NATURAL GROUNDWATER AQUIFER RECHARGE ELEMENT
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12.0 NATURAL GROUNDWATER AQUIFER RECHARGE ELEMENT

[Rule 9J-5.011(1)(g) and (h), F.A.C.]

The Natural Groundwater Aquifer Recharge Element of the Monroe County Comprehensive Plan addresses the data inventory requirements of Rule 9J-5.005(2) of the Florida Administrative Code (F.A.C.). The data inventory requirement will support the development of goals, objectives, policies, and implementation programs for the Natural Groundwater Aquifer Recharge Element (Rule 9J-5.011, F.A.C.).

The Natural Groundwater Aquifer Recharge Element is a required comprehensive plan element under Florida's Local Government Comprehensive Planning and Land Development Regulation Act (Chapter 163, Florida Statutes). The purpose of the element is to provide for necessary public facilities and services correlated to future land use projections.

12.1 Introduction

The potable water supply resources used by Monroe County (County), including both the aquifer system and treatment facilities, are geographically located in Miami-Dade County - entirely outside of the County's jurisdiction (see Chapter 8.0, Potable Water Element). In the County, the surficial aquifer is brackish to saline and contains an inadequate quantity of water for use as a potable water supply. The Florida Keys Aqueduct Authority (FKAA) is the agency that obtains and distributes potable water in the Keys. Discussions of the potable water supply, permitting process and water treatment and distribution systems are presented in Chapter 8.0, Potable Water Element. As a result of the potable water source for the County being located entirely within Miami-Dade County, aquifer protection related to the FKAA's Florida City Wellfield is accomplished through the provisions of the Miami-Dade County Wellfield Ordinance. In the County, groundwater resource protection and management takes place in the context of the regulation of public and private interests in relation to wetlands, wildlife, aquifer discharges to surface waters, and other components of the natural system.

12.2 Geology

Although Mesozoic sediments represent thicknesses well in excess of 10,000 feet, only the more recent Cenozoic sediments have a direct bearing on aquifers of the Keys. Of these, the most important are the sediments deposited since Miocene time, including the Miami Oolite, the Key Largo Limestone, the Tamiami Limestone, the Hawthorne Formation, the Tampa Limestone, and the Suwannee Limestone.

The Miami Oolite (oolitic facies of the Miami Formation) is found at the land surface from Big Pine Key to Key West and is an offshore extension of the same formation found in southeast Florida. It was formed as a shoal deposit in warm shallow seas. Maximum thickness of the formation is 40 feet with an average of 20 feet in the Keys. It is white to yellow in color and

contains considerable fine to medium quartz sand that fills the solution holes. The Miami Oolite has many voids, thereby giving it a high porosity. However, there is little interconnection between the voids, causing it to have low permeability. This formation overlays the Key Largo Limestone in the southern Keys.

The Key Largo Limestone occurs at land surface from Soldier Key, off Miami, to Bahia Honda. It occurs as an ancient reef formation deposited during Pleistocene time. It averages 60 feet in thickness and is approximately 90 miles long at land surface, by 3 miles wide (Parker et al., 1955). It is composed mainly of corals, amorphous limestone and detritus from wastage of the reef. The Key Largo Limestone contains cavities which make it very permeable. As a result, fresh water readily escapes to the sea, and ocean water easily enters the formation.

Hoffmeister and Multer (1964) found that the Miami Oolite passes laterally into the Key Largo Limestone at the southeastern point of Big Pine Key. They also found that the oolite in the rest of the island is underlain by the Key Largo Formation. The gradational contact between the Miami Oolite and the Key Largo Limestone in most places in Big Pine Key lies at a depth of 13 to 20 feet (Hanson, 1980).

The Tamiami Formation underlies the Key Largo Limestone. It is predominantly permeable sand with limestone lenses. It forms the lower part of the Biscayne Aquifer system, with the Miami Oolite and Key Largo Limestone forming the upper part.

The Hawthorne Group underlies the Biscayne Aquifer system and generally acts as a confining layer to the deeper Floridan Aquifer System. It is relatively impermeable and consists of silt, clayey sand, and sand. It is phosphatic and greenish in color. Beneath Key Largo, this sequence is approximately 300 feet thick.

Underlying the Hawthorne Group is the Tampa Limestone. This formation consists of interbedded calcarenite (cemented sand-size grains of calcium carbonate) and calcilutite (flour-size grains). The calcarenite sequences contain abundant mollusk molds, giving it high moldic porosity and permeability. The Tampa Limestone is approximately 600 feet thick. Because of the alternating high and low permeability beds, this formation is considered a minor water-bearing zone of the Floridan Aquifer.

The Suwannee Limestone is considered a principal artisan water-bearing zone of the Floridan Aquifer System. It consists of white, finely porous, chalky limestone composed chiefly of fragmental shells of bryozoa and foraminifera. In Key West, the formation is approximately 450 feet thick.

12.3 Hydrogeology

Two major groundwater systems underlie the County: the deeper Floridan Aquifer System, and the shallower Surficial Aquifer System (the upper portion of which contains the Biscayne Aquifer). **Table 12.1** illustrates the relative positions and productivities of these hydrogeologic units.

Table 12.1 - Groundwater Systems in Monroe County

Hydrogeologic System	Hydrogeologic Unit	Water Resource Potential	Depth*
Surficial Aquifer System	Biscayne Aquifer	Largely saline, must be desalinated for potable use. No additional withdrawals will be permitted. Vulnerable to spills and contamination. Small lenses of relatively fresh water float above the saltwater on some of the larger keys.	The Biscayne Aquifer is the upper part of the Surficial Aquifer System and extends from ground surface to approximately 100 feet deep. The Surficial Aquifer System extends to 200 feet.
Intermediate Confining Unit	Hawthorn Confining Beds	Very low permeability, continuing unit for the Floridan Aquifer System.	200 to 900 feet
Floridan Aquifer System	Floridan Aquifer	Wells yield from 75 to 1,000 gallons of saline water per minute. Requires desalinization for all uses.	900 to 3500 feet

*Depths vary considerably across the County. Depths shown are typical depths in the Upper Keys.

In the Keys, both of these aquifer systems have chloride concentrations which exceed the drinking water criteria of 250 milligrams per liter. Therefore, in most cases, they could be used as a potable water source only after utilization of water quality treatment processes such as desalinization.

In Miami-Dade County, the Biscayne Aquifer (the upper part of the Surficial Aquifer System) is a major source of potable water and essentially all potable water in the Keys is piped via aqueduct to the Florida Keys from wellfields in the Biscayne Aquifer in Miami-Dade County (see Chapter 8.0, Potable Water Element). Some County residents provide their own water supply using home reverse osmosis plants to desalinate Biscayne Aquifer water, or by collecting rain water in cisterns.

On some of the larger islands of the Lower Keys, small lenses of freshwater to slightly brackish water float on the top of the Biscayne Aquifer near the ground surface. Chloride levels in these lenses are generally too high for human consumption, but the lens water is suitable for some irrigation purposes and provides an important source of freshwater for wildlife and vegetation.

The amount of water stored in an aquifer is a function, in part, of water inflow, balanced against the water discharged from an aquifer. This discharge can take the form of either a naturally occurring flow from springs, lakes or wetlands, or in the form of wells. Should the water loss exceed the water inflow, water pressures between adjoining aquifers can be affected, and over drafting, or over mining, can occur, leading to an exchange of water between the aquifers.

Protection of the functions of natural groundwater aquifer recharge areas and natural drainage features in the County is a legitimate goal because of the benefits associated with replenishment of water supplies such as: prevention of lateral movement of salt water from saline zones (known as saltwater intrusion); dilution of contaminants which could contribute to the degrading of the ambient water quality; reduction of surface flooding by providing storage; and prevention of sinkhole formation. The issue of water quality protection must also be addressed because of the potential for recharge areas to receive contaminants and to transfer them to underlying aquifers.

12.4 Freshwater Lenses *[Rule 9J5.011(1)(g), F.A.C.]*

On some of the larger keys, a thin lens of freshwater to slightly brackish water floats on top of the saltier Biscayne Aquifer. The size of the lens is dependent on rainfall, evapotranspiration, groundwater losses to the marine environment, and pumpage (Hanson, 1980). The large Upper Keys, Elliott Key for example (Klein, 1970), do not have permanent lenses despite their large size and the increased rainfall northward. Only the largest of the Lower Keys, Big Pine and Key West, have permanent freshwater lenses (Parker et al., 1955). The Lower Keys are more likely to have lenses because of their geometry and geology. These Keys, in plan view, retain the broad flat of an ooid shoal in contrast to the Upper Keys which are narrow and elongate parallel to the shelf. In addition, the surficial lithologic unit of the Lower Keys (oolite) is less transmissive than that of the Upper Keys (reef). Small, ephemeral lenses occur on other Keys including Sugarloaf Key, Little Torch Key, Cudjoe Key, No Name Key, Little Pine Key, and Ramrod Key.

