. It appears from water quality monitoring data, that the S-10D discharges more pumped stormwater while the S-10A discharges more rainwater drawn for the refuge interior. This implies that preferentially discharging from the S-10D might reduce impact on the pristine areas of the refuge by bypassing more stormwater south into the already impacted area of WCA-2. The refuge hydrodynamic and water quality model will be used, when available, to evaluate alternative gate operation scenarios that may be more protective of pristine refuge areas. It has also been suggested that intensive field studies associated with controlled gate opening events might support better understanding.

Note – The above items could be part of the evaluation described in A.4. above.

3. Reduce the time period for preceding water supply deliveries

Under some conditions, the refuge water regulation schedule requires that an equivalent volume of water be supplied to the refuge must preceding water supply deliveries from the refuge. There is now a concern that under high stage conditions this process may enhance movement of phosphorus into and across the impacted fringe marsh as a result of water level fluctuations. At present, water supply accounting is routinely performed on a seven-day cycle. It has been suggested that this period be reduced to a daily accounting, or that the regulation schedule be revised to allow simultaneous inflow with water supply deliveries.

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Since December 2004, Calvin J. Neidrauer, Chief Engineer in the Water Control Operations Section, South Florida Water Management District, has been providing regular detailed water supply accounting to refuge and SFWMD personnel. These reports will support an evaluation of the need for alteration of water delivery procedures.

Note – The above item could be part of the evaluation described in A.4. above.

Citation:

SFWMD. (2004). "Pump Stations: West Palm Beach Field Station." <
http://www.sfwmd.gov/org/omd/division/540_wpb/geo1b_pump_wpb.html

>.

- End insertion from the Refuge -

Attachment 1**Enhanced Water Quality Monitoring and Modeling Program for the A.R.M.
Loxahatchee National Wildlife Refuge****Project Overview**

In FY 04, a \$1 million Congressional appropriation was specifically targeted to the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) for development of an enhanced water quality monitoring network and to develop hydrodynamic and water quality modeling tools. The appropriation is intended, in part, to improve the scientific understanding of water quality issues in the Refuge and provide information that can be incorporated into water management decisions to better protect of Refuge resources.

A work plan was developed by Refuge staff outlining studies in four areas: (1) increased monthly water quality sampling sites; (2) monitoring of canal water intrusion using surface water conductivity transects into the interior marsh; (3) characterization of sediment and water quality in the perimeter canals of the Refuge; and, (4) development of hydrodynamic and water quality modeling. These four areas are consistent with long-term goals identified in the Refuge's 15 year Comprehensive Conservation Plan and recommendations made by the Technical Oversight Committee for addressing exceedances observed in interim phosphorus levels within the Refuge (http://www.sfwmd.gov/org/ema/toc/archives_mtgs.html#2004). The plan was provided to State, other Federal, and Tribal partners for review and comment in February 2004, and was subsequently improved based on constructive comments received. The plan is available at: http://www.sfwmd.gov/org/ema/toc/archives/docs/refuge_final_work_plan_2004-2006.pdf.

The Refuge's existing water quality monitoring network (used for Federal Consent Decree compliance [EVPA]; Fig. 1) is estimated to cover approximately 60% of the Refuge, leaving 40% of the marsh uncharacterized, predominantly in the outer, impacted regions of the marsh. The additional monthly sampling as part of the enhanced water quality monitoring program focuses on these uncharacterized areas (Fig. 1). This information can then be used to refine operations, when possible, to minimize canal water intrusion into the interior marsh. Sampling for the enhanced water quality monitoring program is designed to be as similar as possible as the compliance monitoring program (e.g., same collection protocols, collection staff, laboratory analyses by SFWMD, data QA/QC, data availability, etc.).

The goal of the modeling exercise is to provide support for Refuge management decisions and planning related to water control operations, water supply, and water quality and provide a foundation for future ecological studies. The model will be maintained to support future management decisions, model development, and monitoring planning. Preliminary modeling is anticipated to be available in FY 06, with completed model(s) available for management decision support in early FY 07.

