Ground Water Monitor Well Network Assessment
A District Task Force Report
Technical Memorandum WS-12

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Cover Photo: W. Hillsboro Canal Tri-zone Floridan Aquifer System Monitor Well with Recorder and Telemetry

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EXECUTIVE SUMMARY

The South Florida Water Management District (District) and the United States Geological Survey (USGS) jointly manage and fund an extensive ground water monitor well network in South Florida. The current network has two distinct groups totaling approximately 669 wells (Switanek, 1999). The first group consists of approximately 394 monitor wells, 109 of which monitor the Floridan aquifer. Data from this group is collected by USGS staff and funded cooperatively between the District and USGS. These wells are jointly maintained between the two agencies. The second group consists of approximately 275 wells. This group of wells is currently monitored and maintained by District staff. Approximately 30 of these monitor the Floridan aquifer.

The District funds this extensive ground water monitor network for the following reasons:

- To develop and calibrate ground water flow models;
- To provide data to regularly assess temporal ground water conditions, especially during droughts;
- To determine background ground water conditions for gauging future performance of Comprehensive Everglades Restoration Projects (CERP); and,
- To provide data for water use permit application evaluations.

Each of the four regional water supply plans (WSP) recently published by the District (SFWMD 1998, SFWMD 2000a, SFWMD 2000b, and SFWMD 2000c) have recommendations referring to the need for additional and improved ground water monitoring within their respective regions. The Lower East Coast (LEC) WSP recommends augmenting the network to expand the existing saltwater intrusion monitoring in the area. The Lower West Coast (LWC) WSP recommends a review of the existing water quality and water level monitoring for each of the three primary aquifer systems in the region (Intermediate, Surficial and Floridan aquifer systems). The Upper East Coast (UEC) WSP recommends developing a comprehensive monitoring program to collect the necessary information to develop the water use, water quality, and water level relationships in the high water use citrus groves in St. Lucie County. And the Kissimmee Basin (KB) WSP has a recommendation for the collection of necessary hydrologic information for the development of models to accurately identify resource concerns.

This report summarizes the results of a District task force evaluation of the aforementioned monitor well network (excluding the Kissimmee Basin Planning Area) and presents specific recommendations for improvements. The report is structured as an implementation handbook through use of stand-alone tables listing specific wells in need of attention (i.e. repair, replacement, automation, etc).

The task force concluded that although the total number of wells in the network overall (669) provides adequate spatial resolution, the frequency of water level readings is not sufficient to support future ground water modeling efforts. Many recent models developed by the District (to support water supply plan development) run on daily time periods because stages in surface water bodies (i.e. canals) vary on a daily basis. The frequency of ground water level monitoring needs to correspond to the daily time periods of the models to ensure adequate model calibration.

As of 1999, there were approximately 132 USGS recorders installed on approximately 20% of the 669 network monitor wells. Water levels in the remaining 537 wells (80% of network) were measured manually each month. The task force recommended an additional 40% of the network (537 wells) be automated which translates into a need for an additional 214 recorders. Approximately 30 of these new recorders should be installed on Floridan aquifer wells. The cost to automate the Floridan aquifer monitor wells could possibly be shared with the CERP Regional ASR Studies Project (CERP PMP- Regional Studies, Draft 2001). The remaining 184 recorders should be installed on existing Surficial and Intermediate aquifer monitor wells. The cost for the District to fully automate each well is approximately $10,000 (in today's dollar). The operation and maintenance (O&M) for each well is approximately $3,000 annually per unit. Therefore, the total cost to install 214 recorders would be approximately **$2,140,000** while O&M costs will be approximately **$642,000**, annually. At least one full-time hydrogeologist would also be needed for one to two years to work on associated logistics such as access agreements, coordination between District staff, and wellhead modifications prior to installing the recorders.

The task force also focused on improving the network and provided the following recommendations:

- 15 wells can safely be eliminated from the network due to data redundancies. A total of 7 from the LEC, 6 from the UEC, and 2 from the LWC;
- At least 54 additional new wells need to be drilled and instrumented in the regional network, 37 in the LEC, 15 in the LWC, and 2 in the UEC;
- 4 new surface water stage recorders were recommended in the LEC and 3 new rainfall gauges for the UEC;
- 40 wells were found to be in need of repair, 18 in the LEC, 16 in the LWC, and 6 in the UEC. 13 of the total 40 wells were repaired by the District in Y2001, prior to this report going to press; and
- 82 wells were identified as a high priority to automate with recorders, 49 in the LEC, 23 in the LWC, and 10 in the UEC.

In addition to addressing the specific needs of the monitor well network, the task force offered other related recommendations as well. Data errors were identified and should be corrected in the database. Compatibility issues were also noted that pertain to data format problems and lack of interconnection between project-specific data. It was recommended that staff be assigned specific regions of the District where they would identify and track new sources of monitoring data and ensure it gets entered into DBHYDRO (District Corporate Hydrologic Database). It was also noted that DBHYDRO's searching capabilities are not strong enough, some data is misclassified (i.e. in the wrong aquifer), and some are absent altogether. Most of these problems will have been rectified by the time this is published.

The District should attempt to coordinate with local governments and utilities that manage local monitoring programs and databases of their own. The District receives much of this data already as part of the water use permit process. The District needs to integrate this data with the data available in DBHYDRO. Integration of data from these sources would be a cost-effective means to increase our coverage both temporally and spatially.

Temporal (semi-annual) water level maps were also recommended for the LEC and LWC. Ground water modelers claim these would be helpful in determining the cone of influence of the major public water supply wellfields in the area.

Funding in the fiscal year (FY) 2002 budget represents only a portion of the total funds needed to implement the task force recommendations. Implementation of the well restoration work is budgeted at 100% of the total cost and should be completed in FY02 in the Water Supply Department. In fact, by the end of calendar year 2001, 13 of the 40 wells in the network were already repaired. Approximately 9% ($25,884) of the total estimated cost ($287,600) for well replacements is proposed in FY02. If funded at this same level each year, replacements can be completed over a five-year time frame. Of course, this does not account for future wells needing replacement. Well automation is the most costly component of the recommendations; approximately 5% ($100,000 for 10 wells) of the total ($2,140,000 for 214 wells) are being funded in FY02. This assumes $10,000 per well automation cost. The proposed plan is to complete automation of the approximately 214 wells, currently taped monthly, over several years. This higher frequency water level data would hopefully be available in time for development of the 2010 water supply plans.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the many people who aided in the successful completion of this Technical Memorandum. We would especially like to thank Mr. Scott Prinos of the United States Geological Survey (Miami sub-District), who reviewed the manuscript and lent technical expertise during the writing of this report. We also extend special thanks to Michael Bennett (of the District) for his expert technical review of the draft document. This report benefited considerably from his organizational and editing contributions during internal peer review.

Appreciation is also extended to the technical and professional staff of the South Florida Water Management District who assisted in the compilation and analysis of data and peer review of this report. This especially pertains to members of the task force not listed as authors on this document including: Milton Paul Switanek, Chris Sweazy, Mark Wilsnack, Paulette Glebocki, and Kenneth Stewart. We also thank Rick Bower, Peter Dauenhauer, David Demonstranti, and John Lockwood for their peer review of the document.

The final technical editing and publication was the result of the fine work of Ms. Sorrel Hoover of Orion Consulting, Inc. Sorrel was patient and professional through the entire document production process.

Finally, we thank Mr. Matthew Morrison (Director of the Water Supply Plan Division) for his cooperation and assistance during the task force and report production phases. We hope this document provides a good foundation for implementing some of the regional water supply plan recommendations being managed in his organization.

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INTRODUCTION

Objectives

This report summarizes the results of an internal task force evaluation of the wells in the South Florida Water Management District's (District) ground water monitor network. Ground water monitor wells in three of the four District water supply planning areas were evaluated for effectiveness and current operating condition by interviewing end users of the data and District staff who regularly obtain data from the wells. The task force defined the following three primary objectives:

- Identify needed improvements to the District's regional ground water monitor well network by identifying its shortcomings through interviews with end users of the data (i.e. modelers) and staff who regularly collect data from the wells;

- Identify other potential problems end-users may have experienced over the years, (i.e. data storage and manipulation issues); and,

- Identify redundancy and data quality issues.

Evaluation of the current monitor well network was initiated in July 2000, shortly after the District's regional water supply plans were published (SFWMD 1998, SFWMD 2000a, SFWMD 2000b, SFWMD 2000c). The task force used regional ground water flow models as a primary tool for developing recommendations. The regional ground water models, so vital in developing plan recommendations, were calibrated and verified using temporal ground water data from the regional monitor well network. Recommendations include the need to improve the data so that District hydrogeologists and engineers are able to develop improved, next generation ground water models in support of future water supply plans and several components of the Comprehensive Everglades Restoration Project (CERP).

Purpose of the Ground Water Monitor Network

The District has managed and/or funded an extensive ground water monitor well network in South Florida since 1955. That network is managed as two groups totaling 669 wells. The first group consists of 394 wells monitored by the United States Geological Survey (USGS) (Miami office) and funded under a cooperative agreement with the District **(Figure 1).** The second group of 275 wells is funded, maintained, and monitored solely by the District **(Figure 2)**.

The four primary reasons why the District funds this extensive ground water monitor network are as follows:

- To develop and calibrate ground water flow models. The data is primarily used for model calibration and verification;

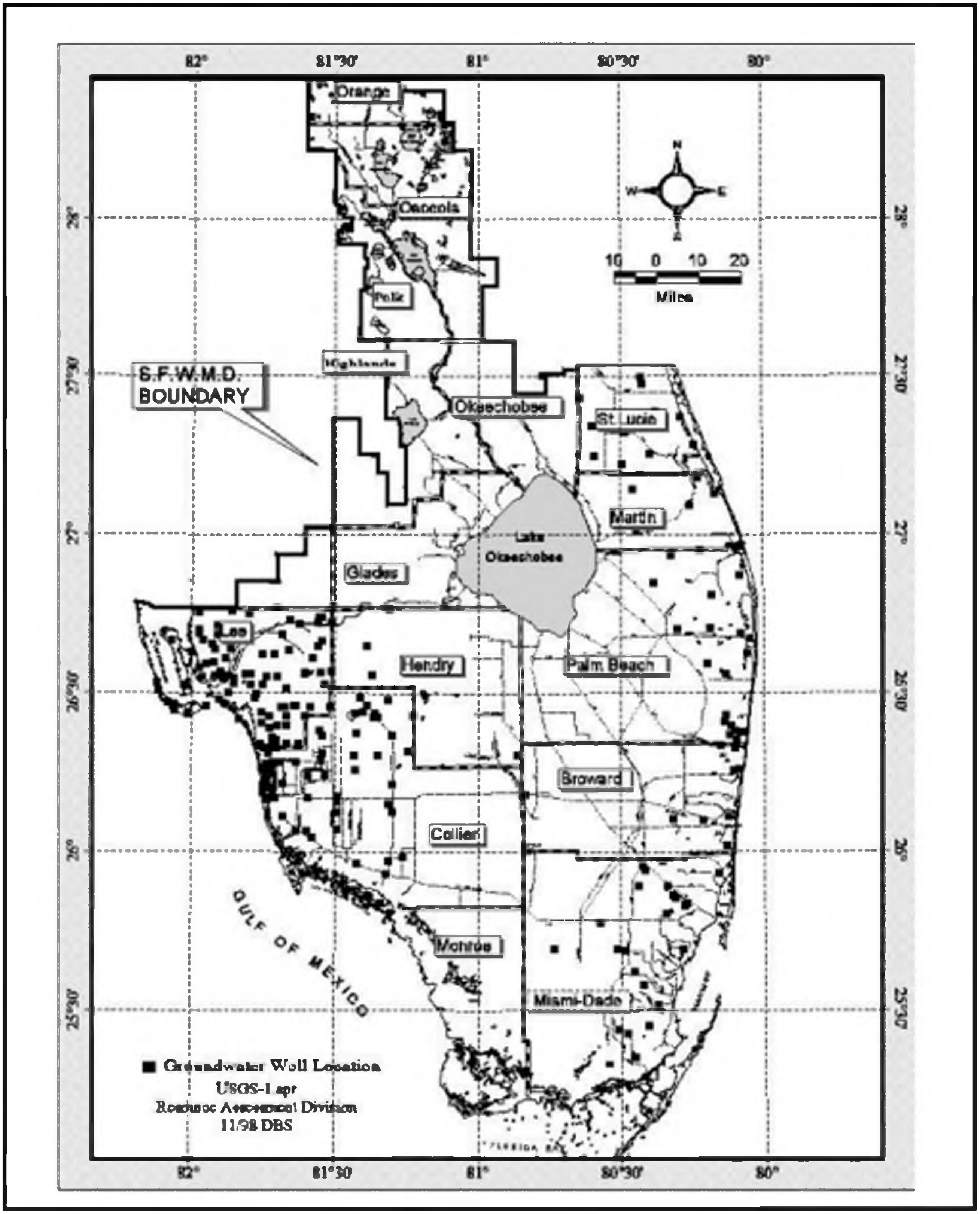

Figure 1: ***Monitor Well Locations Monitored by the USGS.***

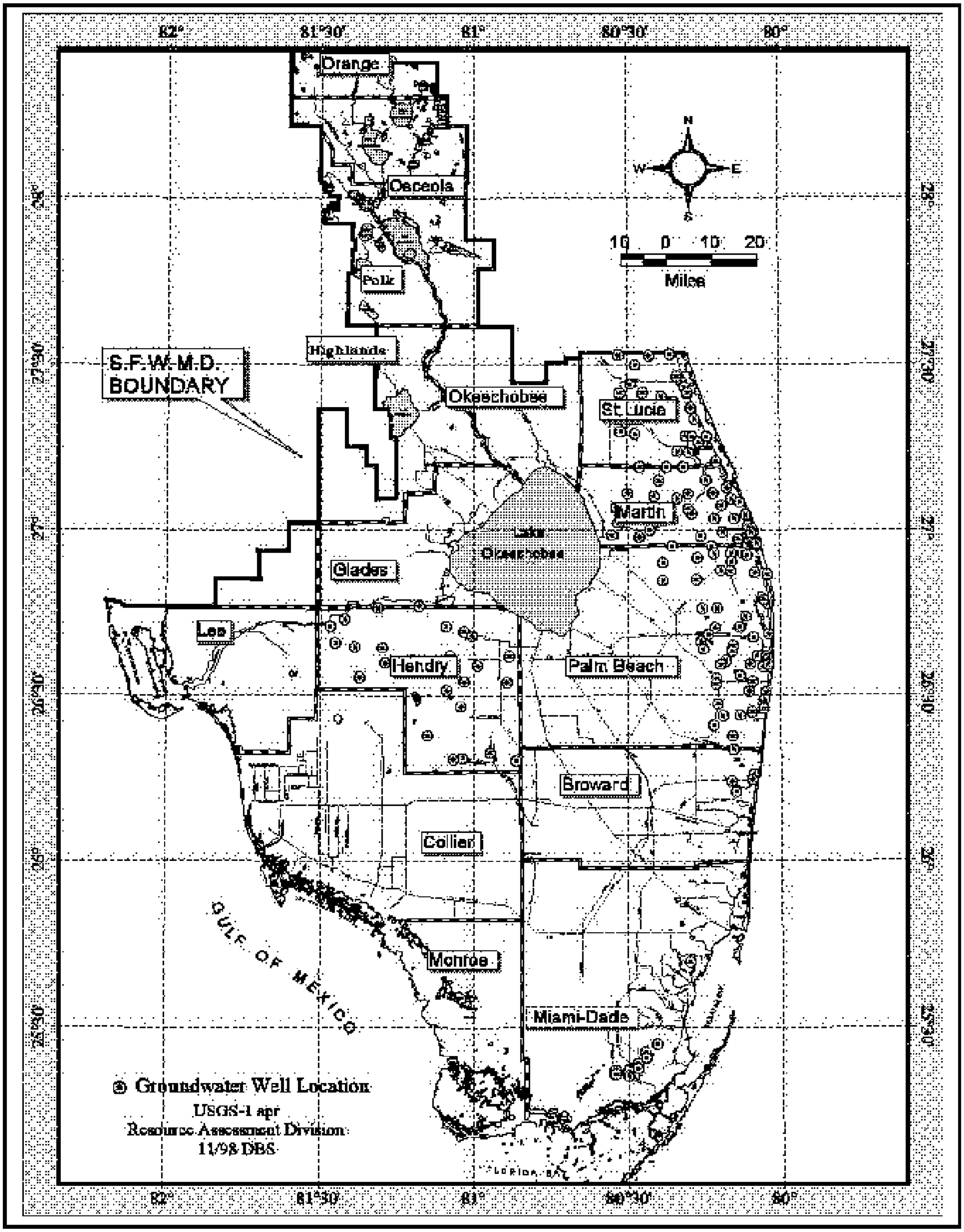

Figure 2: ***Monitor Well Locations Monitored by the District.***

- To provide data to regularly assess temporal ground water conditions during droughts;
- To provide data for water-use permit application evaluations; and,
- Determine background conditions for use in evaluating the future performance of the Comprehensive Everglades Restoration Projects (CERP).

Task Force Review of Monitor Wells' Condition/Needs

A District task force was convened in July 2000 and met monthly through January 2001. The primary purpose was to evaluate the condition of wells in the regional network and determine its usefulness and needs. This task force consisted of various end-users of the monitor well data from various District organizations including:

- Water Supply Department
  - Water Supply Planning and Development Division
  - Hydrologic Systems Modeling Division
  - Water Use Division
- Environmental Monitoring and Assessment Department
- Hydrologic Information Systems and Assessment Division
- Water Resources Operations Department
- Operations Controls Department

In addition, the USGS (Miami sub-District, Scott Prinos) also provided the task force with input.

Members and Methods

Task force members were divided into sub-groups to evaluate the network in their assigned regions. The members by region were as follows:

- **Chairs:** John Lukasiewicz, Cherry James
- **Lower East Coast Planning Area**: Hope Radin, Mark Wilsnack
- **Lower West Coast Planning Area**: Terry Bengtsson, Jeff Herr, Dave Butler
- **Upper East Coast Planning Area**: Emily Hopkins, Hope Radin
- **Regulation**: Paulette Glebocki, Rick Bower

Team members were tasked with evaluating their portion of the network by employing the following five strategies:

1. Interview District ground water modelers (see **Appendix A** for 12 questions asked);
2. Speak with District staff who regularly monitor the wells in the network;
3. Investigate the network by sub-regions;
4. Write draft sub-regional reports summarizing recommendations; and,
5. Help to finalize recommendations into a comprehensive report.

The task force examined the physical condition of the wells in the ground water network, the need to add or remove individual wells and recorders, data management issues, etc. Once these determinations were made, costs were estimated for the recommended repairs, replacements, and data automation.

Findings of the task force are organized in this report by regional planning areas of the District. The four District planning areas include the Lower East Coast, Lower West Coast, Upper East Coast and Kissimmee Basin Planning Area. The Kissimmee Basin Planning Area was not reviewed for the following reasons:

- Limited staffing resources within the task force;
- The region has the least number of monitor wells in the network;
- The region has less water use requirements than the other planning areas; and,
- The Kissimmee Basin Plan Manager is planning his own intensive monitor well network review shortly.

Previous Network Evaluations by the District

One previous documented District review of the network can be found in the literature by Ahn (1996). Ahn (1996) developed a statistical model to determine optimum frequency of sampling and spatial distribution of wells regionally in the LWC planning area. In addition to this internal staff report, two additional journal articles spawned from that evaluation (Ahn and Salas 1997, and Ahn 2000). The stochastic modeling efforts concluded that 41 wells could be removed from the LWC network without adverse effects. However, when additional programmatic criterions were considered, that number was reduced to 24 wells (Switanek, 1999). The programmatic criterion included such things as historic record, water shortage prone areas, wells jointly funded by several agencies, etc. The approach for the evaluation described in this report was programmatic in nature, not statistical.

LOWER EAST COAST PLANNING AREA FINDINGS AND RECOMMENDATIONS

Aquifers in the Region

Underlying the LEC are two major aquifer systems. They are the Surficial Aquifer System (SAS) and the Floridan Aquifer System (FAS). The SAS is comprised of rocks and sediments extending from land surface down to the top of an intermediate confining unit (approximately 120 to 250 feet below land surface (bls)). The locally productive water bearing units of the SAS include the Biscayne aquifer, the water-table aquifer and the Gray limestone aquifer (Reese, 1999). Most municipal and irrigation water is obtained from the SAS in the LEC, although the FAS is also tapped as a water supply source in northern Palm Beach County.

The FAS is found approximately 1,000 feet bls is the LEC and is divided by a middle confining unit into the upper and lower Floridan aquifers. The FAS contains highly mineralized, saline water that gets saltier with depth. The relatively few (reverse osmosis and aquifer storage and recovery (ASR)) water supply wells completed into the FAS in the LEC are mostly completed into the upper Floridan aquifer. Approximately 3,000 feet bls in the lower Floridan aquifer there are zones of cavernous limestones and dolomites with high transmissivities. These cavities are located below the saltwater interface and are used by utilities to dispose treated effluent through the use of Florida Department of Environmental Protection (FDEP) regulated Class V, wastewater injection wells.

The LEC Planning area covers approximately 1,200 square miles and includes essentially all of Miami-Dade, Broward and Palm Beach counties, most of Monroe County, and the eastern portions of Hendry and Collier counties (SFWMD, LEC Water Supply Plan, 2000a). Most of the ground water level data from the LEC are collected by the USGS (in a co-funding agreement with the District) using automated data recorders and to a lesser extent by manual measurements taken on a monthly basis. The majority of monitor wells are completed in the SAS (the primary potable water source), however; District staff also monitor approximately 10 Floridan aquifer well sites. The Floridan aquifer sites have "cluster" wells located in both the upper and lower Floridan aquifers and have recently (Y2001) been automated by the District with Campbell® recorders.

Network Redundancy

The following is a summary of the task force's findings on existing LEC network redundancies. Included are the task force's recommendations for future action on these wells. Lithologic well logs were factored into the analyses, but only when readily available. Hydrographs are presented only where well comparisons resulted in recommendations to remove a specific well from the network. The vertical datum used when referencing well depths is land surface at the site.

Paired Wells with Redundant Hydrographs- Recommend Removing from Network

Wells that provide redundancy in the data were investigated for the entire LEC, but only a few were found in Palm Beach County. **Figure B-1** shows the locations of District and USGS monitor wells in Palm Beach County. A list of seven wells that the task force recommends removing from the network due to redundancy is provided in **Table 1**.

Temporal water levels from wells Pb-1583 and Pb-1590-A are similar in nature (as seen in **Figure C-1)** and correlate 97% of the time. These wells are very close to one another and, although completed at different depths, may be in the same aquifer. Pb-1590-A is a shallow well (20 feet), whereas Pb-1583 is a deep well (160 feet). These wells are located at the junction of SR-441 and Southern Blvd in Wellington and are near future proposed CERP projects. As a result, the task force recommends removing PB-1590-A from the network.

Temporal water levels in wells Pb-595 and Pb-746 correlate 93% of the time (**Figure C-2**). Water levels in well Pb-746 are approximately one foot higher than in Pb-595. These wells are half of a mile from a water treatment plant. Pb-746 is shallower (83 feet) than Pb-595 (115 feet). Both are completed in the SAS and both were once sampled for chloride concentration. In April 1994, chloride sampling in well Pb-746 was discontinued. Chloride sampling was discontinued for Pb-595 in November 1994. At that time, the chloride concentration was above 10,000 milligrams per liter (mg/l). Both wells have historic records dating back to 1975. Well Pb-746 is a USGS well and Pb-595 is a District well. The two wells are 408 feet apart. Well Pb-595 is closer to the wellfield than Pb-746 as reflected in the lower water levels seen in Pb-595. The task force recommends discontinuing monitoring of well Pb-595 because of redundancy in the data record and due to the proximity of the wells to one another in both location and depth.

Temporal water level data from wells Pb-694 (249 feet bls) and Pb-949 (297 feet bls) correlate 84% of the time as can be seen in **Figure C-3.** Available geologic logs in the area extend only to 175 feet bls, therefore, it is not known with certainty if they are completed in the same aquifer. These wells are 375 feet from one another and are near the coast (50 and 425 feet away, respectively). They are not used for salinity monitoring at this time. Well Pb-694 is in poor condition while Pb-949 condition is in good condition. Therefore, the task force recommends keeping Pb-949, and discontinuing monitoring in Pb-694.

Temporal water level data from Surficial aquifer wells Pb-875 (20 feet) and Pb-880 (118 feet), correlate 95% of the time as seen in **Figure C-4.** They have been part of the saltwater intrusion network since 1995. The task force recommends removing Pb-880 from the monitor network because Pb-875 has been successfully used to calibrate the North Palm Beach ground water.

Temporal water level data from wells Pb-1625 (22 feet bls) and Pb-1626 (108 feet bls) correlate 98% of the time as shown in **Figure C-5**. These wells are located near one another and are in the same aquifer. Water levels in Pb-1625 are slightly higher then Pb-1626 (approximately 0.12 feet). According to a nearby log (W-17432), both wells are in sand units. The porosity from the surface to 250 feet bls ranges from 25%-30%. Sand persists from land surface to 135 feet bls, therefore these wells have essentially the same hydrologic properties and one should be sufficient for the network. Since well Pb-1625 is in better condition, the task force recommends keeping it and removing Pb-1626.

