Air and Water Quality Status and Trends in Miami-Dade County
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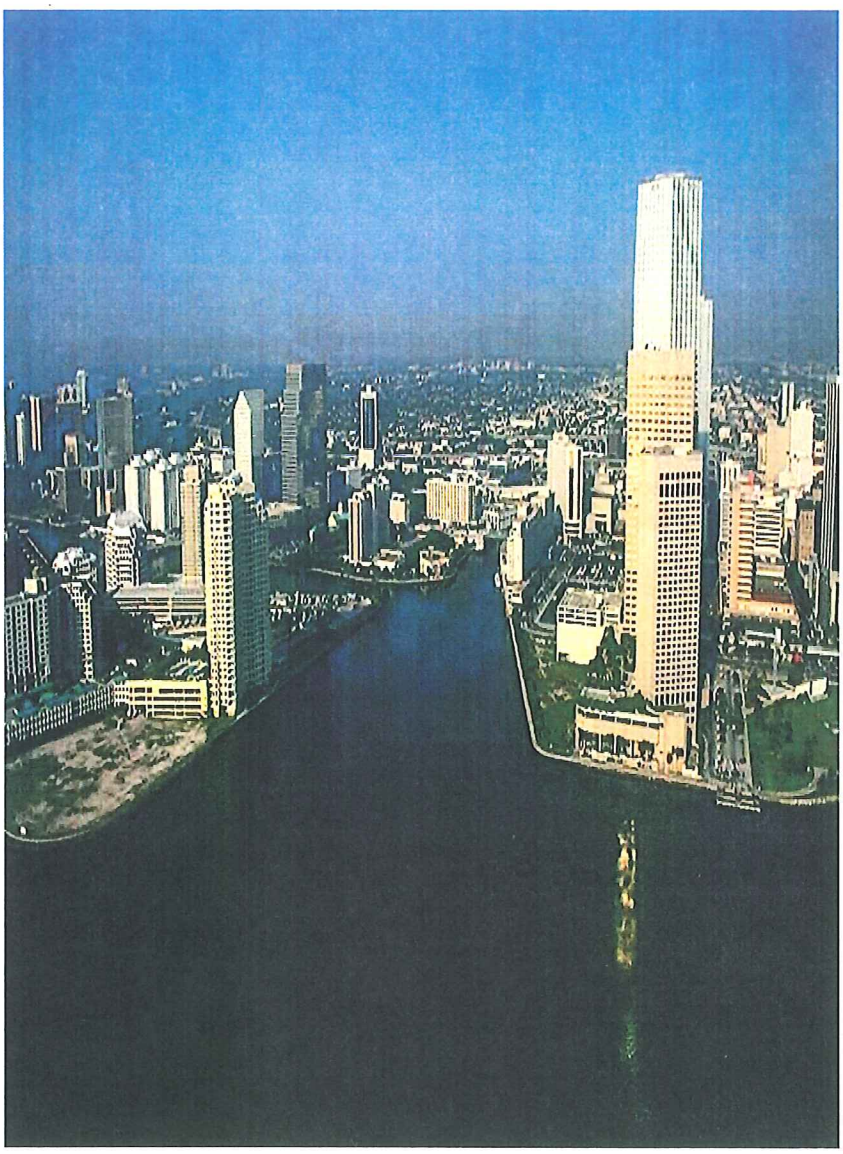
Miami-Dade Department of Regulatory and Economic Resources
Division of Environmental Resources Management



MIAMI-DADE COUNTY

Executive Summary

Miami-Dade County's location, topography and semi-tropical weather patterns contribute to our generally excellent air quality, abundant supply of freshwater, unique natural habitats, and productive bay and coastal waters. These attributes form the foundation of the quality of life for residents and visitors in Miami-Dade County, and help sustain our economy.

Miami-Dade Department of Regulatory and Economic Resources Division of Environmental Resources Management (DERM) monitoring efforts focus on documenting countywide geographic patterns and long-term trends in air and water quality, and also meet state and federal regulatory requirements for protecting human and ecological health. Hundreds of thousands of observations and analyses of air and water are made each year through these programs. Data from monitoring programs are used to determine what "typical" or "normal" conditions are, identify threats or changes from normal, and target areas or types of contamination that require more investigation, clean up, or changes in regulations. These DERM programs are independent of site-specific monitoring of known contaminated sites or permitted facilities that are monitored by property or business owners in connection with regulatory requirements. In cases where specific monitoring identifies a violation of the standards or documents site contamination, DERM works with facility operators and property owners to see that the violation is corrected and action is taken to protect public health and the environment.

Air, groundwater, and surface water quality in Miami-Dade County are generally good, or superior to conditions found in other major metropolitan areas. However, sensitive systems are vulnerable to pollution, and there are some occasions or locations where countywide monitoring shows that air and water quality does not meet numerical standards for specific types of contaminants or characteristics.

Air Quality

The majority of air emissions in Miami-Dade County are the result of motor vehicle emissions. Despite significant increases in the number of vehicles over the past decade, the County has experienced combined "Good and Moderate" Air Quality Index values approximately 99% of the time. Most of the exceptions during this time period have been attributed to smoke-related issues, such as fireworks displays or wildfires. Miami-Dade County's location, limited number of large industrial facilities, and effective existing federal, state, and local regulations all contribute to its good air quality. Over the years, progressive technology and regulation has contributed to reduction of emissions from both mobile and stationary sources of air pollution.

Groundwater Quality and Drinking Water

Underlying all of South Florida is the Biscayne Aquifer, a shallow, porous limestone formation that has historically provided all urban and agricultural freshwater supply, and is recharged by rain as well as flows from the Everglades and other natural areas. Long-term monitoring of typical groundwater quality and wellfield protection areas has shown that more than 99% of sample results from 2007 to 2012 met numerical standards for human and environmental health. Because ***we live and work over the water we drink***, our freshwater supply is vulnerable to contamination, and vigilance is required to protect it. Monitoring has detected contamination from fuels and solvents in some wellfields, and some private wells have been affected by pesticides used in the past. Additional assessment and treatment was required to track and remove these pollutants. However, the rate of occurrence of new petroleum contamination sites (usually associated with underground fuel tanks) has declined over past decades. Monitoring data indicates that land-use regulations effectively prevent contamination in wellfield protection areas, which have a lower incidence of contaminated sites compared to other areas of the County. Some private and public

water supply wells are at risk of contamination from saltwater intrusion, particularly as sea level rises and the interface between saltwater and freshwater moves landward in some areas of the County.

Surface Water Quality

The majority of the coastal waters in Miami-Dade County are designated by the State of Florida as "Outstanding Florida Waters" and receive the highest level of protection. Monitoring data indicate that most open water sites sampled in Biscayne Bay and other tidal waters currently meet or are superior to federal, state, and local standards for recreational use and healthy fish and wildlife. Compared to other Florida bays and estuaries, Biscayne Bay is characterized by very low concentrations of nutrients (much like the Everglades system) and other contaminants, and has excellent water clarity that supports robust seagrass meadows, economically important fisheries populations and ecologically critical habitats such as coral and mangrove habitats. However, some portions of the Bay, canals and rivers exhibit signs of human impact. Some canal segments in urbanized areas are designated by the State of Florida as impaired, usually for bacterial indicators of sewage pollution, and some portions of Biscayne Bay are affected by excess nutrients, which can lead to algal blooms, reduced water clarity, and other ecological effects.

Conclusions and Strategies for Maintaining and Improving Air and Water Quality

Progressive environmental management programs in Miami-Dade County, in collaboration with state and federal efforts, have helped to maintain or even improve our air and water quality despite significant increases in population. This is largely due to improvements in pollution prevention technology and best practices, air and water quality treatment, land-use and stormwater regulations, and environmental remediation and restoration. Protection of natural resources, such as tree canopy, wetlands, clean soils and aquifer structure, and aquatic vegetation help filter, recycle, or trap nutrients or other potential air and water pollutants. These strategies collectively prevent or reduce the occurrence or magnitude of pollution, compared to the past, and allow for more sustainable growth and development.

Declining support from State and federal partner agencies for environmental monitoring and remediation programs represents a potential risk to the unique air and water resources of the County. Monitoring networks, many of which are jointly funded by county partnerships with State and federal agencies, are vital to the early identification of pollution threats, and thus reduce long term costs of protecting human and environmental health. The County should urge state and federal partners to continue funding these important programs.

Stationary sources of air pollution in Miami-Dade County are effectively managed through operating permits. However, since the majority of air emissions in the County are related to motor vehicle emissions, the County should continue to promote smart transportation planning polices and increased use of mass transit.

Environmental data indicate that the County's wellfield protection areas have much fewer contaminated sites than other portions of the County. However, volatile organic compounds from industrial or commercial operations, which can include solvents such as those associated with dry cleaning operations, remain the greatest threat to our groundwater. The County should continue to implement the Wellfield Protection Program, consider modifications to monitoring requirements for dry cleaners, and continue to urge the Florida Legislature to increase funding allocated from the Inland Protection Trust Fund and the Dry Cleaning Solvent Clean-up Program for the cleanup of sites eligible for state cleanup programs.

Despite the general overall good quality of the air and water resources within Miami-Dade County as indicated by the County's regional monitoring network, site specific data from monitoring conducted at permitted facilities, data collected in response to a complaint, or environmental assessments associated with real estate transactions and redevelopment planning, may identify contaminated groundwater or contaminated soils at certain properties throughout the County, as listed in DERM's Annual Report of

Environmentally Contaminated Sites. Contamination at these sites is typically associated with former less environmentally protective industrial practices, past land use, or accidental spills. In cases where contamination exceeds acceptable thresholds, DERM works with property owners and responsible parties to require corrective action needed to render the site protective of human health and the environment. Exposure to contaminated water from onsite wells or contaminated soils can threaten human health, and individuals may have no knowledge that they are being exposed to unsafe conditions. It is important that the County continue to address site specific contamination when identified, and require property owners to take necessary measures to assure human health and the environment are protected.

Data indicate that saltwater intrusion is migrating inland in southern portions of the County and may threaten drinking water supplies. The County should continue to promote policies that protect the aquifer from salt intrusion. This includes continued acquisition and preservation of wetlands that provide freshwater recharge of the aquifer, prohibiting excavations through coastal areas that can lead to landward movement of the saltwater/freshwater interface, and promoting water management policies that serve to better protect the aquifer from salt intrusion.

The Biscayne Aquifer, the County's sole source of fresh drinking water, is just below our feet. Most citizens probably don't realize that in Miami-Dade County we live and work over the water we drink. While regulation and enforcement are a necessary component of environmental protection, education and outreach can also be an important tool in achieving this goal. Therefore, the County should promote education and outreach to better inform businesses and residents about their connection to our natural resources and the important role we all play in protecting them.

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Introduction

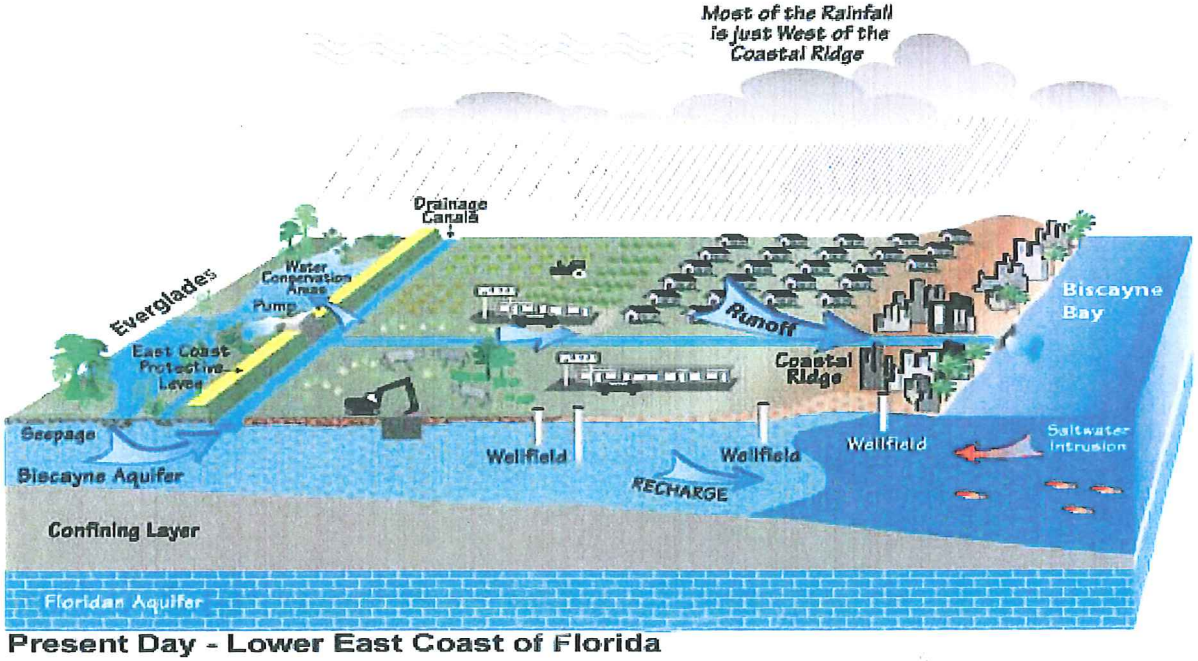
Purpose of Report

The purpose of this report is to provide a summary of the results of long-term air and water quality monitoring programs conducted countywide by Miami-Dade Department of Regulatory and Economic Resources Division of Environmental Resources Management (DERM). The report includes three chapters characterizing typical conditions, current geographic patterns of air quality, groundwater quality, and surface water quality in Miami-Dade, and trends that have been observed over time. The report also describes the history, objectives, and characteristics of each of these major programs.

