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WATER 2020 CONSTRAINTS HANDBOOK

WATER 2020

CONSTRAINTS HANDBOOK

BY

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Special Notice

This document represents the final work product of the Water Resource Constraints Subgroup. This subgroup was one of several dealing with specific issues during the St. Johns River Water Management District's (SJRWMD) Water 2020 water supply planning process during the period 1998-2000. More information about the subgroup process is included in the District Water Supply Plan, which is published by SJRWMD as Special Publication SJ2000-SP1.

The information and statements presented in this document should not be interpreted as being strictly consistent with SJRWMD rules and business practice. Clarifying footnotes are included where significant differences exist.

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ACRONYMS

F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
F.S.	Florida Statutes
SJRWMD	St. Johns River Water Management District
MFLs	minimum flows and levels
ppm	parts per million
PWRCAs	priority water resource caution areas
UF	University of Florida
WSA	Water Supply Assessment

INTRODUCTION

The St. Johns River Water Management District (SJRWMD) is leading a water supply planning effort to identify water sources sufficient to meet projected demands for all user groups within SJRWMD through the year 2020. Through its ongoing water supply Needs and Sources Assessment program, SJRWMD has identified priority water resource caution areas (PWRCAs) (Figure 1-1). The areas within PWRCAs are projected to be unable to meet demands without causing unacceptable harm based on existing water supply plans.

The Water 2020 Program is focusing on developing water supply plans for the PWRCAs that avoid unacceptable harm. The plans are likely to include optimization of existing withdrawals and ground water sources, increased use of alternative sources, and development of other water management strategies (e.g., aquifer storage and recovery, system interconnection, and artificial recharge).

Sustainable sources must be able to supply the needed amounts, as defined by projected demands, without incurring adverse impacts to the water resource, the natural systems dependent upon the resource, and existing legal uses. These restrictions are termed water resource withdrawal constraints.

PREVIOUS APPLICATIONS OF CONSTRAINTS

Water resource constraints have been routinely used in SJRWMD's water supply assessment and planning.

1994 Needs and Sources Assessment

SJRWMD's 1994 Needs and Sources Assessment (Vergara et al. 1994) used potential impacts to native vegetation resulting from lowered surficial water tables as one of the primary determinants of the boundaries of the water resource caution areas. A more detailed account of the native vegetation constraint is provided in Kinser and Minno (1995).

1998 Water Supply Assessment (WSA)

SJRWMD recently completed its 1998 Districtwide Water Supply Assessment (WSA) (Vergara et al. 1998). The WSA was performed to meet the requirements of the Governor's Executive Order 96-297 and Section 373.036(2)(b)4 of the Florida Statutes (*F.S.*). This districtwide

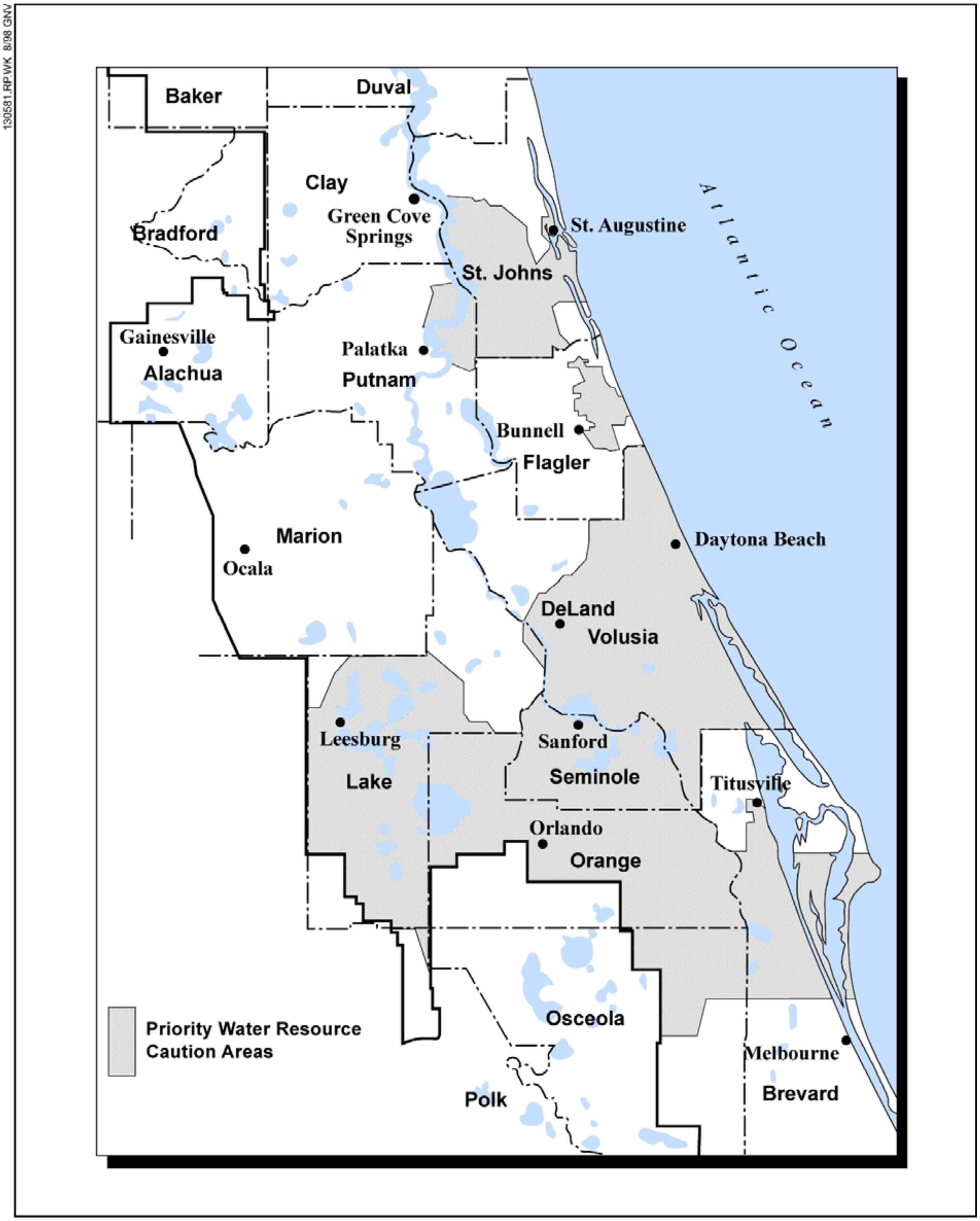

Figure 1-1. Priority Water Resource Caution Areas. Define regions where alternative water supply strategies are needed to meet future needs.

water supply planning effort determined for each water supply planning area whether existing and anticipated sources of water were adequate to supply water for all existing and projected needs and to sustain the water resource and related natural systems.

The 1998 WSA highlights the areas where existing and anticipated sources of water and conservation efforts do not appear adequate to supply water for all existing and future needs without causing unacceptable impacts to the water resources and related natural systems through 2020.

Unacceptable impacts were defined as the limits of water resource impacts beyond which a water resource-related problem would occur (as defined by a constraint). For the WSA, SJRWMD used the following four water resource constraints:

- Impacts to natural systems
- Impacts to ground water quality
- Impacts to existing legal users of water
- Failure to identify a source of supply for planned development

Based on these assessments, SJRWMD concluded that if major water users' current water supply plans are implemented, the potentiometric surface of the Floridan aquifer is expected to decline regionally resulting from cumulative withdrawals of water from the aquifer. In response to these potentiometric surface declines, and in response to withdrawals from the intermediate and surficial aquifers, the surficial aquifer's water table is expected to decline. Also, in response to the potentiometric surface decline, the discharge of numerous springs are expected to decline, and chloride concentrations are expected to increase in some public supply wells in the PWRCAs.

GENERAL ISSUES FOR DEVELOPMENT AND CONSTRAINT APPLICATION

Need for Water Resource Constraints

While ground water has been generally of high quality, reliable, and an inexpensive municipal water supply in the SJRWMD, it is unlikely that all additional future water supply needs can be met by this source without causing some level of unacceptable change to the resource or natural systems. Experience has shown that at some point our water supplies have finite withdrawal limits, beyond which results in changes in resources, such as quality, availability, and/or ability to support other uses.

Long-term effects of excessive withdrawals can be dramatic. When these effects cause impacts deemed unacceptable under the SJRWMD's regulatory criteria, the withdrawal impact must be reduced to an acceptable level. Specifically, actual and planned water supply withdrawals must not cause unacceptable impacts to SJRWMD's natural resources or other existing legal users. These protections are set by State of Florida Water Policy and SJRWMD rules.

Within the Water 2020 planning process, constraints will be used to identify impacts to uses and resources. For the planning process, a constraint is a tool that provides a mechanism for identifying potential future impacts to the resource and existing uses based on projected demands.

Four constraints will be used:

- Minimum flows and levels (MFLs)
- Native vegetation (primarily wetlands)
- Ground water quality
- Existing legal uses

While constraints apply to both planning and permitting, the water supply planning process is separate from the consumptive use permitting process. Issuance of future permits will be influenced by water supply plans that are developed. Criteria, thresholds, and assumptions used in the planning process will be based on the best available information for a regional scale analysis.