The following tapedown, coastal wells are not being used for salinity monitoring: G-2055, G-2063, and G-2064. These wells are, however, monitored by the USGS and are approximately 1,000 feet west of the coast. Two of the new salinity monitoring wells (G-2445 and G-2149) are located near these three wells. They are further inland, approximately one half mile west of the coast. The task force recommends that well G-2064 should be kept to preserve a long historic record, but both wells G-2055 and G-2063 (which is in poor condition) should be removed (see **Table 1**).

Table1: **Wells to Remove from Network in the LEC**

Well Name	Lat	Long	Reason	Source (as of 12/2000)
Pb-595	265800	800523	Redundant data correlates with Pb-746 93% of time.	Radin, Wilsnack
Pb-694	263628	800303	Poor condition, 50 feet from coast, chlorides not monitored; 84% correlation	Radin, Wilsnack, D. Demo
Pb-880	265440	801028	Redundant, 95% with Pb-875	Radin, Linton
Pb-1590A	264209	801512	Correlates with Pb-1583 (deeper well) 97% of time	Radin, Wilsnack
Pb-1626	263015	800408	Correlates 98% with Pb-1625 and in same aquifer; poor well condition	Radin, Demonstranti
G-2055	261400	800622	Tapedown wells; data not being used for modeling	Giddings
G-2063	261501	800553	Tapedown wells; not used for modeling, poor condition	Giddings

Paired Wells with Partially Redundant Hydrographs to Remain in Network

Table 2 lists those paired wells identified in the LEC network with partially redundant hydrographs. These wells should remain in the network. Temporal water level data from wells Pb-1630 (26 feet bls) and Pb-1108 (90 feet bls) correlate 85% of the time. Water levels in Pb-1108 are usually approximately 0.2 feet higher than Pb-1630, with the exception of September 1993 through August 1994 when levels in well Pb-1630 were approximately 0.5 feet higher then PB-1108. The reason for this is unknown. Both wells are completed in the SAS within a similar limestone section, but separated by 20 feet of lower porosity sandstone. Since several CERP projects are proposed in the region along L-40, wells Pb-1630 and Pb-1108 should remain in the well network.

Temporal water level data from wells Pb-1632 (30 feet bls) and Pb-1107 (105 feet bls) correlate 74% of the time (once, two unusually high peaks were recorded from Pb-1632). Water levels in Pb-1632 are approximately 2 feet higher than in Pb-1107. Both wells are completed in the SAS. Pb-1632 is completed in sand, while Pb-1107 is in limestone. They are both located along L-40 and should be kept until CERP needs in the area are identified. Once CERP needs are identified, a decision about discontinuing these wells should be made.

Temporal water level data from wells Pb-1525 (20 feet bls) and Pb-1608 (150 feet bls) correlate 92 percent of the time. Levels in Pb-1525 are slightly higher than in Pb-1608. Pb-1608 is located further up the C-18 canal than Pb-1525, therefore the task force recommends keeping both.

Temporal water level data from wells Pb-693 (275 feet bls) and Pb-846 (160 feet bls) correlate 89% of the time. However, both are taped manually on a monthly basis so the data set used to construct the hydrographs is lacking. Pb-693 water levels are generally 0.5 feet higher than Pb-846. The lithologic well log from a nearby well (W-17594) indicates the wells are completed in Pliocene-Pleistocene age sediments with Pb-846 completed in shell and sand and Pb-693 in a grainstone. Both wells are completed in intervals with high porosity (approximately 30%), but there are intervals of low porosity that separate them. Therefore, both Pb-693 and Pb-846 should remain in the network.

The following "redundancy" was found in wells that the USGS monitors in cooperation with other agencies. This information will be sent to the USGS.

- G-3557 and G-1487 correlate 99% of the time.
- G-3557 and G-3551 correlate 96% of the time.
- G-3551 and G-1487 correlate 90% of the time. A scatter plot of water levels from the two wells shows two distinct linear relationships, one at the beginning of the period of record (POR) and the other at the end. The physical explanation for this is unknown.

Table 2. **Well Pairs with Partially Redundant Hydrographs to Remain in Network**

Well Name	Screen Depth (ft bls)	Correlation	Comments
Pb-1108 Pb-1630	90 26	85%	Near L-40, recommend keeping both in network.
Pb-1632 Pb-1107	30 105	74%	Near L-40, recommend keeping both in network.
Pb-1525 Pb-1608	20 150	92%	Possible semi-confining layer between screens of two wells. Recommend keeping both in network.
Pb-693 Pb-846	275 160	89%	Possible semi-confining layer between screens of two wells. Recommend keeping both in network.
G-3557 G-1487	15 20	99%	USGS funded wells, not District's. Recommend relaying information to USGS.
G-3557 G-3551	15 13	96%	USGS funded wells, not District's. Recommend relaying information to USGS.
G-3551 G-1487	13 18	90%	USGS funded wells, not District's. Recommend relaying information to USGS.

Wells with Hydrographs Mimicking Stages in Adjacent Canals

Table 3 lists District wells in Palm Beach County located near canals analyzed for this memorandum. Their temporal water levels were compared to those in nearby canals and found to correlate. None of these wells demonstrate sufficiently high correlation to be called redundant with stage recorders, therefore all should be kept.

Many USGS monitor wells are near the Preston-Hialeah and Northwest Cargo wellfields, and are funded by cooperators other than the District. Structures S-68 and S-19 have very long periods of records (beginning in 1939 and 1940, respectively) and they should, therefore, be continued. Well G-3465 (DBKEY 07804) located near the Northwest Cargo Wellfield is cased to 28 feet bls into the Biscayne aquifer, has 12 years of data, and is only 1,150 feet away from S-19. Water levels in S-19 (DBKEY 01397) are on average 0.18 feet higher than in well G-3465. USGS staff indicated that the well fields are not at full capacity and that the monitor wells in the area are there to monitor water level changes around the wellfields. Therefore, these wells should all remain in the network.

Table 3. **Palm Beach County Wells Close to Canals – Recommend to Remain in Network**

Well Name	Screen Depth (feet bls)	Aquifer	Canal	POR/Correlation
Pb-715	81	S	C-18	11/88-9/00; 63%
Pb-832	153	S	C-18	11/88-9/00; 50%
Pb-875	24	S	C-18	11/88-9/00; 82%
Pb-1097	160	S	L-40	5/88-9/00; 78%
Pb-1525	22	S	C-18	5/88-9/00; 80%
Pb-1583	160	S	C-51	10/90-10/00; 50%
Pb-1608	150	S	C-18	5/88-9/00; 81%
Pb-1630	30	S	L-40	5/88-9/00; 78%
Pb-1645	25	S	C-51	5/88-10/00; 50%
Pb-1646	90	S	C-51	5/88-10/00; 50%
G-1604	62	B	C-100A	N/A; 84%
G-2443	145	B	C-14	N/A
G-2853	19	S	Hillsboro	10/88-9/99; some
G-3338	100	B	C-111E	2/90-10/00; 82%
G-3339	57	B	C-111E	2/90-10/01; 87%
G-3340	48	B	C-111E	N/A
G-3349	66	B	C-110	N/A
G-3350	83	B	C-110	N/A

S: Surficial Aquifer System
B: Biscayne Aquifer
POR: Period of Record

Well Replacement Needs

Table 4 lists wells in need of replacement and/or activation. Many sources of information were used to develop these recommendations including District staff member Mr. Demonstranti (verbal, 2000) who regularly visits the wells. Additional information was reported by District modelers of Broward County (Giddings) and from data in the District's database.

Destroyed Wells and Lost Wells that Need to be Replaced

Well G-2376 is important since it is the only one of its kind in the area, located between Weston and the Florida Everglades. This well needs to be replaced to fill in the data gap for background water level data for modeling.

G-2443 was destroyed by construction. This well should be replaced because it's an important area to monitor the water levels for the Pompano wellfield.

G-594 is not currently monitored. It is located on the Pennsuco Canal about 2 miles east of Krome Avenue. Past records showed an apparent datum error. This well has been resurveyed and should be reactivated to fill in the data gap.

G-972 cannot be located. This well was located near Hialeah and has been removed from the ground water network and needs to be replaced (Wilsnack, verbal comm. 2001).

G-976, near Miami-Spring, has a DCP recorder. A new permit for rock mining destroyed G-976. This well should be replaced with another nearby or stages in the new quarry should be monitored.

G-1359 was destroyed. It is located ½ mile west of S.W. 137th Avenue and 2.4 miles north of U.S. 41 (Tamiami Trail). The task force recommends that this well be replaced with a lake stage recorder since the cost will be lower than a replacement well.

USGS well Pb-900 (a continuous recorder), in the City of Boca Raton was destroyed by road construction in November 1996. PB-1621 could be a suitable substitute for PB-900, the task force recommends PB-1621 be upgraded to a continuous recorder.

Pb-1573 and Pb-1574 were destroyed by road construction September 2000. Pb-1153, Pb-1577, Pb-1623 were also destroyed. Pb-1576 could not be located. All were in the area bounded by L-40, the Hillsboro canal, C-51 and the Florida Turnpike. The original six wells were clustered at three points. The task force recommends that 6 - 10 wells spread evenly (and away from stress points) replace the destroyed wells. Particular attention should be given to the northwestern, central and southwestern locations within this area since major CERP improvements are proposed there (i.e. the Wellington area, the Agricultural Reserve, and the Site 1 area).

Table 4: **Destroyed or Lost Wells that Need to be Replaced in the LEC**

Well Name	Lat.	Long.	Reason	Source (District Staff)
G-2376	260754	802536	This is an important area for ground water modeling.	Giddings
G-2443	261338	801033	This well should be replaced. It is an important area to monitor the Pompano wellfield.	Giddings
G-594	255251	802707	Past records showed an apparent datum error. The well has been resurveyed and should be reactivated.	Wilsnack
G-972	255523	802613	Cannot be located.	Wilsnack
G-976	254760	802436	A new permit for rock-mining destroyed G-976 (DCP well). This well should be replaced with another nearby and stages in the new quarry should be monitored. To provide background information for CERP data.	Hopkins
G-1359	254721	802529	Task force recommends that this well be replaced with lake stage monitoring.	Wilsnack
Pb-900	263535	800850	PB-1621 could be a suitable substitute for Pb-900, but it needs to be upgraded to continuous recorder (as Pb-900 was).	Hopkins
Pb-1153	264027	801350	The original wells were clustered at three points, we recommend that 6 - 10 wells spread evenly (and away from stress points) replace the destroyed wells. Three of the wells could be at the old locations if well restoration is practical. Particular attention should be given to the northwestern, central, and southwestern locations within this area since major CERP improvements are proposed there (i.e., the Wellington area, the Agricultural Reserve, and the Site 1 area).	Giddings
Pb-1577	263256	801333		
Pb-1623	262548	801216		
Pb-1573	262548	801216		
Pb-1574	262548	801216		
Pb-1576	263256	801333	Well could not be found.	Giddings

Destroyed or Lost Wells- No Replacements Needed

Well Pb-1578 cannot be located. This well does not have to be replaced. District monitor well G-3340, on the C-111 was destroyed by construction. CERP projects are proposed in that area. The task force recommends waiting for recommendations from CERP project managers as to what new wells are needed for that area before replacing. G-3345 was destroyed by construction. Monitor well G-3699 was put in 5,000 feet away and, therefore, does not need to be replaced. Pb-835b, Pb-1618, Pb-1637, PB-618, PB-795, Pb-1602 and Pb-945 were destroyed, but do not need to be replaced. These were tapedown wells used to monitor saltwater intrusion. The network of saltwater intrusion wells was recently redesigned with new wells added to cover the coastal area. Some of these are close to those destroyed wells. **Table 5** lists all wells that do not need to be replaced in the LEC area.

Table 5. **Destroyed or Lost Wells that Do Not Need to be Replaced**

Well Name	Lat.	Long.	Comment
Pb-618	264659	800351	Destroyed
Pb-795	264659	800351	Destroyed
Pb-835b	264104	800258	Destroyed
Pb-945	262711	800409	Destroyed
Pb-1578	263700	800520	Lost
Pb-1602	263244	800620	Destroyed
Pb-1618	261950	800738	Destroyed
Pb-1637	265027	801002	Destroyed
G-3340	251902	803124	Destroyed
G-3345	252719	802412	Destroyed

Well Repair Needs for LEC

Table 6 lists existing network wells in disrepair and the recommended action for each. The District in Y2001 fixed six of these 16 wells listed for repair, prior to this report going to press. The USGS maintains wells in their network within the scope of their resources. However, they do not have a drill rig or well completion equipment for the more complicated well repairs or maintenance tasks. District does assists the USGS whenever possible.

Well G-2055 is located along a road right-of-way and has been damaged by mowers. Damage to the casing threads at the wellhead prevents a screw cap fitting, allowing debris to fall in the well. This is a District monitored well. Recommend re-development and wellhead repair.

New wells Pb-1768, Pb-1773, and Pb-1770 have bends in their casings that will not allow logging equipment to pass through them. Well Pb-1770 allows only some of the equipment to penetrate (Emmett McGuire, USGS, verbal communication, 2000). These wells were installed to augment the saltwater intrusion monitoring near the coast. District staff should visit these wells to determine if a conductivity probe can be lowered in them to total depth.

Pb-935 and Pb-1595 have unprotected PVC standpipes in depressions. These are District monitored wells near State Road 441. This is near areas were CERP projects are proposed so wells should be repaired.

Pb-1620 wellhead is below land surface and floods frequently. This is a District monitored well and the task force recommends raising this wellhead up to prevent frequent flooding.

Pb-1633 and Pb-1634 are both unprotected wells below land surface and they get run over frequently. These are District wells and protective coverings should be installed.

Pb-1635 and Pb-1636 are below land surface, on slopes, and always get filled with dirt. These are District monitored wells. These wells should be raised and covered.

Pb-693 is at land surface. Pb-693 is unmarked and is missing threads for cap. This is a District monitored well and the task force recommends that Pb-693 be re-threaded and a cap installed.

G-3342 is filled with debris and has no cover.

G-757A, G-970, G-976, G-1221, Pb-732 and Pb-809 are USGS wells that need repair. The task force will notify USGS personnel of these wells and will provide assistance, if necessary.

Table 6. **Well Repair Needs in LEC**

Well Name	Description of Problem	Repaired In Y2001	Org	Recommend
G-757A	Filled with sand, water levels still accurate		USGS	Low priority repair
G-970	Unidentified obstructions in well		USGS	Repair
G-976	Unidentified obstructions in well		USGS	Repair
G-1221	Filled with sand, water levels still accurate		USGS	Low priority repair
G-2055	Develop well, repair wellhead		SFWMD	Repair
G-3342	Well filled with debris, no cover		SFWMD	Repair
Pb-693	Missing threads for well cover		SFWMD	Repair
Pb-732	Unidentified obstructions in well		USGS	Repair
Pb-935	Unprotected PVC standpipes in depression		SFWMD	Repair
Pb-809	Unidentified obstructions in well		USGS	Repair
Pb-1595	Unprotected PVC standpipes in depression	✓	SFWMD	Repair
Pb-1620	Wellhead below land surface, floods frequently	✓	SFWMD	Repair
Pb-1633	Unprotected, below land surface, run over	✓	SFWMD	Repair
Pb-1634	Cover needed, below land surface, run over	✓	SFWMD	Repair
Pb-1635	Develop well, below land surface, run over	✓	SFWMD	Repair
Pb-1636	Develop well, below land surface, run over	✓	SFWMD	Repair
Pb-1710	Develop well, sounded to 111', should be 211'TD		SFWMD	Develop
Pb-1717	Develop well, sounded to 147', should be 200'TD		SFWMD	Develop
Pb-1768	Bent downhole casing, probes will not lower		SFWMD	Use conductivity probe - keep
Pb-1773	Bent downhole casing, probes will not lower		SFWMD	Use conductivity probe - keep
Pb-1770	Bent downhole casing, probes will not lower		SFWMD	Use conductivity probe - keep

New Well and Recorder Needs for LEC

A maximum of 37 new monitor wells with recorders are needed in the LEC and are listed in **Table 7.** These wells are required to fill spatial data gaps in the existing coverage including needs for improvements to ground-water models, CERP projects, and early warning drought detection monitoring.

The task force recommends the following: 6-10 wells be added in the area bounded by L-40, the Hillsboro Canal, C-51, and the Florida Turnpike to replace six that were destroyed and to provide background water level information.

Construct eight new recorder wells in Broward County near the Hillsboro Canal, C-11, C-9, Site 1, Oleta River, WCA-3A, C-12, and C-13 near Fort Lauderdale.

The water conservation areas (WCA) need more data. Shallow wells could be beneficial in these areas.

Bird Drive Wetlands - At least three recorder wells are needed. These could be placed in the Northwest corner, in the center and in the southeast corner.

Pennsuco Wetlands - Three or four recorder wells are needed in this wetland. One in the north center area of the wetland, one in the center, and one in the South center, and perhaps one to replace destroyed G-594.

Four recorders are needed in North Miami Dade, two between C-4 and Dressels Canal and two between Lake Belt and FEC canals.

There are no wells between C-12 and C-13 near Fort Lauderdale. More wells are needed in this area for both modeling and CERP.

Miami-Dade County is in a lot better shape than most when it comes to both water level and chloride monitoring. The only area obviously in need of more coverage is in the far west Everglades National Park (ENP) area, where lack of data made it difficult to calibrate the western boundary of the south Dade model. More recorders are needed in eastern ENP.

Chloride data needs to be collected at least monthly to be used effectively for models (Jeff Giddings - SFWMD Broward Ground Water Model, 2000). The chloride data that is collected quarterly or semi-annually was not used in developing the Broward County model.

Surface Water Monitoring Needs

A surface water gauge is needed in WCA 3A - South of I-75 and east of the Miami River/Canal. No stage data in this area exists. Monitoring stages in the Lake Belt area might be less costly than installing new wells and would yield useful information.

Stage recorders should be installed in the eastern portion of the ENP, WCA-3A, Bird Drive Wetlands, and in the Pennsuco Wetlands.

Recorder Needs on Existing Wells

Monthly tapedown well data was not used for the sub-regional LEC ground water modeling in Broward County (Giddings, verbal communication, 2000) and only six of 87 monthly tapedowns were used in the north Palm Beach County model. District regional modelers (Giddings, Linton, Wilsnack, verbal communication, 2000) said recorders were needed on all LEC tapedown wells, if possible. Only wells with continuous data were used in developing and calibrating the south Palm Beach model. No monthly tapedown data were used. In the north Palm Beach model only 5 of 87 monthly tapedown wells were used. A total of 49 recorders are needed so that all tapedown wells in Palm Beach County will be equipped with continuous recorders.

Table 7. **New Monitor Well with Recorders Needs in LEC**

Site Name	# of Wells	Reason	Comments	Source
Site 1 C-11 C-9 WCA-3A Oleta River Ft. Lauderdale	2 1 2 1 1 1	Needed to fill data gap for ground-water modeling and CERP projects.	Suggested locations approximate.	Giddings
Area bounded by L-40, the Hillsboro Canal, C-51, and Fl. Turnpike	6 to 10	Needed to fill data gap for ground-water modeling; will replace 6 destroyed wells and provide background ground water levels for CERP projects.	Includes wells at ACME STA, ACME Impoundment, and Agricultural Reserve.	Adams Giddings
Bird Drive Wetlands	3	Needed to fill data gap for ground-water modeling and CERP projects.	These could be placed in the NW corner, center, and SE corner.	Wilsnack
Pennsuco Wetlands	3 to 4	Needed to fill data gap for ground-water modeling and CERP projects.	One in the north center area of the wetland, one in the center, and one in the south center, and perhaps one to replace destroyed G-594.	Wilsnack
North Miami-Dade between C-4 and Dressels Canal	2	Needed to fill data gap for ground-water modeling.		Wilsnack
North Miami-Dade between Lake Belt and FEC canals	2	Needed to fill data gap for ground-water modeling.		Wilsnack
West and East ENP area	3 to 4	Needed to fill data gap for ground-water modeling.	Should be DCP since western location less accessible.	Wilsnack
Between C-12 and C-13	3 to 4	Needed to fill data gap for ground-water modeling.	Should be DCP since western location less accessible.	Wilsnack
Surface Water Stage Recorders Needed				
WCA 3A – South of I-75	1	Needed to fill data gap		Giddings
Eastern ENP	1	Needed to fill data gap		Wilsnack
Bird Drive Wetland	1	Needed to fill data gap		Wilsnack
Pennsuco Wetland	1	Needed to fill data gap		Wilsnack

ENP: Everglades National Park
WCA: Water Conservation Area

District Database and Data Quality Issues

Water levels in the following Broward County wells have shifted significantly with time: G-1260, G-1213, G1315, G1215, G-853, and G-2444. This could be due to physical changes in nearby canals, changes in land use, or a datum problem.

Well G-1604, also in Broward County, shows a downward shift of water levels after 1995 (from an average of 3 feet to an average of 1.5 feet). ESDA has found a drop pipe within the well on a number of occasions (Demonstranti, verbal comm. 2000). The well is probably being pumped periodically to water a grassy median. There may also be a datum problem.

Levels in G-2147 and possibly well G-2064 spiked in October 1990.

Data from well G-970 and G-968 shifted in June 1997. Well G-2852 is instrumented with a recorder. Given its proximity to the Hillsboro Canal (approximately two miles upstream from S-56), the lack of a relationship between the two water levels is somewhat surprising. However, G-2852 is located very close to Broward County's north regional wellfield. It is questionable whether this location, with strong local influences, is the best one for a well of this type.

Broward County Environmental Resource Management (ERM) has started collecting continuous ground water levels too. District should coordinate with them to have this data added to its DBHYDRO database.

The USGS stores only maximum daily water level data in their database. These daily maximum values are transferred to the District once a year and loaded into DBHYDRO. Models in the LEC typically compute end-of-day water level values. To optimize model calibration, there needs to be consistency between modeled and measured (observed) water levels. Toward that end, end-of-day, rather than maximum values, should be stored and transferred to the District in the future when possible. It would also be very useful to District modelers if the USGS would provide the historic end-of-day readings for the wells in this region. As a result of this task force initiative, these end-of-day and many other useful and supplemental statistical daily values are now being provided to the District by the USGS through our cooperative agreement.

USGS Water Level Mapping Needs

Semi-annual water level maps of the Biscayne aquifer were once developed by the USGS in cooperation with ERM, but were discontinued. The task force recommends that development of these maps resume. District modelers utilized them as a tool to better define the cones of influence. These maps were also used to identify potential recharge and discharge areas that may not have otherwise been evident from single-point monitoring.

LOWER WEST COAST

FINDINGS AND RECOMMENDATIONS

The Lower West Coast (LWC) covers 4,300 square miles and includes all of Lee County, most of Collier and Hendry counties and portions of Charlotte, Glades, and Monroe counties (SFWMD, LWC Water Supply Plan, 2000). Wells in Lee and Collier counties are monitored by USGS staff (through a cooperative agreement with the District) whereas those in Glades and Hendry Counties are taped monthly by District staff. The vast majority of the monitor wells are completed in the water table, Tamiami sandstone, and mid-Hawthorn aquifers. There are five FAS District monitor well sites in the LWC, each monitors several (2-3) zones within the FAS.

Aquifers in the Region

The LWC area is underlain by three aquifer systems. However, only two of them contain aquifers with potable water. The SAS consists of the water table and the lower Tamiami aquifers. The Intermediate Aquifer System (IAS) consists of the sandstone and the mid-Hawthorn aquifers. In some areas, these aquifers are non-potable.

Network Redundancy

In Hendry County, Well HE-1028 appears to be redundant with well HE-1029. These wells are located at the same site and monitor the same aquifer. Of the two wells, HE-1029 appears to be the most useful.

In Lee County, monitor well L-1963 may be considered redundant with L-2186, as seen in **Figure C-6**, and could be removed from the network.

In the Collier County network, there are no redundant wells.

Table 8. **Redundant Wells to be Removed from LWC**

Well Name	Lat	Long	Reason	Source
HE-1028	263509	811703	Redundant with HE-1029	Butler
L-1963	263345	813616	Redundant with L-2186	Bengtsson

Theissen Polygon Coverage in the LWC

Well spatial distribution was analyzed using Theissen Polygons as shown in **Figure D-1 through Figure D-4**. It was concluded that only two redundant wells exist in the network, as listed in **Table 8**.

Figure D-1 is a map of the Theissen Polygons for the water table aquifer. Most of the area has fair or good coverage. However, the adequacy of the coverage decreases near the boundaries.

Figure D-2 shows the Theissen Polygons for the lower Tamiami aquifer. The northeastern and southwestern portions have the best coverage. In the northwest section of the LWC area, the lower Tamiami aquifer may be thin or absent.

Figure D-3 provides the Theissen Polygons for the Sandstone aquifer. The Sandstone aquifer is thin or absent throughout most of the study area. However, in the areas where it is present, it has adequate coverage.

Figure D-4 provides the Theissen Polygons for the mid-Hawthorn aquifer. Most of these monitor wells are located in northern Lee County. The coverage dissipates away from this area. There are no monitor wells in eastern Hendry or Collier counties. The extent of the mid-Hawthorn is not defined in these areas. The monitor well coverage is concentrated in areas of historical use for this aquifer. However, as it is utilized in new areas, the monitor network may need to expand.

