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DRAINAGE AND NATURAL GROUNDWATER AQUIFER RECHARGE

I. INTRODUCTION

A. General. The purpose of the Drainage and Natural Groundwater Aquifer Recharge (DANGAR) Component is to assure that necessary public drainage and aquifer recharge facilities and services correlate to future land use projections. THE DANGAR Support Document provides the data and analysis used as the basis for the DANGAR goals, objectives and policies.

Part I of this element identifies the service area, planning horizons and defines key terms. Part II addresses the data requirements and includes summaries of the major drainage facilities and the major natural aquifer recharge areas. It also identifies the level of service standard for drainage facilities and describes existing drainage facility needs. Part III includes an analysis of the projected future needs for drainage facilities. Part IV addresses implementation of the Component. Part V is the appendix, which includes inventories of drainage facilities.

B. Service Area. The planning service area is the watershed serving Broward County. The regulatory service area is area within the boundaries of Broward County's four dependent drainage districts and the unincorporated areas not within an independent drainage district.

C. Planning Horizon. The short-term planning horizon is 2015; the long-term planning horizon is 2020.

D. Definitions. The following definitions are provided to assist in the reading of the Drainage and Natural Groundwater Aquifer Recharge Component. Sources for the definitions are provided in parenthesis.

Aquifer - a stratum or formation of permeable material that will yield groundwater in useful quantities (U.S. EPA).

Best Management Practices - the most effective methods and devices to reduce or prevent non-point source pollution of groundwater or surface water.

Borrow Canal - In most cases the material for construction of a levee is obtained by excavation immediately adjacent to the levee. The excavation is termed a borrow. When the borrow paralleling the levee is continuous and allows for conveyance of water, it is referred to as a borrow canal. (SFWMD)

Canal - a trench, the bottom of which is normally covered by water, with the upper edges of its two sides normally above water (Chapter 62-310, FAC.).

Channel - a trench, the bottom of which is normally covered entirely by water, with the upper edges of its sides normally below water (Chapter 62-310, FAC.).

Control structures - devices (e.g., culverts, spillways and weirs) placed in the canals to control water surface elevations (stage divide), amount of flow (stage divide or water supply structure), or direction of flow (divide structure) in the canals. In general, a *stage divide* controls water surface elevation upstream of the structure, and it controls water flow (or discharge) downstream of the structure. A *divide structure* is usually located at or near a basin boundary. It prevents water in one basin from entering the other basin. A *water supply structure* is also usually located near a basin boundary. It is used to pass water from one canal to another.

Culvert - a drain, ditch, or conduit, not incorporated in a closed system, that carries drainage water under a driveway, roadway, railroad, pedestrian walk, or public way (The New Illustrated Book of Development Definitions).

Design storm - the most severe storm for which the canals and structures in the basin will accommodate that storm's runoff without flooding occurring in the basin.

Drainage basin or stormwater basin - the area defined by topographic boundaries which contributes stormwater to a watershed, drainage system, estuarine waters, or oceanic waters, including all areas artificially added to the basin (Chapter 9J-5, FAC.).

Drainage detention structure - structure which collects and temporarily stores stormwater for the purpose of treatment through physical, chemical, or biological processes with subsequent gradual release of the stormwater (Chapter 9J-5, FAC..)

Drainage district - a local unit of government with the specific purpose of providing drainage within a limited boundary. Drainage districts may be classified as dependent or independent. A *dependent drainage district* is one where the membership of its governing body is identical to that of the governing body of a single county or municipality. An *independent drainage district* is one that is not dependent.

Drainage ditch or **irrigation ditch -** a man-made trench dug for the purpose of draining water from the land or for transporting water for use on the land and is not built for navigational purposes (Chapter 62-312, FAC.).

Drainage facilities - structures designed to collect, convey, hold, divert, or discharge stormwater; includes stormwater sewers, canals, detention structures, and retention structures (Chapter 9J-5, FAC.).

Drainage retention structure - structure designed to collect and prevent the release of a given volume of stormwater by complete on-site storage (Chapter 9J-5, FAC.).

Dredging - the excavation, by any means, in waters of the state. It is also the excavation (or creation) of a water body which is, or is to be, connected to any of the waters listed in

Section 62-312.030(2), FAC., directly or via an excavated water body or series of excavated water bodies (Chapter 62-312, FAC.).

