CENTRAL FLORIDA WATER INITIATIVE (CFWI)

REGIONAL MONITORING PROGRAM – SUMMARY REPORT

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1. Introduction

Among the guiding principles of the Central Florida Water Initiative (CFWI) is the development of "*strategies to meet water demands that are in excess of the sustainable yield of existing traditional groundwater sources. Strategies should include optimizing the use of existing groundwater sources, implementing demand management, and identifying alternative water supplies that can be permitted and will be implemented as demands approach the sustainable yield of existing sources.*" Therefore, the CFWI process created the Data, Monitoring, and Investigations Team (DMIT or Team) to address this principle.

2. DMIT Purpose and Objectives

As stated in the CFWI Guidance Document, the primary goals of the DMIT are to, "*ensure that available hydrologic, environmental, and other pertinent data collected throughout the region are identified, inventoried, and accessible to support the CFWI technical initiatives and CFWI regulatory activities. Using the inventory of existing data collection activities, the team will collaborate with the other technical initiative teams to report on options for future regional monitoring activities. The team may also be tasked with conducting supplemental investigations or data analysis as necessary, and with retaining an inventory of data collected by the other CFWI Technical Initiative Teams.*" These goals have been broken down into five specific objectives (or tasks), also outlined in the CFWI Guidance document:

- Standard data inventory sheet, Task D1
- Intra-and inter-agency investigation of other existing data, Task D2
- Inventory development, Task D3
- Establish minimum standards for data collection, Task D4
- Report options for regional monitoring, Task D5

Upon completion of these tasks, the DMIT will have both a set of minimum standards for the quality of data collection conducted across the CFWI and a plan for a regional monitoring program that will support the overall goals of the CFWI. This summary document reports options and considerations for future regional monitoring activities along with supporting information used in preparation of future monitoring assessments.

Guidance on the DMIT products was provided by both the Management Oversight Committee (MOC) and the Steering Committee (SC) and final acceptance of the DMIT efforts were accepted by the SC before posting to the CFWI website: www.cfwiwater.com.

3. Existing Monitoring Data Inventory

3.1 Description of the Inventory

The first step in achieving the DMIT goal of developing this report concerning regional monitoring was to develop a single inventory of available and accessible monitoring data within the identified CFWI area. The intent was not to collect and retain monitoring data, but rather to identify and catalog existing metadata for monitoring stations and provide a link that would point users to the data source. For this exercise, the available and accessible data sources were gathered from three water management districts (WMDs) including the St. Johns River Water Management District (SJRWMD), South Florida Water Management District (SFWMD), and Southwest Florida Water Management District (SWFWMD). Sources included resource data, WMD cost-share data [e.g. United States Geological Survey (USGS)-collected data), and consumptive use/water use permittee data.

The quality of the data included in the inventory was reviewed only to assure that the site coordinates are accurate, and to filter sites from the inventory where insufficient information was available to deem it a useful site. It was assumed during the development of this inventory that the data steward responsible for the housing of the recorded data has provided the appropriate quality assurance/quality control (QA/QC) for each site and associated data collection activities. In addition, an effort was made to include only those sites where data has been, or is currently, collected in a manner that meets minimum standards (see CFWI *DMIT Minimum Standards for Data Collection, January 31, 2014*).

To ensure that data across the CFWI could be easily queried, a uniform inventory datasheet (CFWI Task D1) was developed and is shown in Attachment 1. Site location information, type of data collected, and other pertinent data features are included in a single electronic format and incorporated into a database that could be imported into a Geographic Information System (GIS) interface. Once the standard inventory datasheet was developed and agreed upon, a significant amount of intra- and inter- agency coordination was required to ensure that all reasonably available data were included in the inventory (CFWI Task D2). WMD staff collaborated with utility representatives to make sure the inventory was as complete and accurate as possible for CFWI purposes. This task required collaboration between the three WMDs because of varying field nomenclature and differences in database structure. In addition, challenges had to be overcome to catalog other governmental agency (such as the USGS) and permittee monitoring data into the same inventory. These challenges confirmed the need to document the processes for compiling the data locations for future inventory updates and are addressed in the following sections. In some instances the historical water level or other data associated with the inventoried points were not readily available for use in other CFWI technical team work products. Where these occurrences were identified, the Team reports options to yield improved availability of the data.

The DMIT inventory included the following types of metadata for active and inactive monitoring locations:

- Station category (groundwater, surface water, wetland or meteorological)
- Station type (lake, river, stream, ditch, creek, wetland, sinkhole, spring, well)
- Data category (water level, water quality, rainfall, evapotranspiration, soil and vegetation, or flow)
- Monitoring method (monitoring well, piezometer, staff gage, stilling well, rain gage or vegetative assessment)
- Available data period of record and frequency of data collection
- Stations location/coordinates
- Data collection status – active or inactive

Active stations are defined as sites that were part of a continuing effort to collect monitoring data by either a WMD or a consumptive use/water use permittee at the time of inventory development. Stations listed as "inactive" represent sites where monitoring has been discontinued or where isolated/discrete samples were collected in the past. The user of the inventory will need to investigate site locations further based on the individual user's purpose to determine the adequacy of the data set. The inventory also includes a limited number of "proposed stations" that are required to be installed under a water user's permit.

The current version of the inventory contains 2837 unique records of which 2104 are considered still active. The remaining locations are either inactive (650) or proposed (83). The inventory of active stations contains 1575 groundwater, 968 surface water, 115 meteorological and 179 wetland monitoring records. Each monitoring station in the inventory may contain multiple records with each representing the different data types collects at the station.

The end goal of the data inventory is to allow a user to find monitoring locations within the CFWI that contains site specific monitoring details for a particular area. The data inventory is currently posted on the publicly accessible server www.CFWIwater.com in a user friendly Google Earth format. The data inventory does not contain actual monitoring data. Hyperlinks provided in the inventory direct the user to the respective WMD where the user may download data directly.

3.2 Data Redundancy

The WMDs, USGS, local governments and water use permittees are the primary sources of information about stressors acting on surface and groundwater (e.g. rivers, lakes, wetlands, and aquifers). These established monitoring networks provide geologic and hydrologic data during well construction and provide the long-term groundwater level and quality monitoring data collection needed for resource assessments. In addition, the resource monitoring data and subsequent assessments are essential for the development of legislatively mandated water supply plans, are used as back-up for setting minimum flows and levels, and provide a foundation for regulatory evaluations on water use.

The DMIT Inventory was examined to assess and report on whether redundant or unnecessary monitoring stations existed for a specific data category. As part of this review, a GIS proximity spatial analysis was performed as a screening tool to identify where well spacing might be a factor in monitoring redundancy. To identify areas where the proximity of sites might warrant a review, an ArcGIS intersect tool was utilized to search a radius of 500 feet for the surficial aquifer (SA) and 2640 feet for the Upper Floridan aquifer (UFA) Distances, also referred to as monitoring proximity, were used for initial evaluation purposes and reflect professional judgment and similarity to previously completed studies. Additional factors considered in regards to alternative distances included various site conditions such as topography, geologic complexity, groundwater withdrawal points, recharge areas, and other considerations.

The initial screening analysis revealed potentially redundant monitoring sites located in SJRWMD and SWFWMD. Specifically, the initial analysis indicated potentially redundant SA water level monitoring wells in western Seminole County and three areas in Polk County. The initial analysis also revealed potentially redundant UFA water level monitoring wells in western Seminole County and two areas of Polk County. While these areas may appear to have redundant monitoring, it is important to note that monitoring proximity is only one factor in evaluating redundancy and assessments of individual locations are a necessary second step to determine potential duplicative monitoring locations. Based upon the screening analysis performed and subsequent review on the shortlisted sites, no potential data redundancies were identified in SFWMD. Each site identified as potentially redundant was investigated in more detail to report whether these truly have redundant data collection. The results of this additional investigation are described in the next section. The DMIT found to report there is little, if any, redundancy in the current local and regional monitoring in the CFWI.

Moreover, no potential redundancies in meteorological, water quality or Lower Floridan well networks were identified as part of the inventory review either. There is a lack of Lower Floridan aquifer (LFA) wells for both water levels and water quality in the inventory, in particular when considering that several LFA water supply options were identified in the CFWI Regional Water Supply Plan (RWSP). The Team found there are several WMD well cluster sites with wells installed within the SA, UFA, and LFA that provide data on the head gradients in the hydrogeologic system; however, the number of well cluster sites are limited in many regions of the CFWI.

Options to consider when reviewing sites where redundant monitoring may be occurring include: (1) retaining each of these sites as priority areas for future review by DMIT, WMDs, or permittees to omit redundancy; (2) identifying possibilities to share monitoring practices between entities which could streamline monitoring in these regions; (3) perform similar redundancy evaluations periodically to ensure future redundancy is minimized, and (4) coordination and sharing of monitoring plans among monitoring entities.

3.2.1 Data Redundancy in the Surficial Aquifer

Several of the monitoring locations identified in the SA are in areas of high urbanization or are near a number of Floridan groundwater withdrawals points. Both of these factors complicate the assessment of existing field conditions and support data collection at a higher density because they can cloud conclusion on the cause of aquifer condition. The team investigation revealed information concerning who is collecting these data, why it is collected, and efforts to consolidate monitoring. In several cases, the current data are collected by water use permittees as required under permit conditions, and are intended to provide water level and quality data in and near well fields at the resolution necessary to identify potential impacts to local and regional wetlands and surface water bodies. In these cases, before a WMD requires a permittee to install and monitor new or additional stations, staff considers existing WMD, USGS, local government, and other existing consumptive use permit/water use permit (CUP/WUP) stations in order to minimize the burden to the permittee. In addition, permittees often enter into agreements with other permittees to obtain data or share responsibility for monitoring in an effort to reduce burden and the potential for redundancy. For a permit renewal, compliance report, or permit modification, WMD staff evaluate data collected at existing monitoring stations and make the determination of the need for continued monitoring or identify a single entity who will be responsible for reporting the data from each site.

For example, one area in Seminole County and three areas of Polk County appear to have redundant data collection within the SA based on a review of the proximity spatial analysis alone. All of these areas have permitted groundwater withdrawals near wetlands and/or surface water bodies. However, due to the variability in topography, areas of recharge, and the density of withdrawal facilities in the Seminole County, these locations are not considered to be redundant. Also, due to the particularly sensitive nature of the hydrology in the region of the three Polk County areas, it is more critical to collect additional water level information to better assess affects in an area where wetland behavior is less predictable.

In addition to the proximity spatial analysis, the Team also identified areas where duplication may have occurred. Two additional areas reviewed for possible data redundancy are located in the central portion of the Green Swamp, located in southern Lake County, and the Alston Tract, located in the northwest portion of Polk County. Monitoring in these areas of wetlands, considered unimpacted by the effects of pumping, is related to a unique purpose of collecting data for control wetland sites. The high density of monitoring at these control wetland sites assists in the evaluation of the connection between the UFA and wetland systems, and provides one of the few areas where natural variability in wetland hydrology on a temporal and spatial basis can be evaluated in the absence of major changes in UFA heads due to groundwater withdrawals. The Team concluded that these monitoring efforts are not redundant.

Other possible areas of redundant data in the SA were identified along the central and eastern portion of the Lake Wales ridge. Many of the SA monitoring stations in these areas are associated with lakes with set Minimum Flows and Levels. In the DMIT's professional judgment, interaction of groundwater withdrawals and lake features is best monitored with a combination of a staff gage, at least one SA monitoring well, and a UFA monitoring well at each MFL lake, though this may not always be practical. Many of the lakes in this region do not have a minimum of one monitoring device for the lake or SA in the immediate vicinity of the lake, nor is there an UFA monitoring device. Therefore, the DMIT concluded that there are no redundant data sites within this area.

3.2.2. Data Redundancy in the Upper Floridan Aquifer

The proximity spatial analysis also identified some areas where the UFA is being densely monitored and, as with the potentially redundant SA sites, most of these were located in Seminole and Polk Counties. However, some of the UFA wells identified as potentially redundant due to their proximity are wells used to monitor different, discrete permeable zones of the UFA, such as the upper permeable zone and the Avon Park Permeable Zone (APPZ) in the lower part of the UFA. In addition, the density of UFA wells is often associated with a large number of UFA withdrawal points near many of the sites identified. Wellfield monitoring by permittees and regional monitoring by the WMDs provide data on how head gradients change in the areas of immediate influence of wellfield withdrawals and in the areas away from the wellfields.

Areas of central Seminole County that were identified by the proximity spatial analysis were reviewed in more detail for data redundancy within the UFA. The densely monitored areas were found to be monitoring different, discrete aquifer intervals in areas of high groundwater withdrawals; therefore, the DMIT reports these monitoring sites are not redundant. Areas of central and eastern Polk County identified by the proximity analysis were also reviewed for data redundancy within the UFA. These areas have a high variability due to karst features and are densely monitored to establish the hydraulic connection between the UFA and the surficial aquifer near groundwater withdrawals. Additionally, in the Southern Water Use Caution Area (SWUCA) of the SWFWMD, the current density of UFA monitoring is essential for the overall efforts to monitor aquifer recovery in the upper Peace River basin as part of the SWUCA recovery strategy.

