FOUNDATION FOR SUCCESS: THE EVERGLADES CONSTRUCTION PROJECT

Gary F. Goforth, P.E., Ph.D.
South Florida Water Management District
P.O. Box 24680
West Palm Beach, FL 33416-4680

ABSTRACT

The foundation of the State of Florida's interim phosphorus control program for the Everglades is the Everglades Construction Project (ECP). The ECP encompasses six strategically located constructed wetlands, referred to as Stormwater Treatment Areas. The purpose of this paper is to summarize the more significant factors that have contributed to the ongoing success of the ECP. The ECP has enjoyed early successes in cost and schedule controls, but most importantly, the treatment areas have exceeded expectations in removing phosphorus. Key factors for this success include broad-based support of, and continual interaction with, stakeholders and government agencies; effective program and project management; retooling internal business practices at the District; effective peer-review of engineering designs; nurtured partnership with construction contractors; and continual exchange of information between scientists and engineers working on the project. These are presented as a foundation for successful implementation of future Everglades Restoration programs, and may be applicable in other environmental projects.

KEYWORDS

constructed wetlands, Everglades, phosphorus removal, restoration, water quality

INTRODUCTION

The Everglades is a vast freshwater wetland that dominates the landscape of south Florida. Before the 1900s, the Everglades extended unbroken from the south shore of Lake Okeechobee to Florida Bay (Fig. 1) and encompassed more than 10,000 km^2 (Light and Dineen, 1994). Agricultural and urban development have since reduced the present-day Everglades to only 50% of its original extent, of which approximately 3,500 km^2 is impounded within shallow Water Conservation Areas (WCAs) (SFWMD, 1992). The wetland that remains (i.e., the WCAs, the Holey Land and Rotenberger Wildlife Management Areas and Everglades National Park [ENP]) still supports unique biotic communities containing 69 threatened or endangered plant and animal species and is widely regarded as an ecosystem of immense regional, national and international importance. Everglades National Park has been designated as an International Biosphere Reserve, a United Nations World Heritage site and a Wetland of International Importance under the 1987 Ramsar Convention, one of only three wetlands in the world to receive such recognition. Water Conservation Area 1 is part of the Arthur R. Marshall

