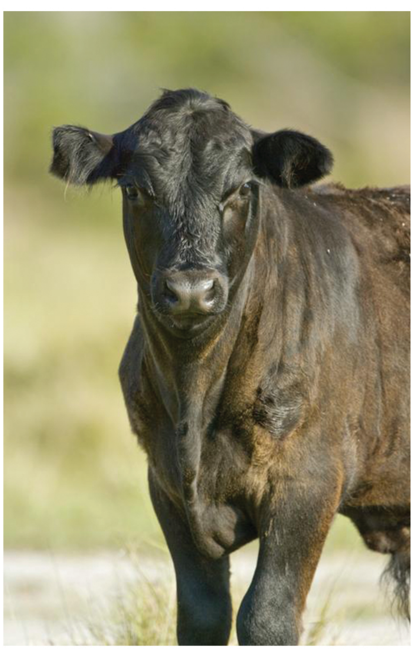
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

SUPPORT DOCUMENT
WATER SUPPLY PLAN UPDATE

Reference Document

2016



2016 Water Supply Plan Support Document

The South Florida Water Management District thanks everyone who contributed to the development and production of this 2016 Water Supply Plan Support Document.

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Acronyms and Abbreviations

ASR	aquifer storage and recovery
AWT	advanced wastewater treatment
AWWA	American Water Works Association
bls	below land surface
C&SF Project	Central and Southern Florida Flood Control Project
CERP	Comprehensive Everglades Restoration Plan
CFP	Cooperative Funding Program
CFWI	Central Florida Water Initiative
CUPCon	Consumptive Use Permitting Consistency
CWCP	Comprehensive Water Conservation Program
DBP	disinfectant/disinfection byproduct
District	South Florida Water Management District
DWMP	District Water Management Plan
DWSA	Districtwide Water Supply Assessment
F.A.C.	Florida Administrative Code
FAS	Floridan aquifer system
FAU/CES	Florida Atlantic University Center for Environmental Studies
FAWN	Florida Automated Weather Network
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
F.S.	Florida Statutes
FY	Fiscal Year
GPD	gallons per day
ICI	Industrial/Commercial/Institutional Self-Supply
kWh	kilowatt-hour
LEC	Lower East Coast
LKB	Lower Kissimmee Basin
LOSA	Lake Okeechobee Service Area
LPRO	lower pressure reverse osmosis

LWC	Lower West Coast
MCL	maximum contaminant level
MF	microfiltration
MFL	minimum flow and level
MGD	million gallons per day
mg/L	milligrams per liter
MIL	mobile irrigation laboratory
mm	millimeter
NEEPP	Northern Everglades and Estuaries Protection Program
NF	nanofiltration
NIS	Naturescape Irrigation Service
O&M	operations and maintenance
PWS	Public Water Supply
RAA	Restricted Allocation Area
REC	Recreational/Landscape Self-Supply
RO	reverse osmosis
SAS	surficial aquifer system
SFWMD	South Florida Water Management District
STA	Stormwater Treatment Area
TTHM	total trihalomethane
UEC	Upper East Coast
UEC Plan Update	Upper East Coast Water Supply Plan Update
UF	ultrafiltration
UF/IFAS	University of Florida/Institute of Food and Agricultural Sciences
UKB	Upper Kissimmee Basin
U.S.	United States
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UV	ultraviolet
Water CHAMP	Water Conservation Hotel and Motel Program
WaterSIP	Water Savings Incentive Program

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Introduction

This *2016 Water Supply Plan Support Document* (Support Document) supplements the regional water supply plan updates produced by the South Florida Water Management District (SFWMD or District). The Support Document provides background information helpful in understanding the SFWMD and highlights issues to be considered when developing comprehensive water supply plans with a 20-year planning horizon. **Figure 1** shows the District's jurisdiction and planning areas.

TOPICS

- Basis of Water Supply Planning
- Significant Changes and Outlook

The District encompasses nearly 18,000 square miles divided into five distinct planning regions: Upper East Coast (UEC), Lower East Coast (LEC), Lower West Coast (LWC), Lower Kissimmee Basin (LKB), and Upper Kissimmee Basin (UKB). The SFWMD prepares water supply plans for the UEC, LEC, LWC, and LKB planning areas. The development of comprehensive water supply plans customized to each region is key to identifying and understanding current and future water needs. The UKB is within the boundaries of the Central Florida Water Initiative (CFWI), where the South Florida, St. Johns River, and Southwest Florida water management districts meet. The CFWI includes Orange, Osceola, Seminole, Polk, and southern Lake counties. Together, the water management districts work with utilities, county and state agencies, and other stakeholders to develop a single regional water supply plan for this area to implement effective and consistent water resource planning, development, and management.

Lake Okeechobee

This Support Document is organized as follows:

- Chapter 1 – Introduction
- Chapter 2 – Resource Protection and Restoration Efforts
- Chapter 3 – Water Source Options and Treatment Technologies
- Chapter 4 – Water Conservation

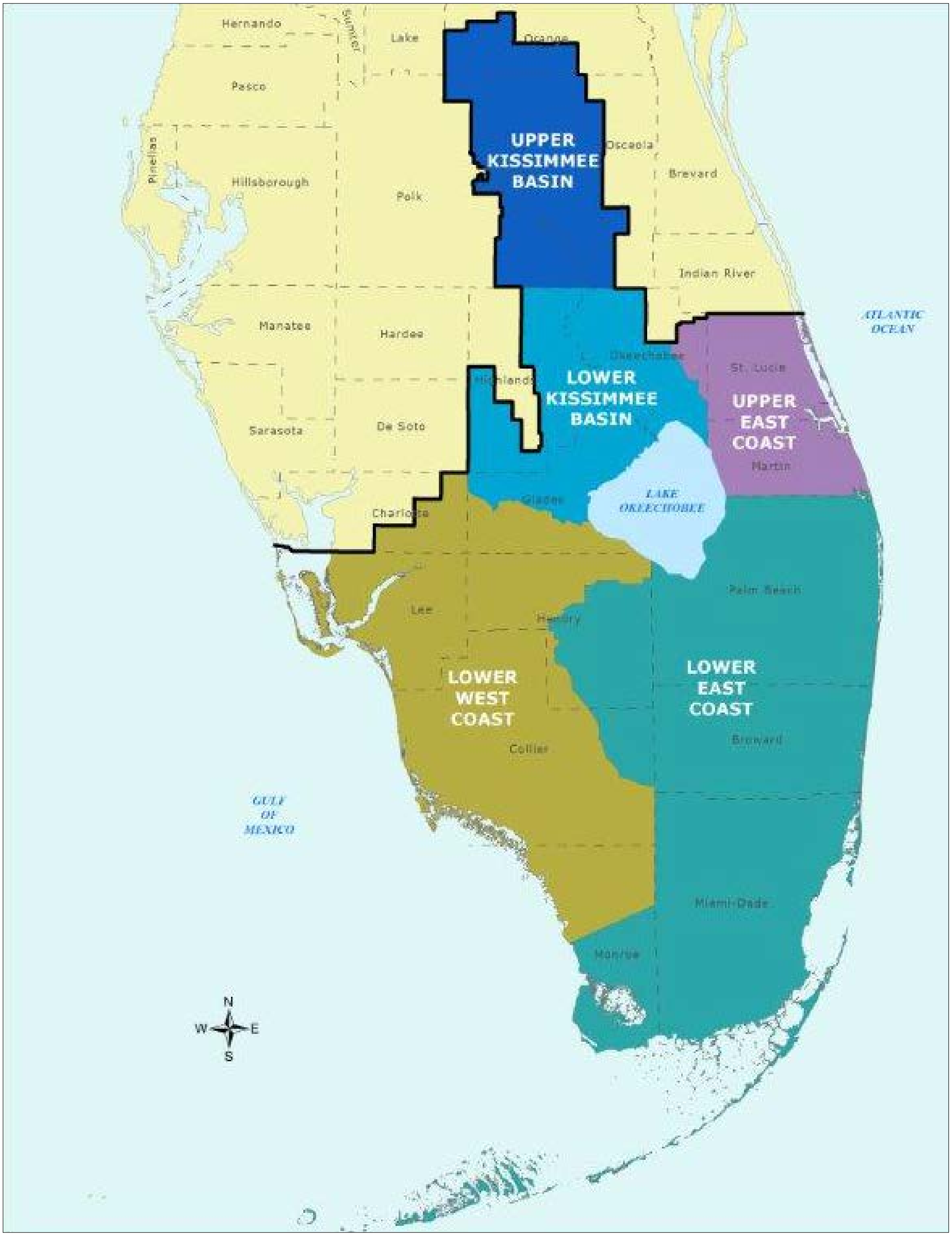

Figure 1. Planning areas of the South Florida Water Management District with county lines for reference.

WATER SUPPLY PLANNING

More than 8.1 million people, plus farms and businesses, use more than 3 billion gallons of water every day in south Florida. By 2040, thousands of new residents are expected to make south Florida their home, increasing demand for fresh water. Ensuring an adequate supply of water to protect, enhance, and restore natural systems as well as meet all other existing and projected needs is a fundamental element of the SFWMD's mission. The goal of the water supply planning process is to determine the region's water needs and develop sound, workable solutions to meet those needs.

The SFWMD completes water supply planning in coordination with other agencies, local governments and utilities, the agricultural industry, environmental interests, and other stakeholders. Public involvement and understanding of agency responsibilities are critical in developing and implementing long-term plans and strategies. Coordination with local governments establishes a closer link between development decisions and water availability.

This section provides a brief legal and historical overview of the water supply planning process. The following subsections explain the relationship between the District's water supply plans and local governments' comprehensive plans as well as the rationale and legislative background of water supply planning.

Legal Authority and Requirements

More than 40 years ago, Maloney et al. (1972) advocated a statewide, coordinated planning framework as the best way to accomplish proper water resource allocation. Subsequently, the Florida Water Resources Development Act of 1972 [Chapter 373, Florida Statutes (F.S.)] was enacted. Chapter 373, F.S., contains legal mandates for water supply planning and development by the water management districts in cooperation with the Florida Department of Environmental Protection (FDEP), who has general supervisory authority over the water management districts. One outcome of this legislation was the establishment of Florida's five regional water management districts. **Figure 2** shows the current legal framework for water supply planning in Florida.

In 1997, the Florida legislature enacted laws specifying the role of the water management districts in water resource and water supply planning and development. The legislative intent was to provide for human and environmental water demands for a 20-year planning horizon.

The State Comprehensive Plan establishes:

> *Florida shall assure the availability of an adequate supply of water for all competing uses deemed reasonable and beneficial and shall maintain the functions of natural systems and the overall present level of surface and groundwater quality.*

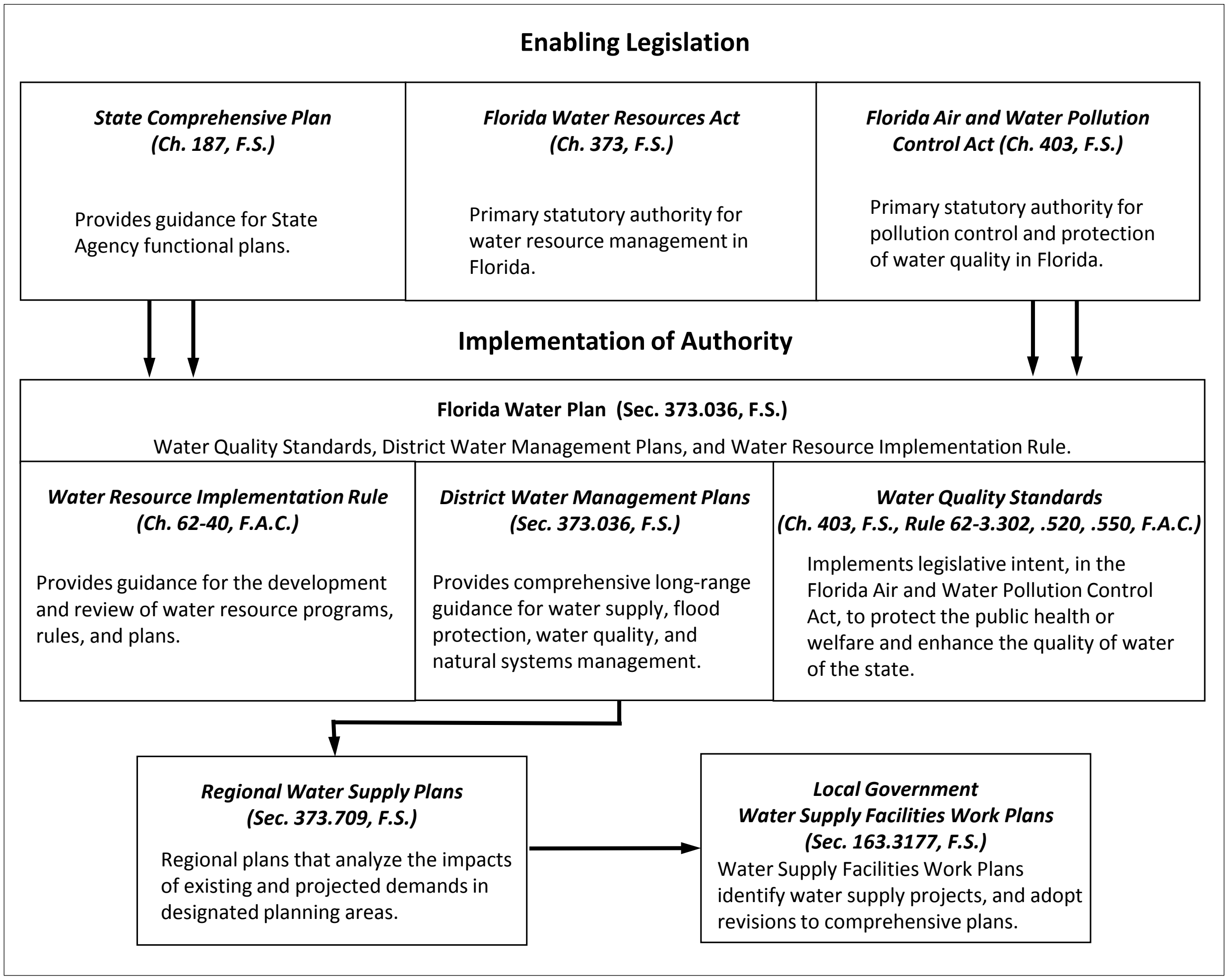

Figure 2. Legal framework for Florida water supply planning.

Section 373.036(1), F.S., requires the FDEP to develop the *Florida Water Plan* in coordination and cooperation with local governments, regional water supply authorities, government-owned and privately owned water utilities, multijurisdictional water supply entities, self-suppliers, and other affected and interested parties. The *Florida Water Plan* includes the following items:

- FDEP programs and activities related to water supply, water quality, flood protection, floodplain management, and natural systems
- FDEP water quality standards
- District Water Management Plans
- Goals, objectives, and guidance for the development and review of programs, rules, and plans relating to water resources, based on statutory policies and directives

The Florida Water Plan now includes the *State Water Policy* (which was renamed the Water Resource Implementation Rule). The Water Resource Implementation Rule [Chapter 62-40, Florida Administrative Code (F.A.C.)] sets forth goals, objectives, and guidance to develop and review water resource programs, rules, and plans. Relevant SFWMD documents resulting from this legislation include the following:

- Water Supply Policy Document (SFWMD 1991)
- Water Supply Needs and Sources (SFWMD 1992)
- District Water Management Plan (DWMP) (SFWMD 1995) – The District approved DWMPs in 1995 and 2000 (SFWMD 2000) as well as updates in 2001, 2002, and 2003 (SFWMD 2001, 2002, 2003). Beginning in 2004, the SFWMD chose to exercise its option to do an annual Water Resource Development Work Program report, published in the *South Florida Environmental Report – Volume II* (SFWMD 2013a), in lieu of the DWMP. In addition, the SFWMD Strategic Plan now contains the long-range planning information formerly reported in the DWMP.
- Districtwide Water Supply Assessment (DWSA) (SFWMD 1998) – In 1997, Chapter 373, F.S., was modified to require each water management district to prepare a DWSA in order to identify areas where water demands may exceed available supplies within a 20-year planning horizon. The SFWMD DWSA confirmed the District's decision to prepare water supply plans that cumulatively cover the entire SFWMD.

Regional Water Supply Plans

Water supply plans and updates provide detailed information and recommended actions to ensure projected water needs can be met within each planning area. The SFWMD updates its regional water supply plans approximately every 5 years. Based on a minimum 20-year planning horizon, current regional water supply plans include the following:

- Population projections and water demand projections for six categories of water use
- A water supply development component
- An analysis of the water resources in the planning area
- A water resource development component, including a funding strategy that must be reasonable and sufficient to pay the cost of constructing or implementing all the listed projects
- The minimum flows and levels (MFLs) established for water resources within the planning area
- Water Reservations adopted by rule pursuant to Section 373.223(4), F.S.

Local Government Water Supply Planning

The water supply projects proposed in the water supply plans for Public Water Supply (PWS) utilities are useful to local governments in the preparation of their Water Supply Facilities Work Plans. Within 18 months following the approval of the relevant SFWMD water supply plan, local governments are required to adopt or amend their Water Supply Facilities Work Plans to reflect the regional water supply plans. The information contained in these Water Supply Facility Work Plans has assisted the SFWMD in coordinating with local government land use planning staff on future water supply planning and water use permitting.

Local Government Comprehensive Plans

The Community Planning Act [Section 163.3164, F.S.] requires each municipality and county to adopt and maintain a comprehensive plan. In Florida, all proposed and approved development in the community must be consistent with the comprehensive plan.

Residential Development in Collier County

Each District water supply plan update contains information on state requirements for local government comprehensive plans, including the following guidance for water supply activities:

- Identify water supply sources needed to meet existing and projected water use demands for the established planning period of the comprehensive plan
- Base future land use plans and amendments on the availability of water and associated public facilities
- Identify alternative and traditional water supply, conservation, and reuse projects needed to meet the water needs identified in the regional water supply plan for the local government's jurisdiction

Water Protection and Sustainability Program

The Water Resource Protection and Sustainability Program requires a substantial level of water supply planning coordination between water management districts; local governments; and PWS, wastewater, and reuse utilities. Section 373.707, F.S., details the intent and purpose of the Water Resource Protection and Sustainability Program, and defines the responsibilities of the utilities and the water management districts.

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Resource Protection and Restoration Efforts

This chapter provides a brief overview and description of some key regulations and statutes that concern the protection of water resources and affect water supply planning in the South Florida Water Management District (SFWMD or District). The chapter also defines natural systems protection efforts and identifies restoration efforts, many of which involve a combination of protection and restoration activities. Protection and restoration of natural systems are accomplished through the integration of planning, regulatory, land acquisition, and restoration programs.

TOPICS

- Water Resource Protection Standards
- Water Use Permitting
- Natural Systems Protection
- Ecosystem Restoration

Water resource protection standards use regulatory mechanisms, such as water use permitting, minimum flows and levels (MFLs), Water Reservations, and Restricted Allocation Areas (RAAs), which are explained in this regulatory overview. The *Applicant's Handbook for Water Use Permit Applications* (Applicant's Handbook; SFWMD 2015) contains additional SFWMD's water use permitting criteria.

Section 373.709, Florida Statutes (F.S.), prescribes the legal authority and requirements for water supply planning with additional guidance provided in Chapters 187 and 403, F.S. The primary regulatory tools related to water supply and uses of water are contained in Chapter 373, F.S., and Chapters 40E-2 and 62-40, Florida Administrative Code (F.A.C.).

The Florida Department of Environmental Protection (FDEP) recently led a statewide effort called Consumptive Use Permitting Consistency (CUPCon) to improve consistency in the consumptive/water use permitting programs implemented by the water management districts. CUPCon resulted in changes to SFWMD water use permitting rules and criteria that became effective in 2014.

When discussing natural systems or ecosystem programs and projects, protection and restoration activities are often connected. Generally, natural systems protection efforts involve resource protection criteria or standards to protect the water resources necessary for the sustained health of a natural system, whereas restoration efforts focus on recovering the original characteristics of an ecosystem.

WATER USE PERMITTING

Water use or consumptive use of water is any use of water that reduces the supply from which it is withdrawn or diverted. The SFWMD's water use permitting program protects the supply and quality of groundwater and surface water resources by requiring permit applicants to demonstrate that their proposed use is reasonable-beneficial, consistent with the public interest, and will not interfere with existing legal uses.

> **INFO**
>
> Examples of specific regulations and water conservation initiatives can be found in each regional water supply plan update.

District rules classify water use permits for activities such as the following:

- Agricultural irrigation
- Golf course irrigation
- Landscape irrigation
- Public water supply
- Dewatering
- Diversion and impoundment
- Commercial and industrial uses

Water use permits are issued by water management districts pursuant to Chapter 373, F.S. The specific conditions of issuance are described in Section 373.223, F.S., and Chapter 40E-2, F.A.C.