The above explanations of higher density areas lead the DMIT to report there is little, if any, redundancy in the current local and regional monitoring in the CFWI. This is not to say that there are not opportunities to remove certain wells within the existing inventory and improve data collection at the same time. For example, it may be possible to install nested well sites that collect water level and water quality information at multiple horizons, thereby affording the opportunity to remove nearby sites that measure levels in a single or partially penetrating horizon. While there may be some cases where a reduction in the number of wells is prudent, there are a number of unknown factors that need to be investigated. Among these factors are:

- Future funding commitments of the monitoring agency
- Changing data needs as a region
- Continued access to the property
- Regional configuration of monitoring networks
- Improvements in technology

Prior to an assessment regarding any site removal it would be advantageous to consider these factors to assure the selected site and those surrounding it are expected to remain in place. Understanding land use changes and development plans can prevent removal of a site that is near a redundant monitoring location already planned for removal.

3.3 Additional Data Collection Needs

A critical aspect of assessing regional monitoring involves identifying areas of the CFWI where the amount of resource information collected could be expanded. The purpose of identifying these areas is to provide WMDs and CFWI Solutions Phase teams guidance for improving regional resource monitoring programs, especially where new water use projects are planned.

The DMIT reports that additional monitoring of environmental conditions would improve the understanding of the inter-workings between various hydrologic systems. However, time and financial issues are also relevant considerations. Utilizing the inventory of existing data collection sites compiled by the team, coupled with resources developed by the other CFWI technical teams, the DMIT developed a process to identify areas where data collection improvements would most improve the understanding of the relationship between hydrologic and environmentally sensitive systems. This exercise resulted in the development of a series of three maps, one for each of the major aquifers - the SA, the UFA, and the LFA – reporting where additional monitoring would be most beneficial. These maps are included as Figures 1, 2, and 3.

The process used to assess areas where monitoring improvements could be made involved utilizing ArcGIS to review the entire CFWI region in order to identify areas of drawdown in the SA where little monitoring is occurring. One option for a monitoring program involves extremely dense monitoring of each hydrologic feature (e.g. in each aquifer "layer"). Another option, geared toward near-term issues, is to "key in" on those regions that would yield the greatest benefit from more immediate, focused monitoring efforts. To gather information regarding this option, DMIT first identified areas on a regional scale (miles) and then additional detailed information was considered to help focus in on a reduced number of areas for monitoring improvements to better define the shape of the areas. Areas where data collection appeared to be limited were then identified. It is important to note that the regions identified are very generalized in nature and are not intended to limit site investigations and data collection.

DMIT also met with the other CFWI technical teams to discuss their thoughts on priority areas for future data collection and limitations in collecting this data. This exercise was extremely beneficial because it enabled DMIT to report further on where the existence of additional data could have significantly improved the CFWI work products produced by each of those teams. The findings from these discussions include consideration of the following topics:

Surficial Aquifer and Wetland Considerations

- CFWI Hydrologic Assessment Team (HAT) East Central Florida Transient (ECFT) groundwater flow model drawdown results for the SA, using the 2035 scenario identified areas of greatest drawdown should be considered for monitoring.
- The following optional areas for monitoring should be considered:
  - Reference monitoring in areas of little drawdown
  - Areas of greatest drawdown, as identified using 2035 scenario levels
  - Areas of greatest difference between ECFT model targets and observed water
  - Areas identified by the Environmental Measures Team (EMT) as Class I wetlands likely to change from not-stressed to stressed in 2035 and occurring in the greatest density

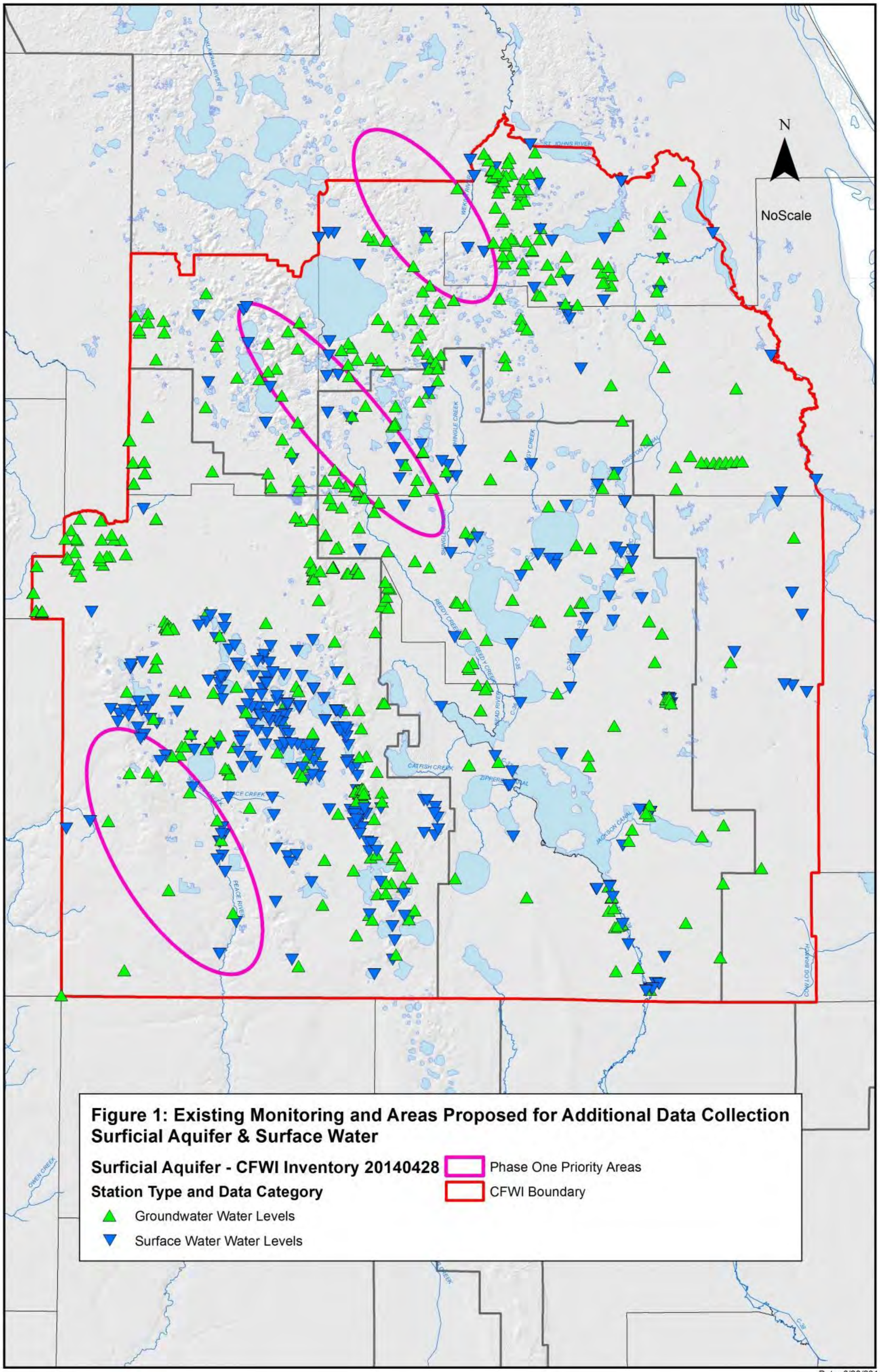

Figure 1: Existing Monitoring and Areas Proposed for Additional Data Collection Surficial Aquifer & Surface Water

Date: 6/20/2014

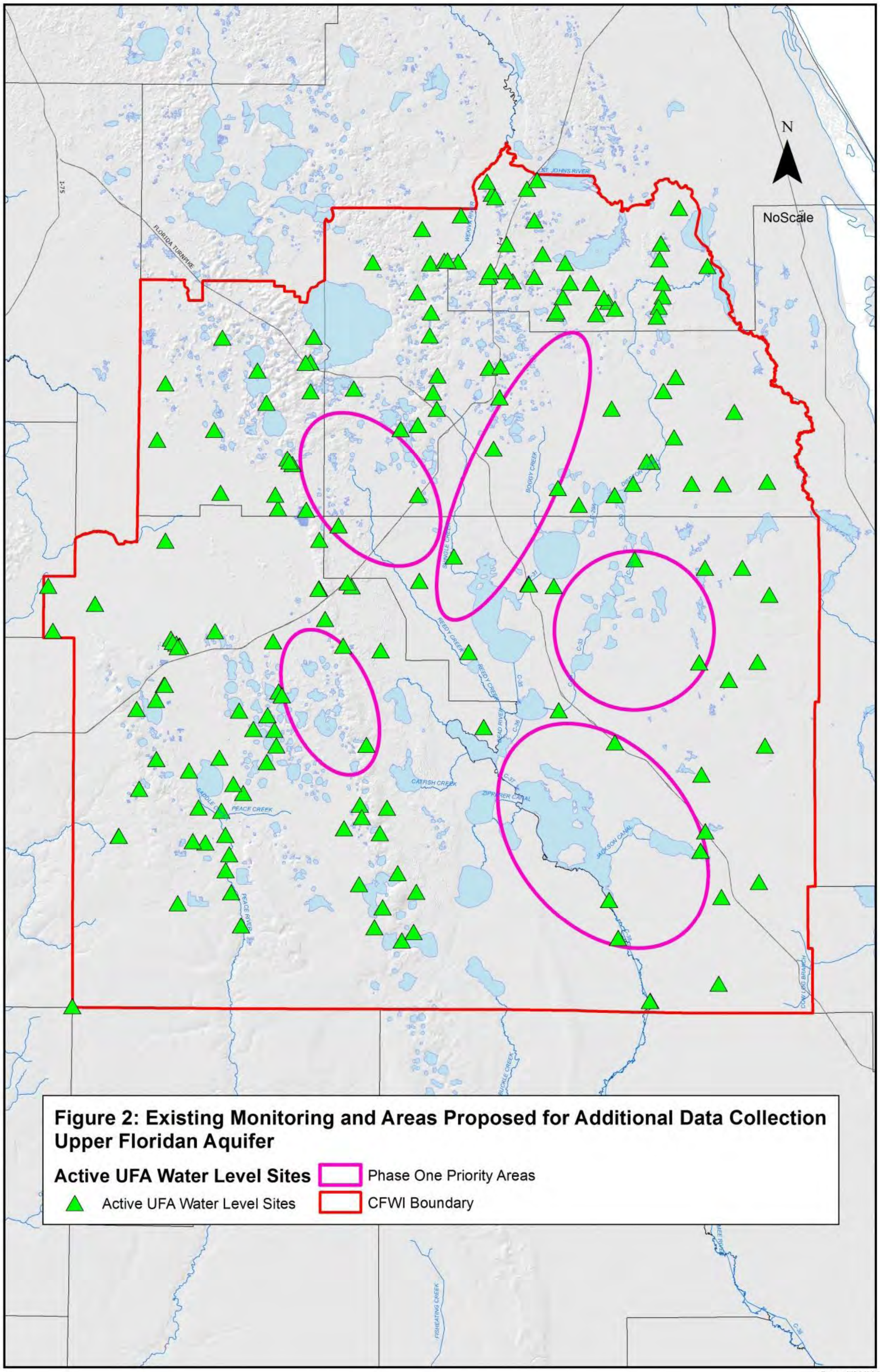

Figure 2: Existing Monitoring and Areas Proposed for Additional Data Collection Upper Floridan Aquifer