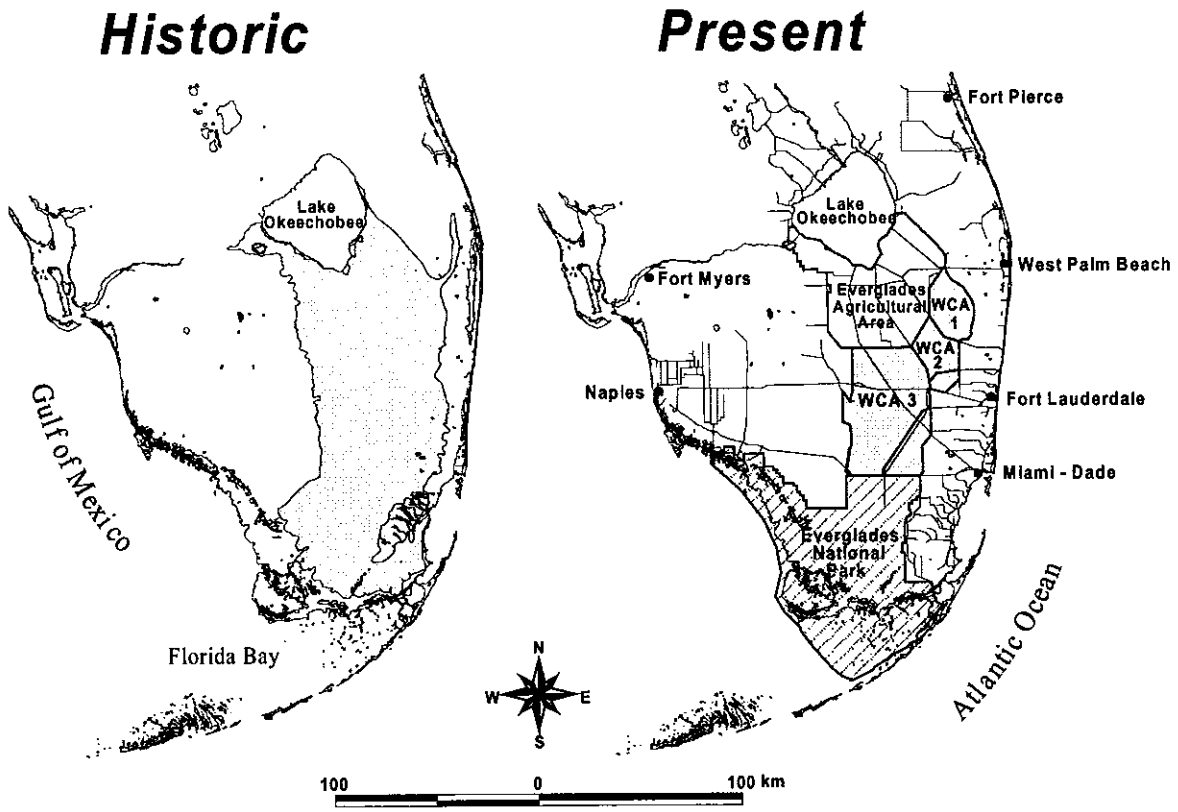

Figure 1. Comparison of areal extent of the historic Everglades with the present-day ecosystem. See text for details.

Loxahatchee National Wildlife Refuge (LNWR). Both ENP and LNWR are federally protected wetlands.

Efforts to manage surface water in south Florida began in the late-1800s. The primary goal was to drain the land and take advantage of its rich organic soils and subtropical climate for agricultural purposes (Anderson and Rosendahl, 1998). Today, the hydrology of the region is managed by the South Florida Water Management District (District), which operates one of the world's largest and most complex flood control and water supply systems. Much of this infrastructure was built (or upgraded) by the U.S. Army Corps of Engineers (USCOE) from 1953 to 1967 as part of the Central and Southern Florida Project (C&SF Project). Management objectives for the C&SF Project have changed over time. Throughout most of its history, the project was operated primarily for regional flood protection during the wet season (May-October) and alternatively, to supply water for farm irrigation and domestic use during the dry season (November-April). In addition to the reduction in spatial extent of the Everglades, unintended adverse impacts of the C&SF Project include disruption of the natural timing, quantity and distribution of water into and through the Everglades, and concentrated introduction of stormwater with elevated levels of phosphorus. The net effect is a dramatic shift in microorganisms and higher species, water quality, soil structure, and vegetation communities within impacted areas totaling tens of thousands of hectares.

PLANNING FOR RESTORATION

The District, in partnership with other state and federal agencies and stakeholders, is undertaking one of the largest ecosystem restoration programs in the world. Florida's 1994 Everglades Forever Act (Act) set into action a plan for restoring a significant portion of the remaining 618,000-ha Everglades ecosystem through a program of construction, research, and regulation activities. The Act addressed water quality, water quantity (including hydroperiod), and the invasion of exotic plant species in the Everglades ecosystem. The Act also establishes both interim and long-term water quality goals to ultimately achieve restoration and preservation of the Everglades. The interim goal of the restoration program is to reduce phosphorus (P) concentrations entering the Everglades to 50 parts per billion (ppb). The foundation of the interim phosphorus control program is the Everglades Construction Project (ECP) which encompasses six strategically located constructed wetlands, referred to as Stormwater Treatment Areas, or STAs (see Figure 2). The STAs comprise almost 17,000 hectares, with a capital cost of approximately $700 million. Operation and maintenance costs through 2014 are estimated at approximately $132 million. Approximately 7,320 hectares are currently operational, and construction is underway on the remaining areas.