Well Repair and Replacement Needs - Hendry County

Several wells were removed from the Hendry County network over the years both as a result of the Ahn (1996) study and due to losing wells because of development, vandalism, or some other mechanism of destruction. Eleven wells listed in **Table 9** were identified for repair and three for replacement. Seven of these 11 were repaired in Y2001, prior to this report going to press. The USGS maintains wells in their network within the scope of their resources. However, they do not have a drill rig or well completion equipment for the more complicated well repairs and maintenance tasks.

Table 9. **Wells to be Repaired/Replaced in Hendry County**

Well	Description of Problem	Repaired in Y2001	Org	Recommend
HE-3	Inactive Hydrograph		SFWMD	Repair
HE-339	Seasonal Flooding	✓	SFWMD	Repair
HE-516	Partially plugged	✓	SFWMD	Repair
HE-556	DCP Damaged		USGS	Repair
HE-620	Casing damaged, also opened to two aquifers		SFWMD	Repair
HE-1042	Possible flooding, inactive	✓	SFWMD	Repair
HE-1043	Possible flooding, inactive	✓	SFWMD	Repair
HE-1075	Seasonal flooding	✓	SFWMD	Repair
HE-1076	Seasonal flooding, inactive	✓	SFWMD	Repair
HE-1077	Seasonal flooding, inactive	✓	SFWMD	Repair
HE-1027	Central Hendry County, well destroyed		SFWMD	Replace
HE-1029	Central Hendry County, well destroyed		SFWMD	Replace

HE-1044	Central Hendry County, well destroyed		SFWMD	Replace
HE-884	Casing twisted		SFWMD	Repair

Well Repair Needs - Collier County

The five wells listed in **Table10** need to either be repaired or replaced. These wells have lost a significant portion of their original depth due to either an open-hole collapse or vandalism.

Table 10. **Wells to be Repaired in Collier County**

Well	Original depth	Casing	Recent Sounding	Other Information	Recommend	Org
C-304	130 ft	125 ft	40 ft	Rocks at 40 ft.	Repair	SFWMD
C-460	66 ft	64 ft	49 ft	Previous sounding was 63 ft.	Repair	SFWMD
C-492	64 ft	60 ft	33 ft	Well has been jetted with only 5 feet added to depth.	Repair	SFWMD
C-1068	200 ft	120 ft	74 ft	Previously jetted.	Repair	SFWMD
C-1070	205 ft	100 ft	50 ft	Previously jetted.	Repair	SFWMD

Well Repair and Replacement Needs - Lee County

Table 11 lists 14 wells in need of replacement or repair in Lee County. Several water quality monitor wells need to be refurbished or replaced due to borehole infilling or vandalism. Other wells that are currently sampled, have uncertainty due to long open-hole intervals, and need to be logged include: L-5723, L-5725 and L-5727. These wells may also require refurbishment or replacement.

Table 11. **Wells to be Repaired or Replaced in Lee County**

Well	Description of Problem	Recommend	Org
L-781	Obstructions, original TD 290, CD 82', Rocks at 75'	Replace	USGS
L-1109	Hole collapsed, samples cannot be taken, dropping well as of 3/01	Replace	USGS
L-1110	Obstructions, or loss of borehole integrity	Replace	USGS
L-1113	Obstruction, original TD 230, CD 126', Obstruction at 134'	Replace	USGS
L-1114	Obstructions, or loss of borehole integrity	Replace	USGS
L-1121	Obstructions, or loss of borehole integrity	Replace	USGS
L-2643	Obstructions, or loss of borehole integrity	Replace	USGS
L-2646	Obstruction, original TD 210, CD 170', Obstruction at 166'	Replace	USGS
L-5649	Obstructions, or loss of borehole integrity	Replace	USGS
L-5669	Obstruction, original TD 30, CD 23', Obstruction at 17'	Replace	USGS
L-5723	Open hole interval too long, needs logs	Log	USGS
L-5725	Open hole interval too long, needs logs	Log	USGS

L-5727	Open hole interval too long, needs logs	Log	USGS
L-5747	Obstruction, original TD 105, CD 59', Obstruction at 67'	Replace	USGS

New Well Recorder Needs for LWC

Many network wells are taped manually once a month in the LWC. This sampling frequency was satisfactory for the simpler ground-water flow models of the past. However, future generation models will require continuous data from automated wells. Daily or hourly data is also required when addressing regulatory issues and impacts of pumping on wetlands. In addition, there are significant diurnal ground-water level fluctuations in the LWC, more than other regions of the District. Ideally, all monitor well sites should be equipped with a recorder. The deterrent to this is obviously initial capital costs, manpower for installation, as well as operating and maintenance (O&M) costs.

The general consensus of District modelers, planners and regulators is that a less dense network of continuous (hourly) measurements would be more useful and more cost-effective than a denser network of monthly tapedown wells. In an area such as the LWC basin where diurnal fluctuations can be large, it is often beneficial to obtain continuous data to accurately assess and interpret the conditions.

District modelers prioritized 23 wells for recorder installations in the LWC as listed in **Table 12.** The expanded monitoring is needed to fill spatial data gaps in the existing coverage for improvements to ground-water models, CERP projects, and early warning drought detection monitoring.

Recorders Needed for Hendry County

Due to the high drawdowns in the lower Tamiami aquifer of southeast Hendry County, the task force recommends that well HE-861 be equipped with a continuous recorder. Nearby well, HE-862, in the surficial aquifer is already on a recorder.

Wells HE-555, HE-556 and HE-851 are all located in north central Hendry County. However, only well HE-556 has a recorder. The task force recommends that wells HE-555 and HE-851 be equipped with a USGS (DCP) recorder.

Recorders Needed for Collier County

Wells C-948, C-951, and C-953 should be instrumented with a data collection platform (DCP) to provide real time, continuous data. A real-time recorder should be installed on two wells located at Southern States Utilities; a real-time conductivity probe should also be installed on the deeper well. These wells are located in the Belle Meade area of Southern Collier County at the intersection of U.S. Highway 41 and State Road 951.

Recorders Needed for Lee County

Monitor wells L-1993, L-1994, L-1995, and L-742 should be instrumented with one satellite DCP recorder and multiple transducers. These wells are located near a rapidly developing area, which includes an airport and the new Florida Gulf Coast University. Monitor wells L-5649, L-5668, L-727, L-728, L-1968, L-5667, and L-735, which are currently taped monthly, should have recorders installed.

Table 12. **High Priority Wells for Recorder Installation in LWC**

Well	Aquifer	Location	Type
HE-555	Mid-Hawthorn	North Central Hendry County	DCP
HE-851	Water Table	North Central Hendry County	DCP
HE-861	Tamiami	Southeast Hendry County	CR10
C-948	Mid-Hawthorn	Northwest Collier	DCP
C-951	Tamiami	Northwest Collier	DCP
C-953	Water Table	Northwest Collier	DCP
C-SSUtil_WT	Water Table	Southern States Utility, SW Collier	DCP
C-SSUtil_LT	Lower Tamiami	Southern States Utility, SW Collier	DCP
C-TibGolf_WT	Water Table	Tiburon Golf Club, NW Collier County	New well/DCP
C-TibGolf_LT	Lower Tamiami	Tiburon Golf Club, NW Collier County	New well/DCP
C-TibGolf_SS	Sandstone	Tiburon Golf Club, NW Collier County	New well/DCP
C-TibGolf_MH	Mid-Hawthorn	Tiburon Golf Club, NW Collier County	New well/DCP
L-1993	Mid-Hawthorn	Central Lee County	DCP
L-1994	Sandstone	Central Lee County	DCP
L-1995	Water Table	Central Lee County	DCP
L-742	Mid-Hawthorn	South Fort Myers	DCP
L-727	Sandstone	East Lee County, Lehigh	CR10
L-728	Water Table	Central Lee County	CR10
L-735	Mid-Hawthorn	Southwest Lee County, Estero	CR10
L-1968	Sandstone	East Lee County, Lehigh	CR10
L-5649	Sandstone	Southwest Lee County, Estero	CR10
L-5667	Water Table	South Lee County	CR10
L-5668	Sandstone	South Lee County	CR10

New Wells and Surface Water Monitoring Needs

New Wells for Collier and Lee Counties

Fifteen new wells are needed in the LWC as listed in **Table 13**. New sandstone and mid-Hawthorn wells should be constructed adjacent to C-1083 near the Lee-Collier county-line and be instrumented with a recorder. Four wells should be drilled and instrumented at the Tiburon Golf Club, Northwestern Collier County. Two new sandstone and mid-Hawthorn wells should be constructed adjacent to wells, L-2194 and L-2195 in southeast Lee County to create a multiple aquifer site. At least one additional Mid-Hawthorn monitor well is needed in Collier County because of the increased water use from that aquifer. There are recent permit applications being processed by the District for Collier County Utilities, Bonita Springs, and Marco Island Utilities. The Mid-Hawthorn aquifer is being used more extensively as the lower Tamiami aquifer becomes tapped out. The District needs background monitoring data in this aquifer at this time for future model development (Lockwood, verbal 2001).

Table 13. **New Well Needs in the LWC.**

Well/Type	Location	Recommendation
Sandstone	South Lee County, next to C-1083	New well/DCP
Mid-Hawthorn	South Lee County, next to C-1083	New well/DCP
Water Table	Northwest Collier, Tiburon Golf Club	New well/DCP
Lower Tamiami	Northwest Collier, Tiburon Golf Club	New well/DCP
Sandstone	Northwest Collier, Tiburon Golf Club	New well/DCP
Mid-Hawthorn	Northwest Collier, Tiburon Golf Club	New well/DCP
Sandstone	Southeast Lee County, next to L-2194 and L-2195	New well/DCP
Mid-Hawthorn	Southeast Lee County, next to L-2194 and L-2195	New well/DCP
Mid-Hawthorn	S. Central Lee County, Corkscrew Wellfield, near L-2193	New well/DCP
Lower Tamiami	Hendry County, L-2 Canal	New well/recorder
Mid-Hawthorn	Hendry County, L-2 Canal	New well/recorder
Lower Tamiami	Hendry County, Deer Fence Canal	New well/recorder
Mid-Hawthorn	Hendry County, Deer Fence Canal	New well/recorder
LTA/MHA	Hendry County, L-2 canal	New well/recorder
LTA/MHA	Hendry County, Deer Fence Canal	New well/recorder

Surface Water Monitoring Needs

The water table aquifer in the LWC is unconfined, geologically variable, and a good source of potable water for public water supply and agricultural uses in the region. Ground and surface water interact and have good connection in the region, therefore, a good network requires coordination between surface and ground water level monitoring. Unfortunately, most of the Water Control Districts do not report surface water stages to the District. Consequently, an adequate ground water/surface water study cannot be conducted without increased surface water data. Therefore, the task force recommends that stage data be required as part of the permit renewal process.

Water Quality Monitoring

Lee County

Current water quality monitoring consists primarily of chloride concentration and specific conductivity at 29 ground water monitoring wells. The frequency of sampling varies between wells and over the periods of record. Based on preliminary results of the USGS, Bonita Springs-saltwater interface study (USGS, FL-662, in Draft), frequency of sampling may need to be reviewed and potentially reduced to quarterly. Also, additional water samples are needed from production wells or nearby monitor wells to detect possible saltwater upconing events. This need may be met by using select wells under water use permits. Known quality wells (including permit numbers) that may potentially be used include:

- CPMW-1 at Cypress Lakes Well Field (36-00150-W)
- MW-3 near Bonita Springs Utilities Wellfield (36-00008-W)
- MW-4 at Bonita Springs Utilities Wellfield (36-00008-W)
- MW-7 at Bonita Springs Utilities Wellfield (36-00008-W)
- LM-2259 at Bonita Bay (36-00282-W)
- LM-2292 at Bonita Bay (36-00282-W)
- CMW-2 at West Bay (36-03098-W)

Interagency Coordination

Lee County has an extensive monitor network of wells completed in the Water-Table aquifer near their public supply wellfields. They maintain a large network of wells. Their data could be incorporated into the District's database. Some Lee County wells are located near or in wetlands, however; these may or may not adequately represent conditions in the Water Table aquifer. Integration of this local monitoring data with that of the District's can be a cost-effective means to increase the water level coverage regionally. However, it will require significant staff time to coordinate and to resolve issues such as data quality, transfer, and format.

Local utilities located near existing District monitor wells offer additional opportunities to join forces. Some examples are Green Meadows Wellfield (L-1983, L-1998 and L-1999), Cypress Lakes Wellfield (L-742), Corkscrew Wellfield (L-1985, L-2193, L-1985 and L-2550), and Fort Myers Wellfield (L-1973, L-1974 and L-2292).

Database and Quality Issues

Data compatibility issues are noted by many District data users and pertain to format problems and lack of interconnection between project-related data. Database management and QA/QC are needed to address the following issues: quality control of the various sources of data, security access issues, and format standards. Some of these are currently being addressed now in response to this task force assessment.

KISSIMMEE BASIN PLANNING AREA

FINDINGS AND RECOMMENDATIONS

As previously mentioned, the Kissimmee Basin Planning Area (KPA) was not extensively reviewed in this task force initiative for the following reasons:

- Limited resources on the task force;
- Region has the least number of wells relative to others; and,
- Region has less ground water use demands than others.

The Plan Manager for the KPA (Chris Sweazy) provided the following recommendations for the region:

- Need to increase monitoring of the SAS, especially in Osceola County;
- Need to increase monitoring of the FAS in areas with thin coverage;
- The number of FAS wells in most areas is adequate, but the frequency of recording needs to increase from monthly to hourly via recorders; and,
- Surface water and ground water monitoring needs to be coordinated.

UPPER EAST COAST FINDINGS AND RECOMMENDATIONS

The Upper East Coast (UEC) covers approximately 1,200 square miles and includes most of Martin, St. Lucie, and a small portion of Okeechobee County (SFWMD, UECWSP, 1998). The vast majority of wells in the UEC are hand taped by District staff. All wells are completed in either the SAS or FAS. Historically, water levels in these aquifers have been measured monthly and bi-annually, respectively. Only about a dozen SAS continuous recorders are operated and maintained in the area by the USGS. Six FAS wells are currently equipped with a District maintained continuous recorders. Sixteen additional recorders are planned for FAS wells in FY02, all in St. Lucie County.

Aquifers in the Region

The SAS underlying the UEC is a shallow (0-150 feet bls), unconfined aquifer with fairly good water quality. Although less productive than the FAS in this region, it is the primary source for urban drinking water and urban irrigation (SFWMD, UECWSP, 1998).

The FAS is separated from the overlying SAS by a thick, low permeability confining layer and is found approximately 800 feet bls in the UEC. The FAS is relatively saline in the planning area and is also artesian, meaning it flows naturally at land surface. Because of concerns of migration of higher salinity water from deeper portions of the aquifer, there is a prohibition on the use of pumps on Floridan aquifer wells within the UEC region. The Floridan is used by agriculture mainly as a back up to surface water, but is becoming increasingly popular for public water supply use by either blending it with fresher water resources or purifying it using reverse osmosis.

Network Redundancy

A general search and analysis for well redundancy was conducted to flush out inefficiencies in the UEC network. Wells analyzed are listed in **Table 14** and discussed below in further detail. This analysis was performed through comparison hydrographs from closely spaced wells and in wells near surface water bodies.

Table 14. **Redundant Wells to Remove from UEC Network**

Well Name	Lat	Long	Recommendation	Source
M-1231	265727	801418	Well possibly damaged, data suspect – investigate further	Demonstrani
M-1052	270821	801118	Drop, redundant hydrograph to M-1004	Hopkins, Radin
STL-298	273616	801835	Drop, redundant hydrograph to STL-172	Hopkins, Radin
M-1237	270429	802559	Drop, 88% correlation with M-1263, 0.5 miles apart	Hopkins, Radin
M-1039	265821	800527	Drop, redundant with M-1024	Hopkins, Radin
STL-295	272610	802819	Drop, 98% correlation with PG-15E, 600 feet apart	Hopkins, Radin
M-1248	271219	802005	Drop, redundant to S-97-H, 96% correlation	Hopkins, Radin

Paired Wells With Redundant Hydrographs – Recommend Removing from UEC

A visual inspection of hydrographs of wells in the UEC identified six sites with potential for redundancy between USGS recorder wells and District maintained GWNET wells. Six wells from these sites are recommended for removal from the network as listed in **Table 14.**

Wells M-1234 (18 feet bls) and M-1231 (182 feet bls) are less than 300' apart, and in the early part of M-1231's record, they tracked fairly well together. In the last half of the record, however, the two appear unrelated to each other. It was reported that M-1231 was damaged some time between April through August 1997. After the well was repaired, its water level behavior was very different from before the repair. The data collected from well M-1231 should be considered suspect. It is recommended that these two wells be further scrutinized by inspection of their lithologic and geophysical log data to determine if one should be eliminated.

Based on variations in water levels in the well pairs and hydrograph comparisons, wells M-1052, STL-298, and M-1039 are redundant and can be safely removed from the network.

Wells M-1237 (160 feet bls) and M-1263 (15 feet bls) are just a little over 0.5 miles apart. Although they are completed to different depths within the aquifer, correlation of the two wells' hydrographs (**Figure C-12**) shows that 88% of the variability in one well's hydrograph can be predicted by the other. If both wells are in equal physical shape, the shallower well, M-1263, is probably the more useful of the two, and M-1237 should be removed from the network.

Wells STL-295 (115 feet bls) and PG-15E (58 feet bls) are within 700 feet of each other. Except for three outlying data points (possibly erroneous), there is a 98% correlation between the water levels (**Figure C-13**) at the two sites over the period of record. They are effectively redundant. Using the same argument as above, the task force recommends removing STL-295 from the network.

A number of comparisons were made between GWNET wells and very nearby surface water stages. Observed water levels at wells M-1240, M-1248, STL-180 and M-1274, all of which border the C-23 canal, were compared to stage recordings at structure S-97. All traces are similar, but well M-1248 tracks the headwater stage at S-97 the closest with a correlation of 96%. The other traces only have a correlation of 50-60%. Given the degree of correlation, it can be assumed that M-1248 provides no additional information over that which is derived from S-97-H, and should be removed from the network.

Paired Wells With Partially Redundant Hydrographs to Remain in Network

The telemetry at G81-T was discontinued on in September of 1998. Prior to that, the upstream stage at that structure correlated 95% of the time with STL-286 and 85% with STL-287. STL-286 and STL-287 are at the same location, but they are probably completed to different depths since they do not have the same levels. During high surface water stands, ground water levels in these two wells are often the same. But at low surface water stands, levels in STL-287 are generally lower than those in STL-286 by one to three feet. Since the telemetry has been discontinued, while G-81 is under construction, monitoring should continue at wells STL-286 and STL-287.

The stages in wells M-1273, M-1081, M-1244 and M-1236 are not similar to S80-H, therefore, all should remain in the network .

M-1086 and M-1088 water levels are not directly influenced by S308-T and all should remain in the network.

Destroyed Well – No Replacement Needed

Two wells, M-1070 and M-1085 are in poor condition. Both are frequently buried, M-1070 by mowing, and M-1085 by agricultural activity. M-1085 is not in a safe location for a long-term monitor well. It has the same median water level as its nearest neighbor M-1086, but with a much smaller range of variability, as would be expected in the controlled environment of a citrus grove. The task force recommends not replacing well M-1085, as it was recently buried.

Wells to be Replaced or Repaired in UEC

Table 15 lists the eight wells in need of repair or replacement in the UEC planning area.

M-1247, on the C-23 levee, was destroyed by truck traffic and should be replaced.

M-1095, on the coastal ridge, was destroyed by unknown forces in 1995 and should be replaced.

Well M-1070 is at the outside entrance to Jonathan Dickenson State Park (JDSP), just off US1, on a high sand ridge. The well is almost always buried and is often found with its cap off, so it probably has a lot of sand in it. With the destruction of M-1095, loss of M-1070 would leave only one well on the high part of the ridge. That is not sufficient. This is a high recharge area for the Surficial aquifer. It has variable topography and relatively large hydraulic gradients. It is recommended that M-1070 be rejuvenated and its surface completion modified to provide more security.

Two wells, M-1095 and M-1247, have been destroyed and it is recommended that they be replaced.

Two wells, STL-175 and STL-176, have been sand filled and need to be repaired then restored to the network.

Three wells, STL-172, STL-213, and STL-313, all have unidentified obstructions at 26 feet bls and need to be repaired and then restored to the network.

Table 15. **Wells to Repair/Replace in UEC**

Well Name	Description of Problem	Recommend	Org
M-1070	JDSP well on high ridge, well buried repeatedly. Develop, repair, and secure site.	Repair	SFWMD
M-1095	On coastal ridge; replace well, destroyed in 1995.	Replace	SFWMD
M-1247	On C-23 levee, was destroyed by vehicular traffic	Replace	SFWMD
STL-175	Sand filled to 50 feet bls	Repair	SFWMD
STL-176	Sand filled to 26 feet bls	Repair	SFWMD
STL-172	Unidentified obstruction at 26 feet bls	Repair	SFWMD
STL-213	Unidentified obstruction at 26 feet bls	Repair	SFWMD
STL-313	Unidentified obstruction at 26 feet bls	Repair	SFWMD

Well Automation and Other Network Modification Needs

Recorder Needs in the UEC

In order to provide greater insight into recharge and evapotranspiration (ET), and improve model uncertainty, continuous recorders are strongly recommended on all wells. All of the existing ground-water models in the UEC were calibrated at monthly stress-periods, based solely on the monthly taped water levels. The SAS models were most sensitive to recharge and ET. Because little useful information on those parameters can be drawn from monthly water levels, they are also the model parameters with the greatest uncertainty.

The most useful information can be gained from sites with both shallow and deep wells. Five such paired sites are strongly recommended to be upgraded from manual tapedowns to recorders as listed in **Table 16**. The locations of these five sites are plotted in **Figure B-8**.

Table 16. **Priority Wells to Automate with Recorder in UEC**

Well Name	Comments	Location
M-1086 M-1088	Shallow Well Deep Well	Dupuis Reserve
M-1249 M-1250	Shallow Well Deep Well	Osceola Plains
M-1276 M-1277	Deep Well Shallow Well	Citrus Area
M-1044 M-1258	Deep Well Shallow Well	Coastal Ridge – Site 1
M-1071 M-1072	Deep Well Shallow Well	Coastal Ridge – Site 2

Rainfall Recorders Needed in Martin County

Although rainfall was not part of the mandate for this task force, it should be noted that the absence of any rainfall data in western central Martin County made it difficult to verify water level data quality in that area. The nearest rain gauge is located more than 15 miles north of Lake Okeechobee and more than 20 miles to the east. At least three additional rain gauges are a critical modeling need in these areas.

USGS Recorder Wells

There are 18 USGS recorder wells in Martin and St. Lucie counties. Monitoring at these sites should continue to provide at least the minimal needed regional coverage in the planning area. This is particularly important since elimination of the redundancies in the District network is contingent upon continuation of the USGS monitoring.

GROUND WATER MONITORING NETWORK FINDINGS AND RECOMMENDATIONS

Ground Water Network

The South Florida Water Management District and the United States Geological Survey jointly manage and fund an extensive ground water monitor well network in South Florida. From the District's perspective, the network is managed in two district groups. One group consists of approximately 394 wells, 109 of which are Floridan aquifer wells. USGS staff monitors these and both the District and USGS jointly maintain them. The second group consists of 275 wells monitored by District staff, approximately 30 of which are completed in the Floridan aquifer. Maintenance of these is the responsibility of the District. The two groups combined bring the total number of wells in the network (GWNET) to approximately 669 (Switanek, 1999).

Each of the four regional WSP's recently published by the District (SFWMD 2000a, SFWMD 2000b, SFWMD 2000c, and SFWMD 2000d) have recommendations referring to the need for additional and improved ground water monitoring within their respective regions. The LEC WSP recommends augmenting the existing network to expand the saltwater intrusion monitoring in the area. The LWC WSP recommends a review of the existing water quality and water level monitoring for each of the three primary aquifer systems in the region (Intermediate, Surficial and Floridan aquifer systems). The UEC WSP recommends developing a comprehensive monitoring program to collect the necessary information to develop the water use, water quality, and water level relationships in the high water use citrus groves in St. Lucie County. And the KB WSP has a recommendation for the collection of necessary hydrologic information for the development of models to accurately identify resource concerns.

This memorandum summarizes the results of a District task force evaluation of the monitor well network and makes recommendations to improve it. A summary table of the findings is given in **Table 17**.

Table 17. **Summary of Ground Water Monitoring Network Evaluation**

Planning Area	Priority Recorders	Remove from Network	Repairs	New Wells	Rainfall Gauges	Surface Water Recorders
LEC	49	7	18	37	0	4
LWC	23	2	16	15	0	0
UEC	10	6	6	2	3	0
Total	**82**	**15**	**40**	**54**	**3**	**4**

Task Force

The task force was established by the Water Supply Planning & Development Division in July 2000 to assess the needs of the current network for additional and improved monitoring as recommended in the recent WSP's. It was comprised of various end-users of the monitor well data from the following District organizations:

- Water Supply Department
  - WSP&D Division
  - Hydrologic Systems Modeling Division
  - Water Use Division
- Environmental Monitoring and Assessment Department
- Hydrologic Information Systems and Assessment Division
- Water Resources Operations Department

The task force evaluated the ground water monitor well network in three of the four District planning areas (minus the Kissimmee Basin Planning area) for effectiveness and condition by interviewing end users of the monitoring data and District staff whom regularly visit the wells. This initiative was timed to follow-up the ground water modeling and WSP development phases at the District, such that the model development experience was fresh in staff's minds.