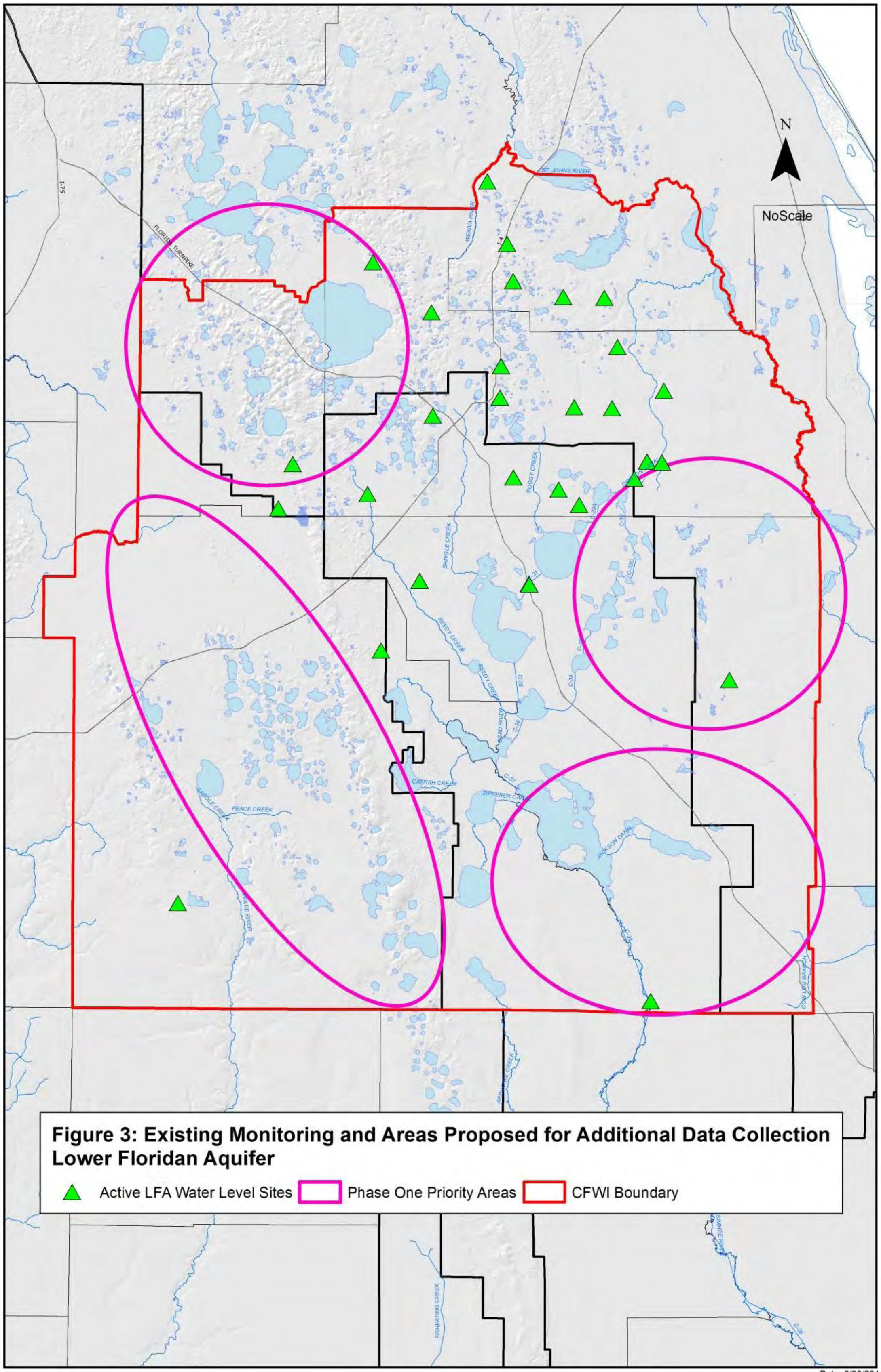

Figure 3: Existing Monitoring and Areas Proposed for Additional Data Collection Lower Floridan Aquifer

  - Areas identified by EMT Class II wetlands that would create a larger set of Class I sites with hydrologic data
- The following "cross check" considerations are reported for use prior to finalizing selection of future monitoring sites:
  - Groundwater Availability Team (GAT) areas of greatest susceptibility to water level change, as identified by the GAT should be "cross checked" with areas preliminarily selected for monitoring as they were found to occur in similar areas of the CFWI.
  - Existing and future water bodies with MFLs and no monitoring should be included in areas preliminarily selected for monitoring.
  - DMIT-developed maps showing areas of greatest data collection density are available to be reviewed to avoid redundant monitoring.

Upper Floridan Aquifer Considerations

- Linking additional monitoring with:
  - Areas of greatest projected drawdown, as identified in the CFWI HAT groundwater flow model drawdown results for the SA, using 2035 scenario.
  - CFWI HAT developed map showing predicted 2035 water use change, specifically those regions with an increase in water use.
  - Areas of greatest difference between ECFT model targets and 2005 model-estimated water levels.
  - GAT developed map showing areas of greatest susceptibility to water level change.
- DMIT developed maps showing areas of greatest data collection density can be utilized for the purpose of avoiding redundant monitoring.

Lower Floridan Aquifer Considerations

- Linking additional monitoring with CFWI HAT 2035 predicted potable water use maps such that regions with anticipated increase in water use also have additional monitoring.
- Areas of greatest difference between ECFT model targets and observed water levels were considered in areas prioritized for monitoring.
- Total dissolved solids contour maps developed for the RWSP were utilized to identify areas of the highest water quality transition for prioritized monitoring.

The technical teams' more general findings include the following:

- There are a limited number of surface water bodies (lake and wetland) sites that include adequate hydrologic water level data (six years or more).
- There are existing and proposed MFL lake locations that do not have SA or UFA monitor wells in proximity to the lake. Nesting monitoring devices should be considered where practical at all existing and proposed MFLs sites.

- Springs flow data appears inadequate in some areas of the model domain and would benefit from being preserved and/or improved to support future groundwater flow model calibrations.
- Some groundwater flow model targets have greater than 5-foot differences from their field-measured data. Data collection for these targets would benefit from further evaluation to improve future model updates.
- The statistical analysis performed as part of the EMT measuring stick evaluation looked at various types of wetland systems across the region. The EMT study identified certain CFWI wetland types that could be considered for better representation via additional hydrologic monitoring efforts. Table 1 compares the total percentage of coverage for a given wetland hydroclass type, as classified by the EMT in 2012, across the CFWI region compared to the number of those wetland hydroclass types that have active monitoring stations found in the DMIT inventory. EMT concludes that isolated wetlands (shown in bold text in Table 1) are believed to be the most hydrologically sensitive wetland type (EMT, 2013). Though not always feasible or practical for regulatory purposes, from a regional monitoring perspective, the DMIT findings indicate the following, three wetland hydroclasses are currently under-represented in monitoring data: 1A Depressional Mesic (Plains), 1B Depressional Xeric (Ridge), especially along the Lake Wales Ridge; and 2A-M Large Isolated (Plains). A factor to consider, going forward and as to these wetland hydroclasses types, is the possibility of linking the regional monitoring program to areas of greatest predicted stress.

Table 1 – Summary of Wetland Hydroclass Coverage

General Physiographic Type	Wetland Hydroclass	Hydroclass Coverage in CFWI (acres)	Hydroclass Coverage in CFWI (percentage)	No. of Active DMIT Monitoring Sites per Hydroclass	No. of Individual Wetlands in CFWI	Percentage of Individual Wetlands Monitored in CFWI
Plains	1A Depressional Mesic	77,986	7%	39	24,423	0.16%
	1E Flatland Lakes	25,407	2%	2	475	0.42%
	2A-M Large Isolated	63,607	6%	20	4,918	0.41%
Ridges	1B Depressional Xeric	8,727	1%	7	3,029	0.23%
	1F Xeric Lakes	90,839	8%	22	1,417	1.55%
	2A-X Isolated Ridges	19,605	2%	15	1,338	1.12%
Other	1C Seepage	22,451	2%	2	771	0.26%
	1D Flats Wetlands	13,680	1%	N/A	390	N/A
	2D Strands/Sloughs	279,646	25%	31	6,415	0.48%
	2F Floodplain	300,665	27%	1	4,094	0.02%
	2G Floodplain Lakes	160,732	14%	N/A	106	N/A
	Not Classified	45,424	4%	11	12,582	0.09%
	TOTAL	1,108,769	100%	150	59,958	-

The DMIT reports that three areas, including the portions of Polk County, south Lake County into north Orange County and the western portion of Seminole County circle in Figure 1 could benefit from additional monitoring of the SA. The DMIT also finds that areas in eastern Polk, Osceola County and southern Orange County could benefit from additional monitoring of the UFA (Figure 2).

In the Lower Floridan aquifer, DMIT reports that the availability of information for the Lower Floridan aquifer within the CFWI is limited and areas that could benefit from additional monitoring include two locations in Osceola County, one in central Polk County, and one in southern Lake and western Orange County (Figure 3). Again, these resulting areas of data collection expansion/improvements are general and qualitative in nature, and should be used with much more specific, localized information before implementing a regional monitoring program. A more detailed report concerning a regional monitoring program follows.

Discussions with the other technical teams indicated that with the advent of Doppler radar information, current levels of climatic data gathering appeared to be adequate for their current investigative needs. Other types of data collection such as soil, vegetative sampling and water quality improvements are discussed under other sections of the report.

4. Regional Resource Monitoring Program Findings

4.1 Specific Findings

The availability of funding for the installation of monitoring stations and annual funds required to continue the monitoring of these stations are important factors in considering additions to the monitoring network. Therefore, it is important that future data collection be as cost effective as possible. To that end, options for future monitoring are identified and consider: (1) the information in Section 3 and (2) input from MFLRT, EMT, and HAT. These options do not consider the areas of monitoring improvement shown in Figures 1, 2, and 3. The technical teams' input includes insight regarding the specific needs for improving the work products developed by their respective teams. In addition, these options consider each WMD's evaluation of the need for data collection near sensitive water bodies and aquifers that have been incorporated into rule, such as MFL Recovery, or through permit issuance. A list of these sites, including information on the location and aquifer system to be monitored, can be found in Attachment 2, and contain specific sites falling under the following categories:

- Sites Currently Identified by WMDs: monitoring locations that are currently budgeted for and those possible future monitoring locations that support regional monitoring activities by the SJRWMD, SFMWD, and SWFWMD are included in Attachment 2. Based on consideration of the information assessed, DMIT reports the monitoring needs are most critical for: (1) improved wetland monitoring in the four-corners area of Lake, Polk, Orange and Osceola Counties and (2) new UFA and LFA monitoring sites in central and eastern Osceola County. While currently no specific WMD plans for construction of additional wetland wells exist, there are a number of existing monitoring sites within these areas that may allow for the installation of new wells or other data improvements. DMIT also identified a number of UFA and LFA sites exist where consideration should be given to create additional nested sites at existing monitoring locations.

- MFLs Lakes: existing and proposed MFL lakes that have no monitoring or limited monitoring in the CFWI are identified in Attachment 2. This includes sites where SA or UFA monitoring may exist, but the sites do not contain monitoring of both aquifers. In some cases, neither SA nor UFA are currently being monitored.
- EMT Wetland Sites: the EMT CFWI Groundwater Availability phase concluded with a statistical risk assessment of stress status change for 44 Class I wetland sites. Class I sites were those that had both an adequate hydrologic period of record and adequate field assessment data, including a known wetland edge elevation, to complete the analysis. However, there are some sites that could be classified as Class I with better monitoring or supplemental field information. General factors for improving the EMT data set are included above in Section 3.3. Sites that could become Class I sites with improved monitoring are included in Attachment 2.
- Springs: as part of the CFWI Groundwater Availability Phase, the HAT found that better springs flow data could significantly improve model calibration. Springs with historically intermittent data that would result in improved model calibration with improved, or sustained, data collection are listed in Attachment 2.
- Permittee Monitoring: A number of monitoring locations have been constructed and are maintained by holders of Consumptive Use Permits. The majority of the monitoring sites identified are required by the special conditions under which the permits were issued. In addition to existing monitoring sites, future monitoring sites are required to be installed pursuant to permit conditions. Specifically, over 80 sites, including water level, wetland and meteorological stations, have been identified for future monitoring. The timing for the construction of these sites may be tied to the operation production facilities so the timing for the installation is not definite. The Districts typically review these sites and the schedules for installation as a routine action of future monitoring work.

4.2 General Findings

In addition to those geographic areas presented in Figure 3 through Figure 5 and Attachment 2 showing limited and redundant data collection, DMIT reports a set of options for monitoring program improvements to achieve an efficient and effective program. Many times, monitoring sites are established with specific goals and often did not consider regional, integrated, or alternative purposes. By taking a bigger-picture look at the development of any monitoring program, resources can be shared and costs lowered. The following list of general options and considerations that DMIT suggests should be considered when developing future monitoring programs:

- Options and considerations regarding future monitoring site selection:

  #1. Consider existing data collection: The DMIT inventory of existing data collection sites is a good source of information to be consulted prior to any implementation or expansion of a monitoring program. A detailed evaluation of the types of data currently collected is a valued tool for comparison to the types of data collection activities proposed in order to find the most efficient and effective locations and methods.

#2. Utilize a statistical design to detect water level change relationships: New monitoring sites should be designed or selected in accordance with a statistical design that will facilitate detection of water level changes, either toward impact or toward improvement. Such design is beyond the scope of the DMIT but may affect the location and types of monitoring devices included in the monitoring program and/or in any control sites needed as part of the program.

#3. Collaborate with other agencies and entities: For every planned monitoring program, there are benfits in exploring opportunities to collaborate with other agencies, such as the Florida Department of Environmental Protection (FDEP), the Florida Geological Survey (FGS), and any other agency or entity that may be conducting monitoring activities or well construction in the area of interest. Generally, DMIT finds that cost sharing on these projects serve multiple objectives.