Filling - the deposition, by any means, of materials in the waters of the state (Chapter 62-312, FAC.).

Flood control - structural and non-structural measures designed to mitigate flood damage to developed areas (Water Resource Atlas of Florida).

Flood plains or **floodprone areas** - areas inundated during a 100-year flood event or areas identified by the National Flood Insurance Program as an A zone on Flood Insurance Rate Maps of Flood Hazard Boundary Maps (Chapter 9J-5, FAC.).

High recharge areas or **prime recharge areas** - areas so designated by the South Florida Water Management District governing body (Chapter 9J-5, FAC.).

Impound - Collecting and confining water as if in a reservoir (Webster's New Collegiate Dictionary).

Natural drainage features - the naturally occurring features of an area which accommodate the flow of significant amounts of stormwater, such as streams, rivers, lakes, sloughs, floodplains and wetlands (Chapter 9J-5, FAC.).

Natural drainage flow - the pattern of surface and stormwater drainage through or from a particular site before the construction or installation of improvements or prior to regrading (Chapter 9J-5, FAC.).

Natural groundwater aquifer recharge areas or **natural groundwater recharge areas** or **groundwater recharge areas -** areas contributing to or providing volumes of water which make a contribution to the storage or regional flow of an aquifer (Chapter 9J-5, FAC.).

Navigable Waters - the waters of the United States, including territorial seas (Federal Water Pollution Control Act, U.S.C. 13627).

Percolation - downward flow or filtering of water through pores or spaces in rock or soil (U.S. EPA).

Pumping station - a building or structure containing the necessary equipment to pump a fluid to a higher level (The New Illustrated Book of Development Definitions).

Recharge - the addition of water to the groundwater system by natural or artificial processes (U.S. EPA).

Runoff - that portion of rainfall not absorbed by soil, evaporated, or transpired by plants, which finds its way into canals or other surface waterbodies.

Seepage - the flow of water through the sides or bottom of a canal or levee caused by a hydraulic gradient.

Spillway - a passage for surplus water to run over or around an obstruction.

Standard Project Storm - a rain fall event yielding amounts of precipitation equivalent to the 100 year storm increased by 25%. (SFWMD)

Standard Project Flood - The stormwater runoff which occurs during the standard project storm. (SFWMD)

Stormwater - the flow of water which results from a rainfall event. (Chapter 9J-5, FAC.).

Tailwater - water below a dam. (Webster's Collegiate Dictionary)

Water surface elevations - the distance from the water's surface in a canal to some referenced elevation or "datum," typically, the National Geodetic Vertical Datum (NGVD). Water surface elevations may be measured in feet or stages.

Weir - a dam in a stream to raise the water level or divert its flow.

Wetlands - those areas that are inundated or saturated by surface water or ground water at a frequency and a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Soils present in wetlands generally are classified as hydric or alluvial, or possess characteristics that are associated with reducing soil conditions. The prevalent vegetation in wetlands generally consists of facultative or obligate hydrophytic macrophytes that are typically adapted to areas having soil conditions described above. These species, due to morphological, physiological, or reproductive adaptations, have the ability to grow, reproduce or persist in aquatic environments or anaerobic soil conditions. Florida wetlands generally include swamps, marshes, bayheads, bogs, cypress domes and strands, sloughs, wet prairies, riverine swamps and marshes, hydric seepage slopes, tidal marshes, mangrove swamps and other similar areas (Chapter 9J-5, FAC.).

II. DATA REQUIREMENTS

Rule 9J-5.0011(1), FAC., requires the component address those facilities which provide service within the local government's jurisdiction. This section addresses the above-described rule requirements.

A. Drainage systems. Water flowing overland during and immediately following a storm event is called stormwater drainage or stormwater runoff. Under the effects of gravity, the drainage flows toward sea level through depressions and channels which comprise the drainage system of an area. Stormwater runoff can be witnessed in any parking lot, driveway, or street during practically all rainstorms, except during the lightest mist. The drainage system may consist of natural features, man-made features, or a combination of both.