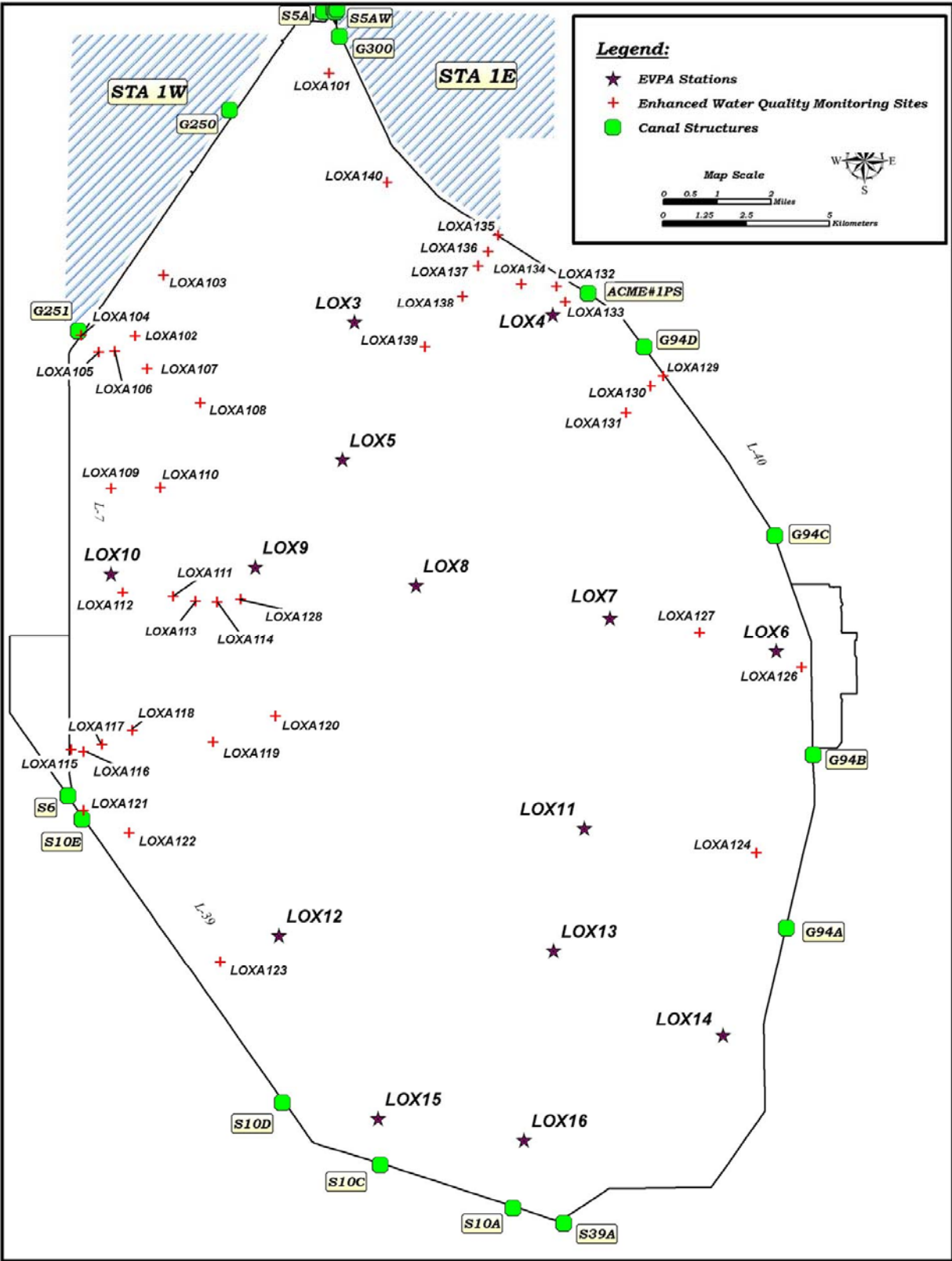


Figure 1: Map of A.R.M. Loxahatchee National Wildlife Refuge showing location of the existing Federal Consent Decree compliance monitoring network (EVPA stations; ★) and the new, enhanced water quality monitoring program stations (+).