The chloride concentrations are usually too high for potable use, but the water is used locally for irrigation and domestic consumptive uses. Irrigation wells have to be very shallow because chloride concentrations increase rapidly with depth. On Big Pine Key, only the upper 15 feet of the aquifer contained water suitable for irrigation (Hanson, 1980). The freshwater lenses of the Florida Keys are considered to be critical to the support of the existing wildlife and plant communities in these areas.

Historically, wells were installed in freshwater lenses. Many of these were installed by private landowners for domestic water supply for the house and/or landscaping, but there were also some commercial uses such as irrigation for nurseries. The amount of water withdrawn from wells is unknown, but anecdotal evidence suggests that withdrawals have declined due to closure of several plant nurseries and due to closure of individual private domestic wells.

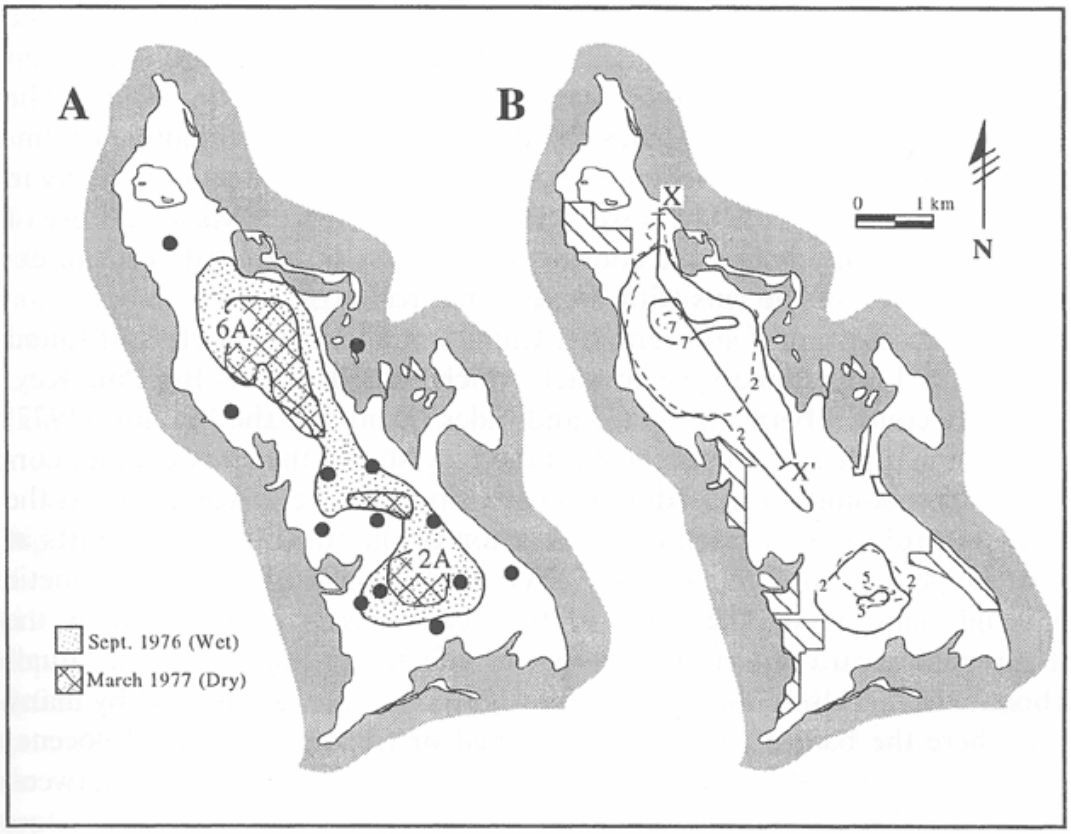
There are many potential sources of contamination to the freshwater lens system because of its high permeability. The main source of contamination is saltwater intrusion, which can be caused by over pumping, drought, or sea level rise.

Recharge areas for the lenses are the permeable surface areas above the lenses. There are no specific maps of recharge areas for the lenses. Big Pine Key has the only permanent freshwater lens system in unincorporated Monroe County; lenses on other islands are ephemeral and/or brackish. **Figure 12.1** represents the extent of freshwater lenses on Big Pine Key and is the best approximation of the recharge area for the lenses on that island. There are no natural drainage features of the freshwater lenses.

12.4.1 Freshwater Lenses on Big Pine Key

There are two distinct freshwater lenses on Big Pine Key. In both lenses, freshwater floats on the underlying saltwater with changes occurring seasonally due to tidal influences and rainfall-dependent freshwater recharge (USFWS, 2009). Hanson (1980) mapped the freshwater lenses in Big Pine Key by monitoring the downhole variation in salinity at monthly intervals (June 1976 to April 1977) at 22 shallow observation wells. The results indicated a considerable lateral expansion and contraction of the lens in response to the seasonal recharge. The maximum thickness of the freshwater column, however, remained fixed, at approximately 16 feet. A map of the freshwater lens system on Big Pine Key is presented in **Figure 12.1**.

Hanson's study (1980) of the fresh water on Big Pine Key found that continued pumping (at the pumping rate at that time) from shallow wells would probably not damage the system. However, he projected that future increased withdrawals from new residences and new or enlarged plant nurseries would "increase the stress on the freshwater lens which can only supply moderate amounts without detrimental effects during most years." Indeed, subsequent investigation shows that the effects of urbanization are being exhibited by the freshwater lens (Stewart et al, 1989). The southeast lens on the Key has decreased in lateral extent and maximum depth and is clearly affected by saltwater intrusion due to pumping and canal dredging activities. A modeled simulation of pre-development and current conditions on Big Pine Key showed that the total volume of the lens has decreased by 20 percent in response to dredging of canals (Langevin et al., 1998). The maps of freshwater lenses on Big Pine Key were being updated in 2010 by a consultant to the County but were not yet available at the time this report was prepared (September 2010).



Maps showing seasonal variation in freshwater lens at Big Pine Key. (A) Boundary of lens defined by the contour of 500 mg L^{-1} Cl^- at 1.5-m depth below water table as mapped by Hanson (1980) from wells (indicated as dots). Stippled area shows limit of freshwater lens in September 1976 (wet season); cross-hatched area shows limit of freshwater lens in March 1977 (dry season). (Adapted from Vacher et al., 1992, after Coniglio and Harrison, 1983.) (B) Location of freshwater-saltwater interface at selected depths (2, 5, and 7 m) below water table as defined by electromagnetic profiling (Wightman, 1990). Dashed line indicates limit in March 1987 (dry season); solid line indicates limit in August 1987 (wet season). Cross-hatching in B indicates areas of finger canals, which clearly limit lens area. (Adapted from Vacher et al., 1992.)

Figure 12.1 - Map of Freshwater Lens on Big Pine Key
(excerpted from Halley et al., 1997).

12.4.2 Freshwater Lenses on Sugarloaf Key and Little Torch Key

Meadows et al. (2004) studied lenses on Sugarloaf Key and Little Torch Key. The following is excerpted from their study report. Electromagnetic profiling and groundwater sampling on Sugarloaf Key and Little Torch Key in the Lower Keys of Florida show that these small, low-lying islands support only brackish-water lenses. On both islands, the lenses have central cores with lower salinities surrounded by areas of increasing salinity. The uppermost few meters of these central zones are uniform and slightly brackish (approximately 3 parts per thousand) year-round on Sugarloaf Key. On Little Torch Key, which is smaller, there is a similar central, uniform brackish zone during the wet season, with salinity slightly higher than on Sugarloaf Key. These lenses are similar in form to many freshwater lenses, except that the central zone is slightly brackish rather than fresh. During the dry season, Little Torch Key loses the central brackish zone, and salinities increase approximately linearly with depth. In the dry-season, the freshwater/saltwater mixing zone effectively extends throughout the lens. Seasonal variations on Little Torch Key are less evident outside the central zone. The central lower-salinity core on Sugarloaf Key coincides with elevations greater than 2.6 feet (0.8 meters). Using vegetation as a proxy for elevation, the central zone corresponds to the highest elevations on Little Torch Key as well. Tidal efficiencies on Sugarloaf Key indicate the tidal signal propagates through the high-permeability, buried Key Largo Limestone, and then upward through the overlying lower permeability Miami Limestone that contain the lenses. Mixing driven by tidal pumping is likely responsible for the absence of true freshwater lenses on these islands (Meadows et al., 2004).

Ross et al. (1994) concluded that sea level rise and associated salinization of groundwater and soil water is a major factor in the reduction of pine forests of Sugarloaf Key. They also concluded that if sea level continues to rise, the Florida Keys will experience a decline in both landscape and species diversity, as species-rich upland communities are replaced by simpler mangrove communities.

12.5 Biscayne Aquifer *[Rule 9J5.011(1)(g), F.A.C.]*

The Biscayne Aquifer, located throughout southeastern Florida (**Figure 12.2**), is the largest supplier of freshwater in southeast Florida. It is the most productive of the shallow unconfined aquifers in the area and is one of the most permeable in the world (Parker et al., 1955). The Biscayne Aquifer is considered an unconfined aquifer. In an unconfined aquifer, water levels are in equilibrium with atmospheric pressure. The upper boundary is termed the water table. The lower boundary is formed by a relatively impermeable bed.