APPLICATION OF CONSTRAINTS TO THE WATER SUPPLY PLANNING PROCESS

The goal of the Water 2020 planning process is to develop a framework of acceptable water supply solutions (Figure 1-2). Constraints will be applied at several stages during the planning process, including:

- Withdrawal optimization
- Economic optimization
- Analysis of alternatives
- Assessment of new sources

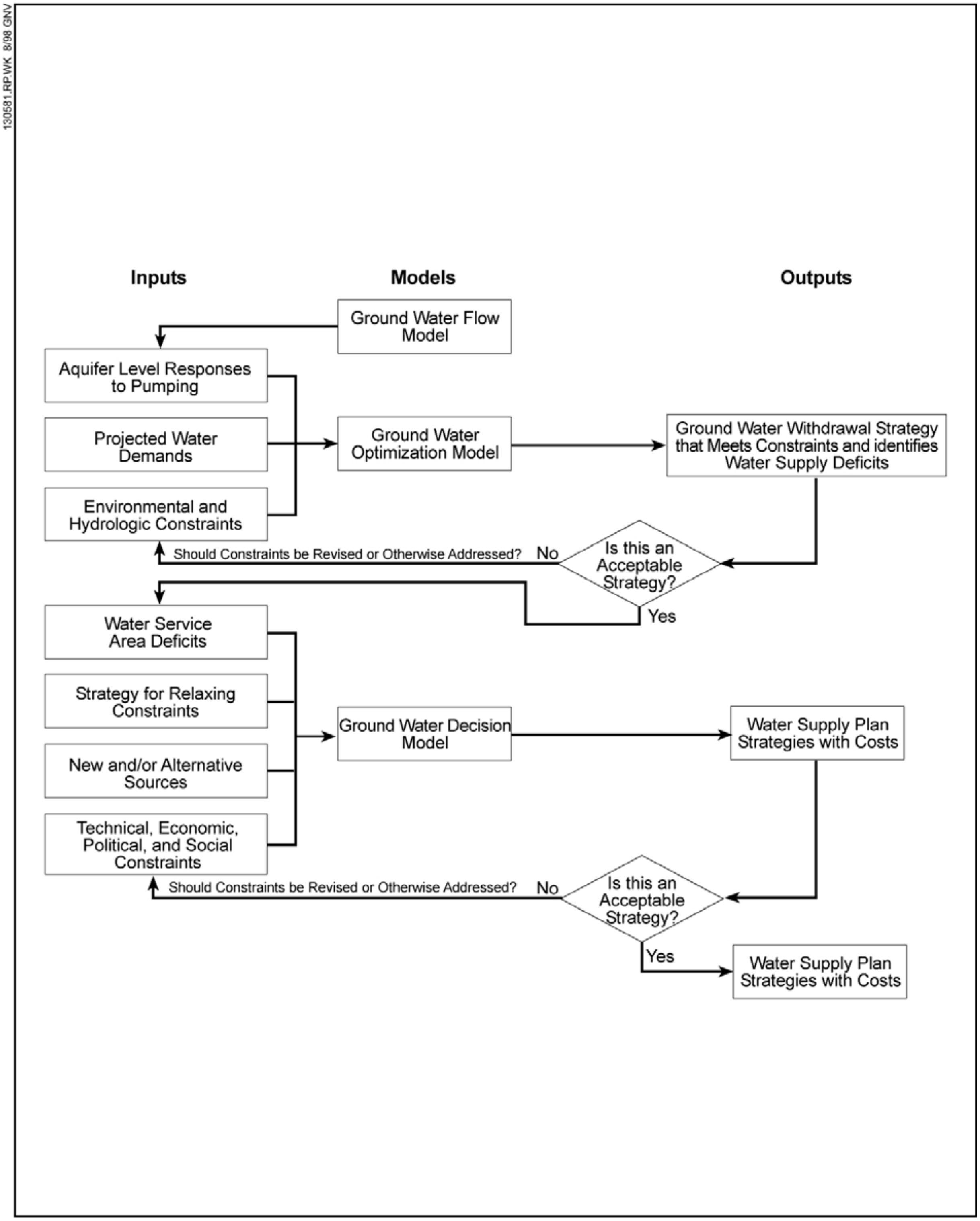

Figure 1-2. Optimization Decision Modeling Process.

SJRWMD's planning tools used in the water supply planning process include:

- SJRWMD Ground Water Flow Models
- SJRWMD Water Quality Models
- University of Florida (UF) Ground Water Allocation (withdrawal optimization) Model
- Water Supply Alternatives Evaluations (feasibility and costs)
- UF Decision (economic optimization) Model

Using these models, the effects of constraints can be investigated, feedback from which will help to *guide* the decision-making process. For example, sensitivity analysis can determine those constraints that are binding, how they affect the objective function, and how they are best implemented to identify acceptable water supply alternatives.

The method for applying the wetlands constraints is dictated by the computer modeling tools used in the respective work group areas. Of the six work group areas, two (Groups 1 and 2) have optimization and decision models to help guide the planning process. For the remaining four work groups (Groups 1A, 3, 4, and 5), the optimization and decision steps in the planning process will be done iteratively by the work group participants and SJRWMD staff.

For the east-central Florida and Volusia optimization and decision models, the constraints are incorporated directly into the model, typically in the model's grid cell associated with the location of the wetland, spring, lake, or other feature. In work group areas 1A, 3, 4, and 5, the contraints will be used in conjunction with the regional ground water flow model and other tools such as site-specific analytical models and surface water hydrology models.

THE CONSTRAINTS HANDBOOK

This handbook provides basic information on water resource constraints as they are used by SJRWMD in the Water 2020 planning process. It is organized in a question-answer format with individual sections devoted to each constraint. Additional technical background, as needed, is provided in an appendix or is referenced within the section.

The following questions are addressed for each constraint:

1. What is the constraint?
2. Why is the constraint needed?
3. What is the specific constraint measurement/datum? (e.g., change in mean stage of a lake)
4. What are the threshold values? (e.g., reduction in lake levels of 0.3 feet)
5. How will the constraint be applied spatially?

The handbook has been prepared as a loose-leaf notebook to allow sections to be updated as appropriate; in this sense, it is a "working" document.

WHERE CAN I FIND ADDITIONAL INFORMATION ABOUT WATER RESOURCE CONSTRAINTS?

Kinser, P. and M.C. Minno. *Estimating the Likelihood of Harm to Native Vegetation from Groundwater Withdrawals.* Technical Publication SJ95-8. SJRWMD. 1996.

Vergara, B. *Water Supply Assessment*. Technical Publication SJ98-XX. SJRWMD. Palatka, FL. 1998.

Vergara, B. *Water Supply Needs and Sources Assessment.* Technical Publication SJ94-7. SJRWMD. Palatka, FL. 1994.

MINIMUM FLOWS AND LEVELS (MFLs)

WHAT IS THE MFLs CONSTRAINT?

This constraint has been defined by provisions of the Florida Statutes, summarized as follows: The constraint consists of minimum flows for specific watercourses and minimum water levels for specific ground water systems and water bodies. These MFLs represent the limit at which further withdrawals would significantly harm the water resources or ecology of the region. The SJRWMD Governing Board will establish MFLs using the best information available at that time. When appropriate, MFLs may be calculated to reflect seasonal variations.

MFLs will be set to prevent adverse impacts to selected surface watercourses, aquifers, and surface waters in accordance with the priority list and schedule developed by the SJRWMD. The priority list will be based on the water resource's importance to the state or region as well as existing or potential for significant harm to the water resource itself or to the state or region's ecology. The list will include those waters that currently or that are reasonably expected to experience adverse impacts from water withdrawals.

When establishing MFLs, the SJRWMD Governing Board is directed by Florida Legislature to consider changes and structural alterations that have already occurred to watersheds, surface waters, and aquifers. Additional considerations include effects from such changes or alterations and the resulting constraints placed on the hydrology of the water body's system. Furthermore, it is recognized that certain water bodies no longer serve their historical hydrologic functions and that recovery to their historic hydrologic conditions may not be economically or technically feasible. Accordingly, the SJRWMD Governing Board may determine the appropriateness of setting an MFL for such a water body based on its historical condition.

This priority list will be updated and submitted on an annual basis to the Florida Department of Environmental Protection (FDEP). After FDEP review and approval, the list will be published in *Florida Administrative Weekly*. The SJRWMD published the priority list for the current year in January 1998 (see references below for additional information). SJRWMD is currently preparing an updated priority list that will include the next three years.

WHY IS THE MFLs CONSTRAINT NEEDED?

The overall water supply plan sets forth acceptable options for water supply development. Florida Legislature has specifically mandated that water supply plans consider established MFLs, which serve to prevent adverse impacts to water resources and ecology of the region. To that end, this constraint ensures that the water supply plan addresses the protection of established MFLs. In the event an existing water body's flow or level is currently or projected to fall below an established MFL within the 20-year planning horizon, Florida statutes require the water supply plan to include either a prevention strategy or a recovery strategy to address the MFL as soon as practicable.

It is important that the water supply plan include MFLs to determine whether the options identified in the plan warrant permit issuance. To obtain a CUP, applicants must demonstrate that the proposed water use will meet all criteria for permit issuance. One important criterion is that the proposed use will not cause or contribute to a violation of an established MFL.

WHAT IS THE SPECIFIC MFLs CONSTRAINT MEASUREMENT/DATUM?

In setting MFLs for a priority water body, the natural variability of levels or flows due to climatic conditions is taken under consideration. In Florida, most water levels and flows are subject to significant fluctuations due to periods of flood and drought. While this condition may be negatively perceived, these fluctuations often are critical to maintaining ecological functions associated with the ecological resources. As a result, MFLs are best defined as a set of minimum hydrologic criteria or statistics that will limit the shift in the existing hydrologic regime to maintain a minimum hydrologic regime that serves to prevent adverse and significant impacts to the water resource (Figure 2-1). Each MFL consists of the following:

- A flow value or water level elevation
- A minimum temporal component defined by a duration (how long this minimum flow or level must occur) and a return interval (how often this minimum flow or level must occur)

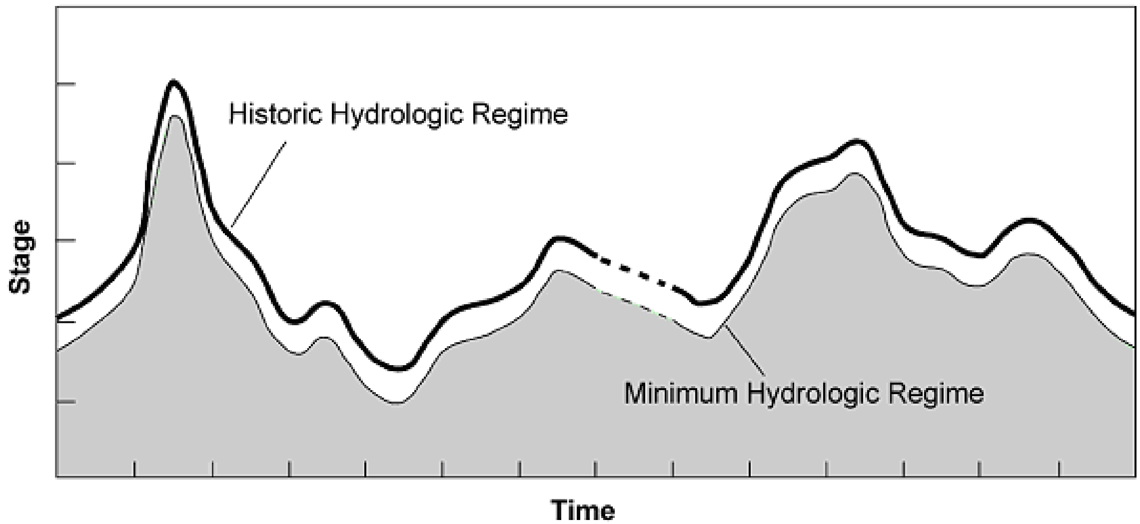

Figure 2-1. Example of Lake Stage Hydrograph for Historic and Minimum Hydrologic Regimes.

Typically, an MFL can be expressed as the minimum percent of time that a particular water level or flow must be met or exceeded over the long term. For more detailed information and definitions of temporal components of MFLs, refer to Chapter 40C-8 of the Florida Administrative Code (*F.A.C*).