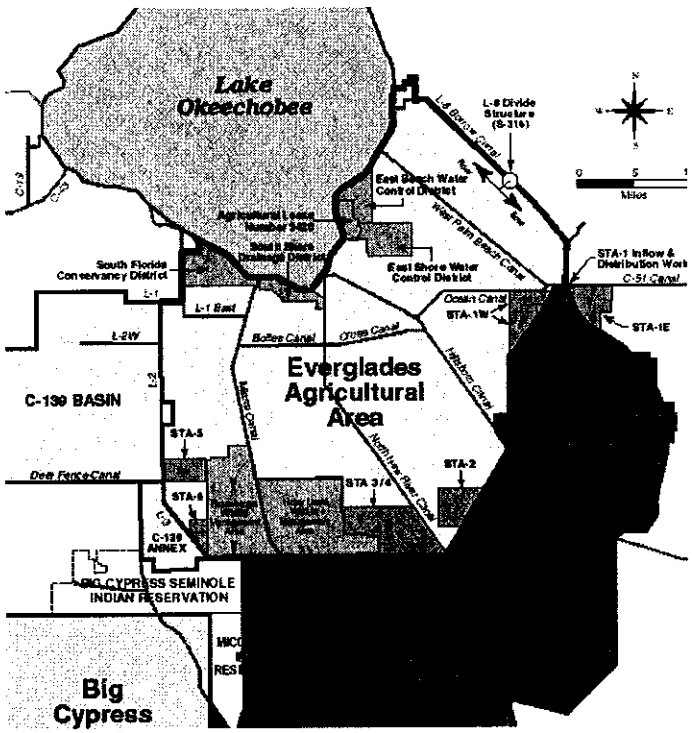

Figure 2. Overview of the Everglades Construction

In addition to the STAs, significant phosphorus load reductions have been achieved through best management practices (BMPs) within the adjacent Everglades Agricultural Area (EAA). The long-term goal is to combine point-source, basin-level and regional solutions in a system-wide approach to ensure that all waters discharged to the Everglades Protection Area achieve final water quality goals by December 31, 2006. With respect to nutrients, the long-term goal is to reduce nutrient discharges to levels that do not cause an imbalance in natural populations of aquatic flora or fauna, however, the numerical interpretation of this narrative standard has not yet been determined. Additional background information can be found in Chimney and Goforth (2000).

The planning phase for the ECP encompassed many tasks carried out by multiple local, state and federal interest groups. Beginning in the late 1970s, District ecologists and

researchers began monitoring and documenting the unintended adverse impacts of regional development and water management on the Everglades ecosystem. The primary factors included phosphorus enrichment from stormwater runoff and alteration of natural hydropatterns. By the 1980s, the District and other interested groups were already investigating ways to reduce the levels of phosphorus in stormwater and restore more natural hydropatterns. Numerous phosphorus reduction alternatives were evaluated during the 1980s and early 1990s, including constructed wetlands, source control (e.g., BMPs), algal raceways, chemical treatment, and aquifer storage and retrieval.

In 1988, the District began the design and construction of the 3,800-acre Everglades Nutrient Removal Project, which at the time was the world's largest constructed wetland for the treatment of stormwater (Chimney and Goforth 2001). The ENR project was the prototype for the stormwater treatment areas of the ECP, and expanded the envelope of constructed wetlands design, construction and operation. Vital to the success of this prototype was constant interaction with world class scientists and engineers in private industry and government (Goforth 2000).

Over the course of the last 15 years, the relationship between stakeholders, the District, state agencies and federal agencies has run the gamut through litigation, mediation, legislation, regulation and has evolved into a very effective partnership. In 1988, the federal government filed a lawsuit against the District and Florida Department of Environmental Protection, alleging a lack of enforcement of state water quality standards. The lawsuit was resolved with a Consent Decree in 1992 which contained a settlement agreement calling for four large constructed wetlands (Chimney and Goforth 2000). However, the permits authorizing the construction and operation of the STAs were challenged by agriculture and environmental interests, which led to a multi-party mediation. This mediation resulted in not only an expanded technical plan calling for six STAs, but added hydroperiod restoration to the scope and established the framework for funding the project with a mixture of state and federal funds, agricultural taxes, and ad valorem taxes. This broad program was encapsulated in the 1994 Everglades Forever Act (Act), a comprehensive Everglades restoration bill passed by the Florida legislature in April 1994. While the Act did not satisfy all critics, after the legal wrangling of 1988-1994, most stakeholders were supportive of the set of research, regulatory and construction programs the Act launched.

PROGRAM MANAGEMENT

Many District business practices were re-tooled for more effective management of the $830 million ECP. These included the following.

1. Development of a strong project management organization to focus exclusively on implementation of the numerous projects contained within the ECP;
2. Establishment of an ECP project controls section to manage cashflow, schedules, and reporting. Specific activities of the project controls unit included
   a. use of a construction industry standard project management software (P3) and scheduling specifications within the larger construction contracts;

   b. use of cost-loaded master schedule, for program cashflow analysis;
   c. establishment of cost estimation control processes;
   d. use of construction contract management software (Expedition);
   e. use of a digital photo database software system (LYNX) for construction progress documentation;
   f. development and roll-out of an ECP project website;
   g. production of quarterly project financial statements that documented actual/projected revenue, expenditures and project cashflow;
3. Co-location of a full-time financial officer to support the ECP
4. Co-location of a full-time procurement officer to support the ECP
5. Revision of the procurement policies and practices to enable more effective and efficient management of the large number and magnitude of design and construction contracts. Specific refinements included the use of single Requests for Proposals to solicit multiple engineering design firms, and the use of continuing services contracts to allow expeditious procurement of critical support services.