The District needs a regional monitor well network for the following reasons:

- To develop and calibrate ground-water flow models. The data is primarily used for model calibration and verification;
- To provide data to regularly assess temporal ground water conditions during drought;
- To determine background conditions for use in evaluating the future performance of the Comprehensive Everglades Restoration Projects (CERP); and,
- To provide staff the data for water use permit application evaluations.

Adequacy of Network Spatial Coverage

From a modeling perspective, there are never enough data points. However, taking both USGS and District taped wells into consideration, the spatial coverage of wells in the District is tolerable (excluding the Kissimmee Basin area). There are, however, some weaknesses to the coverage:

1. Distinct differences (a foot or more on average) have been noted in the region between shallow and deep wells in the surficial aquifer. Given these differences, it would be reasonable for each monitoring location to include

both a shallow and a deep well. Most of the sites, particularly in St. Lucie County are one or the other. This constitutes a blind spot in the data.

2. Given the major changes in topography along the coastal ridge in Martin & St. Lucie counties, and the large head gradients, the coverage is really too sparse to depict the ridge adequately. This problem might be somewhat alleviated if some of the utility-collected monitor well data concentrated along the coast could be verified and incorporated into the network. The drawback to this plan is that the utility wells tend to be influenced by wellfield pumping and there are not any utility wells on the coastal ridge in St. Lucie County.

A disproportionate number of the monitor wells are located along canals or roadways due to the easy accessibility without the logistical concerns of acquiring land access agreements from private owners. There is a danger, however, that the data has been biased through this practice. Observation wells situated along roadways sometimes receive unusual amounts of surface runoff, creating an unnatural recharge pattern at the well. Conversely, wells alongside canals are often more representative of local drainage than regional ambient levels. This would be an appropriate issue for a future District task force to pursue.

Inadequacy of the Network's Temporal Coverage - Automation

Although the total number of wells in the network (669) provides very good spatial resolution of the region, the task force found that temporal coverage is sorely lacking and cannot support next generation ground-water models. Many of the ground-water models recently developed at the District (to support Water Supply Plan development) run on daily stress periods because stages in surface water bodies (i.e. canals) change significantly on a daily basis. This is possible because much of the temporal data input to the models are available on a daily basis, (i.e. rainfall, canal stages, solar radiation, etc.). Since models are calibrated primarily by comparing computed to observed water levels from monitor wells, having only monthly water levels rather than daily is currently a primary limiting factor in model calibration and verification.

As of 1999, there were approximately 132 recorders installed on approximately 20% of the 669 network wells. The datalogger coverage varies per region as follows: LEC has approximately 30% (45 wells) of existing wells on recorders, the LWC 22% (70 wells) of existing wells on recorders, and the UEC 17% (17 wells) of existing wells on recorders (Switanek, 1999). Although the LWC has the most recorders, it also has more aquifers to monitor than the other planning regions. Water levels in the remaining approximately 500 wells (80% of network) are measured by hand on monthly or quarterly site visits.

Although the scope of this task force did not include determining the precise number and locations of wells to automate, the task force recommends that at least an additional 40% of the network wells be converted to recorders. This translates into a need for approximately 214 additional recorder installations. Approximately 30 of these should be installed on Floridan aquifer wells. The cost for these 30 could be shared with the FAS Regional Studies CERP Project (Draft CERP PMP, 2001). The remaining 184 recorders should be installed on non-Floridan wells. Eighty-two high-priority wells were identified for the top of that installation list, 49 in the LEC, 23 in the LWC, and 10 in the UEC. If and when the District prioritizes and commits to automating the additional 40% of the network, a second task force should be convened to identify the exact number and locations of wells to automate.

The cost to install a standard District Campbell® recorder is approximately $10,000. The cost to operate and maintain (O&M) each is approximately $3,000 annually. Using these numbers, the total cost to install 214 recorders will be approximately **$2,140,000** while O&M will cost approximately **$642,000**, annually. In addition, a hydrogeologist will be required for 1-2 years to work out the logistics for these installs such as access agreements, wellhead modifications, coordination issues, etc.

Database and Quality Issues

Not all of the USGS wells being monitored were found in a search of DBHYDRO. This could be attributed to one or more of several causes:

- DBHYDRO searching capabilities not strong enough;
- Misclassification of data within DBHYDRO; or,
- Data was never entered into DBHYDRO.

As a result of identifying and communicating these misclassification errors, they have subsequently been rectified. In addition, obstacles to smooth the transfer of USGS data to the District database have been discussed and are currently being addressed.

While plotting and analyzing water levels from the network wells, several data quality issues were revealed which could be blamed on several possible culprits including: an inaccurate survey of the measuring point to the datum, spikes over fixed time intervals, data shifts, possible pumping effects, atypical trends, bad data points, etc. These QA/QC issues are illustrated in **Figures C-14 through C-19**. The source of the data errors should be determined and corrected in the database; however, this was not within the scope of this task force memorandum.

USGS Transfer of Data Into DBHYDRO

Data from the network wells managed by the USGS must be downloaded from the USGS ADAPS database into DBHYDRO (District corporate database). The download format is extremely cumbersome. Much manual editing is required before the data can be easily loaded into a spreadsheet. The system needs to be simplified and automated. The database, DBHYDRO, is known as the District's corporate database. At this writing, it contains millions of flow, stage, rainfall, ground water and water quality data records. Due to this volume of data, it is highly desirable to have user-friendly access to this information. The Database Design and Programming Section in the Environmental Monitoring Assessment Department (EMA) has made the achievement of that condition a very high priority. To this end, the DBHYDRO Browser (the Browser) application was developed. **Appendix E** provides a brief summary of the DBHYDRO's history and role.

The USGS only stores the maximum daily water level values in their ADAPS database, and transmits these to the District once a year. This limitation was discussed with USGS in early 2000. As a result, the District will now be getting additional daily values over and above max days on a CD Rom at the end of each water year.

District's SALT Database and User's Instructions

With few exceptions, all use of water within the District requires a water use permit. Permits for large water uses, generally greater than 100,000 gallons per day, are evaluated by the staff of the Water Use Division to ensure that they are reasonable-beneficial, in the public interest, and will not harm the water resources or its existing legal uses. To maintain this assurance, conditions of issuance are attached to certain permits that require ongoing monitoring and reporting of data. The requirements often include reporting of actual water use by the overall permit or by facility, and may include reporting of water levels and chloride ion concentration of water from selected facilities. This data is maintained in the Regulation database. The portion of the database where this information resides is currently being extensively redesigned; therefore the information reported at the time of this writing (March 2002) is subject to change and improvement. **Appendix F** gives instructions to access this SALT database.

Potentiometric Map and Water Level Needs

The USGS currently develops bi-annual potentiometric maps of the upper Floridan aquifer in north-central Florida that includes the UEC in cooperation with all water management districts in Florida. However, not all Floridan wells monitored by the SFWMD are incorporated in those maps. It is recommended that the District coordinate with the USGS (Orlando office) to have those additional wells made part of the potentiometric maps.

Development of temporal (semi-annual) water level maps were also recommended for the LEC and LWC. Modelers claim these were helpful in determining the cone of influence of the major public water supply wellfields in the area and ultimately helped them build the models.

Wells to Remove from Network Due to Redundancies

Fifteen wells can safely be eliminated from the network due to hydrograph redundancies, (i.e. between well pairs). Seven can be eliminated in the LEC, six from the UEC, and two from the LWC.

New Wells and Canal Stage Gauges Recommended

At least 54 additional new wells were identified as needed in the regional network; 37 in the LEC and 15 in the LWC, and 2 in the UEC.

Four new surface water stage recorders were recommended in the LEC. Three new rainfall gauges were also recommended for the UEC.

Physical Condition of Wells

Twenty-nine existing wells need replacement for various reasons; 13 in the LEC, 14 in the LWC, and 2 in the UEC.

Forty wells were found in to be in need of repair, 18 in the LEC; 16 in the LWC, and 6 in the UEC.

Eighty-two wells were identified as a high priority to automate with recorders; 49 in the LEC, 23 in the LWC, and 10 in the UEC. By the time this report went to press, in calendar year 2001, 13 of the 40 wells were already repaired.

Coordinate with Local Partners

The District should coordinate with local governments and utilities that manage local monitoring programs of their own. Integration of data from these other sources can be a cost-effective means to increase our coverage both temporally and spatially. For instance, Broward County Environmental Resources Management (ERM) collects continuous ground water level data through the USGS. This data can be captured and integrated into DBHYDRO. The District has already established a link between the District's real-time monitoring web site and ERM's. This type of coordination will require significant staff time to communicate and resolve issues such as data quality, transfer, and format with other local governments and utilities.

FY02 FUNDING INITIATIVES

Funding in the District's FY02 budget represents partial financing of the total cost to implement the task force recommendations. The well restoration recommendations were least costly, implementation of which is proposed at 100% ($164,400) of the total and should therefore, be completed in one year (Y2002). Approximately 9% ($25,884) of the total estimated cost ($287,600) for well replacements is proposed in FY02. The task force recommends that all replacements be completed over a five-year time frame. Well automation is the most costly component of the recommendations, approximately 5% (~$100,000 for 10 wells) of the total ($2,140,000 for 214 wells) are being funded in FY02. This assumes approximately $10,000 per well automation cost. Here the proposed plan is to complete automation of the 214 wells, currently taped monthly by District staff, over a number of years contingent on future budget priorities. This upgraded, high-frequency water level data would hopefully be available in time for development of the 2010 water supply plans.

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APPENDIX A - QUESTIONS POSED BY TASK FORCE TO RECENT DISTRICT GROUND WATER MODEL DEVELOPERS

Questions Posed to District Modelers and End Users of the Data

1. Which wells provide you with the most valuable data?
2. Where are these wells located?
3. What type of data do you use (water level, chemistry)?
4. What is the frequency of data that you need? (Break point, Daily, Monthly ...), what is the least?
5. What are you using the data for (model calibration, water shortage)?
6. What is the source of your data (District, USGS, Other - please name)?
7. Which areas need more data? What type? For what purpose - long-term, short-term?
8. Which data is the least useful to you? Why?
9. Which locations have the longest continuous historical record?
10. Are there any contacts that you know that rely on the District to supply them data for certain locations?
11. Do you know of other agencies or municipality that collect data regularly that could share their data with the District?
12. How would you recommend the monitor network be improved without increasing its cost to the District significantly?

APPENDIX B - WELL LOCATION MAPS

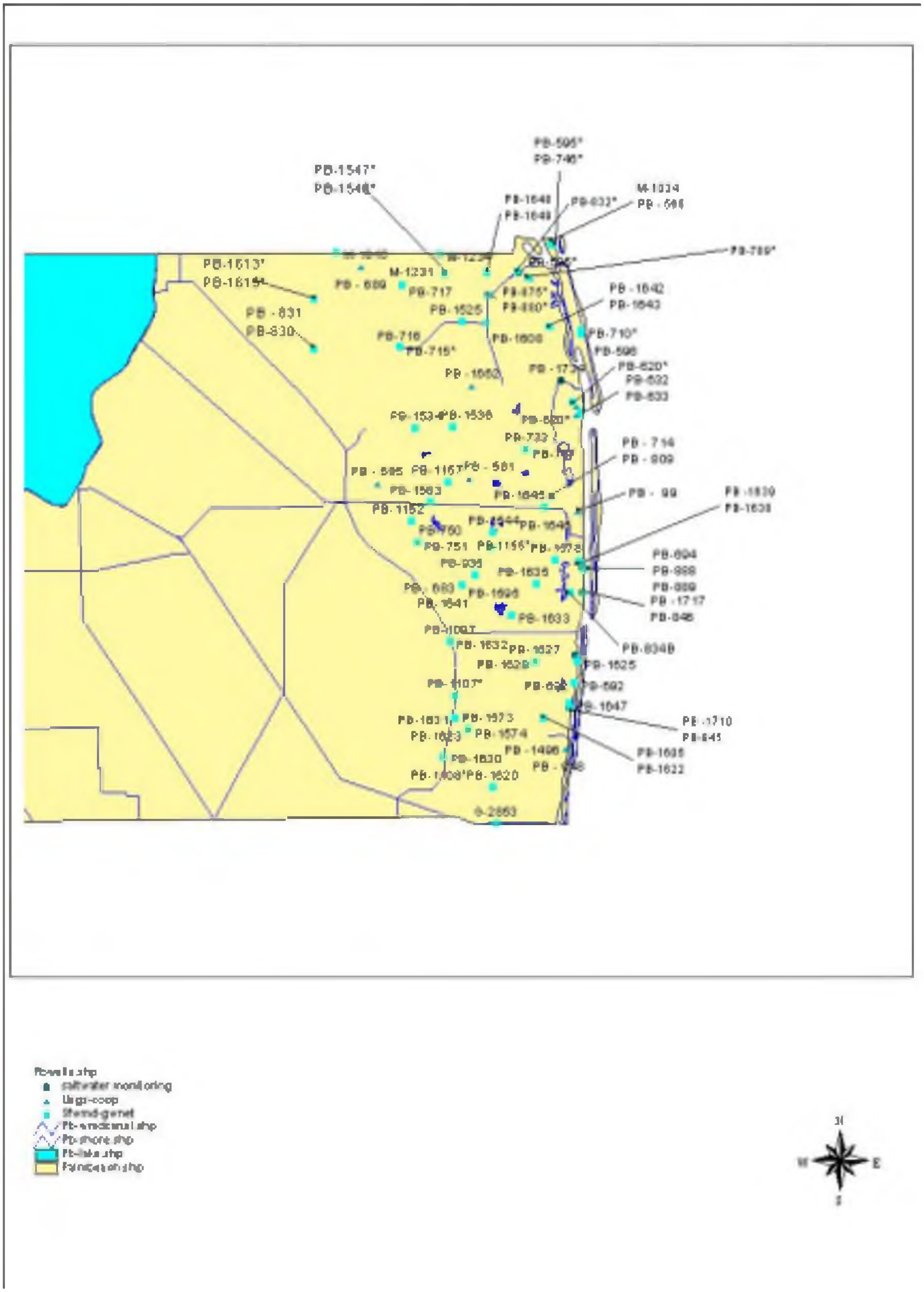


Figure B-1. Palm Beach County Wells.

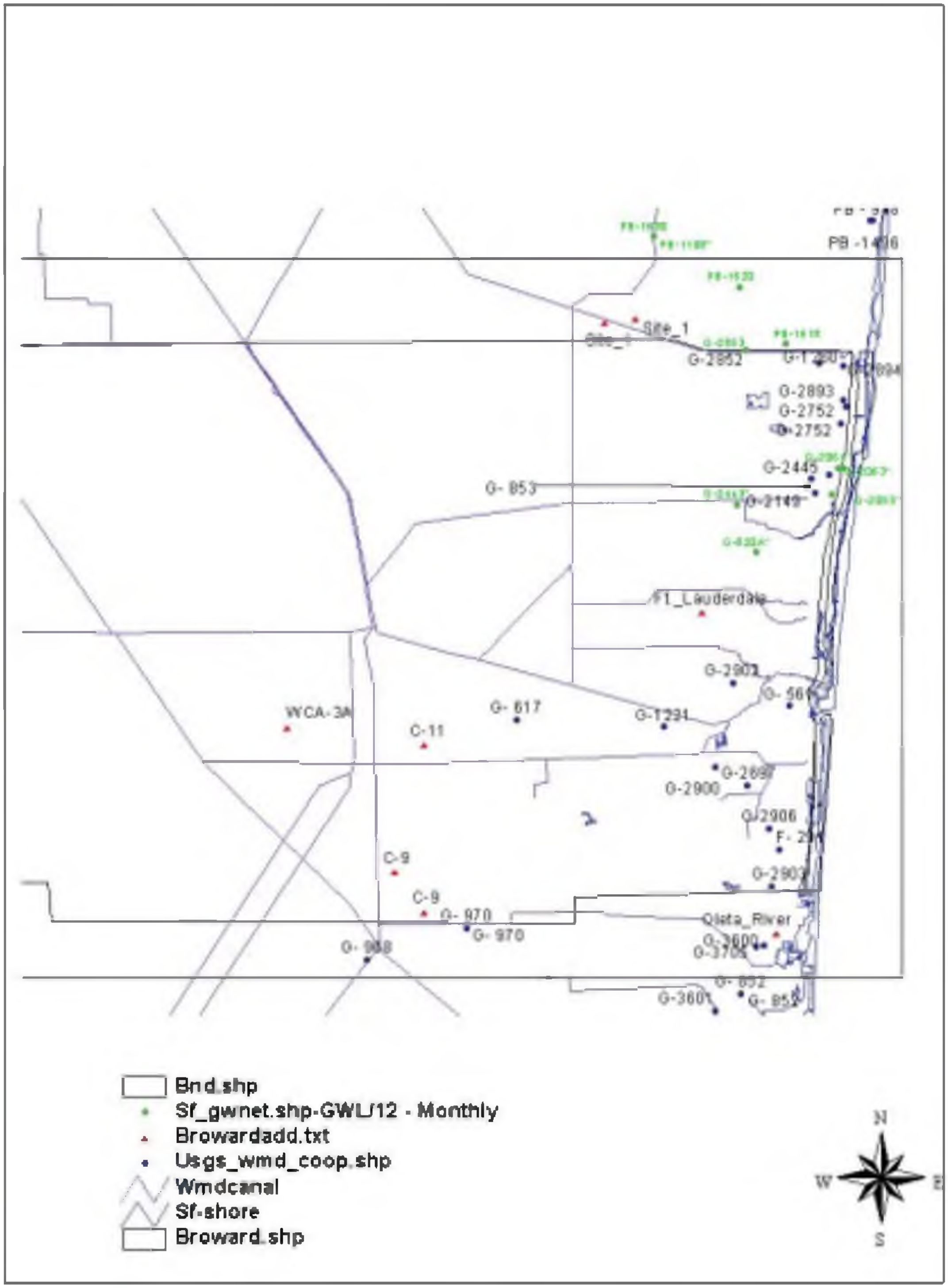


Figure B-2. Monitor Wells located in LEC, Broward County.

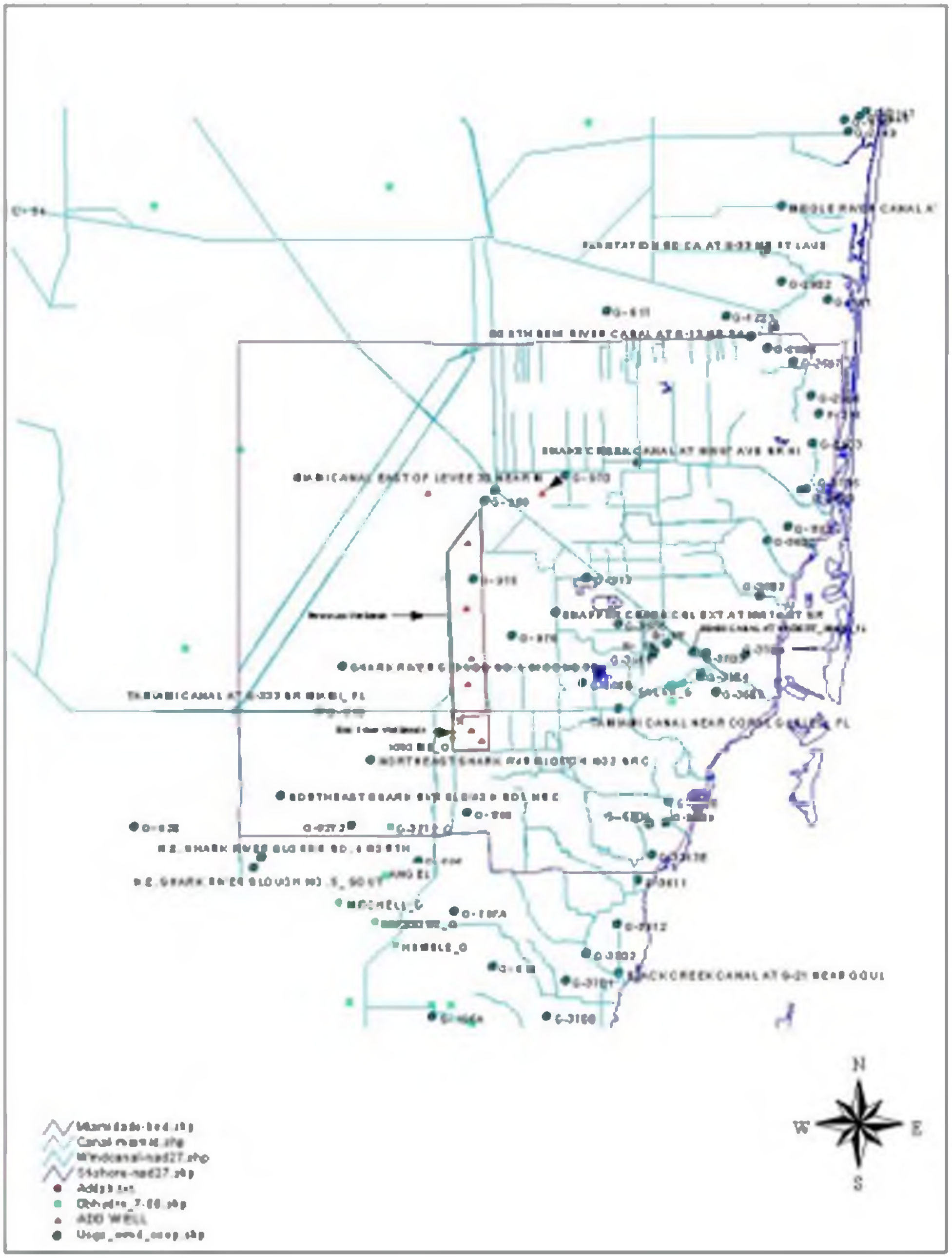


Figure B-3. Monitor Wells for the LEC, North Miami-Dade County.

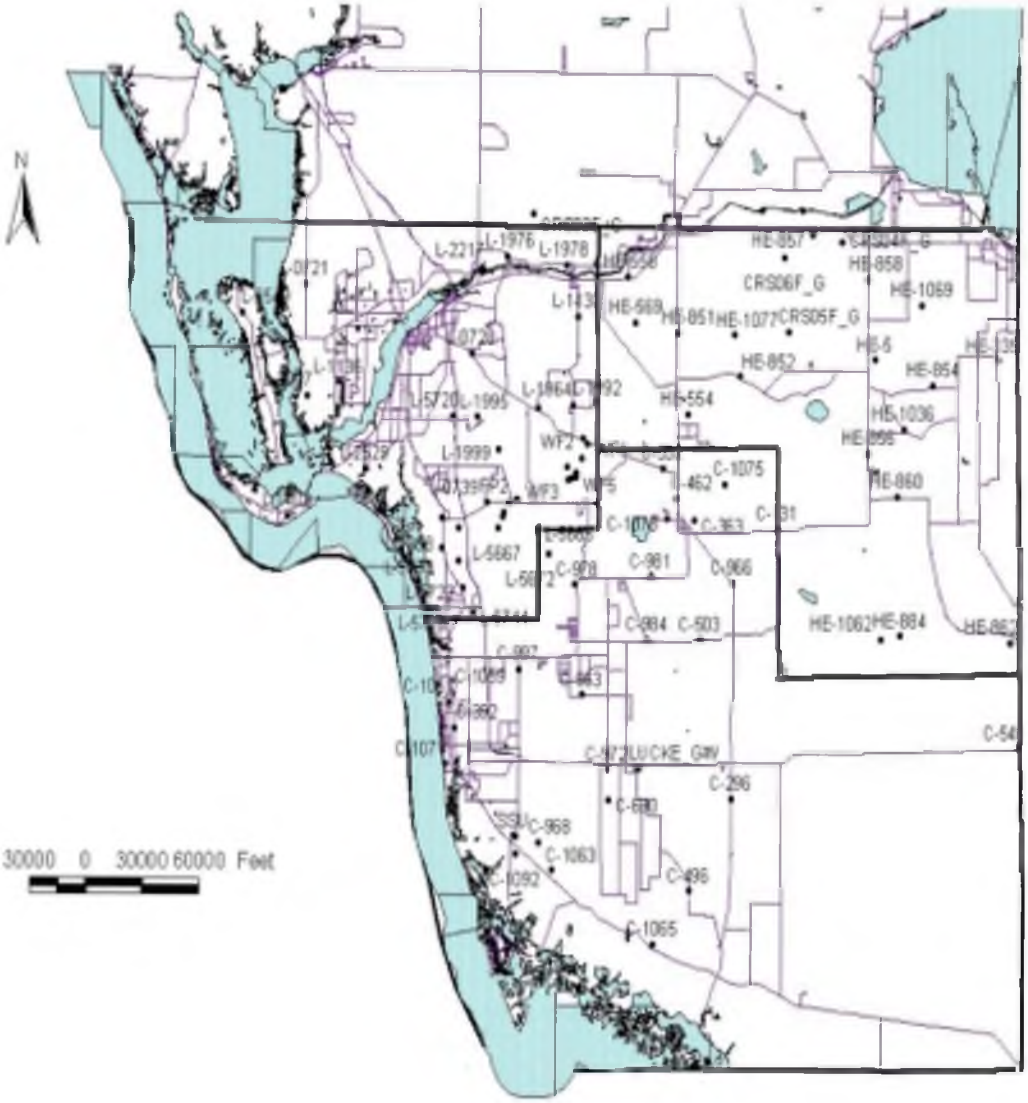


Figure B-4. Monitor Wells for the LWC, Water Table Aquifer.