Types of Water Use Permits

Presently, the SFWMD issues three types of water use permits:

- **General Permit by Rule –** For single family/duplex landscaping, small dewatering projects, and closed-loop systems
- **Noticed General Permit –** For uses with a cumulative average daily use of less than 100,000 gallons per day (GPD) on an annual basis that meet facility and geographic restrictions based on source
- **Individual –** For uses with a cumulative average daily use greater than 100,000 GPD on an annual basis or otherwise do not meet Noticed General Permit thresholds

A water use permit is not required for strictly domestic use at a single family dwelling or duplex provided that the water is obtained from one withdrawal facility for each single family dwelling or duplex. Individual permits for more than 15 million gallons per month require approval from the District's Executive Director or designee. All other permits are approved by District staff.

Permitting Criteria

To obtain a water use permit, the permit applicant must provide reasonable assurances the use is reasonable-beneficial, will not interfere with any existing legal use of water, and is consistent with the public interest, pursuant to Section 373.223, F.S.

In addition, water use permit applicants must review and address relevant portions of the State Water Resource Implementation Rule [Chapter 62-40, F.A.C.] adopted by the FDEP as part of the reasonable beneficial use test. The SFWMD implements this test pursuant to rules adopted in Chapter 40E-2, F.A.C., and in the Applicant's Handbook (SFWMD 2015). Permits are written to ensure uses are consistent with the overall objectives of the District and are not harmful to the water resources of the area [Section 373.219, F.S].

Considerations for issuance of a water use permit, include impact evaluation criteria that establish the hydrologic change that can occur without causing harm. For the purposes of water use permit applications, District staff take into account the harm standard [Chapter 40E-2, F.A.C.] as well as other environmental considerations:

- Saltwater intrusion
- Wetland and other surface water body drawdown
- Pollution movement
- Impacts to off-site land uses
- Aquifer mining
- Use of reclaimed water
- Interference with existing legal uses
- Minimum flows and levels (MFLs)
- Water Reservations
- Restricted Allocation Areas (RAAs)

Detailed criteria concerning proposed water uses and evaluation of potential impacts are contained in Section 3.0 of the Applicant's Handbook (SFWMD 2015).

SFWMD water use permitting rules require planning and implementation of water conservation measures by public water supply (PWS) utilities (and associated local governments), Industrial/Commercial/Institutional Self-Supply (ICI) users, landscape and golf course irrigation users, and agricultural users. Further information about the PWS conservation efforts is provided in **Chapter 4**.

The level of certainty planning goal established in Section 373.709, F.S., is a 1-in-10 year drought event. To be consistent, the District implemented the level of certainty planning goal in its water use permitting program. Permit applicants must demonstrate the conditions for issuance of a permit are satisfied during a 1-in-10 year drought condition. Demands are calculated, assuming the 1-in-10 year drought condition, and impacts resulting from a proposed withdrawal are analyzed during this same drought event.

Permit Duration and Renewal

Water use permits typically are issued for a period of 20 years unless circumstances warrant a shorter or longer permit duration. If an application for renewal is submitted before the permit expiration date, the permit remains in effect until the pending application is processed. Permits require compliance monitoring and reporting, which may include calibrated pumpage, wetland monitoring, saline water monitoring, water level monitoring, 10-year compliance reports, or other project-specific restrictions.

Coordination with Water Supply Plans

The FDEP directed water management districts to improve coordination between planning and permitting staff to ensure that water supply projects incorporated into regional water supply plans have a likelihood of being permittable and that permitting staff would be knowledgeable of these projects and facilitate the successful permitting. To achieve these objectives, permitting and planning staff review all proposed projects considered in a water supply plan using a consistent analysis method. Following the approval of a water supply plan update by the District Governing Board, planning staff present the results to permitting staff.

WATER CONSERVATION IN WATER USE PERMITTING

Water conservation practices are required in water use permits in order for the proposed use to be considered reasonable-beneficial. The District's water use permitting rules in Section 2.3.2 of the Applicant's Handbook (SFWMD 2015) include specific water conservation requirements for PWS, ICI, and Recreational/Landscape Self-Supply (REC) uses. **Chapter 4** provides more information about statewide and Districtwide conservation programs and objectives.

NAVIGATE

Chapter 4 provides an overview of the District's entire Comprehensive Water Conservation Program, including the regulatory initiative programs and implementation element. Water conservation measures that make additional water available from existing sources also are discussed in **Chapter 4**.

Public Water Supply Utilities

All PWS utilities applying for a water use permit are required to develop and implement a standard or goal-based water conservation plan (Sections 2.3.2.F.1.a and 2.3.2.F.1.b, respectively, of the Applicant's Handbook [SFWMD 2015]) that maintains or increases overall utility-specific water conservation effectiveness.

For standard water conservation plans, permit applicants are required to implement the following five elements, as necessary, to achieve efficient use to the extent economically, environmentally, and technically feasible:

1) A water conservation public education program
2) An outdoor water use conservation program
3) Selection of a rate structure designed to promote efficient use
4) A water loss reduction program, if required
5) An indoor water conservation program

The plan is subject to the schedule and reporting requirements specified in the permit. If implementation of the plan fails to demonstrate progress toward increasing water use efficiency, the permittee requests a permit modification, if necessary, to revise the plan to address the deficiency (Section 2.3.2.F.1 of the Applicant's Handbook [SFWMD 2015]).

A goal-based water conservation plan allows a permit applicant to select plan elements that differ from the standard plan but are appropriate to the applicant's service area. If any standard plan elements are not included, the applicant must provide reasonable assurances that the alternative elements will achieve effective conservation at least as well as the standard plan.

ICI and PWR Water Users

Similar to PWS, all ICI and Power Generation Self-Supply (PWR) water use permit applicants are required to submit a water conservation plan to the SFWMD at the time of permit application. Water conservation plans for ICI permit applicants must include the following:

- An audit of water use
- Implementation plan for cost-effective water conservation measures if found to be cost-effective during the audit, including leak detection/repair programs, recovery/recycling, and processes to reduce water consumption
- An employee awareness and consumer education program concerning water conservation
- Procedures and time frames for implementation of tasks

A well-planned and scheduled audit program is a prerequisite for improving and sustaining water use efficiency in an industrial or commercial facility. A water use audit or assessment is a systematic review of all water consumption from point of entry to discharge. A comprehensive audit examines historic water use, identifies on-site water sources and potential opportunities for reducing unnecessary water use, measures or calculates all on-site water consumption, detects leaks, and calculates a facility's true cost of water.

Recreational/Landscape Water Users

Applicants for landscape and golf projects are required to develop a conservation program and submit it with the permit application. The program must include the installation and use of rain sensor devices, automatic switches, or other automated mechanisms that have the ability to override operation of the irrigation system when adequate rainfall has occurred. Other mandatory elements include the use of Florida-Friendly Landscaping™ principles for new or modified projects and limitations to irrigation hours to comply with local government ordinances.

Agricultural Water Users

Agricultural conservation generally focuses on the type of irrigation system. Standard irrigation system types include microirrigation, overhead sprinkler, and flood/seepage irrigation. For certain crops such as citrus and container nurseries, water use permit holders are required to use microirrigation or other systems of equivalent efficiency. The irrigation method should be matched to the specific needs of each crop type. This rule applies to new installations or modifications of existing irrigation systems. Flood/seepage type systems typically are used for small vegetables, corn, rice, and sugarcane production.

Flood/Seepage Irrigation

WATER RESOURCE PROTECTION STANDARDS

As stated earlier, Chapter 373, F.S., provides water management districts with tools consisting of varying levels of resource protection standards to carry out this responsibility.

Florida's Water Resource Implementation Rule [Chapter 62-40, F.A.C.] outlines specific factors to consider in protecting natural systems, including protection of natural seasonal changes in water flows or levels, water levels in aquifer systems, and environmental values associated with aquatic and wetland ecology.

WATER RESOURCE PROTECTION STANDARDS

The terms harm, serious harm, and significant harm are defined in Rule 40E-8.021, F.A.C., and apply throughout the District's water use permit rules. The definitions are as follows:

Harm – The temporary loss of water resource functions, as defined for consumptive use permitting in Chapter 40E-2, F.A.C., that results from a change in surface or groundwater hydrology and takes a period of 1 to 2 years of average rainfall conditions to recover.

Significant Harm – The temporary loss of water resource functions, resulting from a change in surface or groundwater hydrology, that takes more than 2 years to recover but which is considered less severe than serious harm. The specific water resource functions addressed by an MFL and the duration of the recovery period associated with significant harm are defined for each priority water body based on the MFL technical support document.

Serious Harm – The long-term loss of water resource functions, as addressed in Chapters 40E-21 and 40E-22, F.A.C., resulting from a change in surface or groundwater hydrology.

Protecting Water for Natural Systems

In addition to wetland and other surface water body protection criteria, the SFWMD uses the following three rules to protect natural system water (i.e., wetlands, rivers, lakes, estuaries, and aquifers) from consumptive use:

1) Minimum Flows and Levels
2) Water Reservations
3) Restricted Allocation Areas

The District is required to annually develop and submit to the FDEP a list and schedule for MFLs. Included in this "Priority Water Bodies List and Schedule" is information about Water Reservation and Restricted Allocation Area rules under development. The list and schedule is provided in the SFWMD's annual *South Florida Environmental Report – Volume II*, available from http://www.sfwmd.gov/sfer.

Minimum Flows and Levels

The SFWMD is responsible, within its boundaries, for implementing the provisions in Section 373.042, F.S., requiring the establishment of MFLs for surface waters. The minimum flow for a given watercourse specifies the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area. Similarly, the minimum water level identifies the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources. To date, MFL criteria have been adopted for 13 surface water bodies and aquifers within the District, including the following:

PROTECTION

Minimum Flow and Level Criteria

MFL technical criteria are important management tools used by the SFWMD to protect major water bodies from significant harm due to reductions in water levels or flows.

- Lake Okeechobee
- The Everglades (including the Water Conservation Areas, the Holey Land and Rotenberger Wildlife Management Areas, and Everglades National Park)
- Biscayne aquifer
- The LWC aquifer system encompassing three semi-confined units (Tamiami, Sandstone, and Mid-Hawthorn)
- Caloosahatchee River
- North Fork of the St. Lucie River
- Northwest Fork of the Loxahatchee River and Estuary
- Lake Istokpoga
- Florida Bay

Protection of non-consumptive uses may be considered and provided for when establishing MFLs [Section 373.042, F.S.]. A baseline condition for the protected resource functions must be identified through consideration of changes and structural alterations in the hydrologic system [Section 373.042(1)(a), F.S.]. Certain exclusions for establishing MFLs are contained in Section 373.0421(1)(b), F.S.; however, the Everglades Protection Area is not subject to these exclusions.

MFL Recovery and Prevention Strategies

The District prepares a recovery or prevention strategy at the same time the MFL is established. If it is determined that water flows or levels for a water body are below the relevant MFL, or will fall below the MFL within the next 20 years, the District must develop and implement a recovery or prevention strategy [Section 373.0421(2), F.S.].

The general goal of a recovery strategy is to achieve the established MFL as soon as practicable. A prevention strategy aims to keep the existing flow or level from falling below the established MFL criteria. The recovery or prevention strategy includes the provision of sufficient water supplies for reasonable beneficial uses and may include the development of additional water supplies, construction of new or improved storage facilities, and implementation of conservation or other efficiency measures. MFL recovery and prevention strategies are reviewed in concert with Water Supply Plan Updates.

Water Use Permitting Criteria for MFLs

As discussed in the *Water Use Permitting* section of this chapter, as a condition of permit issuance, water use permitting rules require an applicant to provide reasonable assurances that a proposed use of water is in accordance with the established MFLs and implementation rules [Rule 40E-2.301(1)(i), F.A.C.]. Applications for water use are reviewed based on the recovery or prevention strategy approved at the time of permit application review.

Rule 40E-8.021, F.A.C., identifies two categories of impact criteria: direct withdrawals and indirect withdrawals from the MFL water body. Each category is considered in the review of a permit application. Direct withdrawals are those from surface water facilities physically located within the boundaries of an MFL surface water body or groundwater withdrawals that cause a water table drawdown greater than 0.1 feet at any location beneath the MFL surface water body or aquifer, up through a 1-in-10 year drought. Indirect withdrawals are from a water source for a consumptive use that receives surface water or groundwater from or is tributary to an MFL water body. The Applicant's Handbook (SFWMD 2015) describes evaluation criteria for permit renewals and new or modified permits for water bodies subject to an MFL recovery or prevention strategy.

Water Reservations

A Water Reservation is a legal mechanism to set aside water for the protection of fish and wildlife or public health. When a volume of water is reserved, it is not available for allocation to water use permittees [Section 373.223(4), F.S.]. Water Reservations may be developed based on an evaluation of existing water availability for the natural system as well as for water anticipated to become available for the natural system upon completion of water resource development projects.

PROTECTION

Water Reservations

Section 373.470, F.S. and Section 601(h)(4) of the Water Resources Development Act of 2000 requires the SFWMD to reserve or allocate water provided by CERP projects for the natural system identified for each CERP project.

The quantification of the water to be reserved can include a seasonal component and a location component. In quantifying water to be reserved, existing legal uses of water are protected as long as they are not contrary to public interest. Issues associated with determining whether an existing legal use of water is contrary to public interest are determined by the District Governing Board. In addition, reasonable assurances are provided for existing legal users, as cited in Section 373.1501(d)(5), F.S.:

> *Consistent with this chapter, the purposes for the restudy provided in the Water Resources Development Act of 1996, and other applicable federal law, provide reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project components so as to adversely impact existing legal users, that existing levels of service for flood protection will not be diminished outside the geographic area of the project component, and that water management practices will continue to adapt to meet the needs of the restored natural environment.*

SFWMD Water Reservation rule activities to date include the following:

- The District's first Water Reservation rules were adopted for the Comprehensive Everglades Restoration Plan (CERP) Picayune Strand Restoration Project in the Lower West Coast (LWC) Planning Area in February 2009. Separate Water Reservation rules were adopted for Picayune Strand and Fakahatchee Estuary.

Osprey Pair – Estero Bay

- North Fork of the St. Lucie River Rule, as part of the CERP Indian River Lagoon – South Project in the Upper East Coast (UEC) Planning Area, adopted in February 2010.

- Nearshore Central Biscayne Bay Rule, adopted in July 2013.
- CERP Caloosahatchee River (C-43) West Basin Storage Reservoir Rule, adopted in May 2014.
- To provide water essential for the protection of fish and wildlife in the Kissimmee River, its vast floodplain, and the Upper Chain of Lakes, the District authorized the next step in a public process to reserve water for the ecosystem in 2014. Rule development continued in 2015 with two public workshops to update stakeholders, complete draft rule language, and release the draft rule as well as its supporting technical document for public comment. Looking ahead, the final step of this process is to adopt the water reservation by rule.

Restricted Allocation Areas

RAAs encompass large geographic areas with multiple ecosystems. RAA criteria are regulatory mechanisms that protect specific water bodies for a variety of reasons such as protecting water resources from harmful impacts due to consumptive uses of water, assuring MFL recovery strategy implementation components and availability of water for future restoration projects, protecting public health and safety, and preventing interference among and to existing legal uses. RAA criteria are set forth in the Applicant's Handbook (SFWMD 2015). The following geographic areas are designated RAAs:

- Lake Istokpoga/Indian Prairie canal system (1980s)
- C-23, C-24, and C-25 canal system (1980s)
- L-1, L-2, and L-3 canal system (1980s)
- Pumps on Floridan wells in Martin and St. Lucie counties (1980s)
- Northern Palm Beach County/Loxahatchee River Watershed water bodies and Lower East Coast (LEC) Everglades water bodies (2007)
- Lake Okeechobee Service Area (LOSA) (2008)

The purpose of the RAAs is more specifically described in the respective regional water supply plan update and in the Applicant's Handbook (SFWMD 2015).

ECOSYSTEM RESTORATION

Changes in south Florida's hydrology and habitats over the past century have caused degradation of a vital subtropical wetland system. Because of development and drainage in the Greater Everglades, the right quantity and quality of water is not always available during dry periods for both the environment and the human population. Conversely, in wet times, the lack of natural storage capacity often causes damaging flooding of the Everglades and coastal estuaries.

Authorized by Congress in 2001, the CERP is one of the largest environmental restoration programs in history. It serves as a framework for modifications and operational changes to the Central and Southern Florida Flood Control Project (C&SF Project) to restore, preserve, and protect the land and water within the SFWMD's boundary while providing for other water-related needs in the region. The U.S. Army Corps of Engineers (USACE) is the lead federal agency and the SFWMD is the lead state agency for this multidecadal effort.


Snowy Egrets

The SFWMD also is the lead state agency for foundational projects that the CERP builds on; these foundational projects were assumed to be complete during the planning processes for the CERP. Key among the foundational projects is the Modified Water Deliveries to Everglades National Park Project (Mod Waters), which is critical for restoration of more natural flows to Everglades National Park. Other foundational projects include the federally authorized Kissimmee River Restoration Project, Modifications to the C-111 Project, the Critical Restoration Projects, and the State of Florida's Everglades Construction Project.

Restoration scientists, planners, and engineers hope to recover many of the original characteristics of the Everglades that would allow the Everglades to function as a cohesive ecosystem (USACE 2010). Such characteristics would include interconnected wetlands, low concentrations of nutrients in freshwater wetlands, sheetflow, healthy and productive estuaries, hardy native plant communities, and an abundance of native wetland flora and fauna (U.S. Department of the Interior and USACE 2005).

Ecosystem Restoration Initiatives and Projects

This section provides a high-level overview of some of the major initiatives and projects underway at the SFWMD. The District and its partners (e.g., USACE, FDEP) maintain updated information about each undertaking on the internet. The links to dedicated project website pages and related documentation are included in this chapter for easy referencing.

Critical projects were authorized in the Water Resources Development Act of 1996 as restoration projects designed to achieve early benefits to the south Florida ecosystem. A list critical projects is available from
http://www.saj.usace.army.mil/Missions/Environmental/EcosystemRestoration.aspx.

CERP and Everglades Restoration Projects

The CERP is composed of a series of projects designed to capture, store, and redistribute fresh water and to restore the Everglades ecosystem by improving the quality, quantity, timing, and distribution of water flows. Together, the various components of the CERP will benefit the ecological functioning of the south Florida ecosystem, while improving regional water quality conditions, deliveries to coastal estuaries, urban and agricultural water supply, and maintaining existing levels of flood protection.

The SFWMD takes a system-wide approach to protecting and restoring the Southern and Northern Everglades. These interdependent ecosystems originate in central Florida near metropolitan Orlando and stretch southward to the coastal estuaries and bays of south Florida. Projects in the Everglades require involvement from federal and state partners such as the USACE, FDEP, and the Florida Department of Agriculture and Consumer Services (FDACS). Everglades restoration projects are designed to address multiple concerns such as ecosystem health, environmental protection, and water resources for fish and wildlife and consumptive use. Ongoing restoration projects are improving regional water quality, hydrology, and ecology. The latest information about Everglades restoration projects is available from http://www.sfwmd.gov/sferdb. Additional project information is available from http://www.evergladesrestoration.gov.

Everglades Forever Act Projects

Projects related to land acquisition and the design, permitting, and construction of Everglades Stormwater Treatment Areas (STAs) were authorized by the 1994 Everglades Forever Act [Section 373.4592, F.S.]. Annual updates for the Everglades STAs are provided in the *South Florida Environmental Report,* available from http://www.sfwmd.gov/sfer.

Northern Everglades and Estuaries Protection Program

Underscoring the state's commitment to ecosystem restoration, the Florida legislature expanded the Lake Okeechobee Protection Act in 2007 to include the protection and restoration of the interconnected Kissimmee, Lake Okeechobee, Caloosahatchee, and St. Lucie watersheds. This interagency initiative, known as the Northern Everglades and Estuaries Protection Program (NEEPP), focuses on the water storage and water treatment needed to improve and restore the Northern Everglades and coastal estuaries. As part of this initiative, the SFWMD and the State of Florida will expand water storage areas, construct treatment marshes, and expedite environmental management initiatives to enhance the ecological health of Lake Okeechobee and downstream coastal estuaries. The NEEPP requires the SFWMD, in collaboration with the FDEP and the FDACS as coordinating agencies and in cooperation with local governments, to develop and implement protection plans for three northern watersheds: the Lake Okeechobee Watershed, St. Lucie River Watershed, and Caloosahatchee River Watershed. While Northern Everglades projects have been conceptually identified in these plans, specific projects and activities are included in annual work plans and updates in the *South Florida Environmental Report – Volume I*, available from http://www.sfwmd.gov/sfer. Information about the NEEPP and the *2011 Lake Okeechobee Protection Plan Update* (SFWMD 2011) is available from http://www.sfwmd.gov/northerneverglades.

