SOUTH FLORIDA WATER MANAGEMENT DISTRICT

AUDIT OF THE HYDROLOGIC MODELING PROGRAM, SYSTEM DEVELOPMENT LIFE CYCLE

Audit #01-11

Prepared by

Office of Inspector General

Allen Vann, Inspector General
John Lynch, Lead Information Systems Auditor

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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MGT 08-06F
April 3, 2002

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Re: Final Report – Audit of The Hydrologic Modeling Program, System Development Life Cycle, Audit # 01-11

This audit was performed pursuant to the Inspector General's authority set forth in Chapter 20.055, F.S. The audit focused on the standards used in the development, application, and maintenance of hydrologic computer modeling systems at the District. Mr. John T. Lynch, Lead Information Systems Auditor prepared this report.

Sincerely,

Allen Vann
Inspector General

AV/jl
Enclosure

c: Henry Dean
John Fumero

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INTRODUCTION

This report reviews the standards used in the development, application, and maintenance of hydrologic computer modeling systems at the South Florida Water Management District (District). The District uses hydrologic models for operational and planning purposes. These models and their supporting tools continue to be enhanced by the District's professional staff. The staff makes available information about the models and related activities through an extensive Internet portal.

District hydrologic model development and application is supported by the Hydrologic Systems Modeling Division (HSM) and is funded by program activities. The Hydrologic Modeling Division is divided into three sections: Model Development, Regional Applications - short term (operational), and Regional Applications – long term (planning).

The District's Hydrologic Systems Modeling Division has a staff of 23 employees with a total budget for Fiscal Year 2002 of $1,900,450. Program activities supported include the following:

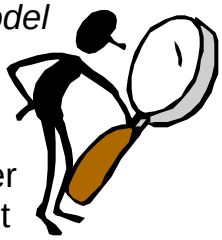
Hydrologic Systems Modeling Division Program Activities	**Budget Amount*
RECOVER (**Re**storation **Co**ordination & **Ver**ification)	$ 497,306
Model Maintenance/Model Upgrade	264,263
Model Development	203,473
CERP Project Support	171,098
Program Support	165,636
District-Wide Modeling Support	99,448
LEC Plan Regional Development & Coordination	87,418
Section Management	87,046
Project Operational Planning	85,693
Southwest Fl Feasibility Study	80,237
Everglades Rainfall Driven Operations	61,980
ECP Basin Specific Feasibility Studies	33,282
Interagency Modeling Support	22,664
CERP Program Management	16,660
Program Element Support	11,925
D-B Lev&Cnl&C-4 E STR WPA BB,T	7,428
Budget Preparation/Documentation	4,893
Total	**$1,900,450**

* Source: FY 2002 Activity Line Item Budget Report

The most significant cost associated with development and application of hydrologic systems models is staffing. The staff cost account for $1,719,600 of the total budget.

BACKGROUND

In 1991, Dr. Daniel P. Loucks, Chairman of a model advisory panel wrote in his paper *Assessment and Recommendations for Model Development and Use in the South Florida Water Management District*, "Every major water management agency in the modern world today depends on models to help predict and evaluate the impacts resulting from possible water and related land resource development and management policies. The District, being one of the major and most advanced water resource management agencies in the state and the nation, is no exception."



The District professional staff depends upon a variety of computer models to evaluate the impact of water related issues. In "Appendix A" of this report several of these models are listed. We reviewed the three major models that are maintained and/or under development by the Hydrologic Systems Modeling Division staff:

1. "The **South Florida Water Management Model** (SFWMM) is a regional-scale computer model that simulates the hydrology and the management of the South Florida water resources system from Lake Okeechobee to Florida Bay. The model simulates all the major components of the hydrologic cycle in south Florida on a daily basis using climatic data for the 1965-1995 period."[1]

It was initially developed in the late 1970's through the early 1980's and written in the Fortran 77 programming language. The model's 31 years of data use in simulations will soon be expanded to utilize 35 years of historic data to include 1996 through 1999. The SFWMM has been used for projects such as:

- USACE Modified Water Deliveries General Design.
- Regional-scale hydrologic effects of the Everglades Construction Project.
- Lower East Coast Regional Water Supply Planning effort.
- Lake Okeechobee Regulation Schedule Study.

[1] *South Florida Water Management Model.* South Florida Water Management District. Retrieved on January 7, 2002 from the District Web: http://iweb/iwebB501/wsd/hsm/models/sfwmm/fact_sht.htm.

- Central & Southern Florida Comprehensive Review Study (C&SF Restudy).

2. The **Natural System Model** (NSM) is used to review various SFWMM scenarios. "The Natural System Model (NSM) simulates the hydrologic response of a pre-drained Everglades system. The NSM does not attempt to simulate the pre-drained hydrology. Rather, more recent climatic data is used to simulate the pre-drained hydrologic response to current hydrologic input. . . . The use of recent input data, e.g. rainfall, potential evapotranspiration, tidal and inflow boundaries, allows for meaningful comparisons between the current managed system and the natural system under identical climatic conditions."[2]

3. "The **South Florida Regional Simulation Model** (SFRSM) will be the next generation SFWMM that will be developed using recent advances in computer technology, in particular, GIS, databases, and Object-Oriented model development. The new SFRSM will also make use of the more realistic, accurate and efficient numerical algorithms to simulate hydrology and water management in south Florida using a variable mesh structure.

It is expected that the SFRSM will eventually replace the existing SFWMM. Years of development and testing will be needed before SFRSM becomes fully operational for the entire system."[3]

The plan for the SFRSM includes a four component system that will include:

- The Hydrologic Simulation Engine (HSE), it simulates the hydrology in south Florida, including the C&SF Project.
- The Management Simulation Engine (MSE), it simulates the management activities, including the operation of the C&SF Project.
- The Graphical User Interface (GUI), to provide a simple tool for graphically "setting-up" the model and interpreting its results.