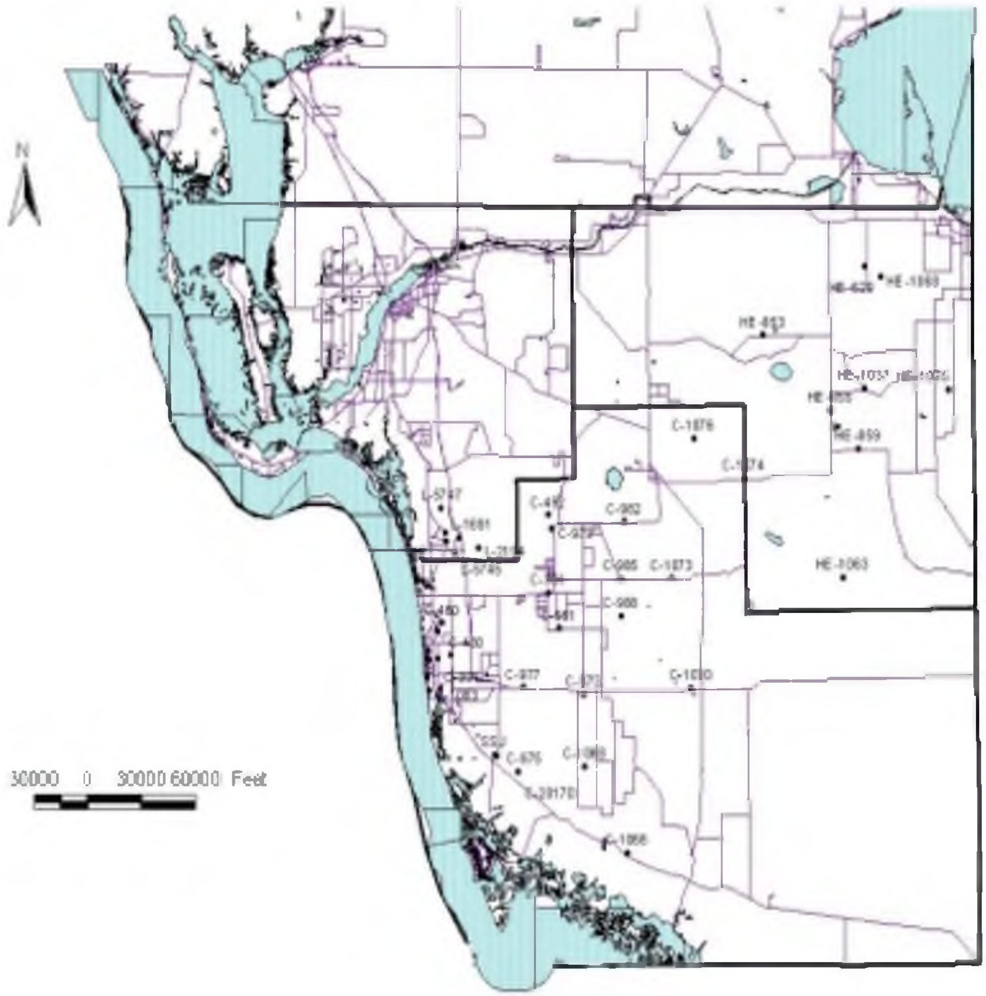


Figure B-5. Monitor Wells located in LWC, Lower Tamiami Aquifer

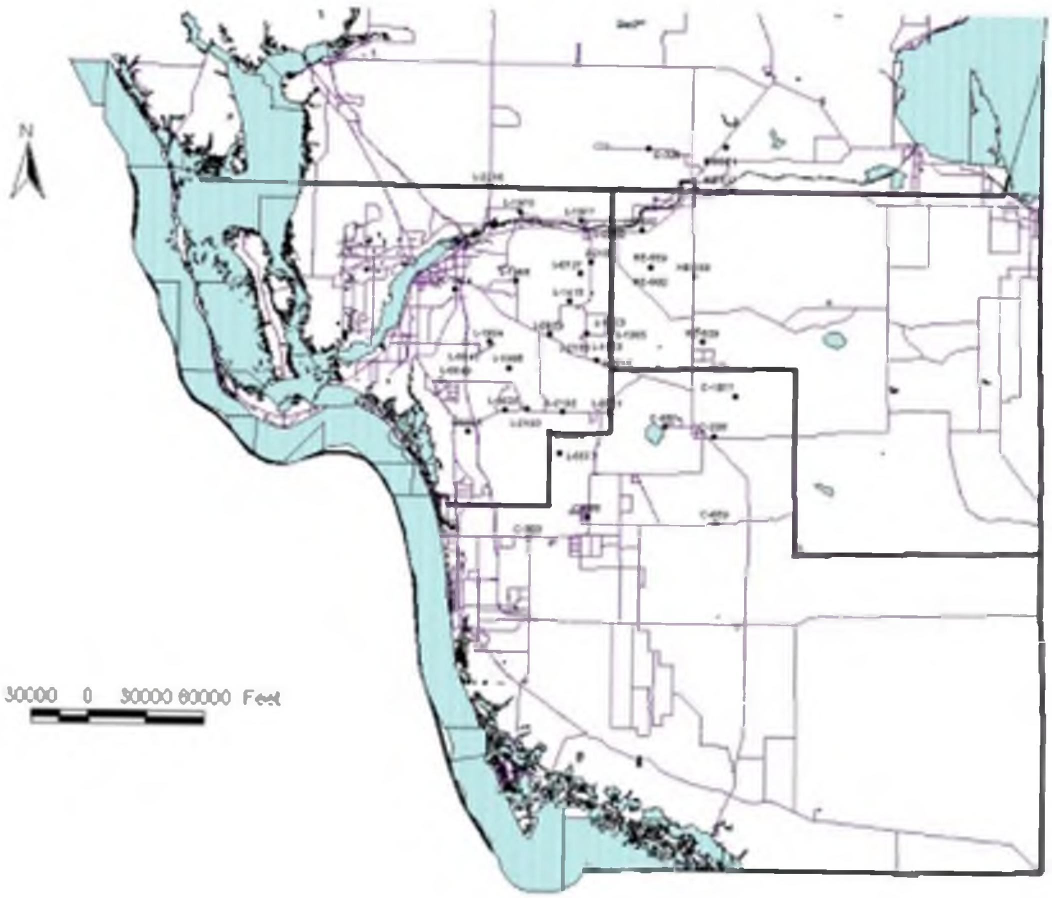


Figure B-6. Monitor Wells for the LWC, Sandstone Aquifer.

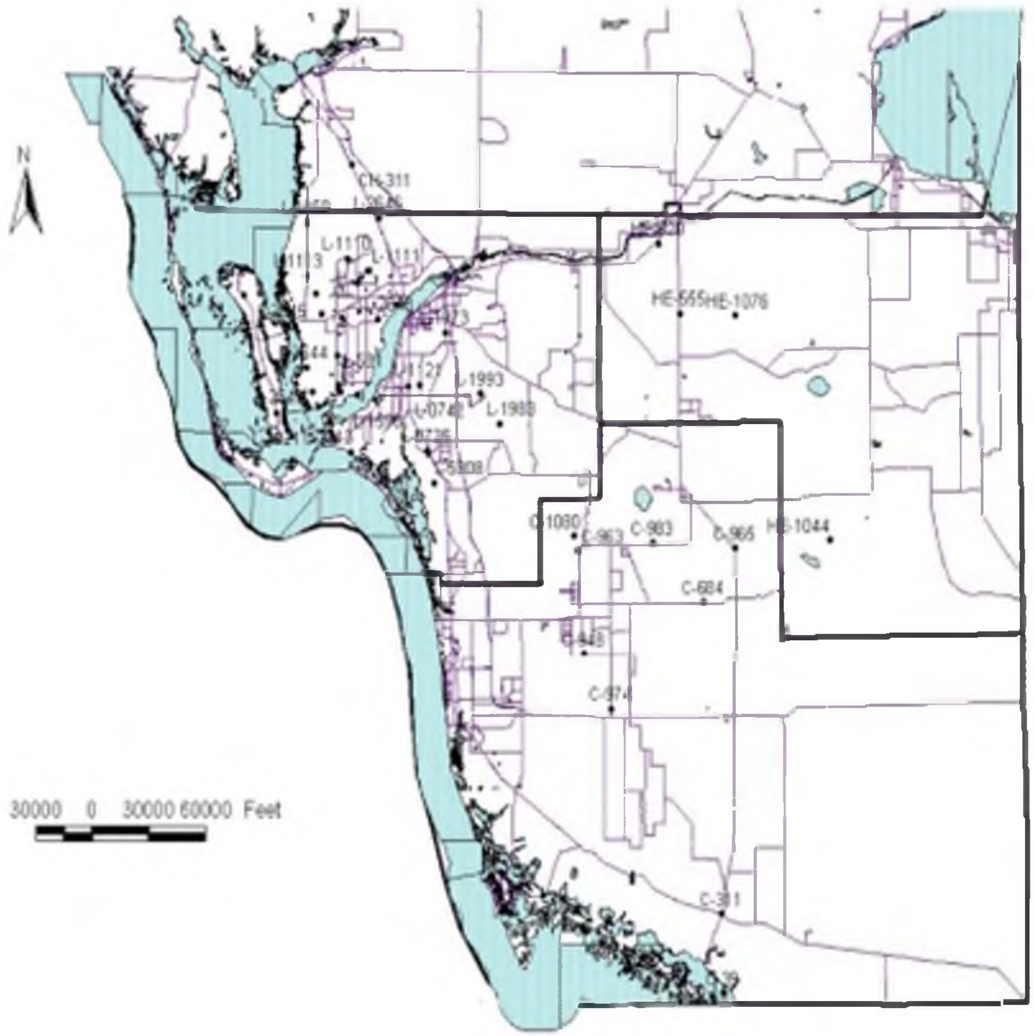


Figure B-7. Monitor Wells for the LWC, Mid-Hawthorn Aquifer

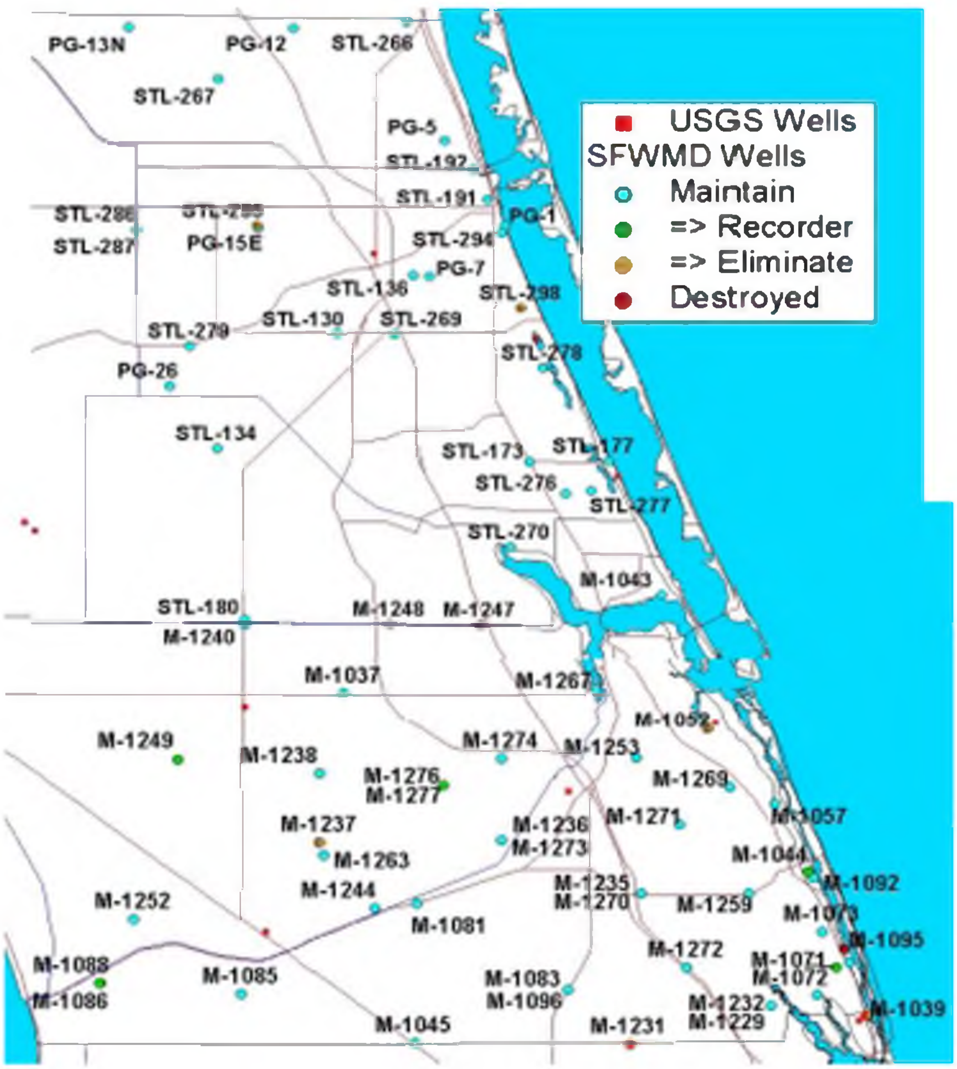


Figure B-8. Monitor Wells Located in UEC, St. Lucie and Martin County.

APPENDIX C - HYDROGRAPHS USED IN ANALYSIS OF REDUNDANCIES

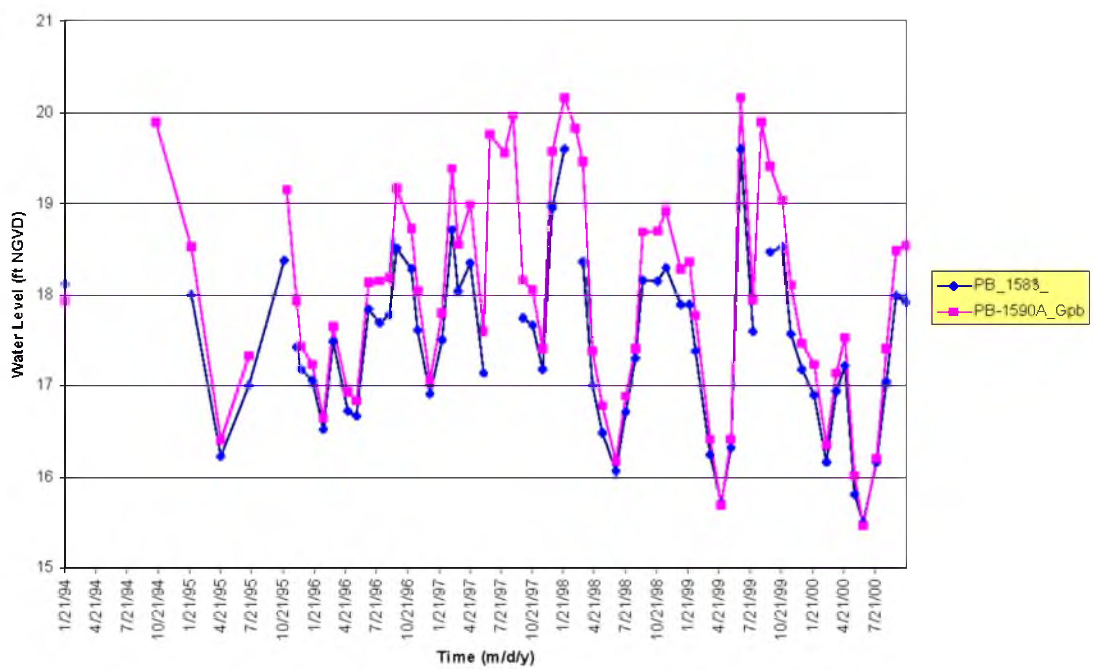


Figure C-1. Hydrographs of Wells Pb-1583 versus Pb-1590-A.

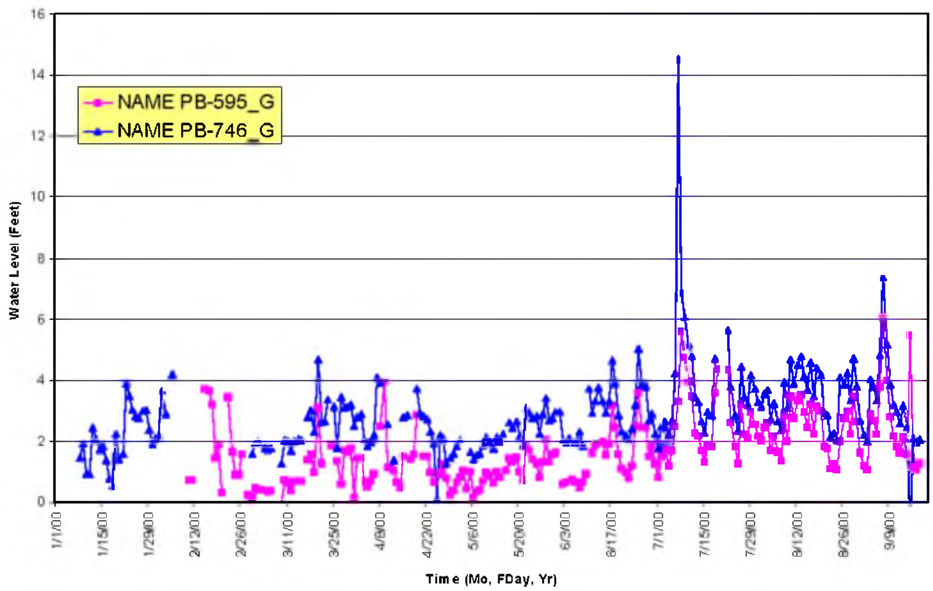


Figure C-2. Hydrographs of Wells Pb-595_G versus Pb-746_G.

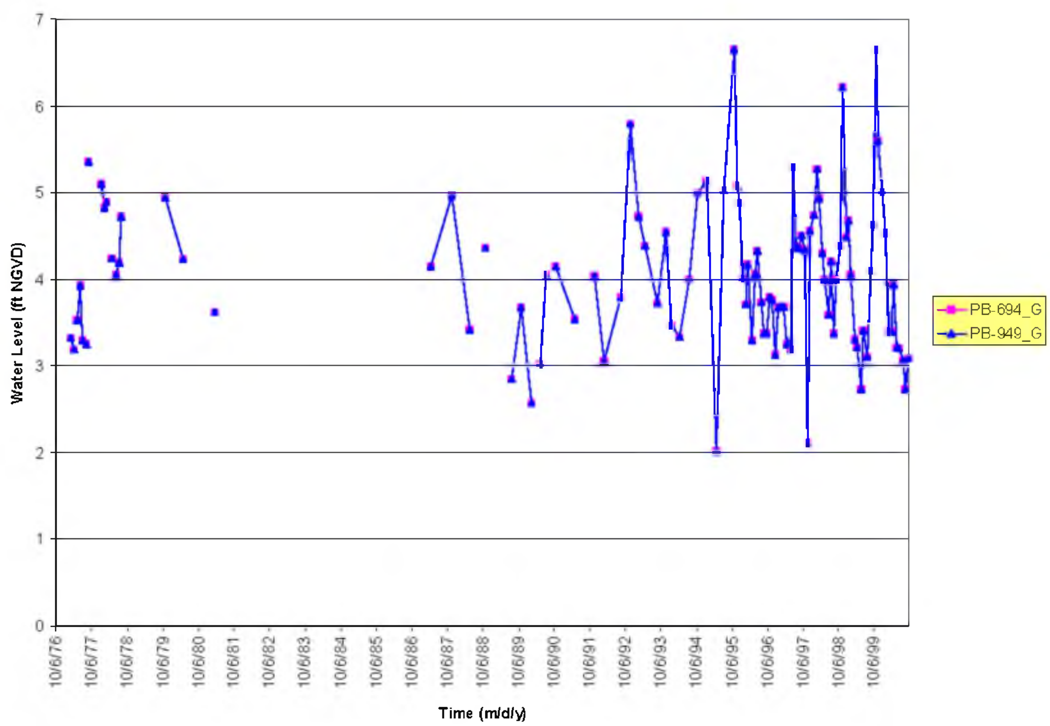


Figure C-3. Hydrographs of Wells Pb-694 versus Pb-949.

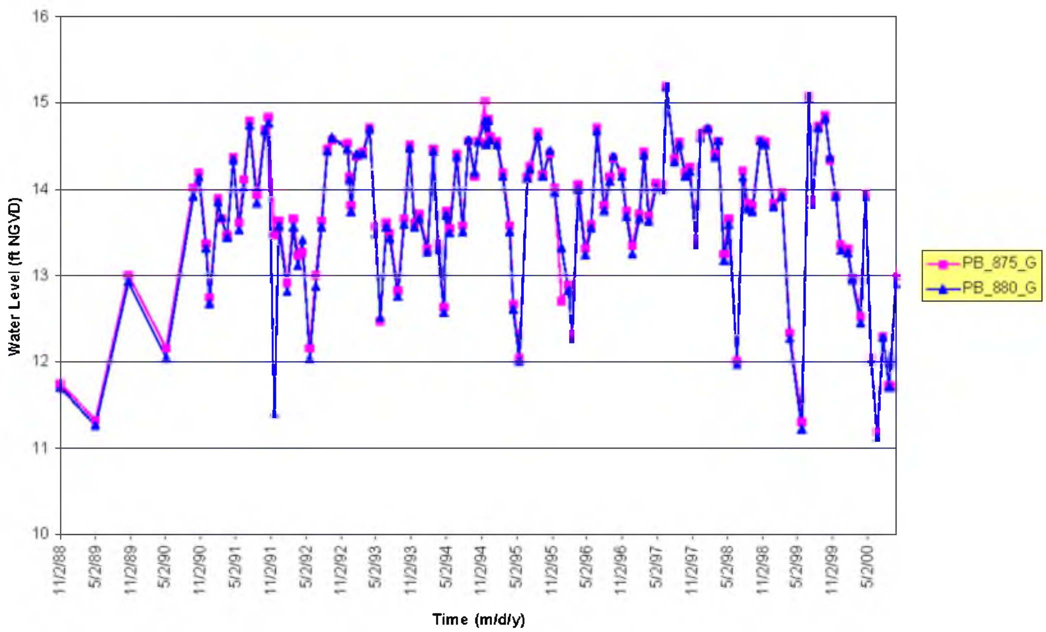


Figure C-4. Hydrographs of Wells Pb-875 versus Pb-880.

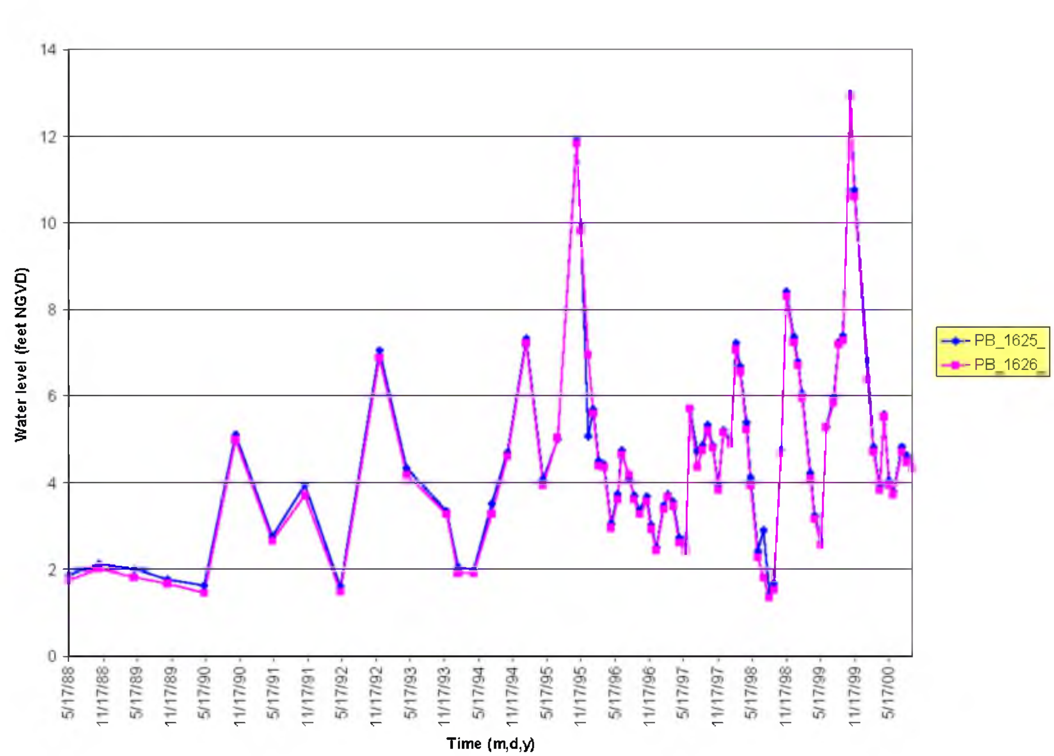


Figure C-5. Hydrographs of Wells Pb-1625 versus Pb-1626.