In addition, excellent support was provided by staff of virtually every business unit of the agency.

DESIGN

Through a process of scientific research and evaluation, litigation, mediation, legislation, and consensus building, the design objectives of the ECP have evolved to include the following:

1. to reduce the phosphorus concentration entering the Everglades to an interim target of 50 ppb (measured as total phosphorus); this objective will be achieved in conjunction with the BMPs of upstream landowners;
2. to increase the supply of water to the Everglades;
3. to improve the spatial distribution and timing of inflows to the Everglades;
4. to improve the flood control of an adjacent urban watershed while maintaining flood protection in the other basins;
5. to reduce harmful discharges of freshwater to coastal estuaries; and
6. to the extent possible, reduce phosphorus loading to Lake Okeechobee from local drainage districts along the southern and eastern shores.

Throughout the design process, engineers and scientists collaborated to capture the best available information on wetland treatment systems, and to develop the most appropriate design criteria. Some of the more challenging issues included characterizing stormwater inflows and phosphorus loads, determining appropriate nutrient removal performance characteristics, and estimating hydraulic design parameters relating to densely-vegetated systems. The District has invited extensive public involvement and interaction during design and construction. Since 1991, the District has hosted an STA design group that has met almost monthly to review plans, discuss critical design issues and communicate progress. In addition, numerous oversight groups have provided critical insight and guidance at appropriate times, including legislative, financial and inter-agency.

The design process combined in-house staff with engineering consultants, construction contractors, external review groups and independent peer-review. Once the decision was made to use constructed wetlands, the design of the STAs proceeded in three phases:

1. One of the most important aspects contributing to the success of this project was the quality of the **Conceptual Design Document** for the entire ECP. The initial conceptual design was completed by the consulting firm of Burns & McDonnell in March 1992 (Burns and McDonnell, 1992). This conceptual design was later revised in February 1994, as a result of mediation among the District, state and federal agencies and other stakeholders (Burns and McDonnell, 1994), and eventually codified in the 1994 Act. The conceptual design evolved over the course of two and a half years as the public debate was finalized. The 1994 document provided a sound road map to for the implementation of the ECP.

2. **General Design Memoranda** for individual ECP components were prepared by Burns & McDonnell between 1994 and 1996; and

3. **Detailed Design Reports** and associated plans and construction contract specifications were prepared by multiple consulting firms, including Hutcheon Engineers (STA-1 West), Stanley Engineers (STA-1 Inflow and Distribution Works), Brown & Caldwell (STA-2), Prescott-Follett (outflow pump stations for STA-1 West and STA-2), and Burns & McDonnell (STA-3/4, STA-5 and STA-6). In addition to these larger works, multi-discipline engineering services were provided by several consultants, including Metcalf & Eddy, Peer Consultants, Nodarse, Sverdrup Civil, Milian Swain, Weidener Surveying, and Muniz/Hazen & Sawyer. Also, District staff engineers completed the design for several of the smaller facilities. Detail design is currently underway for STA-1 East by the ACOE.