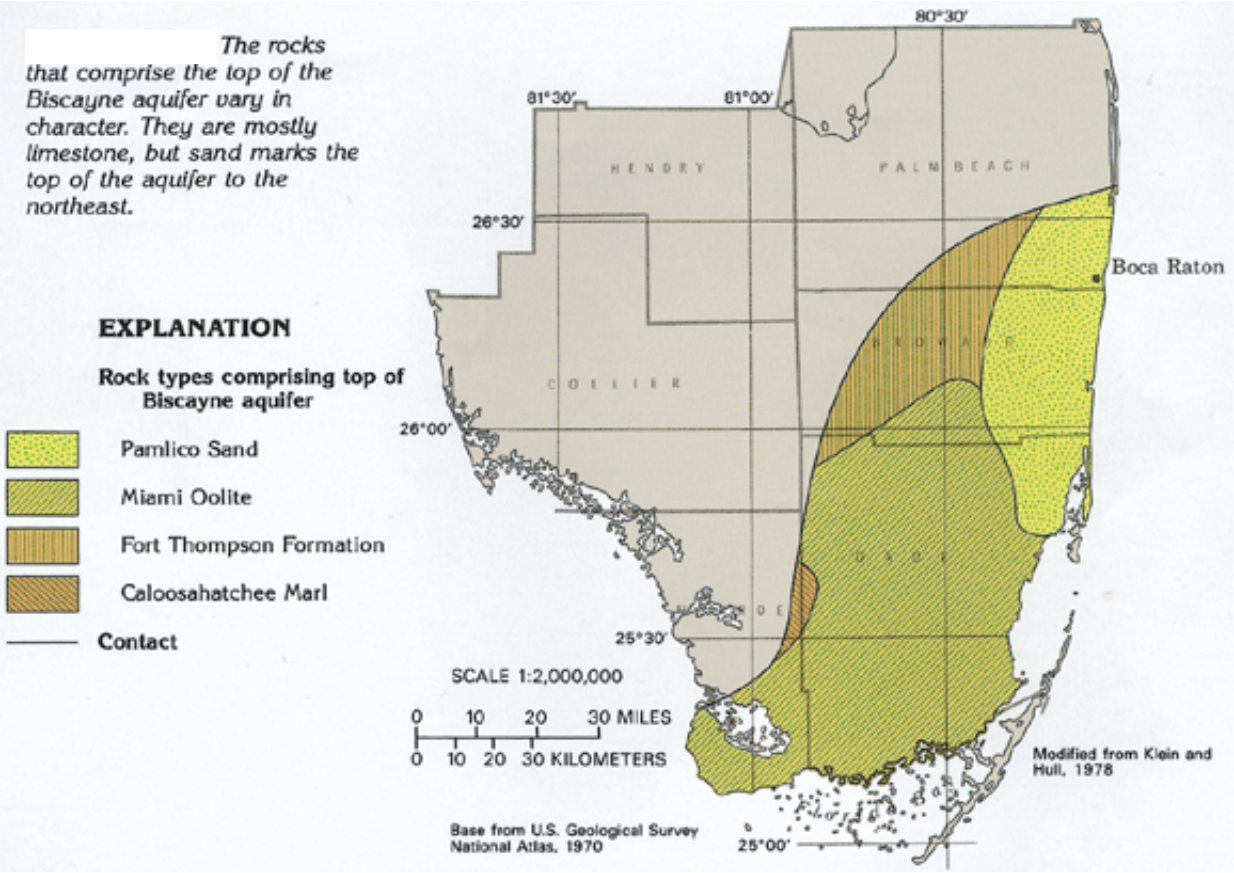


Figure 12.2 - Map of the Biscayne Aquifer
(excerpted from Miller, 1990).

In the Florida Keys, the Biscayne aquifer is approximately 100 feet thick and includes the Miami Oolite, Key Largo Limestone, and the upper permeable portions of the Tamiami Formation.

In the Keys, water from the Biscayne Aquifer ranges from brackish to chloride levels associated with seawater, and requires desalinization for potable use. As a result, the Biscayne Aquifer in the Keys is not used as a drinking water source and potable water is piped via aqueduct to the Florida Keys from a wellfield (the Florida City Wellfield) in the Biscayne Aquifer in southeastern Miami-Dade County. The FKAA is the agency responsible for obtaining and delivering freshwater to the Keys. They treat the water in Florida City, then pipe it via aqueduct to Florida Keys residents. Because water from the Florida City Wellfield is the primary source of potable water to the Keys, contamination by saltwater intrusion or other contaminants in the Florida City Wellfield would be a disaster for the Keys. Continued water quality monitoring, and appropriate management to control saltwater intrusion, are crucial to the protection of the County's water supply and are requirements of the FKAA Water Use Permit.

As noted earlier, some County residents provide their own water supply using home reverse osmosis plants to desalinate Biscayne Aquifer water, or collecting rain water in cisterns. However, due to the limited availability of fresh groundwater and its vulnerability to saltwater intrusion, and importance to wildlife and native vegetation, very few wells have been permitted in the shallow aquifer since the 1980s. Review of the South Florida Water Management District (SFWMD) ePermitting database (accessed June 4, 2010) (**Table 12.2**) indicates the SFWMD has issued five current water use permits for facilities drawing water from the Biscayne Aquifer in the Keys. These include industrial water uses such as aquaculture/fish tanks and air conditioner heat exchangers. In addition, SFWMD has issued 12 current permits for construction zone dewatering. On the mainland, Everglades National Park has public water supply permits to draw water from the Biscayne Aquifer for use in the park office and restroom facilities.

In addition to water use wells, there are injection wells known as Class V wells that are used to dispose of treated sewage. These Class V wells are permitted by the Florida Department of Environmental Protection (FDEP). In 2000, there were roughly 750 sewage disposal wells, ranging in depth from 30 to 90 feet, operating in the Florida Keys. FDEP regulates underground injection wells according to the federal Safe Drinking Water Act.

Table 12.2 - Water Use Permits Issued by SFWMD for Monroe County

Permit No.	Approved Date	Status	Permit Type	Expiration Date	Project Name	Watersource/ Receiving Body	Landuses	Party of Concern
44-00048-W	6-Oct-88	Complete	Water Use Renewal	6-Dec-88	City Of Key West Wastewater Treatment Plant	;	Dewatering	Applicant: Danis/Shook
44-00048-W	16-Jun-88	Complete	New Water Use	12-Sep-88	City Of Key West Wastewater Treatment Plant	;	Dewatering	Applicant: Danis/Shook
88-00071-W	14-Mar-88	Complete	New Water Use (General Permit)	9-Mar-08	Gu8-2169 (5515 Overseas Highway Marathon Fl)	;	Generic (Old GP's)	Applicant: Gulf Products Division B.P. Oil Company
88-00072-W	14-Mar-88	Complete	New Water Use (General Permit)	9-Mar-08	Gu7-2162 (79971 Overseas Highway Islamorada Fl)	;	Generic (Old GP's)	Applicant: Gulf Products Division B.P. Oil Company
44-00002-W	12-May-88	Complete	Water Use Renewal	15-Apr-91	Ocean Reef Inc	;	Golf Course	Applicant: Ocean Reef Inc
44-00001-W	10-Mar-88	Complete	Water Use Renewal	10-Mar-91	Card Sound Golf Club	;	Golf Course	Applicant: Card Sound Golf Club (Lessee)
44-00002-W	13-Jun-85	Complete	Water Use Modification	15-Apr-88	Ocean Reef Club - Harbor Course And Dolphin Course	;	Golf Course	Applicant: Ocean Reef Club Inc
81-00473-W	28-Dec-81	Complete	New Water Use (General Permit)	24-Nov-01	Proposed Concrete Batch Plant	;	Industrial	Applicant: City National Bank Of Miami As Trustee
80-00070-W	23-Apr-80	Complete	New Water Use (General Permit)	29-Jan-99	Coral Harbor Club Condominium	;	Industrial	Applicant: Long Ray
79-00202-W	14-Nov-79	Complete	New Water Use (General Permit)	29-Jan-99	Public Housing	;	Industrial	Applicant: Frigola Alfred
79-00184-W	5-Oct-79	Complete	New Water Use (General Permit)	29-Jan-99	Turtle Kraals Water Supply Well	;	Industrial	Applicant: Armsby John W. C/O Paul Kenson Jr. & Assoc
79-00216-W	17-Dec-79	Complete	New Water Use (General Permit)	29-Jan-99	Water Well For Florida Bay Club Key Largo Fl	;	Landscape	Applicant: Netter Charles C/O Paul C. Kenson Jr. & Assoc
44-00001-W	7-Jan-88	Complete	Water Use Renewal	15-Apr-89	Card Sound Golf Club	;	Landscape	Applicant: Ocean Reef Club Inc
44-00398-W	22-Sep-09	Withdrawn	New Water Use (General Permit < 3 Mgm)		Theater Of The Sea Inc.	;	Landscape	Applicant: Theater Of The Sea Inc
44-00002-W	7-Jun-79	Complete	New Water Use	7-Jun-89	Ocean Reef Club	;	Public Water Supply;Landscape	Applicant: Ocean Reef Club Inc
44-00372-W	10-Apr-07	Complete	New Water Use (General Permit < 3 Mgm)	12-May-27	Kraus Supermarket	Biscayne Aquifer	Aquaculture	Applicant: Kraus Commercial Property Group Llc
44-00183-W	11-Jan-93	Complete	New Water Use (General Permit)	11-Dec-12	Exxon Station #4-5727	Biscayne Aquifer	Industrial	Applicant: Exxon Company Usa
44-00188-W	30-Sep-93	Complete	New Water Use (General Permit)	12-Jun-12	Marathon Airport Terminal Facilities	Biscayne Aquifer	Industrial	Applicant: Monore County Commissioners Office
44-00157-W	18-Jun-91	Complete	New Water Use (General Permit)	5-Jun-11	Remedial Action Plan	Biscayne Aquifer	Industrial	Applicant: Universal Brands Inc
44-00144-W	21-Dec-90	Complete	New Water Use (General Permit)	21-Dec-10	Texaco (10898 Overseas Highway Marathon Key)	Biscayne Aquifer	Industrial	Applicant: Texaco
13-01499-W	20-Oct-00	Complete	New Water Use (General Permit)	20-Oct-20	Everglades National Park 14 Sites And Headquarters	Biscayne Aquifer	Public Water Supply	Applicant: Everglades National Park
13-00651-W	22-Jul-93	Complete	New Water Use (General Permit)	19-Jul-13	Everglades National Park	Biscayne Aquifer	Public Water Supply	Applicant: Everglades National Park
44-00002-W	14-Jan-93	Complete	Water Use (Individual Basin Extension)	12-Sep-94	Ocean Reef Club Inc	Dade/Monroe County	Golf Course	Applicant: Ocean Reef Club Inc
44-00001-W	11-Jul-91	Complete	Water Use Renewal	11-Jul-94	Card Sound Golf Club	Dade/Monroe County	Golf Course	Applicant: Card Sound Golf Club Inc