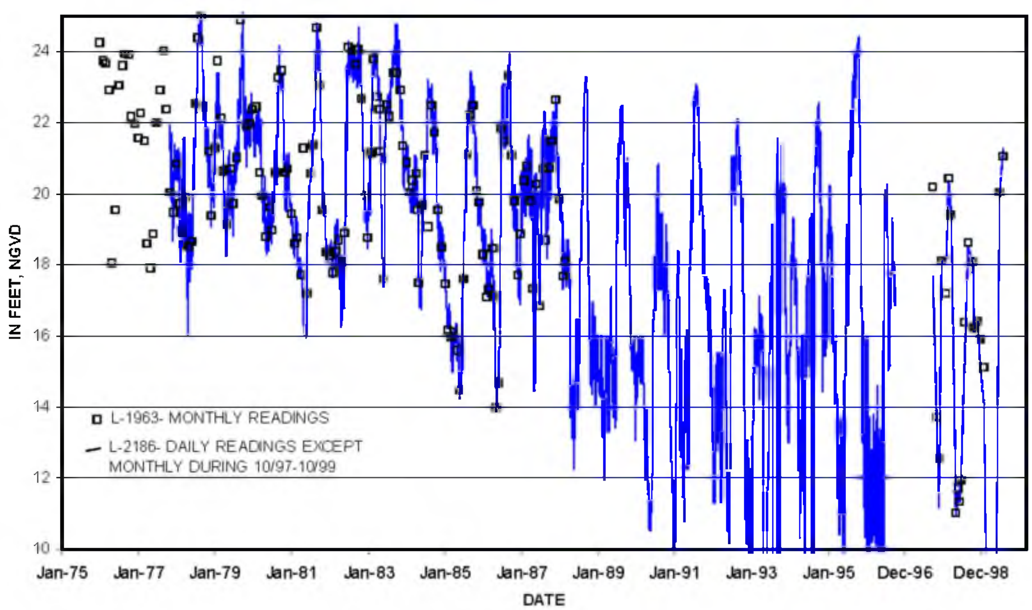


Figure C-6. Hydrographs of Wells L-1963 versus L-2186.

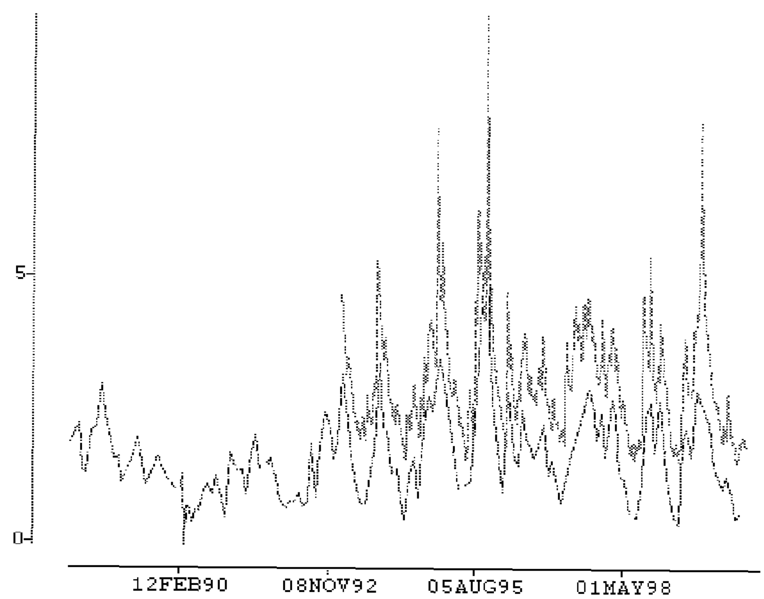


Figure C-7. Hydrographs of Wells M-1024 (purple) versus M-1039 (red).

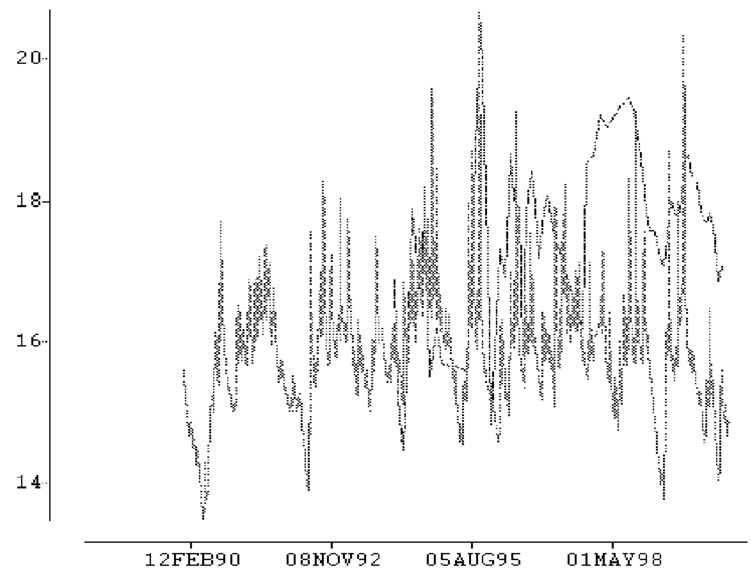


Figure C-8. Hydrographs of Wells M-1234 (purple) versus M-1231 (red).

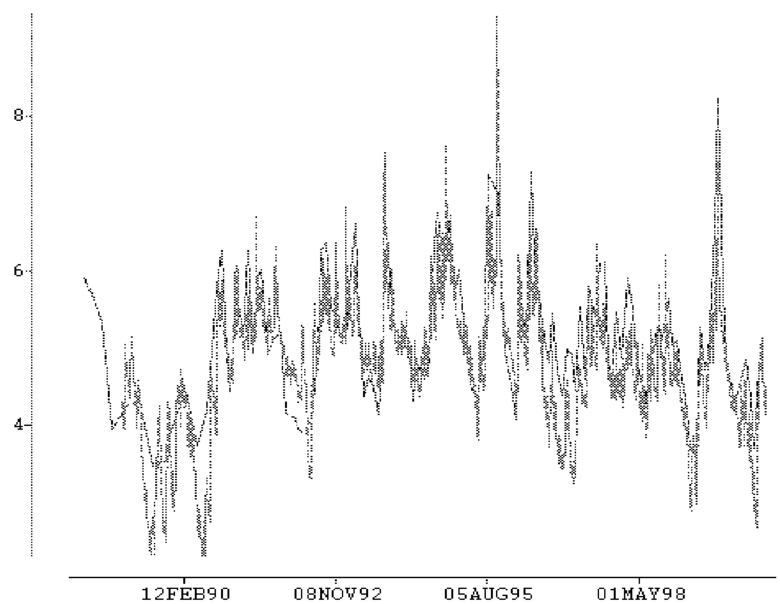


Figure C-9. Hydrographs of Wells M-1004 (purple) versus M-1052 (red).

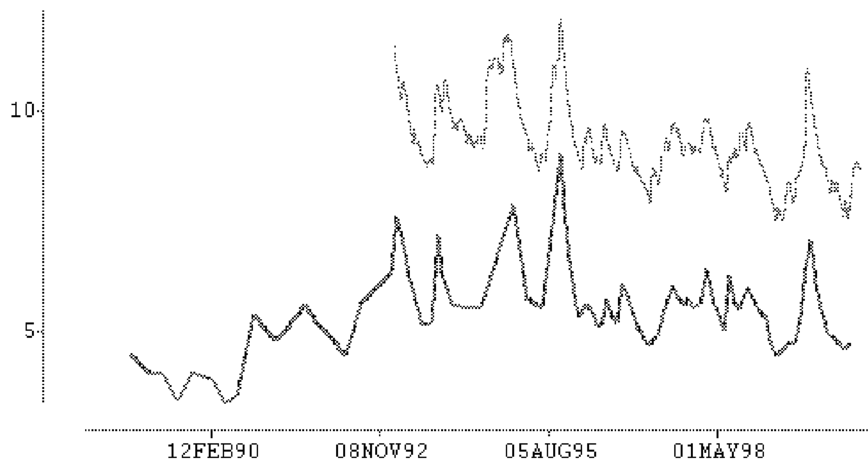


Figure C-10. Hydrographs of Wells STL-175 (purple) versus STL-177 (red).

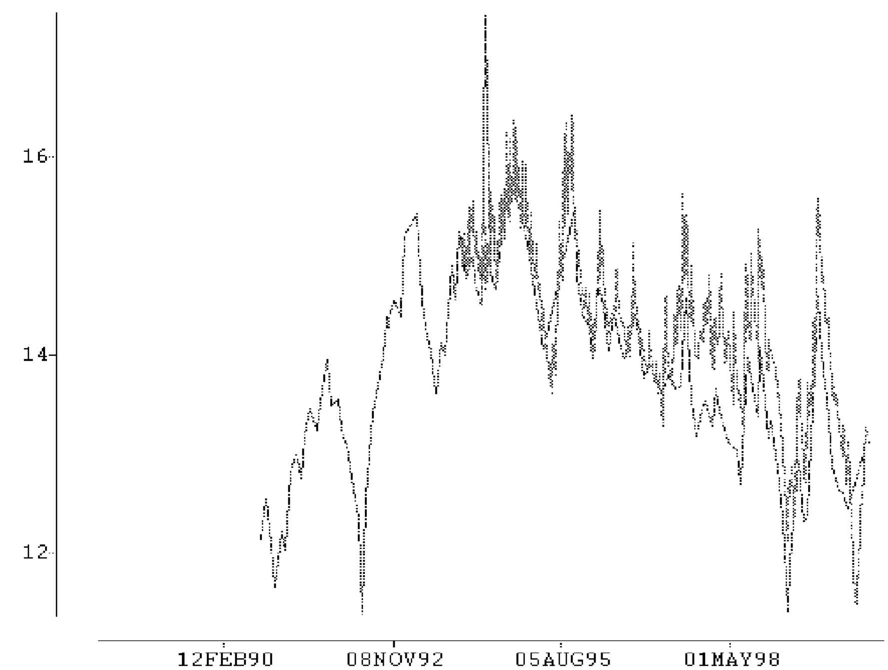
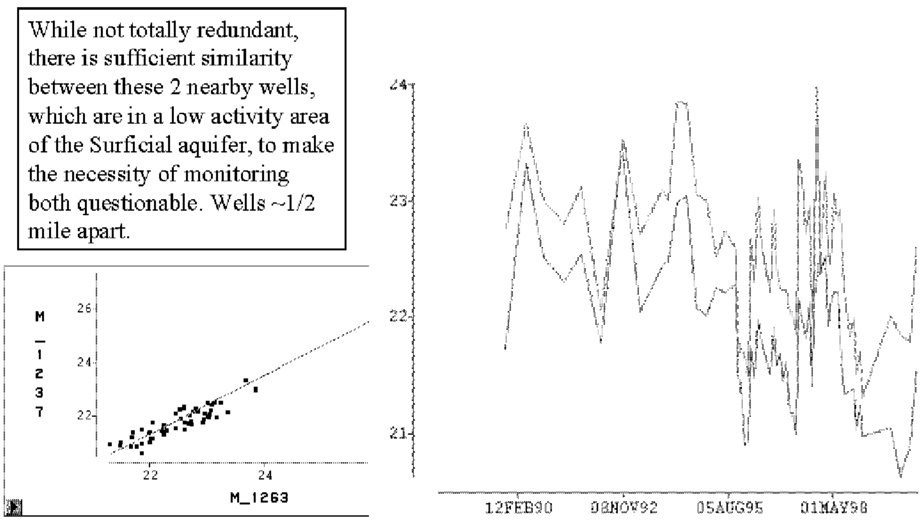


Figure C-11. Hydrographs of Wells STL-172 (purple) versus STL-298 (red).

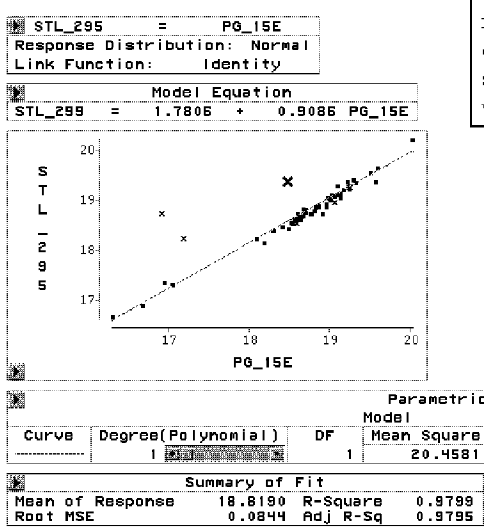


		Parametric	
		Model	
Curve	Degree(Polynomial)	DF	Mean Square
	1	1	42.8247

Summary of Fit			
Mean of Response	21.9214	R-Square	0.8838
Root MSE	0.3230	Adj R-Sq	0.8816

Figure C-12. Hydrographs of Wells M-1237 (TD = 160) and M-1263 (TD = 7).

These 2 wells are only about 600 ft apart. Although they are at different depths, and represent slightly different landuses, excepting 3 outlying points, there is almost 98% correlation between the water-levels at the 2 sites.



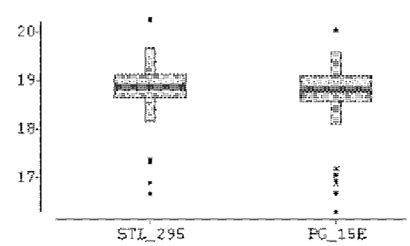


Figure C-13. Correlation between Hydrographs STL-295 versus PG-15E.

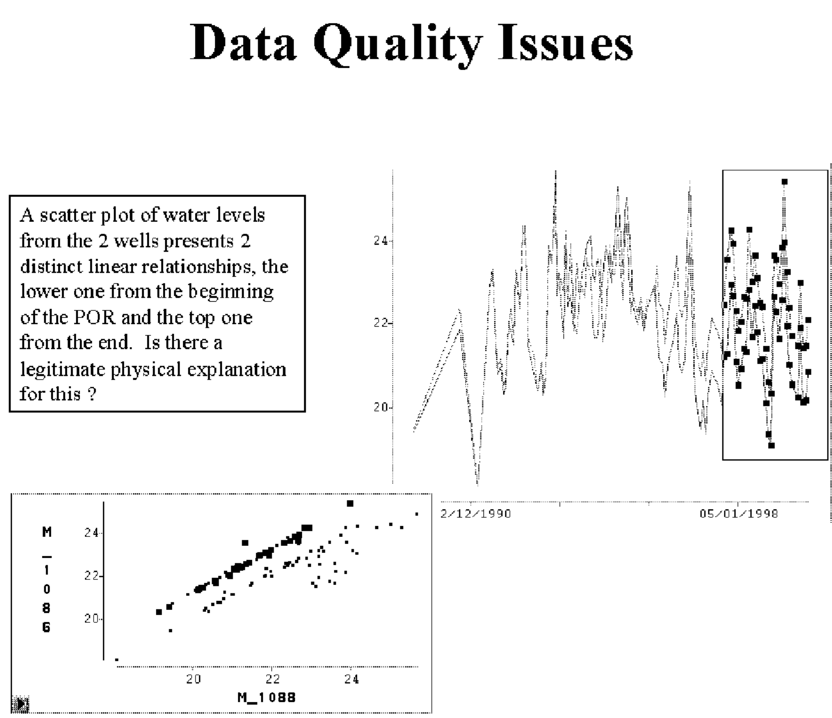


Figure C-14. Hydrographs of Wells M-1086 (TD = 45) and M-1088 (TD = 10).

Data Quality Issues

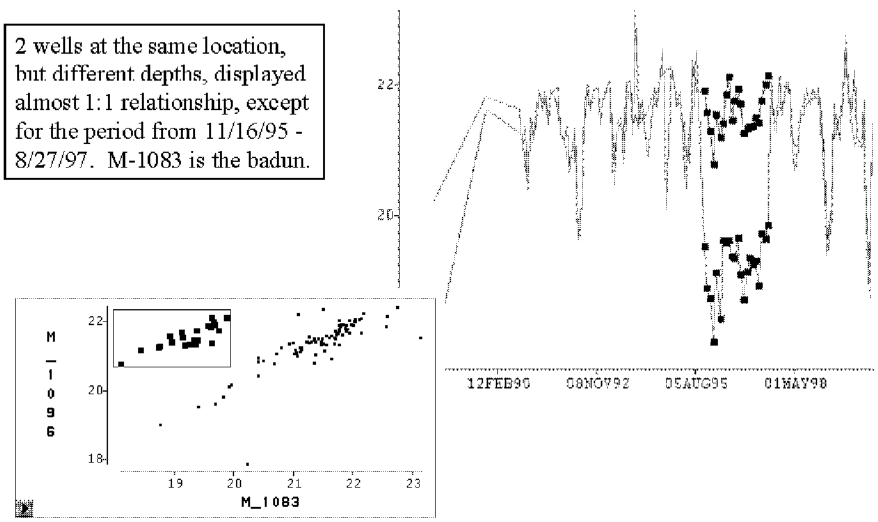


Figure C-15. Hydrographs of Wells M-1096 (TD = 105) & M-1083 (TD = 24).

Data Quality Issues

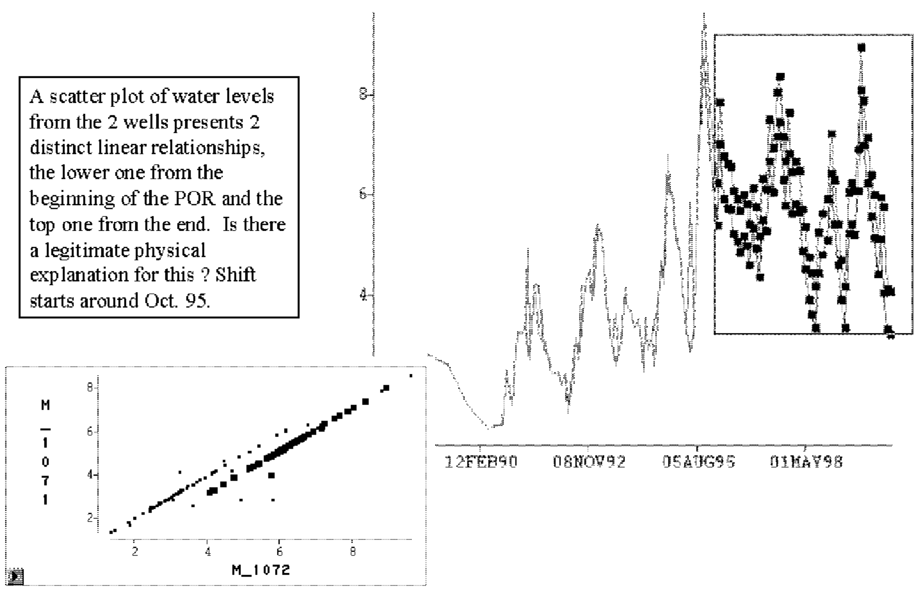


Figure C-16. Hydrographs of Wells M-1071 (TD = 118) & M-1072 (TD = 34).

Data Quality Issues

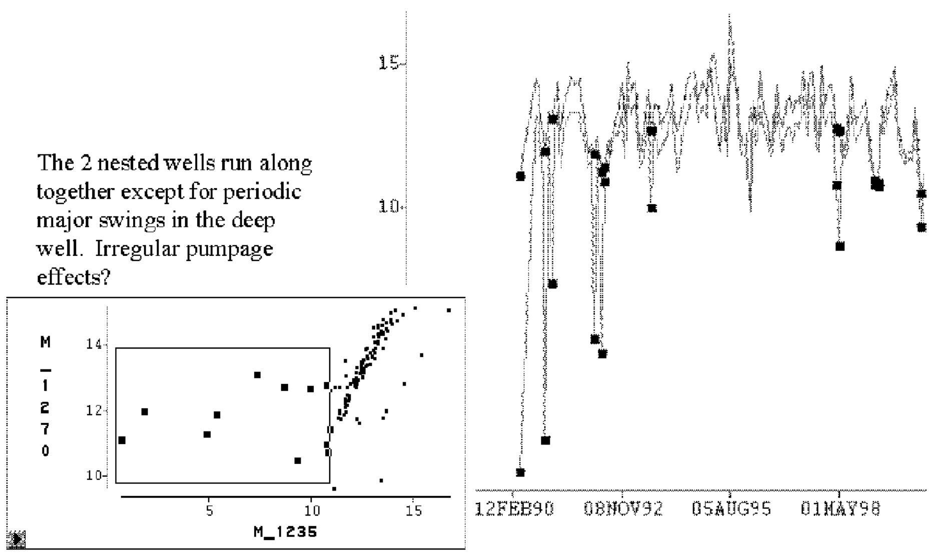
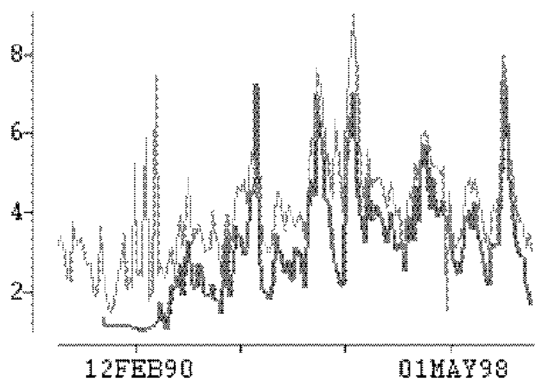


Figure C-17. Hydrographs of Wells M-1270 (TD = 21) & M-1235 (TD = 150).

Data Quality Issues

Two wells at the same location, near the intracoastal, but completed at different depths. Unlike all of the other such paired wells in the area, this one shows an upward gradient. Why?



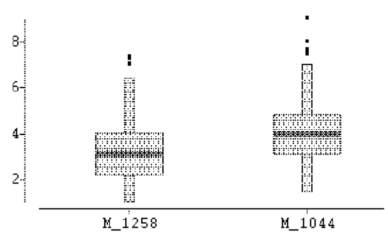


Figure C-18. Hydrographs of Wells M-1258 (TD = 18") & M-1044 (TD = 163").

Data Quality Issues

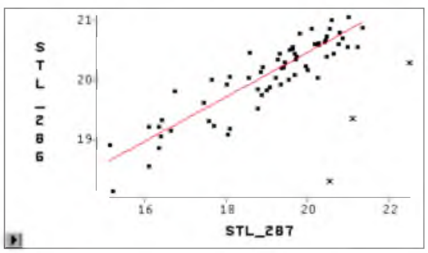
Bad Data Points?

Bad Data Points?

STL_286 = STL_287	
Response Distribution:	Normal
Link Function:	Identity

Model Equation

STL_286 = 12.9660 + 0.3752 STL_287



Parametric Regression Fit

Curve	Degree(Polynomial)	Model DF	Model Mean Square	Error DF	Error Mean Square
	1	1	21.8654	62	0.0786

Summary of Fit

Mean of Response	20.1077	R-Square	0.8178
Root MSE	0.2803	Adj R-Sq	0.8149

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Stat	Prob > F
Model	1	21.8654	21.8654	278.3115	0.0001
Error	62	4.8710	0.0786		
C Total	63	26.7363			

STL-286 & STL-287

Shallow & deep at same location - 80% correlation except for 3 points, where behave inversely.

Figure C-19. Hydrographs of Wells STL-286 and STL-287.

APPENDIX D - THEISSEN POLYGONS

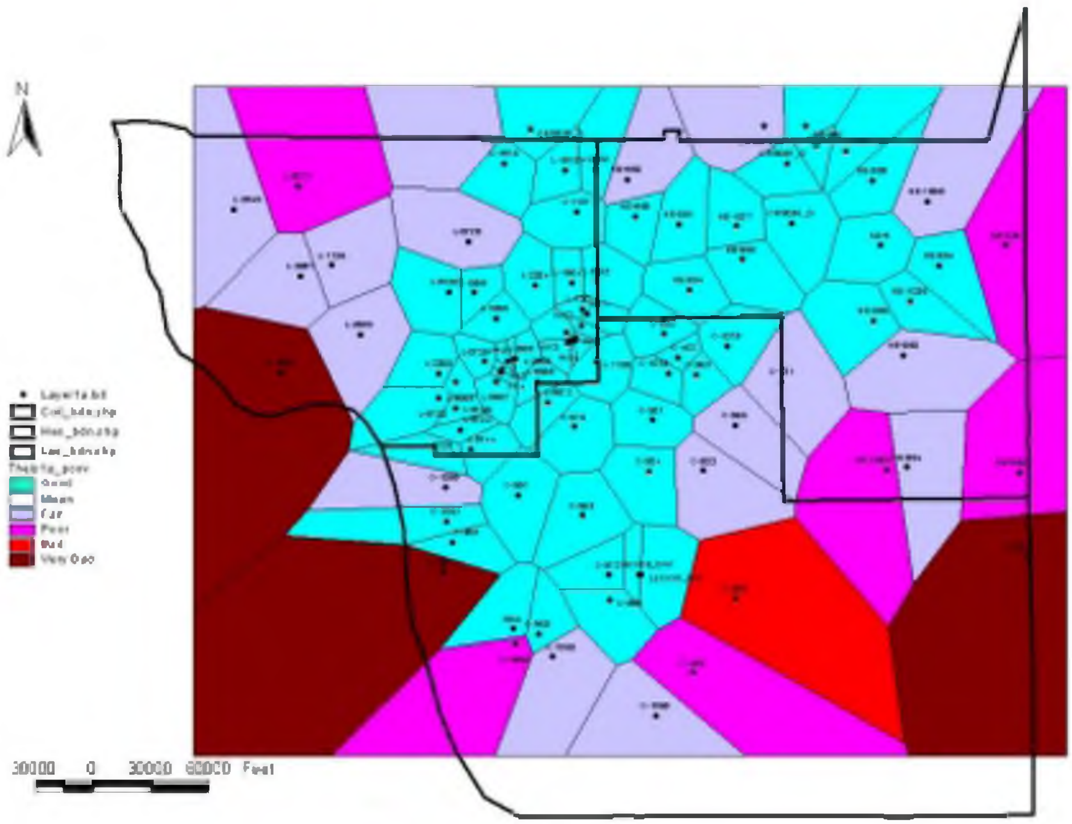


Figure D-1. Theissen Polygons for the Water Table Aquifer.