Natural drainage systems are defined by the topography of an area. The largest feature of a natural drainage system is the drainage basin, or watershed. The watershed consists of a network of streams, rivers and tributaries which collectively convey all the surface water from a geographic region to one particular place. This place is called the major drainage feature or receiving body and it may be a river, lake or bay. The boundary of a basin is called the basin divide. This is the point where elevation differentials delineate receiving bodies. In South Florida, the natural elevation differentials are not as easily discernable as they are in hilly or mountainous terrain.

Man-made drainage facilities are artificial constructs, designed to store or convey stormwater runoff. Swales, ditches, canals and stormsewers are typical conveyance structures, collecting stormwater runoff and directing it toward downstream receiving waters. Stormwater storage structures are generally classified as either detention or retention facilities. Detention facilities are designed to temporarily impound runoff and release it gradually to downstream portions of the drainage system through an outlet structure. Retention facilities are impoundments which release stormwater by evaporation and by percolation into the ground, with no direct discharge to surface waters. There are two types of on-site detention/retention systems. Wet detention/retention uses a water storage area with a bottom elevation less than one foot above the average wet season water table to provide storage and recharge the aquifer. Dry detention/retention uses open areas with a bottom elevation at least one foot above the average wet season water table to store the storm water runoff. Both of these techniques will provide aquifer recharge, however, dry detention is preferred from a water quality standpoint since the soils and ground cover provide a natural filtering process.

Drainage systems were used in the past to reclaim land from the Everglades for agricultural development and human settlement. Contemporary thought during the time period was that all wetlands, including the Everglades, were useless wastelands which should be drained for more useful purposes.

Today, drainage systems are used to reverse some of the impacts to the Everglades through the creation of the Water Conservation Areas, which provide protection of the remaining Everglades. Drainage systems are also used as a means of recharging groundwater and preventing saline intrusion, in addition to the original purpose of protecting life and property from floods.

Drainage systems can be structured into three tiers: primary, secondary and tertiary. Each tier is designed to accommodate a certain quantity of storm water runoff. Water flow is managed and

controlled throughout the system by devices which include spillways, culverts, weirs, canals, and pumping stations.

Tertiary drainage systems provide the initial localized control, collection and treatment of storm water runoff. In the unincorporated areas and its dependent districts, these drainage systems are permitted by the Broward County Environmental Protection Department under county-wide rules and regulations. Tertiary water flow consists of runoff from streets, parking lots, driveways, lawns and other saturated surfaces. Typical tertiary drainage structures include retention and detention ponds, ditches, culverts, and storm sewers. Tertiary drainage systems serve a spectrum of development types including residences, shopping malls, industrial parks and planned communities.

The secondary drainage system consists of canals and other structures which operate as intermediate mechanisms to deliver storm water from the tertiary drainage system to the primary drainage system. The conveyance structures include canals, pumping stations, spillways, culverts and weirs. The secondary drainage system is operated by dependent and independent local water control districts and municipalities. Dependant drainage districts are managed by the county or municipal governments, while independent drainage districts operate autonomously by a special grant of authority. As illustrated in Map 7-2, there are a total of twenty-three drainage districts: nine are dependent drainage districts and fourteen are independent drainage districts. Local water control districts are divided into sub-basins which empty into the primary drainage system.

Some districts contain only one sub-basin and others may contain several. Sub-basins empty into a primary drainage canal. Secondary canals often flow north or south towards a primary canal which often flows from the west to the east. Every sub-basin contains at least one secondary canal. A typical sub-basin usually drains a narrow strip of land, approximately one mile wide, separated by major roadways. County canals, and canals maintained by the County under contract, are periodically inspected by the Water Management Division (WMD) to insure debris removal, aquatic weed control, and proper operation of flood control gates. All complaints are investigated and, if necessary, the responsible party is notified to correct deficiencies. An inventory of the dependent and independent drainage districts, their enabling authority, and their permitting programs are included as Appendix 7-A.

The primary drainage system collects and conveys storm water from the secondary drainage system to the Atlantic Ocean, Intracoastal Waterway and Dade County water bodies, and in a limited number of cases, to the Everglades. Primary drainage canals, rivers, and levees in Broward County are components of a regional water management system which is controlled by the South Florida Water Management District (SFWMD) and the US Army Corps of Engineers (COE). It consists of 14 drainage basins ranging in size from less than 5 square miles to over 500square miles. The SFWMD and the COE operate and maintain the primary canal system within the basins and establish discharge limits for releases from the secondary canal system. Limitations on discharge are determined by the capacity of the receiving primary canal to accept and safely remove storm water. Discharge is measured in cubic feet per second per square mile.