Table 12.2 - Water Use Permits Issued by SFWMD for Monroe County (continued)

Permit No.	Approved Date	Status	Permit Type	Expiration Date	Project Name	Watersource/ Receiving Body	Landuses	Party of Concern
44-00001-W	15-Mar-79	Complete	New Water Use	15-Oct-88	Card Sound Golf Club	Floridan Aquifer & On-Site Canals	Landscape	Applicant: Ocean Reef Club Inc
44-00002-W	11-Jul-01	Complete	Water Use (Letter Modification)	15-Dec-05	Ocean Reef Club	Floridan Aquifer System	Golf Course	Applicant: North Key Largo Utility Corp
44-00002-W	9-Jun-94	Complete	Water Use Renewal	15-Dec-05	Ocean Reef Club Inc	Floridan Aquifer System	Golf Course	Applicant: Ocean Reef Club Inc
44-00002-W	13-Jun-02	Complete	Water Use Modification	13-Jun-22	Ocean Reef Community	Floridan Aquifer System	Golf Course;Landscape	Applicant: Ocean Reef Club J
44-00284-W	6-Apr-01	Complete	New Water Use (General Permit)	6-Apr-21	Silver Shores Mobile Home Park	Floridan Aquifer System	Landscape	Applicant: Silver Shores Leaseholders Association
44-00001-W	10-May-07	Complete	Water Use Renewal	10-May-27	Card Sound Golf Club	Floridan Aquifer System;On-Site Lined Man Made Reservoir	Golf Course	Applicant: Card Sound Golf Club Inc
44-00001-W	11-Aug-94	Complete	Water Use Renewal	28-Feb-07	Card Sound Golf Club	Floridan Aquifer System;On-Site Lined Man Made Reservoir	Golf Course	Applicant: Card Sound Golf Club Inc
	29-Jul-03	Withdrawn	New Water Use (General Permit)		Key Deer Crossings	Ground Water	Dewatering	Applicant: Gilbert Southern Corp
	9-Apr-08	Void	New Water Use (General Permit)		Area 4 Wastewater Treatment Plant	Groundwater	Dewatering	Applicant: City Of Marathon
44-00442-W	8-Jan-10	Complete	New Water Use (General Permit)	24-Jan-15	Gravity Injection Wells 5	On-Site Borrow Pit(S)	Dewatering	Applicant: City Of Key West
44-00440-W	30-Nov-09	Complete	New Water Use (General Permit)	30-Nov-14	Gravity Wells 4 / Triple Chamber Outfall Installation	On-Site Borrow Pit(S)	Dewatering	Applicant: City Of Key West
44-00415-W	25-Aug-08	Complete	New Water Use (General Permit)	25-Aug-09	Garrison Bight Restrooms Sanitary Sewer	On-Site Borrow Pit(S)	Dewatering	Applicant: City Of Key West
44-00389-W	4-Jan-08	Complete	New Water Use (General Permit)	6-Jan-09	Key West Pump Station D A Modifications And Forcemain Ext	On-Site Borrow Pit(S)	Dewatering	Applicant: City Of Key West
44-00312-W	18-Jul-03	Complete	New Water Use (General Permit)	19-Jul-04	Pump Assisted Stormwater Drainage Intersections	On-Site Borrow Pit(S)	Dewatering	Applicant: Key West City Of
44-00315-W	11-Jul-03	Complete	New Water Use (General Permit)	12-Jul-04	Air Traffic Control Tower Operation Facility	On-Site Borrow Pit(S)	Dewatering	Applicant: Us Navy
44-00302-W	17-Oct-02	Complete	New Water Use (General Permit)	17-Oct-03	Stock Island Vacuum Sewer Expansion Phases 1-3	On-Site Borrow Pit(S)	Dewatering	Applicant: Key West Resort Utility Corp
44-00002-W	12-Sep-91	Complete	Water Use Renewal	12-Apr-94	Ocean Reef Club Inc	South Dade	Golf Course	Applicant: Ocean Reef Club Inc
44-00358-W	6-Mar-07	Withdrawn	New Water Use (No-Notice General Permit)		Railway Apartments	Surficial Aquifer	Dewatering	Applicant: Old Town Key West Development L L C
44-00158-W	21-Jun-91	Complete	New Water Use (General Permit)	29-Jan-10	Parks B Banks	Surficial Aquifer System	Agricultural	Applicant: Banks Parks B
44-00155-W	4-Apr-91	Complete	New Water Use (General Permit)	19-Feb-11	585049 Owens Oil Service Station	Surficial Aquifer System	Industrial	Applicant: Arnold Owens Inc
44-00206-W	9-May-96	Complete	New Water Use (General Permit)	9-May-99	Jet Engine Test Cell (Swmu-9)	Surficial Aquifer System	Industrial	Applicant: Commanding Officer-Naval Air Station
		No Response	New Water Use (General Permit < 3 Mgm)		Holiday Inn Express	Taron Creek	Public Water Supply;Landscape	Applicant: S H Marathon Ltd
44-00448-W	11-Feb-10	Complete	New Water Use (General Permit)	14-Feb-15	Stormwater Gravity Injection Wells Phase V I	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00422-W	3-Mar-09	Complete	New Water Use (General Permit)	10-Apr-14	Key Largo	Water Table Aquifer	Dewatering	Applicant: Key Largo Wasterwater Treatment District

Table 12.2 - Water Use Permits Issued by SFWMD for Monroe County (continued)