Background

Miami-Dade County's location, topography and semi-tropical weather patterns contribute to generally excellent air quality, abundant supply of freshwater, and productive coastal waters, all of which form the foundation of quality of life for residents and visitors, a sustainable economy, and healthy natural habitats supporting fish and wildlife. Underlying all of South Florida is the Biscayne Aquifer, a shallow, porous limestone formation that has historically provided all urban and agricultural freshwater supply, and is recharged by rain as well as flows from the Everglades and other natural areas. Miami-Dade County is internationally recognized for its beaches and clean air, and our drinking water is of exceptional quality. Sensitive aquatic ecosystems, including coral reefs, Biscayne Bay and Everglades marshes, are so unique that two National Parks, a National Marine Sanctuary, Florida aquatic preserves and water conservation areas have been established within Miami-Dade, a circumstance that occurs nowhere else in the United States. Yet, Miami-Dade also supports the largest resident population in the State of Florida, and a robust tourist industry. Population has increased from approximately 1.6 million in 1980 to 2.5 million in 2010. Population is projected to increase to almost 2.8 million by 2030. With this growth in population has come increased demand for drinking water, flood protection, services, and land for urban development.

Our wealth of environmental resources provides an advantage, but also requires vigilance to maintain the outstanding natural values that make Miami-Dade a great place to live and visit. Our porous aquifer is especially vulnerable to contamination: we live and work over the water we drink! The aquifer and



Present Day - Lower East Coast of Florida

drinking water supply is also vulnerable to saltwater intrusion, particularly as sea level rises. Human activities on land, including past and present development and water management practices, have impacted groundwater and surface water quality. Pollutants generated by land-based activities can be conveyed to drinking water wellfields, coastal waters and other natural areas by stormwater runoff or other discharges.

General Objectives of Miami-Dade County's Long-term Monitoring Programs

DERM has been involved in air, groundwater, and surface water monitoring activities for decades. These long-term programs have distinct goals and methods, but share some general objectives. All of the programs are organized to characterize countywide, larger-scale patterns and temporal trends in air and water quality, rather than monitor a specific potential source or cause of pollution. Each monitoring program is designed to help determine typical or "background" condition and range of normal variability of air and water quality. This helps managers to determine if healthy conditions are being maintained, or to recognize a potential threat at an early point and thereby prevent permanent or severe impacts to human or ecosystem health. Results can also identify areas or potential pollutants that require more detailed monitoring, restoration or remediation activities, or changes in regulations. The programs are also designed to meet certain regulatory requirements set by federal, state, county and local laws for air, drinking water, and surface water quality. Each program involves collaboration and data-sharing with federal and state resource management agencies, and provides policy makers with science-based information to guide legislative and regulatory decisions.

These monitoring programs provide support and information for other county programs that serve to protect air, ground water and surface water quality as well, such as permitted facility inspection programs and control and minimization of impacts of storm water runoff. DERM's air and water sampling is separate and distinct from mandated monitoring carried out at known contaminated sites, or major industrial facilities that are potential sources of pollution, by private or other public entities. In cases where specific monitoring identifies a violation of the standards or documents site contamination, DERM works with facility operators and property owners to see that the violation is corrected and action is taken to protect public health and the environment.

Air Quality Status and Trends

Air Quality Background and History

Air is composed of many different gases. The mix and amount of gases determine whether ambient air is designated as clean or polluted. Air pollution is the presence in the outdoor atmosphere of pollutants in quantities which are, or may be, harmful to human health or welfare, animal and plant life, or otherwise interfere with the enjoyment of life. Air contaminants such as smoke, dust, dirt, and particulates contribute to air pollution, and can come from both natural and human sources. In Miami-Dade County for example, natural sources include windblown dust and soot generated from brush and wildfires. Manmade sources include motor vehicle exhaust, electric power utilities and industrial fuel combustion, construction and manufacturing operations, as well as a variety of industrial processes that generate smokestack or other miscellaneous emissions.

Exposure to these pollutants may cause adverse health effects, especially to sensitive groups such as young children, the elderly, and individuals with existing respiratory issues or compromised immune systems. Adverse health effects caused by breathing contaminated air can include mild irritation of the respiratory system resulting in coughing and throat soreness. More serious health effects may include reduced lung function or aggravation of asthma and other chronic lung diseases such as emphysema and bronchitis. Over the years, growing national concerns about the health effects of air pollution episodes led to a series of federal government Clean Air Act legislative actions, culminating in the 1990 Clean Air Act Amendments that define today's regulations. The primary reason for development of air regulations is to protect human health, and federal law has established National Ambient Air Quality Standards (NAAQS) for six "criteria" pollutants: ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM_{10} which has a size of 10 microns or less, and $PM_{2.5}$ which has a size of 2.5 microns or less), and lead.

One major consideration is that the United States is a nation of drivers. In fact, within Miami-Dade County the majority of air emissions are the result of motor vehicle emissions. The number of motor vehicles in the County increased at a greater rate than population growth. During the 30-year period starting in 1980, Miami-Dade County's population increased by 65%, although the number of motor vehicles during the same period increased by 127% (from 1.1 million vehicles to 2.5 million vehicles). Despite this growth, the County's good air quality has been maintained, due in large part to proactive rulemaking at the federal level for cutting-edge tailpipe emissions controls on new vehicles, as well as cleaner fuels.

Factors affecting local air quality

The air quality in Miami-Dade County is considered good to excellent when compared to other metropolitan cities of similar size. The County's location, limited number of large industrial facilities, and effective existing federal, state, and local air quality regulations all contribute to maintaining its good air quality. Naturally occurring features of the area, such as being on a peninsula with flat topography and strong Atlantic Ocean breezes help dissipate air pollution. Local businesses, acting as community stakeholders and good neighbors, have reduced air emissions from industrial facilities significantly over the past twenty years through installation of technologically advanced air emission control devices, changes in operating procedures to use less harmful materials, and increased awareness of environmental impacts of doing business.

Air Programs

The County's local air programs began in the 1970s. Chapter 24 of the Miami-Dade County Code (the Code) required that sources of air pollution obtain air operating permits. In the early 1980s, the County entered into an agreement with the State of Florida to conduct inspections at state-regulated sources of air pollution, and in 1995 Miami-Dade DERM received delegation of both the state permitting and the state air compliance programs; this delegation has been renewed every year since. The County also has commitments pertaining to the management of air programs pursuant to a federal grant agreement with the United States Environmental Protection Agency (USEPA).

There are many commercial operations located in the County that generate air pollution during the course of their daily business activities. Such commercial and industrial operations are known as stationary sources of air pollution. Regulation of these facilities is a significant component of the County's overall air pollution control strategy. For example, the Board of County Commissioners adopted a local ordinance in 1986 that led to significant reductions in countywide emissions of sulfur dioxide from combustion sources. The stationary source program has two main components: the permitting and the compliance programs.

The permitting program encompasses approximately 26 major sources of air pollution and over 1,200 minor sources of air pollution. Examples of major sources in Miami-Dade County include, but are not limited to, cement plants, power plants, and surface coating operations. Examples of minor sources include crematories, concrete batch plants, and paint and body shops. The compliance component of the stationary source program involves conducting on-site inspections, reviewing facility records and reports, witnessing stack testing for air emissions, and providing compliance assistance. DERM works with the regulated community to help reduce air emissions. Community outreach is an integral element of compliance assistance activities. In a typical year, DERM conducts approximately 1,500 air-related inspections and observes approximately 90% of stack tests for air emissions conducted within the County.

Our efforts to reach out to industry groups, along with emissions regulations, have resulted in many businesses modernizing their operations. Several have installed more efficient air pollution control equipment, and others have switched to state of the art manufacturing processes. For example, between 1999 and 2006, some painting facilities have opted to use paints and cleaning agents that are formulated to produce less air pollutants, while two cement manufacturing plants have replaced their wet process kilns to more efficient dry process kilns which consume significantly less fuel during operation. Similarly, Florida Power and Light has reduced air emissions and dependence on oil with the installation of several combined cycle power plants that run on natural gas. Figure 1 illustrates a trend of decreasing air pollution from major source facilities since 1995. Over the past ten years there has been a significant decrease in the amount of annual emissions from major air pollution sources in the County, ranging from a high of approximately 32,000 tons in 2003 to just over 10,000 tons in 2011. This decrease can be attributed in part to more stringent federal and state programs for controlling emissions. However, some of this decrease can also be attributed to reduced production at some facilities as a result of the economy, which includes a reduction in operating hours of approximately 60% at several major facilities since 2007.

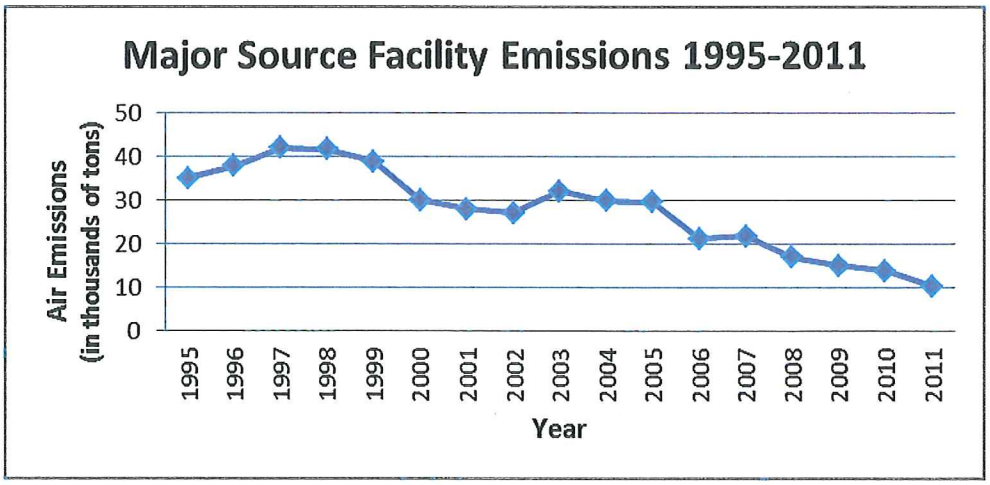


Figure 1. Trend of Decreasing Air Pollution from Major Source Facilties

DERM Air Quality Management staff are actively engaged in transportation planning efforts by reviewing local development projects as well as participating in committee meetings. Efforts include routine evaluation of proposed land use and development projects and consideration of possible strategies in coordination with other organizations to ensure the healthy growth of our community.

DERM is charged with enforcing the federal National Emissions Standards for Hazardous Air Pollutants (NESHAPs) regulations which are designed to prevent the release of asbestos fibers to the ambient air. Although the use of asbestos in buildings has been banned since 1979, there are still approximately 3,500 building products on the market today that contains asbestos. The regulations require that an asbestos survey be conducted before any renovation at any commercial or select multi-unit residential building. DERM reviews all renovation/demolition plans from municipalities and within unincorporated Miami-Dade County to ensure compliance with this requirement and that asbestos fibers are not released into the ambient air. Furthermore, in accordance with federal asbestos regulations, DERM must be notified of all demolition and asbestos abatement projects, and typically inspects these projects to ensure compliance with the regulations. DERM staff also observes the asbestos abatement projects, which are required to be performed under strict engineering controls by a certified asbestos contractor.

Air Monitoring Network Design and Strategy

In April 1964, the Board of County Commissioners passed Chapter 24 of the Code of Miami-Dade County, known as the Environmental Protection Ordinance. Since the 1970s, a comprehensive network of Ambient Air Monitoring sites was established to monitor and measure the concentration of the six criteria pollutants. Lead monitoring in air was eventually discontinued because the pollutant levels fell below detectible limits due mostly to the removal of lead from gasoline. Pursuant to USEPA regulations, Miami-Dade County was designated as "non-attainment" for ozone in 1977, meaning that the County was not meeting the NAAQS for that pollutant. Miami-Dade County was re-designated as "attainment-maintenance" for ozone in 1995, and was granted "full attainment" status in 2005. The EPA also considered designating the County as non-attainment for carbon monoxide during the early 1980s, but did not do so because the County was able to achieve compliance through the help of federally-mandated emissions standards and controls for motor vehicles. It is imperative that the County maintain vigilance through its air programs to ensure that it continues to meet all NAAQS criteria.