For lakes and rivers, a set of specific MFLs has been established to protect the ecologically critical aspects of the hydrologic regime. For the Wekiva River, and for some of the first lakes for which MFLs were adopted, five minimum levels and flows were set (Figure 2-2). For most lakes, three MFLs have been adopted, including the minimum frequent high, the minimum average, and the minimum frequent low. Table 2-1 summarizes critical environmental functions protected by each minimum level.

For aquifer levels at springheads, a single minimum level has been set corresponding to the minimum average discharge required at the springhead to prevent adverse harm. In the case of most springs, this determination has been made based on minimum average springflow needed to maintain the baseflow component of a minimum acceptable hydrologic regime in the spring run or receiving water. A good example of this is the Wekiva River, where minimum springflow conditions were established based on the minimum hydrologic regime needed in the Wekiva River. However, in some cases, other critical

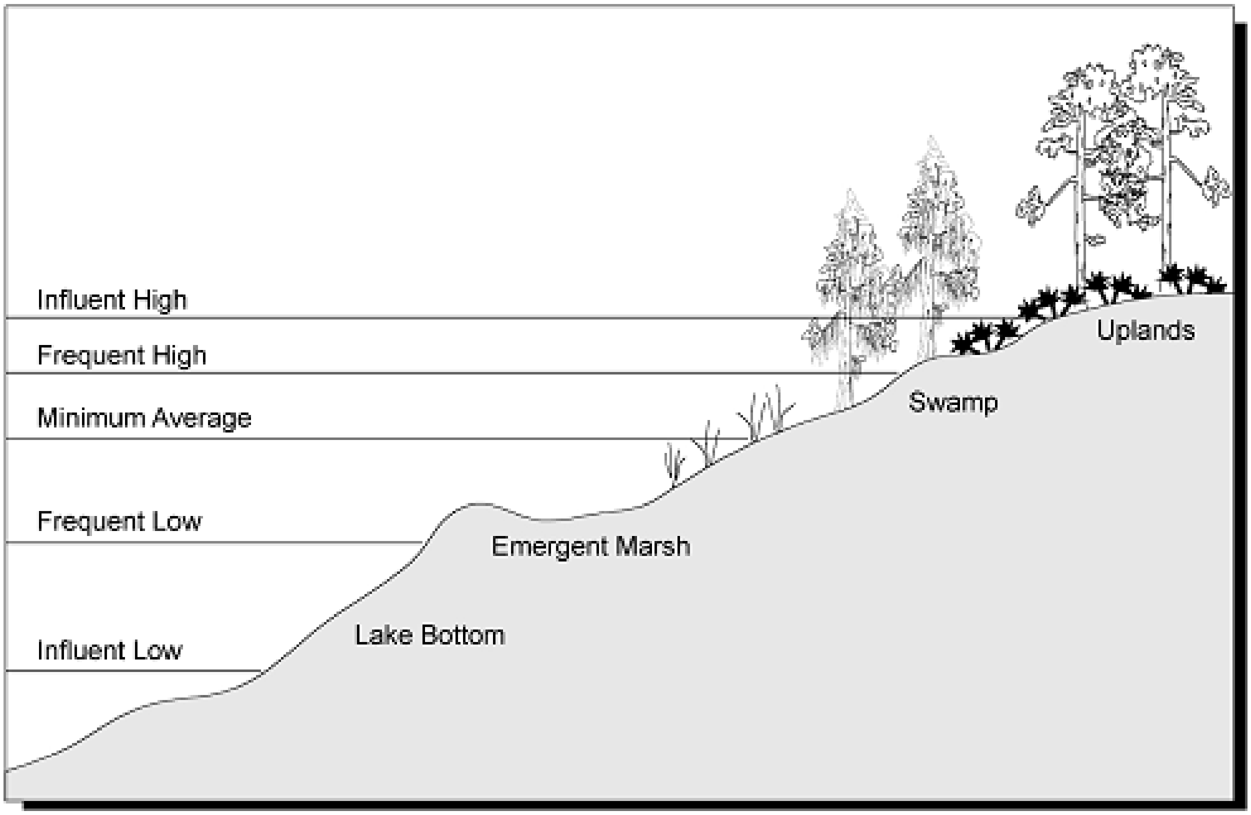

Figure 2-2. Range of Minimum Levels that can be Set to Support Environmental Functions.

Table 2-1. Minimum Levels for Wekiva River Support Specific Environmental Functions.

Minimum Level	Typical Environmental Functions Addressed by Minimum Level	Minimum Percent of Time Inundated
Minimum Frequent High	Floodplain habitat for fish Detritus transport Maintenance of mixed swamp Nutrient recycling	15 to 20
Minimum Average	Maintain hydric soilsGermination of mixed swamp Limit potential encroachment of upland plants	50 to 60
Minimum Frequent Low	Maintain fish refugia and passage Germination of aquatic plants Insert plant communities Prevent major soil subsidence Navigation and recreation	80 to 85

environmental functions determine minimum aquifer levels at springheads. A good example is Blue Springs in Volusia County, where a minimum flow for the spring is being developed based on protecting critical manatee wintering habitat in the spring run.

WHAT ARE THE MFLs VALUES?

The actual MFLs values have been adopted by rule and are listed in Florida Administrative Code (*F.A.C.)*, Chapter 40C-8.

To protect lakes with MFLs, the minimum average lake level is being used as the planning level constraint. Conceptually, this constraint is defined as follows: the allowable change from the average lake level under existing conditions to the minimum average level as illustrated in Figure 2-3. This approach is being used for several reasons:

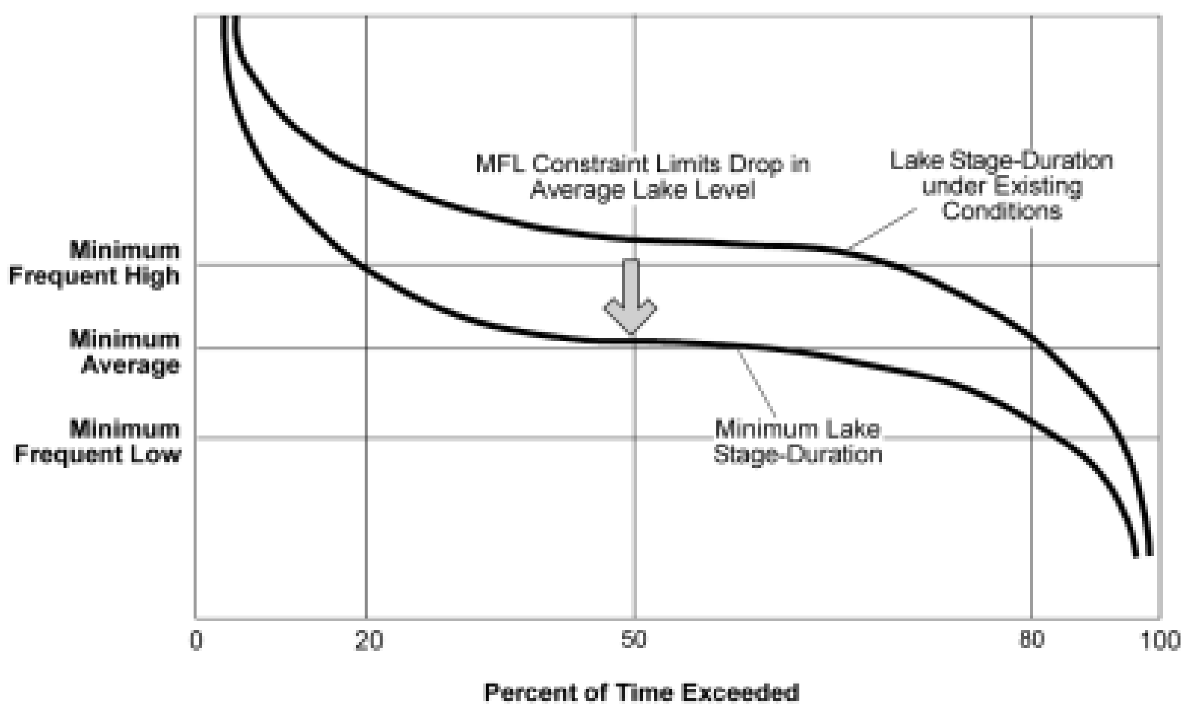

Figure 2-3. Example of Lake Stage-Duration Curves for Existing Condition and Minimum Average Condition.

- From a statistical standpoint, the average level (central tendency) is the most critical in defining the overall lake hydroperiod. [1]
- The minimum average lake level protects one of the more critical aspects of the lake environment—the extent of hydric soils.
- Changes in average level can be predicted with a reasonable degree of certainty using available steady-state ground water flow models.

Using this constraint, the allowable change in average lake level initially will be used as the maximum allowable change in the surficial aquifer of the regional ground water flow models.

Many lakes exist within the priority water resource caution area of which only a small set of lakes has adopted MFLs at this time. The SJRWMD plans to adopt MFLs for many additional lakes that also may be sensitive to changes in ground water levels resulting from increased pumping. For that reason, a generalized constraint was developed based on the limited number of MFL lakes completed to date. For existing lakes with MFLs, the average lake level decline (change from historical average to a new minimum average) is 0.3 feet with a 0.34 feet standard deviation. Based on this data, and the precision to which changes in the surficial aquifer can be predicted, a general lake constraint was set at 0.5 feet change in the average lake level.

Similarly, many significant springs exist within the priority water resource caution area that do *not* have MFLs set at this time. To prevent drastic springflow reductions, which would otherwise be inconsistent with future MFLs, a background constraint is proposed to initially limit springflow reductions to 15 percent. This percentage reduction is based on the MFLs set for major springs in the Wekiva Spring System. Springs were classified as either high or moderate sensitivity to ground water declines. Considered highly sensitive are those springs with rare, threatened, or endangered species located on public lands or used for public water supply. All other springs were considered moderately sensitive. If necessary, constraints on

[1] Among the five MFL thresholds, the average is the best defined statistic and therefore among these values is the most useful in the water supply planning process for developing and applying wetland constraints when data are limited.

moderately sensitive springs could be relaxed to allow up to 25 percent flow reduction.

In addition to those values listed above, minimum flows and levels currently being completed for Lake Washington, Taylor Creek (downstream of Taylor Creek Reservoir), and Blue Springs are anticipated to be available and useful as constraints in the current planning effort.

HOW WILL THE MFLS CONSTRAINT BE APPLIED SPATIALLY?

MFLs for specific waterbodies, aquifers, and springs will be applied in the ground water modeling domain at the appropriate location representative of that feature. For example, in the regional ground water flow models and optimization models for east-central Florida and Volusia County, minimum aquifer levels and associated springflows will be included as a constraint in the particular model cell that includes that feature. In areas without regional ground water flow models, any relevant MFLs will be used in evaluating impacts of proposed water supply demands using a variety of tools such as analytical flow models for particular wellfields or surface water hydrology models.