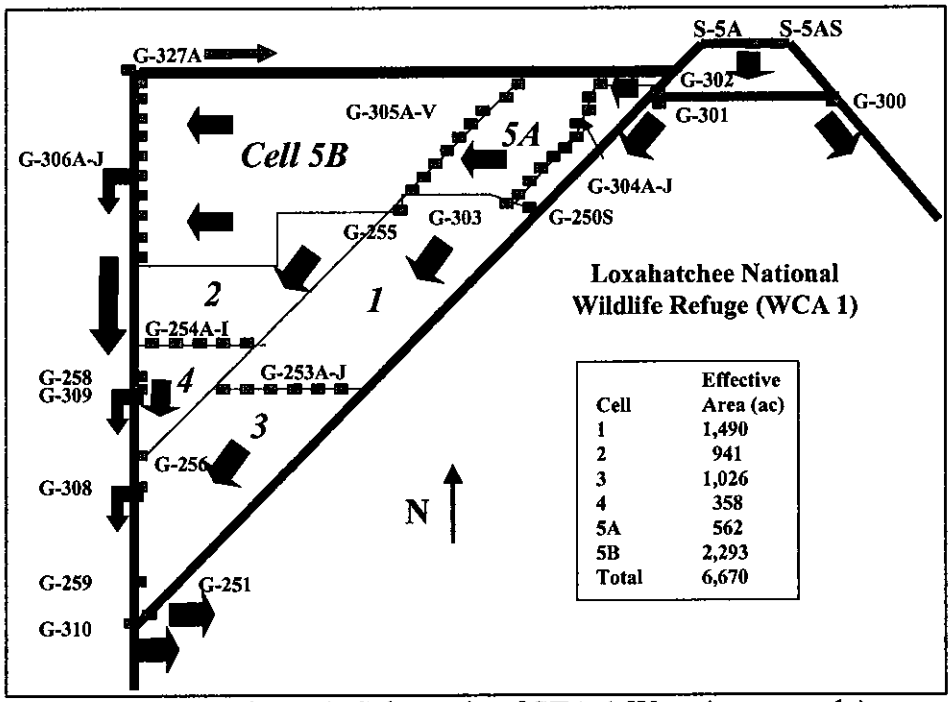

Figure 3. Schematic of STA-1 West (not to scale).

Throughout the design process, the District encouraged review by stakeholders and technical experts, independent peer-review, and construction contractors' value engineering as part of a formal partnering process. In addition to improving the designs, these activities led to considerable cost savings, including the use of refurbished 8- and 10-cylinder diesel engines in place of new engines (cost saving: approximately $1.5 million), and resizing the outflow pump station for STA-2 (cost savings: approximately $3 million).

State environmental permitting for the ECP has proceeded smoothly, due to a consolidated regulatory process coordinated by the Florida Department of Environmental Protection.

Research on ways to optimize the nutrient removal performance of the STAs has continued throughout the ECP implementation period, and adaptive management is an ongoing activity. In addition, from the outset, there has been a constant exchange between research scientists and engineers, and maximum flexibility has been designed into STAs.

CONSTRUCTION

The District has awarded over $310 million in construction contracts related to the ECP. Due to a combination of favorable construction markets and strong owner control, these contracts came in at a savings of more than $20 million compared to the 1994 estimates. For every major contract, the District entered into a formal partnering arrangement with the contractor to ensure high quality work with minimal impacts to schedule and budget.

In addition, contractors were encouraged to review the plans and specifications for opportunities of value engineering. To date, construction change orders have totaled less than 3%.

EARLY RESULTS

Over 7,320 ha of treatment areas (STA-1 West, STA-2, STA-5 & STA-6) are operational. Construction is underway on STA-1 East and STA-3/4, and both are scheduled to begin operation in 2003. The initial phosphorus removal performance of the STAs has been better than the design criterion of 50 ppb. The initial 1,515-ha treatment area in STA-1 West has been fully operational since August 1994, and has consistently produced annual phosphorus concentrations less than 25 ppb (see Figure 4). Similarly, average discharge concentrations from the 352-ha STA-6 have remained below 25 ppb, despite receiving considerably greater inflow than estimated during design.

CONCLUSIONS

The South Florida Water Management District (District), in partnership with other state and federal agencies and stakeholders, is undertaking one of the largest ecosystem restoration programs in the world. The cooperative efforts of state and federal agencies and continual active participation by stakeholders have yielded significant successes to date in the design, construction and operation of the ECP. To date four large STAs totaling over 17,000 acres of effective treatment area are fully operational and removing phosphorus that otherwise would have entered the Everglades. Some of the more significant contributing factors include

- broad-based state and federal support, with active participation by stakeholders and environmental interests