Air quality monitoring is currently performed through a network of USEPA- and Florida Department of Environmental Protection (FDEP)-approved stations using state-of-the-art technologies to measure ambient levels of the criteria pollutants. Most air monitoring equipment operates on a continuous basis with the capability of transmitting minute and hourly data to a remote polling computer. A network of 16 air quality monitors at 9 locations within the County collects, processes, and reports approximately 7.5 million minutes of pollutant data per year. It should be noted that the number of monitoring stations currently being maintained by DERM in the County exceeds the federally required minimum.

The general criteria for identifying prospective site locations are based upon the concept of Spatial Scale Representativeness: monitoring air quality in select representative areas and then applying that information to other areas with similar characteristics, and on a larger scale for the County as a whole. It considers characteristics such as types and abundance of facilities in the area surrounding the monitoring site and geographical location.

All in all, the network is designed to meet four basic monitoring objectives listed below:

1. to determine highest concentrations expected to occur in the area covered by the network;
2. to determine representative concentrations in areas of high population density;
3. to determine the impact on ambient pollution levels of significant sources or source categories; and
4. to determine general background concentration levels.

The data collected are used to assess air quality with respect to federal standards, determine air quality trends, and develop policies and programs for controlling emissions from specific stationary and mobile sources. DERM staff calibrates, maintains, and performs quality control checks on the monitors and associated equipment to ensure that all ambient air data is properly compiled, verified, and entered into the State of Florida air quality database. The Air Quality Index (AQI) is reported daily for public dissemination via local media outlets, the USEPA's AIRNow website (www.airnow.gov), or through telephone requests to DERM after 4:00 p.m. on weekdays. The Air Quality Index converts each measured pollutant's concentration in the air to a number on a scale of 0 to 500. An Air Quality Index level of 100 corresponds to a particular pollutant's standard value as established under the Clean Air Act, where an Air Quality Index level of 100 or below means that a pollutant's reading is in the satisfactory range. Table 1 below illustrates the Air Quality Index categories and their corresponding ranges.

Air Quality Category	AQI Value Range
Good	0 to 50
Moderate	51 to 100
Unhealthy for Sensitive Groups	101 to 150
Unhealthy	151 to 200
Very Unhealthy	201 to 300
Hazardous	301 to 500

Table 1. Air Quality Category and corresponding Air Quality Index Value Range

Air Quality Data Trends

For every year since 2004, Miami-Dade County has experienced combined Good and Moderate Air Quality Index values approximately 99% of the time. Most of the exceptions during this time period have been attributed to smoke-related issues, such as fireworks displays or wildfires. Figure 2 below indicates the percentage of Good, Moderate, and Unhealthy for Sensitive Groups days for calendar years 2004 through 2012. As shown below, each year reported one or two "Unhealthy for Sensitive Groups" days, with a high of five days in 2008 and a low of zero days in 2005.

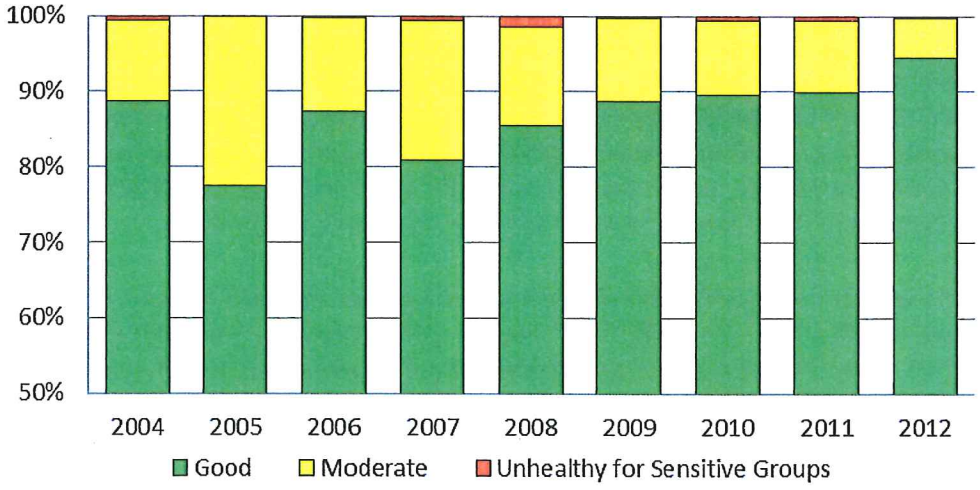


Figure 2. Percentage of Air Quality Index Days per Year

The map below (Figure 3) includes the location of the air permitted facilities as well as the monitoring sites in Miami-Dade County.

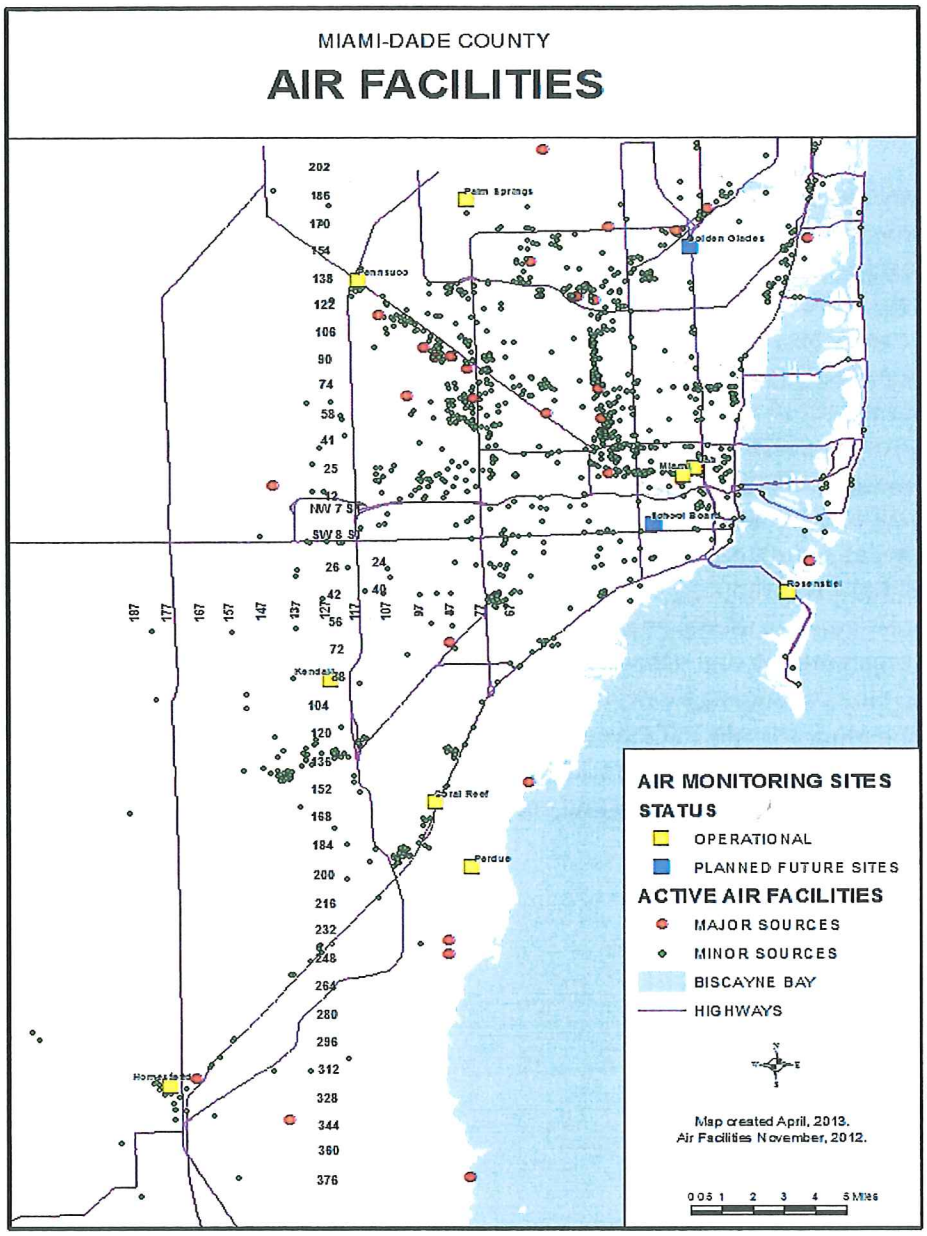


Figure 3. Map of Air Monitoring Sites and Air Facilities

Air Quality Improvement Measures and Outlook

In order for continued improvements to the air quality of the County, existing programs need to be maintained. Miami-Dade County leads by example in promoting the use of clean energy vehicles: the majority of new sedan vehicles purchased by the County for its fleet are hybrid vehicles, and many county-owned garages and buildings contain electric vehicle charging stations. The County also participates in the Southeast Florida Regional Partnership (SFRP), a voluntary collaboration of more than 200 public, private, and civic stakeholders from Miami-Dade, Monroe, Broward, Palm Beach, Martin, St. Lucie, and Indian River counties which is developing the "Seven50," a blueprint for ensuring economic prosperity and the best-

possible quality of life for Southeast Florida over the next 50 years. The partnership seeks greater opportunities for sustained job creation, access to affordable housing, a better menu of transportation options, and more people-friendly and environment-friendly places to live. Miami-Dade County is also a member of the Southeast Florida Regional Climate Change Compact comprised of Broward, Miami-Dade, Monroe, and Palm Beach counties which have partnered together in hopes of mitigating the causes and adapting to the consequences of climate change.

Air Quality Specific Summary/Conclusions

Even as our county continues to grow and expand, we as residents continue to enjoy good air quality. This achievement is made possible through a number of factors: the County is located on a peninsula and has a naturally flat topography; we receive very little if any transport pollution from neighboring areas; our current monitoring sites are strategically placed throughout the County to provide the most accurate representation of county air quality; and we have effective existing federal, state, and local regulations that established industry-specific emissions limits and standards. In a 2008 article, Forbes Magazine identified Miami as No. 1 on their list of the 10 cleanest cities in America by using American Lung Association data to compare rankings for air pollution and ozone levels among all 49 United States metropolitan areas with populations exceeding 1 million. Ultimately, our industry partners play a very important role in our local environment as well as in building the County economy and developing our communities. By working together to implement regulatory and voluntary programs, the amount of air pollution from industrial sectors in our area has been reduced significantly in the past decade. Other opportunities for protecting and improving our air quality include: improving outreach efforts to citizens including presentations to civic and professional organizations and schools to promote green activities such as using mass transit, bike riding, car sharing, etc.; conducting workshops for industry to promote the use of low solvent technology and other environmentally friendly initiatives; expansion of the current mass transit network and replacing old fleet vehicles with hybrid vehicles to reduce air pollution. Through these efforts Miami-Dade County can continue to have superlative air quality and enjoy the benefits that go along with it.

Groundwater Status and Trends

Groundwater Monitoring in Miami-Dade County

The Miami-Dade Water and Sewer Department (WASD) is permitted to provide potable water from 15 wellfields to a projected population of almost 2.8 million persons in the year 2030. As the County's population has grown, so too has our challenge to meet our water supply needs while protecting our water supply from contamination, necessitating a multi-faceted wellfield protection program that includes inspection and regulation of facilities generating hazardous waste, assessment and cleanup of contaminated sites, and ongoing groundwater quality monitoring.

Groundwater monitoring is essential for establishing baseline water quality of the aquifer system, determining trends in groundwater quality and detecting and predicting changes in groundwater quality resulting from the effects of various land use activities and potential sources of contamination. The County maintains a network of groundwater monitoring locations pursuant to regulatory and voluntary programs. The three groundwater quality monitoring programs in Miami-Dade County are the Ambient Monitoring Program, Wellfield Protection Monitoring Program and Saltwater Intrusion Monitoring Program.

The County also obtains information on groundwater quality conditions through data submitted to DERM from compliance groundwater sampling at certain permitted facilities, assessment and remediation groundwater sampling at contaminated sites, and post-closure groundwater sampling related to solid waste facilities. Should site-specific monitoring data provided by regulated facilities indicate an exceedance of a standard or an unsatisfactory trend, then more detailed assessment, corrective actions, or soil or water clean-ups are undertaken through DERM's local or delegated authority.

History of Miami-Dade County Groundwater Monitoring Programs

Groundwater quality monitoring in Miami-Dade County was historically conducted by the United States Geological Survey (USGS) prior to 1980. In 1981, the DERM Ambient Groundwater Monitoring Program was established, and consisted of the sampling of existing USGS wells to determine baseline water quality throughout the County. In 1983, the Water Quality Assurance Act was adopted into Florida Statute 403.063. The law requires the state to establish a groundwater quality monitoring network designed to detect or predict contamination of the groundwater resources of the state. As a result, the Florida Department of Environmental Protection (FDEP) began a statewide effort known as the Ambient Groundwater Monitoring Program and contracted with DERM to collect groundwater samples beginning in 1987. The FDEP-contracted groundwater monitoring was discontinued in 1999; however, the DERM Ambient Groundwater Monitoring Program, consisting of the monitoring of 47 monitoring wells, continues to this day.

DERM also conducts routine groundwater quality sampling of a network of monitoring wells (135 total) within the draw-down areas of major county wellfields as illustrated by Figures 4 and 5. The monitoring wells are located between the wellheads and potential pollutant sources to detect any contaminants migrating towards the production wellheads, thereby serving as an early warning system for contamination that could threaten the County's water supply wells.