B. Major drainage features. There are fourteen (14) major drainage features or basins within Broward County: four drainage basins are situated in the undeveloped (western) area and ten drainage basins are within Broward County's developable (eastern) area. Appendix 7-B provides information on the functions and the level of service standard for each of the fourteen basins. Appendix 7-C provides information on the design criteria for the structures within each drainage basin. The descriptions of the drainage basins summarized herein and the information in Appendices 7-B and 7-C are based upon technical memoranda prepared by the South Florida Water Management District SFWMD.

The following abbreviations are used to describe the structures located within each drainage basin:

C - Canal
G - non-Federal structure used to supplement the Federal Central and South Florida Flood Control Project (C&SF)
L - Levee designation in the C&SF Project
S - Structure in the sub-basin.

1. **Water Conservation Area 2A.** The Water Conservation Area 2A (WCA 2A) basin has an average area of 164.7 square miles and is located in south-central Palm Beach County (65.5 square miles) and in north-central Broward County (99.2 square miles). The WCA 2A is connected to Lake Okeechobee by way of the North New River Canal (NNRC). Regulatory releases from the lake, made to the canal by way of the S-351, are passed through the S-2 and the S-7 basins in the Everglades North New River and Miami Area, and are discharged by gravity flow or pumping from the canal into the WCA by way of the S-7. Regulatory releases from the lake to the WCA 2A are rare events and are only a small part of the water discharged to the WCA by way of the S-7.

In addition to regulatory releases from the lake, the NNRC may be used to supply water from Lake Okeechobee to the C-13, C-14 and the NNRC basins for irrigation and municipal water supply. These water supply releases are passed through the WCA 2A by way of the NNRC and the L-35B borrow canal.

There are two C&SF Project canals affecting water management in WCA 2A: the NNRC and the L-35B borrow canal. The NNRC connects Lake Okeechobee to WCAs 2A and 3A. The connection to Lake Okeechobee is by way of the S-2 and the S-351 at the north end of the canal at South Bay west of Belle Glade. The connection with WCA 2A is by way of the S-7 at the intersection of the L-5 and the L-6, just east of U.S. Highway 27 on the Palm Beach/Broward County line. The connection with WCA 3A is by way of the S-150 just west of the S-7. From the S-7, the NNRC passes on through the WCA and provides a means of conveying water from Lake Okeechobee to eastern Broward County.

The L-35B borrow canal connects the NNRC to the C-13 and the C-14. The canal runs

west-east just north of the L-35B making an open channel connection to the NNRC at its west end and connecting to the C-14 at its east end by way of the S-38.

The WCA 2 also is impounded by six levees: L-6, L-35B, L-36, L-38E, L-38W, and L-39. These levees were designed to hold water in WCA 2A at stages estimated to occur during the Standard Project Flood.

2. **Water Conservation Area 2B.** The WCA 2B basin, located in central Broward County, has an area of 43.8 square miles. WCA 2B is an area of significant recharge to the Biscayne Aquifer. Water supplied to the aquifer by way of WCA 2B is important to maintaining groundwater levels in coastal areas. Adequate groundwater levels are essential to proper management of municipal wellfields and to restrict saltwater intrusion to groundwater. The borrow canals of the levees impounding the WCA on the east cut into the Biscayne Aquifer and intercept some of the groundwater flow to the east. The intercepted groundwater and seepage through the levees are an important source of water to adjacent basins in Broward County: to the C-13 and C-14 basins by seepage to the L-35A and L-36 borrow canals and to the NNRC basin by seepage through L-35 to the NNRC. The rates of seepage through L-35, L-35A, and L-36 are not regulated by specific operation of Project structures, although the rates are probably affected by the stages held in the NNRC and the L-35A and L-36 borrow canals.

WCA 2B is impounded by five levees: L-35, L-35A, L-35B, L-36, and L-38E. The L-35, L-35A, and L-36 intercept seepage from the WCA and conveys this water to adjacent basins for maintenance of groundwater levels for municipal water supply.