As discussed in the previous section, within the east-central Florida and Volusia regional flow models, MFLs for lakes initially will be represented by a constraint on the surficial aquifer's decline of 0.5 feet. This will apply to wherever lakes are located and expected to be susceptible to declines in the upper Floridan aquifer. Lakes that meet the following criteria were proposed to adopt the generalized constraint unless a similar wetland constraint had been previously proposed for the area:

- Lakes greater than 25 acres in size
- Lakes that were closed with no significant inlet and outlet

Using this approach, the surficial aquifer is being constrained to a maximum 0.5 ft decline in approximately 50 to 100 cells in the East Central Model and approximately 25 to 50 cells in the Volusia model.

WHERE CAN I FIND ADDITIONAL INFORMATION ABOUT MFLs?

F.A.C. Chapter 40C-8. (October 20, 1996 revision is most current at this time).

F.S. Regional Water Supply Planning. Chapter 373. Section 373.0361.

F.S. Minimum Flows and Levels. Chapter 373. Section 373.042.

F.S. Establishment and Implementation of Minimum Flows and Levels. Chapter 373. Section 373.0421.

Hupalo, et. al. *Establishment of Minimum Flows and Levels for the Wekiva River System.* Technical Publication SJ94-1. SJRWMD. Palatka, FL. 1994.

Minno, Marc C. Estimated Spring Constraint Thresholds. Memorandum to Hal Wilkening SJRWMD. May 5, 1998.

Neubauer, Ph.D., C. A Calculated Average Hydrologic Decline for District Lakes to be Used for Calculating Boundary Conditions for the Floridan Aquifer under District Lakes. Memorandum to Hal Wilkening. SJRWMD. May 13, 1998.

Rao, D. and D.A. Clapp. *Preliminary Evaluation of the Impacts of Spring Discharge Reductions on the Flow of Receiving Water Bodies and Natural Systems, Central Florida*. Technical Publication SJ96-SP3. 1996.

SJRWMD. Priority List and Schedule for Establishing Minimum Flows and Levels. Narrative Discussion to Governing Board. November 11, 1997.

SJRWMD. Priority List and Schedule for Establishment of Minimum Flows and Levels in 1998. *Florida Administrative Weekly*. Volume 23, Number 52. December 26, 1997.

NATIVE WETLAND VEGETATION

WHAT IS THE NATIVE WETLAND VEGETATION CONSTRAINT?

Results of investigations by SJRWMD and others demonstrate that changes in a wetland's hydrologic regime, such as a reduction in the surficial aquifer level, may affect the structure and species composition of the vegetative community. The wetland constraint establishes maximum drawdown values for specific wetland community types, which if exceeded, are likely to result in the replacement of dominant vegetative species by those characteristic of drier community types.

WHY IS THE NATIVE VEGETATIVE WETLANDS CONSTRAINT NEEDED?

A key aspect of water supply planning is to develop water management strategies and alternative sources that will eliminate, avoid, or reduce the extent of the projected future impacts to natural systems (wetlands, lakes, and springs). Assessments performed by SJRWMD staff demonstrate that hydrological impacts to natural systems will likely result from the *ground water* pumpage for the years 2010 through 2020 (Figure 3-1). The purpose of the wetlands constraint is to ensure protection of wetland communities that may be impacted by pumpage-induced reductions in the surficial aquifer.

WHAT IS THE SPECIFIC NATIVE VEGETATIVE WETLANDS CONSTRAINT MEASUREMENT/DATUM?

Table 3-1 summarizes the categories of change that wetland communities may undergo due to dewatering. These five categories of expected ecological change in wetlands are based on the degree to which plant and animal species composition will change as a result of differing degrees of water level drawdown (CH2M HILL, 1996). Drawdown can be defined as a decline in the surficial water table relative to a predetermined reference datum. A drawdown could result in changes in composition and relative dominance of vegetative species within the wetland community. For example, a fresh water marsh is commonly dominated by plant species such as pickerelweed, arrowhead, and sawgrass. A drawdown of 0.55 feet may be expected

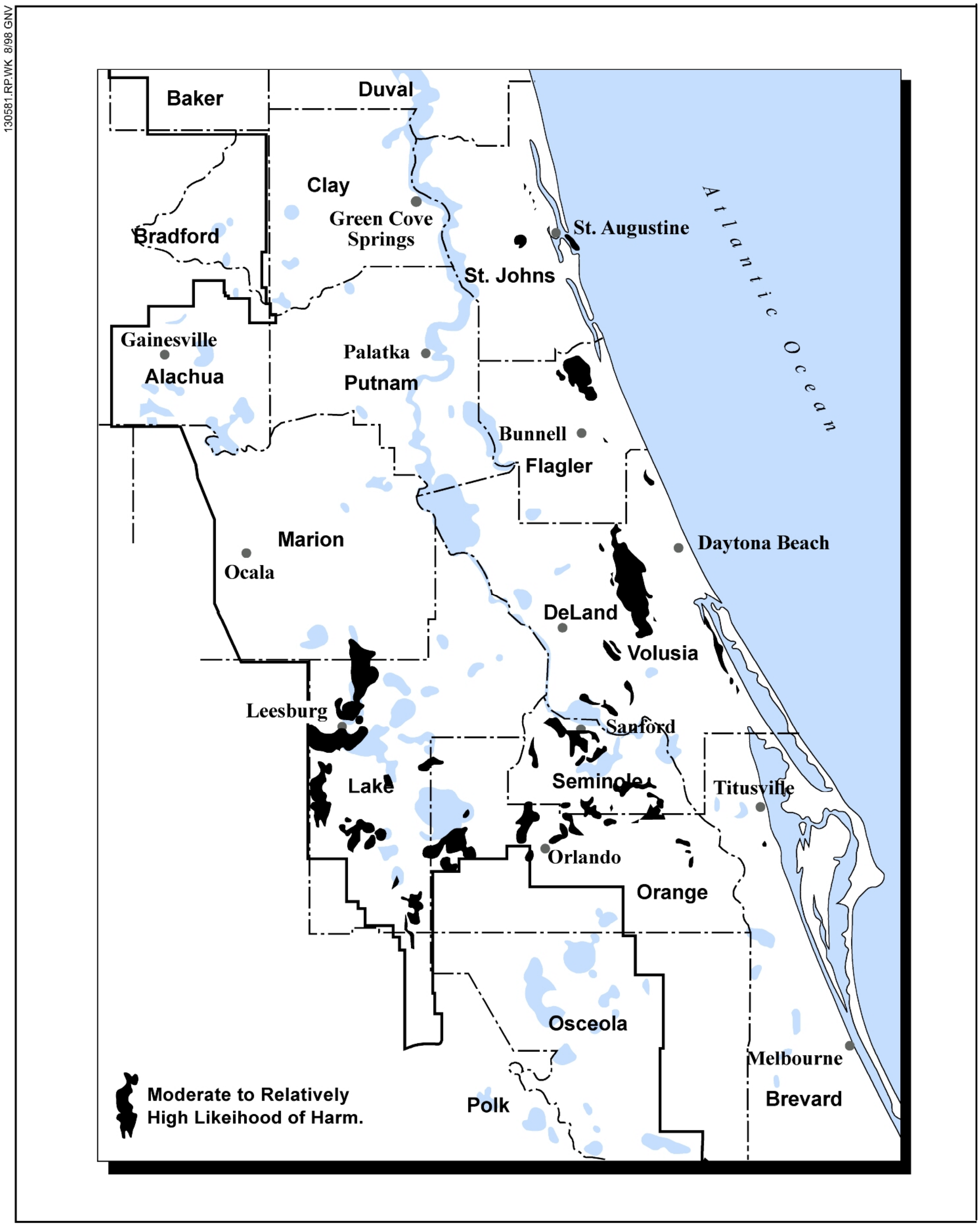

Figure 3-1. Final Model Results. Sensitive plant communities on easily dewatered soils in areas of significant drawdown would most likely be harmed.

Table 3-1. The Five Categories of Expected Ecological Change in Wetlands.

Category 1: No expected change in dominant plant and animal communities

Category 2: Moderate shift in dominant species while wetland community type remains the same.

Category 3: Change in dominant species results in different wetland type indicative of drier conditions.

Category 4: Ongoing species composition changes result in community typical of upland/wetland transition zone.

Category 5: Upland conditions prevail.

to lead to the replacement of these freshwater marsh plants by species characteristic of wet prairie communities such as blue maidencane, St. Johns wort, and beakrushes.

Because the goal of the water resource constraint is to prevent significant harm to the target resource, the threshold is set to protect the type, nature, and function of the community (Figure 3-2). To this end, the transition values between categories 2 and 3 were used to define drawdown levels for the constraint.

WHAT ARE THE NATIVE VEGETATIVE WETLAND CONSTRAINT VALUES?

Categories of change were assigned to each wetland type based on typical hydrographs developed from scientific literature and unpublished data. This information is summarized in CH2M HILL (1996). Table 3-2 shows values for specific wetland types.

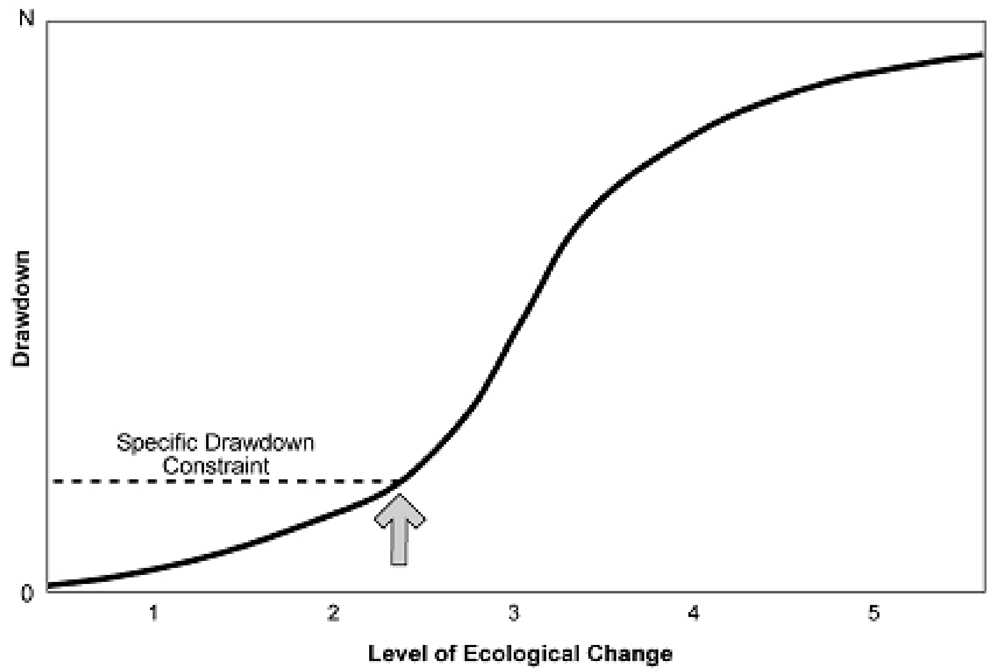

Figure 3-2. Relationship Between Drawdown and Ecological Change.