Kissimmee River Restoration Project

The Kissimmee River Restoration Project is a large-scale multi-phased ecosystem restoration effort. The project 1) reestablishes the river-floodplain system's ecological integrity by recreating the river's physical form and reestablishing pre-channelization hydrologic characteristics; 2) provides the water storage and regulation schedule modifications needed to approximate the system's historical water levels and flow; and 3) increases the quantity and quality of shoreline habitat in Lakes Kissimmee, Hatchineha, Tiger, and Cypress for the benefit of fish and wildlife. In addition, the project ensures the maintenance of existing flood protection.

Three of four canal backfilling phases of the Kissimmee River Restoration Project are complete. Backfilling of the C-38 Canal began in 1999 with Reach I construction (completed in 2001); work continued north in two additional construction phases, which were completed in 2007 and 2009, respectively. The remaining Reach II/III construction is scheduled to begin in 2016, with overall completion in late 2019. Other construction associated with the Kissimmee River Restoration Project includes levee removal, water control structure additions/improvements, flood protection, and various infrastructure improvements within the project area, including the headwater lakes.


Kissimmee River Restoration

SUMMARY

Projects and programs to protect and restore natural resources are essential to ensuring an adequate supply of water for natural systems. Natural systems protection efforts also involve resource protection criteria or standards to protect the water resources necessary for the sustained health of a natural system. Various scientific, policy, and legal tools are used to protect water supplies for the needs of natural systems, as well as water supply regulatory programs which protect, enhance, mitigate, and monitor wetlands and water resources.

NAVIGATE

Detailed information about MFLs, Water Reservations, and RAA rules are available from the District's website at http://www.sfwmd.gov/watersupply.

Status updates are provided annually in the *South Florida Environmental Report – Volume II*, available from http://www.sfwmd.gov/sfer.

Related rule development and peer-review activities can be accessed from http://www.sfwmd.gov/webboards.

Details concerning MFLs can be found in the Applicant's Handbook (SFWMD 2015) and the SFWMD website at: http://www.sfwmd.gov/portal/page/portal/xweb%20-%20release%202/rules%20statutes%20and%20criteria.

Additional information about RAA criteria can be found in the Applicant's Handbook (SFWMD 2015).

Pelican among Mangroves

3

Water Source Options and Treatment

This chapter discusses water source options and water treatment processes for public water supply (PWS), along with related costs. The source of water generally will determine the type of treatment needed to produce potable water that meets the standards of the Safe Drinking Water Act. Surface water has more suspended solids and bacteria than is found in groundwater. Additionally, the water quality and temperature of surface water has seasonal variability. Generally, groundwater has more constant water temperature and water quality.

TOPICS

- Groundwater
- Surface Water
- Seawater
- Reclaimed Water
- Storage Solutions
- Interconnects

WATER SOURCE OPTIONS

Within the South Florida Water Management District (SFWMD or District), groundwater is the primary source of water for PWS utilities. Some groundwater is fresh and requires minimal treatment while other water is brackish and requires substantial treatment to meet drinking water standards. The water supply sources available to PWS utilities and other users include the following:

- **Groundwater** – Water beneath the surface of the ground, primarily withdrawn from three south Florida aquifer systems: the surficial aquifer system (SAS), intermediate aquifer system, and Floridan aquifer system (FAS).
- **Surface Water** – Water from lakes, rivers, and canals is used occasionally by PWS utilities and extensively by agricultural permittees.
- **Seawater** – In south Florida, the sources of seawater are the Atlantic Ocean and Gulf of Mexico.
- **Reclaimed Water** – Water that is reused after receiving at least secondary treatment and basic disinfection, flowing out of a domestic wastewater treatment facility.

Additional options for PWS utilities include storage solutions such as Aquifer Storage and Recovery (ASR), regional and local retention, and reservoirs. Utility interconnects, a physical connection between the distribution systems of two PWS utilities, are used as a means to address a temporary shortfall or for long-term water supply.

The chemical constituents or quality of the water dictates the treatment technologies and processes, and thus cost, necessary to meet water quality standards.

The scope of this Support Document does not include a comprehensive discussion of process technologies and components. Readers should use the information as a starting point for understanding some of the fundamental considerations and costs of incorporating new water supplies and treatment capabilities within specific localities. Unless otherwise noted, the cost information presented in this chapter cites the CDM, Inc. report, *Water Supply Cost Estimation Study* (Cost Study) (CDM 2007a).

Cost Study

The Cost Study and addendum (CDM 2007a,b) provide engineering cost data as well as cost estimation relationships and curves to evaluate various water treatment technologies used for PWS in the District's water supply planning areas. Costs are planning-level estimates. The report also includes case studies for some technologies constructed close to the time of the study such as surface water and seawater treatment facilities. The case studies address actual facility sizes and their costs.

Water Treatment Plant in Collier County

Where treatment technologies are addressed, the costs associated with facilities of 5, 10, 15, and 20 million gallons per day (MGD) have been evaluated. For some treatment processes and technologies, the costs for 1 MGD and 3 MGD of the treatment capacity are provided also.

However, due to economies of scale, the capital cost per gallon per day of treatment capacity increases sharply as the facility capacity decreases from 5 MGD to 1 MGD, and the capital and operations and maintenance (O&M) costs become much larger components of the total project cost. For example, the cost of concentrate disposal for a 1 MGD lower pressure reverse osmosis (LPRO) treatment facility is essentially the same as for concentrate disposal for a 20 MGD LPRO facility. This is largely because of the fixed capital cost of a deep injection well for concentrate disposal in this capacity range. The labor component of the O&M cost becomes much more important for a smaller capacity facility due to typical process automation.

The Cost Study provides opinions of probable cost considered to be order-of-magnitude estimates as defined by the American Association of Cost Engineers. The costs are regarded as accurate within +50 percent or -30 percent, and are presented in August 2006 dollars. After the release of the Cost Study, construction costs of water infrastructure rose substantially, then a reversal in pricing trends occurred. In 2010, it was determined that the August 2006 dollar estimates were still valid for use to portray market conditions.

The Cost Study cites energy costs of $0.10 per kilowatt-hour (kWh) based on review of planning-level power costs for water utilities in Palm Beach and Collier counties. Information from several PWS utilities in 2015 indicates that for planning purposes, when considering plants that operate facilities, wells, and other pumps, the rate of $0.09/kWh appears reasonable.

The costs of various water source options across the District were presented in terms of capital, O&M, and total production costs on a unit-cost basis, expressed in dollars per 1,000 gallons. The following cost definitions apply to the terms used in the study:

- **Construction Costs** – The total estimated amount expected to be paid to a qualified contractor to build the required facilities, including costs for all materials, equipment, and installation.
- **Non-Construction Capital Costs** – Services such as engineering, design, permitting, and administration; and construction project contingencies associated with the constructed facilities.
- **Land and Acquisition Costs** – Unless otherwise noted, the land and land acquisition costs are not included in the calculation of the total capital cost.
- **Total Capital Costs** – The total capital costs for each of the water supply and wastewater system components are the sum of the construction and non-construction costs.
- **O&M Costs –** The costs of operating and maintaining the water supply system components each year, including costs for energy, chemicals, component replacement, and labor.
- **Equivalent Annual Capital Costs** – To compare the costs for various technologies, capital investments are converted to equivalent annual capital costs. The parameters used in this amortization of initial capital investment are a term of 20 years and a discount rate of 7 percent. The 20-year term approximates the overall cost-weighted useful life of the capital investment in facilities and equipment.
- **Total Annual Production Costs** – This cost category includes O&M costs and an annual renewal and replacement fund deposit that is not included as part of the O&M costs. The annual renewal and replacement fund deposit is equal to 10 percent of the equivalent annual capital cost, and is for replacement of major equipment during the course of the 20-year service life of the facilities.
- **Annual Production (Unit) Cost** – A ratio of total annual production costs and a facility's annual finished water production rate expressed in dollars per 1,000 gallons.

Groundwater Supply Systems

Groundwater supply systems are composed of wellfields and related features such as pipelines and pumps. The production of each well is limited by several factors, including the rate of water movement in the aquifers, rate of recharge, aquifer storage capacity, potential environmental impacts, proximity to sources of contamination, proximity to existing legal users, and the potential for saltwater intrusion. A combination of these factors determines the number, depth, diameter, and distribution of wells that can be constructed at a specific site. These factors also affect the rate at which the wells can be pumped.

The cost of well construction is a function of diameter, depth, and underlying sediments. The costs include drilling, construction, and casing to professional standards, geophysical logging, aquifer testing as appropriate, and the final wellhead. Many utilities have found that a test well was helpful to understand the hydrogeology of the site and design the wellfield and wells.

Equipment costs to operate the wellfield include pumps, piping, valves, fittings, meters, well house, and electrical controls. Costs to construct groundwater wells and send the water to a water treatment plant represent only one component in the water withdrawal process.

Surface Water Supply Systems

The costs associated with surface water withdrawal are for pumps to obtain the water from the source at a steady rate and for piping to transmit the water to the water treatment plant. **Table 1** provides estimates of costs to install water-pumping facilities designed to divert surface water.

Table 1. Pump installation and operating costs[a] (From: CDM 2007a).

Pump Type	Engineering/Design Cost	Construction Costs	O&M Cost
Electric	$50,000	$3 to 4 million[b]	$60/hr
Diesel	$50,000	$1.5 to 3 million	$40/hr

[a] For estimating purposes, a pump rated at 60,000 gallons per minute (GPM) is assumed.
[b] Does not include cost of installing electrical power to site.

Seawater Supply Systems

The cost of seawater desalination is higher than the cost of brackish groundwater desalination due to seawater's higher salt content, which requires specialized intake facilities and concentrate disposal. However, technological advancements and incremental improvements in productivity and efficiency of RO membranes, pumps, energy recovery devices, and overall system configurations have reduced the cost of production of desalinated seawater.

Seawater contains approximately 3.5 percent or 35,000 parts per million (ppm) of dissolved salts, most of which is sodium chloride ($NaCl$), with lesser amounts of sulfates, magnesium, potassium, and calcium. Therefore, removal of salts is required before potable or irrigation uses are feasible. The salt removal is accomplished with desalination treatment technology such as distillation, reverse osmosis (RO), or electrodialysis reversal. Some utilities with seawater desalination plants have found that a pilot test facility is helpful to understand the water that will be processed by the plant to more effectively design the full desalination plant.

The cost of seawater desalination appears to be reduced when the desalination facility is co-located with power generating facilities that use seawater for cooling. There are many potential benefits of co-locating desalination facilities with electric power plants (e.g., sharing facility components). Cost savings also are associated with using the existing intake and discharge structures of the power plant to provide raw water to the desalination facility and a means for concentrate disposal. It is possible to dispose of the desalination process concentrate by blending it with the power plant's coolant water discharge. Another significant advantage of using power plant cooling water as a source is that the temperature of the water is elevated, which reduces the pressure and associated energy needed to produce the finished water product.

Table 2 shows a brackish surface or seawater desalination facility co-located with a power plant listing cost-saving features, including savings from economy of scale. When considering costs for using seawater, the proximity to a major potable water transmission system or network must be considered. In most areas of the SFWMD, coastal areas are highly urbanized.

Table 2. Estimated project costs for developing a co-located brackish surface water or seawater treatment facility (From: Metcalf & Eddy 2006).

Candidate Site	Facility Capacity (MGD)	Water Quality (TDS) (ppm)	Total Construction Costs (millions)	Capital $/Gallon of Capacity	Total Annual O&M Costs (millions)	Equivalent Annual Costs ($/1,000 gallons)
Fort Lauderdale	20	15,000	$148.0	$7.40	$10.40	$3.88
Fort Myers	10	15,000	$91.1	$9.11	$6.40	$4.66

ppm = parts per million; TDS = total dissolved solids.

Capital costs for building and maintaining a seawater treatment facility were developed by sizing individual components for each candidate site. Unit prices were estimated from equipment manufacturer pricing and recent historical data from other projects; equipment, electrical, and instrumentation costs were added when appropriate. After construction costs were estimated and totaled, the following cost assumptions were made:

- A 25 percent contingency cost adjustment was added for items that were unanticipated expenses and uncertainties.
- The final construction cost estimate based on 2006 dollars also includes a 17 percent cost adjustment for the contractor's overhead expenses, mobilization, demobilization, bonding, and insurance.
- The final project estimate includes a 10 percent cost adjustment for engineering.
- The capital costs are based on a finished water production quantity that is unique to each of the candidate sites.

The costs presented in this section were considered budget-level costs (in 2010) with an accuracy of +30 percent to -15 percent, and reflect capital amortized at 7 percent for 20 years.


St. Lucie West Water Treatment Facility

Advances in membrane technologies have reduced the cost of seawater RO treatment substantially, generating interest in the implementation of RO in Florida, Texas, and California. Costs can vary widely between states due to regulatory requirements and site-specific conditions. The regulatory landscape differs vastly in the communities and states served by desalination facilities. These differences have an impact on project delivery timelines, legal costs, and design of the seawater RO facility in some cases (WateReuse 2012). In addition, as with any infrastructure project, the various components supporting the overall desalination treatment facility can vary and are based on site location.

For example, the 25 MGD Tampa Bay, Florida co-located seawater facility became fully operational in 2007 and is operating at a cost of $3.38 per 1,000 gallons (Tampa Bay Water 2008). In Carlsbad, California, a 50 MGD co-located seawater desalination facility was completed in late 2015 (Carlsbad Desalination Project 2015). Water from the plant is expected to cost $1,849 to $2,064 per acre-foot ($5.67 to $6.33 per 1,000 gallons), depending on how much is purchased (San Diego County Water Authority 2012).

Reclaimed Water

The costs associated with the production of reclaimed water includes the treatment of the water as well as transmission lines, storage facilities, and a backup disposal system. When reclaimed water is provided to existing facilities, the end users may need to modify their irrigation systems to receive the reclaimed water. Cost savings include reducing the use of alternative water disposal systems, negating or reducing the need for an alternate water supply development, and reducing fertilization costs for the end user using the system for irrigation. More information about existing wastewater treatment facilities, including water reuse data, is provided in the appendices of each regional water supply plan update.

Storage

The cost of storage will vary based on the storage option and the volume of water to be stored. The three major types of potential storage options are aquifer storage and recovery, regional and local retention, and reservoirs.

Aquifer Storage and Recovery

ASR systems are composed of injection and monitor wells, a water treatment facility, and related features such as pipelines and pumps. The volume of water that may be injected into an ASR well is limited by several factors, including aquifer storage capacity, water quality in the aquifer, and water availability. A combination of these factors determines the number of wells that can be constructed at a specific ASR site.

Treatment costs for meeting federal water quality regulations are the main driver for treatment associated with ASR systems, particularly regarding disinfection technology. Disinfection is required to inactivate biologic pathogens that may enter the aquifer through an ASR well. Therefore, the source of the water also affects the treatment and monitoring. Arsenic remains a potential challenge for existing and future ASR systems because the injection of waters into an aquifer can release naturally occurring arsenic contained within the surrounding rock.

Hillsboro Canal ASR Pilot Project

Estimated costs for an ASR system depend on many factors, including hydrogeologic conditions, number of wells, well depths, flow rates, water treatment process, required number of monitor wells, and other required features. **Table 3** provides estimated costs for a 2 MGD potable water ASR system and a 5 MGD surface water ASR system.

Table 3. ASR cost estimates (From: CDM 2007a).

System Capacity (1 well) (MGD)	Costs by Category					
	Capital	Non-Construction	Land Acquisition	Annual O&M	Equivalent Annual	$ per 1,000 gal
2 (potable)	$2,000,000	$160,000	$0	$200,000	$134,885	$0.54
5 (surface)	$5,000,000	$830,000	$0	$500,000	$644,718	$1.02

The potable water cost information assumes that the 2 MGD potable ASR system will be located at the water treatment facility site and have a 70 percent recovery rate. Because the example ASR well will be recharging highly treated potable water into the aquifer, the costs associated with monitoring generally are lower. The 5 MGD surface water ASR system cost information assumes microfiltration treatment of the injected water and a 70 percent recovery rate. The monitoring program for the surface water ASR system scenario would be more extensive with higher costs.

Regional and Local Retention

Projects in this category capture and store excess surface water, and include reservoirs, retention of water in secondary canals, and use of excess surface water to supplement irrigation quality reclaimed water. Regional and local retention costs vary because they are project and site specific. Because the costs vary greatly based on the type and location of the projects, only cost information for reservoirs is included in this section.

Costs associated with surface water storage depend on the site-specific conditions of each reservoir. A site located near an existing waterway increases the flexibility of design and management while reducing costs associated with water transmission infrastructure. Lower site elevations allow maximum storage while reducing costs associated with water transmission and construction excavation but may require more land. Deeper reservoirs result in higher levee elevations, which can substantially increase construction costs, but can have significant savings in land acquisition costs.

Table 4 depicts costs associated with two types of reservoirs. The first is a minor facility with pumping inflow structures and levees designed to handle a maximum water depth of 4 feet. It also has internal levees and infrastructure to control internal flows and discharges. The second type is a major facility with greater depth but an infrastructure similar to the minor facility. Costs increase substantially for construction of higher levees, but may be partially offset by reduced land requirements. Related costs not included in the surface water storage option are costs for inflow and outflow transmission infrastructure as well as costs for water treatment facilities, if any (depending on the end user).

Table 4. Surface water storage costs (From: U.S. Army Corps of Engineers [USACE] and SFWMD 2005*; CDM 2007a).

Reservoir Type	Storage	Costs			
		Construction ($/acre-foot)	Engineering/ Design ($/acre-foot)	O&M ($/acre-foot)	Land ($/acre)
Minor Reservoir	Range	7,667 – 13,020	1,146 – 1,230	194 – 241	3,666 – 24,690
	Average	10,344	1,188	218	13,295
Major Reservoir	Range	1,867 – 6,295	75 – 513	12 – 111	2,702 – 32,533
	Average	3,440	297	52	14,188

*All costs were obtained from CDM (2007a) except for Land costs, which were obtained from USACE and SFWMD (2005).

Utility Interconnections

The costs associated with PWS interconnects depend on the size, distance, and potential engineering challenges. Typically, an interconnect system includes booster pump stations, transmission mains, valves, jack and bores, encasements, and tunneling. Costs are site-specific.

WATER QUALITY AND TREATMENT

The first portion of **Chapter 3** introduced the first phase of the water delivery and treatment process – withdrawal from the water source – along with related costs. This section reviews water treatment quality considerations, and the technologies and processes used to treat water supplies from each water source.

TOPICS

- Water Quality Standards
- Water Treatment Technologies
- Wastewater Treatment Technologies
- Groundwater Contamination

Water Quality Standards

Water for potable (suitable for drinking) and nonpotable water uses have different water quality requirements and treatability constraints. Potable water has very specific quality standards to protect human health while water quality limits for nonpotable uses vary and are dictated by the intended use of the water.

Drinking Water Standards

There are two types of drinking water standards, primary and secondary. Both standards establish maximum contaminant levels (MCLs) for public drinking water systems. Primary drinking water standards include contaminants that can pose health hazards when present in excess of the MCL. Secondary drinking water standards, commonly referred to as aesthetic standards, are parameters that may be characterized by objectionable appearance, odor, or taste of the water, but are not necessarily health hazards. Current MCLs for drinking water in Florida are available from http://www.floridadep.org.

Nonpotable Water Standards

Nonpotable water uses include golf course, landscape, agricultural, and recreational irrigation as well as some industrial and commercial uses, and the water quality standards for each type of use may vary. For example, high iron content usually is not a factor in water used for flood irrigation of food crops, but requires removal for irrigation of ornamental crops. Excessive iron must be removed for use in microirrigation systems, which become clogged by iron precipitates.

Irrigation uses require that the salinity of the water not exceed levels damaging to crops, either by direct application or through salt buildup in the soil. In addition, water constituents harmful to irrigation system infrastructure or equipment (e.g., iron or calcium) must be at acceptable levels or economically removable. Water used for recreation/landscape irrigation purposes, including golf courses, often has additional aesthetic requirements such as color and odor. Water for industrial use is required to meet certain criteria (e.g., the suspended solids and salinity of the water cannot be so high as to build up scales or sediments in the equipment).

In addition to water quality considerations associated with the intended use of nonpotable water, reclaimed water is subject to wastewater treatment standards ensuring the safety of its use. Problems that might be associated with reclaimed water are only of concern if they hinder the use of the water or require special management techniques to allow its use. A meaningful assessment of irrigation water quality, regardless of source, should consider local factors such as specific chemical properties, irrigated crops, climate, and irrigation practices (Water Science and Technology Board 1996).