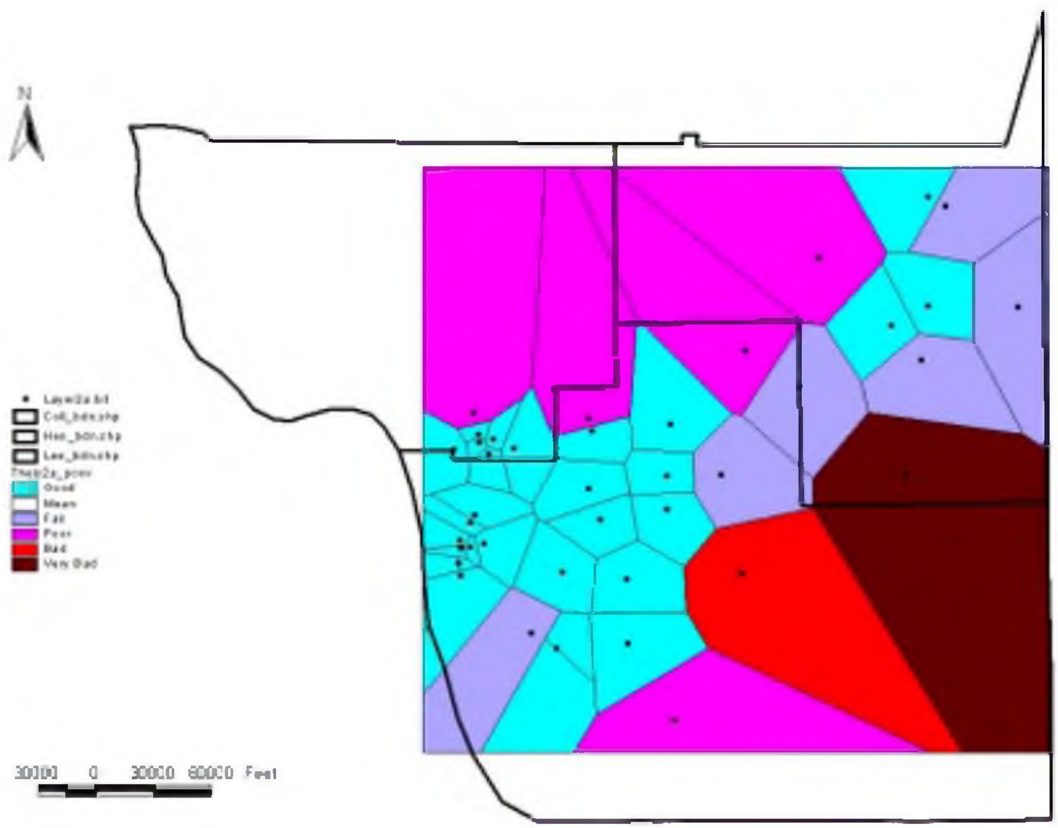


Figure D-2. Theissen Polygons for the Lower Tamiami Aquifer.

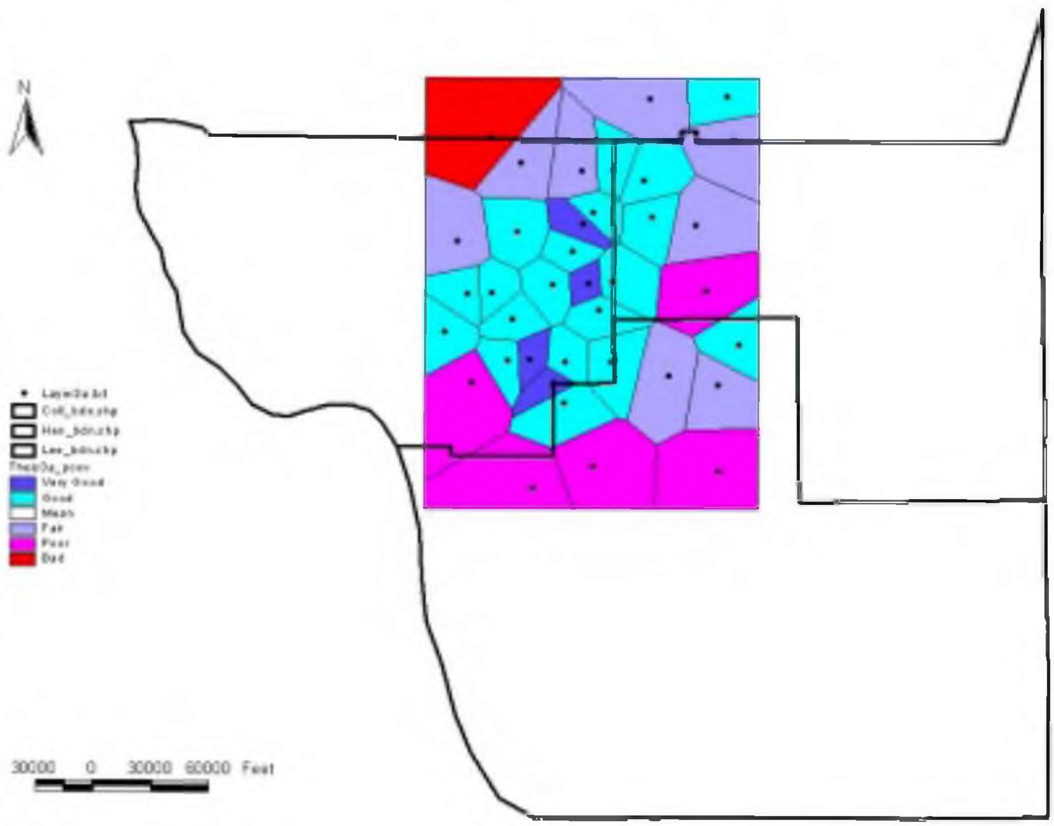


Figure D-3. Theissen Polygons for the Sandstone Aquifer.

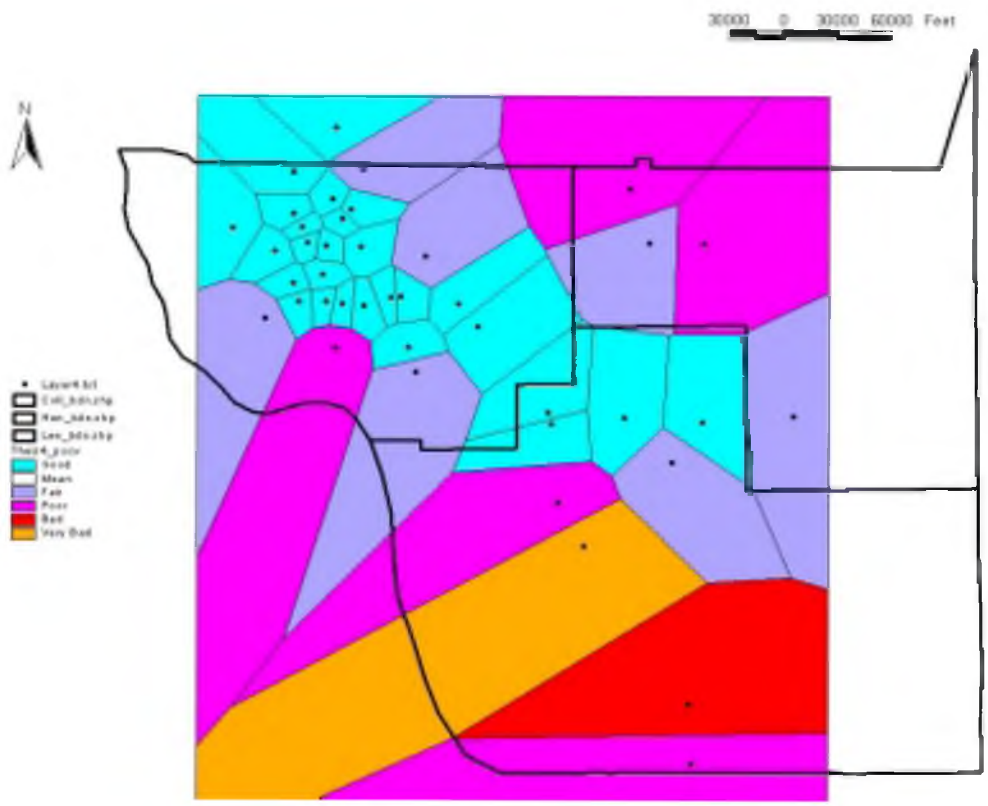


Figure D-4. Theissen Polygons for the Mid-Hawthorn Aquifer.

APPENDIX E - DBHYDRO

SUMMARY OF DBHYDRO

For the 2001 water year, data collected at over 400 ground water sites in South Florida will be directly downloaded from ADAPS (the USGS national database) to DBHYDRO.

In addition, the District measures and records levels from approximately 240 wells in the District. All were used in this report and are stored on DBHYDRO.

Plans are underway to link other databases constructed and maintained by District staff to DBHYDRO. Some of these, such as WILMA (Well Information and Lithological-Geophysical Maintenance Application, the ground water subsystem of DBHYDRO) and LAMIS (Land Management Information System, water control structure benchmark and reference elevation information) offer supplemental data necessary to support water supply monitoring and modeling efforts.

The database, DBHYDRO, is known as the District's corporate database. At this writing, it contains millions of flow, stage, rainfall, ground water and water quality data records. Due to this volume of data, it is highly desirable to have user-friendly access to this information. The Database Design and Programming Section in the Environmental Monitoring Assessment Department (EMA) has made the achievement of that condition a very high priority. To this end, the DBHYDRO Browser (the Browser) application was developed.

The Browser is a platform-independent application and has some very useful features including hydrograph capabilities and a listing of all hydrologic and meteorologic data locations with values stored on DBHYDRO. The address for the browser is http:// iweb/dbhydro. External users may not have direct access to the Browser, but the site accepts the file transfer protocol (ftp) through an application known as REMO (a copy of DBHYDRO that is placed outside the firewall and is updated monthly. The complete DBHYDRO User's Guide is available on the website in .pdf format as well as user's guides for other features of the Browser.

Finally, DBHYDRO Browser is a dynamic application that is continually improved. As users provide feedback to EMA, resources are dedicated to assessing customer needs and implementing improvements.

APPENDIX F - DISTRICT SALT DATABASE AND USER'S INSTRUCTIONS

SALT DATABASE - USER'S INSTRUCTIONS

With few exceptions, all use of water within the District requires a water use permit. Permits for large water uses, generally greater than 100,000 gallons per day, are evaluated by the staff of the Water Use Division to ensure that they are reasonable-beneficial, in the public interest, and will not harm the water resources or its existing legal uses. To maintain this assurance, we attach conditions of issuance to certain permits that require ongoing monitoring and reporting of data. The requirements often include reporting of actual water use by the overall permit or by facility, and may include reporting of water levels and chloride ion concentration of water from selected facilities. The data is maintained in the Regulation database. The portion of the database where this information resides is currently being extensively redesigned; therefore the information reported at the time of this writing (March 2002) is subject to change and improvement.

This appendix gives instructions to access the SALT database.

Figure F-1 shows how to access the log-in window. From the START button in the lower left corner of the Windows screen, select Programs, then Oracle Apps, then regdb 5.0.

In the login window (**Figure F-2**) enter "pub" as both user name and password, and "genp" as the database.

You are now in the Regulation main menu page **(Figure F-3)**. Select PPC, then WUC, then Monitoring Data, then Saltdb, PWS/NPWS chart. This will bring you to to the data chart screen (**Figure F-4**).

The sole data output available at this time is charts. The options available on the screen are:

- Begin and End Dates of the graph: Format is DD-MMM-YYYY.
- Permit Number (You can only enter, not browse)
- Well Number (You can only enter, not browse)
- Y-values: You may select data-driven (the range of the y-axis brackets the range of the data) or enter your own minimum and maximum values

Figure F-1. Launching the Database. Select Start / Programs / Oracle Apps / regdb 5.0.

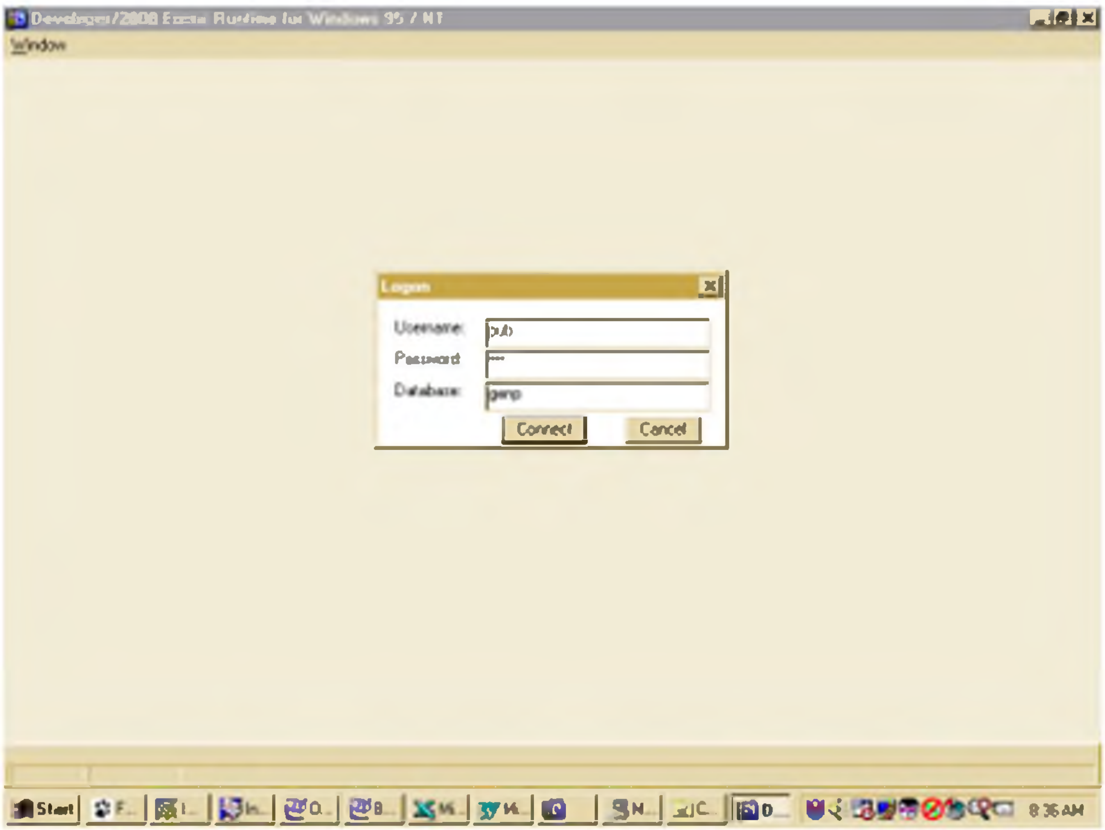


Figure F-2. Logging On (the password is 'pub').

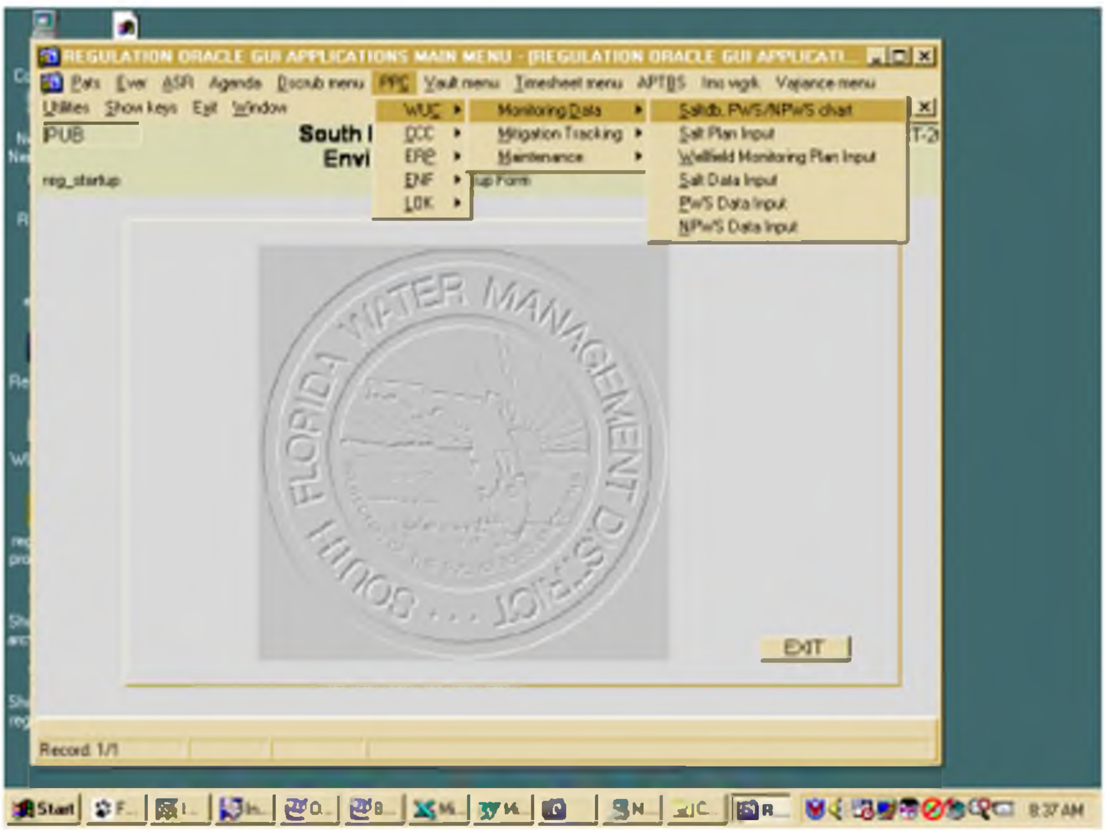


Figure F-3. Accessing the Data Graphing Menu. Select PPC / WUC / Monitoring Data / Saltdb

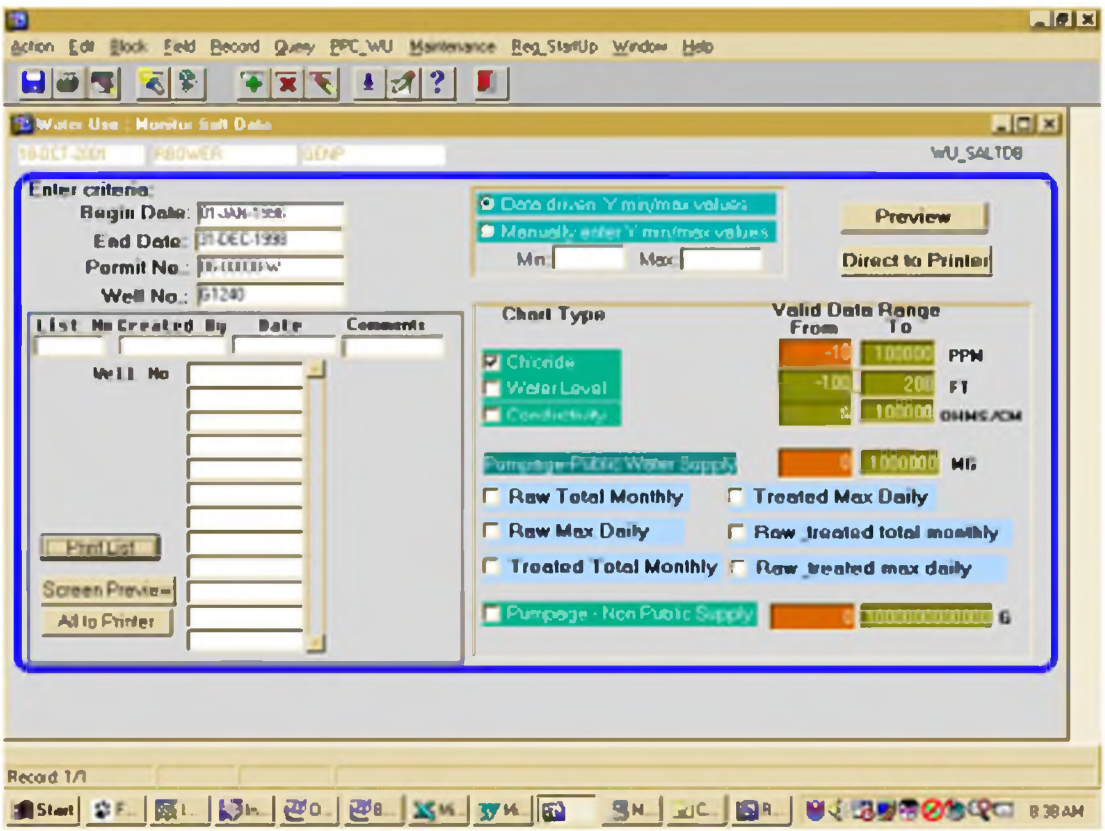


Figure F-4. The Graph Selection Menu.

The chart options include:

- Chloride
- Water Level
- Conductivity
- Raw Total Monthly Water Use (Public Water Supplies)
- Raw Max Daily Water Use (Public Water Supplies)
- Treated Total Monthly Water Use (Public Water Supplies)
- Treated Max Daily Water Use (Public Water Supplies)
- Raw and Treated Total Monthly Water Use (Public Water Supplies)
- Raw and Treated Max Daily Water Use (Public Water Supplies)
- Water Use (All Other Water Use Types)

If data is available, the system will generate a chart. If multiple charts are selected, the system produces each separately. You may select to preview the chart on the screen or route to a printer. Note that Chloride, Conductivity and Water Level are produced only for the selected well, while water use charts are produced for the entire permit.

If you do not know what permits have information available, you may browse the Salt Plan screen. **Figure F-5** shows the steps to that screen and **Figure F-6** shows the screen itself. To browse, place the cursor in Permit Number, then select Query / Execute, or single-click the "flashlight" icon. You can then tab through each permit and obtain a list of associated wells. If you know the permit number and just need the list of wells, enter that number in the permit number field and single-click the flashlight or select Query / Execute to get the well list for that permit. **Figure F-7** is a preview screen for graphs.

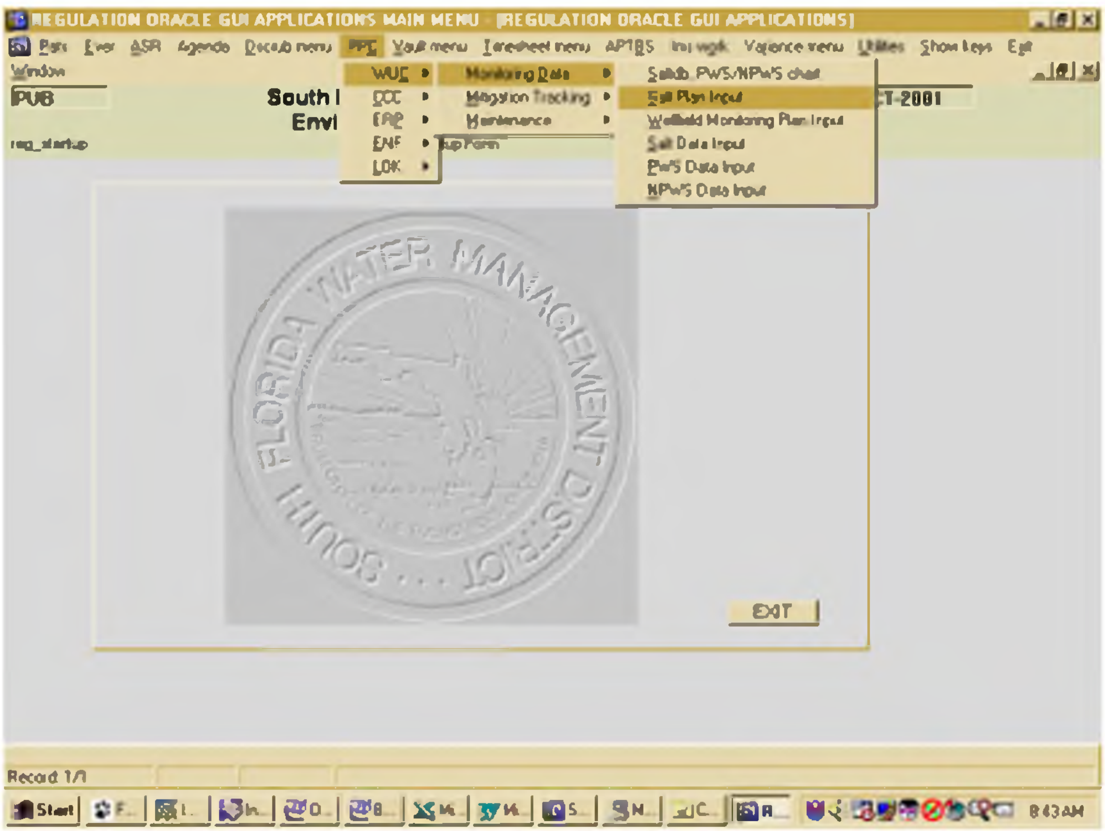


Figure F-5. Accessing the Salt Plan Screen. Select PPC / WUC / Monitoring Data / Salt Plan Input.