Table 3-2. Values for Specific Wetlands Types.

Wetland Type	Feet of Drawdown
Bay Swamp	0.35
River/Lake Swamp	0.35
Cypress Swamp	0.55
Mixed Forest	0.35
Freshwater Marsh	0.55
Saltwater Marsh	Not Used
Wet Prairie	0.35
Emergent Aquatic Vegetation	0.85
Submergent Aquatic	1.20
Mixed Scrub-Shrub	0.75
Non-Vegetated Wetland	1.20

HOW WILL THE WETLANDS CONSTRAINTS BE APPLIED?

The wetland constraint will be applied to specific wetlands areas in each planning area. The specific constraint locations are designated as control points. Each control point is associated with a specific grid cell in a regional ground water flow model. A series of control points and their associated numerical constraints were distributed throughout SJRWMD. Wetland control points were selected by using a GIS selection process in which only cells with sparse wetlands (5 to 10 acres) and those with 35 to 45 percent wetland coverage (Figure 3-3) were included in the sample population. This process ensured full representation of isolated wetland and wetland boundary areas. Other modifications to the selection process included:

- Thinning of clusters of cells
- Exclusion of coastal areas and a buffer along the St. Johns River
- Reallocation of some points based on expert opinion

Figure 3-3 shows the distribution of wetland control points for Volusia model domain. In the figure, the model grid cell containing the sensitive wetland is highlighted. Studies show that the "pump now and mitigate later" approach to water supply development would result in unacceptable impacts to wetland and aquatic systems and the projected cost of mitigating the impacts would be prohibitive (CH2M HILL, 1998). The high cost of fully mitigating impacts prompted the SJRWMD to seek practical and cost effective ways to minimize impacts.

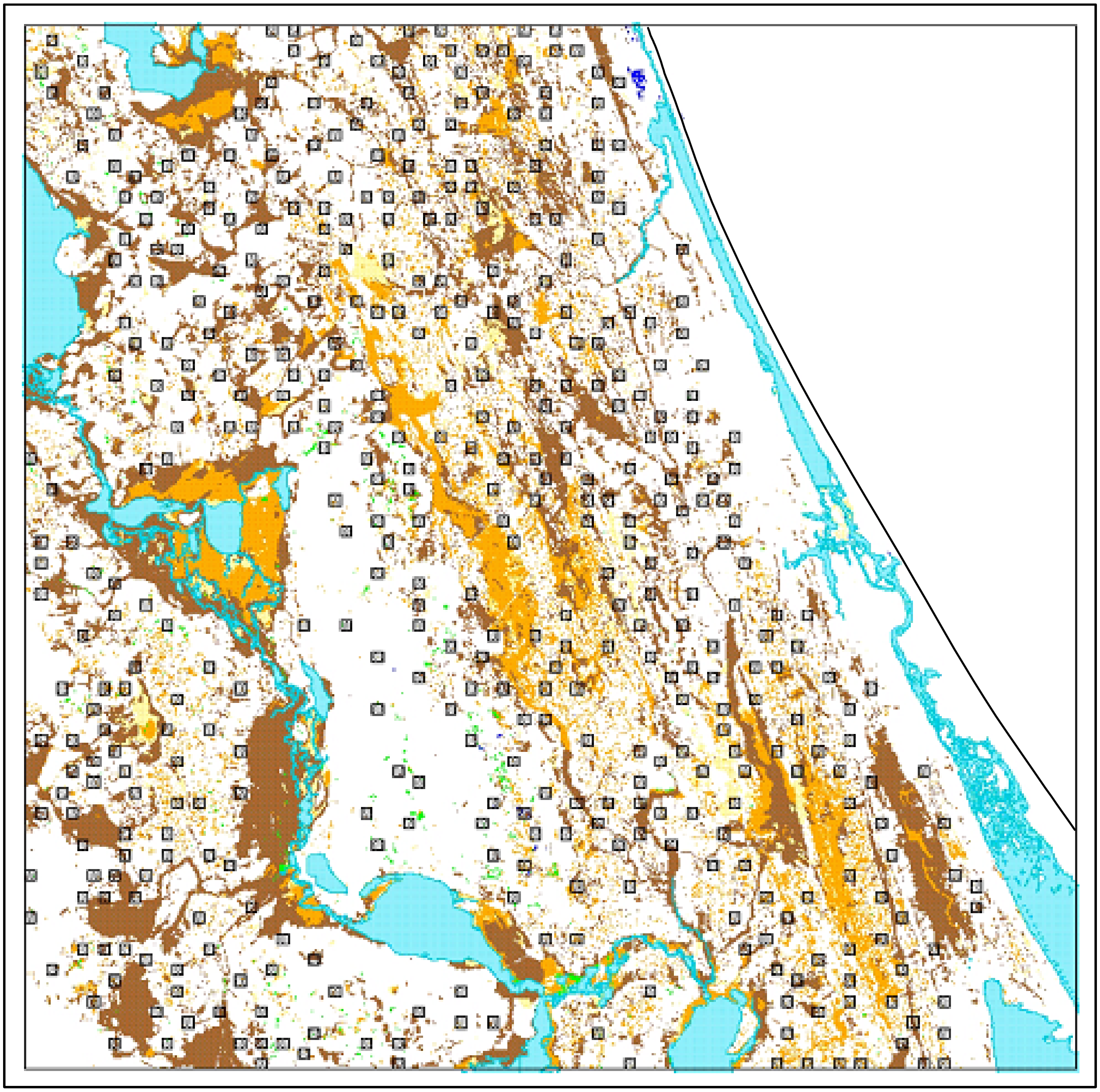

Figure 3-3. Allocation of Wetland Control Points in Volusia County.

The set of control points is used to constrain model drawdown and to indicate areas having either a surplus or deficit of available water. This process is shown in the diagram below (Figure 3-4).

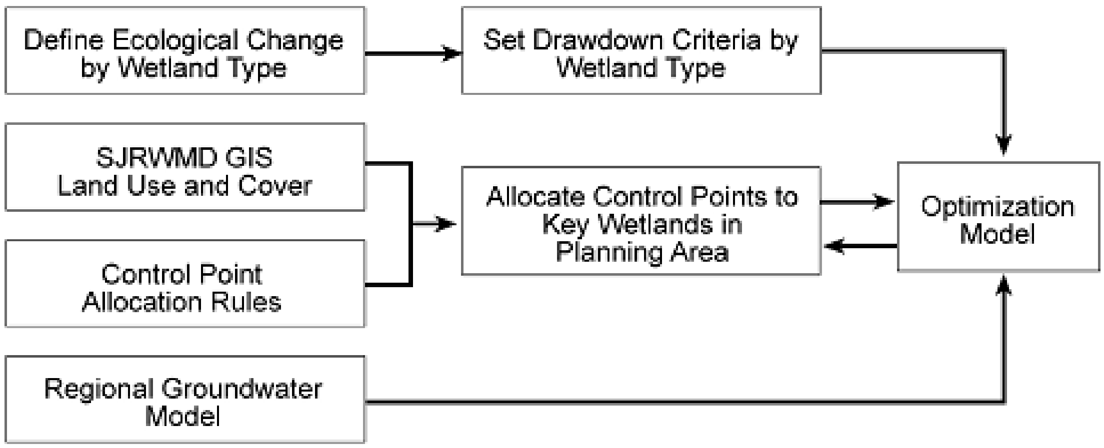

Figure 3-4. Model Application of Wetland Constraints.

WHERE CAN I FIND ADDITIONAL INFORMATION ABOUT NATIVE VEGETATIVE WETLANDS CONSTRAINTS?

CH2M HILL. *Alternative Water Supply Strategies Investigations. Application of Planning-Level Cost Estimating Procedure.* Technical Memorandum E.1.H. April 1998.

CH2M HILL. *Water Supply Needs and Sources Assessment. Alternative Water Supply Strategies Investigation. Wetlands Impact, Mitigation, and Planning-level Cost Estimating Procedure*. Special Publications SJ96-SP7. 1996.

Kinser, P. and M.C. Minno. Estimating the Likelihood of Harm to Native Vegetation from Ground Water Withdrawals. Technical Publication SJ95-8. SJRWMD. 1996

GROUND WATER QUALITY

WHAT IS THE GROUND WATER QUALITY CONSTRAINT?

The water quality constraint described in this section addresses the protection and long-term viability of ground water resources, specifically the Floridan aquifer. Over time, water quality can deteriorate as a result of regional changes in the ground water flow system or changes caused by well withdrawals, either individually or as a group. The constraint is a water quality limit placed on the ground water resource whereby water quality is allowed to change up to that limit.

The initial management constraint for the purposes of the planning process is to continue to allow for increased withdrawals as long as the quality of water from production wells does not exceed the current drinking water standard of 250 parts per million (ppm) chloride concentration, or the existing chloride concentration at that location, whichever is greater.

WHY IS THE GROUND WATER QUALITY CONSTRAINT NEEDED?

The need for the constraint is consistent with the overall water resource planning process. That is, the constraint is needed to ensure the long-term use of available ground water resources without creating adverse impacts to either the ground water flow system and related natural resources, or to other existing users.

Conditions which cause the need for the constraint:

Water quality in the Floridan Aquifer deteriorates with depth.

The Floridan aquifer is one of the most prolific aquifers in the world. Its aerial extent encompasses all of Florida (extending outward to the ocean) and portions of Alabama, Georgia, and South Carolina. Much of the Floridan aquifer is under artesian pressure, meaning that the aquifer is overlain and confined by low permeability geologic materials (Figure 4-1). When an aquifer exists under this condition, water levels in wells rise above the top of the aquifer.

Rainwater percolates down underground to replenish our water sources. Areas where downward infiltration of water into the aquifer occurs, allowing for deep percolation, are called recharge areas.