3. **Water Conservation Area 3A.** The WCA 3A basin has an area of 767.3 square miles and is located in western Broward County (568.4 square miles) and northwestern Dade County (198.9 square miles). WCA 3A is connected to Lake Okeechobee by way of the North New River and Miami Canals. Regulatory releases from the lake are made to the NNRC by way of the S-351, are passed through the S-2 and S-7 basins in the Everglades Agricultural Area (EAA), and are discharged into the WCA by way of the S-150. Regulatory releases from the lake to the Miami Canal are made by way of the S-354, are passed through the S-3 and S-8 basins in the EAA, and are pumped to WCA 3A by way of S-8. Regulatory releases from the lake to WCA 3A are rare events and are only a small part of the water discharged to the WCA by way of S-8 and S-150.

The four C&SF Project canals primarily affecting water management in WCA 3A are the Miami Canal, the L-37A borrow canal, the NNRC, and the C-60. The Miami Canal and the NNRC connect WCA 3A to Lake Okeechobee.

The Miami Canal connects to Lake Okeechobee by way of S-3 at the north end of the canal at the town of Lake harbor. The connection to WCA 3A is by way of the S-8, 15 miles west of U.S. Highway 27 on the Broward/Palm Beach County line. The Miami

Canal crosses WCA 3A from northwest to southeast leaving WCA 3A and entering WCA 3B at the S-151. The canal continues to the southeast entering tidewater at Biscayne Bay. Most of the Miami Canal within WCA 3A has been re-dug parallel to its original channel and is known by its Project name, the C-123.

The L-67A borrow canal is on the WCA 3A side of the L-67A and connects the Miami Canal to S-333 and the S-12 structures. There are no structures directly controlling flow into or out of this canal. Flow in the canal is indirectly affected by the operation of the S-12 structures, S-333 and S-151.

The NNRC connects to Lake Okeechobee by way of the S-2 at the north end of the canal at South Bay west of belle Glade. The connection with WCA 3A is by way of the S-150 just west of the S-7. It also makes a connection with WCA 2A by way of the S-7 at the intersection of L-5 and L-6, just east of U.S. Highway 27 on the Palm Beach/Broward County line.

The C-60 conveys discharge from the S-140 to a bridge on I-75 about 4.3 miles east of the L-28. It was constructed to facilitate the movement of water away from the S-140 so that the tailwater level at the pump remains within design conditions. The canal is aligned from the S-140 due east for 2.7 miles. It then extends to the southeast connecting to the north borrow of I-75. A bridge on I-75 at that point allows conveyance to the south. This alignment was chosen to make use of an existing bridge on what was then the Everglades Parkway (SR 838), and to form an impoundment for research studies between the canal levee and the Everglades Parkway (now I-75). The impoundment area was to be used for studies in wildlife management and evaporation and seepage control experiments. Water levels in the impoundment are controlled by two 48 inch culverts.

WCA 3A is impounded by seven levees: L-4, L-5, L-28, L-29, L-38W, L-67A, and L-68A. These levees were designed to hold water in WCA 3A at stages estimated to occur during the Standard Project Flood.

4. **Water Conservation Area 3B.** The WCA 3B basin has an area of 153.6 square miles and is located in south-central Broward County (30.5 square miles) and north-central Dade County (123.1 square miles). WCA 3B is an area of significant recharge to the Biscayne Aquifer. Water supplied to the aquifer by way of WCA 3B is important to maintaining groundwater levels in coastal areas. Adequate groundwater levels are essential to proper management of municipal wellfields and to restrict saltwater intrusion to groundwater. The borrow canals of the levees impounding WCA 3B cut into the Biscayne Aquifer and intercept some of the groundwater flow to the east. The intercepted groundwater and seepage through the levees is an important source of water to adjacent basins in Dade County.

The Miami Canal is the C&SF Flood Control Project canal primarily affecting water

management in WCA 3B. The C-304 is that section of the Miami Canal from the S-151 to the S-31. It crosses the upper quarter of the WCA from northwest to southeast. It is used primarily to convey water across the WCA from either Lake Okeechobee or WCA 3A to eastern Dade County and southeastern ENP. The reaches of the Miami Canal west of WCA 3B convey water to WCA 3B from Lake Okeechobee and WCA 3A.