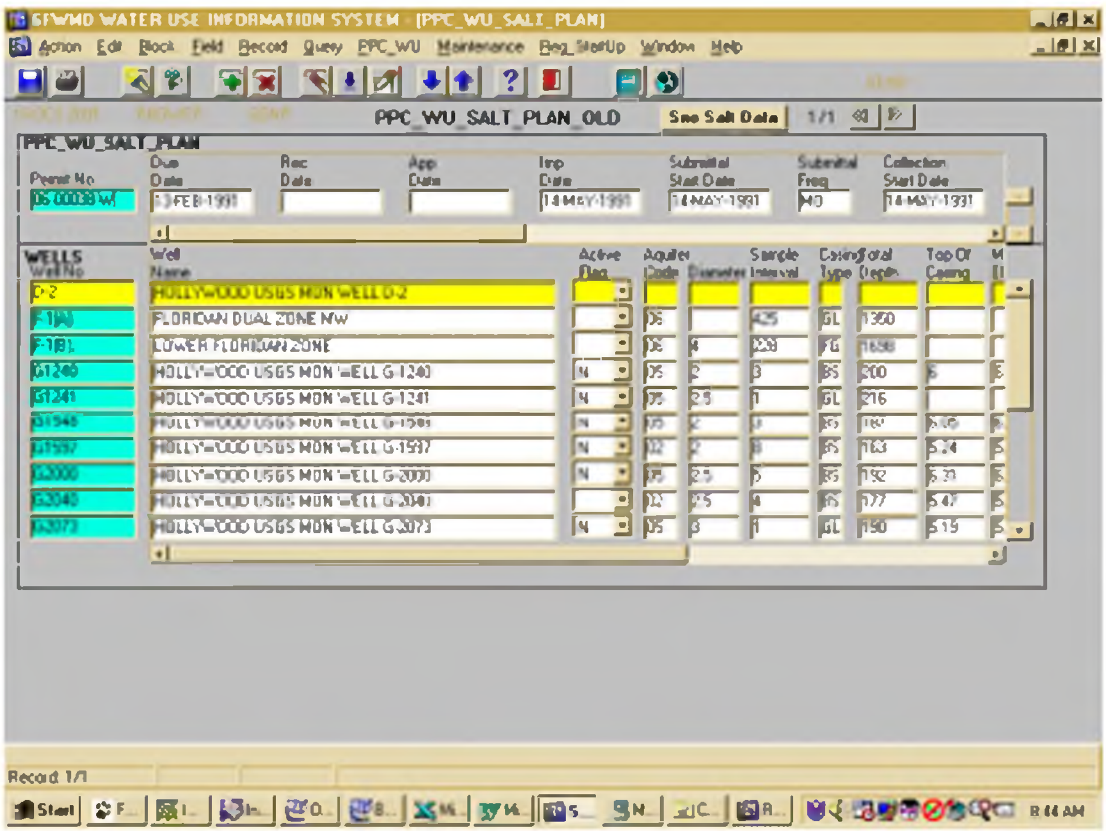


Figure F-6. The Salt Plan Screen. Execute Query (or single-click the flashlight) from a blank field to view all, or enter a selected permit number and execute query.

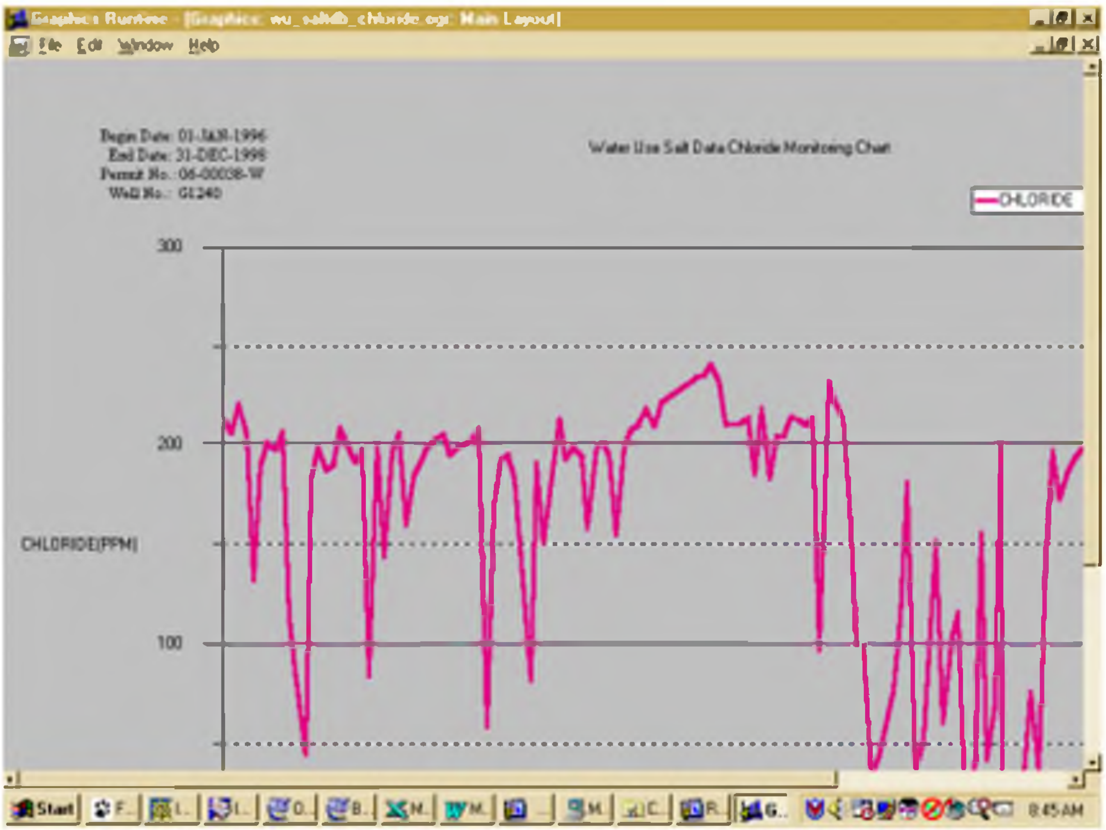


Figure F-7. Preview Screen for Graphs.

Users who are familiar with the query tools in MS Access or Excel, or with PL/SQL, may access the database tables directly (again, be aware this portion of the database is being redesigned by June 2002, these tables will no longer contain current data and may have been eliminated). This approach is helpful if you want to, for example, perform statistical analyses of the data. The tables and associated data fields are as follows:

TABLE: PPC_WU_WM_PWS_DATA (water use data for public water supplies)
PERMIT_NO
WELL_NO
PWS_DATE
RAW_TOTAL_MONTH_PUMPAGE (million gallons per month)
RAW_MAX_DAILY_PUMPAGE (million gallons per day)
TREATED_TOTAL_MONTH_PUMPAGE (million gallons per month)
TREATED_MAX_DAILY_PUMPAGE (million gallons per day)
STATUS

TABLE: PPC_WU_WM_NPWS_DATA (water use data for all uses other than PWS)
PERMIT_NO
WELL_NO
NPWS_DATE
TOTAL_MONTH_PUMPAGE (gallons per month)
FACILITY_TYPE
ENTER_DATE
ENTERED_BY
STATUS

TABLE: PPC_WU_WM_SALT_DATA (chloride, water level and specific conductance data)
PERMIT_NO
WELL_NO
SALT_DATE
WATER_LEVEL (feet; reference not specified)
CHLORIDE (milligrams per liter)
CONDUCTIVITY (microsiemens per centimeter)
SAMPLE_DEPTH
PUMPAGE
TDS (milligrams per liter)
STATUS

APPENDIX G – HANDBOOK OF TABLES

Table1: **Wells to Remove from Network in the LEC**

Well Name	Lat	Long	Reason	Source (as of 12/2000)
Pb-595	265800	800523	Redundant data correlates with Pb-746 93% of time.	Radin, Wilsnack
Pb-694	263628	800303	Poor condition, 50 feet from coast, chlorides not monitored; 84% correlation	Radin, Wilsnack, D. Demo
Pb-880	265440	801028	Redundant, 95% with Pb-875	Radin, Linton
Pb-1590A	264209	801512	Correlates with Pb-1583 (deeper well) 97% of time	Radin, Wilsnack
Pb-1626	263015	800408	Correlates 98% with Pb-1625 and in same aquifer; poor well condition	Radin, Demonstranti
G-2055	261400	800622	Tapedown wells; data not being used for modeling	Giddings
G-2063	261501	800553	Tapedown wells; not used for modeling, poor condition	Giddings

Table 2. **Well Pairs with Partially Redundant Hydrographs to Remain in Network**

Well Name	Screen Depth (feet bis)	Correlation	Comments
Pb-1108 Pb-1630	90 26	85%	Near L-40, recommend keeping both in network.
Pb-1632 Pb-1107	30 105	74%	Near L-40, recommend keeping both in network.
Pb-1525 Pb-1608	20 150	92%	Possible semi-confining layer between screens of two wells. Recommend keeping both in network.
Pb-693 Pb-846	275 160	89%	Possible semi-confining layer between screens of two wells. Recommend keeping both in network.
G-3557 G-1487	15 20	99%	USGS funded wells, not District's. Recommend relaying information to USGS.
G-3557 G-3551	15 13	96%	USGS funded wells, not District's. Recommend relaying information to USGS.
G-3551 G-1487	13 18	90%	USGS funded wells, not District's. Recommend relaying information to USGS.

Table 3. **Palm Beach County Wells Close to Canals – Recommend to Remain in Network**

Well Name	Screen Depth (feet bis)	Aquifer	Canal	POR/Correlation
Pb-715	81	S	C-18	11/88-9/00; 63%
Pb-832	153	S	C-18	11/88-9/00; 50%
Pb-875	24	S	C-18	11/88-9/00; 82%
Pb-1097	160	S	L-40	5/88-9/00; 78%
Pb-1525	22	S	C-18	5/88-9/00; 80%
Pb-1583	160	S	C-51	10/90-10/00; 50%
Pb-1608	150	S	C-18	5/88-9/00; 81%
Pb-1630	30	S	L-40	5/88-9/00; 78%
Pb-1645	25	S	C-51	5/88-10/00; 50%
Pb-1646	90	S	C-51	5/88-10/00; 50%
G-1604	62	B	C-100A	N/A; 84%
G-2443	145	B	C-14	N/A
G-2853	19	S	Hillsboro	10/88-9/99; some
G-3338	100	B	C-111E	2/90-10/00; 82%
G-3339	57	B	C-111E	2/90-10/01; 87%
G-3340	48	B	C-111E	N/A
G-3349	66	B	C-110	N/A
G-3350	83	B	C-110	N/A

S: Surficial Aquifer System
B: Biscayne Aquifer
POR: Period of Record

Table 4: **Destroyed or Lost Wells that Need to be Replaced in the LEC**

Well Name	Lat.	Long.	Reason	Source District Staff
G-2376	260754	802536	This is an important area for ground water modeling.	Giddings
G-2443	261338	801033	This well should be replaced. It is an important area to monitor the Pompano wellfield.	Giddings
G-594	255251	802707	Past records showed an apparent datum error. The well has been resurveyed and should be reactivated.	Wilsnack
G-972	255523	802613	Cannot be located.	Wilsnack
G-976	254760	802436	A new permit for rock-mining destroyed G-976 (DCP well). This well should be replaced with another nearby and stages in the new quarry should be monitored. To provide background information for CERP data.	Hopkins
G-1359	254721	802529	Task force recommends that this well be replaced with lake stage monitoring.	Wilsnack
Pb-900	263535	800850	PB-1621 could be a suitable substitute for Pb-900, but it needs to be upgraded to continuous recorder (as Pb-900 was).	Hopkins
Pb-1153	264027	801350	The original wells were clustered at three points, we recommend that 6 - 10 wells spread evenly (and away from stress points) replace the destroyed wells. Three of the wells could be at the old locations if well restoration is practical. Particular attention should be given to the northwestern, central, and southwestern locations within this area since major CERP improvements are proposed there (i.e., the Wellington area, the Agricultural Reserve, and the Site 1 area).	Giddings
Pb-1577	263256	801333		
Pb-1623	262548	801216		
Pb-1573	262548	801216		
Pb-1574	262548	801216		
Pb-1576	263256	801333	Well could not be found.	Giddings

Table 5. **Destroyed or Lost Wells that Do Not Need to be Replaced**

Well Name	Lat.	Long.	Comment
Pb-618	264659	800351	Destroyed
Pb-795	264659	800351	Destroyed
Pb-835b	264104	800258	Destroyed
Pb-945	262711	800409	Destroyed
Pb-1578	263700	800520	Lost
Pb-1602	263244	800620	Destroyed
Pb-1618	261950	800738	Destroyed
Pb-1637	265027	801002	Destroyed
G-3340	251902	803124	Destroyed
G-3345	252719	802412	Destroyed

Table 6. **Well Repair Needs in LEC**

Well Name	Description of Problem	Repaired In Y2001	Org	Recommend
G-757A	Filled with sand, water levels still accurate		USGS	Low priority repair
G-970	Unidentified obstructions in well		USGS	Repair
G-976	Unidentified obstructions in well		USGS	Repair
G-1221	Filled with sand, water levels still accurate		USGS	Low priority repair
G-2055	Develop well, repair wellhead		SFWMD	Repair
G-3342	Well filled with debris, no cover		SFWMD	Repair
Pb-693	Missing threads for well cover		SFWMD	Repair
Pb-732	Unidentified obstructions in well		USGS	Repair
Pb-935	Unprotected PVC standpipes in depression		SFWMD	Repair
Pb-809	Unidentified obstructions in well		USGS	Repair
Pb-1595	Unprotected PVC standpipes in depression	✓	SFWMD	Repair
Pb-1620	Wellhead below land surface, floods frequently	✓	SFWMD	Repair
Pb-1633	Unprotected, below land surface, run over	✓	SFWMD	Repair
Pb-1634	Cover needed, below land surface, run over	✓	SFWMD	Repair
Pb-1635	Develop well, below land surface, run over	✓	SFWMD	Repair
Pb-1636	Develop well, below land surface, run over	✓	SFWMD	Repair
Pb-1710	Develop well, sounded to 111', should be 211'TD		SFWMD	Develop
Pb-1717	Develop well, sounded to 147', should be 200'TD		SFWMD	Develop
Pb-1768	Bent downhole casing, probes will not lower		SFWMD	Use conductivity probe - keep
Pb-1773	Bent downhole casing, probes will not lower		SFWMD	Use conductivity probe - keep
Pb-1770	Bent downhole casing, probes will not lower		SFWMD	Use conductivity probe - keep

Table 7. **New Monitor Well with Recorders Needs in LEC**

Site Name	# of Wells	Reason	Comments	Source
Site 1 C-11 C-9 WCA-3A Oleta River Ft. Lauderdale	2 1 2 1 1 1	Needed to fill data gap for ground-water modeling and CERP projects.	Suggested locations approximate.	Giddings
Area bounded by L-40, the Hillsboro Canal, C-51, and Fl. Turnpike	6 to 10	Needed to fill data gap for ground-water modeling; will replace 6 destroyed wells and provide background ground water levels for CERP projects.	Includes wells at ACME STA, ACME Impoundment, and Agricultural Reserve.	Adams Giddings
Bird Drive Wetlands	3	Needed to fill data gap for ground-water modeling and CERP projects.	These could be placed in the NW corner, center, and SE corner.	Wilsnack
Pennsuco Wetlands	3 to 4	Needed to fill data gap for ground-water modeling and CERP projects.	One in the north center area of the wetland, one in the center, and one in the south center, and perhaps one to replace destroyed G-594.	Wilsnack
North Miami-Dade between C-4 and Dressels Canal	2	Needed to fill data gap for ground-water modeling.		Wilsnack
North Miami-Dade between Lake Belt and FEC canals	2	Needed to fill data gap for ground-water modeling.		Wilsnack
West and East ENP area	3 to 4	Needed to fill data gap for ground-water modeling.	Should be DCP since western location less accessible.	Wilsnack
Between C-12 and C-13	3 to 4	Needed to fill data gap for ground-water modeling.	Should be DCP since western location less accessible.	Wilsnack
Surface Water Stage Recorders Needed				
WCA 3A – South of I-75	1	Needed to fill data gap		Giddings
Eastern ENP	1	Needed to fill data gap		Wilsnack
Bird Drive Wetland	1	Needed to fill data gap		Wilsnack
Pennsuco Wetland	1	Needed to fill data gap		Wilsnack

ENP: Everglades National Park
WCA: Water Conservation Area

Table 8. **Redundant Wells to be Removed from LWC**

Well Name	Lat	Long	Reason	Source
HE-1028	263509	811703	Redundant with HE-1029	Butler
L-1963	263345	813616	Redundant with L-2186	Bengtsson

Table 9. **Wells to be Repaired/Replaced in Hendry County**

Well	Description of Problem	Repaired in Y2001	Org	Recommend
HE-3	Inactive Hydrograph		SFWMD	Repair
HE-339	Seasonal Flooding	✓	SFWMD	Repair
HE-516	Partially plugged	✓	SFWMD	Repair
HE-556	DCP Damaged		USGS	Repair
HE-620	Casing damaged, also opened to two aquifers		SFWMD	Repair
HE-1042	Possible flooding, inactive	✓	SFWMD	Repair
HE-1043	Possible flooding, inactive	✓	SFWMD	Repair
HE-1075	Seasonal flooding	✓	SFWMD	Repair
HE-1076	Seasonal flooding, inactive	✓	SFWMD	Repair
HE-1077	Seasonal flooding, inactive	✓	SFWMD	Repair
HE-1027	Central Hendry County, well destroyed		SFWMD	Replace
HE-1029	Central Hendry County, well destroyed		SFWMD	Replace
HE-1044	Central Hendry County, well destroyed		SFWMD	Replace
HE-884	Casing twisted		SFWMD	Repair

Table 10. **Wells to be Repaired in Collier County**

Well	Original depth	Casing	Recent Sounding	Other Information	Recommend	Org
C-304	130 ft	125 ft	40 ft	Rocks at 40 ft.	Repair	SFWMD
C-460	66 ft	64 ft	49 ft	Previous sounding was 63 ft.	Repair	SFWMD
C-492	64 ft	60 ft	33 ft	Well has been jetted with only 5 feet added to depth.	Repair	SFWMD
C-1068	200 ft	120 ft	74 ft	Previously jetted.	Repair	SFWMD
C-1070	205 ft	100 ft	50 ft	Previously jetted.	Repair	SFWMD

Table 11. **Wells to be Repaired or Replaced in Lee County**

Well	Description of Problem	Recommend	Org
L-781	Obstructions, original TD 290, CD 82', Rocks at 75'	Replace	USGS
L-1109	Hole collapsed, samples cannot be taken, dropping well as of 3/01	Replace	USGS
L-1110	Obstructions, or loss of borehole integrity	Replace	USGS
L-1113	Obstruction, original TD 230, CD 126', Obstruction at 134'	Replace	USGS
L-1114	Obstructions, or loss of borehole integrity	Replace	USGS
L-1121	Obstructions, or loss of borehole integrity	Replace	USGS
L-2643	Obstructions, or loss of borehole integrity	Replace	USGS
L-2646	Obstruction, original TD 210, CD 170', Obstruction at 166'	Replace	USGS
L-5649	Obstructions, or loss of borehole integrity	Replace	USGS
L-5669	Obstruction, original TD 30, CD 23', Obstruction at 17'	Replace	USGS
L-5723	Open hole interval too long, needs logs	Log	USGS
L-5725	Open hole interval too long, needs logs	Log	USGS
L-5727	Open hole interval too long, needs logs	Log	USGS
L-5747	Obstruction, original TD 105, CD 59', Obstruction at 67'	Replace	USGS

Table 12. **High Priority Wells for Recorder Installation in LWC**

Well	Aquifer	Location	Type
HE-555	Mid-Hawthorn	North Central Hendry County	DCP
HE-851	Water Table	North Central Hendry County	DCP
HE-861	Tamiami	Southeast Hendry County	CR10
C-948	Mid-Hawthorn	Northwest Collier	DCP
C-951	Tamiami	Northwest Collier	DCP
C-953	Water Table	Northwest Collier	DCP
C-SSUtil_WT	Water Table	Southern States Utility, SW Collier	DCP
C-SSUtil_LT	Lower Tamiami	Southern States Utility, SW Collier	DCP
C-TibGolf_WT	Water Table	Tiburon Golf Club, NW Collier County	New well/DCP
C-TibGolf_LT	Lower Tamiami	Tiburon Golf Club, NW Collier County	New well/DCP
C-TibGolf_SS	Sandstone	Tiburon Golf Club, NW Collier County	New well/DCP
C-TibGolf_MH	Mid-Hawthorn	Tiburon Golf Club, NW Collier County	New well/DCP
L-1993	Mid-Hawthorn	Central Lee County	DCP
L-1994	Sandstone	Central Lee County	DCP
L-1995	Water Table	Central Lee County	DCP
L-742	Mid-Hawthorn	South Fort Myers	DCP
L-727	Sandstone	East Lee County, Lehigh	CR10
L-728	Water Table	Central Lee County	CR10
L-735	Mid-Hawthorn	Southwest Lee County, Estero	CR10
L-1968	Sandstone	East Lee County, Lehigh	CR10
L-5649	Sandstone	Southwest Lee County, Estero	CR10
L-5667	Water Table	South Lee County	CR10
L-5668	Sandstone	South Lee County	CR10

Table 13. **New Well Needs in the LWC.**

Well/Type	Location	Recommendation
Sandstone	South Lee County, next to C-1083	New well/DCP
Mid-Hawthorn	South Lee County, next to C-1083	New well/DCP
Water Table	Northwest Collier, Tiburon Golf Club	New well/DCP
Lower Tamiami	Northwest Collier, Tiburon Golf Club	New well/DCP
Sandstone	Northwest Collier, Tiburon Golf Club	New well/DCP
Mid-Hawthorn	Northwest Collier, Tiburon Golf Club	New well/DCP
Sandstone	Southeast Lee County, next to L-2194 and L-2195	New well/DCP
Mid-Hawthorn	Southeast Lee County, next to L-2194 and L-2195	New well/DCP
Mid-Hawthorn	S. Central Lee County, Corkscrew Wellfield, near L-2193	New well/DCP
Lower Tamiami	Hendry County, L-2 Canal	New well/recorder
Mid-Hawthorn	Hendry County, L-2 Canal	New well/recorder
Lower Tamiami	Hendry County, Deer Fence Canal	New well/recorder
Mid-Hawthorn	Hendry County, Deer Fence Canal	New well/recorder
LTA/MHA	Hendry County, L-2 canal	New well/recorder
LTA/MHA	Hendry County, Deer Fence Canal	New well/recorder

Table 14. **Redundant Wells to Remove from UEC Network**

Well Name	Lat	Long	Recommendation	Source
M-1231	265727	801418	Well possibly damaged, data suspect – investigate further	Demonstrani
M-1052	270821	801118	Drop, redundant hydrograph to M-1004	Hopkins, Radin
STL-298	273616	801835	Drop, redundant hydrograph to STL-172	Hopkins, Radin
M-1237	270429	802559	Drop, 88% correlation with M-1263, 0.5 miles apart	Hopkins, Radin
M-1039	265821	800527	Drop, redundant with M-1024	Hopkins, Radin
STL-295	272610	802819	Drop, 98% correlation with PG-15E, 600 feet apart	Hopkins, Radin
M-1248	271219	802005	Drop, redundant to S-97-H, 96% correlation	Hopkins, Radin

Table 15. **Wells to Repair/Replace in UEC**

Well Name	Description of Problem	Recommend	Org
M-1070	JDSP well on high ridge, well buried repeatedly. Develop, repair, and secure site.	Repair	SFWMD
M-1095	On coastal ridge; replace well, destroyed in 1995.	Replace	SFWMD
M-1247	On C-23 levee, was destroyed by vehicular traffic	Replace	SFWMD
STL-175	Sand filled to 50 feet bls	Repair	SFWMD
STL-176	Sand filled to 26 feet bls	Repair	SFWMD
STL-172	Unidentified obstruction at 26 feet bls	Repair	SFWMD
STL-213	Unidentified obstruction at 26 feet bls	Repair	SFWMD
STL-313	Unidentified obstruction at 26 feet bls	Repair	SFWMD

Table 16. **Priority Wells to Automate with Recorder in UEC**

Well Name	Comments	Location
M-1086 M-1088	Shallow Well Deep Well	Dupuis Reserve
M-1249 M-1250	Shallow Well Deep Well	Osceola Plains
M-1276 M-1277	Deep Well Shallow Well	Citrus Area
M-1044 M-1258	Deep Well Shallow Well	Coastal Ridge – Site 1
M-1071 M-1072	Deep Well Shallow Well	Coastal Ridge – Site 2

Table 17**. Summary of Ground Water Monitoring Network Evaluation**

Planning Area	Priority Recorders	Remove from Network	Repairs	New Wells	Rainfall Gauges	Surface Water Recorders
LEC	49	7	18	37	0	4
LWC	23	2	16	15	0	0
UEC	10	6	6	2	3	0
Total	82	15	40	54	3	4