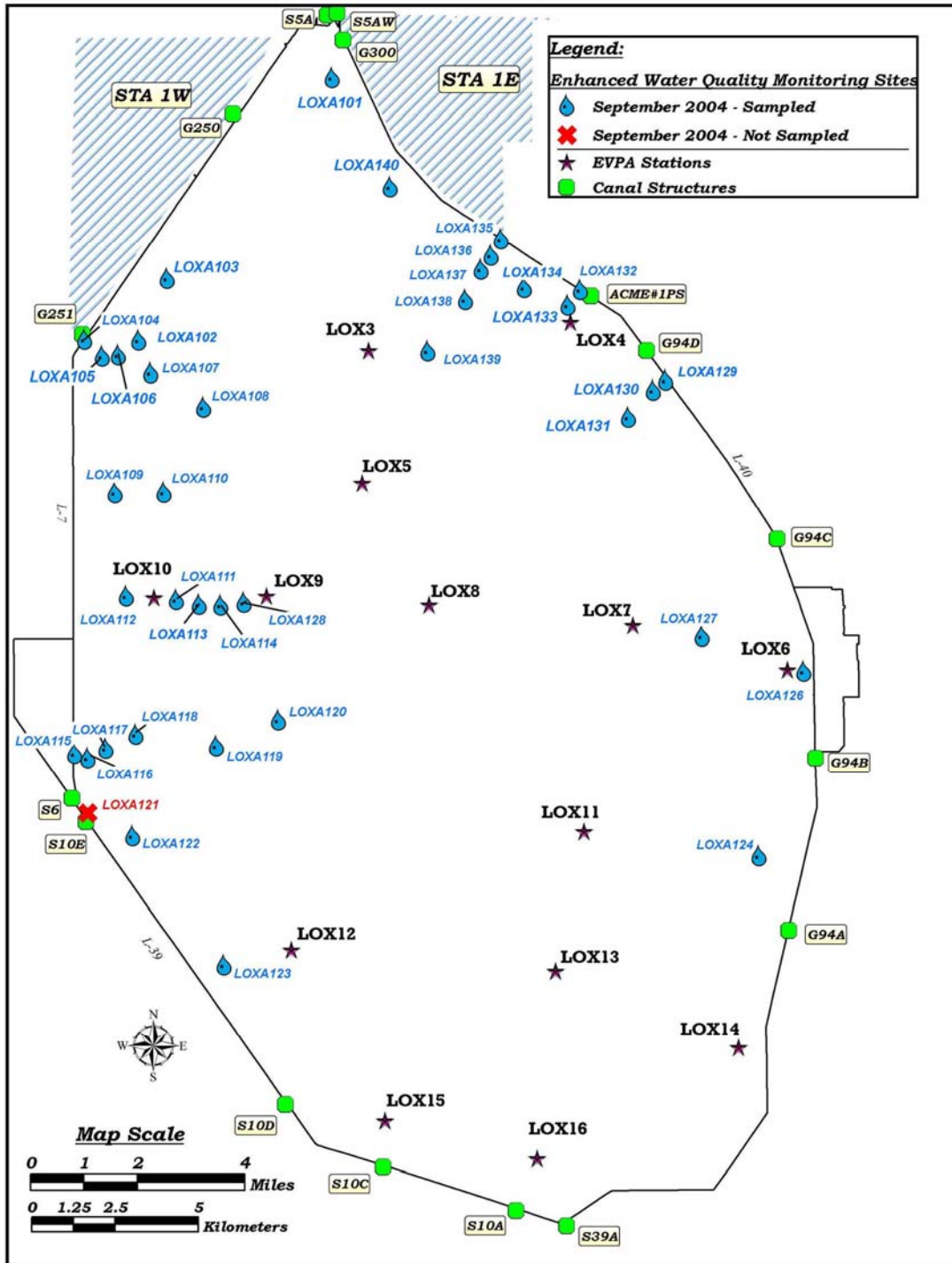


Figure 2: September 2004 map of enhanced water quality monitoring program stations sampled (water drop symbol) in the A.R.M. Loxahatchee National Wildlife Refuge.