Wellfield water quality monitoring is mandated as a condition of the County's current 20-year South Florida Water Management District Water Use Permit. The Northwest Wellfield's monitoring includes additional monitoring within the rock mining areas for the purpose of testing for bacteria and pathogens, based on the potential for surface water (lakes created from mining) to influence groundwater.

Saltwater intrusion is monitored through a joint effort by WASD, DERM and the USGS. A network of monitoring wells drilled to the base of the aquifer are installed and sampled by USGS under a cooperative contract to identify the location of the saltwater intrusion front, identify any significant movement of the salt front, and map its location.

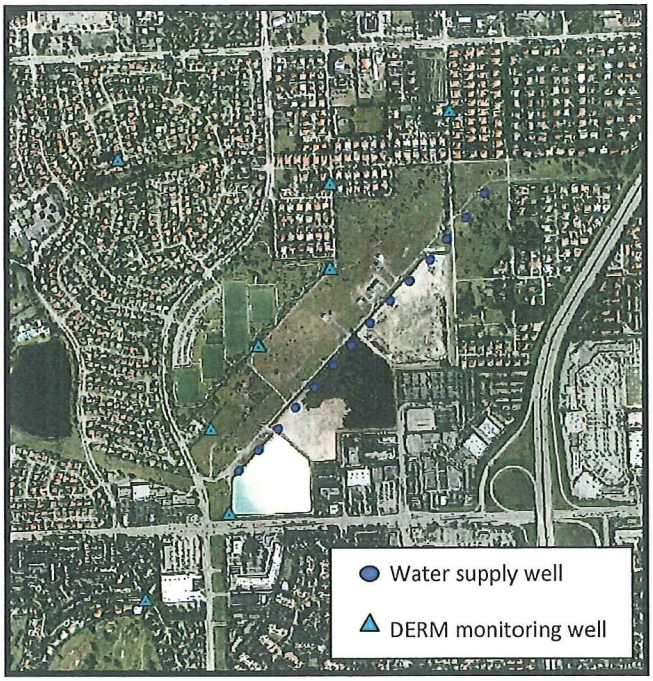


Figure 4. Southwest Wellfield

Groundwater Monitoring Program Design and Strategy

Ambient Groundwater Monitoring Program monitoring well locations were selected based on countywide hydrogeological characteristics, land use, potential sources of contamination and historical water quality data. The location of Wellfield Program monitoring wells was based on travel time for water to flow through the aquifer and reach the well or wellfield, groundwater flow paths and potential contaminant sources (e.g., landfills, rock mining areas, industrial facilities, etc.). Figure 5 illustrates the location of all monitoring wells DERM currently samples. Monitoring wells comprising the saltwater intrusion monitoring network are installed in locations appropriate to monitor salt line movement.

Throughout the course of DERM's monitoring efforts, field methods for groundwater sample collection have changed as procedures for obtaining representative groundwater samples have evolved. Currently, DERM's groundwater sampling methods adhere to the FDEP's Standard Operating Procedures for Field Activities, effective December 3, 2008. Groundwater sample results are quality-control checked by the DERM Laboratory and undergo secondary validation by DERM staff.

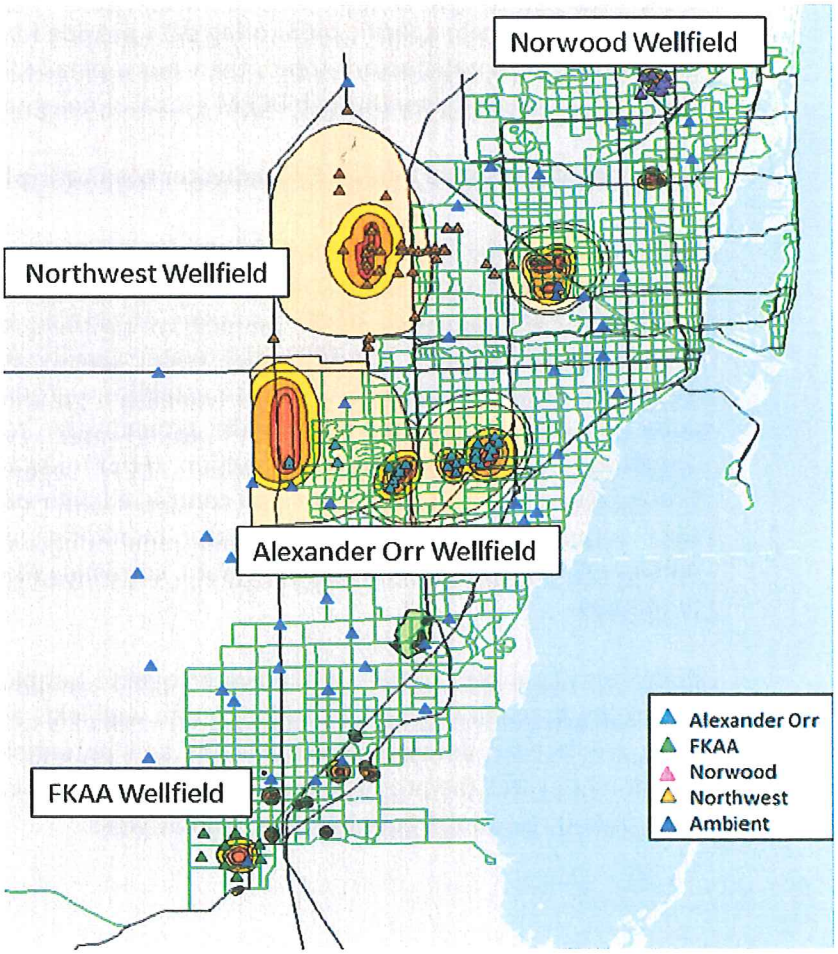


Figure 5. Map of wellfield protection areas and groundwater sampling

Ambient Program monitoring is conducted biannually, coinciding with the wet and dry seasons, and the Wellfield Program network wells are sampled three times a year, with the exception of FKAA which is sampled twice a year. For the Ambient and Wellfield Monitoring Programs, a comprehensive set of field and chemical parameters is analyzed. Monitoring within the Lake Belt area is conducted quarterly and includes analysis for *Giardia*, *Cryptosporidium*, bacteria and microscopic particulates. Appendix 1-1 indicates the parameters analyzed for the Ambient Program, the Wellfield Program and/or the Lake Belt area sampling.

Role of Local, State and Federal Groundwater Quality Criteria

The United States Environmental Protection Agency's (USEPA) National Primary Drinking Water Regulations (or primary standards) are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. In Florida the groundwater standards are equivalent to the drinking water standards. Chapter 24 of the Code of Miami-Dade County, has established potable water standards and groundwater Cleanup Target Levels, which are equivalent to national and state standards, to protect human health and aquatic life and prevent nuisance conditions.

Miami-Dade County Groundwater Data Results and Trends (2007-2012)

This report evaluates the results of 434,160 analyses for contaminants that were made as part of Ambient and Wellfield Protection Area groundwater monitoring activities conducted by the County from 2007 to 2012. The contaminants detected, and the number of results that exceeded standards, are indicated in Appendix 1-2. The percentage of total sample results exceeding standards from 2007 to 2012 has remained at or below 1 percent, as illustrated in Figure 6 below.

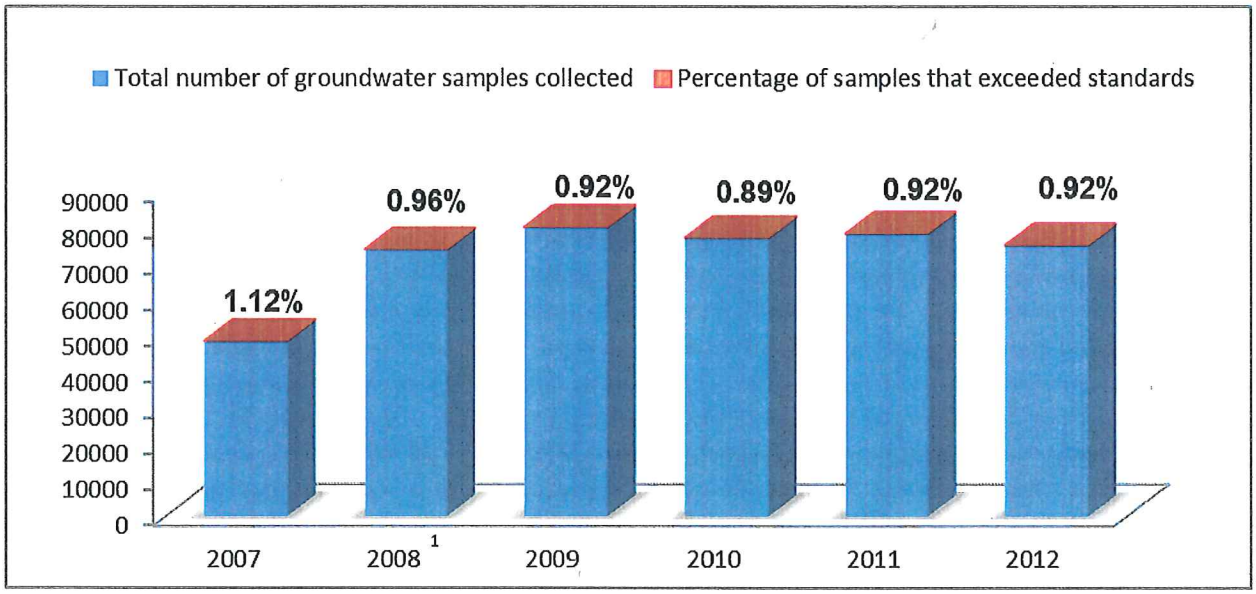


Figure 6. Number of analyses of groundwater samples and % of results exceeding standards

1. Sampling for the Norwood Wellfield contamination began in 2008, resulting in an increase in total samples collected.

Common constituents in groundwater, originating from the rocks and minerals the groundwater comes in contact with, include calcium, chloride, fluoride, magnesium, potassium, sodium and sulfate. The median values for these constituents in groundwater in Miami-Dade County between 2007 and 2012 were generally similar to previously reported historic values in the Biscayne Aquifer and therefore no degradation of groundwater quality for these parameters has been observed.

Apparent Color and Total Dissolved Solids are not considered primary pollutants with associated health effects, but rather serve as indications of the aesthetic characteristics of drinking water. The number of county samples exceeding Apparent Color standards was generally consistent from 2007 to 2012. The median values for Total Dissolved Solids were similar to the median value reported for the Biscayne Aquifer in 1987.

Nutrients such as phosphorus and nitrogen are naturally occurring in groundwater, however agriculture, landfills and sources of domestic waste can contribute to elevated levels which can harm the environment and human health. Concentrations of nutrients in the Biscayne Aquifer (i.e., ammonia, nitrate-nitrite and total phosphorus) are generally low. The few sample results that exceeded standards (4 of 488 ammonia samples in 2012) are located near agricultural lands, wetlands, or sources of domestic waste (i.e., septic tank systems).

Over one hundred different pesticides, herbicides and insecticides were analyzed by the County during the 2007 to 2012 monitoring period. Only the chemical insecticide Dieldrin has been found at levels exceeding standards (in less than or equal to 2.3% of total samples analyzed during the monitoring period). Dieldrin has also been found in private drinking water wells in the County. Dieldrin was originally produced in 1948 and was extensively used between the 1950s and 1970s for soil and seed treatment, mosquito control and for termite treatment until it was banned from agricultural use in 1974 and banned from all other uses in 1987. Dieldrin's use for termite control is suspected as the source of documented impacts to private drinking water wells in the County. To address the Dieldrin contamination of private drinking water wells, DERM created an inventory of residential properties served by private wells and this database was provided to the Florida Department of Health (FDOH). In November of 2010, FDOH distributed information pamphlets to county residents who use private drinking water wells advising them of the need for well water testing and available testing programs. In the event that private drinking water wells are contaminated, affected citizens are directed to FDEP, which provides assistance with the necessary filtration system. In some cases where feasible, county water service lines have been extended to supply affected properties with a clean drinking water source.

Volatile Organic Compounds (VOCs) are organic compounds which may occur naturally in the environment or occur only as a result of human-related activities. VOCs are used and produced in the manufacture of paints, adhesives, petroleum products, pharmaceuticals, and refrigerants. They are often compounds of fuels, solvents, hydraulic fluids, paint thinners, and dry cleaning fluids. VOCs are a contaminant of concern in groundwater because some are persistent, have the potential to migrate to drinking-water wells, and many are toxic and are known or suspected human carcinogens. The VOC with the highest percentage of total detections (ranging from 1.6% to 6.1% of total samples) during the 2007 through 2012 monitoring period was vinyl chloride. The vinyl chloride detections were predominantly documented in the area of the Norwood Wellfield, which along with the Hialeah/Preston/Miami Springs Wellfields, is contaminated with low levels of VOCs from dry cleaners and other industrial sources. After vinyl chloride was detected in the Norwood Wellfield production wells in 2006, several production wells were taken out of service. In March 2008, DERM and the FDOH approved a corrective action plan involving the use of air stripping technology to address the VOC contamination in the Norwood Wellfield production wells. The treatment system has been in operation since May of 2008. The Hialeah/Preston/Miami Springs Wellfields were shut down in 1982 and a treatment system was developed with funding assistance from the US EPA. Use of air stripping towers beginning in 1992 allowed the Hialeah/Preston/Miami Springs Wellfields to resume operation.