Permit No.	Approved Date	Status	Permit Type	Expiration Date	Project Name	Watersource/ Receiving Body	Landuses	PARTY OF CONCERNS
44-00441-W	17-Dec-09	Complete	New Water Use (General Permit)	17-Jan-14	W W T P Area 3	Water Table Aquifer	Dewatering	Applicant: City Of Marathon
44-00412-W	23-Dec-09	Complete	Water Use (Letter Modification-Minor GP)	30-Jan-12	Walgreens	Water Table Aquifer	Dewatering	Applicant: Walgreens
44-00447-W	4-Feb-10	Complete	New Water Use (General Permit)	5-Feb-11	White Street Stormwater Pump Station	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00443-W	27-Jan-10	Complete	New Water Use (General Permit)	1-Feb-11	Marathon Vacuum Station 5	Water Table Aquifer	Dewatering	Applicant: Oac Action Construction Corp
44-00445-W	6-Jan-10	Complete	New Water Use (General Permit)	6-Jan-11	Marathon Service Area 5 Sewer & Stormwater Collection System	Water Table Aquifer	Dewatering	Applicant: Lanzo Construction Co.
44-00412-W	12-Aug-08	Complete	New Water Use (General Permit)	1-Dec-09	Walgreens	Water Table Aquifer	Dewatering	Applicant: Walgreens
44-00405-W	14-Aug-09	Complete	Water Use (Letter Modification-Minor GP)	12-Nov-09	Navy P P V Housing -Trumbo Point	Water Table Aquifer	Dewatering	Applicant: Southeast Housing Llc
44-00413-W	14-Aug-08	Complete	New Water Use (General Permit)	20-Sep-09	Seagrape Apartments	Water Table Aquifer	Dewatering	Applicant: Carlisle Development Group
44-00405-W	21-Aug-08	Complete	New Water Use (General Permit)	22-Aug-09	Navy P P V Housing -Trumbo Point	Water Table Aquifer	Dewatering	Applicant: Southeast Housing L L C
44-00409-W	14-Jul-08	Complete	New Water Use (General Permit)	15-Jul-09	Triple Chamber Outfall Structure Installation	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00406-W	6-Jun-08	Complete	New Water Use (General Permit)	27-Jun-09	Gravity Injection Wells-Phase 3	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00401-W	30-Apr-08	Complete	New Water Use (General Permit)	3-Jun-09	Area 4 And 6 Wwtp	Water Table Aquifer	Dewatering	Applicant: City Of Marathon
44-00399-W	11-Mar-08	Complete	New Water Use (General Permit)	29-Mar-09	Pump Station	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00388-W	21-Dec-07	Complete	New Water Use (General Permit)	21-Dec-08	Big Coppitt Wwtp	Water Table Aquifer	Dewatering	Applicant: Fkaa
44-00375-W	31-May-07	Complete	New Water Use (General Permit)	2-Jul-08	Gravity Injection Wells Phase 2	Water Table Aquifer	Dewatering	Applicant: Key West City Of
44-00375-W	21-Sep-07	Complete	Water Use (Letter Modification-Minor GP)	23-Jun-08	Gravity Injection Wells Phase 2	Water Table Aquifer	Dewatering	Applicant: Key West City Of
44-00355-W	2-May-07	Complete	New Water Use (General Permit)	18-May-08	Front And Whitehead Street Stormwater Improvements	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00371-W	5-Apr-07	Complete	New Water Use (General Permit)	5-Apr-08	Margaret And Angela Streets Stormwater Improvements	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00338-W	15-Jun-05	Complete	New Water Use (General Permit)	24-Jun-06	Gravity Injection Well	Water Table Aquifer	Dewatering	Applicant: Key West City Of
44-00331-W	21-Dec-04	Complete	New Water Use (General Permit)	21-Dec-05	Key Largo Wastewater Management System	Water Table Aquifer	Dewatering	Applicant: Key Largo Wastewater Treatment District
		Hold For Conc	New Water Use (General Permit)		George Street Stormwater Basin Improvements	Water Table Aquifer	Dewatering	Applicant: City Of Key West
44-00385-W		No Response	New Water Use (General Permit)		Hawks Cay Pool Well Points	Water Table Aquifer	Dewatering	Applicant: Hawks Cay Investors Ltd
44-00419-W	20-Nov-08	Complete	New Water Use (General Permit < 3 Mgm)	29-Dec-28	Hawks Nest Condo	Water Table Aquifer	Industrial	Applicant: Hawks Nest Condominium Inc
44-00192-W	14-Dec-93	Complete	New Water Use (General Permit)	8-Nov-13	Bp Site #24589 - Fdep Fac #448511957	Water Table Aquifer	Industrial	Applicant: Bp Oil Company

Source: SFWMD ePermitting Database June 4, 2010.

Recharge of the Biscayne Aquifer occurs primarily to the north of Monroe County and includes (1) infiltration of rainfall or irrigation water through surface materials to the water table; (2) infiltration of surface water imported by overland flow in the Water Conservation Areas or by canals; and (3) infiltration of urban runoff by way of drains, wells, or ponds (Fish and Stewart, 1991). Recharge by rainfall is greatest during the wet season, from June to November, and recharge by canal seepage is greatest during the dry season, from December to May (Fish and Stewart, 1991). Recharge occurs throughout most of Miami-Dade County and the Water Conservation Areas of Miami-Dade, Broward, and Palm Beach Counties. In the southern part of Miami-Dade County, groundwater flows southward into Monroe County (Fish and Stewart, 1991).

Due to several factors (including the low and gentle topography, the effects of canals and other water management structures, the effects of pumping, and seasonal variations in rainfall), there is not a distinct line that separates aquifer recharge areas from discharge areas. Areas and canals that are recharge areas at one time (during summer rainstorms or during the winter rainy season) may be discharge areas during other times. Portions of the Everglades in mainland Monroe County, for example, alternate between recharge areas and discharge areas. However, discharge tends to dominate with increasing proximity to Florida Bay, which is a major regional discharge area in Monroe County. At a regional scale, the Keys are within the discharge area, but rainfall on the islands provides some localized and episodic recharge.

Discharge in Monroe County is by: (1) groundwater flow to canals, to seepage areas near the coast, and widespread and direct seepage into marine waters; (2) evapotranspiration; and (3) wells pumped for municipal, domestic, or other supplies (Fish and Stewart, 1991). Groundwater discharge and evapotranspiration are greatest during the wet season when water levels, temperature, and plant growth rates are high (Fish and Stewart, 1991). In the Keys where there are no natural rivers, there is no natural drainage of the Biscayne Aquifer into discernible drainage features such as rivers.

Perennial aquifer recharge areas include the Water Conservation Areas (**Figure 12.3**). In addition, the non-coastal (northern) parts of Everglades National Park and the non-coastal parts of Miami-Dade County contribute recharge to both the Florida City Wellfield and the Surficial Aquifer System under Monroe County.

The quality and quantity of raw water in the Biscayne Aquifer is of paramount importance to regional supply. Aquifer recharge and water storage are the key components of maintaining an abundant water supply. A major difficulty with the raw water supply is not the average annual quantity of available water, but the seasonal variability in available quantity. Approximately 80 percent of South Florida's average annual rainfall occurs during the wet season from May to September. Water supply issues are addressed in Chapter 8.0, Potable Water Element.

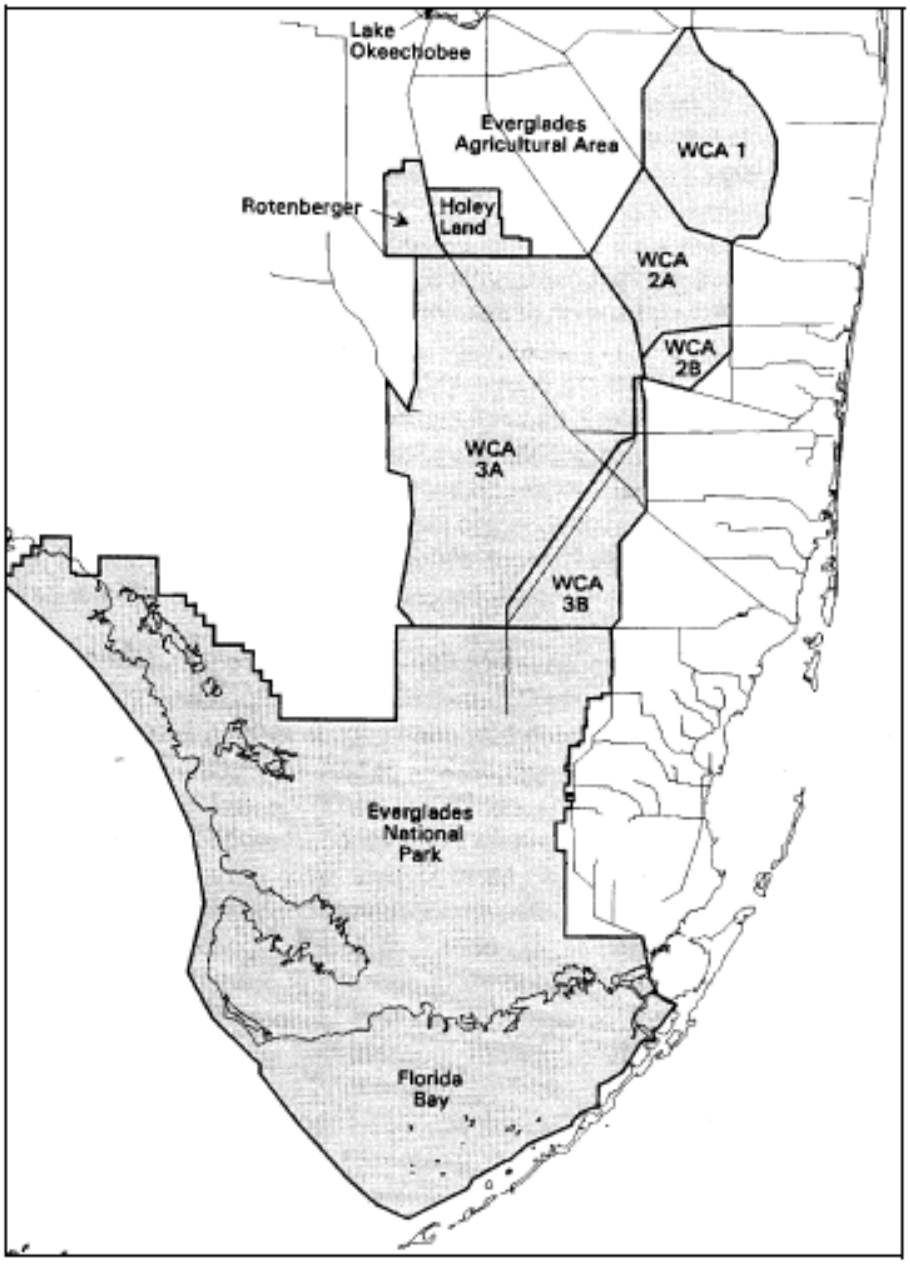


Figure 12.3 - Map of Aquifer Recharge Areas for the Biscayne Aquifer
(excerpted from Lower East Coast Regional Water Supply Plan, Planning Document, prepared by the South Florida Water Management District, May 2000).