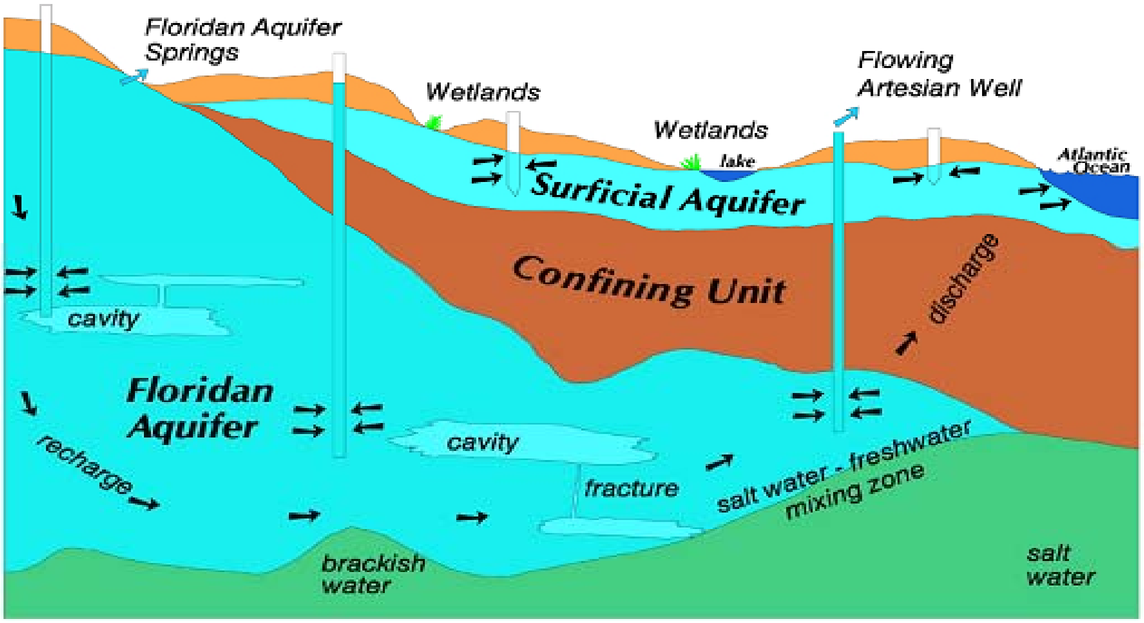

Figure 4-1. Schematic Cross-Section of Aquifer Systems in the SJRWMD.

Discharge areas, such as ground water seeps and springs, are areas where ground water flows toward the surface.

The Floridan aquifer was formed as a result of a marine environment and is composed of limestone and dolomites, with varying hydraulic properties. Because of this depositional environment, the uppermost parts of the aquifer contain fresh water, and with depth, water quality deteriorates with chloride concentrations approaching that of seawater (Figure 4-2). Conceptually, fresh ground water in this state exists in a lens form that is underlain by denser, more highly mineralized water.

Water quality in the Floridan Aquifer deteriorates near discharge areas, generally near the coast.

Water quality also tends to deteriorate near natural discharge areas, generally located toward the coast, including the St. Johns River in East-central Florida. Discharge areas are controlled by the area's overall geology. In some areas, confining units may become thin or absent. Some areas include springs. In the case of the upper and middle St. Johns River valley, water quality deteriorates rapidly with proximity to the river. Again, this is the result of poor-quality water upwelling from deep within the aquifer, resulting from lack of confinement or other hydrogeologic conditions.

Poor-quality water may exist in the Floridan aquifer within close proximity to the bottom of a well or within close lateral distance to the well.

Because water quality deteriorates with depth, wells that derive water from the Floridan aquifer may be constructed in a manner such that the bottom lies very close to the poorer-quality water. When water is withdrawn from such a well, the potential exists for poor-quality water to move up and into the borehole of the pumping well.

The well's water quality will continue to deteriorate to the level of the poorer quality zone located beneath the well. The rate at which the water quality deteriorates also depends on the rate of withdrawal from the well. This physical process is called salt water upconing beneath a pumping well (Figure 4-3). Salt water upconing can occur in an individual or group of wells. This process can be evaluated and/or predictions can be made using an analytical or numerical model.

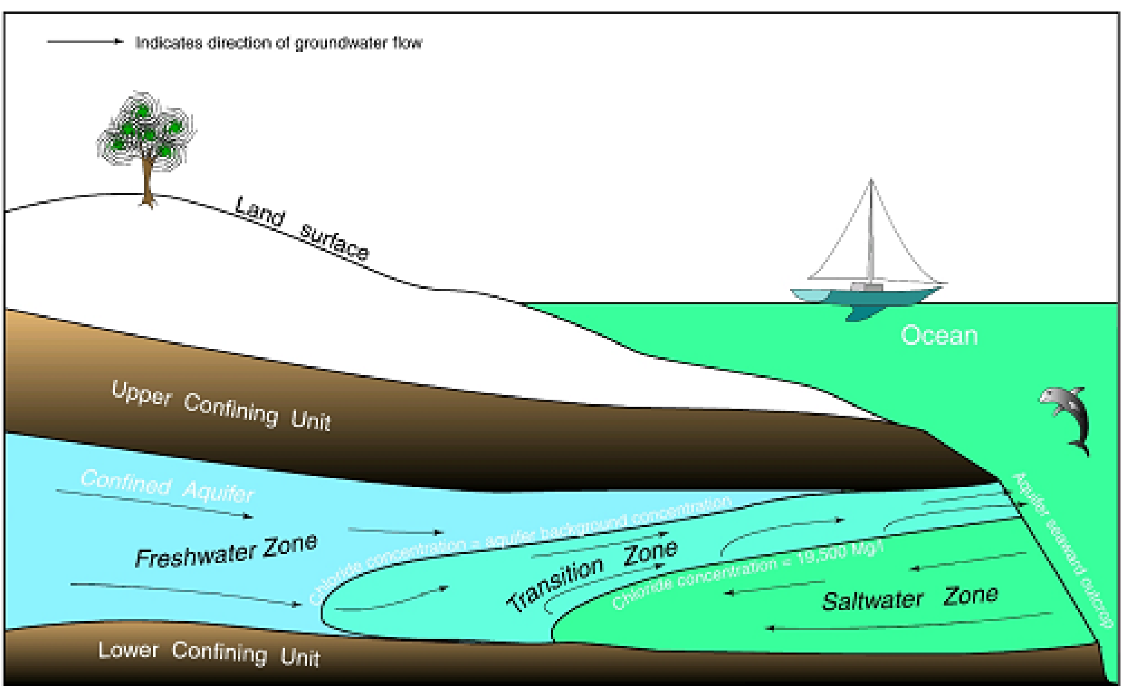

Figure 4-2. Schematic of Coastal Aquifer System.

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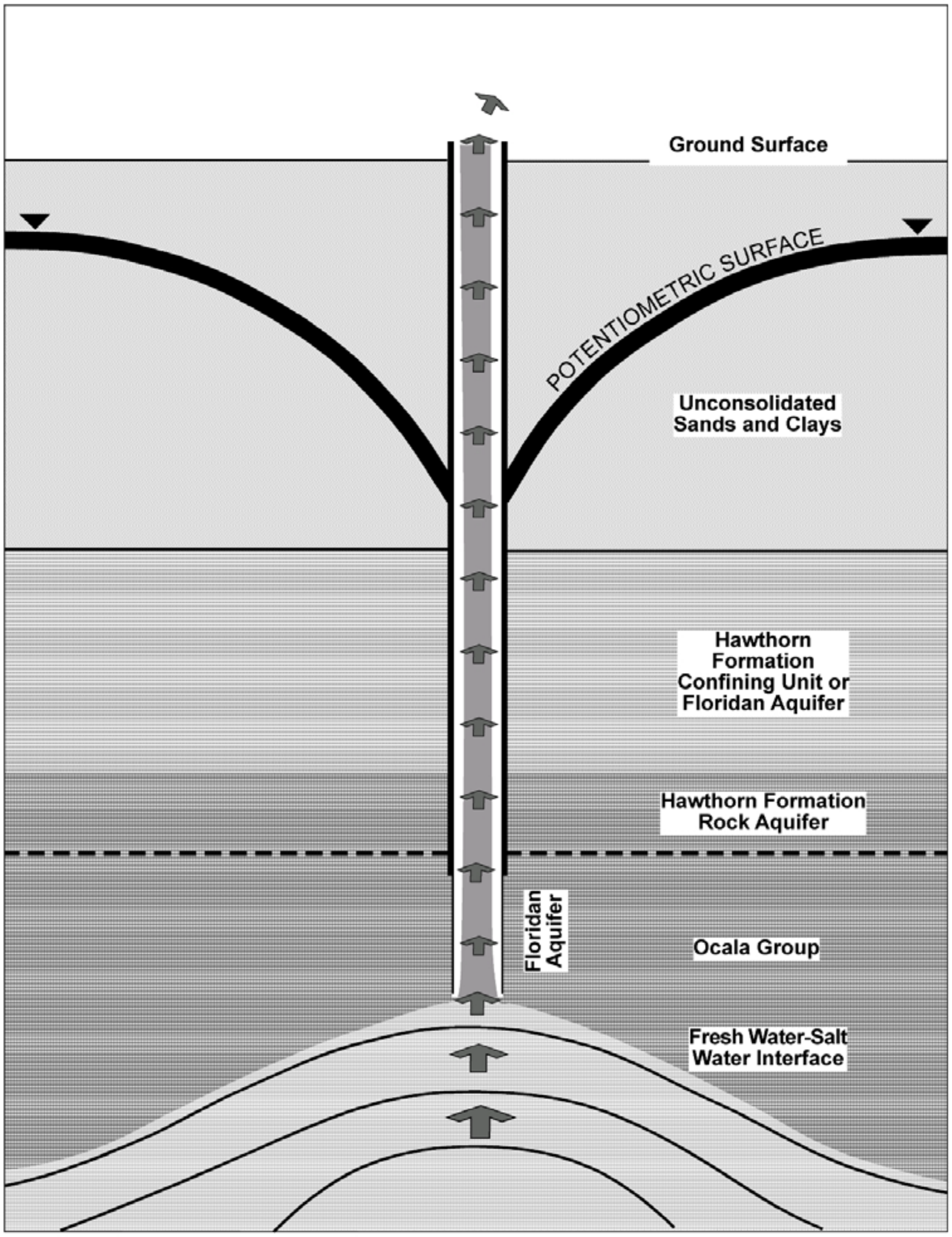

Figure 4-3. Schematic Diagram of Salt Water Upconing.

Movement of the poor-quality water associated with the transition zone results from localized or cumulative regional withdrawals and hydrogeologic conditions.

Lowered water levels resulting from pumping water from a well can cause the upconing of poor-quality water into the fresher zones of the Floridan aquifer. In a similar fashion, a regional decline in water levels (pressures associated with the sum of all the withdrawals of a given area) can cause the lateral movement of that transition zone toward the area of concentrated withdrawal. This process is generally referred to as lateral salt water intrusion. Those wells closest to the front of the transition zone are first affected because the fresh water lens is relatively thin in this area (Figure 4-4). The rate at which the front moves is associated with the density of withdrawals, the cumulative quantity of withdrawal, and the hydrogeologic characteristics of the aquifer. This process can be evaluated and predictions can be made using an analytical or numerical model.

In summary, the two hydrogeologic processes managed by this constraint are saline water upconing and lateral saline water intrusion.