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[2] *Natural Systems Model (NSM) Version 4.5.* South Florida Water Management District. Retrieved on January 7, 2002 from the District Web: http://iweb/iwebB501/wsd/hsm/models/nsm/nsm45doc/nsm45.htm.

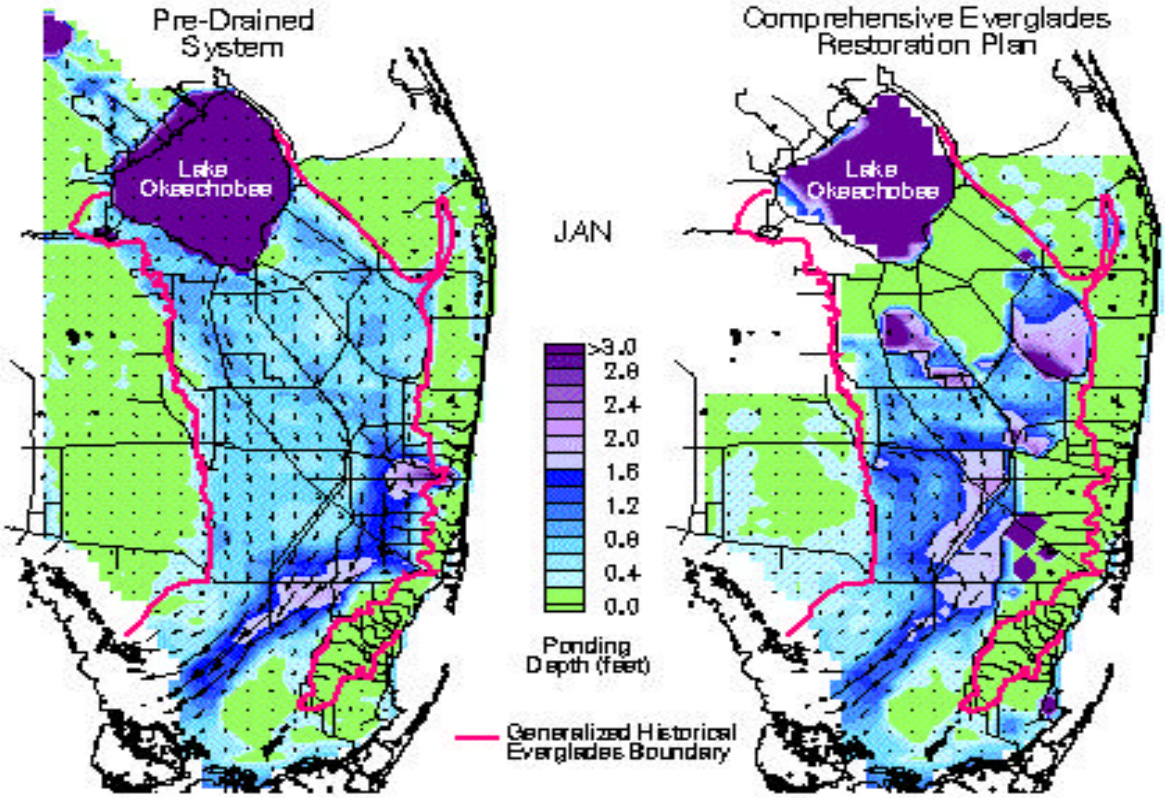
[3] *South Florida Regional Simulation Model.* South Florida Water Management District. Retrieved on January 7, 2002 from the District Web: http://iweb/iwebB501/wsd/hsm/models/sfrsm/index.htm.

- The Relational Data Base (DB), to provide convenient storage and retrieval of model data.

Currently the **HSE** component of the SFRSM is in operation and being use for projects such as:

- Loxahatchee National Refuge; *Conservation Area 1.*
- Southern Everglades; *Conservation Area 3, Everglades National* Park, and Big Cypress National Preserve.
- SW Florida Feasibility Study; *District West Coast, Caloosahatchee Basin, and parts of Big Cypress National Preserve.*

MODEL COMPARISON, NSM vs. SFWMM



Natural System Model v4.5, NSM

South Florida Water Management Model v3.5, SFWMM

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of this audit were to:

- Review computer modeling programs for adherence to generally accepted system development life cycle standards in producing reliable and accurate end products, controls over program development, and application of program change management.
- Ascertain whether adequate resources to meet the users' needs (hardware, software & human) are devoted to the program.

We focused on the procedures used by the Hydrologic Systems Modeling Division in model development and the extent that their procedures comport with best practices for computer program development.

Our methodology included:

1. Review the current use and future plans for computer models at the District.
2. Evaluate the Information Systems controls over the System Development Life Cycle as used at the District.
    - Standards,
    - Procedures, and
    - Approvals.
3. Interview project managers, software developers, systems administrators, and end users to determine:
    - Status of supporting computer hardware and software,
    - Level of support staff,
    - Future plans, and
    - Unmet needs.

This audit was conducted in accordance with "generally accepted government auditing standards" as promulgated by the Comptroller General of the United States. In addition, we were guided by the "Standards for Information Systems Auditing" as developed by The Information Systems Audit and Control Foundation Standards Board.

EXECUTIVE SUMMARY

Strategic Modeling Plan & Systems Development Standards Are Needed

In 1999, a District white paper recommended that a strategic modeling plan be developed. However, to date, a strategic modeling plan has not been prepared. In response to this audit the Hydrologic Systems Modeling (HSM) Division indicated that it will take the lead in assembling a small group to develop the Strategic Modeling Plan in Fiscal Year 2003.