Water Treatment

Potable Water Treatment Processes

The technologies and processes employed to produce potable water that meets drinking water standards are presented in the following sections of this chapter. Chlorination, lime softening, and membrane processes are processes currently employed by PWS water treatment facilities within the District's jurisdiction. The type of treatment needed depends on the quality and type of the source water. Higher levels of treatment are needed to meet increasingly stringent drinking water quality standards. Water treatment also is required wherever lower quality raw water sources are pursued to meet future demand.

Potable Water Treatment Facilities

In the SFWMD, potable water is supplied by three main types of treatment facilities:

1) Regional PWS, municipal, or privately owned facilities

2) Small developer/homeowner association or utility-owned PWS treatment facilities

3) Self-supplied domestic wells serving individual residences

It is common for smaller interim facilities to be constructed until regional potable water becomes available. The smaller water treatment facility typically is abandoned upon connection to the regional water system. A brief description of the various water treatment methods is followed by cost information for the most common types of new water treatment facilities built within the SFWMD.

Water Treatment Facility – Pumps to Membrane Trains

Water Treatment Technology Processes and Components

The goal of water treatment technology processes and components is to remove existing contaminants in the water, or reduce the concentration of contaminants so the water becomes fit for its desired end use. Lime softening is an inexpensive treatment process commonly used in water treatment facilities throughout Florida to reduce hardness. When these facilities need to be replaced, however, utilities are switching to membrane treatment technology processes. In membrane filtration, water passes through a thin film of semipermeable membrane, which retains contaminants according to their size. Membrane processes can remove dissolved salts and organic materials that react with chlorine disinfectant byproducts precursors. These processes can provide softening as well. The most commonly used membrane processes to treat drinking water are ultrafiltration (UF), microfiltration (MF), nanofiltration (NF), and RO. Each membrane process offers a different solution for different source waters. All membrane processes are pressure-driven, with higher energy costs associated with higher pressure.

Application of a particular technology depends on source water quality and characteristics as well as the desired treated water quality. Technology continues to improve as the U.S. Environmental Protection Agency (USEPA) adopts more stringent water quality regulations. No single water treatment technology process is applicable for the entire range of inorganic and organic compounds. While the rejection of many inorganic compounds by RO and NF membranes is well documented, the rejection of small organic molecules within the range of the microconstituent category is much more complex. It is not appropriate to generalize that all organic molecules over a specific molecular weight will be highly rejected by a given RO or NF membrane. Methods to determine the actual rejection rate of a particular microconstituent or group of microconstituents by a particular membrane include bench scale and pilot testing. The process recovery rate depends on the water source and the process setup as shown in **Table 5**.

Table 5. General water treatment technology process recover rates.

Process	Recovery Rate (%)	Comments
RO seawater	30 – 50	
RO brackish	70 – 90	Depends on the source water's TDS level
NF	80 – 95	Can remove turbidity, microorganisms, disinfection byproduct precursors, and hardness as well as a fraction of the dissolved salts
UF and MF	85 – 97	UF and MF membranes do not have the capability of removing dissolved salts from water; they typically separate larger non-dissolved materials
Lime softening	95 – 99	Effective at reducing water hardness for some source water but is relatively ineffective at controlling contaminants

MF = microfiltration; NF = nanofiltration; RO = reverse osmosis; TDS = total dissolved solids; UF = ultrafiltration.

Source water requires some pre-treatment to remove particulates, suspended sediments, and volatile substances. Pre-treatment includes aeration, coagulation, flocculation, and filtration. The type of pre-treatment will vary based on the source water.

Aeration Process Units

In the aeration process, air is brought into contact with water to transfer volatile substances to or from the water, a process referred to as desorption or stripping. Aeration in water treatment is used primarily to:

- Reduce the concentration of taste- and odor-causing substances, and to a limited extent, oxidize organic matter.
- Remove substances that may interfere with or add to the cost of subsequent water treatment (e.g., the removal of carbon dioxide from water before lime softening).
- Add oxygen to water, primarily for oxidation of iron and manganese, so the elements may be removed by further treatment.
- Remove radon gas or volatile organic compounds considered hazardous to public health.

Desorption or stripping can be accomplished through packed towers, diffused aeration, or tray aerators.

- **Packed Towers** – A packed tower consists of a cylindrical shell containing packing material, which usually is individual pieces randomly placed into the column. The shapes of the packing material vary and can be made of ceramic, stainless steel, or plastic. Water is introduced at the top of the tower and falls down through the tower as air is passing upward.
- **Diffused Aeration** – Diffused aeration consists of bringing air bubbles in contact with water. Air is compressed and then released at the bottom of the water through bubble diffusers. The diffusers distribute the air uniformly through the water cross-section and produce the desired air bubble size. Diffused aeration is not widely used.
- **Tray Aerators** – Cascading tray aerators depend on surface aeration that takes place as water passes over a series of vertically arranged trays. Water is introduced at the top of a series of trays and aeration of the water takes place as the water cascades from one tray to the other.

Coagulation, Flocculation, and Sedimentation Process Units

Coagulation, flocculation, and sedimentation remove suspended material and color, and may be used as a pre-treatment for other processes or technologies such as RO. Coagulation is the process of combining small particles into larger aggregates. During coagulation, a chemical such as alum (aluminum sulfate) is added to raw water. When the water is stirred, the alum forms sticky globs, or flocs, which attach to small particles composed of bacteria, silt, and other contaminants. The water is kept in a settling tank or basin where the flocs sink to the bottom. This prolonged phase of purification is called flocculation and sedimentation. Rapid filters are then used to retain most of the flocs and other particles that escape the chemical coagulation and sedimentation processes.

A high-rate ballasted flocculation/sedimentation process, consisting of a proprietary system with the trade name ACTIFLO®, has replaced the traditional rapid mix coagulation, flocculation, and sedimentation process. This process is used to treat large flow rates with variable raw water quality.

The ACTIFLO® process operates like a conventional flocculation sedimentation design, except that 130- to 150-micrometer sand (microsand) is added to the water during the flocculation process to enhance coagulation and settling. The microsand adds surface area in the coagulation process, which substantially improves the frequency of collision of dispersed or colloidal particles in the raw water with oppositely charged coagulated flocculation. This action accelerates the coagulation and flocculation processes. The microsand also provides "ballast" to the flocculation, resulting in flocculation settling velocities that are 25 to 35 times faster than flocculation produced in conventional flocculation sedimentation processes. When compared to the conventional flocculation sedimentation process, this combination of improved coagulation efficiency and rapid flocculation settling characteristics provides the following:

- Higher quality settled water (as measured via particle counts in the 2 to 4 micrometer range)
- More stable performance during raw water upset conditions
- Reduced coagulant demand (particularly under high algae conditions)
- Reduced process footprint

Filtration Process Units

Filtration process units remove particulate matter from the water supply. Filtration involves passing water through layers of sand, coal, and other granular material to remove microorganisms, including viruses, bacteria, and protozoans such as *Cryptosporidium*. Filtration attempts to mimic the natural filtration of water as it moves through the ground. After the water is filtered, it is treated with chemical disinfectants such as chlorine to kill any organisms that might have made it through the filtration process. The most common filtration methods are rapid filtration, slow sand filtration, activated carbon filtration, and membrane filtration.

- **Rapid Filtration** – Rapid filters are deep beds of sand, anthracite and sand, or granular activated carbon with particle sizes of approximately 1 millimeter (mm). The filters are operated at flow velocities of approximately 15 to 50 feet per hour. Rapid sand filtration typically follows settling basins in conventional water treatment units.
- **Slow Sand Filtration** – Slow sand filtration is a biological treatment process. Typically, a slow sand filter has a depth of 2 feet and operates at flow rates of 0.3 to 1.0 feet per hour. The vital process in slow sand filtration is the formation of a biologically active layer, called the Schmutzdecke, in the top 20 mm of the sand bed. This layer provides an effective surface filtration of very small particles, including bacteria, parasites, and viruses. Any particles that pass through the Schmutzdecke may be retained in the remaining depth of the sand bed by the same mechanisms that exist in rapid filtration.

- **Activated Carbon Filtration** – Active carbon filters remove organic compounds that impart taste and odor to the water. However, these filters may also reduce the number of microbial organisms, including viruses and parasites. Carbon filtering uses activated carbon to remove contaminants and impurities using chemical adsorption. The carbon filter is designed to provide a large surface area that allows maximum exposure to the filter media. Carbon filters are most effective in removing chlorine, sediment, and volatile organic compounds from water. They are not effective in removing minerals, salts, and dissolved inorganic compounds. The efficacy of a carbon filter is also based on the flow rate. Carbon filters are used as pre-treatment devices for RO systems and as specialized filters designed to remove chlorine-resistant cysts such as *Giardia* and *Cryptosporidium*.

Ultrafiltration and Microfiltration Processes

UF and MF are low-pressure water treatment technology processes. UF removes nonionic matter, higher molecular weight substances, and colloids (extremely fine-sized suspended materials that will not settle out of the water column). MF removes coarser materials than UF; although MF removes micrometer and submicrometer particles, it allows dissolved substances to pass through.

Treatment technologies such as UF and MF remove suspended particles by a sieving type of filtration process. The small pore sizes in UF and MF membranes represent a physical barrier to larger-sized contaminants such as bacteria, *Cryptosporidium*, and *Giardia* cysts. Due to the larger pore size of the membranes used for MF, the process is not as effective as UF for removing viruses.

Nanofiltration Process

NF is a diffusion-controlled membrane filtration process using nominal pore size and higher pressure than UF and MF. NF systems can remove virtually all cysts, bacteria, viruses, synthetic and organic compounds, and humic materials.

NF membranes generally are effective for removing particles 10 to 100 micrometers in size, making them well suited for removing high molecular weight molecules (e.g., dissolved organics such as disinfectant/disinfection byproduct [DBP] precursors) and hardness ions. NF membranes commonly are applied for softening, which is sometimes referred to as membrane softening. One advantage of membrane softening technology is its effectiveness at removing organics that function as total trihalomethane (TTHM) and other DBP precursors. In recent years, utilities have been replacing aging lime softening facilities with NF processes to accommodate current and projected regulatory standards.

Desalination/Reverse Osmosis Process

Desalination processes treat saline water to remove or reduce chlorides and dissolved solids, resulting in the production of fresh water suitable for human consumption or irrigation. South Florida utilities use several types of membrane processes for producing potable water from brackish sources.

There are several desalination processes that do not use membranes and are not used in south Florida. Electrodialysis and electrodialysis reversal generally are not considered efficient or cost-effective for organic removal (American Water Works Association [AWWA] 1988). Distillation treatment processes are based on evaporation.

RO is a high-pressure process that relies on forcing water molecules (feedwater) through a semipermeable membrane to produce fresh water (product water or permeate). Heavy metals, dissolved salts, and compounds such as leads and nitrates are unable to pass through the membrane, and therefore are left behind for disposal as concentrate or reject water.

Reverse Osmosis Treatment Facility

RO membranes are effective in desalination of brackish and seawater raw water supplies. In addition to treating a wide range of salinities, RO rejects naturally occurring and synthetic organic compounds, metals, and microbiological contaminants effectively.

Due to the level of removal efficiency, a typical RO application may require a raw water blend stream (bypassing the RO process) with the finished water, or the post-treatment addition of calcium hardness, alkalinity, and a corrosion inhibitor to produce a stable finished water that does not present corrosion concerns for the downstream distribution system.

As of June 2014, there are 36 brackish and two seawater desalination PWS facilities operating within the SFWMD, with two brackish water facilities under construction. The existing facilities have the capacity to produce 269 MGD. The two new facilities will increase the overall production capacity by 18.9 MGD, bringing the Districtwide total capacity to 288 MGD.

Lime Softening Process Units

Lime softening refers to the addition of lime (calcium hydroxide) to raw water to reduce water hardness. When lime is added to raw water, a chemical reaction occurs that reduces water hardness by precipitating calcium carbonate and magnesium hydroxide. While the lime softening process is effective at reducing hardness for some source water, it is relatively ineffective at controlling contaminants such as chlorides, nitrates, TTHM precursors, and others (Hamann et al. 1990). Chloride levels of raw water sources expected to serve lime softening facilities should be below the chloride MCLs to avoid possible exceedance of the standard in the treated water. Additionally, lime softening facilities with raw water sources and nitrate concentrations exceeding the MCL probably will require additional treatment. Disinfectants may be added at several places during the treatment process. To achieve better disinfection efficiency, the disinfectant is added after the lime softening process. Many existing lime softening facilities are modifying their treatment processes because of changing Safe Drinking Water Act regulations for TTHMs and DBPs that require utilities to comply with the standards for these groups of compounds.

Water Treatment Technology Costs

Cost information presented in this chapter, unless otherwise noted, was obtained from the Cost Study (CDM 2007a). All costs in the Cost Study are adjusted to August 2006 dollars and were considered valid in 2010. Costs presented throughout this chapter are considered order-of-magnitude estimates for planning purposes. These estimates are not a substitute for the detailed evaluation that should accompany utility-specific feasibility and design studies needed to assess and construct such facilities.

The total capital costs for the water supply and wastewater system components are the sum of the construction and non-construction costs. Probable capital costs include raw water supply, pre- and post-treatment, process equipment, transfer pumping, plant infrastructure, residuals disposal, yard piping, electrical, instrumentation and controls, site work, general requirements, contractor overhead and profit, project and construction contingency, technical services, and owner administration. Unless otherwise noted, total capital costs do not include costs for land and land acquisition, O&M, permitting, design- and engineering-related inflow and outflow transmission, well construction, production costs, and disinfection.

The following are additional points to consider in estimating potential water treatment costs:

- Capital costs for new facilities will be much greater than costs for facility expansions as new facilities generally are not phased; most costs are upfront and not incremental.
- Costs for raw water transmission mains usually are included in well construction costs.
- Well construction and O&M costs are difficult to estimate due to the variation in costs by planning region; in well types depending on aquifer source (differences in size, depth, and wellhead equipment requirements); and in economy of scale (cost per well usually is reduced in multi-well projects). Nevertheless, well construction or surface water intake costs are included in the estimation of capital costs for each water treatment technology process.
- Facility infrastructure-related costs such as yard piping, electrical, instrumentation, and controls are estimated by a factor applied to the treatment process component subtotal and included in the estimation of a treatment technology process capital cost.
- Land acquisition, permitting, and development-related costs are not provided as these costs are site-specific and highly dependent on local conditions.

Ultrafiltration and Microfiltration Water Treatment Cost

This cost estimate for UF and MF water treatment processes includes components for a completed functioning facility: raw water supply, pre- and post-treatment, typical UF or MF process component, finished water stabilization, intermediate (in-plant) storage, transfer pumping, backup power generation, and general facility infrastructure. This estimate does not include capital costs such as land acquisition, rights-of-way, transmission mains, and utilities. Related costs do not include unusual site work such as wetland mitigation, demucking, and pilings; finished water storage and high service pumps; and distribution mains. The probable costs for UF or MF technology are shown in **Table 6**.

Table 6. Estimated costs associated with ultrafiltration and microfiltration treatment technology (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$9,786,990	$14,191,000	$1,339,530	$1,078,000	$2,552,000	$2.10
10	$16,825,950	$24,397,000	$2,302,904	$1,720,000	$4,253,000	$1.57
15	$22,802,950	$33,064,000	$3,121,008	$2,289,000	$5,722,000	$1.36
20	$28,293,450	$41,025,000	$3,872,470	$2,841,000	$7,100,000	$1.22

Additional considerations:

- The intake includes slotted intake screens, pump basin, and vertical turbine intake pumps, and assumes that the intake is located on the facility site.
- The pretreatment includes automatic backwashing 300-micrometer screens and the addition of a coagulant aid.
- The UF or MF units include the membrane equipment, membrane basins, permeate pumps, backwash, cleaning, and integrity test systems.
- The UF or MF systems are assumed to operate at 90 percent recovery.
- The post-treatment system includes caustic soda, sodium hypochlorite, ammonia, and fluoride systems.
- Facility infrastructure includes the membrane building as well as miscellaneous structures.
- The residuals treatment system includes an equalization basin, residuals thickener, and centrifuge.
- For cost estimation purposes, it is assumed that:
    - The new facility is built on a virgin site with no issues requiring unusual site work or foundation preparation such as wetland mitigation, substantial site filling, demucking, or pilings.
    - The facility is located directly adjacent to a surface raw water source such that raw water transmission piping is considered included in the yard piping line item cost.
    - The facility is located directly adjacent to a power supply such that the power transmission system to the facility is considered included in the electrical cost allowance.
    - Project implementation is a traditional design-bid-build approach, with owner operation.
    - O&M costs are based on an assumed unit electrical power cost of $0.10/kWh.
    - The equivalent annual capital cost is based on an annual interest rate of 7 percent.
    - An annual deposit equal to 10 percent of the equivalent annual capital cost is budgeted for a renewal and replacement account.

Nanofiltration Water Treatment Cost

Table 7 presents probable costs for NF technology. For cost estimation purposes, the same assumptions are made as described previously for MF/UF technology. This estimate does not include capital costs such as land acquisition, rights-of-way, transmission mains, and utilities; unusual site work such as wetland mitigation, demucking, and pilings; finished water storage and high service pumps; and distribution mains.

Table 7. Estimated costs associated with nanofiltration treatment technology (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
1	$11,073,000	$16,056,000	$1,515,573	$634,000	$2,302,000	$9.46
3	$14,262,000	$20,680,000	$1,952,046	$1,141,000	$3,288,000	$4.50
5	$16,674,000	$24,178,000	$2,282,232	$1,646,000	$4,156,000	$3.42
10	$23,156,000	$33,576,000	$3,169,337	$2,836,000	$6,322,000	$2.34
15	$28,670,000	$41,573,000	$3,924,197	$3,913,000	$8,229,000	$1.95
20	$34,612,000	$50,188,000	$4,737,392	$4,992,000	$10,203,000	$1.75

Considerations:

- Shallow water aquifers are assumed to supply the raw water for the NF treatment facility.
- The design capacity for each well is approximately 2 MGD of raw water per well.
- The NF process is assumed to operate at an 85 percent recovery rate with no raw water blend.
- The number of wells required depends on the raw water feed to the facility at the rated capacity and assumes 20 percent will be standby wells.
- Pre-treatment includes raw water acidification, antiscalant feed, and micrometer cartridge filtration.
- The membrane system includes stainless steel membrane feed pumps and feed piping, membrane skids (pressure vessels, skid piping, membrane elements, control valves, and instrumentation), a membrane cleaning system, and process piping. Post-treatment includes packed-tower type degasification, a caustic (sodium hydroxide) feed system for pH adjustment, and application of a corrosion inhibitor.
- Pre- and post-treatment chemical systems include bulk storage tanks and containment basins, day tanks, metering pumps, chemical piping, and chemical injection quills or diffusers.

Brackish Groundwater RO Water Treatment Cost

The pre-treatment, process, and post-treatment components provided for brackish groundwater RO technology are essentially the same as for the NF system. Exceptions include minor differences for items such as pipe pressure ratings.

Considerations:

- The raw water supply for the brackish groundwater RO treatment technology is assumed to be from Upper Floridan aquifer wells.
- The design capacity for each well is approximately 2 MGD of raw water per well.
- The lower pressure RO process (compared to NF) is assumed to operate at a 75 percent recovery rate, with no raw water blend.
- The number of wells required depends on the raw water feed to the facility at the rated capacity and assuming 20 percent standby wells.

The probable costs for the brackish groundwater RO technology are shown in **Table 8**. The estimates do not include capital costs such as land acquisition, rights-of-way, transmission mains, and utilities; unusual site work such as wetland mitigation, demucking, and pilings; finished water storage and high service pumps; and distribution mains.

Table 8. Estimated costs associated with brackish groundwater reverse osmosis treatment technology (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
1	$14,406,000	$20,889,000	$1,571,774	$588,000	$2,757,000	$11.33
3	$20,407,000	$29,590,000	$2,793,087	$1,171,000	$4,243,000	$5.81
5	$23,926,000	$34,693,000	$3,274,774	$1,758,000	$5,361,000	$4.41
10	$33,503,000	$48,579,000	$4,585,514	$3,181,000	$8,226,000	$3.04
15	$44,197,000	$64,086,000	$6,049,265	$4,526,000	$11,180,000	$2.65
20	$54,536,000	$79,077,000	$7,464,309	$5,910,000	$14,120,000	$2.42

Estimated costs are planning-level cost estimates made without detailed engineering design and a margin of error from +50 percent to -30 percent.

Brackish Surface Water RO Water Treatment Cost

The pre-treatment, process, and post-treatment components provided are essentially the same as the groundwater NF systems, with the exception of an additional pre-treatment step of media filters required upstream due to higher levels of suspended particulate contaminants present in a surface water supply.