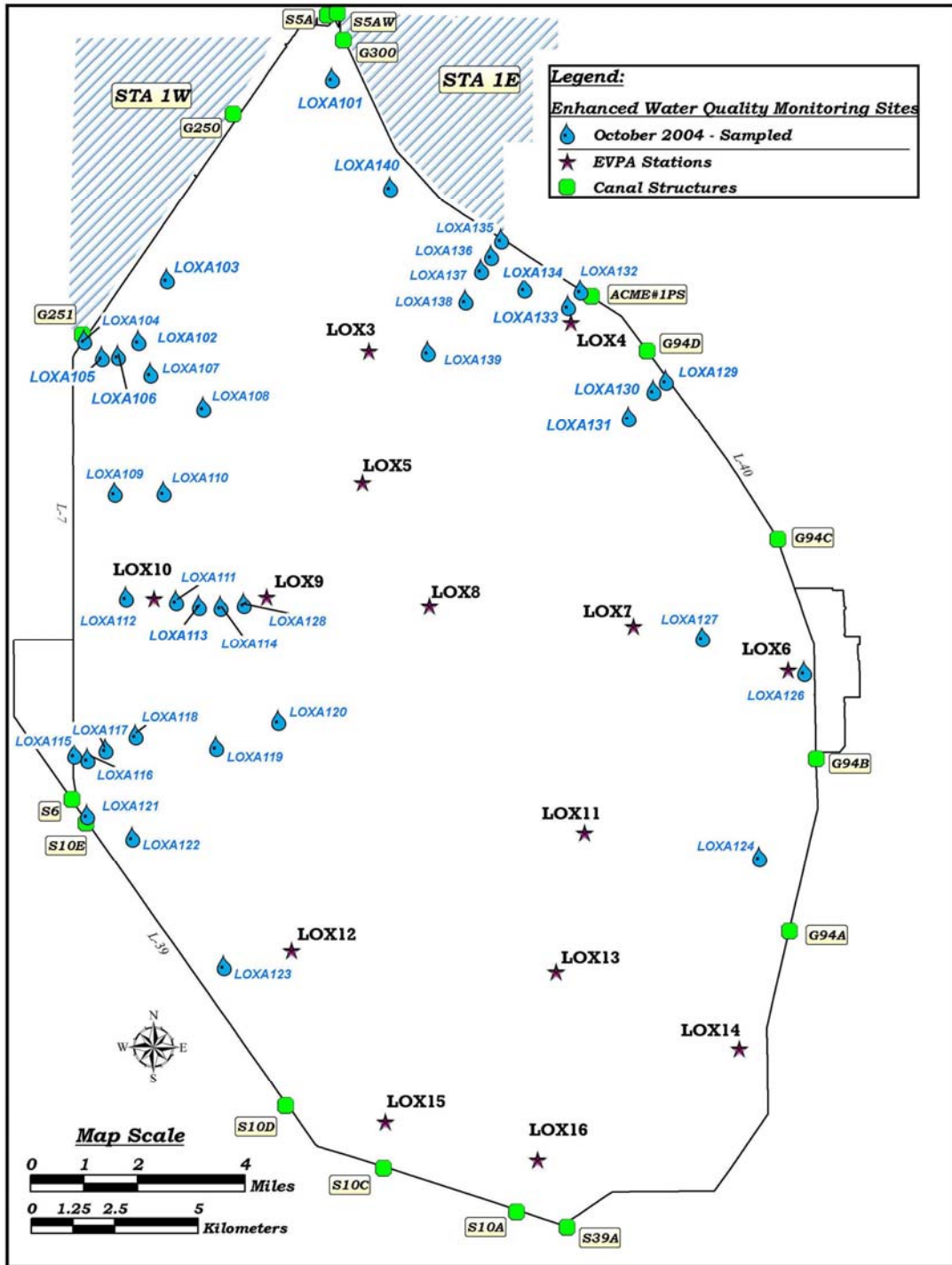


Figure 3: October 2004 map of enhanced water quality monitoring program stations sampled (water drop symbol) in the A.R.M. Loxahatchee National Wildlife Refuge.