The HSM Division staff uses an informal review process, for modeling in-lieu of the more formal System Development Life Cycle (SDLC) processes. HSM Division has agreed to review the ongoing modeling development efforts and identify areas of the SDLC process that require attention.

Review File Access Authority & Store Backups At Remote Location

Staff involved in model application and development have ready access to the model programs, supporting data sets, and program output. For security purposes, access controls need to be reviewed to ensure that each staff member's access is necessary and appropriate so as to prevent possible unauthorized access to programs and/or data. Going forward, the Division will review access controls (including read, write, and execute privileges) for modeling computer data and program files on a regular basis.

General backup and recovery activities are in place for these systems and provide the necessary protection in the event of lost program or data files. However, to ensure against a total loss, routines should entail off-site storage of "disaster recovery" backup copies of the programs and data. The Information Technology Department agreed to strengthen backup procedures.

Future Resource Needs Should Be Addressed

While staffing within the HSM Division is effectively organized, a "job study" should be conducted to establish a more appropriate set of the job descriptions and corresponding salary structure. Accordingly, the Human Resources Department compensation staff has agreed to perform a market analysis of hydrologic modelers with comparable skills and roles in private/public organizations.

In addition, the Water Supply Department will develop a report by August of 2002 on recommendations addressing solutions to meeting increased demands for both short-term and long-term manpower resources for District computer modeling.

The current computer hardware and software environment meets staff needs but future plans for improvements with less expensive hardware and non-proprietary software are currently being tested. In the long term this change will benefit the District and non-District users by reducing the costs of modeling computer systems. The Information Technology Department and the HSM Division will collaborate in the development of a plan by June of 2002 to effectively replace the Sun/Solaris Workstations.

FINDINGS AND RECOMMENDATIONS

Strategic Modeling Plan & Systems Development Standards Are Needed

Modeling Plan

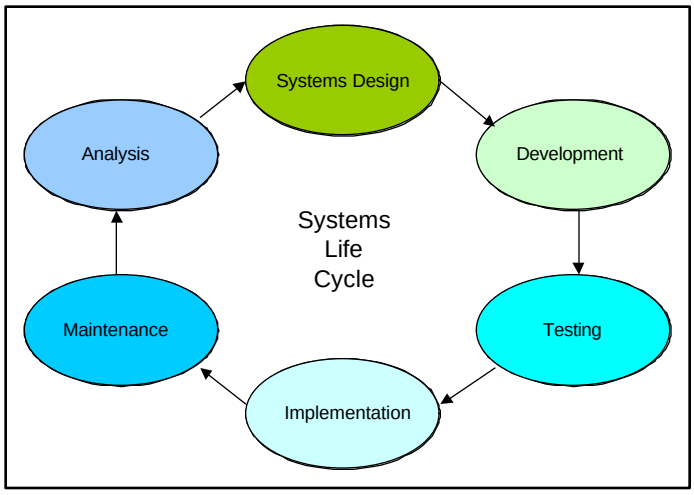
In 1999 the District's white paper entitled "The Future of Modeling at the SFWMD" recommended that a strategic modeling plan be developed. However, to date, a strategic modeling plan has not been prepared. According to the white paper having a modeling plan would help:

- Improve Management Practices, Coordination,
- Increase Modelers Productivity, and
- Plan Future Needs.

Identifying these "issues and constraints" as goals, determining the objectives and the related tasks could provide the structure for a strategic analysis. The resulting strategic modeling plan could serve as a needed measurement tool.

SDLC

In-lieu of the more formal System Development Life Cycle (SDLC) process, Hydrologic Systems Modeling Division staff uses an informal review process for modeling.



SDLC is a term that refers to the process used in the development or procurement of a computer software system. This process has accepted standards for information systems' business practices.

Each of the life cycle stages should include:[4]

- The steps to be performed and their sequence,

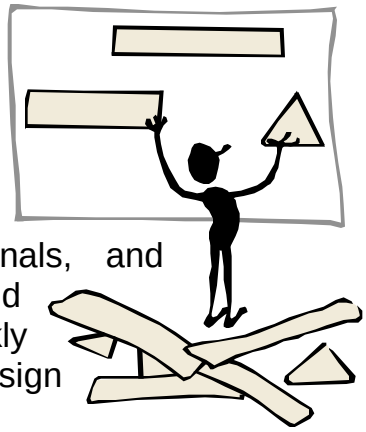
[4] Leonard L. Sutton and Donald F. Caniglia, *Handbook of IT Auditing, 2001 edition,* (Warren, Gorham, and Lamont, 2000), B3-4, B3-5, & B3-6

- Status points and *approval* procedures,
- Planning and project management procedures,
- The role and responsibilities of the parties involved,
- *Documentation* requirements, and
- Steps for incorporating security, controls, and *audit trails*.

The stages of the cycle are as follows:[5]

Analysis (Planning) – A formal planning process should be required to identify the needs and goals of preparing models. Cost benefit data should be collected and analyzed and user needs and requirements should be assessed. The *draft* white paper report titled "The Future of Modeling at the SFWMD," commissioned by the Director of the Hydrologic Modeling Division, included a recommendation to "develop a full strategic plan for modeling activities within the Water Management Planning and Implementation Program."[6] The report was never finalized and the District has not adopted a formalized strategic plan for hydrologic modeling activities.

Design – There should be both a high level design and detailed design. The basic functions and capabilities of the prospective model are defined at the high level. Other areas such as the input and output needs, storage requirements and processing should be covered during the more detailed design. At the District, model designs and the supporting methodology is reviewed by in-house staff, consultants, published in professional journals, and presented by staff at professional seminars and conferences. However, with the exception of weekly staff meetings, there is no formal process leading to design approval.