#4. Cluster wells: When developing new or re-developing older monitoring sites well clustering, particularly in light of access concerns, typically lowers costs.

#5. Use public lands: Given public access is available on public lands and cost reduction may be possible, DMIT suggests consideration of establishing monitoring sites on public lands.

#6. Monitor MFLs lakes: DMIT suggests monitoring programs at all MFLs lakes consider including surface water, SA and UFA where practical, and rainfall measurements.

#7. Conduct a redundancy evaluation: As new sites are added to the inventory, consideration should be given to conducting a periodic evaluation of potential site redundancy. Previous sections discussed areas of potential redundancy, and listed a number of sites for re-evaluation consideration at appropriate points in the future when monitoring practices are under review (such as permit renewals). These re-evaluations may require the collaboration of multiple agencies which may not always be practical, so this should be done on case-by-case basis.

#8. Use DMIT Minimum Standards for Data Collection: DMIT suggests consideration be given to the standards specified in the DMIT Minimum Standards for Data Collection document when new monitoring sites are established.

#9. Improve model calibration criteria: DMIT found that consideration of model calibration criteria, such as location, discrete monitoring zone, and period of record, when planning new monitoring sites is important.

#10. Re-survey wells: DMIT identified where investigation and consideration of re-surveying those wells identified by the HAT as having the poorest (having 5 feet or more of difference) model calibration resulting from poor field conditions would yield benefits.

#11. Characterize leakance: CFWI HAT identified the collection of hydrologic/hydrogeologic information at new and existing monitoring sites as important to improve future model upgrades. Amongst the main concerns identified by HAT is the ability to characterize leakance between the SA and UFA, and the UFA and the LFA.

#12. Maintain spring flow and water quality data: DMIT found that consideration of continued collection of springflow and water quality data where it currently exists, and the expansion of such data collection would provide benefits in future assessment activities. Spring flow measurements for some springs have a limited number of measurements for the purpose of model calibration. Where possible, consideration of increasing the frequency of spring flow measurement for these springs or maintaining existing monitoring would yield benefits. Specific sites for consideration of these options are named in Attachment 2.

#13: Utilize “wetland edge”:

- DMIT found that consideration of surveying or otherwise identifying the wetland edge; as defined by EMT and Chapter 62-340, F.A.C.; would yield additional lake and wetland sites where hydrologic data is currently collected since this point is used in the evaluation of wetland stress.
- DMIT suggests consideration of hydrologic monitoring of Mesic/Plains-type wetland sites with known wetland edge, or easily-determinable wetland edge because those can easily become EMT Class I wetlands.

#14: Expand wetland monitoring:

- Expanding hydrologic monitoring of Xeric/Ridge-type wetland sites because these sites can be the most informative for water level behavior purposes.
- Consideration of continuing and adding monitoring of isolated wetland types, including monitoring of soils, vegetation and water levels is important in the wetland investigations.
- Depressional mesic, depressional xeric, and isolated ridge systems may be underrepresented amongst monitored systems as percentage of the total wetland population.
- Consideration of avoiding selection of new sites where high degrees of altered hydrologic conditions are present would yield less useful information than unaltered sites.
- Attention should be paid to both wetlands that are expected to indicate stress and baseline, or reference wetlands, that are not.

#15. Expand Lower Floridan Aquifer water quality monitoring: DMIT finds the absence of water level and quality monitoring from the Lower Floridan aquifer is problematic given the proposed increase in LFA use for water production by 2035. Data are particularly limited in portions of Polk and southeastern Osceola Counties.

While routine water quality monitoring might be preferred, the periodic sampling of existing LFA wells would provide welcomed insight into the current conditions of that aquifer and provide valuable insight for new modeling efforts. This is especially true for water quality data considering the use of the LFA as an alternative water supply.

#16. Improve data access and storage:

- Access to the data that are being collected and stored by the State, local government agencies, and permittees is a key reason for the development of this inventory. As discovered during the inventory development, not all of the recorded data are stored and readily available in an electronic format as WMD or State data is. A program whereby all water level and water quality data collected by State, local agencies, and permittees are stored in a manner that allows access to the data in a uniform electronic format could potentially improve access and compatibility in future studies.
- There are additional sources of information, such as State and non-water use permittee municipal data that exist but were not included in the current Inventory, due to the inability to verify the collection and storage standards or because the data is not currently being stored in a format that allow electronic format for access. Investigation of these additional sources as time allows is considered a means of enabling the use of these potential sources of information.

5. Findings Regarding Data Density

Though the original charge of the DMIT was to provide general guidelines for improved regional monitoring, an appropriate level of monitoring density for each of the major aquifer systems was requested by the CFWI Management Oversight Committee. Because of the complexity of aquifer systems in central Florida, an option for developing such values would be to perform intensive statistical studies to discern the appropriate data collection density. Such studies would need to be updated and re-evaluated frequently as additional data points are added. In the absence of the time or resources to conduct such a study, DMIT presents recommendations for a minimum and optimum amount of monitoring based on the analyses described below.

DMIT's approach to developing a minimum recommendation was to start with the monitoring sites that both met a specific, urgent need and fit within the DMIT recommendations for regional monitoring improvement and efficiency. Attachment 2, specific recommendations, lists the sites that are most urgently needed, and the following section discusses an implementation plan for prioritizing and expanding upon those specific sites. It is important to recognize that there will be both budgetary and access constraints that will affect implementation of any strategy.

DMIT's approach to developing an optimum recommendation was different for each aquifer. The term 'optimum' may imply an ideal and comprehensive monitoring program that would provide users with adequate information to better calibrate modeling tools and attempt to identify cause and effect relationships for water level change. Therefore an optimum level of monitoring may take decades or more to achieve, and requires continued updating and re-evaluations as additional data becomes available.

5.1 SA Recommendations

The intent of defining a minimum number and an optimum number of SA monitoring sites is to strive to obtain sufficient and accurate data to be used in the development of models that will better predict the interrelationship between aquifers. It is not only difficult to predict a specific number of monitoring sites that would represent a minimum or an optimum, but implementation will also be influenced by both budgetary and access constraints. In spite of the correlation between wetland water level data and ground water data, the following recommendation for SA minimum and optimum monitoring sites are not to be construed as a replacement or alteration in any way to the existing network of piezometers and staff gauges.

Surficial Aquifer Minimum – a minimum number of SA monitoring sites should be that number of SA monitoring wells added to all existing and minimal proposed LFA/UFA and IAS (as appropriate) nested well sites to evaluate hydraulic interaction between all aquifers. There are currently 104 nested sites with no SA wells. In addition, WMDs and permittees alike have identified a number of SA sites that are slated for monitoring for a number of sites, as shown in Attachment 2. There are 61 SA sites listed in Attachment 2 that should be implemented, bringing the total to 165, shown in Figure 4.

Implementation to achieve the minimum number of SA well sites may be accomplished in phases. Phase 1 implementation should include those 18 SA monitoring sites named in Attachment 2 that fall within the areas circled in Figure 1.

Phase 2 of the implementation plan involves establishment of remaining SA Attachment 2 sites and establishing SA monitoring wells such that they are clustered with existing and proposed UFA/LFA and IAS (as appropriate) wells so that there is an appropriate number of monitoring well clusters per each discrete physiographic region throughout the remainder of the CFWI boundaries. Commensurate with the second phases of executing "minimum" surficial monitoring, existing, isolated (non-cluster) SA monitoring station water level elevation data should be evaluated for period of record and consistency. Those stations determined to not meet acceptable construction and data standards should be eliminated and then re-established with an existing UFA, LFA and Intermediate (as appropriate) water level monitoring station as a well cluster.

Surficial Optimum - an optimum number of SA monitoring wells would ensure that a sufficient number of SA well clusters (a deep SA well and a shallow SA well) exist. These well

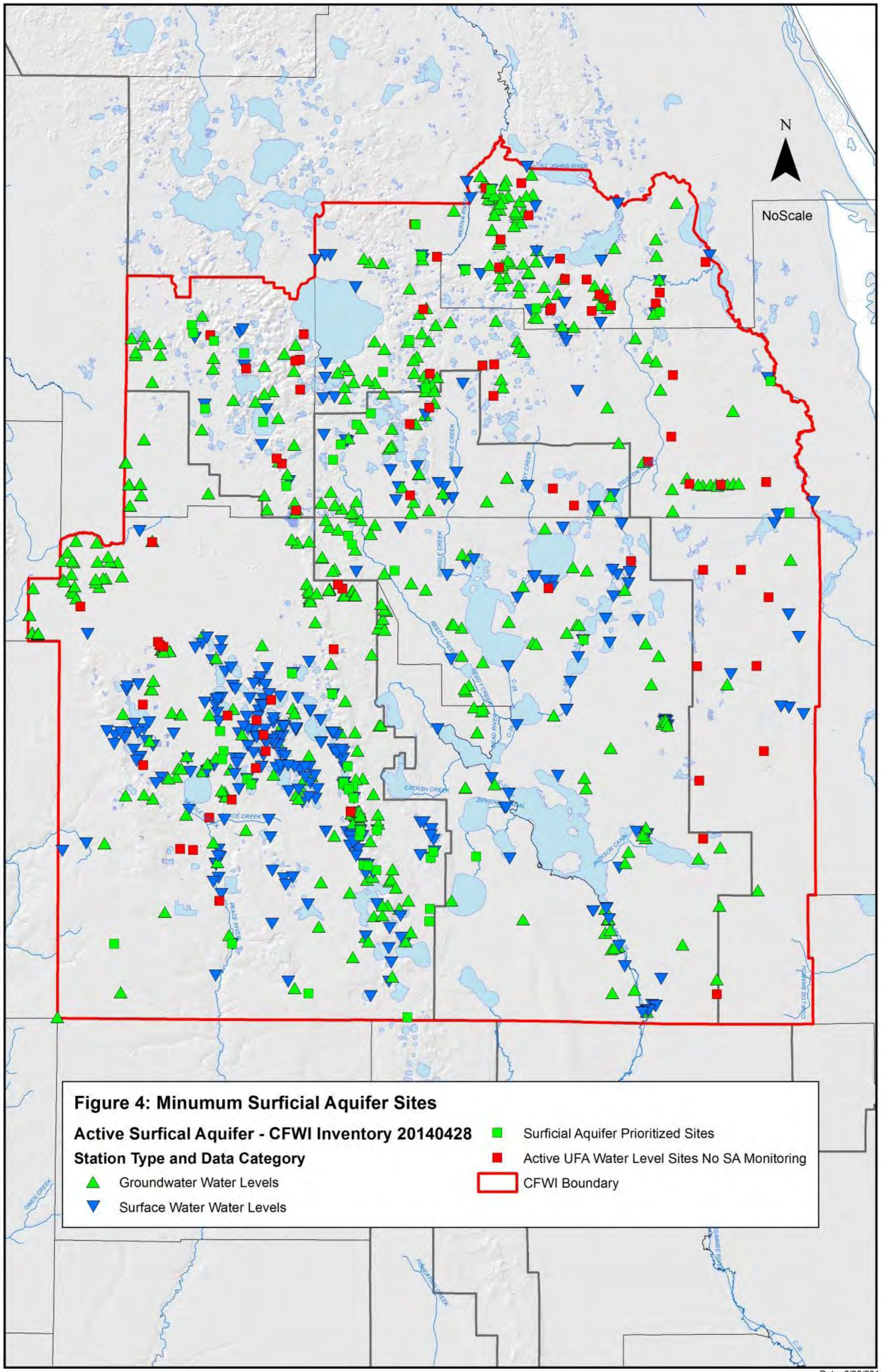

Figure 4: Minumum Surficial Aquifer Sites

Date: 6/20/2014

clusters should be co-located with UFA, LFA and Intermediate (as appropriate) well clusters, located regionally per each discrete hydro geographic area, such as the Geneva Bubble, or each geographic region that is topographically discrete, such as coastal plain flatwoods, the DeLand Ridge, or Citrus Ridge (White, 1970). The Distribution of a SA monitoring well network would ensure that each physiographic region is adequately monitored to ensure sufficient model representation with no reduction in the existing network.

Determination of a 'sufficient' number of wells is extremely difficult to determine without an extensive, detailed statistical evaluation. This evaluation falls outside capabilities and schedule for this team, and may be an exercise that it not productive as a single, one-time evaluation. For this reason, DMIT finds that a SA optimum cannot be quantified, but suggests that future SA wells be co-located with UFA, LFA, and Intermediate clusters, and that effort be made to represent discrete physiographic regions.