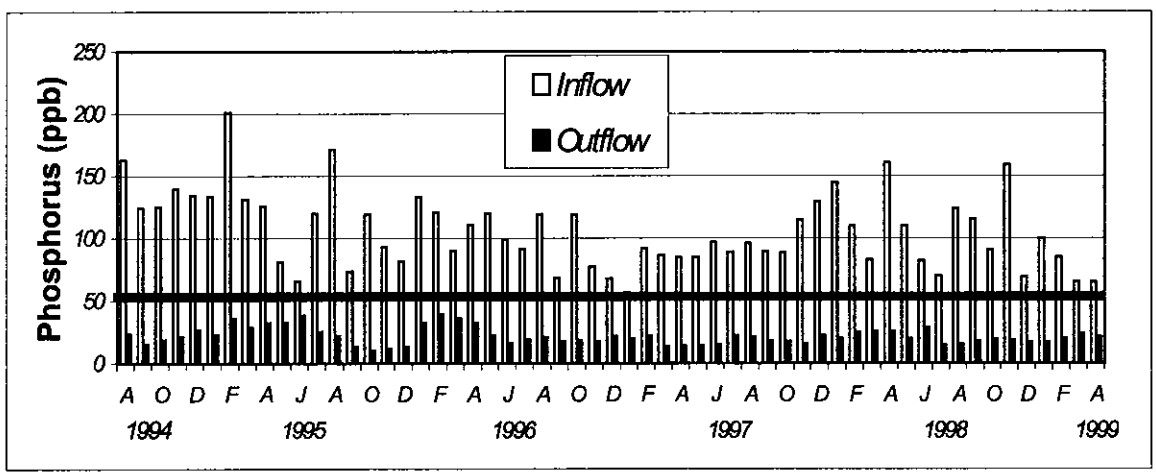

Figure 4. Initial phosphorus removal performance for STA-1 West Cells 1-4 (from Chimney et al., 2000)

- comprehensive state legislation codified this broad-based support and established sustainable revenue streams
- an effective program management and strong project management structure was implemented at the SFWMD, including cost-loaded project scheduling, use of industry-standard project management software, assignment of full-time procurement officer and full-time financial officer
- constant interaction with stakeholders, other agencies, the state legislature, and independent technical review groups
- vital peer-review of engineering designs and effective partnering programs with the construction contractor
- the District retooled many business procedures in order to more effectively manage the large ECP, including procurement, financial controls and reporting, communications, assignment of a full-time procurement officer and a full-time financial officer, and dedicated legal support.
- A continuous exchange of ideas and peer-review between the scientists and engineers of the ECP has been integral in the ECP to date, and for establishing a foundation for making future decisions

More information can be obtained at the following website:
http://www.sfwmd.gov/org/erd/ecp/3_ecp.html.

ACKNOWLEDGEMENTS

Acknowledgements are extended to the entire ECP team of engineers, scientists, construction specialists, financial analysts, attorneys, administrative staff and other professionals.

REFERENCES

Anderson, D.L and P.C. Rosendahl, 1998. Development and management of land/water resources: the Everglades, agriculture and south Florida. J. Am. Wat. Res. Assoc. 34: 235-249.

Burns and McDonnell (1992). *Everglades Protection Project Conceptual Design – Stormwater Treatment Areas.* Prepared for the South Florida Water Management District, West Palm Beach, Florida.

Burns and McDonnell (1994). *Everglades Protection Project Conceptual Design.* Prepared for the South Florida Water Management District, West Palm Beach, Florida.

Chimney M. and Goforth G. (2000). Environmental impacts to the Everglades ecosystem: A historical perspective and restoration strategies. In: *Proceedings 7th International Conference on Wetland Systems for Water Pollution Control,* University of Florida, Gainesville, Florida, pp. 159-168.

Chimney M. J., Nungesser M., Newman J., Pietro K., Germain G., Lynch T., Goforth G. and M. Z. Moustafa (2000). Chapter 6: Stormwater treatment areas – status of research and monitoring to optimize effectiveness of nutrient removal and annual report on operational compliance. In: *Everglades Consolidated Report*, South Florida Water Management District, pp. 6-1 to 6-127.

Chimney M. and Goforth G. (2001, in press). History and description of the Everglades Nutrient Removal Project,

Goforth G. (2000). Surmounting the engineering challenges of Everglades restoration, In: *Proceedings 7th International Conference on Wetland Systems for Water Pollution Control,* University of Florida, Gainesville, Florida, pp.697-705.

Light, S.S. and J.W. Dineen, 1994. Water control in the Everglades: a historical perspective. In: S.M. Davis and J.C. Ogden (eds.), Everglades - The Ecosystem and Its Restoration, St. Lucie Press, Delray Beach, FL, pp. 47-84.

SFWMD, 1992. Surface Water Improvement and Management Plan for the Everglades - Planning Document. SFWMD.