Considerations:

- The raw water supply for the brackish surface water RO treatment technology is assumed to be from a surface water source such as a brackish river or estuary.

- The intake includes slotted intake screens, pump basin, and vertical turbine intake pumps, and assumes that the intake is located on the facility site.
- The brackish surface water RO process is assumed to operate at a 75 percent recovery rate, with no raw water blend.

Table 9 presents the probable costs for brackish surface water RO technology. Related costs do not include capital costs such as land acquisition, rights-of-way, transmission mains, and utilities; unusual site work such as wetland mitigation, demucking, and pilings; finished water storage and high service pumps; and distribution mains.

Table 9. Estimated costs associated with brackish surface water reverse osmosis treatment technology (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$25,927,000	$37,594,000	$3,548,608	$1,846,000	$5,750,000	$4.73
10	$33,768,000	$48,963,000	$4,621,761	$3,371,000	$8,455,000	$3.13
15	$42,883,000	$62,180,000	$5,869,352	$4,818,000	$11,274,000	$2.68
20	$52,464,000	$76,073,000	$7,180,753	$6,310,000	$14,209,000	$2.43

Estimated costs are planning-level cost estimates made without detailed engineering design and a margin of error from +50 percent to -30 percent.

Seawater RO Water Treatment Cost – Surface Intake Co-Located with a Power Plant

The pre-treatment, process, and post-treatment components provided are essentially the same as the brackish surface water RO system, including media filter pre-treatment. There are some differences in equipment and pipe pressure ratings due to the increased operating pressure of seawater RO systems versus brackish water RO systems.

Considerations:

- The raw water supply for the seawater RO water treatment technology is assumed taken from a saltwater bay or intracoastal waterway.
- The intake uses the existing cooling water intake for the power plant, and concentrate is discharged to the cooling water outfall.
- The seawater RO process is assumed to operate at a 50 percent recovery rate.

Probable costs for the seawater RO water treatment technology with the surface intake co-located with a power plant are shown in **Table 10**. The estimates do not include capital costs such as land acquisition, rights-of-way, transmission mains, and utilities; unusual site work such as wetland mitigation, demucking, and pilings; finished water storage and high service pumps; and distribution mains.

Table 10. Estimated costs associated with seawater reverse osmosis treatment technology (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$27,192,000	$39,429,000	$3,721,819	$3,145,000	$5,750,000	$5.95
10	$44,203,000	$64,094,000	$6,050,020	$6,230,000	$8,455,000	$4.77
15	$64,019,000	$92,828,000	$8,762,307	$9,248,000	$11,274,000	$4.48
20	$79,610,000	$115,436,000	$10,896,342	$12,432,000	$14,209,000	$4.18

Estimated costs are planning-level cost estimates made without detailed engineering design and a margin of error from +50 percent to -30 percent.

Water Treatment Technology Process Components

This section addresses water treatment process units that provide incremental treatment process capacity to an existing water treatment facility. It includes cost estimates for accommodating brackish groundwater, brackish surface water, and seawater.

Nanofiltration Process Units

Nanofiltration process units can be used as: 1) an incremental water treatment facility capacity increase for an existing facility originally designed to accommodate future capacity increases, or 2) a pre-treatment process unit for a high-pressure RO treatment facility such as a seawater desalination facility. The NF process unit consists of cartridge filters; membrane feed pumps; pre-treatment chemicals (acid and antiscalant); the membrane units (membrane pressure vessels, frames, and piping); piping inside the membrane building, cleaning system, instruments and controls; and electrical equipment.

The probable costs for NF process addition are shown in **Table 11**. The estimates do not include capital costs such as land acquisition, rights-of-way, transmission mains, and utilities; unusual site work such as wetland mitigation, demucking, and pilings; finished water storage and high service pumps; and distribution mains.

Table 11. Estimated costs associated with nanofiltration process addition (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
1	$10,562,000	$15,315,000	$1,445,628	$615,000	$2,206,000	$9.07
3	$12,728,000	$18,455,000	$1,742,021	$1,086,000	$3,002,000	$4.11
5	$14,389,000	$20,863,000	$1,969,320	$1,646,000	$3,812,000	$3.13
10	$18,666,000	$27,066,000	$2,554,839	$2,836,000	$5,647,000	$2.09
15	$23,050,000	$33,424,000	$3,154,989	$3,913,000	$7,384,000	$1.75
20	$26,951,000	$39,080,000	$3,688,876	$4,992,000	$9,050,000	$1.55

Brackish Water RO Process Units

The brackish water RO process unit can be used as: 1) an incremental water treatment facility capacity increase for an existing facility originally designed to accommodate future capacity increase, or 2) a replacement process unit during the conversion of an existing water treatment facility to a different water source such as a conversion from an NF to a RO treatment facility with the source changing from a shallow freshwater aquifer to a brackish aquifer. The brackish water RO process unit consists of cartridge filters; membrane feed pumps; pre-treatment chemicals (acid and antiscalant); membrane units (membrane pressure vessels, frames, and piping); piping inside the membrane building, cleaning system, instruments, and controls; and electrical equipment.

Table 12 presents probable costs for the RO process addition. Related costs do not include capital costs such as land acquisition, rights-of-way, transmission mains, and utilities; unusual site work such as wetland mitigation, demucking, and pilings; finished water storage and high service pumps; and distribution mains.

Table 12. Estimated costs associated with brackish water reverse osmosis process addition (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
1	$12,959,000	$18,791,000	$1,773,737	$574,000	$2,525,000	$10.38
3	$16,065,000	$23,294,000	$2,198,789	$1,128,000	$3,547,000	$4.86
5	$18,136,000	$26,297,000	$2,482,251	$1,757,000	$4,488,000	$3.69
10	$21,923,000	$31,788,000	$3,000,562	$3,180,000	$6,481,000	$2.40
15	$26,830,000	$38,905,000	$3,672,357	$4,525,000	$8,565,000	$2.03
20	$31,379,000	$45,500,000	$4,294,878	$5,909,000	$10,633,000	$1.82

Disinfection Process Components

All potable water requires disinfection as part of the treatment process before distribution. Disinfection, the process of inactivating disease-causing microorganisms, provides essential public health protection. Disinfection methods include chlorination, ultraviolet (UV) light radiation, and ozonation.

PWS facilities are required to provide adequate disinfection of finished/treated water and a disinfectant residual in the water distribution system. Disinfectant may be added at several places in the treatment process, but adequate disinfectant residual and contact time must be provided prior to distribution to the consumer.

Chlorination

Chlorine is a common disinfectant. The use of free chlorine as a disinfectant often results in the formation of unacceptable levels of TTHMs and other DBPs when free chlorine combines with naturally occurring organics in the raw water source. Existing treatment processes are being modified to comply with changing water quality standards. Add-on treatment technologies that effectively remove these compounds or prevent their formation include ozone disinfection, granular activated carbon, enhanced coagulation, membrane systems, and switching from chlorine to chlorine dioxide (Hoffbuhr 1998).

The primary disinfectant used within the SFWMD is chlorine dioxide or chlorine used with ammonia to form chloramine, and on-site generation of sodium hypochlorite. The rate of disinfection depends on the concentration and form of available chlorine residual, time of contact, pH, temperature, and other factors. Current disinfection practice is based on establishing an amount of chlorine residual during treatment and then maintaining an adequate residual to the customer's faucet.

The construction costs for a chlorination system using on-site generation of sodium hypochlorite include equipment and installation. O&M costs include energy and chemicals, but do not include labor and normal maintenance, which are covered under the facility O&M labor (CDM 2007a). Probable costs associated with a chlorination system using on-site generation of sodium hypochlorite are shown in **Table 13**.

Table 13. Estimated costs for chlorination disinfection by on-site generation of sodium hypochlorite (From CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$1,745,000	$2,530,000	$238,814	$18,000	$281,000	$0.23
10	$2,941,000	$4,264,000	$402,491	$36,000	$478,000	$0.18
15	$3,985,000	$5,778,000	$545,402	$54,000	$654,000	$0.16
20	$4,946,000	$7,172,000	$676,986	$72,000	$817,000	$0.14

Ultraviolet Light

The UV light disinfection process does not use chemicals. Microorganisms, including bacteria, viruses, and algae, are inactivated within seconds of radiation with UV light. The UV disinfection process takes place as water flows through an irradiation chamber. Microorganisms in the water are inactivated when the UV light is absorbed. A photochemical effect is created and vital processes are stopped within the cells, thus rendering the microorganisms harmless. Ultraviolet light inactivates microbes by damaging their nucleic acids, thereby preventing the microbe from replicating. When a microbe cannot replicate, it is incapable of infecting a host. UV light is effective in inactivating *Cryptosporidium*. One major advantage of UV light disinfection is that it is capable of disinfecting water faster than chlorine, and without the need for retention tanks or potentially harmful chemicals (AWWA 2003).

The probable costs for UV disinfection were derived from technology cost estimates for complying with new drinking water regulations under the USEPA (2005). All capital cost estimates were derived directly from the USEPA capital cost tables with appropriate adjustments for inflation, contractors, and project mark-ups. CDM (2007a) developed the O&M costs (except for replacement parts and materials) using standard unit costs for power and labor. **Table 14** presents probable costs for UV disinfection.

Table 14. Estimated costs for ultraviolet light disinfection (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
1	$436,998	$633,998	$60,000	$11,800	$77,800	$0.37
3	$496,999	$720,999	$68,000	$21,200	$96,000	$0.14
5	$627,000	$909,000	$86,000	$28,200	$122,800	$0.10
10	$1,244,000	$1,804,000	$170,000	$46,700	$233,700	$0.09
15	$1,995,000	$2,893,000	$273,000	$65,400	$365,700	$0.09
20	$2,700,000	$3,915,000	$370,000	$86,300	$493,300	$0.08

Ozonation

Ozonation is a water disinfection method that uses the same type of ozone found in the atmosphere. By adding ozone to the water supply and then sending an electric charge through the water, water suppliers inactivate disease-causing microbes, including *Giardia* and *Cryptosporidium*. Contact times required for disinfection by ozone are short (seconds to several minutes) compared to the longer disinfection time required by chlorine. Ozonation is an effective way to alleviate most of PWS taste and odor issues (AWWA 2003).

Ozonation is widely used in western Europe. However, in the U.S., use of ozonation is limited. The Orlando Utilities Commission has been using ozonation since 2002. Other community water suppliers using ozonation are located in California, Colorado, Michigan, Maine, New Jersey, Oklahoma, Pennsylvania, Texas, Wisconsin, and Wyoming. The cost of ozonation is approximately four times higher than that of traditional chlorine disinfection because of the greater amount of electricity needed for water treatment. Another disadvantage of ozonation is that unlike chlorine, ozone dissipates quickly in water supplies; contaminants entering the water after it is disinfected and leaves the facility could go untreated. However, ozonation does not produce the DBPs associated with chlorine disinfection. The probable costs for ozonation were derived from technology cost estimates for complying with new drinking water regulations (USEPA 2005). **Table 15** shows probable costs for ozonation disinfection.

Table 15. Estimated costs of ozonation (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
1	$743,998	$1,078,998	$102,000	$50,800	$163,000	$0.78
3	$1,369,999	$1,984,999	$187,000	$60,200	$265,900	$0.39
5	$1,994,000	$2,892,000	$273,000	$69,500	$369,800	$0.30
10	$3,068,000	$4,448,000	$420,000	$101,600	$563,600	$0.21
15	$4,048,000	$5,869,000	$554,000	$133,700	$743,100	$0.18
20	$4,892,000	$7,094,000	$670,000	$167,300	$904,300	$0.15

Considerations:

- All capital cost estimates were derived directly from the USEPA capital cost tables, with appropriate adjustments for inflation and contractor and project mark-ups.
- The O&M costs (except for replacement parts and materials) were developed using standard unit costs for power, liquid oxygen, and labor.
- The USEPA cost tables assumed:
  - A design dose of 4.5 milligrams per liter (mg/L)
  - Contact time of 12 minutes
  - N+1 equipment redundancy for achieving 0.5-log *Cryptosporidium* inactivation credit under the USEPA (2005)
- These assumptions represent conservative design criteria for providing 3-log *Giardia* inactivation for water supplies with moderate ozone demand and decay rates, based on CDM's ozone design experience.
- The ozone-generation building cost was based on a unit cost of $150 per square foot, based on CDM's design experience, which was higher than the unit cost used in the USEPA estimates.
- Power and liquid oxygen chemical costs for O&M cost were calculated based on:
  - Average process flows for each design capacity
  - An average ozone dose of 2.5 mg/L
  - Constant ozone-in-oxygen concentration of 10 percent by weight
- The required O&M labor for the ozone system assumes that this process is an add-on process to a fully staffed conventional water treatment facility with no additional staff positions required.

Distribution Process Components

Distribution process components are likely to be common among the various water treatment technology processes. Process components listed in this section include finished water storage and high service pumping.

Finished Water Storage

Finished water storage facilities such as ground storage tanks, towers, and reservoirs provide storage of treated water before it is distributed to users. The storage provides a reserve of water to avoid service interruption during system emergencies, helps maintain uniform system pressure, permits reduction in sizes of distribution mains, and helps meet peak system demands while allowing a water treatment facility to operate at a relatively constant rate. The finished water storage requirements and associated costs are assumed the same for various treatment technologies for each facility capacity. Costs include a pre-stressed concrete (Crom-type) ground storage tank sized to provide approximately 50 percent of the rated facility capacity daily flow. For example, for a 10 MGD facility, a 5 million gallon storage tank is provided. Probable costs for the finished water storage component are shown in **Table 16**.

Table 16. Estimated costs for finished water storage (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$1,045,000	$1,515,000	$143,005	$143,000	$0.12
10	$1,899,000	$2,754,000	$259,958	$260,000	$0.10
15	$2,562,000	$3,715,000	$350,670	$351,000	$0.08
20	$3,036,000	$4,402,000	$415,518	$416,000	$0.07

High Service Pumping

High service pumps are used to pump treated water into the water distribution system. The high service pumping requirements and associated costs are assumed the same for various treatment technologies for each facility capacity. Costs include a high service pumping system with a firm pumping capacity equal to 200 percent of the facility capacity rating to meet peak hour demands. This corresponds to a peak hour demand-to-maximum day demand peaking factor of 2.0. **Table 17** presents probable costs for the high service pumping component. The cost estimates do not include distribution system piping and finished water storage component costs.

Table 17. Estimated costs for high service pumping (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$633,000	$918,000	$86,653	$86,000	$182,000	$0.15
10	$930,000	$1,350,000	$127,430	$182,000	$327,000	$0.12
15	$1,099,000	$1,594,000	$150,462	$290,000	$455,000	$0.11
20	$1,399,000	$2,029,000	$191,523	$401,000	$612,000	$0.10

Wastewater Treatment Technologies

Wastewater treatment in the SFWMD is provided by regional, municipal, or privately owned wastewater treatment facilities, small developer/homeowners association or utility-owned wastewater treatment facilities, and septic tanks for some single family homes. Wastewater treatment in the SFWMD is regulated by the FDEP. Pursuant to Chapter 62-600, F.A.C., the following wastewater treatment facilities are exempt from the FDEP regulation and are regulated by the local health department for each county:

- Those with a design capacity of 2,000 gallons per day (GPD) or less, which serve the complete wastewater and disposal needs of a single establishment
- Septic tank drain field systems and other on-site sewage systems with subsurface disposal and a design capacity of 10,000 GPD or less, which serve the complete wastewater disposal needs of a single establishment

Many of the smaller wastewater treatment facilities are constructed on an interim basis until regional wastewater facilities become available. Upon connection to a regional wastewater system, smaller wastewater treatment facilities typically are abandoned.

Wastewater treatment facilities use integrated processes to treat wastewater to a desired quality. At a minimum, wastewater facilities in Florida provide secondary treatment. These facilities typically dispose of effluent via deep injection wells or ocean outfalls. Ocean outfall is further discussed in the *2013 Lower East Coast Water Supply Plan Update* (SFWMD 2013b).

The *2013 Reuse Inventory* (FDEP 2014) indicates 112 wastewater facilities located within the SFWMD reused approximately 271 MGD of reclaimed water for beneficial purposes. Disposal of the remaining 575 MGD of treated wastewater was by deep well injection and discharge to the ocean. More information about existing wastewater treatment facilities, including water reuse data, is provided in the appendices of each regional water supply plan update.

Advanced Secondary Treatment

Advanced secondary treatment typically refers to the addition of filtration and high-level disinfection to a standard secondary treatment facility. Treatment facilities that use reclaimed water for public access irrigation (the most common end use) must provide advanced secondary treatment. The following information includes an overview of advanced treatment and processes used to produce higher quality reclaimed water. It does not include related components such as transmission systems, storage, alternative disposal, and modifications to the application area for wastewater treatment.

Granular Media Filters Followed by Ultraviolet Disinfection

Filtration is a component of advanced secondary wastewater treatment, which provides a reclaimed water quality that can be used for public access irrigation. Granular media filtration, typically sand, is a polishing step that lowers the levels of suspended solids and associated contaminants in treated wastewater. This filtration, followed by UV disinfection, kills pathogenic microorganisms in the wastewater before being discharged into the environment. Types of granular media filters include slow sand, rapid sand, deep bed, upflow, pulsed bed dual, and multimedia. To achieve high-level disinfection in an advanced secondary treatment process, monitoring and chemical feed equipment is also needed.

The costs associated with granular media filters followed by UV disinfection are presented in **Table 18**. The construction costs include all equipment, material, and installation; the O&M costs include all energy, labor, and other maintenance. The following assumptions were applied to develop the cost estimates:

- Granular media filter construction cost is based on deep bed filters. The cost includes equipment, concrete, and installation.
- UV construction cost is based on an in-vessel medium pressure system.
- The facility infrastructure includes a building to house process equipment.

Table 18. Estimated costs for granular media filters followed by ultraviolet disinfection (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$4,309,000	$6,247,000	$590,000	$421,000	$1,070,000	$0.59
10	$8,376,000	$12,145,000	$1,146,000	$841,000	$2,102,000	$0.58
15	$12,485,000	$18,103,000	$1,709,000	$1,262,000	$3,142,000	$0.57
20	$15,832,000	$22,957,000	$2,167,000	$1,683,000	$4,067,000	$0.56

Advanced Wastewater Treatment

Advanced wastewater treatment (AWT) involves the upgrade of an existing wastewater treatment facility from advanced secondary treatment to AWT to achieve nitrogen and phosphorus removal. AWT refers to a level of treatment that meets effluent limits of 5 mg/L total suspended solids, 5 mg/L carbonaceous biochemical oxygen demand, 3 mg/L total nitrogen, and 1 mg/L total phosphorus on an annual average basis.

In the past, AWT was associated with facilities that use stream discharge for effluent disposal. However, AWT is now employed to allow use of reclaimed water for wetland restoration, groundwater recharge systems, and other advanced uses of reclaimed water.

Five-Stage Bardenpho Process

Many AWT process configurations have been developed to accomplish biological nutrient removal from advanced secondary treatment effluent. One configuration commonly used in Florida to provide high levels of nitrogen and phosphorus removal is the five-stage Bardenpho process. **Table 19** presents the costs for AWT that include a five-stage Bardenpho process and deep bed filters after secondary clarification to further remove total suspended solids.

Table 19. Estimated costs for advanced wastewater treatment – five-stage Bardenpho process (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$17,326,320	$25,123,000	$2,371,000	$1,417,000	$4,025,000	$2.21
10	$27,809,760	$40,323,000	$3,806,000	$2,738,000	$6,925,000	$1.90
15	$38,291,880	$55,524,000	$5,241,000	$4,037,000	$9,802,000	$1.79
20	$48,252,600	$69,967,000	$6,604,000	$5,322,000	$12,586,000	$1.72

Membrane Bioreactor Process

One of the most important technological advances in biological wastewater treatment is the development and application of a membrane bioreactor process for full-scale municipal wastewater treatment. The membrane bioreactor is a suspended growth-activated sludge system that uses microporous membranes for solid and liquid separation instead of secondary clarifiers. The membrane component uses low-pressure MF or UF membranes and eliminates the need for clarification and tertiary filtration. The membranes typically are immersed in an aeration tank; however, some applications use a separate membrane tank. One of the key benefits of a membrane bioreactor system is that it effectively overcomes the limitations of poor settling of sludge in conventional activated sludge processes.

The construction costs developed for a membrane bioreactor facility are based on the following process modules: influent pumping, preliminary treatment, aeration tanks, membrane tanks, UV disinfection, effluent pump station, and sludge treatment and handling. Process construction cost includes estimates for anoxic and aeration tanks, process blowers, return activated sludge pumps, membrane tanks, air scour blowers, permeate pumps, and membrane cleaning system. The Modified Ludzack-Ettinger process is assumed for the membrane bioreactor configuration. **Table 20** shows the costs for the membrane bioreactor process.