Development – The development and/or procurement of both the software and hardware components of the system are done in this next stage of the process. A unit within the Hydrologic Modeling Division is charged with the responsibility of modeling program development. The staff uses Sun Workstations equipped with the Solaris Unix operating system, Sun server

[5] *Stages of the Systems Life Cycle (1999-2000).* The Penn State School of Information Sciences and Technology. Retrieved on May 21, 2001 from the World Wide Web: http://www.ist.psu.edu//courses/110_content/topic_10/lesson_04/10_04_02.html.

[6] South Florida Water Management District, *White Paper Report: The Future of Modeling at the SFWMD*, (Hydrologic Systems Modeling Division, August 1999), 24.

workstations, and utility software tools such as Fortran 77 compilers, C++ program compilers, debugging program utilities, and Unix script files.

The development of new models takes into consideration the capability of existing models as they relate to District programs such as Water Supply Planning, Everglades Restoration Project, and the Comprehensive Everglades Restoration Plan.

Changes to models are documented via internal memorandums. During weekly staff meetings activities of this development unit are held with both the unit supervisor and the Division Director reviewed. There are no formal steps required for program development and documentation.

Testing – Upon completion, the system is typically tested. The tests should be documented and approved. Division staff test models with a set of "standard" data sets. E-mail is sent to appropriate staff advising them of computer model runs. Staff is expected to review the test results of these runs in order to evaluate differences, assure that the water budgets are balanced and variations are explained. There is no formalized process for "sign-off" approval of model test.

Implementation (and Conversion) - This stage involves putting the new system into production and training the users on how it operates. If this is a replacement or modification to an existing system, conversion issues need to be taken into consideration. After the developers are satisfied with the test result, changes to the models are implemented as the next (new) version and updated using the CVS software system.[7] A staff member has been assigned the responsibility for updating and maintaining the system. The Division Director reviews with staff model changes prior to implementation.

Maintenance (Change Control) – Updates, revisions, or improvements to the system are normal changes. Changes start the cycle again.

In addition to keeping new and old versions on-line with CVS, the model runs are backed up on compact discs (CD's). These backup copies include the model program version, test data, and the results (output) from model runs used by the District in management, planning or technical decision making.

A staff member in the HSM division has the responsibility of maintaining and preserving the CD's containing this information. The CD's are logged stored

[7] Program changes are preserved and controlled with the use of Concurrent Versions System (CVS) version control software.

in CD file books located in the Hydrologic Modeling Division's general office area and are not adequately secured. The Division keeps an on-line copy of the CD log as a reference document.

Recommendations:

(1) A strategic Hydrologic Modeling Plan should be prepared.

Management Response: The Hydrologic Systems Modeling Division (HSM) will take the lead in assembling a small group to develop the Strategic Modeling Plan in FY03. This group will use the framework to be developed in the ITD's long-range Strategic Technology Plan and initiate the development of a more detailed Strategic Modeling Plan during the next fiscal year. HSM will request funding in the FY03 budget to hire a contractor to facilitate and coordinate the development of the Strategic Modeling Plan

Responsible Department/Division: Hydrologic Systems Modeling

Estimated Completion Date: July 31, 2003

(2) The District should adopt a formal System Development Life Cycle process for model development including design, development, testing, implementation, and maintenance (change management) with all the necessary authorizing documentation (audit trail) for the steps in the process.

Management Response: (a) HSM will review the ongoing modeling development efforts to identify the areas of SDLC process that require attention. (b) HSM will review the current processes used by IT to aid in the development of a modified process that addresses HSM's particular issues. IT will provide assistance and support for these efforts.

Responsible Department/Division: (a) Hydrologic Systems Modeling and (b) Information Technology

Estimated Completion Date(s): (a) September 20, 2002 and (b) January 1, 2003

(3) The backup compact disc storage books should be maintained in a secure and locked area.

Management Response: HSM will prepare a complete set of compact disc storage books to be stored in a secure, protected environment provided by IT.

Responsible Department/Division: Hydrologic Systems Modeling

Estimated Completion Date: September 1, 2002

Review File Access Authority &
Store Backups At Remote Location

Access

The Unix system file access permission levels are “owner” (creator of the file), “group” (select groups of users), and “other” (the world at large). The owner has read, write and execute privileges to the files. The group and other may be granted any privilege of read, write, and/or execute.

Security for accessing the program source code, program object code, and data files for the Hydrologic Systems Modeling Division is maintained by using a group named HSM. The Division grants computer file read, write, and execute privileges to all members of the HSM group. “Other” District users are granted read only privileges to this group.

During our review of the Unix users groups for the Hydrologic Systems Modeling Division, we found that several District users outside of the Division were members of the shared Unix user group HSM. This access provides an opportunity for changes to the program, data, or results files on the server without the review or approval of the Hydrologic Systems Modeling Division. In addition, all employees of the Division, regardless of their responsibilities, have access to the files within the HSM Unix group.

Backup

The Unix file server containing the computer files used by the Division is located in the main computer room on the third floor of the Emergency Operations Center building. The server devoted to the Division, like all District supported Unix servers, is backed up to tape by the Information Technologies Department both as a daily (weekdays) incremental backup and a weekly full backup. The weekly backup process copies all files on the disk to magnetic tape. Whereas, the incremental backup process only copies files that have changed since the last backup. A backup cycle consists of a full backup and the subsequent increments up to, but not including, the next full backup.

The District keeps a backlog of four to five weeks of backup cycles. These backups are used to protect the users in situations where a file is either incorrectly changed, inadvertently deleted, or is damaged. Beyond the four to five week period files that were not backed up locally by the user cannot be recovered. As stated previously, the HSM Division staff does make their own copies on CD of “the model program version, test data, and the results

(output) used by the District in management, planning or technical decision making."