5.2 Wetland Monitoring:

Wetland Minimum – Based on a GIS analysis of the wetlands hydroclass representation within each geomorphic region it was determined that there are numerous hydroclass wetland types exist within identified physiographic regions that are not currently represented in a monitoring program. Because the physical hydrologic characteristics of wetlands can differ between each physiographic area it cannot be assumed that a given hydro class of wetland responds similarly to ground water stresses across all physiographic regions. Therefore, a minimum number of wetland monitoring sites should be that there be at least one monitoring site per hydroclass of wetland within each of the identified physiographic regions. This would result in the addition of 107 wetland monitoring sites to meet a minimum of wetland sites that are monitored. Similar to the surficial aquifer monitoring recommendations, achieving the minimum number of wetland monitoring sites may be served in a phased approach, with wetlands in areas identified in the gap analysis (yellow circles in figure X) as being a priority, and wetlands located in the areas identified by the GAT as most susceptible to groundwater withdrawals, occur in the first phase of implementation. The remaining sites would then occur in the second phase.

Wetland Optimum - an optimum number of wetland monitoring sites would be that there is one wetland monitoring site for each 10 percent by acreage for each hydroclasses of wetlands within each physiograghic region. This value is based on an assessment that due to the varied acreage area (minimum 1.6 acres, maximum 192,062.7 acres) that each hydroclass wetlands occupies, throughout the different physiographic regions that using this method of calculation would ensure that sufficient area of these many systems would be represented in the monitoring program, particularly those that have been determined as being "under-represented (Section 3.3). Because there are currently numerous monitoring sites that may be associated with a CUP or WUP, the recommended number of optimum wetland monitoring sites should not result in a reduction in any of the existing monitoring that exists as a result of a permit requirement. Taking into account the existing SA well locations this would result in the need for 192 additional well sites.

5.3 UFA Recommendations

DMIT has reviewed the UFA monitoring points currently found in the inventory and summarized the conclusions drawn in Section 3 of this report. In summary, DMIT finds that additional monitoring of the UFA in most portions of the CFWI would be beneficial to understanding the complex behavior of the system and its influences. This section summarizes DMIT's recommendation for a minimum and optimum amount of monitoring that should be implemented to improve upon this understanding.

UFA Minimum WMDs and permittees are in a relatively constant state of monitoring program expansion, and DMIT supports those existing efforts by recommending that the specific priority sites named in Attachment 2 be considered a 'minimum' recommendation for near-term regional monitoring program implementation. As discussed in Section 4, the sites named in Attachment 2 were selected based on a number of factors, including the creation of nested sites with the addition of these UFA sites to existing LFA or SA sites. There are currently 40 new UFA monitoring sites planned for various parts of the CFWI, as described in Attachment 2, which the DMIT recommends as a minimum level of additional monitoring in the CFWI. These sites are shown in Figure 6.

There is a significant amount of planning that would need to be done to implement even a minimum level of sites. Implementation involves not only prioritization of an implementation schedule, but cost considerations as well. Therefore, DMIT has identified the minimum number of sites into 2 phases:

- Those 4 sites provided in Attachment 2 that fall within the Figure 2 areas identified as needing additional data collection should be considered 'Phase 1 Priority' sites to be installed first.
- All 26 remaining Attachment 2 sites are considered Phase 2 Priority Sites.

UFA Optimum Previous work conducted by each of the three WMDs participating in the CFWI have been conducted involving geospatial, statistical analysis to determine what level of UFA monitoring would produce interpolated potentiometric surface values of varying levels of accuracy. Specifically, SJRWMD and SFWMD have reviewed their respective UFA monitoring networks using a hexagonal grid method, developed by R.A. Olea (Olea 1984a and Olea 1984b). SWFWMD has developed their Regional Observation and Monitor well Program (ROMP) based on a 10-mile grid (SWFWMD, 2012). These studies all suggest that improving statistical representation of potentiometric surface between monitoring sites could require anywhere from dozens to hundreds of new UFA wells throughout the CFWI, depending on the target level of accuracy. SJRWMD uses a 45,000-ft hexagonal grid pattern for UFA wells to map UFA potentiometric water levels based on the kriging analysis of various grid sizes (Osburn, 2000). This grid size and pattern yielded a reasonable mean standard deviation of 6.86 ft, using a data

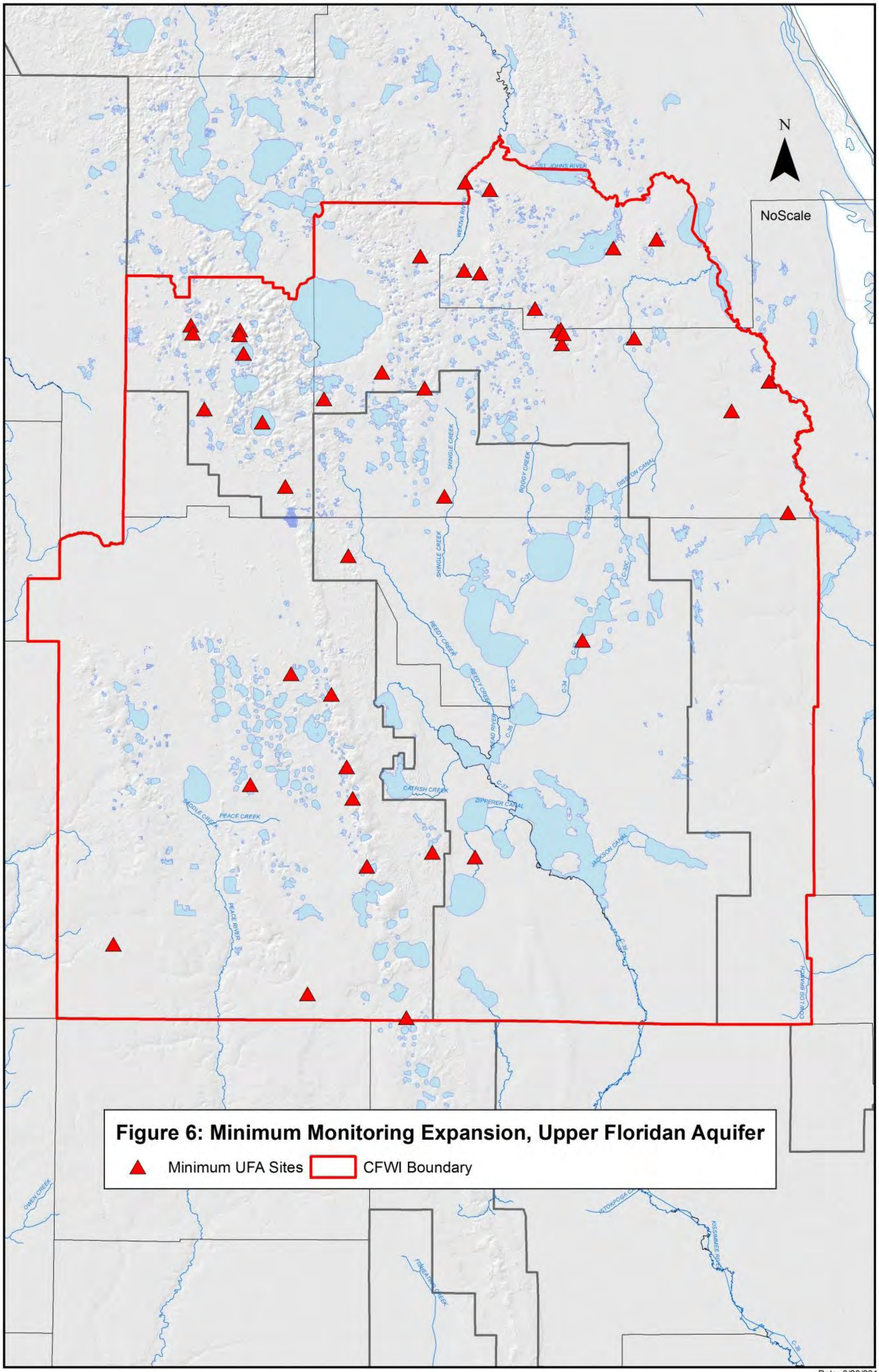

Figure 6: Minimum Monitoring Expansion, Upper Floridan Aquifer

Date: 6/20/2014

variance, which was similar to results of much smaller grid sizes. This grid network was adopted by SWFWMD as a recommended future monitoring plan within the SWFWMD portion of the CFWI. Though not exact, similar grid patterns were independently considered by SFWMD. An 'optimized' 96,000-ft grid was recommended for SFWMD as the largest grid size that would yield a mean prediction standard error within the District's groundwater flow modeling criterion of 5 ft. Though a 45,000 ft grid network was not specifically evaluated as part of this exercise, a 40,000 grid network was with a resulting mean prediction standard error of 2.76 ft.

Though each WMD has evaluated this methodology differently, they have each vetted the general approach, and therefore DMIT recommends that the use of a 45,000-ft hexagonal grid, as shown in Figure 7, be adopted for use as an UFA optimum. Currently, there are 89 hexagonal grids with existing or planned UFA monitoring equipment, leaving 30 that would require additional monitoring to reach an optimum level of UFA monitoring. Only those grids in which 50% or more of the hexagonal grid falls within the CFWI are counted for this exercise.

5.4 LFA Recommendations

There are 44 active LFA locations currently monitored within the CFWI. Of these sites, 29 locations are monitored for water levels and 34 are monitored for water quality. The majority of the LFA locations are found in Orange and Seminole Counties. Based upon the work completed in this report, areas in central Lake and Polk counties and southern and eastern Osceola County are regions that have been identified as having historically received less attention for studies involving the LFA. The yellow circles shown in Figure 3 show these general regions where LFA monitoring could be improved the quickest due to lack of current information. In part, the reason for this reduced amount of LFA sites has a great deal to do with the previous locations of the LFA development as a water supply source. Utilities within Orange and Seminole Counties were among the first to begin use of the LFA in the region and as part of that effort completed additional testing and monitoring for those areas. Those areas in Lake, Polk and Osceola counties have had less LFA production wells constructed and therefore few monitoring sites were previously warranted. The proposed increased future use of the LFA identified as an water supply option in the RWSP suggests the need to intensify LFA monitoring and testing in areas of proposed expansion – in particular within Polk and Osceola Counties.

LFA Minimum – Figure 8 identifies locations where the Districts have given a high level review of site conditions or have identified current proposals for LFA well construction. The minimum number of LFA monitoring sites would be best served by those 18 identified in Attachment 2. In the larger region located in Polk County two locations would be preferred due to the size of the identified circle. Of those 18 sites, those that fall within the Figure 3 priority areas would be best suited for construction and testing as part of a nested set of wells having monitoring horizons including LFA(s), UFA, APPZ, IAS and SA aquifer monitoring.

LFA Optimum – The optimum number of LFA monitoring locations would involve placing a LFA(s) monitor at each of the identified existing and proposed UFA optimum nested well sites.