WHAT IS THE SPECIFIC GROUND WATER QUALITY CONSTRAINT MEASUREMENT/DATA?

The water quality constraint limits the change in chloride concentration of water withdrawn from the Floridan aquifer (Figure 4-5). Water withdrawn for potable supply will be allowed to change from an initial condition to a maximum of 250 ppm chloride concentration. This concentration is USEPA's recommended limit for drinking water. Wells that are used in a blending process for potable supply above 250 ppm will not be allowed to change above the initial concentration. Other wells for various purposes will be limited to similar changes in concentration. If specific user groups need more stringent limits, they can be accommodated in the modeling process.

WHAT ARE THE GROUND WATER QUALITY VALUES?

Values of chloride concentration for the water quality constraint are derived from two or more sources. Initial conditions are estimated from maps of chloride concentrations in the Floridan aquifer, produced by the SJRWMD. These maps are composite data sources from observation wells, test-hole drilling, geophysical logging,

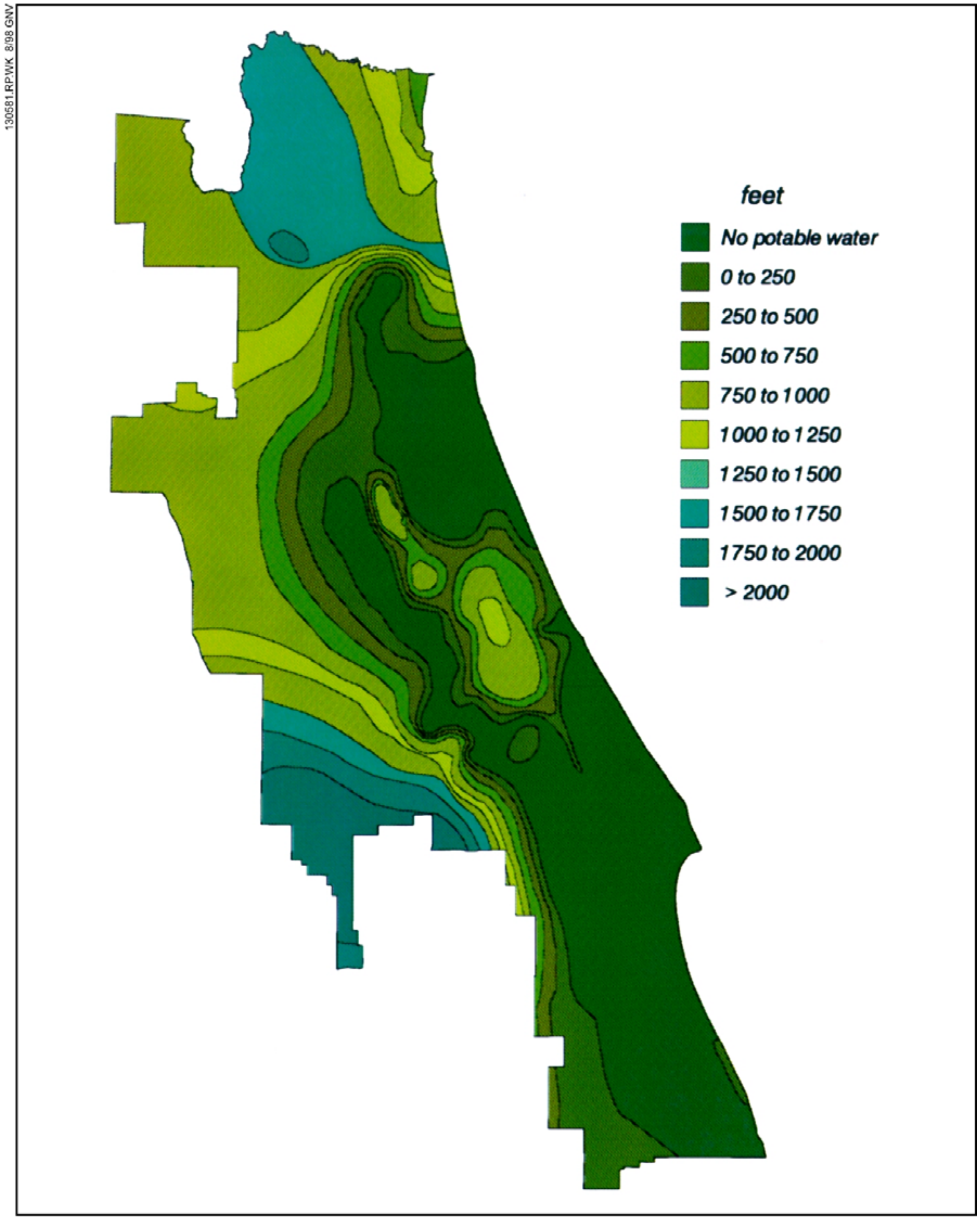

Figure 4-4. Thickness of Potable Water in the Floridan Aquifer.

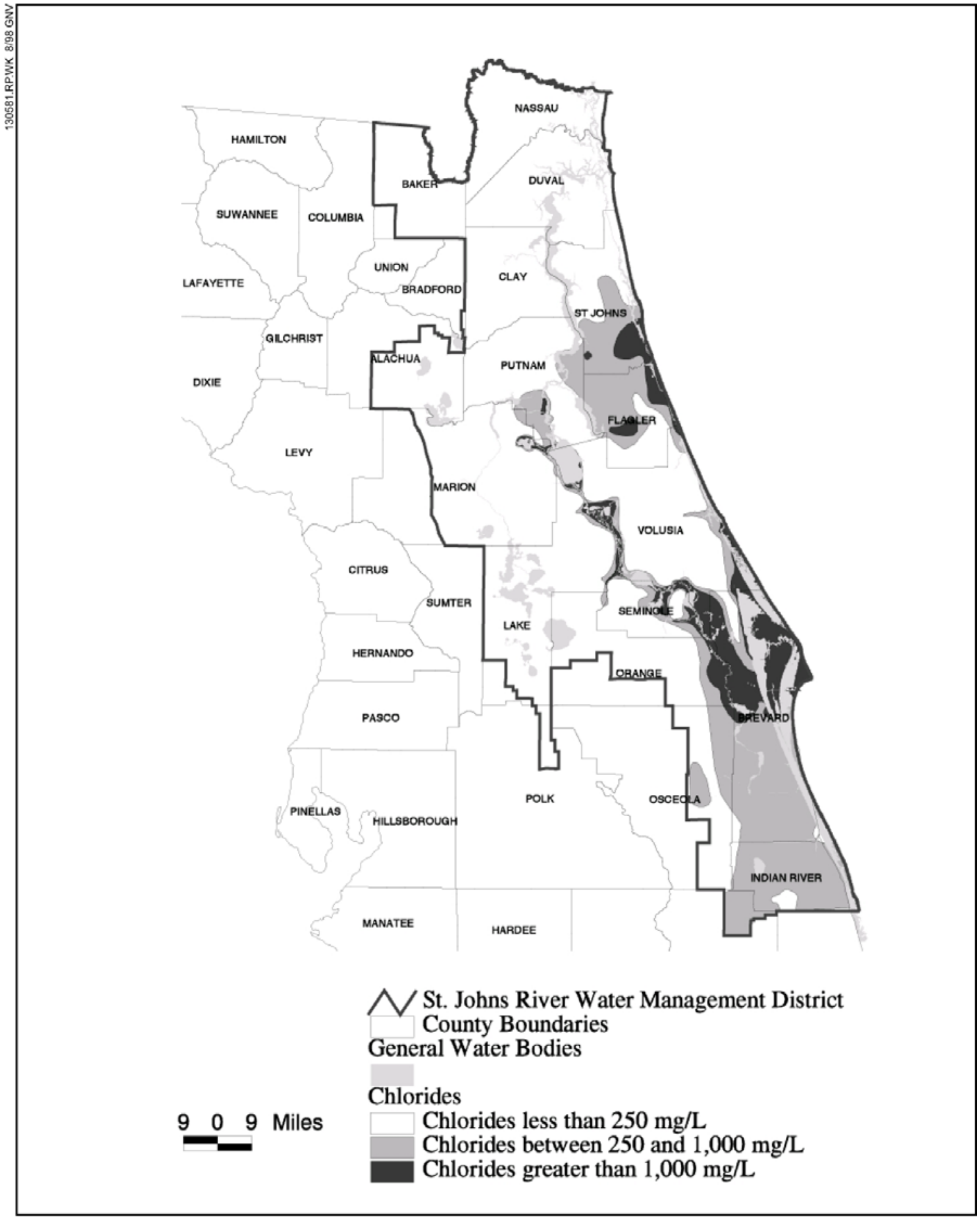

Figure 4-5. Chloride Concentrations in the Upper Floridan Aquifer.

downhole samples, or results of Time Domain Electromagnetic Surveys. From this information, the depth to the 250 ppm isochor was determined as a starting condition in the numerical modeling analysis. In this analysis, 1995 withdrawal rates were applied to the wellfield locations to determine an initial chloride concentration for use in the 2020 Decision Modeling. Some initial concentrations assigned to well fields were derived from data supplied by utility operators.

HOW WILL GROUND WATER QUALITY CONSTRAINTS OPERATE?

This constraint will operate within the Decision/Optimization Modeling Process. For each model, a matrix of influence coefficients is developed. The influence coefficient matrix is a set of data that represents the relationship between the change in the model's quantity of ground water withdrawn from a cell and the change in chloride concentration in that cell. Given that information, the Decision/Optimization Model determines whether the proposed cumulative projected demand (2020) can be met by accommodating the water quality constraint and other environmental constraints. If the demand cannot be met, then the withdrawal rates are optimized spatially and reduced to a quantity that allows for all constraints to be met. If a well or wells cannot meet the projected demand, the shortfall in the 2020 demand (need) is called the deficit. This is the total amount of water, including all other deficit areas, which the Decision/Optimization will query to determine alternative source strategies. If the Decision Model selects an alternative to acquire additional ground water supplies from an undeveloped source area, then the water quality constraint evaluation will be accomplished separately, apart from the model.

HOW WILL GROUND WATER QUALITY CONSTRAINTS BE APPLIED TEMPORALLY/SPATIALLY?

In the decision model the constraint is applied to each active cell within the boundaries of the regional ground water flow model where withdrawal occurs. The models being used are "steady-state"models. In other words, given the projected 2020 demand on the ground water flow system, the model simulates what the long-term change will be in the system. In this condition, it is assumed that climatic conditions will remain similar to historical conditions. Because of the nature of the Floridan aquifer, steady-state conditions may be achieved in a short amount of time (years). However, the impact of the decline of the Floridan aquifer on other natural resources may take tens of years to fully respond to the 2020 stress.

WHERE CAN I FIND ADDITIONAL INFORMATION ABOUT GROUND WATER QUALITY CONSTRAINTS?