Recharge and storage of South Florida's water resources are managed by the SFWMD, an arm of State government, in coordination with the U.S. Army Corps of Engineers. The regional water conveyance canals and water storage system, or Water Conservation Areas, were constructed by the U.S. Army Corps of Engineers with federal funds and are operated and maintained by SFWMD. SFWMD also determines additional management and construction needs for the canal or groundwater system and regulates major water inputs and withdrawals which impact these systems. SFWMD manages and operates its sophisticated network of floodgates, pumping stations, canals, levees, and Water Conservation Areas to maintain the delicate balance between flood and drought throughout the year. Groundwater resources are also proximal to natural areas subject to heightened regulatory protection such as Everglades National Park. Wet seasonal rainfall is captured and stored in Lake Okeechobee and the Water Conservation Areas. Water releases from these sources can be made so that water flows south to Miami-Dade County to aid in maintaining an adequate water supply throughout the year.

The fresh and salt waters of the region come into contact along the coast. When stream flow and water tables are high, sea water is prevented from moving inland; when stream flow and water levels are low, sea water moves up tidal streams and into the aquifer, rendering the groundwater unpotable in coastal areas. The progressive movement of the saltwater interface inland has been halted by the SFWMD, but the saltwater intrusion problem is a constant threat in South Florida, especially in times of drought. It is projected that the region's saltwater intrusion issues will become susceptible to increased risk as South Florida experiences additional sea level rise. For the Biscayne Aquifer, this may result in reduced availability of freshwater for potable use which will be even more exacerbated during periods of drought (Heimlich et al., 2009).

The direct connection between the ground and surface water systems makes the Biscayne Aquifer susceptible to pollution and disruption from urban activities at the land surface. Many contaminants are rapidly diluted in the large volumes of water contained in the aquifer, and the porous limestone acts as a filter. However, high concentration of pollutants can overload and incapacitate the aquifer's natural cleansing action.

Sources of contamination can be divided between point sources and nonpoint sources. A "point source" is defined as any discernible, confined and discrete facility that discharges pollution. Landfills, impoundments, gasoline stations, septic tanks, and cesspits are examples of point sources which can contaminate the groundwater aquifers. Because the aquifer is very permeable, effluent from septic tanks and cesspits moves easily through the drainfield and can migrate off site. Septic tank effluent characteristically contains bacteria including fecal coliform and fecal streptococcus as well as other various virus and chemical pollutants. This could pose public health concerns for those households using well water for consumptive uses such as bathing.

Nonpoint sources are any discernible sources of pollution not associated with point sources. They are more pervasive and less controllable sources of pollution. Stormwater runoff from urban areas is an example of nonpoint pollution which affects both ground and surface water. Typical components of nonpoint source pollution are those contaminants resulting from the application of substances or the weathering of substances associated with urban development. Oils and greases, trace metals, pesticides, herbicides and nutrients can be expected to emanate from urbanized areas. Treatment systems for these pollutants typically consist of holding areas to attenuate runoff. As such, these areas may contribute pollutant loads to the surficial aquifer. It is, nevertheless, believed that the risk to the surficial aquifer is less than the risk to surface waters from direct discharge of runoff.

Several studies have been performed that demonstrate the transmissivity of the substrates of the Florida Keys and the rapid exchange of wastewater from onsite systems or injection wells to surface waters. Kruczynski (1999) summarized this information on water quality of groundwater in the Florida Keys and the following was excerpted from that report.

Lapointe et al. (1990) measured significant nutrient enrichment of groundwater contiguous to onsite disposal systems at several sites. Mean dissolved inorganic nitrogen [987 micromolar (uM)] was 400 times higher and mean soluble reactive phosphorus (9.77 uM) was 70 times higher in groundwater adjacent to a septic tank seepage field compared to a reference site. Concentrations of nitrogen and phosphorus decreased in the groundwater away from the septic tank toward the adjacent canal, presumably due to dilution by groundwater. They also theorized that some of the soluble reactive phosphorus was absorbed by the substrate. Concentrations of nutrients in the canals (dissolved inorganic nitrogen 4.91 uM; soluble reactive phosphate 0.43 uM) were elevated compared to control sites. Concentrations of nutrients in the canals were highest in the summer because of seasonally maximum tidal ranges and increased flushing during the summer wet season (Kruczynski, 1999).

Shinn et al. (1994) placed and sampled 24 wells beneath the Keys, nearshore areas, and outer reefs to determine if sewage effluent from Class V wells is reaching offshore reef areas via underground flow. Class V wells (drilled 90 feet and cased to 60 feet) were permitted by FDEP for disposal of wastewater. Sample wells were located in transects off Ocean Reef Club, Key Largo, and Saddlebunch Keys and were sampled quarterly for one year. Investigators found well water to be consistently hypersaline with a marked increase in ammonia in offshore groundwater. Other forms of nitrogen and phosphorus present in offshore groundwater were only slightly elevated above levels found in surface marine waters. Highest levels of nitrate, nitrite, and phosphorus were found in shallow onshore groundwaters (Kruczynski, 1999).

Nearshore wells were observed to discharge water during falling tides and draw water into the wells during rising tides. This "tidal pumping" results in considerable

water movement in and out of the upper few meters of limestone and is a likely mechanism for mixing and transferring nutrient-rich groundwater into overlying surface waters (Kruczynski, 1999).

Paul et al. (1995) placed a man-made tracer virus in a septic tank and into a 45 foot deep injection well in Key Largo and found the virus in the surface waters of an adjacent canal and the Atlantic Ocean in 11 and 23 hours, respectively. Rates of migration ranged from 1.87 to 79.3 feet/hour (0.57 to 24.2 meters/hour). They concluded that current onsite disposal practices in the Florida Keys can lead to rapid nutrient enrichment and fecal contamination of subsurface and surface marine water in the Keys (Kruczynski, 1999).

Paul et al. (1997) repeated the viral tracer experiment with 40 foot deep injection wells on Key Largo and a permitted 90 foot deep Class V injection well on Long Key. At both sites, viral tracers appeared in the groundwater within 8 hours after injection, and in marine surface waters 10 hours in Key Largo and 53 hours in Long Key (Kruczynski, 1999).

Chanton (1998) completed two extensive surveys and mapped areas of concentrations of natural tracers near the Keys. Groundwater seepage areas were found on both the Florida Bay and Atlantic Ocean sides of the Keys. Two injection studies were completed: one on Key Largo and one on Long Key. In both tests, the tracer was injected into groundwaters and was observed, greatly diluted (approximately one million times) within hours to days in nearby surface waters. At the Long Key site, it was found in a canal located across U.S. 1 from the injection site. Wastewater injected into the groundwater at Long Key rapidly migrated toward the surface due to the fact that freshwater "floats" on the highly saline groundwater (Kruczynski, 1999).

Kump (1998) sampled groundwater in wells drilled to various depths surrounding a wastewater injection well on Long Key. He confirmed the presence of a shallow, low-salinity lens floating on top of the groundwater. Distribution of nutrients away from the site of injection was variable, but phosphate, nitrate, and ammonia concentration appeared to be highest nearest the injection well at a depth of 16 feet. However, the elevated concentrations of these nutrients were observed in sampling wells located in different directions from the point of injection. The absence of phosphate in high pH waters in shallow wells leads to the postulation that phosphate may be removed by adsorption onto the limestone substrate (Kruczynski, 1999).

In October 1996, Kump injected phosphate at the same time that Chanton injected a non-reactive tracer (sulfur hexafloride- SF6) into a Class V injection well (60/90 feet) at Long Key. Within 4 hours there were elevated tracers at the sampling well located between the injection well and the Atlantic Ocean. The peak of both tracers occurred after about 3 hours. After the peak, the ratio of the tracers fell because the concentration of phosphate fell more rapidly than that of SF6. Using data from one

of the sampling wells, it was calculated that the tracer SF6 appeared to be moving vertically at about 23 feet per day. The pattern of early SF6 peaks in some wells that are associated with phosphate peaks, and later SF6 increases with no increase in phosphate concentration at other wells, cannot be ascribed simply to dilution of phosphate by groundwater. The predicted phosphate concentrations based on the assumption of no preferential uptake and the observed tracer concentrations would be well above detection at many of the wells. These observations support the hypothesis that phosphate is being stripped from the groundwater. The rate and long term capacity of substrates in stripping phosphate was unknown (Kruczynski, 1999).