The combination of the automated Information Technology Department backup cycle tapes and the user generated CD copies provide reasonable assurance that HSM Division's work is protected. However, a disaster recovery (off-site) copy of the Unix server backup cycle tapes is not created. In the Information Systems Security Audit, we had recommended that, "Resources necessary for an off-site backup copy of server data should be provided."[8]

Recommendations:

(4) Review all members of the Unix "HSM group" to determine if access with read, write, and execute privileges to this group is necessary to their job responsibilities.

Management Response: (1) HSM will review the current "group" access privileges and take steps to remove any external staff member who does not require HSM group privileges. (2) HSM will review the privileges of internal staff to identify who needs read, write and execute privileges for modeling being developed and used within HSM. (3) Information Technology Division will work with HSM to insure that UNIX access privileges are managed and reviewed on a regular basis.

Responsible Department/Division: Hydrologic Systems Modeling

Estimated Completion Date: July 1, 2002

(5) Ensure that a disaster recovery backup copy of the server data is created and stored at an off-site location.

Management Response: IT will review the backups and the procedures used for this server to make sure they adhere to the recommendations

Responsible Department/Division: Information Technology

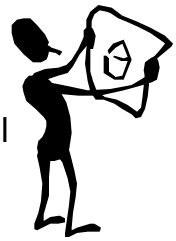
Estimated Completion Date: October 1, 2002

[8] *Audit of the District's Information Systems Security* (Report No. 98-03). South Florida Water Management District, p.21.

Future Resource Needs Should Be Addressed

Staffing

In order to support the functional requirements for District wide hydrologic modeling support, the Hydrologic Systems Modeling Division is organized into three units. These units support: (1) regional short term requests for operational modeling activities, (2) regional long term needs for planning activities, and (3) model development.



The first two units utilize the model as applications to the District's need to determine the impact of operational activities and the more long term impact of planned activities as changes to the physical system occur. The third unit, development, concentrates on refining the existing computer models and developing new computer models that take advantage of improvements in data, software and computer hardware. The separation of development from application allows the developmental activities to progress without being significantly impacted by the day-to-day demands for modeling support.

The salary of the staff represents 90% of the Division's total budget. Job descriptions for the staff are represented by the following job titles: Senior Supervising Engineer, Senior Engineer, Lead Engineer, Engineer, Senior Engineering Associate, and Hydrogeologist. In addition, a new job description of Chief Hydrologic Modeler was added in August of 2001.

With the exception of the new job description of Chief Hydrologic Modeler, the job descriptions and associated salary ranges may not appropriately reflect the "knowledge, skills, and abilities" and "duties and responsibilities" of the staff. These jobs not only require the traditional professional technical skills of the descriptions being used, but also an advanced knowledge of how to apply computer hardware and software to hydrologic systems.

Hardware/Software

Currently, the staff utilizes Sun Workstations with the Sun Solaris operating system. The current configuration costs approximately $14,000 per system plus software. The existing systems of workstations, file servers, and software tools are adequate for the modeling staff's direct activities.

However, the District is considering the use of power PC's[9] and the Linux operating system[10] as the new platform for modeling programs. Each staff member involved in modeling currently has both a PC and Sun Workstation. With a change to a power PC utilizing the Linux operating system, the cost per PC workstation would be approximately $3,500 including the use of the public domain non-proprietary Lunix system.

The modeling staff would no longer have a need for the more expensive Sun Workstations and the use of proprietary software. In addition, with District using a more open system, the modeling "customers" (District staff, other Government agencies, consultants, and the Public) could more reasonably afford the PC equipment necessary to utilize the models at their own locations.

The Information Technology Department tested the PC configuration with Redhat Linux version 2.4 for compatibility and use on the District network. Subsequent to the successful test, the District's computer Architectural Review Committee (ARC) in June of 2001 approved PC/Linux as a District standard and a test system was ordered for the Hydrologic Modeling Division.

Public domain software tools such as program compilers (Fortran 77 and C++) and program debugging utilities (the "tools" of the modelers) were also tested successfully in the PC/Linux configuration.

Recommendations:

(6) The District's compensation staff should initiate a "job study" to determine if the District has adequately described the positions necessary for hydrologic computer modeling and determine if the salary structure is appropriate to the market demand for such positions.

Management Response: HR/Compensation will perform a market analysis of hydrologic modelers with comparable skills and roles in private/public organizations.

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[9] A personal computer with at least 60 Gb HD (gigabytes of Hard Drive disk space), 1 Gb RAM (gigabytes of Random Access Memory), Dual CPU (Central Processor Unit) running at 1.5 Ghz (Gigahertz).

[10] Linux is an operating system that was developed by Linus Torvalds at the University of Helsinki in Finland. It supports both PC and non-PC computer platforms, this includes both PC Intel and Sun workstation processors.

Responsible Department/Division: Human Resources

Estimated Completion Date: June 30, 2002

(7) Efforts to replace the Sun/Solaris Workstations for District modelers with the less expensive power PC/Linux configuration utilizing public domain software should be completed.

Management Response: The Information Technology Division and the Hydrologic Systems Modeling division will collaborate in the development of a plan to replace the Sun/Solaris Workstations which will include software conversion for District modelers with Power PC/Linux configuration utilizing public domain software by June 2002 if funds are available. This plan will identify the complete migration path from Unix-based Sun/Solaris environment to a PC-based Linux environment and a time schedule for migration.

Responsible Department/Division: Information Technology

Estimated Completion Date: January 31, 2003

In the management response to this audit (fully contained in Appendix B), responsible District management stated that:

> "*The shortage of manpower for modeling at the District has been identified many times during the last decade. In spite of many efforts to resolve this problem, staff could not keep pace with the increasing demands for modeling. As a consequence, efforts such as 'cross training' received lower priority over many years and this led to the worsening of the 'single person dependency' on several models. Although the Strategic Modeling Plan should address the long-term resolution of this issue, some immediate steps are necessary to meet the immediate needs of such important projects as CERP".*

Therefore, a group including Water Supply staff, CERP staff and the CORPS has been assembled to "inventory demands and develop solutions" to the issue of both short-term and long-term manpower resource requirements for modeling. Recommendations from the efforts of this group will be presented as a "white paper" report in August of 2002.