Table 20. Estimated costs for advanced wastewater treatment – membrane bioreactor process (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$50,896,000	$73,799,000	$6,966,000	$2,219,000	$9,882,000	$5.41
10	$78,338,000	$113,591,000	$10,722,000	$3,645,000	$15,439,000	$4.23
15	$104,142,000	$151,006,000	$14,254,000	$5,109,000	$20,788,000	$3.80
20	$122,715,000	$177,937,000	$16,796,000	$6,890,000	$25,366,000	$3.47

Microfiltration/Reverse Osmosis Process

Another advanced wastewater process to treat existing secondary effluent is the addition of MF and RO systems to the secondary treatment facility. The construction costs for the MF and RO process include pre-treatment facilities, an MF system, and an RO system. **Table 21** presents the costs for the MF and RO process. The following assumptions are used to develop cost estimates for the MF and RO option:

- Pre-treatment construction cost includes estimates for rotary drum 2-mm fine screens.
- MF system cost is based on a submerged MF system and includes equipment, concrete, and installation.
- RO system cost includes membranes, a break tank, an in-line pump station, and chemical feed and storage systems for pH adjustment and corrosion protection. The cost estimate is based on a RO system with an 80 percent recovery rate.
- Concentrate disposal is based on a deep injection well, which is included in the cost estimate.

Table 21. Estimated costs for advanced wastewater treatment – microfiltration/reverse osmosis (From: CDM 2007a).

Facility Capacity (MGD)	Construction Cost	Capital Cost	Equivalent Annual Capital Cost	Annual O&M Cost	Total Annual Production Cost	Cost (per 1,000 gal)
5	$45,234,000	$65,590,000	$6,191,000	$3,311,000	$10,121,000	$5.55
10	$73,636,000	$106,772,000	$10,079,000	$6,256,000	$17,343,000	$4.75
15	$97,911,000	$141,972,000	$13,401,000	$7,194,000	$21,935,000	$4.01
20	$118,615,000	$171,992,000	$16,235,000	$9,592,000	$27,451,000	$3.76

GROUNDWATER CONTAMINATION AND IMPACTS TO WATER SUPPLY

Some contaminants can be costly and difficult for water treatment facilities to remove from drinking water supplies. The cost and degree of difficulty depends on the contaminant (i.e., any physical, chemical, biological, or radiological substance or matter in water) [Section 403.852(9), F.S.].

An effective groundwater monitoring program is critical for accurate determination of groundwater degradation. Improperly located monitor wells can result in the oversight of a contaminant plume. In addition, certain unacceptable parameters may not be observed in the groundwater for many years, depending on soil adsorption capacities and groundwater gradient. The following discussion reviews major groundwater contamination sources.

Groundwater Contamination Sources

Aquifers can be contaminated in several ways. Activity occurring on ground surfaces can contaminate the SAS, while saltwater intrusion presents a potential threat to aquifers. Once a contaminant enters an aquifer, it can be difficult to remove. In many cases, leaks, spills, or discharges of contaminants result in contamination of large areas of the aquifer. Therefore, preventing contamination of the aquifer by protecting PWS wells and wellfields from activities that present a possible contamination threat is preferable. Many counties have enacted ordinances for well protection.

Saltwater Intrusion

Saltwater intrusion is the movement of saline water into freshwater aquifers and can occur laterally or vertically. The intrusion of saline water could occur in most coastal aquifers hydraulically connected to seawater. Within the SFWMD, salinity control structures have been installed in all canals that connect to tidal basins to limit saltwater encroachment and maintain freshwater heads on the inland side.

Freshwater aquifers that overlie saline aquifers also could be contaminated by saline water. Relict seawater (connate water with high salinity) is found in some areas of the District in deeper portions of the SAS. As the freshwater aquifer is pumped, upconing of saline water may occur, which could degrade water supplies. PWS utilities as well as other use classes establish monitor wells to provide information about the quality of the water in the aquifers.

In the past, cross-contamination of shallow aquifers has occurred from FAS wells within the District. The causes of contamination vary. Several artesian wells were drilled into the FAS for agricultural water supply and oil exploration from the 1930s through the 1950s. The wells were constructed with casings that extend to approximately 200 feet or less below land surface (bls). This construction method exposed shallower freshwater zones to invasion by more saline FAS water.

Over time, the steel casings of some properly constructed wells have corroded, allowing interaquifer exchange. Occasionally, an abandoned well was plugged improperly or simply left open, free flowing on the land surface and recharging the SAS with saline water. In addition, as FAS water is used as a supplemental source for agriculture during periods of water shortage, brackish water can infiltrate the SAS.

The Water Quality Assurance Act passed in 1981 requires FAS wells to be equipped with a valve capable of controlling discharge from the well. Property owners are responsible for wells located on their land. Permit holders are required to maintain their wells and properly abandon them when necessary.

The SFWMD Water Use Regulatory Database includes compliance data associated with respective water use permits. Saltwater intrusion data are maintained as a component of this compliance data, and include information about chlorides, specific conductance, and water levels from the monitoring network information contained in the Water Use Regulatory Database. The monitoring network receives monitor well data supplied by PWS utilities and the U.S. Geological Survey (USGS).

The effects of saltwater intrusion, upconing, aquifer cross-contamination, and connate water can create complex and somewhat unpredictable scenarios for local groundwater quality. Although monitor wells provide a great deal of information where they exist, there are limits as to how many wells can be installed. Where more saltwater interface data are required, additional methods must be considered; for example, geophysical surveys can provide useful information about the extent of saltwater intrusion (Benson and Yuhr 1993).

Microconstituents

Microconstituents comprise a relatively new group of compounds whose health effects are presently unknown. The FDEP (2009) defines microconstituents as follows:

> *Microconstituents, sometimes known as "emerging pollutants of concern," are chemicals found in a wide array of consumer goods, including pharmaceuticals and personal care products. Some of the microconstituents are considered "endocrine disrupters" (compounds such as synthetic estrogen, PCBs, dioxin, and some pesticides that may interfere with or modify hormone processes within an organism)*.

The number of constituents that fall within the microconstituent definition is well beyond the number of contaminants currently monitored in drinking water. As technology has advanced to the point that trace quantities of these chemicals can now be detected, a substantial amount of research activity is devoted to determining the distribution and occurrence of these substances in drinking water, the associated health implications, and methods of treatment for contaminants that may be considered a health risk. Microconstituent removal may become a performance standard in the future.

The USGS (2002) performed a national water quality survey of microconstituents. The survey, *Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999–2000*, is available from http://toxics.usgs.gov/pubs/OFR-02-94/index.html.

Solid Waste Sites

Although groundwater monitoring began in the early 1980s for landfills, inactive sites may still pose a threat to groundwater resources. Many of Florida's older landfills and dumps were used with little or no control over the types of material disposed.

Leachate is the contaminant-laden liquid that drains from a landfill. Leachates often contain high concentrations of nitrogen and ammonia compounds, iron, sodium, sulfate, total organic carbon, biological oxygen demand, and chemical oxygen demand. Less common constituents that may also be present include metals such as lead or chromium and volatile or synthetic organic compounds associated with industrial solvents such as trichloroethylene, tetrachloroethylene, and benzene. The presence and concentration of contaminants in the leachate depends on several factors that dictate the extent and character of the resulting groundwater impacts, including the following:

- Landfill size and age
- Types and quantities of wastes produced in the area
- Local hydrogeology
- Landfill design and filling techniques

The FDEP is responsible for rule development, solid waste policy, and implementation of Florida's solid waste management program. More information about solid waste is available from http://www.floridadep.org/waste/categories/solid_waste.

Hazardous Waste Sites

The FDEP sponsors several programs that provide support for hazardous waste site cleanup, including:

- Early Detection Incentive Program
- Petroleum Liability and Restoration Program
- Abandoned Tank Restoration Program
- Petroleum Cleanup Participation Program
- Preapproved Advanced Cleanup Program

Locations and cleanup status can be obtained through the FDEP Waste Management Section. The FDEP website provides current listings of hazardous waste sites, available from http://www.floridadep.org.

Superfund Program Sites

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, commonly known as "Superfund," authorized the USEPA to identify and remediate uncontrolled or abandoned hazardous waste sites. The National Priorities List targets sites considered to have high health and environmental risks. More information about the USEPA's Superfund Program is available from http://www.epa.gov.

Septic Tanks

Septic systems are a common method of on-site waste disposal for single-family homes and small commercial facilities. Septic tanks exist throughout the District's planning areas and are a threat to groundwater resources used as drinking water sources. Older systems installed prior to regulatory separation requirements between the bottom of the tank's associated drain field and the top of the seasonal high water table are a particular threat. In many neighborhoods served by septic tanks, centralized wastewater collection systems are being installed.

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Water Conservation

Water conservation (conservation) includes any activity or action that reduces the demand for water, including those that prevent or reduce wasteful or unnecessary uses and those that improve efficiency for necessary uses. Conservation (also referred to as demand management) is an integral part of water supply planning and water resource management; it can reduce, defer, or eliminate the need for expansion of water supply sources to meet current or future demands.

This chapter addresses the role of conservation in water supply, the South Florida Water Management (SFWMD or District) Comprehensive Water Conservation Program for South Florida, conservation planning as part of the water use permitting process, and some of the tools and programs the District administers to help users achieve water use efficiency.

Water use efficiency and conservation is a sound practice and should be maximized, regardless of the water source. The implementation of conservation programs often is among the lowest cost solutions to meet future water needs and has been shown to reduce costs to ratepayers over the long term if properly planned and implemented. **Table 22** compares the costs of developing 1,000 gallons of water supply through new facility construction or the expansion of an existing facility, and the costs of saving 1,000 gallons through water conservation.

Table 22. Comparison of alternative water supply development costs and water conservation costs for 1,000 gallons (From: CDM 2007a; Hazen and Sawyer 2013).

Water Conservation*	New Treatment Facility Construction**				Expansion of Existing Treatment Facility**			
Typical Conservation Programs	Nanofiltration Capacity		Low Pressure RO Capacity		Nanofiltration Process Train Capacity		Low Pressure RO Train Capacity	
	1 MGD	5 MGD	1 MGD	5 MGD	1 MGD	5 MGD	1 MGD	5 MGD
$0.07 – $3.00	$9.46	$3.42	$11.33	$4.41	$9.07	$3.13	$10.38	$3.69

*Data from Hazen and Sawyer (2013).
**Data from CDM (2007a).

Water conservation projects exceeding $3.00 per 1,000 gallons of water saved typically are not implemented by utilities because that is the point where developing alternative water supplies often becomes price competitive. However, the cost threshold of conservation measures should be compared to the cost of the location-specific cost for additional water supply. In some cases, the conservation projects may be the most appropriate.

COMPREHENSIVE WATER CONSERVATION PROGRAM

In 2008, the District's Governing Board approved the Comprehensive Water Conservation Program (CWCP). The overarching vision of the CWCP is to achieve a measurable reduction in water use; inspire governments, citizens, and businesses to value and embrace a conservation ethic; and serve as a model for water conservation. The CWCP is organized into three initiatives: 1) education and marketing, 2) voluntary and incentive-based measures, and 3) regulatory. Each initiative has corresponding goals and specific yet adaptable implementation strategies. Though the District is fully committed to implementing the action steps identified in the CWCP, the program is independent from the water use permitting process and is non-binding. The scope and implementation schedule of the action steps outlined in the program are subject to funding levels and voluntary participation by public water suppliers and other participating user groups. The following describes each initiative of the CWCP and provides an overview of actions the District has taken.

Education and Marketing

Education and marketing are essential to accomplish a measurable reduction in water use and instill a lasting conservation ethic. Education, including technical assistance and outreach efforts, delivers important knowledge of water supply challenges and solutions that water managers and municipalities face in south Florida as well as the need for regulatory water use measures. Education and marketing promote adoption of conservation-based behaviors as well as the changes and technologies necessary to reduce demands. SFWMD provides support to public water supply (PWS) utilities in their efforts to promote, develop, and implement conservation.

Educational and outreach programs, including those listed below, combined with conservation best management practices can yield substantial water savings.

- Educational programs for elementary and high school students
- Media campaigns for the general public
- Informative billing for end users
- Water use efficiency training for landscape, irrigation, and building management professionals
- Florida-Friendly Landscaping™ demonstration gardens
- Conservation workshops and exhibits for targeted groups and the general public
- Irrigation water audits for residential, commercial, and agricultural users
- Indoor water use audits for residential and commercial users
- Retrofit and rebate programs for replacing inefficient water use devices and equipment

SFWMD-Sponsored Education Programs

The SFWMD has sponsored a variety of educational and marketing programs. Partnerships have been established with other sponsors such as the Florida Section of the American Water Works Association (AWWA), the University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS), the Florida Nursery Growers and Landscape Association, the Florida Department of Environmental Protection (FDEP), and numerous local governments and utilities in the District. The following is an overview of some of the educational water conservation programs the District has supported.

Water Conservation Public Service Announcements

The Water Conservation Public Service Announcement Airport Campaign partners SFWMD with five regional airports: Southwest Florida International Airport, Orlando International Airport, Miami International Airport, Fort Lauderdale-Hollywood International Airport, and Palm Beach International Airport. The public service announcement campaign (scrolling billboards in the terminals) encourages visitors to conserve water during their stay in Florida.

Xtreme Makeover in Homestead

The Great Water Odyssey

In a cooperative effort between the District and Florida Atlantic University's Center for Environmental Studies (FAU/CES), elementary school students use a computer-based interactive curriculum to learn about water resources and their protection and conservation. Using the Odyssey program, third, fourth, and fifth grade students can be taught science, history, geography, social studies, reading, and math in an engaging way. The Odyssey program nurtures a greater awareness and appreciation of Florida's watersheds and their ecosystems, and promotes responsible actions for the health, protection, and use of Florida's water resources.

Teacher Training

The SFWMD works with school districts, local governments, and regional organizations to identify school-based curricula used to educate students on water resource issues. FAU/CES provides teacher training workshops for elementary, middle, and high school teachers for The Great Water Odyssey and Everglades: An American Treasure science-based curricula programs. Information about the FAU/CES teacher training programs is available from http://www.ces.fau.edu/education.

Regional Community Outreach

The District coordinates outreach efforts with municipalities and counties to engage the public and establish a water conservation ethic. A robust Speakers' Bureau supports year-round presentations to civic groups and homeowner associations touting Florida-Friendly Landscaping™ and indoor water-saving tips including plumbing retrofits.

Throughout the District's 16 counties, active partnerships with local government entities provide opportunities for numerous regional initiatives. Water conservation workshops, outdoor community events, and collaborative public forums help raise awareness and inform residents about long-term protection and conservation of water resources.

Voluntary and Incentive-Based Water Conservation Measures

Voluntary and incentive-based water conservation measures are an integral part of the District's CWCP. This approach offers support and guidance for users looking to conserve water. Other benefits include public recognition for having taken steps to improve efficiency, getting ahead of future utility rate increases, and investing in efficiency measures before regulatory changes are imposed.

Some programs provide financial incentives to users who upgrade to more efficient water-using devices. This is important because implementing conservation measures and practices often requires capital investments and many residential and non-residential water users have little discretionary income for efficiency upgrades.

Agricultural users operate under fluctuating market conditions and are subject to outside pressures, including weather, pests, and pathogens. To attain higher levels of efficiency, significant capital costs are often required. Non-agriculture business owners are often in similar circumstances, which makes investments in efficiency improvements difficult. Therefore, financial incentives and assistance for these water users is often necessary to ease the financial burden of making critical investments.

District-Sponsored Voluntary and Incentive-Based Programs

The District sponsors a variety of voluntary and incentive-based programs. Partnerships have been established with other agencies such as the Florida Section of the AWWA, UF/IFAS, Florida Nursery Growers and Landscape Association, various local governments and utilities, and other Florida water management districts. The following is an overview of some of these programs and action items.

Certification and Recognition Programs

Florida Water Star^{SM}

Florida Water Star^{SM} is a voluntary, points-based certification program that improves water efficiency in the built environment by encouraging the use of appropriate water-saving landscapes, irrigation systems, and household appliances and fixtures. The Florida Water Star^{SM} Program offers the following certification levels:

- Standard Silver – for new and existing residential buildings
- Gold – for additional water savings in residential buildings
- Community – for master-planned communities
- Commercial/Institutional – for new and existing non-residential buildings (offices, retail and service establishments and institutional and non-industrial commercial buildings)

Local governments that adopt Florida Water Star^{SM} Silver criteria as their water conservation standard for new residential properties can expect new homes in their jurisdictions to use as much as 35 percent less water than their current residential stock of single-family homes with permanent in-ground irrigation systems. Savings of up to 45 percent may be anticipated for homes built to Florida Water Star^{SM} Gold criteria. This program has been linked to the

Florida-Friendly Landscape and Florida Green Building Coalition programs whereby efforts to meet the criteria of one program are credited toward certification in one (or both) of the others.

Through the District's role as the Administrator of the Florida Water Star℠ program, and in partnership with the Florida Nursery Growers and Landscapers Association and the Florida Irrigation Society, the District provides accredited training to irrigation and landscape professionals. Once accredited, these professionals are knowledgeable in water efficiency design and maintenance principles applicable in any scenario as well as being able to install efficient systems according to Florida Water Star℠ program criteria.

Water CHAMP

Launched in 2002 by the Southwest Florida Water Management District, the Water Conservation Hotel and Motel Program (Water CHAMP) is a recognition program established specifically for the lodging industry. In 2009, the SFWMD implemented a pilot release of the Water CHAMP program in the Florida Keys, and has since expanded to include ten municipalities and utilities in five counties. The program recognizes lodging facilities that conduct voluntary linen and towel reuse programs and install high-efficiency (1 gallon per minute) faucet aerators in guest bathrooms. It is estimated this program can save approximately 20 gallons of water per occupied room per night, and hotels participating in Water CHAMP fulfill part of the criteria needed to be a designated property under the FDEP's Florida Green Lodging Program.

Water Use Audits for Commercial and Institutional Users

A water use audit is a systematic and comprehensive survey of all water-using fixtures, appliances, equipment, and practices at a facility, campus, or residence. This type of investigation should always precede an efficiency improvement program at any large facility. Specifically, water audits can:

- Identify leaks and wasteful use
- Ensure all inefficient devices are identified
- Ensure all newer (efficient) devices are operating properly
- Identify the improvements that will provide the best returns on investment
- Provide a benchmark for measuring water efficiency program successes

To assist users conducting water use audits at commercial and institutional facilities, the SFWMD published the *Water Efficiency and Self-Conducted Water Audits at Commercial and Institutional Facilities, A Guide for Facility Managers*. This guide assists facility managers through detailed self-conducted water use assessment procedures and evaluation of water usage and potential for conservation for the most common points of water use at commercial or institutional facilities. Conservation professionals are encouraged to incorporate this guide into their outreach efforts toward commercial and institutional water users. While District staff cannot conduct audits as a standing service, staff will meet with large users to help acquaint them with the guidebook and its companion water use and savings spreadsheet calculators. These resources are available for download from the District's conservation website at http://www.the District.gov/conserve under "Businesses."

Cost-Share Funding

The District historically has administered a cost-sharing program, the Water Savings Incentive Program (WaterSIP), accessible to local governments and utilities, homeowner associations, commercial entities, and agricultural operations for technology and hardware-based conservation programs. Since its inception in 2003, the WaterSIP program has funded 181 projects, with a total allocation of $5.1 million and an estimated savings of 7.8 MGD. WaterSIP has been combined with the District's alternative water supply development and stormwater cost-share program under the title Cooperative Funding Program (CFP). Additional information regarding Water SIP and the CFP, including application standards and funding schedules, can be found on the SFWMD's webpage.

Leading by Example

Leading by Example is a CWCP initiative for the District to lead state and local governments by example in water conservation. The program aims to reduce indoor and outdoor water use in all municipal buildings within the District's jurisdiction. To lead by example, the District conducted comprehensive indoor and outdoor water audits of its own facilities in 2009. The audits evaluated water use and efficiency, and identified opportunities for water conservation. The District is phasing in the recommendations outlined in the water audits as funding is made available. As of December 2014, four locations have implemented all measures recommended for those facilities, with the majority of work completed at the remaining facilities. In addition, the District's owned-facilities have achieved Florida-Friendly Yard certification, following UF/IFAS Florida-Friendly Landscaping™ principles, except for the Big Cypress Basin Field Station, which is currently working toward certification.

Florida Automated Weather Network

The Florida Automated Weather Network (FAWN) is a statewide research and data project operated by UF/IFAS. FAWN management tools provide decision support functions to growers, using historical weather data and crop modeling technology to help farmers maximize irrigation efficiency. The District has supported FAWN with funding for more than a decade. In lieu of funding, one year the District assisted FAWN with the installation of two weather stations on District property. Access to the database is available from http://fawn.ifas.ufl.edu/data.