12.6 Floridan Aquifer *[Rule 9J5.011(1)(g), F.A.C.]*

In South Florida, the Floridan Aquifer System is a confined or artisan system. An artisan aquifer is saturated and is bounded at the top and bottom by completely impermeable beds. The water level rises above the top of the confined aquifer in tightly-cased wells which are open only to the artisan aquifer. The Floridan Aquifer System underlies all of Florida and parts of the adjacent states of Georgia and Alabama. In Miami-Dade County it occurs at about 900 feet below sea level (Parker et al., 1955). It consists of a 1,500 foot thick series of artisan water-bearing zones within the Tampa and Suwannee Limestones. The Floridan Aquifer System is confined above by the Hawthorne Group and below by less permeable limestone and dolomite units. In December 1975, the static head in the Floridan aquifer ranged from 38 to 41 feet above mean sea level in Key Largo (Beaven and Meyer, 1978). Wells into the Floridan Aquifer System in the Keys range from 75 gpm (gallons per minute) to more than 1,000 gpm, with 750 gpm being the average. Flow rates depend upon the amount of penetration into aquifer and the types of sediments encountered (Parker et al., 1955).

Although available in significant quantities, Floridan water requires desalinization treatment before it is suitable for either potable or irrigation use. Chloride concentrations in the Floridan Aquifer System range from 1,600 to 20,000 milligrams per liter, with concentrations generally increasing to the south. FKAA has recently been required to construct Floridan Aquifer Production Wells, a Floridan Aquifer Reverse Osmosis Treatment Facility, and a Demineralized Concentrate Disposal Well pursuant to its Water Use Permit. Based on the SFWMD ePermitting database (accessed June 4, 2010) (**Table 12.2**), there are only three consumers in the County that are using enough Floridan Aquifer water to require an individual SFWMD permit: Ocean Reef Community (golf course and landscaping), Silver Shores Mobile Home Park (landscaping), and Card Sound Golf Course (golf course irrigation).

The Floridan Aquifer System is the best source of raw water for large desalinization operations because it has low chloride levels compared to the Biscayne Aquifer in the Keys or compared to seawater. The water in the Floridan Aquifer System has potential as a source of supply for public and industrial purposes after desalinization. Chloride and dissolved solid concentrations are major considerations when

determining the cost effectiveness of a desalinization process (Lapointe and O'Connell, 1989). Water from the upper portion of the Floridan Aquifer System (brackish zone) could provide raw water for treatment at reasonable cost for large-scale municipal and industrial supply. The Floridan Aquifer System does not outcrop or receive direct recharge anywhere in South Florida. Therefore, there is no potential for contamination from surface sources. Concern does exist, however, that large withdrawals from the Floridan Aquifer could cause upwelling or encroachment of saline water which in turn would increase production costs for current and future reverse osmosis/desalinization plants.

As a confined aquifer in South Florida, the Floridan Aquifer System has no natural recharge areas in South Florida. The Floridan Aquifer System is recharged in central and northern Florida, southern Georgia, and small parts of adjoining Alabama and South Carolina. There are no natural recharge areas within the jurisdiction of Monroe County. With no natural recharge in Monroe County, maps of recharge areas are not applicable.

12.7 Regulatory Framework *[Rule 9J5.011(1)(h), F.A.C.]*

The overall intent of federal and State regulation of groundwater aquifers is the protection of public drinking water supplies from contamination. The protection of water table levels and the regulation of aquifer withdrawals are primarily under the domain of the SFWMD, while water quality is regulated by FDEP. These agencies may also be involved in the preservation of freshwater resources in general where they are not used for mass public consumption, but the effective regulation of these resources are carried out mainly at the local government level.

In the Florida Keys, lenses are not recognized as a source of potable water supply and, therefore, are not subject to potable supply regulations.

12.7.1 Federal Regulations

U.S. Public Law 104-182, "Safe Drinking Water Act" was enacted on August 6, 1996, to reauthorize and amend the prior law to continue implementing a nationwide system of monitoring and controlling the quality of water supplied by public water systems. The U.S. Environmental Protection Agency (USEPA) was given authority to administer the Act. In addition, the Act also required USEPA to develop criteria for selecting critical aquifer protection areas. The program calls for state and local governments to map those areas and develop protection plans, subject to USEPA review and approval. Once a plan is approved, USEPA may enter into an agreement with the local government to implement the plan.

The Safe Drinking Water Act provides for the protection of public water system wellfields and aquifers used as the sole source of a community drinking water supply.

Amendments provide for wellfield protection which require states to work with local governments through the planning process to identify and to protect wellhead areas.

USEPA is currently promulgating additional Water Quality Standards for the State of Florida's Lakes and Flowing Waters, 40 CFR Part 131, which regulate discharges that impact surface and groundwater resources.

12.7.2 State Regulations

USEPA generally regulates water quality standards, although water quality standards at the State level are developed by FDEP and adopted by the Environmental Regulatory Commission. FDEP is charged with enforcing the standards, although it may delegate some of its authority to the regional water management district or other governmental units. Other regulatory authority, such as the land use/zoning powers of local government, directly impact water quality, and the SFWMD has established a program to address water resource concerns related to land use and other comprehensive plan issues.

The permitting programs of SFWMD and FDEP achieve their joint goal through different mechanisms. FDEP's statutory authority and regulatory program for protection of the State's water quality addresses discharges into the waters of the State. This program is distinguished from the SFWMD regulatory water use program which addresses withdrawals from surface and ground water sources. The SFWMD program protects the quality of the State's water resources (primarily related to the movement of constituents). Decisions in this program can cause discharge of pollutants into the water resources through the transport of pollutants in "used" water.

FDEP Rules within Chapter 403, F.S., "Florida Safe Drinking Water Act," and Chapter 62-528, Part III, F.A.C., classify and regulate the use of aquifers. The FDEP has also developed increasingly stringent regulatory requirements for facilities which discharge to groundwater under Section 62-528, F.A.C., and for those facilities which inject materials underground through deep well injection. Groundwater quality standards are included in Chapter 62-528, F.A.C., with Florida Keys groundwater generally falling under Class G-III criteria. These criteria set standards for protection of public health in general and the protection of natural systems from toxic substances, but nutrients are not addressed.

The SFWMD consumptive use permitting program regulates quality issues associated with water withdrawals by evaluating the potential for a withdrawal to cause the following:

- saltwater intrusion;
- harm to offsite land uses;
- harm to wetlands or other surface waters;

- pollution of the water resources;
- is otherwise reasonable-beneficial;
- interfere with presently existing legal uses;
- is in accordance with Section 373.2295, F.S. relative to the interdistrict transfer of groundwater and Section 373.223(3), F.S. concerning water transport and use of groundwater or surface water across county boundaries;
- appropriately makes use of reclaimed water;
- is consistent with the public interest;
- is in accordance with established minimum flows and levels; and
- will not withdraw water reserved under Chapter 40E-10, F.A.C.

The SFWMD also requires well plugging pursuant to Chapter 373.207, F.S., to prevent the movement of saline water into freshwater aquifers.

The SFWMD uses FDEP's water quality standards and water body classifications to determine the water quality status of aquifer and surface waters. The SFWMD will recommend to FDEP new standards (including site-specific alternative criteria) or classifications as necessary to protect the water resources of the state.

In the development of Surface Water Improvement and Management plans, water supply plans for specific geographic subregions, and other planning documents, the SFWMD may identify areas and water bodies for which additional protection is necessary. The development of such water quality guidelines or caps will be done in coordination with FDEP. The SFWMD will continue to develop or support initiatives such as the wellfield protection programs to assist local governments in linking water quality with land use decisions. The SFWMD Surface Water Improvement and Management process will identify, recommend and implement solutions for water quality problems within specific priority water bodies.

The SFWMD may allow movement of lower quality water into a higher quality aquifer to occur only in limited, defined circumstances when the use is necessary for maximum reasonable-beneficial use and is consistent with the FDEP ground water classification. To achieve water quality protection and enhancement in these situations, it is recommended that the regional water supply plans establish boundaries and recommend water quality-caps beyond which a use may not degrade an aquifer, as consistent with state water quality standards.

As a corollary, the SFWMD regional water supply plans may establish areas of water quality which, on a local or regional level, may have already exceeded the recommended limits. In these instances, the SFWMD may apply regulatory means of enhancing water quality, to the extent possible, to meet the specified water quality requirements of the defined area. However, SFWMD caps will not allow degradation of a source to a point which exceeds the FDEP classification for the water body. The SFWMD will encourage linkage of the proposed groundwater boundaries and caps with local government land use decisions similar to wellfield protection ordinances

with the intent that local governments make land use decisions based on potential aquifer development as consistent with the water quality protection and enhancement goal.

12.7.3 Local Regulations

At the present time, the County has no special regulatory programs related to protection of natural groundwater aquifer recharge areas, nor has there been any comprehensive identification of these areas. While Chapter 380, F.S., does express concern for preservation of freshwater wetlands for wildlife, the only specific regulation directly affecting groundwater is the prohibition of well excavation in "high quality pineland" areas. Existing local regulations presently affecting ground water pollution sources are mainly limited to those addressing stormwater runoff.

12.7.4 Wellfield Protection

In 1983, FDEP began developing a wellhead protection program to prevent contamination of public water supplies. The program, known as the G1-Rule, is based on groundwater quality, a five-year travel time contour, and a calculated radius of protection. Since its adoption, the G1-Rule has been challenged in court and as a consequence has not been successfully implemented. However, FDEP encourages and supports local governments to take the lead in protecting their drinking water supplies and is assisting the Florida Department of Community Affairs with related comprehensive planning.