Appendix A

OTHER MODELS

ATLSS, Across Trophic Level System Simulation.

Includes panther, deer, wading bird, sparrow, alligator, fish, hydrology and vegetation submodels.

ELM, Everglades Landscape Model.

A regional scale ecological model that predicts landscape response to water management scenarios.

EWQM, Everglades Water Quality Model.

LOWQM, Lake Okeechobee Water Quality Model.

Simulates eutrophication process in water column and underlying sediments in Lake Okeechobee.

Mangrove Model.

Response of mangroves to changes in water quantity and quality.

ROGEM, River of Grass Evaluation Methodology.

A collection of landscape scale equations which predict relative fish and wildlife habitat quality responses to restoration alternatives.

Subregional Ground Water Models.

Broward County, Collier County, Upper East Coast Floridan,Hendry County, Jensen Beach Zoom, Lee County, Martin Coastal, Martin County, St. Lucie County, North Miami-Dade County, and South Palm Beach County.

Appendix B

MANAGEMENT RESPONSE MEMORANDUM

MGT 08-06

MEMORANDUM

TO: Allen M. Vann, CPA, Inspector General

THROUGH: Alvin V. Jackson, Jr., Deputy Executive Director, Corporate Resources
Chip Merriam, Deputy Executive Director, Water Resources Management

FROM: Kenneth G. Ammon, P. E., Director, Water Supply Department

DATE: March 28, 2002

SUBJECT: Draft Report: Audit of the Hydrologic Modeling Program, System Development Cycle, #01-11

I would like to thank you and John Lynch for initiating and carrying out the audit of the hydrologic modeling program. John Lynch, who has had a long tenure at the District, certainly has the knowledge and experience necessary for the audit of this important program. In my opinion, he covered our program thoroughly by conducting numerous interviews and reviewing a wealth of written material provided to him.

I am very pleased with the overall findings of the audit and agree on all seven recommendations. My comments and responses to each of the recommendations made in the audit report follow.

One important issue that I would like to see included in the audit report is the excessive workload for the current level of staffing in HSM to accomplish existing and future workloads, as well as the lack of time for cross training. I have pointed this out several times over the years. There have been many "brush-fire" projects during the last five years that required many staff members to work numerous hours of overtime. I have added one additional recommendation to address these issues.

Recommendation (1): A Strategic Modeling Plan should be prepared.

Management Response:

Management agrees with the recommendation.

The Information Technology Department has prepared a request for proposal, which calls for a firm (to be determined) to develop a long-range, Strategic Technology Plan. ITD has further developed a request for proposal for the assessment of the current District Disaster Recovery / Business Continuity Plan and in 2003 ITD plans to develop a request for proposal to implement the findings of the Disaster Recovery / Business Continuity Assessment. The two requests for proposal will be advertised for bid in the coming month. The Hydrologic Modeling Program will be part of both initiatives. The Strategic Technology Plan as well as the Disaster Recovery / Business Continuity Assessment are planned for completion in August 2002. The Information Technology Strategic Plan will provide the framework from which the Strategic Modeling Plan can follow. This effort should occur in FY03.

The Hydrologic Systems Modeling Division (HSM) will take the lead in assembling a small group to develop the Strategic Modeling Plan in FY03. This group will use the framework to be developed in the ITD's long-range Strategic Technology Plan and initiate the development of a more detailed Strategic Modeling Plan during the next fiscal year. HSM will request funding in the FY03 budget to hire a contractor to facilitate and coordinate the development of the Strategic Modeling Plan.

Proposed completion dates: Strategic Technology Plan: August 2002
Strategic Modeling Plan: July 2003

Background: As you have correctly pointed out, the need to develop a Strategic Modeling Plan was identified in the District's white paper entitled "The Future of Modeling at the SFWMD" commissioned by the Hydrologic Systems Modeling Division in 1999. This paper identified numerous issues associated with modeling and was meant to be a guiding document for numerous tasks to be implemented in the years to come. At the time, the draft date for completing the strategic modeling plan was January, 2000.

In an effort to implement some of the recommendations made in the above white paper, the Modeling Technology Group (MTG) assembled again during the latter part of 1999. The group created a very rough draft of recommendations, which included:

(a) Create a Modeling Advisory Committee (MAC) for advising the Executive Office in making major modeling decisions;
(b) Authorize and allocate resources for MAC to initiate a project for developing a Strategic Modeling Plan at the District; and
(c) Authorize and allocate time for the MAC to design a pilot IT project within the Hydrologic Systems Modeling (HSM) Division to identify and implement current IT issues related to modeling.

This work was interrupted for two reasons:
(a) Hydrologic Systems Modeling division's priorities were shifted because of the unprecedented drought 2000-2001; and
(b) The group realized the need to wait until after the CERP reorganization was completed.

Recommendation (2): The District should adopt a formal System Development Life Cycle process for modeling development including design, development, testing, implementation, and maintenance (change development) with all the necessary authorizing documentation (audit trail) for the steps in the process.

Management Response:

Management agrees with the recommendation.

- HSM will review the ongoing modeling development efforts to identify the areas of SDLC process that require attention.

  Proposed completion date: September 20, 2002

- HSM will review the current processes used by IT to aid in the development of a modified process that addresses HSM's particular issues. IT will provide assistance and support for these efforts.