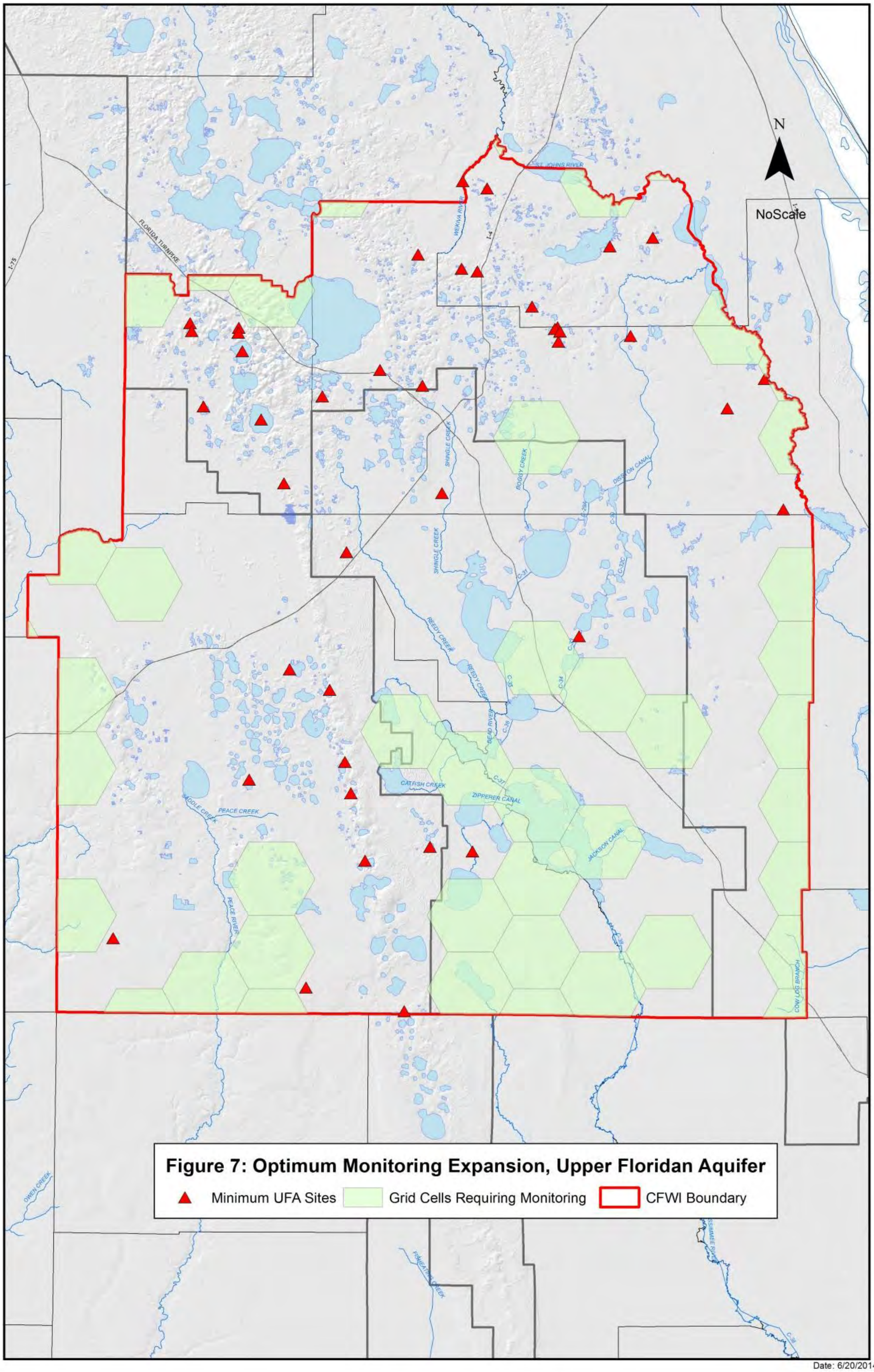

Figure 7: Optimum Monitoring Expansion, Upper Floridan Aquifer

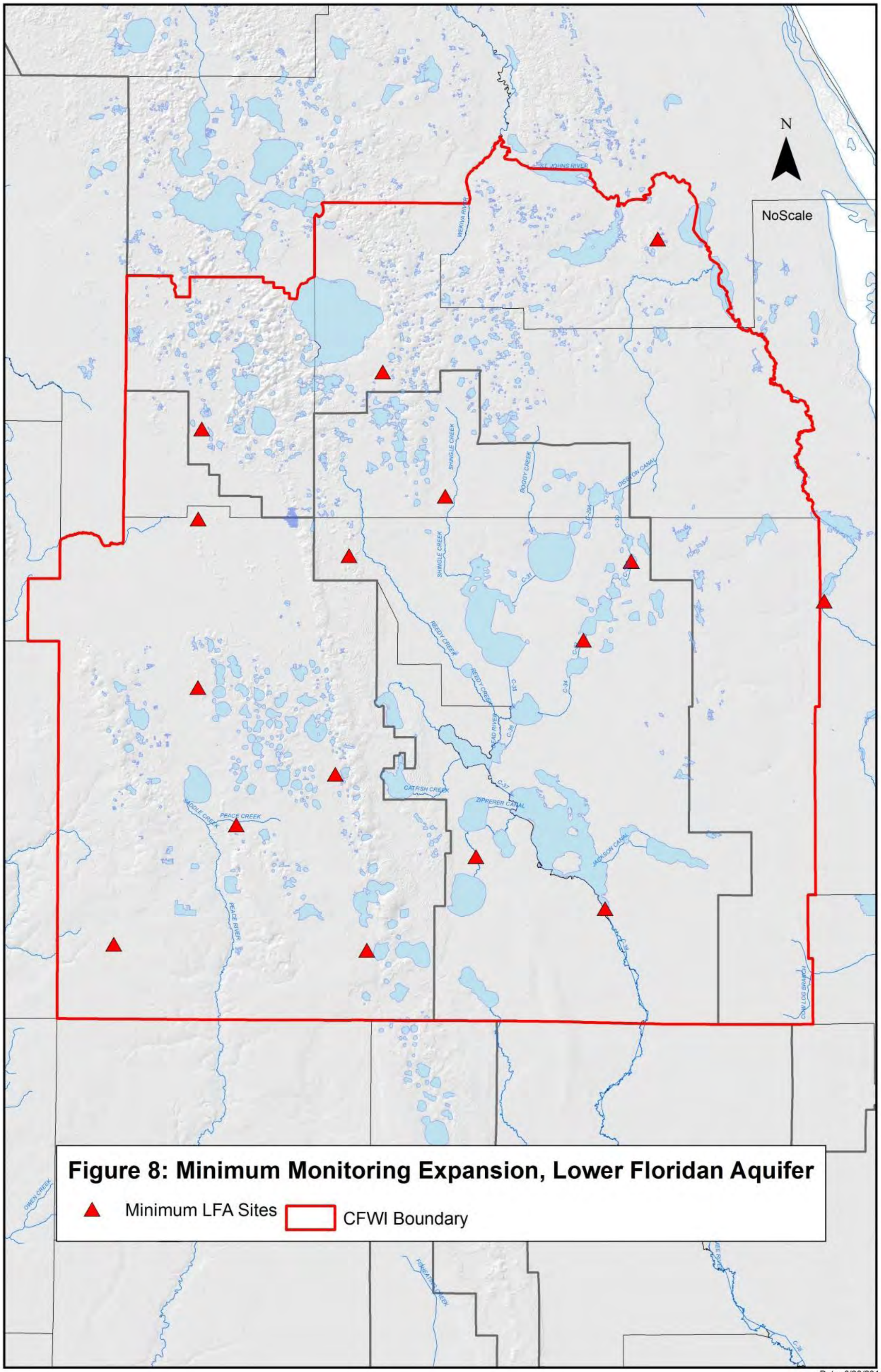

Figure 8: Minimum Monitoring Expansion, Lower Floridan Aquifer

Available geologic and hydrogeologic information (such as lithology and groundwater geochemistry) for existing LFA monitoring wells would first be evaluated to interpret regional patterns of similarity and dissimilarity where additional information would not and would be beneficial, respectively, for improved understanding of subsurface geologic and water quality conditions. For example, new and existing LFA monitoring wells should be sampled and analyzed for the major ion suite at least once every two years as appropriate to establish baseline conditions. Sampling frequency may be increased after the baseline has been established.

Some of the UFA optimum nested well sites that also meet accessibility requirements would then be selected as locations for new LFA monitoring well(s) installation. It may be necessary to repeat this approach as data is acquired and evaluated for the new LFA monitoring wells. This would provide for ideal regional long-term water level and water quality monitoring of the LFA as well as evaluation of the hydraulic interaction between all aquifers. Where appropriate, two LFA monitoring wells would be constructed at the same nested well site in areas of the CFWI where both the LFA below MCUI and the LFA below MCUII are present (expected in roughly the eastern half of Polk County). Adoption of a policy to collect data at the optimum number of sites would result in the construction of 83 LFA well locations. These are shown in Figure 9.

6. Process for Future DMIT Inventory Updates

The CFWI Steering Committee has requested that the DMIT inventory of environmental monitoring locations be updated periodically to account for new information being collected and to address the changing needs of the ongoing CFWI evaluations. The process envisions annual updates to the inventory for the inclusion of new site information not previously accounted for in the inventory. The process also envisions a larger update to the current inventory that will occur every two years. This 2-year update is more involved and DMIT suggests consideration be given to including the following:

1. A review of the current (previous) inventory data structure to address changing needs;
2. The inclusion of new types of information such as aquifer performance, hydro-stratigraphy or reported water use;
3. Expand the number of sources of information for monitoring data by investigating data collection standards and access to the recorded data.
4. Meetings with other CFWI support teams to assess changing data needs;
5. Review, document and update programming (scripts) written to develop the previous inventory;
6. Update user friendly inventory interface

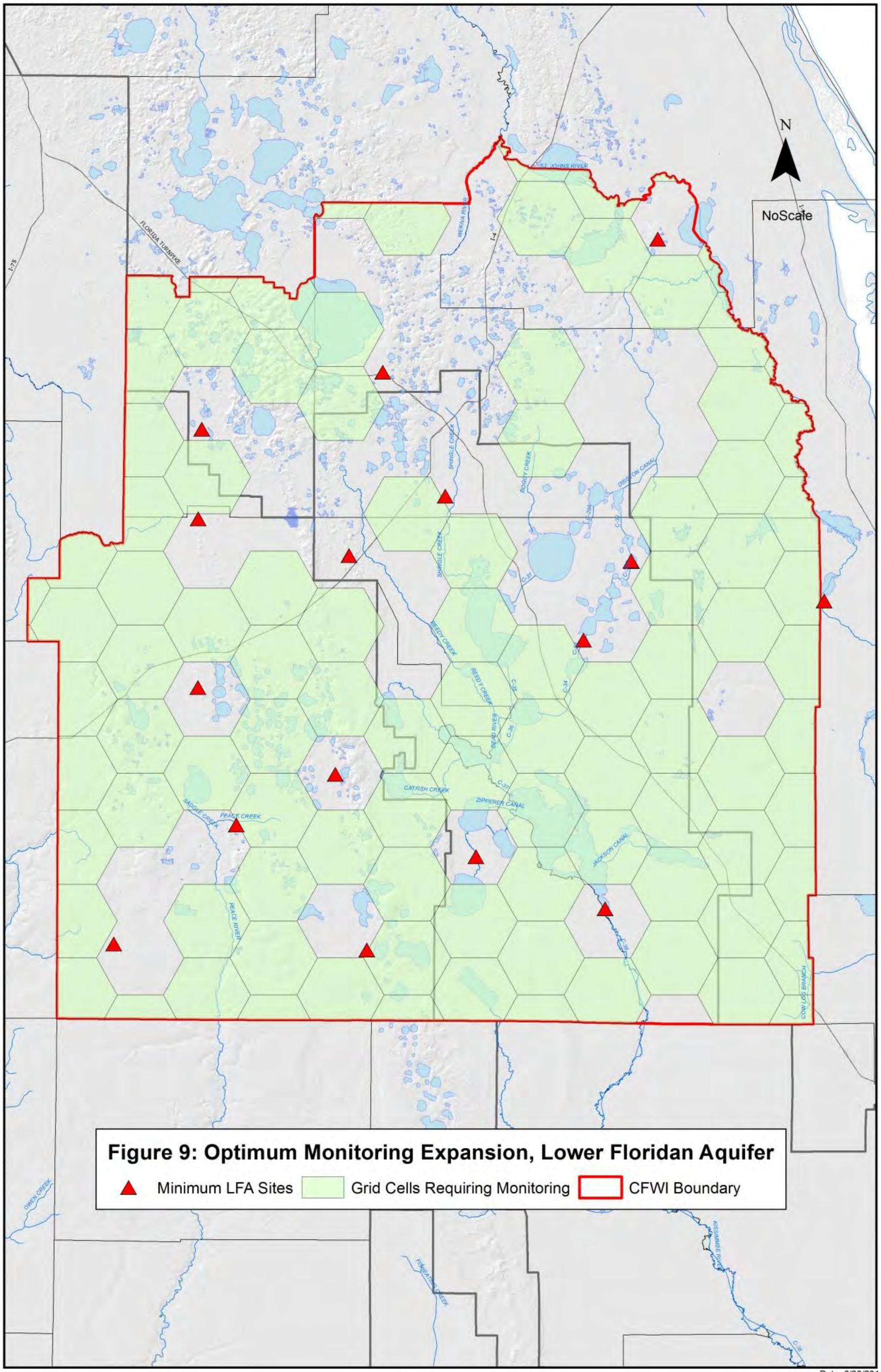

Figure 9: Optimum Monitoring Expansion, Lower Floridan Aquifer

7. Review USGS's list of endangered sites and attempt to retain monitoring efforts at all sites, but in particular those with long periods of record or areas identified as needing more data collection.
8. Review FDEP's Florida Water Resource Monitoring Council's Water Catalog for progress on developing a state-wide water resources database.
9. Produce a DMIT progress report summarizing:
    i. Improvements to the previous inventory
    ii. Status of DMIT implementation monitoring recommendations
    iii. Revise/Update DMIT monitoring recommendations

In addition, the update process recognizes that staffing assignments at the government agencies and permittee organizations changes over time. Staff changes can complicate efforts to reproduce a consistent inventory. To this end it will be important to document the methods used to assemble the inventory and to update staff involved in the effort as changes occur. Initially, responsibility for executing the DMIT periodic updates will go to the staff in the following positions: Hydrologist IV, Engineering and Hydro Science (SJRWMD), Lead Hydrologist in the Orlando Service Center (SFWMD), and Manager, Hydrologic Data Section (SWFWMD).

7. Costs for Implementation

It is difficult to develop standardized costs for monitoring wells across such a large and geologically varied area such as the CFWI. For the purpose of this report, WMDs have provided typical costs for devices installed in their Districts over the past few years. Obviously, costs will vary greatly with depth, access, and situation, and costs can be improved significantly when wells are nested.