For Miami-Dade County, wellfield protection planning began in the late 1970s. The Wellfield Protection Program is based on the need to protect the drinking water resources from potential contamination and the delineation of prohibitive or protection zones. Various wellfield protection zones are identified based on modeled contaminant travel time and drawdown. Specific wellfield protection rules are located in Chapter 24-12.1 of the Code of Miami-Dade County.

The FKAA wellfield is located just west of Florida City and consists of 10 operational wells. Each well extends into the Biscayne Aquifer, which serves as the primary raw water source. Raw water quality at the FKAA wellfield has historically been acceptable for potable water supply. Water quality data included in the permit modification application indicated that the water is hard and low in turbidity, color and iron. Review of the data for the 2008 application (SFWMD Water Use Permit No. Re-issue 13-00005-W, March 2008) indicated that water quality had changed little if any as a result of current withdrawals. No percolation ponds, hazardous or toxic waste disposal sites, sewer mains, saline water bodies or wastewater treatment facilities are located within a 1 mile radius of the wellfield. The *Wellfield Protection Program* (CH2MHill, 2010) identifies potential contamination sources. The FKAA wellfield is currently protected by the Miami-Dade County Wellfield Protection

Ordinance which is administered by the Department of Environmental and Resource Management.

A condition of the permit requires FKAA to monitor and submit data from the Salt Water Intrusion Monitoring program to the SFWMD on a monthly basis. In accordance with an additional condition of the permit FKAA is implementing a Saline Water Intrusion Monitoring program which utilizes monitoring wells to measure any movement of the saline water interface. An example of the SFWMD criteria to prevent saltwater intrusion is that 1 foot head of fresh water be maintained between the wellfield and the saline water source. Saltwater intrusion usually results from a sustained decrease in fresh water head, allowing saltwater to migrate inland. Results of groundwater modeling indicate that drawdowns associated with increased withdrawals are minimal. The FKAA in cooperation with the United States Geologic Survey (USGS) maintains a water quality monitoring network around the wellfield that is sampled monthly. The network includes 19 monitoring wells, 2 of which have continuous water level recorders. The *Wellfield Protection Program* (CH2MHill, 2010) identifies the well locations and provides analytical data. From the data included in the 2008 Application for Water Use Permit Modification Renewal, it was concluded that in 2008 the 1,000 milligrams per liter isochlor is estimated to be six miles southeast of the well field in approximately the same location reported in 1974.

12.7.5 Freshwater Lens Resources

The freshwater lens systems of the Florida Keys are considered to be critical to the support of the existing wildlife and plant communities in these areas. There is a need for continued efforts towards monitoring their condition, including size and water quality. Protection of the lens systems should be accomplished through regulation of withdrawals and of land use in recharge and wetland areas. Of particular concern are: freshwater withdrawals for private consumptive uses, loss of recharge areas to impervious surface coverage, contamination of groundwater from surface sources, and salt water intrusion due to sea level rise.

It has been demonstrated that the freshwater lens on Big Pine Key has suffered some reduction from its former size. While droughts and sea level rise may be contributors to this phenomenon, it cannot be disputed that freshwater withdrawals have their effect on the lens. New dredge and fill projects are largely prohibited in the Keys both by State and local governments. Further increases in private consumptive withdrawals should not be permitted and alternative water sources are needed.

The current Stormwater Management Ordinance does address the need to handle stormwater on site, but it does not stress the need to retain natural drainage features and reduce impervious surfaces. Standards are needed to ensure impervious surfaces do not reduce the quantity or quality of aquifer recharge to the point where the natural resources are significantly degraded. Incentives could be provided to reduce existing impervious areas. Specialized requirements or incentives may be

appropriate in areas that serve as aquifer recharge areas for freshwater lenses. Acquisition of important recharge areas may also be an option for preservation.

The County already implements some regulations that serve the purpose of protecting the freshwater lens recharge areas. Mining can pose a threat to recharge areas. Therefore, the County prohibits any resource extraction activity that would cause the introduction of saline aquifer waters into fresh water aquifers.

In addition, a habitat analysis is required for any proposed development in slash pinelands or tropical hardwood hammock. Since pineland habitat is an indicator of freshwater lens recharge areas, the County now requires a relatively high open space ratio in these areas.

The County also requires on-site retention of stormwater, which helps the fresh water filter into the ground and eventually into the freshwater lenses, instead of draining to lower ground where it would more likely evaporate or drain into the ocean.

12.7.6 Water Conservation

The Water Resources Act of 1972 formally designated the conservation of water as a key policy of the state and mandated that state and regional water resource agencies take steps to prohibit wasteful and unreasonable uses of the state's water supply. For South Florida, the adoption of the act also thrust the SFWMD into a lead role in water supply planning and regulation.

Water conservation is a high priority in SFWMD policy and rules as well as FDEP rules, in keeping with the statutory mandate. Implementation of demand management programs will be both passive (public information) and active (irrigation using micro-irrigation systems, use of reclaimed water, leak detection, water conservation rate structures, model landscape codes, use of rain sensors, ultra low flow plumbing structures in new construction, etc).

As part of its efforts to conserve freshwater resources in areas of high demand, the SFWMD will continue to analyze and support the development of alternative water sources such as use of Floridan Aquifer withdrawals, reverse osmosis, and use of reclaimed water. Also, as noted below, the SFWMD will continue to investigate and support other supply augmentation alternatives. The development of other supply sources, however, does not lessen the requirements for conservation and efficient water uses. As discussed below, inefficient or wasteful uses of water are not considered reasonable or beneficial under Florida law.

A related concept found in Florida's water use policy is the use of the lowest quality water available and appropriate for a specific use. This policy, for example, encourages the replacement of high quality ground water with treated wastewater for

irrigation purposes if a feasible source is available. The effect of this policy is to optimize the utilization of available resources by requiring diversification of sources. The SFWMD identifies areas that have or will experience water supply problems in the next 20 years. During the past decade, the use of potable water for lawn and landscape irrigation has drawn extensive attention, culminating in new year-round water conservation rules, and has been the focus of numerous conservation campaigns. These efforts have included water shortage awareness campaigns and Florida-Friendly (low-irrigation landscaping) programs.

Some water conservation measures are identified in the County Code of Ordinances. Examples include restrictions on landscape irrigation during certain times of the day when evaporative losses are high, unnecessary watering of impervious areas, and rain sensors on irrigation systems - new installations of automatic irrigation systems must be equipped with a water sensing device that will automatically discontinue irrigation during periods of rainfall (Code of Ordinances, Chapter 12, Article IV, Section 12-82). There are also potable water conservation standards, including the requirement for installation of toilets with a maximum flush of 3.5 gallons, showerheads and faucets with a maximum flow rate as specified in the Florida Building Code; and independent water systems are encouraged whenever permitted (Code of Ordinances, Chapter 12, Article III, Section 114-46). Additional water conservation measures may be applicable, including incentives for water conservation features installed on remodeling work that does not otherwise require upgrades to meet current codes.

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CHAPTER 12.0 – NATURAL GROUNDWATER AQUIFER RECHARGE ELEMENT

Commenter: Kevin G. Wilson, P.E. - Engineering & Project Management Dept. Comments Received: 8/17/2010		
Location	**Comment**	**K&S Response**
Sec 12.7.5 (Freshwater Lens Resources) page 23	Do we wish to provide incentives in the revised ordinance to eliminate existing impervious area? Should the requirements (or incentives) be different in areas with fresh water lenses like BPK?	Agree, revised in Section 12.7.5 paragraph 3.
Sec 12.7.6 (Water Conservation) page 24	Do MCC require use of rain sensors on irrigation systems? Does require low flow supply fixtures (e.g., showerheads, or toilets)? Incentives for remodels not requiring upgrades to new codes?	Agree, added to the end of Section 12.7.6.
Commenter: FKAA (Jolynn Reynolds) Comments Received: 10/25/2010:		
Location	**Comment**	**K&S Response**
Section 12.4 Freshwater Lenses (page 4)	The FKAA only requires wells to be abandoned only in areas that SFWMD provided grant funding after Hurricane George	This sentence was unnecessary and was deleted.
Section 12.7.4 Wellfield Protection (page 22)	Refer to Exhibit 3.4 in the FKAA Wellfield Protection Program for potential contamination sources; refer to section 3.5 for the SWIM well monitoring network; there are 15 monitoring wells, only two of those wells have continuous water level monitoring and no more canals are part of the FKAA's monitoring network	Added references to the Wellfield Protection Program which identifies potential contamination sources, and saltwater intrusion monitoring well locations and data. Updated the info on the FKAA monitoring network.
Commenter: FKAA (Julie Cheon) Comments Received: 6/11/2011		
Location	**Comment**	**K&S Response**
Natural Groundwater Aquifer Recharge Element, page 22	Suggested change: The network includes ~~15~~ 19 monitoring wells, 2 of which have continuous water level recorders. The *Wellfield Protection Program* (CH2MHill, 2010) identifies the well locations and provides analytical data.	Revised number of wells as suggested.