  Proposed completion date: January 1, 2003

Background: The Hydrologic Systems Modeling division is developing a replacement for the District's premier tool for modeling, the South Florida Water Management Model (SFWMM). The new model, currently named as Regional Simulation Model (RSM), consists of two major components:

(a) Hydrologic Simulation Engine (HSE)
(b) Management Simulation Engine (MSE)

Over the last 5 years, the division made an extensive effort to follow many of the steps identified in the System Development Life Cycle (SDLC) process. Several contractors were recruited to aid in the

development of the new model using Object-Oriented modeling technology and this effort provided valuable insights as to how one should proceed with the implementation of these emerging technologies. More recently, the staff took over the development and proceeded to complete the first component, Hydrologic Simulation Engine (HSE), and is now in the process of applying this tool in at least three areas of the District. Because of the manpower shortage in the development group, the staff may not have had time to fully follow the steps of the SDLC process in detail.

Recommendation (3): The backup compact disc storage books should be maintained in a secure and locked area.

Management Response:

Management agrees with the recommendation.

- HSM will prepare a complete set of compact disc storage books to be stored in a secure, protected environment provided by IT.

  Proposed completion date: September 1, 2002

Recommendation (4): Review all members of the Unix "HSM group" to determine if access with read, write, and execute privileges to this group is necessary to their job responsibilities.

Management Response:

Management agrees with the recommendation.

- HSM will review the current "group" access privileges and take steps to remove any external staff member who does not require HSM group privileges.

  Proposed completion date: July 1, 2002

- HSM will review the privileges of internal staff to identify who needs read, write and execute privileges for modeling being developed and used within HSM.

  Proposed completion date: July 1, 2002

- Information Technology Division will work with HSM to insure that UNIX access privileges are managed and reviewed on a regular basis.

  Proposed completion date: July 1, 2002

Recommendation (5): Ensure that a disaster recovery backup copy of the server data is created and stored at an off-site location.

Management Response:

Management agrees with the recommendation.

- IT will review the backups and the procedures used for this server to make sure they adhere to the recommendations.

  Proposed completion date: October 1, 2002

Background: The Information Technology Division has created a request for proposal to address the assessment of the Disaster Recovery / Business Continuity plans currently existing at the District. This RFP is due to be released for bids this month and the work completed by this August 2002.

Additionally, in FY03 ITD's direction will be to create a request for proposal engaging a contract firm to act on the findings of the assessment. The Hydrologic Modeling server will, as will all servers, become part of this assessment.

Recommendation (6): The District's compensation staff should initiate a "job study" to determine if the District has adequately described the positions necessary for hydrologic computer modeling and determine if the salary structure is appropriate to the market demand for such positions.

The Hydrologic Systems Modeling Division is completely in agreement with the audit report regarding this issue. In fact, this has been brought to the attention of Human Resources Division and some initial effort has been undertaken. We suggest that the job study be accelerated before we see a turnover in the trained modelers in HSM.

Management Response:

Management agrees with the recommendation.

HR/Compensation will perform a market analysis of hydrologic modelers with comparable skills and roles in private/public organizations.

Proposed completion date: June 30, 2002 with a report on the outcome.

Recommendation (7): Efforts to replace the Sun/Solaris Workstations for District modelers with the less expensive power PC/Linux configuration utilizing public domain software should be completed.

Management Response:

Management agrees with the recommendation.

The Information Technology Division and the Hydrologic Systems Modeling division will collaborate in the development of a plan to replace the Sun/Solaris Workstations which will include software conversion for District modelers with Power PC/Linux configuration utilizing public domain software by June 2002 if funds are available. This plan will identify the complete migration path from Unix-based Sun/Solaris environment to a PC-based Linux environment and a time schedule for migration.

Proposed completion date: January 2003

<u>Proposed Recommendations:</u>

Recommendation (8): An analysis of the adequacy of the current staffing level in HSM for meeting the short-term and long-term modeling needs of all major projects/functions should be conducted. Develop a plan for meeting the future modeling needs.

The shortage of manpower for modeling at the District has been identified many times during the last decade. In spite of many efforts to resolve this problem, staff could not keep pace with the increasing demands for modeling. As a consequence, efforts such as "cross training" received lower priority over many years and this led to the worsening of the "single person dependency" on several models. Although the Strategic Modeling Plan should address the long-term resolution of this issue, some immediate steps are necessary to meet the immediate needs of such important projects as CERP.

Management Recommendation:

A small group consisting of the District (represented by both Water Supply and CERP) and the CORPS has been assembled to develop an inventory of modeling demands and develop a solution to

the problem of inadequate modeling resources. Once the inventory is complete, HSM will carry out the following tasks:

- Identify the modeling tasks that can be contracted out and encourage project managers to budget funding for them in the upcoming years.
- Request staff and/or positions redirected to HSM to be trained and assigned to higher priority District initiatives requiring regional-scale modeling
- Request senior managers to set priorities for modeling tasks in HSM.

Proposed completion date: White paper by August 1, 2002

JO/nm

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William Hall
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Kenneth Tarboton
Randy Van Zee
Joe Weber

GLOSSARY of TERMS

These definitions were developed by District staff or were drawn from the "Free On-line Dictionary of Computing," by Dennis Howe @ Web Site: http://www.foldoc.org.

application program (Or "application")

A complete, self-contained program that performs a specific function directly for the user. This is in contrast to systems software such as an operating system (OS), which exists to support application programs.

audit trail (computer)

A record showing who has accessed a computer system and what operations he or she has performed during a given period of time. Audit trails are useful both for maintaining security and for recovering lost transactions.

backup

A spare copy of a file or system of files, usually kept on magnetic tape or other removable medium such as compact disc, for use in the event of failure or loss of the original files or system.

compact disc rewritable (CD-RW)

A rewritable version of CD-ROM (CD read only memory). A CD-RW drive can write about 650 megabytes of data to CD-RW media an unlimited number of times. Most CD-RW drives can also write once to CD-R media. CD-R is sometimes considered a better technology for archival purposes as the data cannot be accidentally modified or tampered with, and encourages better archival practices.

change control

In a computer production program or database application, the process of administering modifications to the programs or data. This includes administrative authorization approval and providing an audit trail for modification activities.

computer aided software development

A technique for using computers to help with one or more phases of the software life cycle, including the systematic analysis, design, implementation and maintenance of software.

crash

A sudden, usually drastic failure of a computer system as a result of a hardware or software problem.