Agricultural Mobile Irrigation Labs

Agricultural mobile irrigation labs (MILs) evaluate the performance of irrigation systems and encourage the adoption of efficient irrigation hardware and management practices that conserve water in an agricultural setting. In 2009, the District discontinued funding of the MIL program; however, six operating MILs cover all counties within the District except Monroe as of Fiscal Year (FY) 2015. Local municipalities are encouraged to investigate opportunities to expand the deployment of MILs.

Urban Mobile Irrigation Labs

Landscape water audits performed by urban MILs measure the performance of a landscape irrigation system. In addition, urban MILs provide recommendations for operation and management of the system to improve efficiency. Recommendations may include: adjusting irrigation timers to assure that a water-conserving schedule is being followed; replacing sprinkler heads to assure that the system is providing adequate coverage and not wasting water by irrigating impervious surfaces; and installing computerized irrigation controllers rainfall and soil moisture sensors.

Landscape Irrigation

As of FY 2015, one District-funded urban MIL remains in operation in the Big Cypress Basin. In addition, Broward County's Naturescape Irrigation Service (NIS) program has an MIL program. The NIS MIL conducts irrigation evaluation on large-scale irrigation systems such as schools, parks, and residential systems that use PWS-supplied water for irrigation within the 19 communities of the Broward Water Partnership. The NIS is part of the Broward County Environmental Planning and Community Resilience Division.

The Miami-Dade Water and Sewer Department also supports an MIL program, the Urban Conservation Unit. This program targets single-family homes (at no cost to the homeowner) to provide irrigation system evaluations and recommendations for efficiency improvements along with $500 to implement the recommendations. A second branch of the program focuses on homeowner associations to provide similar services along with a rebate of $2,850 to implement the recommendations. This program is a partnership between Miami-Dade Water and Sewer Department, Florida Yards and Neighborhoods program, and the University of Florida's Cooperative Extension Service. Local municipalities are encouraged to investigate opportunities to expand the deployment of MILs.

Technical Assistance

Upon request, the SFWMD can provide technical assistance on water efficient technology, hardware, and practices to water users in all categories. A repository of downloadable water conservation technical documents as well as educational materials can be found on the District Water Conservation website www.the District.gov/conserve. Additionally, District staff are available to work with local governments, utilities, and large end-users wishing to develop long-term water use efficiency programs.

Regulatory Initiatives

Regulatory measures are one of the three main tools of an effective conservation program. Regulations or mandates can be used to shift improved practices or efficiency devices into mainstream use and, when applied at the regional or state level, simplify working conditions for commercial users operating in multiple counties. As regulations require users to make costly investments in efficiency improvements, some regulations could be matched with financial assistance programs to ease this burden.

Local governments can adopt conservation-related ordinances. These include requiring greater water use efficiency in new construction such as the International Green Construction Code and standards derived from the Florida Water Star℠ program and the Florida Green Building Coalition. One advantage of ordinance and code adoption is that they can be adopted in whole or in part as appropriate for the existing conditions in the locality. Regulations, mandates, or ordinances can be adopted: statewide, by statute; by local governments, per ordinance; and by water management districts, by rule. Utilities may be able to require their implementation as a condition of service.

District-Sponsored Regulatory-Based Initiatives

The SFWMD has enacted a variety of regulatory-based actions to reduce water demand in south Florida. The following is a brief overview of some of these action items.

Year-Round Landscape Irrigation Rule for Water Conservation

The District Governing Board adopted the Year-round Landscape Irrigation Conservation Measures (Year-round Irrigation Rule) in 2010 to provide a framework for consistent implementation to ensure the long-term sustainability of water resources in the region, increase water use efficiency, and prevent and curtail wasteful water use practices for landscape irrigation by all users. Chapter 40E-24, Florida Administrative Code (F.A.C.), places permanent limits on landscape irrigation throughout the District. The rule includes the following:

- Limiting landscape irrigation to 2 days per week with a 3-day week provision in some counties. Refer to the SFWMD website for a county map and local landscape irrigation requirements
- No irrigation allowed on any day between 10 a.m. and 4 p.m.
- Irrigation using reclaimed water, rain harvesting systems, and various low-volume methods, such as micro-irrigation, container watering, and hand watering with a hose and automatic shut-off nozzle, can be conducted at any time.
- Additional watering is allowed following the installation of new lawns and landscaping for up to 90 days, with specific limits.

Changes to the Water Use Permitting Process

In 2013, the SFWMD embarked on an effort to update its water use permitting criteria as part of a statewide effort headed by the FDEP. The goal was to increase consistency in the water use permitting process and water supply-related programs among the five water management districts. These changes, effective as of July 14, 2014, affected the conservation component of the water use permitting process. These changes are described in detail in **Chapter 2**.

Model Ordinances, Conservation Ordinance Review

Model ordinances assist local governments and other governing bodies to expedite the process of adopting conservation-oriented standards in areas such as new construction and major building renovations. District staff are available to review conservation ordinances for local governments to provide helpful feedback during their ordinance development.

Located on the District's conservation webpage are several model ordinance documents.

- District's Model Water Conservation Ordinance for Landscape Irrigation – Transfers the enforceability of the District's year-round irrigation rule to the local government.
- Florida-Friendly Landscaping Model Covenants, Conditions and Restrictions for New and Existing Community Associations – Addresses the private contract provisions found in deed restrictions, subdivision covenants, and other restrictions used by developers and homeowners associations.
- Model Ordinance for the Installation, Maintenance, and Operation of Sensing Devices on Automatic Landscape Irrigation Systems – Requires the proper installation, repair, and operation of moisture sensing devices on automatic lawn and landscape irrigation systems by licensed contractors and property owners or managers, provides for licensing of contractors that work on such irrigation systems, and provides penalties.
- Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes – Intended to reduce sources of nutrients coming from urban landscapes to reduce the impact of nutrients on Florida's surface and ground waters, Section 403.9337, Florida Statutes (F.S.), requires adoption of the fertilizer ordinance if the locality is within the watershed of an impaired waterbody; elsewhere, its adoption is strongly encouraged.

In addition to these ordinances, Section 373.228(4), F.S., requires the water management districts to work with FDEP and other state agencies and commercial, as well as landscape and irrigation-focused workgroups to develop Florida-Friendly Landscaping design standards for new construction and model guidelines for urban, commercial, and residential landscape irrigation. The resultant document, the Landscape Irrigation and Florida-Friendly Design Standards, is intended for use by local governments when developing landscape irrigation and Florida-Friendly Landscaping ordinances and can be found on the District's conservation webpage.

SUMMARY

Water conservation is recognized as part of the solution to meet long-term water supply needs in the south Florida. Because conservation typically is less expensive to implement than the development of new water sources, including the expansion of treatment capacity at existing facilities, it should be maximized before more costly development options are implemented, regardless of source.

The SFWMD's CWCP outlines the action steps of the District's conservation efforts, including the administration or support of several programs working directly with end users and with local governments and utilities. Local governments and utilities are encouraged to review the programs and other opportunities discussed in this chapter as well as the District's CWCP to help them establish local conservation programs. Finally, District staff stand ready to assist those program developers with technical support, collaborative educational campaigns, ordinance review, and long-term demand management planning.

Glossary

1-in-10 year drought A drought of such intensity that it is expected to have a return frequency of once in 10 years. A drought in which below normal rainfall occurs, and has a 90 percent probability of being exceeded over a 12-month period. A drought event that results in an increase in water demand to a magnitude that would have a 10 percent probability of being exceeded during any given year.

Acre-foot The volume of water that covers 1 acre to a depth of 1 foot; 43,560 cubic feet; 1,233.5 cubic meters; or 325,872 gallons, which is approximately the amount of water it takes to serve two typical families for one year.

Algae Simple single-celled, colonial, or multi-celled (mostly aquatic) plants, containing chlorophyll and lacking roots, stems, and leaves.

Alternative water supply Salt water; brackish surface water and groundwater; surface water captured predominately during wet-weather flows; sources made available through the addition of new storage capacity for surface or groundwater, water that has been reclaimed after one or more public supply, municipal, industrial, commercial, or agricultural uses; the downstream augmentation of water bodies with reclaimed water; stormwater; conservation programs; and any other water supply source that is designated as nontraditional for a water supply planning region in the applicable regional water supply plan [Section 373.019, F.S.].

Anoxic Denotes the absence of oxygen.

Applicant's Handbook *Applicant's Handbook for Water Use Permit Applications*. Read in conjunction with Chapters 40E-2, Florida Administrative Code (F.A.C.), the Applicant's Handbook further specifies the general procedures and information used by SFWMD staff for review of water use permit applications with the primary goal of meeting SFWMD water resource objectives.

Aquatic Consisting of, relating to, or being in water; living or growing in, on or near the water.

Aquifer A geologic formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs.

Aquifer Storage and Recovery (ASR) The underground storage of storm water, surface water, fresh groundwater or reclaimed water, which is appropriately treated to potable standards and injected into an aquifer through wells during wet periods. The aquifer (typically the Floridan aquifer system in south Florida) acts as an underground reservoir for the injected water, reducing water loss to evaporation. The water is stored with the intent to later recover it for use in the future during dry periods.

Aquifer system A heterogeneous body of (interbedded or intercalated) permeable and less permeable material that functions regionally as a water yielding hydraulic unit and may be composed of more than one aquifer separated at least locally by confining units that impede ground-water movement, but do not greatly affect the hydraulic continuity of the system.

Artesian A commonly used expression in aquifer discussions, generally synonymous with "confined" and referring to subsurface (ground) bodies of water which, due to underground drainage from higher elevations and confining layers of soil material above and below the water body (referred to as an artesian aquifer), result in underground water at pressures greater than atmospheric.

Baseline A specified period of time during which collected data are used for comparison with subsequent data.

Biscayne aquifer A portion of the surficial aquifer system, which provides most of the fresh water for Public Water Supply and agriculture within Miami-Dade, Broward, and southeastern Palm Beach County. It is highly susceptible to contamination due to its high permeability and proximity to land surface in many locations.

Brackish water Water with a chloride level greater than 250 milligrams per liter (mg/L) and less than 19,000 mg/L.

Capacity Capacity represents the ability to treat, move, or reuse water. Typically, capacity is expressed in million gallons per day (MGD).

Central and Southern Florida Flood Control Project (C&SF Project) A complete system of canals, storage areas, and water control structures spanning the area from Lake Okeechobee to both the east and west coasts and from Orlando south to the Everglades. It was designed and constructed during the 1950s by the U.S. Army Corps of Engineers (USACE) to provide flood control and improve navigation and recreation.

Central Florida Water Initiative (CFWI) A collaborative approach to resolve water supply technical and policy issues within the CFCA and address the limitations of the 2006 CFCA Action Plan, while still fulfilling the plan's original water resource objectives.

Channel A natural or artificial watercourse with a definite bed and banks that confines and conducts flowing water.

Channelization (1) The artificial enlargement or realignment of a stream channel. (2) Straightening a stream or river to allow water to travel through the area more quickly. (3) The process of changing or straightening the natural path of a waterway. Channelization is often used as a means of flood control, but its negative effects often outweigh its advantages. For example, channelization often damages wetlands associated with rivers and streams.

Comprehensive Everglades Restoration Plan (CERP) The federal-state framework and guide for the restoration, protection, and preservation of the south Florida ecosystem. The CERP also provides for water-related needs of the region, such as water supply and flood protection.

Concentration The amount of a constituent divided by the volume of the material (e.g., milligrams per liter).

Confined aquifer (1) Water-bearing stratum of permeable rock, sand, or gravel overlaid by a thick, impermeable stratum. An aquifer that contains groundwater, which is confined under pressure and bounded between significantly less permeable materials, such that water will rise in a fully penetrating well above the top of the aquifer. In cases where the hydraulic head is greater than the elevation of the overlying land surface, a fully penetrating well will naturally flow at the land surface without means of pumping or lifting. (2) Also known as artesian or pressure aquifer, the confined aquifer exists where the groundwater system is between layers of clay, dense rock, or other materials with very low permeability. Water is under more pressure in a confined aquifer than in an unconfined aquifer. Thus, when tapped by a well, water is forced up, sometimes above the soil surface. This is how a flowing artesian well is formed.

Confining unit A body of significantly less permeable material than the aquifer, or aquifers, that it stratigraphically separates. The hydraulic conductivity may range from nearly zero to some value significantly lower than that of the adjoining aquifers, and impedes the vertical movement of water.

Conservation (See *Water conservation*)

Consumptive use Any use of water that reduces the supply from which it is withdrawn or diverted.

Contact time A measure of microorganism inactivation due to time and concentration of a disinfectant.

Cost Study *Water Supply Cost Estimation Study*, a comprehensive study of the costs associated with various alternative water supply options conducted by Camp, Dresser & McKee, Inc., under contract to the South Florida Water Management District.

Cryptosporidium A protozoan parasite that infects the intestinal tracts of humans and other vertebrates.

Cubic feet per second (cfs) A rate of water flow (e.g., in streams and rivers). It is equal to a volume of water one foot high and one foot wide flowing a distance of one foot in one second. One “cfs” is equal to 7.48 gallons of water flowing each second. As an example, if a car’s gas tank was 2 feet by 1 foot by 1 foot (2 cubic feet), then gas flowing at a rate of 1 cubic foot/second would fill the tank in 2 seconds.

Demand The quantity of water needed to be withdrawn to fulfill a requirement.

Demand management Reducing the demand for water through activities that alter water use practices, improve efficiency in water use, reduce losses of water, reduce waste of water, alter land management practices, and/or alter land uses.

Desalination A process that treats saline water to remove or reduce chlorides and dissolved solids, resulting in the production of fresh water.

Dike An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee.

Disinfection The process of inactivating microorganisms that causes disease. All potable water requires disinfection as part of the treatment process prior to distribution. Disinfection methods include chlorination, ultraviolet (UV) radiation, and ozonation.

Disposal Effluent disposal involves the wasteful practice of releasing treated effluent back to the environment using ocean outfalls, surface water discharges, and deep injection wells.

Domestic Self-Supply (DSS) The water demand use category that includes water used by households whose primary sources of water are private wells or water treatment facilities with pumpages of less than 0.1 million gallons per day.

Domestic use Use of water for household purposes, such as drinking, bathing, cooking, or sanitation.

Domestic wastewater Wastewater derived principally from residential dwellings, business or commercial buildings, institutions, and the like; sanitary wastewater; sewage.

Drainage basin Areas of land where surface water from rain or runoff converge to a single point at a lower elevation, usually the exit of the basin, where the waters join another water body such as a river, lake, reservoir, estuary, wetland, or ocean.

Drawdown (1) The vertical distance between the static water level and the surface of the cone of depression. (2) A lowering of the ground-water surface caused by pumping.

Drought A long period of abnormally low rainfall, especially one that adversely affects growing or living conditions.

Ecosystem Biological communities together with their environment, functioning as a unit.

Ecosystem restoration The process of reestablishing to as near its recent natural condition as possible, the structure, function, and composition of an ecosystem.

Effluent Water that is not reused after flowing out of any facility or other works used for the purpose of treating, stabilizing, or holding wastes. Effluent is “disposed” of.

Electrodialysis Dialysis that is conducted with the aid of an electromotive force applied to electrodes adjacent to both sides of a water treatment membrane.

Elevation The height in feet above mean sea level according to National Geodetic Vertical Datum (NGVD) or North American Vertical Datum (NAVD). May also be expressed in feet above mean sea level as reference datum.

Estuary A partially enclosed part of the wide lower course of a river where its current is met by open ocean tides or an arm of the sea; where riverine fresh and oceanic salt water meet.

Evapotranspiration (ET) The total loss of water to the atmosphere by evaporation from land and water surfaces and by transpiration from plants.

Everglades America's Everglades is a vast subtropical marsh and mangrove area noted for its wildlife and a critical part of southern Florida's water supply. The Northern Everglades and Estuaries Protection Program [Section 373.4595, F.S.] subdivided the Greater Everglades ecosystem into northern and southern Everglades along the Caloosahatchee and St. Lucie rivers and Lake Okeechobee.

Everglades Construction Project (ECP) Twelve interrelated construction projects located between Lake Okeechobee and the Everglades. The cornerstone of the ECP is the Everglades Stormwater Treatment Areas (Everglades STAs). The STAs are constructed wetlands intended to reduce phosphorus in waters that discharge to the Everglades Protection Area. The ECP also contains four hydropattern restoration projects designed to improve the volume, timing, and distribution of water entering the Everglades.

Everglades Protection Area This area comprises the Arthur R. Marshall Loxahatchee National Wildlife Refuge, Water Conservation Areas, and Everglades National Park.

Exceedance (1) The violation of the pollutant levels permitted by environmental protection standards. (2) The violation of water levels or flows as established in Minimum Flow and Level rules.

Existing legal use of water A water use that is authorized under a District water use permit or is existing and exempt from permit requirements.

Filtration The method by which water treatment facilities physically remove constituents to improve water quality for Public Water Supply, irrigation, or other uses. Utlrafiltration, microfiltration, and nanofiltration are all examples of this process.

Finished water Water that has completed a purification or treatment process; water that has passed through all the processes in a water treatment facility and is ready to be delivered to consumers. Contrast with *raw water*.

Florida Administrative Code (F.A.C.) The Florida Administrative Code is the official compilation of the administrative rules and regulations of state agencies.

Florida Department of Agriculture and Consumer Services (FDACS) FDACS is the state agency that communicates the needs of the agricultural industry to the Florida legislature, the FDEP, and the water management districts. The FDACS is also charged with handling general consumer problems, such as complaints against businesses. The FDACS oversees Florida's Soil and Water Conservation districts, which coordinate closely with the U.S. Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS).

Florida Department of Environmental Protection (FDEP) The FDEP is the state agency charged with protecting, conserving, and managing Florida's natural resources and enforcing the state's environmental laws. The SFWMD operates under the general supervisory authority of the FDEP, which includes budgetary oversight.

Florida-Friendly Landscaping Quality landscapes that conserve water, protect the environment, are adaptable to local conditions, and are drought tolerant. The principles of such landscaping include planting the right plant in the right place, efficient watering, appropriate fertilization, mulching, attraction of wildlife, responsible management of yard pests, recycling yard waste, reduction of stormwater runoff, and waterfront protection. Additional components include practices such as landscape planning and design, soil analysis, the appropriate use of solid waste compost, minimizing the use of irrigation, and proper maintenance.

Florida Statutes (F.S.) The Florida Statutes are a permanent collection of state laws organized by subject area into a code made up of titles, chapters, parts, and sections. The Florida Statutes are updated annually by laws that create, amend, or repeal statutory material.

Florida Water Plan State-level water resource plan developed by the FDEP under Section 373.036, F.S.

Floridan aquifer system (FAS) A highly used aquifer system composed of the Upper Floridan and Lower Floridan aquifers. It is the principal source of water supply north of Lake Okeechobee, and the Upper Floridan aquifer is used for drinking water supply in parts of Martin and St. Lucie counties. From Jupiter to south Miami, water from the FAS is mineralized (total dissolved solids are greater than 1,000 mg/L) along coastal areas and in southern Florida.

Flow The actual amount of water flowing by a particular point over some specified time. In the context of water supply, flow represents the amount of water being treated, moved, or reused. Flow is frequently expressed in millions of gallons per day (MGD).

Fresh water An aqueous solution with a chloride concentration equal to or less than 250 milligrams per liter (mg/L).

Geologic unit A geologic unit is a volume of rock or ice of identifiable origin and age range that is defined by the distinctive and dominant, easily mapped and recognizable petrographic, lithologic, or paleontologic features that characterize it.

Giardia A protozoan parasite that infects the gastrointestinal tracts of humans and other vertebrates.

Governing Board Governing Board of the South Florida Water Management District.

Groundwater Water beneath the surface of the ground, whether or not flowing through known and definite channels. Specifically, that part of the subsurface water in the saturated zone, where the water is under pressure greater than the atmosphere.

Groundwater recharge (See *Recharge*)

Harm As defined in Rule 40E-8.021, F.A.C., the temporary loss of water resource functions that results from a change in surface or groundwater hydrology and takes a period of one to two years of average rainfall conditions to recover.

Hydrogeologic unit Any rock unit or zone that, because of its hydraulic properties, has a distinct influence on the storage or movement of groundwater.

Hydrogeology The geology of groundwater, with particular emphasis on the chemistry and movement of water.

Hydrology The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks and in the atmosphere.

Hydropattern Water depth, duration, timing, and distribution of fresh water in a specified area. A consistent hydropattern is critical for maintaining various ecological communities in wetlands.

Indian River Lagoon (IRL) Extending for 156 miles from north of Cape Canaveral to Stuart along the east coast of Florida, this lagoon is one of America's most diverse estuaries, home to thousands of plant and animal species.