Blackhawk Geosciences, Inc. *Re-examination of the 1986 and 1988 TDEM Soundings in Seminole County, Florida.* SJ92-SP15. 1992.

Blackhawk Geosciences, Inc. *Time Domain Electromagnetic Measurements, East-central Florida. SJ 92-5.* 1992.

Boniol, Don. *Summary of Groundwater Quality in the SJRWMD.* SJ96-SP13. 1996.

CEES Blackhawk Geosciences Division. *Time Domain Electromagnetic Soundings.* SJ93-SP1. SJRWMD. July 1992.

CEES Blackhawk Geosciences Division. *Updated Time Domain Electromagnetic Survey Data: Seminole County, Florida.* SJ93-SP2. 1993.

CH2M HILL. *Identification of Brackish Water Sources* (in review). SJ98-SPXX. 1998.

Demas, et al. *Decision Modeling for Alternative Water Supply Strategies* (in review). SJ98-SPXX. 1998.

GeoTrans, Inc. *Wekiva River Basin Groundwater Flow and Solute Transport Modeling Study Phase III: Three-dimensional Density Dependant Groundwater Flow and Solute Transport Model Development.* SJ92-SP21. 1992.

Hatfield, et al. *Water Resource Allocation and Quality Optimization Modeling.* SJ96 -SP5. 1996.

Hydrogeologic Inc. *Groundwater Flow and Solute Transport Modeling Study for Eastern Orange County, Florida and Adjoining Regions.* SJ93-SP4. 1994.

Hydrogeologic Inc. *Groundwater Flow and Solute Transport Modeling Study for Seminole County, Florida.* SJ94-SP6. 1993.

Koulekey, Kodjo C. *Modeling Saltwater Upconing in Coastal Aquifers*. Dissertation. Department of Civil Engineering, University of Florida. Gainesville, FL. 1986.

Motz, L.H. *Predicting Saltwater Upconing Due to Well Field Pumping*. Proceedings from International Association of Hydrogeologists Symposium. *Future Groundwater Resources at Risk.* IAHA Publication No. 222. Department of Civil Engineering, University of Florida. Gainesville, FL. 1994

Motz, L.H. *Salt-water Upconing in an Aquifer Overlain by a Leaky Confining Bed.* Department of Civil Engineering, University of Florida. Gainesville, FL. Published in *Groundwater*. Vol. 30, No. 2. 1992.

Subsurface Detection Investigations, Inc. *Time Domain Electromagnetic Mapping of Saltwater in Northeast & East-Central Florida.* SJRWMD. SJ97-SP1. November 1996.

Subsurface Detection Investigations, Inc. *Time Domain Electromagnetic Mapping of Saltwater in Northeast & East-Central Florida.* SJ94-SP8. SJRWMD. October 1994.

Williams, Stan. *A Regional Flow Model of the Volusia Ground Water Basin.* SJ97-3. 1997.

INTERFERENCE WITH EXISTING LEGAL USES

WHAT IS THE EXISTING LEGAL USES CONSTRAINT?

To obtain a consumptive use permit from SJRWMD, the applicant must demonstrate that the use for water will not cause interference with an existing legal use of water. Interference with a legal use of water is defined as a decrease in the withdrawal capability of any individual withdrawal facility of a legal use of water which was existing at the time of the application for the permit such that the existing user experiences economic, health, or other type of hardship. Interference may relate to either ground water quantity or ground water quality (e.g., salt water intrusion). Interference is further defined in subsection 9.4.4 of the SJRWMD's Applicant's Handbook: Consumptive Uses of Water, October 20, 1996.

In the consumptive use permitting process, SJRWMD evaluates interference on a case-by-case basis. If a requested allocation causes no interference with legal uses of water existing at the time of permit application, and other evaluation criteria are met, SJRWMD will allocate the requested amount of water. However, if the requested amount results in interference, SJRWMD can only allocate that portion of the requested amount that will not result in interference with legal uses of water existing at the time of permit application. As an alternative, the applicant may mitigate the interference, in which case SJRWMD can allocate the requested amount.

HOW IS THIS CONSTRAINT USED IN THE PLANNING PROCESS?

The planning process is separate from the consumptive use permitting process. The purpose of the water resource planning process is to ensure adequate supplies of water for all reasonable, beneficial uses. Protection of legal uses is intrinsic to this purpose. A key issue in considering interference as a constraint is whether proposed withdrawals could lower surface water or ground water levels to a point at which interference occurs in the withdrawal capability of existing permitted uses. Because interference evaluation is controlled by project-specific factors (primarily facility characteristics), it must generally be performed on a project-by-project basis, rather than at the planning level.

For this reason, interference will not be used as an initial constraint in the regional optimization and decision modeling. However, interference will be used as a constraint later in the planning process when selected water supply alternatives are evaluated in detail. The SJRWMD's initial focus regarding interference with existing legal uses will be on areas where it is known or anticipated to be an issue.

Although interference will not be used as an explicit constraint in the regional optimization and decision model, existing legal uses are expected to be protected in the model through the application of the other three principal constraints: Minimum Flows and Levels, Native Vegetation, and Water Quality. These environmental constraints are sensitive to smaller changes in surface and ground water levels than what is usually required to significantly reduce well or pump capacity, causing an interference.

In summary, interference with existing legal uses will be utilized as a constraint where it is known or anticipated to be an issue. For the purpose of the SJRWMD's water supply planning effort, interference will not be used as an initial constraint in the regional optimization and decision modeling due to difficulties in representing detailed facility characteristics. Interference will, however, be used as a constraint in further evaluation of water supply options selected for detailed evaluation. This constraint will be evaluated along with the other constraints as appropriate.

REFERENCES

Blackhawk Geosciences, Inc. *Re-examination of the 1986 and 1988 TDEM Soundings in Seminole County, Florida.* SJ92-SP15. 1992.

Blackhawk Geosciences, Inc. *Time Domain Electromagnetic Measurements, East-central Florida. SJ 92-5.* 1992.

Boniol, Don. *Summary of Groundwater Quality in the SJRWMD.* SJ96-SP13. 1996.

CEES Blackhawk Geosciences Division. *Time Domain Electromagnetic Soundings.* SJ93-SP1. SJRWMD. July 1992.

CEES Blackhawk Geosciences Division. *Updated Time Domain Electromagnetic Survey Data: Seminole County, Florida.* SJ93-SP2. 1993.

CH2M HILL. *Alternative Water Supply Strategies Investigations. Application of Planning-Level Cost Estimating Procedure.* Technical Memorandum E.1.H. April 1998.

CH2M HILL. *Identification of Brackish Water Sources* (in review). SJ98-SPXX. 1998.

CH2M HILL. *Water Supply Needs and Sources Assessment. Alternative Water Supply Strategies Investigation. Wetlands Impact, Mitigation, and Planning-level Cost Estimating Procedure.* Special Publications SJ96-SP7. 1996.

Demas, et al. *Decision Modeling for Alternative Water Supply Strategies* (in review). SJ98-SPXX. 1998**.**

F.A.C. Chapter 40C-8. (October 20, 1996 revision is most current at this time).

F.S. Regional Water Supply Planning. Chapter 373. Section 373.0361.

F.S. Minimum Flows and Levels. Chapter 373. Section 373.042.

F.S. Establishment and Implementation of Minimum Flows and Levels. Chapter 373. Section 373.0421.

GeoTrans, Inc. *Wekiva River Basin Groundwater Flow and Solute Transport Modeling Study Phase III: Three-dimensional Density Dependant Groundwater Flow and Solute Transport Model Development.* SJ92-SP21. 1992.

Hatfield, et al. *Water Resource Allocation and Quality Optimization Modeling.* SJ96 -SP5. 1996.

Hupalo, et. al. *Establishment of Minimum Flows and Levels for the Wekiva River System.* Technical Publication SJ94-1. SJRWMD. Palatka, FL. 1994.

Hydrogeologic Inc. *Groundwater Flow and Solute Transport Modeling Study for Eastern Orange County, Florida and Adjoining Regions.* SJ93-SP4. 1994.

Hydrogeologic Inc. *Groundwater Flow and Solute Transport Modeling Study for Seminole County, Florida.* SJ94-SP6. 1993.

Kinser, P. and M.C. Minno. *Estimating the Likelihood of Harm to Native Vegetation from Ground Water Withdrawals.* Technical Publication SJ95-8. SJRWMD. 1996.

Koulekey, Kodjo C. *Modeling Saltwater Upconing in Coastal Aquifers*. Dissertation. Department of Civil Engineering, University of Florida. Gainesville, FL. 1986.

Minno, Marc C. Estimated Spring Constraint Thresholds. Memorandum to Hal Wilkening SJRWMD. May 5, 1998.

Motz, L.H. *Predicting Saltwater Upconing Due to Well Field Pumping*. Proceedings from International Association of Hydrogeologists Symposium. *Future Groundwater Resources at Risk.* IAHA Publication No. 222. Department of Civil Engineering, University of Florida. Gainesville, FL. 1994

Motz, L.H. *Salt-water Upconing in an Aquifer Overlain by a Leaky Confining Bed.* Department of Civil Engineering, University of Florida. Gainesville, FL. Published in *Groundwater*. Vol. 30, No. 2. 1992.

Neubauer, Ph.D., C. A Calculated Average Hydrologic Decline for District Lakes to be Used for Calculating Boundary Conditions for the Floridan Aquifer under District Lakes. Memorandum to Hal Wilkening. SJRWMD. May 13, 1998.

Rao, D. and D.A. Clapp. *Preliminary Evaluation of the Impacts of Spring Discharge Reductions on the Flow of Receiving Water Bodies and Natural Systems, Central Florida*. Technical Publication SJ96-SP3. 1996.

SJRWMD. Priority List and Schedule for Establishing Minimum Flows and Levels. Narrative Discussion to Governing Board. November 11, 1997.

SJRWMD. Priority List and Schedule for Establishment of Minimum Flows and Levels in 1998. *Florida Administrative Weekly*. Volume 23, Number 52. December 26, 1997.

Subsurface Detection Investigations, Inc. *Time Domain Electromagnetic Mapping of Saltwater in Northeast & East-Central Florida.* SJ94-SP8. SJRWMD. October 1994.

Subsurface Detection Investigations, Inc. *Time Domain Electromagnetic Mapping of Saltwater in Northeast & East-Central Florida.* SJ97-SP1. SJRWMD. November 1996.

Vergara, B. *Water Supply Assessment*. Technical Publication SJ98-XX. SJRWMD. Palatka, FL. 1998.

Vergara, B. *Water Supply Needs and Sources Assessment.* Technical Publication SJ94-7. SJRWMD. Palatka, FL. 1994.

Williams, Stan. *A Regional Flow Model of the Volusia Ground Water Basin.* SJ97-3. 1997.