C++

One of the most used object-oriented programming ***<See object-oriented programming>*** *languages, a superset of C developed primarily by Bjarne Stroustrup at AT&T Bell Laboratories in 1986.*

fortran (Formula Translation)

The first and, for a long time, the most widely used programming language for numerical and scientific applications. ***Fortran 77*** *is a popular version of Fortran with Block IF, PARAMETER and SAVE statements added, but still no WHILE. It has fixed-length character strings, format-free I/O, and arrays with lower bounds.*

GUI (graphical user interface)

The use of pictures rather than just words to represent the input and output of a program. The program displays certain icons, buttons, dialogue boxes etc. in its windows on the screen and the user controls it mainly by moving a pointer on the screen (typically controlled by a mouse) and selecting certain objects by pressing buttons on the mouse while the pointer is pointing at them.

hardware

The physical, touchable, material parts of a computer or other system. The term is used to distinguish these fixed parts of a system from the more changeable software or data components.

information systems security

Control techniques and measures applied to an Information Technology Process that satisfies the business requirement to safeguard information against unauthorized use, disclosure or modification, damage or loss and is enabled by physical, logical and administrative controls which ensure access to systems, data and programs is restricted to authorized users. (Brian A. Coleman, CISA)

iweb (Intranet)

Any network that provides similar services within an organization to those provided by the Internet outside it but which is not necessarily connected to the Internet. The commonest example is the use by an organization as an internal network for easy distribution of information within the organization.

local area network (LAN)

Networks that cover a smaller area such as a complex of buildings are called a Local Area Network, LAN. Multiple Local Area Networks can be interconnected through a Wide Area Network. (i.e. B-50 to B-1 computer communications link.)

linux operating system

linux is an operating that was developed by Linus Torvalds at the University of Helsinki in Finland. It was developed under the GNU General Public License and its source code is freely available to everyone. It supports both PC and non-PC computer platforms, including both the PC Intel and Sun workstation processor. (See operating system.)

model

***<See simulation>** A description of observed behavior, simplified by ignoring certain details. Models allow complex systems to be understood and their behavior predicted within the scope of the model, but may give incorrect descriptions and predictions for situations outside the realm of their intended use. A model may be used as the basis for simulation.*

object code

The machine code generated by a source code language processor such as an assembler or compiler. A file of object code may be immediately executable or it may require linking with other object code files, e.g. libraries, to produce a complete executable program.

object-oriented programming

The use of a class of programming languages and techniques based on the concept of an "object" which is a data structure (abstract data type) encapsulated with a set of routines, called "methods", which operate on the data.

on-line

Accessible directly via a computer (or terminal), rather than on paper or other removable medium such as magnetic tape or CD.

open system (portability)

The ease with which a piece of software (or file format) can be "ported", i.e. made to run on a new platform and/or compile with a new compiler.

operating system (OS)

The low-level software, which scheduled tasks, allocates storage, handles the interface to peripheral hardware and presents a default interface to the user when no application program is running.

password

An arbitrary string of characters chosen by a user or system administrator and used to authenticate the user when he attempts to log on in order to prevent unauthorized access to his account.

platform

Specific computer hardware. It may also refer to a specific combination of hardware and operating system.

power PC

A personal computer with at least 60 Gb HD (gigabytes of Hard Drive disk space), 1 Gb RAM (gigabytes of Random Access Memory), Dual CPU (Central Processor Unit) running at 1.5 Ghz (Gigahertz).

recovery

The process of restoring computer data file with a backup copy usually after a crash or accidental deletion of a file.

relational data base

A relational database allows the definition of data structures, storage and retrieval operations and integrity constraints. In such a database the data and relations between them are organized in tables. A table is a collection of records and each record in a table contains the same fields. Certain fields may be designated as keys, which means that searches for specific values of that field will use indexing to speed them up.

simulation

Attempting to predict aspects of the behavior of some system by creating an approximate (mathematical) model of it. This can be done by physical modeling, by writing a special-purpose computer program or using a more general simulation package, probably still aimed at a particular kind of simulation (e.g. structural engineering, fluid flow).

software

Computer programs, as opposed to the computers on which they run (the "hardware").

solaris operating system

The version of the UNIX operating system developed for the Sun Systems, Inc. workstations. ***<See operating system>***

source code

The form in which a computer program is written by the programmer. Source code is written in some formal programming language (such as Fortran or C++) which can be compiled automatically into object code.

strategic plan

Functional blueprint which clearly and concisely defines a strategic framework resulting from the planning process.

user(s)

The people who either use computers directly, or use the information they provide; also called computer users or end users.

webmaster

The alias or role of the person(s) responsible for the development and maintenance of one or more web servers and/or some or all of the web pages at a web site. The term does not imply any particular level of skill or mastery.

wide area network *(WAN)*

A computer communications network used to access information with a link over distances of more than one kilometer. Multiple Local Area Networks (LAN's) can be interconnected through a Wide Area Network. (District-wide computer communications network.)

World Wide Web (WWW)

An Internet client-server hypertext distributed information retrieval system, which originated from the CERN High-Energy Physics laboratories in Geneva, Switzerland.