In 2012, the chemical trichloroethene was identified at levels exceeding its standard in two adjacent monitoring wells located within the draw-down area of the Alexander Orr Wellfield in southwest Miami-Dade County. Trichloroethene is commonly used as a solvent and degreaser. While the source of the trichloroethene in the two wells is unknown, a spill of the chemical to the ground or dumping into a storm

drain is suspected. WASD has increased its sampling of the Alexander Orr supply wells for this contaminant and to date, trichloroethene has not been detected in any Alexander Orr production well water samples. The drinking water supply has not been impacted by the trichloroethene contamination; however, to ensure the continued safety of the water supply, DERM is conducting remediation of the contaminant plume.

The percentage of sample results that exceeded standards for iron ranged from 39% to 49% between 2007 and 2012. While high iron levels may be a result of the monitoring well's metal casings, iron levels above standards were also documented in wells constructed of polyvinyl chloride, with higher concentrations at depth. The 2005 DERM report *Background Concentrations of Iron in Groundwater in Miami-Dade County*, identified a mean concentration of 706 µg/L for iron in groundwater, higher than the Chapter 24 and USEPA standard (300 µg/L) which is based on cosmetic or aesthetic considerations (FDEP's health-based standard for iron is 4200 µg/L). The widespread and consistent occurrence of high iron levels from 1983 to present is suggestive of a natural background origin.

Arsenic is a natural constituent of soils in the County and may also be attributed to human activities, including the use of arsenic-containing insecticides, pesticides and herbicides, wood preservation, mining activities, metal refining processes and the burning of fossil fuels. A 2002 investigation by DERM *(Environmental Quality Monitoring at Five Municipal Golf Courses in Miami-Dade County)* demonstrated the impact of arsenic-containing herbicides used for turf maintenance on soil and groundwater beneath golf courses in the County. However, the percentage of groundwater samples that exceeded the arsenic standard between 2007 and 2012 remained at or below 2 percent with no discernible trends over time. WASD's 2012 Water Quality Report identified arsenic results of not detectable or 1 part per billion in the drinking water, well below the maximum health related contaminant level of 10 parts per billion. The only Miami-Dade County wellfield monitoring well that exceeded arsenic standards in 2012 is located in the Newton Wellfield, where past agricultural activities are suspected as the source of the elevated arsenic. WASD and DERM are currently addressing the arsenic contamination in the Newton wellfield monitoring well. The drinking water supply has not been impacted by the arsenic contamination.

Total and fecal coliform bacteria are routinely tested in the groundwater in Miami-Dade County. Coliform bacteria are considered "indicator organisms"; their presence warns of the potential presence of other bacteria, viruses, or disease causing organisms. Sources of total and fecal coliform in groundwater can include agricultural runoff, effluent from septic systems or sewage discharges, and infiltration of domestic or wild animal fecal matter. Total coliform includes fecal coliform bacteria such as *Escherichia coli* (*E. coli*), as well as other types of coliform bacteria that are naturally found in the soil. Fifty-nine percent of the wells with two or more consecutive total coliform detections in 2011 and 2012 are located in areas not served by sanitary sewers, in wetlands with periodic standing water, or near agricultural areas. The remaining monitoring wells with two or more consecutive total coliform detections were either wells equipped with USGS boxes, which have been found to house wildlife that could contribute to higher coliform levels, or wells with flush-to-ground design that have been found to fill with standing water after heavy rains. Poor well maintenance and construction can increase the risk that bacteria in standing water will enter wells.

Giardia lamblia and *Cryptosporidium parvum* are parasites which are found in surface water and enter the environment through fecal contamination such as sewage or animal waste. If they make their way into our drinking water supply, which can occur when a water supply well is located close enough to surface water such that it receives direct surface-water recharge, these parasites can cause severe intestinal infections and can be a significant health concern. *Cryptosporidium parvum* is of particular concern because of its resistance to chemical disinfection; it has been known to survive the normal chlorination process at drinking water facilities. In 2008, scientists from the USGS concluded that the drinking water from the County's Northwest Wellfield was at risk of contamination due to the close proximity of existing lakes created from limestone rock mining activities. In the Lake Belt area of the Northwest Wellfield, the County

tests the groundwater (and certain surface water locations) for *Giardia* and *Cryptosporidium*, along with microscopic particulate analysis, which identifies organisms that occur in surface water. Since the inception of groundwater monitoring by DERM for these parasites in 1999, no *Giardia* cysts or *Cryptosporidium* oocysts have been detected in the County's groundwater samples.

Inland movement of sea water in Miami-Dade County began in the 1920s and 1930s when canals were constructed that lowered groundwater levels and water supply withdrawals increased. Some water supply wells near the coast had to be abandoned. Since that time, efforts have been made (i.e., installation of salinity control structures in canals, routing additional water to the County, etc.) to prevent inland saltwater flow. The County has contracted with USGS for data collection relating to groundwater elevations and saltwater intrusion since at least the 1950s. WASD and DERM fund the USGS's operation and maintenance of 90 water level recording stations and 74 saltwater monitoring stations. Chloride sampling is done monthly, quarterly or annually depending on location and induction logs are collected annually for select wells. The inland extent of the saltwater interface at the base of the Biscayne aquifer in 2005 versus 2011 can be seen in Figure 7. All 10 wells east of the salt front from the Broward County line to the C-2 Canal have been showing an increasing trend in chloride concentration, which indicates a regional cause for the movement rather than localized well withdrawals.

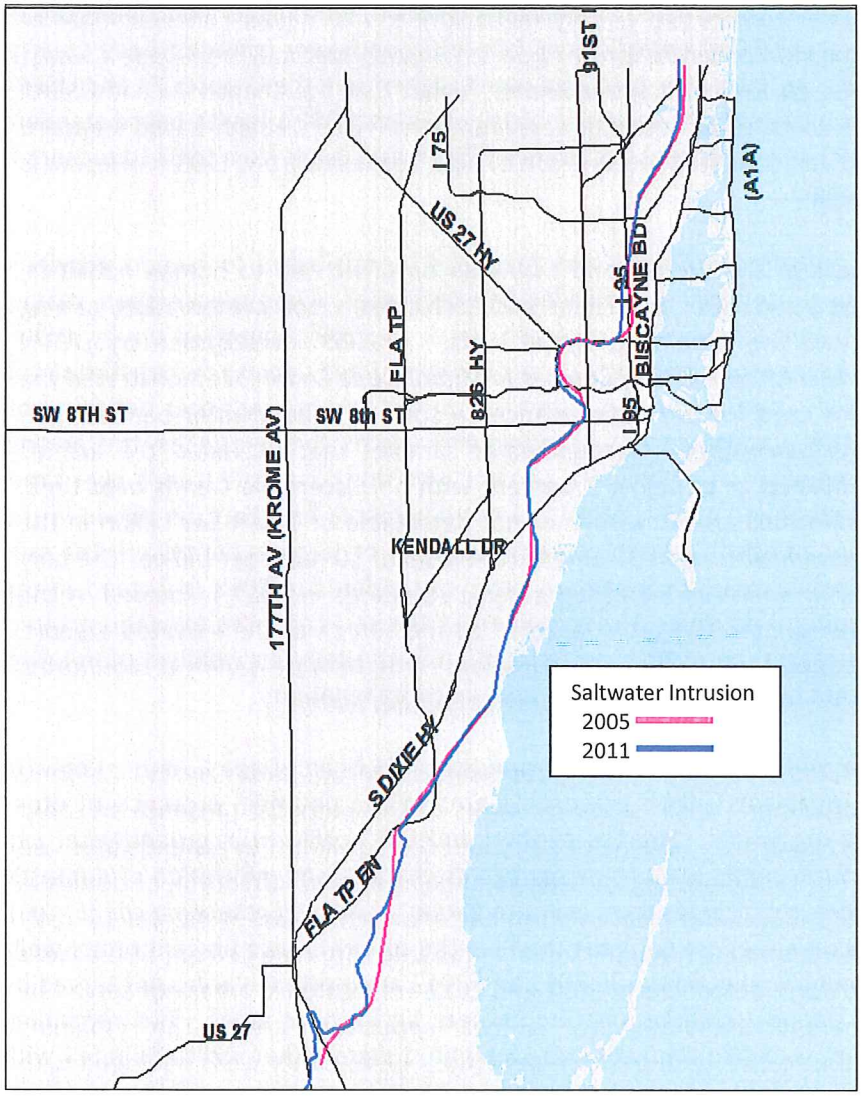


Figure 7. Extent of Saltwater Intrusion at base of the aquifer

Contaminated Sites Evaluation

DERM groundwater monitoring results indicate minimal changes in Biscayne Aquifer water quality between 2007 through 2012. However, as demonstrated at the Hialeah/Preston/Miami Springs and Norwood Wellfields, contamination can compromise our water supply and result in costly groundwater treatment. Despite the growth that has occurred in the County over the years, the number of new contamination discharges reported annually has decreased over time. In fact, as indicated in Figure 8, 2012 had the lowest number of newly reported petroleum contamination discharges in Miami-Dade County since 1996 (14 discharges in 2012 versus 131 in 1996). State laws requiring underground storage tank upgrades largely contributed to this decrease.

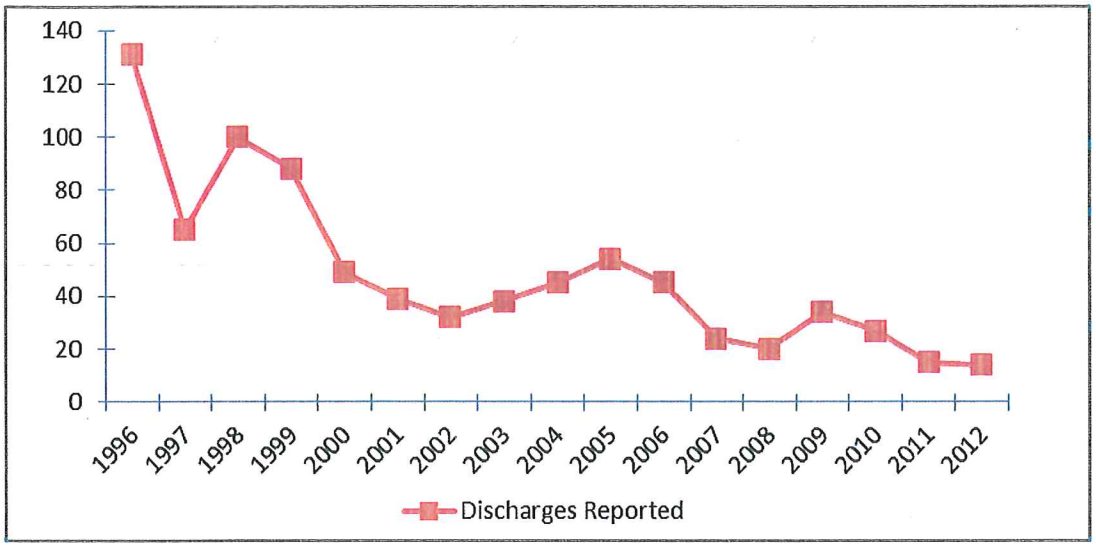


Figure 8. New Petroleum Discharges Reported

The density of contaminated sites within wellfield protection areas over time has consistently been lower than in other areas of the County, as shown in Table 2 below, largely due to land use regulations, restrictions within the wellfield protection areas and inspections by DERM of industrial sites. The lower density of contaminated sites within wellfield protection areas demonstrates the success of county efforts to protect our wellfields from contamination.

	2001	2002	2007	2008	2009	2010	2011	2012
Wellfield Protection Areas (WPAs)	1.6	1.5	1.3	1.3	1.2	1.2	1.2	1.2
Miami-Dade County (excluding the WPAs)	6.5	6.6	6.3	6.3	6	6.2	6.3	6

Table 2. Density of Contaminated Sites (number per square mile)

Recommendations for Improving Groundwater Quality

While progress has been made in preventing contamination, the existence of 2,129 open contaminated sites requiring cleanup in the County continues to pose a risk to our water supply. Of the 2,129 open contaminated sites in Miami-Dade County, 64% are in one of two state-funded cleanup programs: the Inland Protection Trust Fund (IPTF) Program and the Dry Cleaning Solvent Cleanup Program, both created by the Florida Legislature to fund the cleanup of petroleum and dry cleaner sites, respectively. The FDEP administers cleanup of program sites on a priority basis and currently 58% of petroleum contaminated sites, and 85% of dry cleaner contaminated sites are inactive due to limited funding. In 2012, none of the 182 contaminated dry cleaner program sites in the County received site closure for cleanup, and only 5 have received closure since 2007. Higher prioritization at the legislative level should be given to increasing funding for the cleanup of sites eligible for state cleanup programs. At the local level, the County can increase its investigation and assessment of inactive contaminated sites within wellfield protection areas and request emergency cleanup funding from FDEP if migration of the contamination is discovered.