Industrial/Commercial/Institutional Self-Supply The water demand use category that includes water used by industrial, commercial, or institutional operations withdrawing a minimum water quantity of 0.1 million gallons per day from individual, on-site wells.

Infiltration The movement of water through the soil surface into the soil under the forces of gravity and capillarity.

Injection well Refers to a well constructed to inject treated wastewater directly into the ground. Wastewater is generally forced (pumped) into the well for dispersal or storage in a designated aquifer. Injection wells are generally drilled below freshwater levels, or into unused aquifers or aquifers that do not deliver drinking water.

Institute of Food and Agricultural Sciences (IFAS) Agricultural branch of the University of Florida that performs research, education, and extension.

Intermediate aquifer system This aquifer system consists of five zones of alternating confining and producing units. The producing zones include the Sandstone and Mid-Hawthorn aquifers.

Intrusion (See *Saltwater intrusion*)

Irrigation The application of water to crops and other plants by artificial means.

Irrigation efficiency The average percent of total water pumped or delivered for use that is delivered to the root zone of a plant.

Lagoon A body of water separated from the ocean by barrier islands, with limited exchange with the ocean through inlets.

Lake Okeechobee Located in south Florida, the lake, at 730 square miles, is the largest freshwater lake in Florida and the second-largest freshwater lake wholly within the United States.

Landscape irrigation The outside watering of shrubbery, trees, lawns, grass, ground covers, vines, gardens, and other such flora, not intended for resale, which are planted and are situated in such diverse locations as residential and recreation areas, cemeteries, public, commercial and industrial establishments, and public medians and rights of way.

Leachate Liquid containing soluble substances that percolates through the ground, such as water seeping through a landfill.

Levee An embankment to prevent flooding or a continuous dike or ridge for confining the irrigation areas of land to be flooded.

Marsh A frequently or continually inundated unforested wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions.

Mean sea level (MSL) (1) The level of the surface of the sea between mean high and mean low tide; used as a reference point for measuring elevations. (2) The average height of the sea for all stages of the tide over a 19-year period, usually determined from hourly height observations on an open coast or in adjacent waters having free access to the sea. (3) (FEMA) For purposes of the National Flood Insurance Program (NFIP), the National Geodetic Vertical Datum (NGVD) of 1929 or other datum, to which base flood elevations shown on a community's Flood Insurance Rate Map (FIRM) are referenced.

Micro-constituents Sometimes known as "emerging pollutants of concern," these are chemicals found in a wide array of consumer goods, including pharmaceuticals and personal care products (FDEP) that may end up in Public Water Supplies. Presence or absence of these may eventually have water quality criteria set for them.

Microfiltration A membrane separation process in which particles greater than about 20 nanometers in diameter are screened out of a liquid in which they are suspended.

Micro-irrigation The application of small quantities of water on or below the soil surface as drops or tiny streams of spray through emitters or applicators placed along a water delivery line. Micro-irrigation includes a number of methods or concepts, such as bubbler, drip, trickle, mist or microspray, and subsurface irrigation.

Microorganism A microscopic organism, including bacteria, protozoans, yeast, viruses, and algae.

Minimum Flow and Level (MFL) The point at which further withdrawals would cause significant harm to the water resources or natural systems. MFLs are established by water management districts pursuant to Sections 373.042 and 373.0421, F.S., for a given water body and set forth in Parts II and III of Chapter 373.

Million gallons per day (MGD) A rate of flow of water equal to 133,680.56 cubic feet per day, or 1.5472 cubic feet per second, or 3.0689 acre-feet per day. A flow of one million gallons per day for one year equals 1,120 acre-feet (365 million gallons). To hold one million gallons of water, you would need to build a swimming pool approximately 267 feet long (almost as long as a football field), 50 feet wide, and 10 feet deep.

Model A computer model is a representation of a system and its operations, and provides a cost-effective way to evaluate future system changes, summarize data, and help understand interactions in complex systems. Hydrologic models are used for evaluating, planning, and simulating the implementation of operations within the SFWMD's water management system under different climatic and hydrologic conditions. Water quality and ecological models are also used to evaluate other processes vital to the health of ecosystems.

Monitor well Any excavation by any method to monitor fluctuations in groundwater levels, quality of underground waters, or the concentration of contaminants in underground waters.

National Geodetic Vertical Datum (NGVD) 1929 A geodetic datum derived from a network of information collected in the United States and Canada. It was formerly called the "Sea Level Datum of 1929" or "mean sea level." Although the datum was derived from the average sea level over a period of many years at 26 tide stations along the Atlantic, Gulf of Mexico, and Pacific Coasts, it does not necessarily represent local mean sea level at any particular place.

Natural system A self-sustaining living system that supports an interdependent network of aquatic, wetland-dependent, and upland living resources.

Net water demand (or user/customer water demand) is the water demand of the end user after accounting for treatment and process losses, and inefficiencies. When discussing Public Water Supply, the term "finished water demand" is commonly used to denote net demand.

Nitrogen A common element that is essential for life, occurs in all organisms, and is a natural part of aquatic ecosystems. The nitrogen cycle describes movement of the element from the air, into the biosphere and organic compounds, then back into the atmosphere. Nitrogen is a large component of animal waste and discharges from septic tanks. Synthetically produced ammonia and nitrates are key components of industrial fertilizers, which are significant pollutants of water systems. Nutrient pollution in groundwater, a common source of drinking water, can be harmful even at low levels.

North American Vertical Datum (NAVD) of 1988 The official civilian vertical control datum (reference for elevation data) for surveying and mapping activities in the United States.

Nutrients Organic or inorganic compounds essential for the survival of an organism. In aquatic environments, nitrogen and phosphorus are important nutrients that affect the growth rate of plants.

Parameter Whatever it is you measure; a particular physical, chemical, or biological property that is being measured.

Parts per million (ppm) The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations. Equivalent to 1 milligram per liter (mg/L).

Permeability The capacity of a porous rock, sediment, or soil for transmitting a fluid.

pH A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

Phosphorus An element that is essential for plant life and is a common constituent of agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent. However, when excess phosphorus reaches natural wetlands like the Everglades, it can promote the growth of harmful algae and plants that damage the ecosystem.

Planning Area The SFWMD is divided into five areas within which planning activities are focused: Upper Kissimmee Basin (UKB), Lower Kissimmee Basin (LKB), Upper East Coast (UEC), Lower West Coast (LWC), and Lower East Coast (LEC).

Potable water Water that is safe for human consumption.

Power Generation Self-Supply The water demand use category that describes the difference in the amount of water withdrawn by electric power generating facilities for cooling purposes and the water returned to the hydrologic system near the point of withdrawal.

Public Water Supply The water demand use category that includes finished water supplied by water treatment facilities for potable use (drinking quality) with projected average pumpages greater than 0.1 MGD.

Raw water (1) Water that is direct from the source — groundwater or surface water — without any treatment. (2) Untreated water, usually that entering the first unit of a water treatment facility. Contrast with *Finished water*.

Reasonable-beneficial use Use of water in such quantity as is needed for economic and efficient utilization for a purpose, which is both reasonable and consistent with the public interest.

Recharge The replenishment of a water body or aquifer by the absorption of water. Recharge is the primary method by which water enters an aquifer. Groundwater recharge is a hydrologic process where water moves downward from surface water to groundwater.

Recharge area The land area over which precipitation infiltrates into soil and percolates downward to replenish an aquifer. Recharge occurs as part of the hydrologic cycle.

Reclaimed water Water that has received at least secondary treatment and basic disinfection and is reused after flowing out of a domestic wastewater treatment facility [Rule 62-610.200, F.A.C.].

Recreational/Landscape Self-Supply The water demand use category that includes water used for landscape and golf course irrigation. The landscape subcategory includes water used for parks, cemeteries, and other irrigation applications greater than 0.1 million gallons per day (MGD). The golf course subcategory includes those operations not supplied by a Public Water Supply or regional reuse facility.

Regional Water Supply Plan Update Detailed water supply plan developed by the District under Section 373.709, F.S., providing an evaluation of available water supply and projected demands, at the regional scale. The planning process projects future demand for 20 years and recommends projects to meet identified needs.

Reservation of water (See *Water Reservation*)

Reservoir An artificial or natural water body used for water storage. Reservoirs can be above- or below-ground.

Restricted Allocation Area Area designated within the District for which allocation restrictions are applied regarding the use of specific sources of water. The water resources in these areas are managed in response to specific sources of water in the area for which there is a lack of water availability to meet the projected needs of the region from that specific source of water.

Retention The prevention of stormwater runoff from direct discharge into receiving waters; included as examples are systems that discharge through percolation, exfiltration, filtered bleed-down, and evaporation processes.

Retrofit The replacement of existing water fixtures, appliances, and devices with more efficient fixtures, appliances, and devices for the purpose of water conservation.

Reuse The deliberate application of reclaimed water for a beneficial purpose. Criteria used to classify projects as “reuse” or “effluent disposal” are contained in Rule 62-610.810, F.A.C. The term “reuse” is synonymous with “water reuse.”

Reverse osmosis (RO) A membrane process for desalting water using applied pressure to drive the feedwater (source water) through a semipermeable membrane.

Rule Of or pertaining to regulatory programs of the District and other agencies, which are set forth as various prescribed guides for conduct, action, or criteria.

Runoff That component of rainfall, which is not absorbed by soil; intercepted and stored by surface water bodies; evaporated to the atmosphere; transpired and stored by plants; or infiltrated to groundwater, but which flows to a watercourse as surface water flow.

Saline water Water that contains a significant amount (referred to as concentration) of dissolved salts. Sodium chloride is the primary salt in saline water. Untreated saline water generally cannot be used for purposes such as drinking, landscape irrigation, and agriculture.

Saline water or saltwater interface The hypothetical surface of chloride concentration between fresh water and seawater where the chloride concentration is 250 mg/L at each point on the surface.

Salinity The dissolved salt content of a body of water. Salinity is a unitless quantity.

Salt water (See *Seawater*)

Saltwater intrusion The invasion of a body of fresh water by a body of salt water, due to its greater density. It can occur either in surface water or groundwater bodies. The term is applied to the flooding of freshwater marshes by seawater, the upward migration of seawater into rivers and navigation channels, and the movement of seawater into freshwater aquifers along coastal regions.

Saturated zone The part of the subsurface that is saturated with water. The upper surface of this zone, open to atmospheric pressure, is known as the water table (phreatic surface).

Seawater Water with a chloride concentration at or above 19,000 mg/L.

Secondary wastewater treatment Treatment that follows primary wastewater treatment. It involves the biological process of reducing suspended, colloidal, and dissolved organic matter in effluent from primary treatment systems, which generally removes 80 to 95 percent of the oxygen-demanding substances and suspended matter. Secondary wastewater treatment may be accomplished by biological or chemical-physical methods. Activated sludge and trickling filters are two of the most common means of secondary treatment. Disinfection is the final stage of secondary treatment.

Seepage irrigation Irrigation that conveys water through open ditches, relying primarily on gravity instead of emitters, sprinklers, or other devices to deliver water. Water is applied to the soil surface (e.g., in furrows) and held for a period of time to allow infiltration, or to the soil subsurface by raising the water table to wet the root zone.

Self-Supply The water used to satisfy any water need, not supplied by reclaimed water or a Public Water Supply utility.

Serious harm As defined in Rule 40E-8.021, F.A.C., the long-term loss of water resource functions resulting from a change in surface or groundwater hydrology.

Service area The geographical region in which a public water supplier (utility) provides water to customers. In water supply planning, there are three types of service areas: the area currently (in the base year) served, the area planned to be served at the end of the planning period, and the area where the water supplier has the legal right to distribute water.

Significant harm As defined in Rule 40E-8.021, F.A.C., the temporary loss of water resource functions, which result from a change in surface or groundwater hydrology, that takes more than two years to recover, but which is considered less severe than serious harm.

Stage The height of a water surface above an established reference point (datum or elevation).

Storm water Water that does not infiltrate, but accumulates on land as a result of storm runoff, snowmelt runoff, irrigation runoff, or drainage from such areas as roads and roofs.

Stormwater discharge Precipitation and snowmelt runoff from roadways, parking lots, roof drains that is collected in gutters and drains; a major source of nonpoint source pollution to water bodies and a challenge to sewage treatment facilities in municipalities where the storm water is combined with the flow of domestic wastewater (sewage) before entering the wastewater treatment facility.

Stormwater treatment area (STA) Constructed water quality treatment wetland that uses natural biological processes (such as plant uptake) to reduce levels of phosphorus from surface water runoff.

Stream A general term for a body of flowing water; a natural watercourse containing water at least part of the year. In hydrology, it is generally applied to the water flowing in a natural channel as distinct from a canal.

Surface water Water on the surface of the planet that is naturally open to the atmosphere, including water in lakes, ponds, rivers, canals, reservoirs, estuaries, and oceans.

Surficial aquifer system (SAS) Often the principal source of water for urban uses within certain areas of south Florida. This aquifer is unconfined, consisting of varying amounts of limestone and sediments that extend from the land surface to the top of an intermediate confining unit.

Swamp Area of low-lying land that is dominated by woody plants and is frequently flooded. Swamps are important for flood protection and nutrient removal.

Trihalomethanes (THMs) A group of organic chemicals that sometimes occur in drinking water as a result of chlorine treatment for disinfectant purposes. THMs are formed when chlorine reacts with naturally occurring organic material found in water such as decaying vegetation. Through epidemiological studies, THMs have been associated with some adverse health effects.

Treatment facility Any facility or other works used for the purpose of treating, stabilizing, or holding water or wastewater.

Unconfined aquifer A permeable geologic unit or units only partly filled with water and overlying a relatively impervious layer. Its upper boundary is formed by a free water table or phreatic surface under atmospheric pressure. Also referred to as Water table aquifer.

Upconing Process by which saline water underlying fresh water in an aquifer rises upward into the freshwater zone as a result of pumping water from the freshwater zone.

U.S. Army Corps of Engineers (USACE) A federal agency under the U.S. Department of Defense, and a major Army command involved in a wide range of public works throughout the world. Key responsibilities include civil engineering projects such as flood control, design and construction of flood protection systems, and environmental regulation and ecosystem restoration. Within the SFWMD, the USACE is responsible for managing Lake Okeechobee water levels, makes operational decisions about whether to retain or release water based on the USACE's regulation schedule release guidance, and is a partner on many restoration projects.

U.S. Environmental Protection Agency (USEPA) An independent federal agency established to coordinate programs aimed at reducing pollution and protecting the environment. The USEPA is responsible for a variety of monitoring, research, standard-setting, and enforcement activities to ensure environmental protection, including water quality, in the U.S.

U.S. Geological Survey (USGS) A scientific agency of the Federal Government established to study the landscape of the U.S., its natural resources, and the natural hazards that threaten it. The USGS has four major science disciplines: biology, geography, geology, and hydrology.

Utility Any legal entity responsible for supplying potable water for a defined service area.

Utility interconnections Physical connections between utilities in different service areas. These interconnections are also formal methods by which utilities can move water around during times of high demand, such as during water shortages.

Wastewater The combination of liquid and water-carried pollutants from residences, commercial buildings, industrial plants, and institutions together with any groundwater, surface runoff, or leachate that may be present.

Water conservation Reducing the demand for water through activities that alter water use practices (e.g., improving efficiency in water use and reducing losses of water, waste of water, and water use).

Water Conservation Areas (WCAs) Part of the original Everglades ecosystem that is now diked and hydrologically controlled for flood control and water supply purposes. These are located in the western portions of Miami-Dade, Broward, and Palm Beach counties, and preserve more than 1,350 square miles, approximately 50 percent of the original Everglades.

Water control structure An artificial structure designed to regulate the level/flow of water in a canal or water body (e.g., weirs, dams).

Water management The general application of practices to obtain added benefits from precipitation, water, or water flow in any of a number of areas such as irrigation, drainage, wildlife and recreation, water supply, watershed management, and water storage in soil for crop production. Watershed management is the analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents. Watershed management for water production is concerned with the quality, quantity, and timing of the water that is produced.

Water quality A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water quality standards The physical, chemical, and biological condition of water as applied to a specific use. Federal and state guidelines set these criteria based on the water's intended use, whether for recreation, fishing, drinking, navigation, shellfish harvesting, or agriculture.

Water Reservation A water reservation is a legal mechanism to set aside water for the protection of fish and wildlife or the public health and safety from consumptive water use. The reservation is composed of a quantification of the water to be protected, which includes seasonal and location components.

Water resource development The formulation and implementation of regional water resource management strategies, including the collection and evaluation of surface water and groundwater data; structural and nonstructural programs to protect and manage water resources; the development of regional water resource implementation programs; the construction, operation, and maintenance of major public works facilities to provide for flood control, surface and groundwater storage, and groundwater recharge augmentation; and related technical assistance to local governments and Public Water Supply utilities [Section 373.019, F.S.].

Water reuse (see *Reuse*)

Water shortage Is a formal recognition of times when immediate future demands for water may exceed supply. Water shortages may or may not be the result of low rainfall (drought).

Water supply development The planning, design, construction, operation, and maintenance of public or private facilities for water collection, production, treatment, transmission, or distribution for sale, resale, or end use [Section 373.019(24), F.S.].

Water table The surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere; defined by the level where water within an unconfined aquifer stands in a well.

Water table aquifer An unconfined aquifer within which is found the water table. Synonymous with the surficial aquifer system in certain planning areas.

Water use Any use of water that reduces the supply from which it is withdrawn or diverted.

Water well An excavation or structure created in the ground by drilling, coring, digging, driving, boring, washing, or jetting to access groundwater in underground aquifers.

Watershed A region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Wellfield One or more wells producing water from a subsurface source. A tract of land that contains a number of wells for supplying a large municipality or irrigation district.

Wetland An area that is inundated or saturated by surface water or groundwater with vegetation adapted for life under those soil conditions. Florida wetlands generally include swamps, marshes, bayheads, bogs, cypress domes, and strands, sloughs, wet prairies, riverine swamps and marshes, hydric seepage slopes, tidal marshes, mangrove swamps, and other similar areas. Florida wetlands do not include longleaf or slash pine flatwoods with an understory dominated by saw palmetto.

Withdrawal Water removed from a ground- or surface-water source for use.

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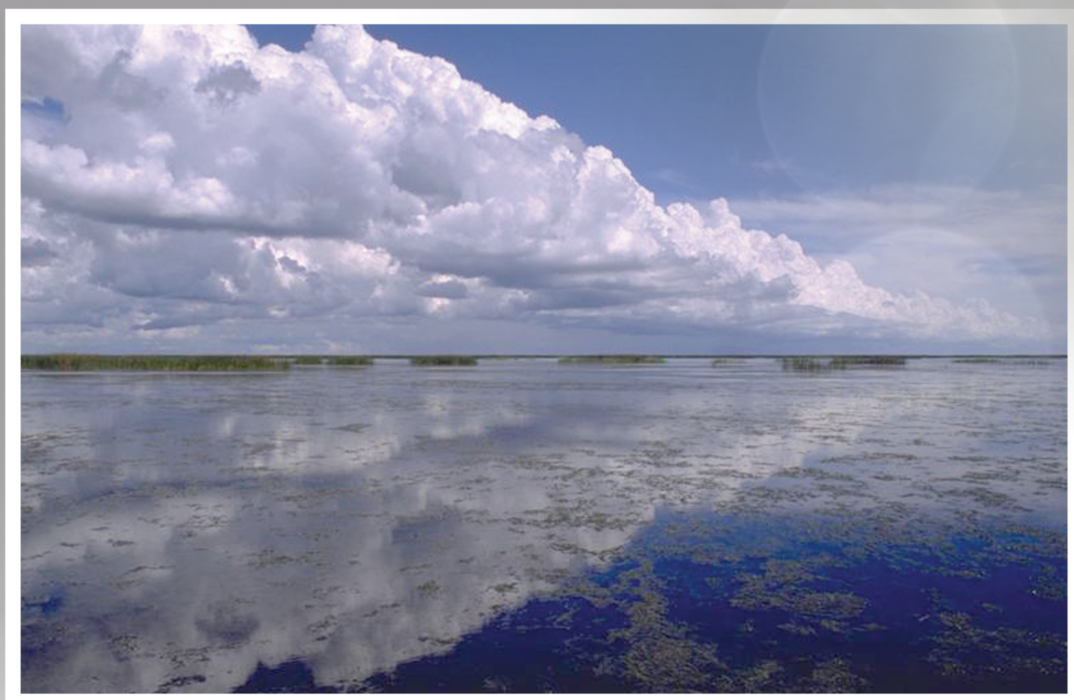
Meeting South Florida's water supply needs
while safeguarding its natural systems requires
innovative solutions, cohesive planning,
and a shared vision.



South Florida Water Management District

Committed to managing and
protecting our region's water resources

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