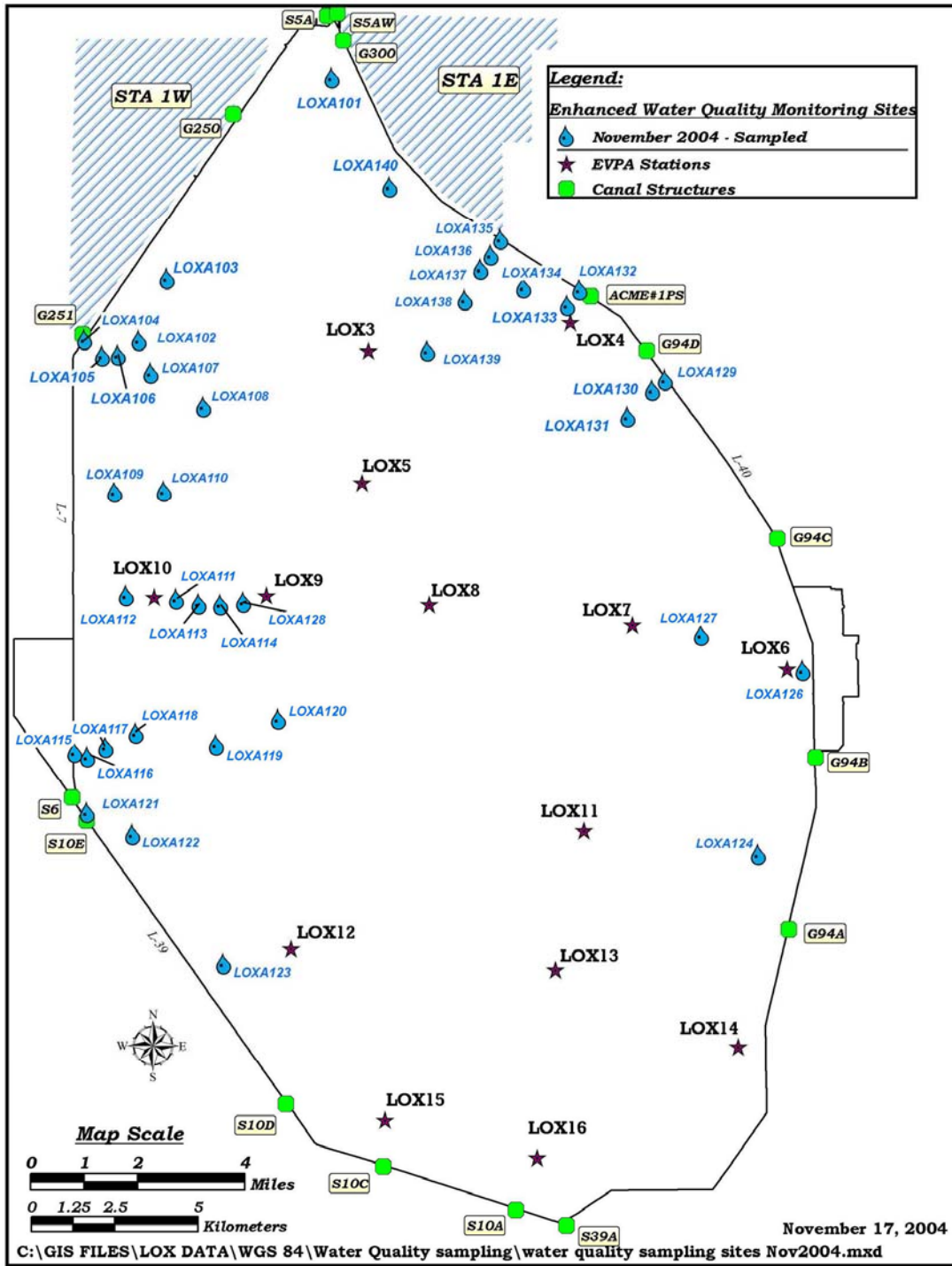


Figure 4: November 2004 map of enhanced water quality monitoring program stations sampled (water drop symbol) in the A.R.M. Loxahatchee National Wildlife Refuge.

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Table 1: Conductivity sonde deployment information for 2004 (as of November 2004).

Site	Description	Month									
		March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
LOXA104	NW Transect 0 (canal)				X	X	X	X	X	D	
LOXA105	NW Transect 0.5										
LOXA106	NW Transect 1										
LOXA107	NW Transect 2										
LOXA108	NW Transect 4	X									
LOXA111											
LOXA112											
LOXA113											
LOXA114											
LOXA115	SW Transect 0 (canal)	X	X	X	X				X	D	
LOXA116	SW Transect 0.5	X	X	X	X	X	X	X	X	D	
LOXA117	SW Transect 1	X	X	X	X	X	X	X	X	D	
LOXA118	SW Transect 2	X	X	X	X	X	X	X	X	D	
LOXA119	SW Transect 4	X	X	X	X	X	X	X	X	D	
LOXA120	SW Transect- X5										
LOXA126											
LOXA127											
LOXA128											
LOXA129	NE Transect S 0 (canal)				X	X	X	X	X	D	
LOXA130	NE Transect S										
LOXA131	NE Transect S										
LOXA132	NE Transect N 0 (canal)				X	X	X	X	X	D	
LOXA133	NE Transect N				X	X	X	X	X	D	
LOXA134	NE Transect N										
LOXA135	NE Transect STA1E 0 (canal)	X	X		X	X	X	X	X	D	
LOXA136	NE Transect STA1E 0.5	X	X		X	X	X		X	D	
LOXA137	NE Transect STA1E 1	X	X		X	X	X	X	X	D	
LOXA138	NE Transect STA1E 2	X	X		X	X	X	X	X	D	
LOXA139	NE Transect STA1E 4	X	X		X	X			X	D	
LOX4	EVPA site/refuge gauge				X	X				D	

X = Sonde was deployed and data was recorded successfully for all or part of this month

D = Sonde is currently deployed