The most significant threat to our groundwater (with respect to human health, persistence and movement in groundwater, and remediation costs) is volatile organic compound (VOC) contamination from

commercial/industrial sites, including dry cleaners. Dry cleaner solvent contamination resulted in the temporary shut-down of the Hialeah/Preston/Miami Springs and Norwood Wellfields. Currently there is no regulatory requirement in the County for dry cleaners to monitor the groundwater below their site or have a monitoring well available for routine sampling by DERM. Further evaluation and discussion on modifications to the County's Environmental Protection Ordinance with respect to operating requirements for dry cleaner facilities is recommended.

To account for changes in the County's groundwater use (including alternative water supplies and water reuse), underground wastewater disposal and factors such as the effect of climate variability on water levels and saltwater intrusion, the County's monitoring network will require ongoing evaluation, and as needed, modification, with respect to vertical and horizontal spatial density, frequency of data collection and analyses sampled (to include new or emerging threats, such as pharmaceuticals and other chemicals). Additionally, based on the interaction between surface water and groundwater in certain areas of the County, greater integration of the County's groundwater monitoring network with its surface water monitoring network can improve our ability to identify the causes and sources of impairment and threats.

The construction and integrity of the monitoring wells in DERM's network, some of which are deteriorating due to age, require evaluation. Replacement of monitoring wells is required to prevent improperly constructed wells from causing contamination (i.e., acting as a conduit for the migration of contaminants from the surface) and to ensure that water samples accurately reflect the chemical composition of the groundwater.

Efforts to educate homeowners and businesses on means to prevent contamination, including how to properly apply agricultural or landscape maintenance chemicals and implement best management practices for those that handle or store hazardous wastes, should continue and/or expand for protection of our groundwater quality.

Improperly used or operated septic systems and failing sewer infrastructure can contaminate the groundwater and lead to waterborne disease outbreaks and other adverse health effects. Therefore, upgrades to sewer infrastructure along with municipal regulations governing septic tank installations, ensuring adequate septic tank operation and maintenance and/or replacing septic systems with sewer systems, can further protect our water supply.

Chloride data collected by the USGS has revealed that the salt front at the base of the Biscayne Aquifer in South Miami-Dade County is migrating westward, potentially threatening the drinking water supply for the Florida Keys and the Cities of Homestead and Florida City. Continued USGS saltwater intrusion monitoring and modeling will assist in assessing future impacts on our water resources while local projects, implementation of the Comprehensive Everglades Restoration Plan (CERP) and improved water management practices and mitigation will help restore more natural freshwater flows and periods of inundation in an attempt to reduce salt intrusion in the underlying portions of the aquifer. The County should continue to promote policies that protect the aquifer from saltwater intrusion. This includes continued acquisition and preservation of wetlands that provide freshwater recharge of the aquifer, prohibiting excavations in coastal areas that can lead to landward movement of the saltwater/freshwater interface, and promoting water management policies that serve to protect the aquifer. Through its partnership with Monroe, Broward and Palm Beach Counties in the Southeast Florida Regional Climate Change Compact (executed in January 2010), the County can continue its efforts to plan and prepare for climate change, and its effects on saltwater intrusion.

Background

Miami-Dade County's Biscayne Bay Surface Water Quality Monitoring Program (BBWQMP) was initiated in 1979 in partnership with the State of Florida, to gain a better understanding of the condition of Biscayne Bay, and to support restoration and other initiatives described in the County's Biscayne Bay Management Plan, completed in 1981. The water quality program initially had 47 sampling stations within Biscayne Bay. By 1992, surface water monitoring activities expanded to include tributaries and the major canals discharging to the bay with a consistent and integrated sampling scheme. The program has been reviewed and optimized multiple times over its 34 year history, and presently evaluates surface water quality at 117 locations throughout the County (71 stations within Biscayne Bay and its tributaries, and 46 stations in the major canal systems (Figure 9).

The BBWQMP supports multiple management and regulatory programs, initiatives and requirements. The Biscayne Bay system includes state Aquatic Preserves, a National Park, and a National Marine Sanctuary, and thus is designated an "Outstanding Florida Water" by the State of Florida, receiving the highest levels of protection. The general management goal for Biscayne Bay has been to maintain or improve its excellent water quality. The Florida Legislature designated Biscayne Bay a "Priority Water Body" and the South Florida Water Management District developed and adopted the "Biscayne Bay Surface Water Improvement Management (SWIM) Plan". Based upon mutual interests of improving and protecting Biscayne Bay, the State of Florida, primarily through the SFWMD, has partnered with the County in supporting the surface water quality program. Water quality in all surface water is highly variable, and can be affected by a combination of natural factors, including geography, weather patterns, tides, or season, and human-related actions. Therefore, one priority objective of the BBWQMP is to describe typical or "background" water quality characteristics, considering normal variations, so as to allow recognition of a condition that is atypical or perhaps related to an extreme event or pollutant impact. Other objectives are to detect large scale patterns and long term trends, describe general effects of canal

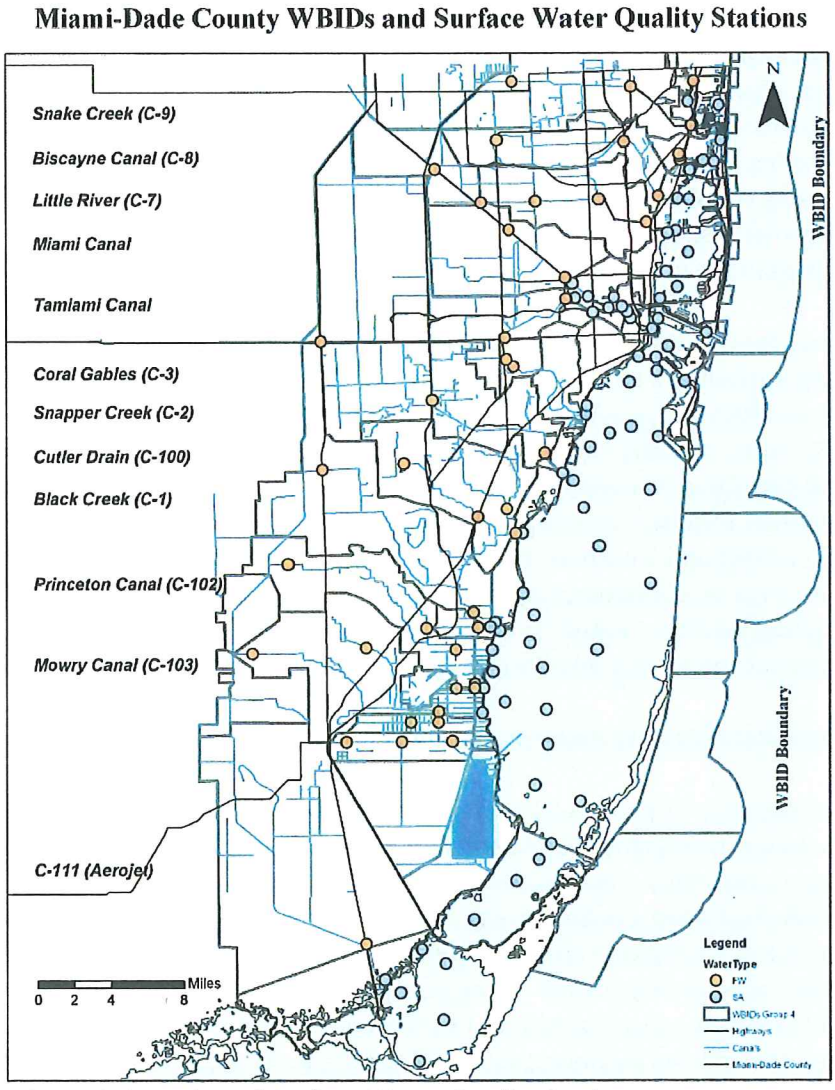


Figure 9. Location of Surface Water Quality Stations

discharge, and fulfill specific requirements of the County's and municipal co-permittees' federally-mandated NPDES (National Pollution Discharge Elimination System) and MS-4 (Municipal Separate Storm Sewer System) permits. The combination of these objectives has resulted in an information resource that documents excellent water quality in the Bay, links land uses with some types of water quality impacts, and targets areas in need of ecological restoration, infrastructure improvements, or more detailed monitoring to identify sources of pollution. The large data set was instrumental in recent establishment of protective surface water quality criteria for nutrients in Biscayne Bay.

Monitoring Network and Design

Miami-Dade's BBWQMP is a countywide, "ambient" (i.e. background or normal condition) monitoring program, with regularly scheduled monthly sampling. The network of sampling stations employs a watershed and basin approach, including sampling sites in major canals and the adjoining downstream sections of the Bay and adjacent coastal water bodies. This sampling network has been recently incorporated into the State of Florida's "Water Body Identification" basins, to develop its listing of impaired waters, a statutory requirement related to the U.S. Clean Water Act. The major canals reflect water quality in each basin, as they receive flows from secondary canals, overland runoff, and groundwater seepage. Monitoring the major drainage canals along with Biscayne Bay waters allows for assessment of the prevailing conditions and typical range of variation in the tributaries and the Bay, potential effects of the waters that discharge into the Bay, and patterns in water quality that may be related to canal operations, land uses in the watershed, or tropical storms and other natural events.

During monthly visits to the monitoring locations, data and samples are collected to assess various water quality attributes and chemical conditions. Presently the BBWQMP evaluates 240 specific parameters or characteristics (Appendix 2-1). These include commonly measured characteristics such as temperature, acidity (pH), salinity, and dissolved oxygen (DO) concentration, as well as parameters that indicate ecological status or contaminants that are potentially harmful or toxic to plants, animals or people. The parameters include the amount of nutrients in the water, chlorophyll-a (an indicator of algal blooms and thus a reflection of nutrient balance), water clarity measures, various toxicants and contaminants (heavy metals, organic contaminants), and human health indicators (bacterial concentrations). Extensive Quality Assurance/Quality Control procedures and guidance documents have been established and utilized throughout the sample and data collection, analysis, summarization, and report phases.

Surface Water Quality Patterns and Historic Trends

Past development practices (such as extensive dredging and filling of tidal waters and wetlands or lack of stormwater management or wastewater treatment infrastructure) and drainage in the watershed damaged Biscayne Bay many decades ago. Past construction of flood control canals, causeways, artificial islands, seawalls, and deep dredged areas resulted in the loss of wetland and seagrass communities and altered physical and biological water quality characteristics in Biscayne Bay. Naturally vegetated shorelines and bottom habitats help absorb wave energy and stabilize sediments, whereas seawalls reflect wave energy and boat wakes which contribute to shoreline erosion and suspension of silt and mud. North Biscayne Bay was most impacted by these past development practices, and has relatively poorer water clarity than south Biscayne Bay. However, surface water quality has improved over the past 30 years even though population has continued to increase. This is largely due to improved sewer and drainage infrastructure, parks and preserves, limitations on dredging and filling, pollution control and restoration initiatives. In the mid-1950s, centralized sewage treatment plants were constructed, and permitted discharge of effluent to the canals or any part of Biscayne Bay was discontinued. Additionally, there are no major direct discharges of industrial pollutants permitted to any surface water body in Miami-Dade County. In the present day, most pollution that reaches surface water originates from upland use or discharges, and is conveyed to canals and coastal waters by stormwater runoff or groundwater flows.

Most open water sites sampled in Biscayne Bay currently meet or are superior to federal, state, and local water quality standards for recreational use and healthy fish and wildlife. Compared to other Florida bays and estuaries, Biscayne Bay is characterized by very low concentrations of nutrients (much like the Everglades system) and other contaminants, and has excellent water clarity that supports robust seagrass meadows, economically important fisheries populations and ecologically critical habitats such as coral, mangrove and hard bottom habitats. However, some portions of the Bay and some tributaries still exhibit signs of human impact.