Table 2 – Summary of Monitoring Cost Estimates

Device Type	Range of Cost, per Device	Average Cost, per Device
Wetland Piezometer	$800-$1,500	$1150
SA Well	$2,000-$13,000	$7500
UFA Well	$15,000-$200,000	$107,500
LFA Well	$140,000-$500,000	$320,000

Using the monitoring options described in Section 5, above, the DMIT estimates that the minimum and optimum levels of monitoring could cost:

- Wetland minimum: 107 new sites are identified for an estimated cost of $123,050
- Wetland optimum: 192 new sites are identified for an estimated cost of $220,800
- Surficial aquifer minimum: 104 new sites are identified for an estimated cost of $780,000
- Surficial aquifer optimum: an optimum number of sites could not be quantified.
- Upper Floridan minimum: 40 new sites are identified for an estimated cost of $4,300,000.
- Upper Floridan optimum: 70 new sites are identified for an estimated cost of $7,525,000.

- Lower Floridan minimum: 18 new sites are identified for an estimated cost of $5,760,000
- Lower Floridan optimum: 101 new sites are identified for an estimated cost of $32,320,000

8. Conclusions and Summary

This document presents general and specific findings for developing and expanding a regional monitoring program in more efficient and effective ways, including the following considerations in monitoring site selection:

1. Consider existing data collection
2. Utilize a statistical design to detect water level change relationships
3. Collaborate with other agencies and entities
4. Cluster wells
5. Use public lands
6. Monitor MFLs Lakes
7. Conduct a redundancy evaluation
8. Use DMIT Minimum Standards for Data Collection
9. Improve model calibration criteria
10. Re-survey wells
11. Characterize leakance
12. Maintain spring flow and water quality data
13. Utilize wetland edge
14. Expand wetland monitoring
15. Expand Lower Floridan Aquifer monitoring
16. Improve data access and storage

In summary, there does not appear to be widespread redundancy of data collection in the CFWI region. Those areas identified to contain a number of sites in close proximity to one another appear to be justified but could benefit from monitoring data sharing amongst local partners. In general, monitoring data is most limited for the LFA and SA. General areas where monitoring should be improved are presented in Figure 1, Figure 2, and Figure 3. These areas were identified based on a number of factors, including CFWI groundwater flow model results, the existence of information on MFLs lakes and EMT wetlands, location of projected demand withdrawals and other valuable input from the other CFWI technical teams. While improved data collection throughout the region would be beneficial, priority effort made in the areas identified in these figures will yield the most urgently needed information.

The mere process of reviewing and compiling available monitoring information completed by the DMIT was a useful exercise in identifying a number of data collection practices that can be improved and streamlined. While some were addressed, others were not due to schedule and resource restrictions. By using existing methodologies and adopted schemes for monitoring approaches, DMIT was able to formulate the following estimates for a minimum and optimum range of monitoring:

Table 3 – Summary of Monitoring Options

Surficial Aquifer	Total
Minimum	148
Optimum	See guidelines
Wetlands	
Minimum	107
Optimum	192
Upper Floridan	
Minimum	40
Optimum	70
Lower Floridan	
Minimum	18
Optimum	101

These monitoring options are represented in Figures 4, 5, 6, 7, and 8. Funding and site access will be two of the most limiting factors to implementing a number of the recommendations identified in this document. In recent years, state and local budgets have limited the expansion of some data gathering activities, including staffing, for the WMDs and local governments. Reliance on funding from independent sources may also hinder the implementation of the data improvement recommendations. The best opportunity for consistent program improvements may be in the continued development of a five-year hydrologic monitoring workplan that is jointly funded and implemented by the WMD's. In this manner, funding and work commitments can be coordinated in a cost effective and timely manner.

9. References

- CFWI DMIT, "Minimum Standards for Water Resource Data Collection, Site Establishment and Field Data Collection Protocols." January 31, 2014
- CFWI EMT, "Development of Environmental Measures for Assessing Effects of Water Level Changes on Lakes and Wetland in the Central Florida Water Initiative Area." September, 2013.
- Sepulveda, Nicasio, et. Al, "Groundwater Flow and Water Budget in the Surficial and Floridan Aquifer Systems in East-Central Florida." USGS Scientific Investigations Report 2012-5161, 2012.
- Bhat, et. Al, "Designing a Groundwater-Level Monitoring Network Using Geostatistics: A Case Study SFWMD For South and Central Florida, USA." World Environmental and Water Resources Congress, 2012.
- Olea, R.A., "Sampling design optimization for spatial functions." Mathematical Geology, 1984a.
- Olea, R.A., "Systematic Sampling of Spatial Functions." Series on Spatial Analysis No. 7, Lawrence, Kansas, Kansas Geological Survey, 1984b.

- W.L. Osburn, P.G., "Geostatistical Analysis: Potentiometric Network for the Upper Floridan Aquifer in the St. Johns River Water Management District." Technical Publication SJ2000-1.
- SWFWMD Geotechnical Section Workplan 2013-2015, October 2012
- GAT presentation to the Steering Committee Presentation on June 28th, 2013, PowerPoint presentation available on the CFWI.com website.
- White, W.A., 1970, Geomorphology of the Florida Peninsula, Florida Bureau of Geology Geological Bulletin N. 51., Tallahassee Florida.

Attachment 1: Standard Inventory Sheet

Attachment 1

Data Monitoring and Investigations Team

Inventory Structure

Field name	Definition	Example values
GIS_ID	GIS generated ID	Number sequence
Unique_ID	Unique ID created by DMIT	Number sequence
Stn_ID	Identifier used as the station ID in the source agency internal database	24443; 1172; 57941
Stn_Name	Station or site name used by source agency	ROMP 41 AVPK PZ MONITOR; OFR-60; A-0002; Little Bear Lake
Stn_Descr	Location description or other information about the station or site	St. Cloud Deep OSF-44; Hilochee WMA; ROMP 60X
WMD	Water management district the station is located in	SFWMD; SWFWMD; SJRWMD
County	County the station is located in	Orange; Polk; Seminole
Permittee	Water use permittee responsible for performing monitoring as part of permit conditions, if applicable	Orlando Utilities Commission; City of Lake Alfred; STOPR
Permit_No	Permit number of water use permit, if applicable	080128; 49-57-07206; 8522
Pm_WU_Type	Type of water use permitted for the station, if applicable	Public Supply; Agricultural; Commercial / Industrial
Stn_Cat	Water management district or other agency resource monitoring station, or permittee monitoring station required as part of permit conditions	RM; PM
Site_Cat	General matrix or site category from which the data is collected	Meteorlogical; Groundwater; Surface Water
Stn_Type	Type of station that data collection occurs at or in	Canal; Lake; Pond; Rainfall; River; Stream; Spring; Well; Wetland
Data_Cat	Kind of data collectedat the station	Levels; Quality; Rain; Flow; Soil and vegetative
Mon_Method	Method, means, or way by which the monitoring data is collected	Piezometer; Staff Gage; Rain Gage; Monitoring Well; Production Well; Flow Meter; Soil and Vegetative Assessment
Wetl_Class	Wetlands classification for station or transect, if applicable	Depression Marsh; Dome Swamp; Floodplain Forest; Strand Swamp
FLUCFCS	Florida Land Use, Cover, and Forms Classification System code at station, if applicable	1100; 2200; 4110
FLUC_DATE	Florida Land Use, Cover, and Forms Classification System code at station, date	1995; 2000; 2004
WR_Name	Name of the water body, wetland, or aquifer from which the monitoring data is collected; may be same as Station Name	Little Bear Lake; Upper Floridan Aquifer; Unnamed Wetland

Field name	Definition	Example values
Mon_Status	Monitoring data collection is active and ongoing or data collection has been discontinued and is currently inactive	Active; Inactive
Col _Agency	Agency, utility, or permittee collecting and reporting data from monitoring station (not intended to mean consultants)	SFWMD; SWFWMD; SJRWMD; OUC; OCU; USGS; NWS
Frequency	Frequency of data collection, expressed as continuous or number of times per year	Continuous; Daily; Monthly; Quarterly; Annually; Periodic; Baseline; Five-year
Type_WA	Type or method of wetlands assessment; could be soil and vegetation analysis; hydrologic indicators; boundaries; and other	Soil and vegetative; photographic; survey data; other
Csg_Depth	For wells or piezometers, the casing depth in feet below land surface	75; 233
Tot_Depth	For wells or piezometers, the total depth in feet below land surface	125; 300
POR_Start	Date data collection started at the station	MM/DD/YYYY
POR_End	Date of last available data for active station, or date data collection ended for inactive station	MM/DD/YYYY
MFL_Site	Station is located at an active or proposed minimum flows and levels site	Yes; No; Proposed
ECFT_Mod	Data from station was used for ECFT model calibration	Yes; No
LSE	Land surface elevation	5; 122
V_Datum	Vertical datum for station	NGVD29; NAVD88
Lat_dd	Latitude north, expressed as decimal degrees	29.54758611
Long_dd	Longitude west, expressed as decimal degrees	-82.41166667
H_Datum	Horizontal reference for station location	NAD27; NAD83; WGS84
Hyperlink	Link to agency web site where data can be acquired	
Comment	Additional comments about the station or monitoring	