Compared to open coastal waters, canals and rivers typically have lower dissolved oxygen, poorer clarity, and higher concentrations of nutrients and contaminants than the receiving waters in the Bay. Canals in urbanized areas often do not meet standards for human recreational contact, due to chronically elevated concentrations of bacterial indicators of sewage pollution. Potential sources of bacterial indicators include aging sanitary sewer infrastructure, areas with septic tanks instead of sewers, animal waste, or decomposing organic matter in soils. Some tributaries also exhibit elevated concentrations of nutrients, particularly phosphorus or nitrogen compounds, which act as fertilizers and may trigger excessive growth of algae or aquatic weeds. Sources of nutrients include fertilizers that may be applied in agriculture areas or

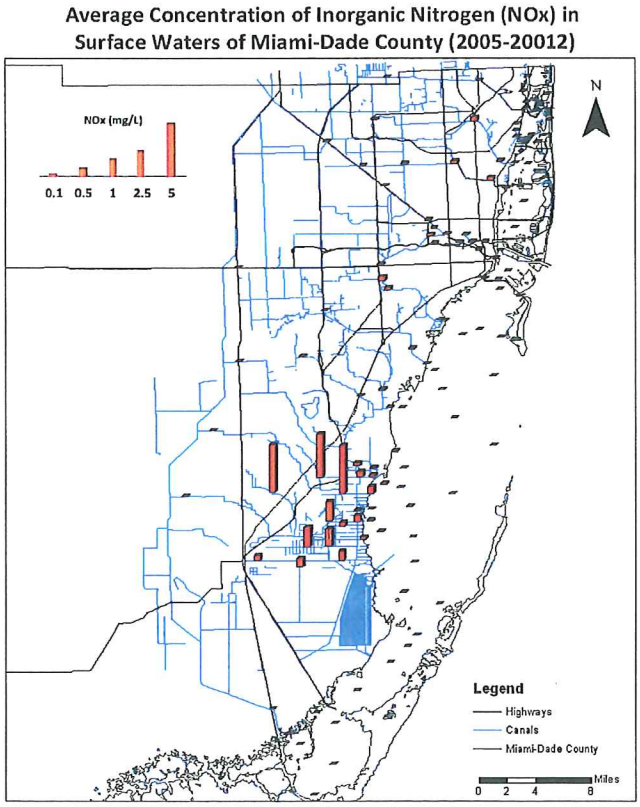


Figure 10. Concentration of inorganic nitrogen in surface waters of Miami-Dade. The highest levels occur in south Miami-Dade agricultural regions.

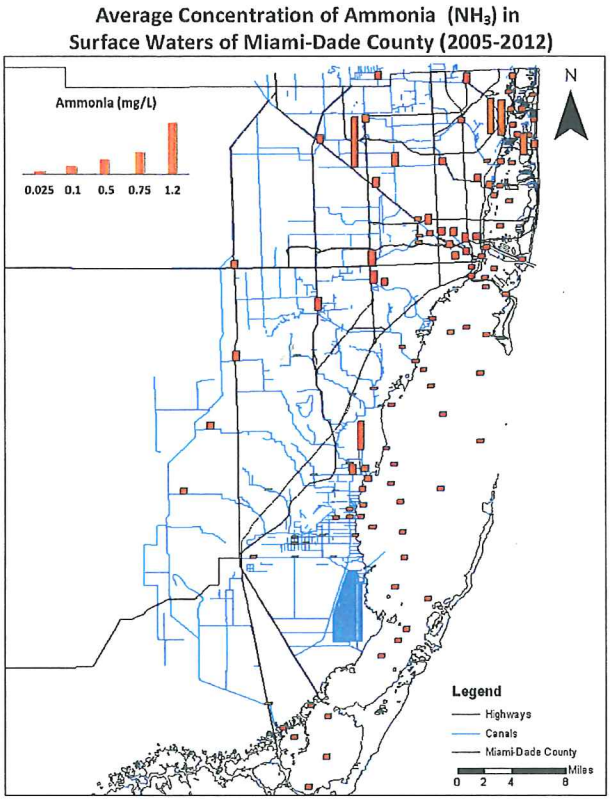
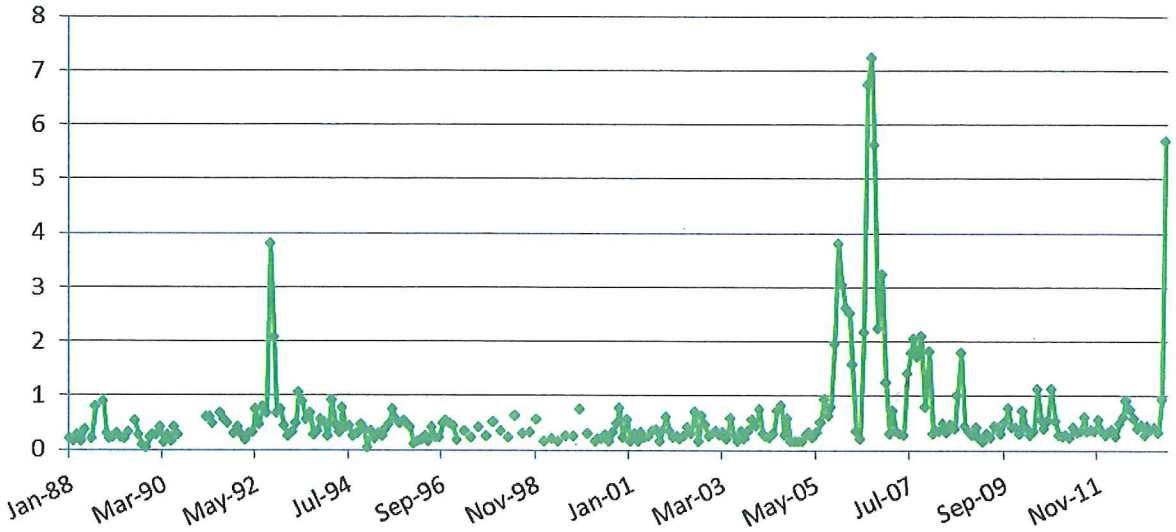


Figure 11. Concentration of ammonia nitrogen in surface waters of Miami-Dade. The highest levels occur in regions adjacent to landfills.

urban landscaping and be conveyed via stormwater runoff, sewage (again from failing infrastructure or septic tanks) or leaking landfills. For example, canals that drain areas with agricultural land uses exhibit highest concentrations of nitrogen that is associated with fertilizer (Figure 10). Highest concentrations of phosphorus and ammonia typically occur in the most intensely urbanized areas, or locations near landfills (Figure 11). Canal discharge carries the contaminants downstream to Biscayne Bay and other tidal waters, where areas with limited connection to the ocean are most likely to be affected particularly following major rainfall or storm events. Intermittent discharges of large volumes of freshwater to tidal areas also disrupts normal, more stable salinity patterns, which can stress nearshore marine plants and nursery habitats for fish and shellfish.

While water quality generally has met federal, state and local criteria, three recent events highlight the sensitivity of the system to minor perturbations. Algal 'blooms' (algae present in abnormally high abundance) are generally considered to be an indication of degraded conditions in areas where they occur. The first incident began in 2005, following a series of hurricanes, as well as major construction projects along US Hwy. 1 in far south Miami-Dade County. This bloom of microscopic blue-green algae reached unprecedented concentration and duration in southern Biscayne Bay, Card Sound, and Barnes Sound. Chlorophyll-a concentrations remained elevated for three years, and at highest peaks, exceeded "normal" concentrations by a factor of almost 100 times. Reduced water clarity also impacted seagrass, by reducing the amount of light reaching the bay bottom. The bloom was most likely triggered by high concentrations of the nutrient phosphorus in canal discharges, releases from construction sites, and by disturbance of bottom sediments. The second event involves parts of the western shoreline of Biscayne Bay from Vizcaya to Coral Gables, where a dense growth of attached green algae has grown over and killed shallow seagrass beds. Most recently, in June 2013, a bloom dominated by diatoms (a type of microscopic single-celled marine algae) was detected in Card Sound and portions of south Biscayne Bay. By July 2013,

Figure 12. Card Sound Chlorophyll-a (ug/L), January 1988-June 2013



the bloom had spread over large areas of the entire bay. Chlorophyll reached levels 2-50 times higher than have been typically recorded over the past decades. This bloom is still under investigation, and causes are not known, but may be related to unusually high volumes of rain and canal flow early in the rainy season. The bloom events during the last decade are clearly unusual compared to the long term prevailing condition of the Bay, and underscore its sensitivity to both human and natural disturbances.

Surface Water Quality and Florida Impaired Waters Rule

Miami-Dade County, the Florida Department of Environmental Protection (FDEP), and the United States Environmental Protection Agency (USEPA) have established numerical standards or criteria that apply to the fresh and salt surface waters of the County. As an Outstanding Florida Water, Biscayne Bay and adjoining tidal waters are also subject to an FDEP narrative standard, which prohibits permitting of activities that would permanently degrade water quality. This "antidegradation" standard affords the highest level of regulatory protection for surface waters, and is intended to assure that water bodies with water quality far better than numerical standards will not decline to the point of noncompliance. These standards and criteria are codified in the County Code, Florida Administrative Code, and Federal regulations. It is important to note that while the criteria do not include values for every chemical or potential pollutant, criteria are periodically reviewed, and added or revised based on new/updated information. The criteria are based upon scientifically determined characteristics necessary to protect "Human Health and Safety", or associated with the "Protection of Fish and Wildlife".

All surface waters (fresh and salt waters) within the State of Florida are classified as "Class III" waters (unless explicitly designated otherwise in the Florida Administrative Code). These waters carry a "Designated Use" of being suitable for "Fish Consumption, Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife." State of Florida regulatory intent is for all waters to meet their Designated Use. A water body is considered to meet its designated use when it meets all established numeric water quality criteria. If one or more parameters regularly do not meet the criteria, the water body is deemed to not be meeting its designated use, and is declared "impaired".

To determine the compliance status of particular water bodies or segments of water bodies, the FDEP developed a method to evaluate the available surface water quality data against the established criteria. The method is defined in Florida's "Impaired Waters Rule" (62-303 F.A.C.). The State rules take into account that natural events (e.g., tropical storms & hurricanes) can occasionally cause otherwise healthy water bodies not to comply with one or more water quality criteria. Florida regulations require a water body segment to meet the given criteria at least 90% of the time, or it will be declared impaired. The method evaluates the data available from the most recent 7.5 years to determine the frequency that a water body fails to meet all criteria.

The FDEP defined 39 distinct water body segments, called "WBIDs" (Water Body Identifications) in Miami-Dade County and assessed them against numeric criteria. As previously mentioned, although overall surface water quality in the County is good, there are canal segments and portions of Biscayne Bay that do not meet one or more of the established criteria. In 2010, the FDEP evaluated the status of all monitored water body segments in the county, comparing more than 1,900 surface water quality characterizations to criteria. This assessment relied heavily upon DERM's long term water quality data. The parameters that were assessed included measures of biological activity, physical characteristics of the water, heavy metals, human health, and toxicants/contaminants. The "toxicants and contaminants" is the largest category, with over 140 specific compounds tested for throughout the county. The evaluation showed that concentrations of toxicants, organic contaminants and heavy metals complied with, and were actually well below standards or were not detectable in the water body segments. Overall, 98.7% of all the comparisons indicated the waters of Miami-Dade County met established criteria.

Twenty-four of the 1,900 comparisons (1.3%) did not meet water quality standards, and some water body segments were found to be impaired for one or more measures. These were spread across 17 water bodies, involving 13 canal segments and four bay areas. The majority of incidences of non-compliance were for fecal coliform (a bacterial indicator of sewage pollution), noted in 12 canal segments (Figure 13), followed by chlorophyll-a, (an indicator of algal growth and nutrient imbalance) in 4 segments of Biscayne Bay. The canal segments with bacterial impairments are in the heavily developed and urbanized central and eastern portions of the County. As previously noted, aging infrastructure, septic tanks, and animal waste conveyed via stormwater runoff may contribute to these impairments. Identification and reduction of pollution sources has been a county priority for decades. Considerable investment has been made in the infrastructure of the stormwater and sanitary sewer systems.