Attachment 2: Specific Prioritized Monitoring Sites

Attachment 2
Data Monitoring and Investigations Team
Specific Findings

SITE NAME	COUNTY	EXISTING/PROPOSED	PROPOSED AQUIFER TO MONITOR	PURPOSE	RECOMMED	LAT	LONG
Tosahatchee Creek and Taylor C	ORANGE	Proposed	APPZ	WMD Priority	Install new wells	28.497500	-80.998300
Lake Jesup	SEMINOLE	Proposed	APPZ	WMD Priority	Install new wells	28.724400	-81.185200
Winter Garden	ORANGE	Proposed	IAS	WMD Priority	Install new wells	28.550000	-81.550000
SR 46 and CR 426	SEMINOLE	Proposed	IAS	WMD Priority	Install new wells	28.736400	-81.116900
ROMP 42- Bereah	POLK	Budgeted_Proposed	IAS	SWUCA Support/10 Mile RO	Install New Well	27.683128	-81.661953
ROMP 46- Baird	POLK	Not Budgeted_Proposed	IAS	SWUCA Support/10 Mile RO	Install New Well	27.750313	-81.966477
PRINCE PARCEL TEST WELL - Site	indian River	Proposed	LFA	improved model calibration	New LFA well Install/pump t	27.382200	-80.455487
Eva Tower	LAKE	Proposed	LFA	WMD Priority	Install new wells	28.469200	-81.834400
HH-2-IC	Orange	Proposed	LFA	improved model calibration	new nested well cluster	28.294167	-81.601403
Winter Garden	ORANGE	Proposed	LFA	WMD Priority	Install new wells	28.550000	-81.550000
C-33 Canal Well	Osceola	Proposed	LFA	improved model calibration	new nested well cluster	28.177122	-81.232853
Lake Joel	Osceola	Proposed	LFA	pump test	new LFA/UFA well and testi	28.287047	-81.157642
OSF-22 LFA @ lake Joel	Osceola	Proposed	LFA	improved model calibration	new LFA	28.287506	-81.158119
OSF-52 LFA Well	Osceola	Proposed	LFA	improved model calibration	new LFA construction	27.803053	-81.198279
River Lakes Conservation area	Osceola	Proposed	LFA	WQ monitoring, model impr	LFA/UFA/SAS	28.231956	-80.854869
Shingle Creek @ rain gauge	Osceola	Proposed	LFA	improved model calibration	new contruction & testing U	28.377233	-81.450400
East Bartow	POLK	Budgeted_Proposed	LFA	LFA Expolratory Well	Install New Well	27.917943	-81.775752
Frostproof	POLK	Budgeted_Proposed	LFA	LFA Expolratory Well	Install New Well	27.744349	-81.570468
Green Swamp Lower Floridan	POLK	Not Budgeted_Proposed	LFA	LFA to Collect background L	Install New Well	28.344034	-81.838780
ROMP 46- Baird	POLK	Not Budgeted_Proposed	LFA	SWUCA Support/10 Mile RO	Install New Well	27.750313	-81.966477
ROMP 75	POLK	Not Budgeted_Proposed	LFA	Add LFA to Existing ROMP 7	Install New Well	28.108848	-81.837281
S.R. 60 near Lake Weo & Rosilie	Polk	Proposed	LFA	improved model calibration	new LFA and UFA wells	27.875311	-81.400428
Waverly	POLK	Budgeted_Proposed	LFA	LFA Expolratory Well	Install New Well	27.989255	-81.621080
SR 46 and CR 426	SEMINOLE	Proposed	LFA	WMD Priority	Install new wells	28.736400	-81.116900
BOGGY MARSH	LAKE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.390009	-81.701185
CHERRY LAKE	LAKE	Proposed	SAS	MFLs	Install new SAS well	28.592256	-81.816567
LAKE EMMA	LAKE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.614280	-81.851827
LAKE LOUISA	LAKE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.480006	-81.738131
LAKE LUCY	LAKE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.603056	-81.849246
LAKE MINNEOLA	LAKE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.575280	-81.768410
PINE ISLAND LAKE	LAKE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.497504	-81.829800
Lake David Estates	Orange	Proposed	SAS	wetlands monitoring	establish new weltands mor	28.492544	-81.568642
LAKE HIAWASSEE	ORANGE	Proposed	SAS	MFLs	Install new SAS well	28.528317	-81.482166
Orange Co. - Conservll	Orange	Proposed	SAS	wetlands monitoring	establish new weltands mor	28.427022	-81.627675
PREVATT LAKE	ORANGE	Proposed	SAS	MFLs	Install new SAS well	28.712123	-81.489905
ROCK SPRINGS	ORANGE	Proposed	SAS	MFLs	Install new SAS well	28.755832	-81.499238
SF-WH aka Summerlake	Orange	Proposed	SAS	wetlands monitoring	establish new weltands mor	28.449203	-81.615708
SJR @ SR 50	ORANGE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.538791	-80.939067
Summerport Village	Orange	Proposed	SAS	wetlands monitoring	establish new weltands mor	28.476689	-81.590781
TAYLOR CREEK	ORANGE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.355343	-80.909590
WEKIWA SPRINGS	ORANGE	Proposed	SAS	MFLs	Install new SAS well	28.711994	-81.460306
Winter Garden	ORANGE	Proposed	SAS	WMD Priority	Install new wells	28.550000	-81.550000
C-33 Canal Well	Osceola	Proposed	SAS	improved model calibration	new nested well cluster	28.177122	-81.232853
Cane Island	Osceola	Proposed	SAS	wetlands monitoring	establish new weltands mor	28.273042	-81.530386
Palms CC & Resort	Osceola	Proposed	SAS	wetlands monitoring	establish new weltands mor	28.309442	-81.597083
Windsor Hills	Osceola	Proposed	SAS	wetlands monitoring	establish new weltands mor	28.321597	-81.603397
Clinch Lake	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.744489	-81.529492
Crystal Lake	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.903484	-81.583348
Dinner Lake	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.967866	-81.601062
Eagle Lake	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.981730	-81.759606
Lake Amoret	POLK	Not Budgeted_Proposed	SAS	MFL- SAS + UFA (UFA to Sup	Install New Well	27.861479	-81.569718
Lake Annie	POLK	Budgeted_Proposed	SAS	MFL- SAS + UFA	Install New Well	28.000069	-81.602262
Lake Aurora	POLK	Not Budgeted_Proposed	SAS	MFL- SAS + UFA (UFA to Sup	Install New Well	27.881383	-81.467249
Lake Bonnie	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.910924	-81.555955
Lake Easy	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.855623	-81.556545
Lake Eva	POLK	Not Budgeted_Proposed	SAS	MFL- SAS + UFA	Install New Well	28.100749	-81.627045
Lake Josephine	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.862969	-81.576800
Lake Lee	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.977562	-81.608507
Lake Lowery	POLK	Not Budgeted_Proposed	SAS	MFL- SAS + UFA	Install New Well	28.129396	-81.690269
Lake Mabel	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.970928	-81.593458
Lake Mcleod	POLK	Not Budgeted_Proposed	SAS	MFL- SAS + UFA (UFA to Sup	Install New Well	27.974407	-81.753662
Lake Starr	POLK	Not Budgeted_Proposed	SAS	MFL- SAS + UFA (UFA to Sup	Install New Well	27.956287	-81.592639
Lake Trout	POLK	Not Budgeted_Proposed	SAS	MFL- SAS + UFA	Install New Well	27.650465	-81.507178
Lake Venus	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.974767	-81.609580
Little Aurora	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.873092	-81.471809
North Lake Wales	POLK	Not Budgeted_Proposed	SAS	MFL- SAS	Install New Well	27.910773	-81.581931
Peace River @ Bartow	POLK	Not Budgeted_Proposed	SAS	Quantify Relationship Betwe	Install New Well	27.843017	-81.811263
Peace River @ Ft Meade	POLK	Not Budgeted_Proposed	SAS	Quantify Relationship Betwe	Install New Well	27.751716	-81.782033
ROMP 42- Bereah	POLK	Budgeted_Proposed	SAS	SWUCA Support/10 Mile RO	Install New Well	27.683128	-81.661953
ROMP 46- Baird	POLK	Not Budgeted_Proposed	SAS	SWUCA Support/10 Mile RO	Install New Well	27.750313	-81.966477
S.R. 60 near Lake Weo & Rosilie	Polk	Proposed	SAS	improved model calibration	new LFA and UFA wells	27.875311	-81.400428
Wetland Monitoring	POLK	Not Budgeted_Proposed	SAS	Wetalnds - No Monitoring	Install New Well	28.048226	-81.802750
Wetland Monitoring	POLK	Not Budgeted_Proposed	SAS	Wetalnds - No Monitoring	Install New Well	28.020319	-81.797117
Wetland Monitoring	POLK	Not Budgeted_Proposed	SAS	Wetalnds - No Monitoring	Install New Well	28.008863	-81.799098
Wetland Monitoring	POLK	Not Budgeted_Proposed	SAS	Wetalnds - No Monitoring	Install New Well	27.802183	-81.472610
Wetland Monitoring	POLK	Not Budgeted_Proposed	SAS	Wetalnds - No Monitoring	Install New Well	27.784222	-81.473539
LAKE BRANTLEY	SEMINOLE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.692500	-81.420903
LAKE HOWELL	SEMINOLE	Proposed	SAS	MFLs	Install new SAS and UFA wel	28.639820	-81.308585
MIAMI SPRINGS	SEMINOLE	Proposed	SAS	MFLs	Install new SAS well	28.710278	-81.442570
MILLS LAKE	SEMINOLE	Proposed	SAS	MFLs	Install new SAS well	28.634723	-81.113117
PALM SPRINGS	SEMINOLE	Proposed	SAS	MFLs	Install new SAS well	28.691112	-81.392569
SANLANDO SPRINGS	SEMINOLE	Proposed	SAS	MFLs	Install new SAS well	28.688889	-81.395624
SR 46 and CR 426	SEMINOLE	Proposed	SAS	WMD Priority	Install new wells	28.736400	-81.116900
STARBUCK SPRING	SEMINOLE	Proposed	SAS	MFLs	Install new SAS well	28.696829	-81.391065
SYLVAN LAKE	SEMINOLE	Proposed	SAS	MFLs	Install new SAS well	28.804996	-81.380345
BOGGY MARSH	LAKE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.390009	-81.701185
LAKE EMMA	LAKE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.614280	-81.851827
LAKE LOUISA	LAKE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.480006	-81.738131
LAKE LUCY	LAKE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.603056	-81.849246
LAKE MINNEOLA	LAKE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.575280	-81.768410
NORTH LAKE APSHAWA	LAKE	Proposed	UFA	MFLs	Insall new UFA (for North ar	28.608146	-81.774427

PINE ISLAND LAKE	LAKE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.497504	-81.829800
SOUTH LAKE APSHAWA	LAKE	Proposed	UFA	MFLs	Insall new UFA (for North ar	28.601171	-81.775408
WEKIVA RIVER @ SR 46	LAKE	Proposed	UFA	MFLs	Install new UFA well.	28.815181	-81.419475
Econ Sandhills (East of Econ, No	ORANGE	Proposed	UFA	WMD Priority	Install new wells	28.599000	-81.152000
HH-2-IC	Orange	Proposed	UFA	improved model calibration	new nested well cluster	28.294167	-81.601403
LAKE AVALON	ORANGE	Proposed	UFA	MFLs & WMD Priority	Install new UFA well.	28.512814	-81.641354
LAKE BURKETT	ORANGE	Proposed	UFA	MFLs	Install new UFA well. SHARE	28.610835	-81.267844
LAKE HIAWASSEE	ORANGE	Proposed	UFA	MFLs	Install new UFA well.	28.528317	-81.482166
LAKE IRMA	ORANGE	Proposed	UFA	MFLs	Install new UFA well.	28.590836	-81.266455
LAKE MARTHA	ORANGE	Proposed	UFA	MFLs	Install new UFA well. SHARE	28.608613	-81.272288
LAKE PEARL	ORANGE	Proposed	UFA	MFLs	Install new UFA well.	28.604725	-81.263955
PREVATT LAKE	ORANGE	Proposed	UFA	MFLs	Install new UFA well.	28.712123	-81.489905
SJR @ SR 50	ORANGE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.538791	-80.939067
TAYLOR CREEK	ORANGE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.355343	-80.909590
Winter Garden	ORANGE	Proposed	UFA	WMD Priority	Install new wells	28.550000	-81.550000
C-33 Canal Well	Osceola	Proposed	UFA	improved model calibration	new nested well cluster	28.177122	-81.232853
Shingle Creek @ rain gauge	Osceola	Proposed	UFA	improved model calibration	new contruction & testing U	28.377233	-81.450400
Lake Amoret	POLK	Not Budgeted_Proposed	UFA	MFL- SAS + UFA (UFA to Sup	Install New Well	27.861479	-81.569718
Lake Annie	POLK	Budgeted_Proposed	UFA	MFL- SAS + UFA	Install New Well	28.000069	-81.602262
Lake Aurora	POLK	Not Budgeted_Proposed	UFA	MFL- SAS + UFA (UFA to Sup	Install New Well	27.881383	-81.467249
Lake Eva	POLK	Not Budgeted_Proposed	UFA	MFL- SAS + UFA	Install New Well	28.100749	-81.627045
Lake Lowery	POLK	Not Budgeted_Proposed	UFA	MFL- SAS + UFA	Install New Well	28.129396	-81.690269
Lake Mcleod	POLK	Not Budgeted_Proposed	UFA	MFL- SAS + UFA (UFA to Sup	Install New Well	27.974407	-81.753662
Lake Starr	POLK	Not Budgeted_Proposed	UFA	MFL- SAS + UFA (UFA to Sup	Install New Well	27.956287	-81.592639
Lake Trout	POLK	Not Budgeted_Proposed	UFA	MFL- SAS + UFA	Install New Well	27.650465	-81.507178
ROMP 42- Bereah	POLK	Budgeted_Proposed	UFA	SWUCA Support/10 Mile RO	Install New Well	27.683128	-81.661953
ROMP 46- Baird	POLK	Not Budgeted_Proposed	UFA	SWUCA Support/10 Mile RO	Install New Well	27.750313	-81.966477
S.R. 60 near Lake Weo & Rosilie	Polk	Proposed	UFA	improved model calibration	new LFA and UFA wells	27.875311	-81.400428
LAKE BRANTLEY	SEMINOLE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.692500	-81.420903
LAKE HOWELL	SEMINOLE	Proposed	UFA	MFLs	Install new SAS and UFA wel	28.639820	-81.308585
Lake Jesup	SEMINOLE	Proposed	UFA	WMD Priority	Install new wells	28.724400	-81.185200
SANLANDO SPRINGS	SEMINOLE	Proposed	UFA	MFLs	Install new UFA well.	28.688889	-81.395624
SR 46 and CR 426	SEMINOLE	Proposed	UFA	WMD Priority	Install new wells	28.736400	-81.116900
SYLVAN LAKE	SEMINOLE	Proposed	UFA	MFLs	Install new UFA well.	28.804996	-81.380345
Walker Ranch Sites (2)	Osceola	Existing	Update survey	update survey	survey wetland edge and tie	28.077798	-81.392287
Oak Island	Osceola	Existing	Update survey	update survey	survey wetland edge and tie	28.290541	-81.448432
Prairie Lake	ORANGE	Existing	IMPROVE	Make it an EMT Class I	Maintain existing weekly da	28.595104	-81.508483
CLIFTON SPRINGS NR OVIEDO	SEMINOLE	Existing	Improve data collection	Improved HAT Model Calibr	Improve data set; maintain	28.699872	-81.238118
ISLAND SPRING IN WEKIVA RIVE	SEMINOLE	Existing	Improve data collection	Improved HAT Model Calibr	Improve data set; maintain	28.823444	-81.417167
Intercession City, OSF-100	Osceola	Existing	???	UFA not currently monitore	UFA	28.255944	-81.504111
WITHERINGTON SPRINGS NR AP	ORANGE	Existing	Improve data collection	Improved HAT Model Calibr	Improve data set; maintain	28.714925	-81.489908
WEKIVA SPRINGS NR APOPKA	ORANGE	Existing	Improve data collection	Improved HAT Model Calibr	Maintain or Increase to mor	28.711886	-81.460422
ORF-60	Orange	Existing	UFA	improved model calibration	add new UFA to existing nes	28.378804	-81.587739
OUC Substation 19	Orange	Existing	UFA	improved model calibration	new UFA well at existing site	28.403278	-81.353778
OSF-70	Osceola	Existing	???	improved model calibration	monitoring of UFA	28.252369	-81.328200

Summary:

Proposed SAS Wells	61
Proposed UFA Wells	40
Proposed LFA Wells	18
Proposed APPZ Wells	2
Proposed IAS Wells	4