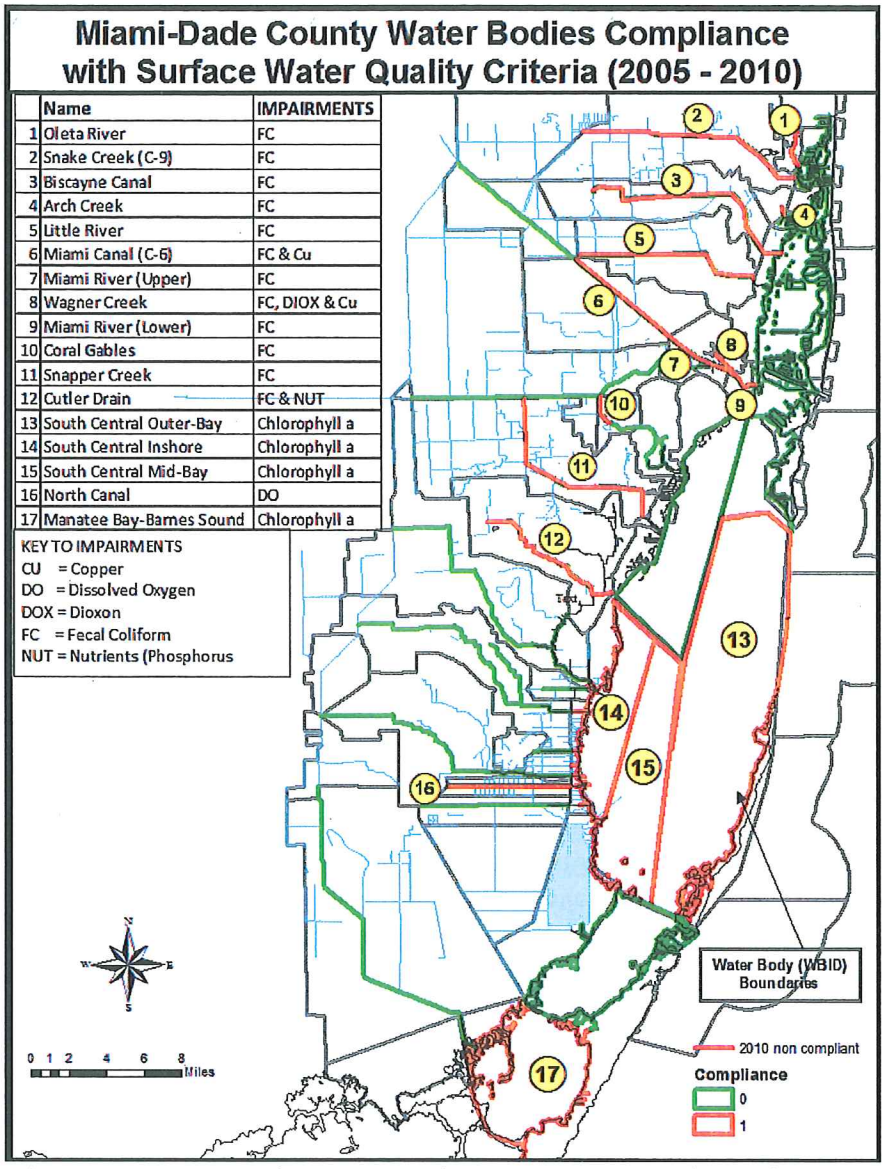


Figure 13. Water Bodies meeting their Designated Use (Green) and those not meeting one or more criteria (Red). Abbreviations: FC=Fecal Coliform: NUT=Nutrients. Cu=Copper: DIOX= Dioxin

The Stormwater Master Plan has identified and implemented stormwater conveyance and water quality improvement projects. These have included expenditures of more than $500 million to install and upgrade 18,000 drainage structures and installation of over 1 million linear feet of drainage piping throughout the County, as well as retrofitting or removal of existing stormwater outfalls to surface water. Additionally, more than $1.8 billion has been expended by WASD between 1995 and 2011 to upgrade and improve the County's sanitary collection and treatment systems. These investments, along with DERM's continuing efforts to insure compliance with environmental codes and habitat restoration projects have resulted in notable improvement in surface water quality within the Miami-Dade County surface waters.

The cumulative benefits of these investments and activities are apparent in the trends over time. It is significant that monitoring has documented stable or improving conditions in the vast majority of measures of surface water quality, despite a more than 60% increase in population over the period that comprehensive monitoring has been conducted. It is especially noteworthy that two of the most chronically polluted water bodies in the County, Miami River and Wagner Creek, have shown dramatic improvement with respect to sewage contamination (Figure 14). The most recent two years of data show the Miami River as being compliant with all surface water quality criteria, and even Wagner Creek has periodically met numeric criteria for fecal coliform bacteria. This represents an 80% decrease in typical fecal coliform concentrations in Wagner Creek over the past five years.

More than two years of additional data has been collected since the completion of the FDEP's 2010 impaired water body evaluation in Miami-Dade County. The decreasing trend in the Miami River and Wagner Creek implies that they may no longer be listed as "impaired" when the FDEP includes new data in future assessments. Improvements over time have been documented in 21 water body segments, which show decreasing concentrations of fecal coliform bacteria. Only Military Canal in south Miami-Dade County showed an increasing trend in fecal coliform. It should be noted that this increase is slight, and the concentrations of bacterial indicators in Military Canal are still far less than the water quality criterion for fecal coliform.

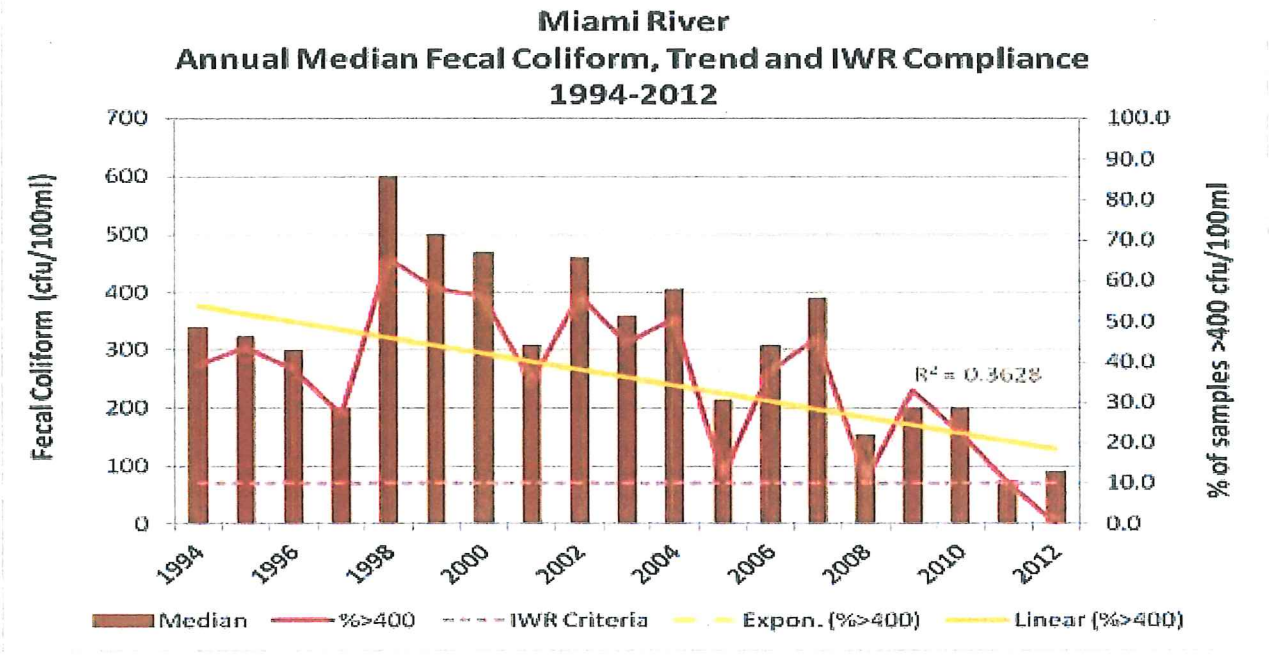


Figure 14. Indicators of sewage pollution in the Miami River decreasing over time

In the open waters of Biscayne Bay, water quality remains safe for all recreational uses, though some portions exhibit increased occurrence or duration of algal blooms in the past decade compared to historic patterns. It is noteworthy that the chlorophyll-a criteria (an indicator of algal biomass) for Biscayne Bay, which are based on long-term typical conditions, are among the most stringent estuarine standards in the state, and reflect the exceptional overall water quality within the Bay. The chlorophyll-a concentration is related to the amount of critical nutrients available for algae and other plants to grow. In Biscayne Bay, the limiting nutrient is phosphorus, as it is in the Everglades wetland system. Recent assessment of phosphorus concentrations in Biscayne Bay segments showed either no change or decreasing long-term trend for this parameter.

In general, the majority of nutrient and coliform trends over time in the County's water body segments are stable or improving. 94.7% of all comparisons (excluding water bodies with missing or insufficient data comparisons) show either stable or improving conditions.

Table 3. Summary of trends for major surface water quality parameters 2005-2012

Parameter	No. of water bodies with **Declining (Worsening) Trend**	No. of water bodies with **Improving Trends**	No. of water bodies with **Stable Trends**	% WBIDS with **Stable or Improving Trends***
Total Phosphorus	2	13	22	94.6%
Ammonia	1	25	11	97.3%
Fecal Coliform	1	21	15	97.3%
Chlorophyll-a	0	5	7	100.0%
Total Nitrogen	4	10	13	85.2%
TOTALS	**8**	**74**	**68**	**94.7%**

* Percentage based on evaluation of those water bodies with sufficient data to allow assessment

Recommendations for Surface Water Quality Protection

Multiple areas of Miami-Dade County include surface waters that still do not presently meet State-designated uses, because not all surface water quality standards are met. The greatest concern regarding maintaining the quality of the County's surface waters continues to be pollutant discharges in the watershed and nonpoint source discharges of stormwater runoff into the canal systems. The following recommendations suggest strategies to maintain and improve overall water quality, recreational value, and ecological health of the County's surface waters.

- Continue to work with the State of Florida:
  - To define appropriate nutrient criteria for the canal systems in the County and South Florida.
  - Based on methods, procedures and resources developed by the State, assess those water bodies that continue to be impacted by sewage contamination and identify actions to remediate these impairments. These activities would be developed and conducted through a multi-agency effort, involving appropriate departmental, municipal, and state partners and stakeholders.

- Work in collaboration with WASD to identify regions of the County where infrastructure additions and upgrades would service basins with existing fecal coliform impairments.

- Provide for continued monitoring of surface waters to allow future assessments of status and trends and detect water quality impacts throughout the County, including maintaining funding partnerships with the State of Florida, which has management responsibility for primary canals and aquatic preserves.

- Support the Stormwater Utility and Stormwater Master Plan activities, which provide significant surface water quality benefits through the appropriate retention and treatment of stormwater runoff.

- Insure full compliance and minimize variances with the Miami-Dade Comprehensive Development Master Plan and the Code of Miami-Dade County, which serve to protect the County's surface water quality by minimizing discharges of pollutants and maintaining ecological features, such as wetlands, mangrove shorelines, and aquatic vegetation that naturally filter and enhance water quality.

- Continue to implement or partner in local and regional habitat and water restoration projects, such as shoreline stabilization, mangrove planting, and the Comprehensive Everglades Restoration Plan which are expected to enhance both quality and quantity of freshwater delivery to the wetlands and coastal estuaries, such as Biscayne Bay.

Summary Conclusions

Progressive environmental management programs in Miami-Dade County, in collaboration with state and federal efforts, have helped to maintain or even improve our air and water quality despite significant increases in population. Air, groundwater, and surface water quality in the County are generally good or superior to conditions found in other major metropolitan areas. Human and environmental health standards are met by approximately 99% of analytical results or data assessments. This is largely due to improvements in pollution prevention technology and best practices, air and water quality treatment, land-use and stormwater regulations, and environmental remediation and restoration. Furthermore, the protection of natural resources, such as tree canopy, wetlands, clean soils, aquifer structure and aquatic vegetation, which filter, trap or recycle nutrients and other pollutants, has also helped to maintain or improve our air and water quality. These strategies collectively prevent or reduce the occurrence or magnitude of pollution, compared to past practices, and allow for more sustainable growth and development.

DERM monitoring efforts focus on documenting countywide geographic patterns and long-term trends in air and water quality while meeting state and federal regulatory requirements for protecting human and ecological health. Hundreds of thousands of observations and analyses of air and water are made each year. Data from monitoring programs are used to determine "typical" or "normal" conditions, to identify threats or changes from normal, and to target areas or types of contamination that require more investigation, clean up, or changes in regulations.

Declining support from State and federal partner agencies for environmental monitoring and remediation programs represents a potential risk to the unique air and water resources of the County. Monitoring networks, many of which are jointly funded by county partnerships with State and federal agencies, are vital to the early identification of pollution threats, and thus reduce long term costs of protecting human and environmental health. The County should urge State and federal partners to continue funding these important programs.

Stationary sources of air pollution in Miami-Dade County are effectively managed through operating permits. However, since the majority of air emissions in the County are produced by motor vehicles, the County should continue to promote smart transportation planning polices and increased use of mass transit.

Environmental data indicate that the County's wellfield protection areas have much fewer contaminated sites than other portions of the County. However, volatile organic compounds from industrial or commercial operations, which can include solvents such as those associated with dry cleaning operations, remain the greatest threat to our groundwater. The County should continue to implement the Wellfield Protection Program, consider modifications to monitoring requirements for dry cleaners, and continue to urge the Florida Legislature to increase funding allocated from the Inland Protection Trust Fund and the Dry Cleaning Solvent Clean-up Program for the cleanup of sites eligible for state cleanup programs.

The County should continue to promote policies that protect the aquifer from salt intrusion. This includes continued acquisition and preservation of wetlands that provide freshwater recharge of the aquifer, prohibiting excavations through coastal areas that can lead to landward movement of the saltwater/freshwater interface, and promoting water management policies that serve to better protect the aquifer from salt intrusion.

The Biscayne Aquifer, the County's sole source of fresh drinking water, is just below our feet. Most citizens probably don't realize that in Miami-Dade County we live and work over the water we drink. While regulation and enforcement are a necessary component of environmental protection, education and outreach can also be an important tool in achieving this goal. Therefore, the County should promote education and outreach to better inform businesses and residents about their connection to our natural resources and the important role we all play in protecting them.

Monitoring data indicate stable or improving surface water quality trends. However, some canal segments and some areas of the Bay do not always meet water quality standards for certain parameters. The County should continue to investigate and address impacts identified in urban canals related to sewage contamination. Biscayne Bay is particularly sensitive to water quality impacts and therefore the County should continue programs that address stormwater quality and reduce excessive amounts of inorganic nutrients in canals or coastal waters which can affect water clarity and marine plants and animals.