WCA 3B is impounded by four levees: L-29, L-30, L-33, and L-67A.

5. **Hillsboro Canal Basin.** The Hillsboro Canal basin has an area of approximately 102 square miles and is located in northeastern Broward County (40 square miles) and southeastern Palm Beach County (62 square miles). The two Project canals in the basin are the Hillsboro Canal and the section of the L-36 borrow canal between the Hillsboro Canal and the S-38B control structure.

The Hillsboro Canal connects Lake Okeechobee to the Atlantic Ocean. It enters the basin through the S-39 control structure at the intersection of L-36 and L-40. Within the Hillsboro Canal basin, the Hillsboro Canal is aligned to and just north of SR 827 west of SR 7 and parallel to and one-half mile north of SR 810 east of SR 7. Direction of flow in the canal is normally to the east with discharge to the Intracoastal Waterway just west of the intersection of A1A and SR 810.

The L-36 borrow canal is aligned north-south along the western boundary of the basin and south of the Hillsboro Canal. The canal intercepts seepage from WCA 2A and is tributary to the Hillsboro Canal. Direction of flow in the canal is to the north to the Hillsboro Canal.

6. **Cypress Creek (C-14) Canal Basin.** The C-14 basin has an area of 59 square miles and is located in northeastern Broward County. The C-14 basin is divided into an eastern basin (34 square miles) and a western basin (25 square miles). There are two Project canals in the C-14 basin: C-14 and the section of the L-36 burrow canal between the C-14 and control structure S-38B.

The C-14 is aligned east-west in the alignment of the old Pompano Canal from the L-36 burrow canal to a point approximately one-half mile east of Florida's Turnpike. East of that point, the canal alignment follows the old channel of Cypress Creek. Direction of flow in the canal is to the east with a discharge to the Intracoastal Waterway about three-quarters of a mile south of SR 814. A short reach of canal connects C-14 to the Pompano Canal. This interconnecting canal makes an open channel connection with C-14 one-half mile east of Florida's Turnpike, and it connects to the Pompano Canal by way of G-65 at 21st Avenue, one-quarter mile west of Powerline Road. Since G-65 is normally closed, flow in this canal is usually to the west to C-14. When G-65 is open to supply water to the Pompano Canal basin, flow in the canal is reversed.

The L-36 borrow canal is aligned north-south along the western boundary of the basin. Only that part of the canal north of C-14 is in the C-14 basin. Direction of flow in the northern part of the L-36 borrow canal is to C-14. The part of the L-36 borrow canal south of C-14 conveys water from C-14 to the C-13 basin. It does not contribute flow to the C-14 basin.

7. **Pompano Canal Basin.** The Pompano Canal basin has an area of approximately 7.2 square miles and is located in northeastern Broward County. The Pompano Canal is the only C&SF Project canal in the basin and is aligned east-west, south of and approximately parallel to Atlantic Avenue from 21st Avenue (one-quarter mile west of Powerline Road) to Cypress Road. East of Cypress Road, the canal is aligned northwest-southeast and extends from Cypress Road to the Intracoastal Waterway. At its west end at 21st Avenue, the canal connects to the C-14 by way of G-65. At its east end the canal makes an open channel connection with the Intracoastal Waterway about three- quarters of a mile south of SR 814. Direction of flow is to the east with discharge to the Intracoastal Waterway.

8. **Middle River (C-13) Canal Basin.** The C-13 basin has an area of approximately 39 square miles and is located in eastern Broward County. The C-13 is divided into an eastern basin (9 square miles) and a western basin (30 square miles). The boundary between the basins runs approximately north-south through S-36. A five square mile area north of the eastern C-13 drains to the North Fork of the Middle River and is known as the North Fork of the Middle River basin. This basin includes no canals or control structures.

There are three C&SF Project canals in the C-13 basin: C-13, the section of the L-36 borrow canal between C-14 and L-35A, and the section of C-42 between S-125 and L-35A. The C-13 is aligned east-west extending from C-42 on the west to the Intracoastal Waterway on the east. C-13 makes an open channel connection with C-42, 1.8 miles south of the intersection of L-35A and L-36. At the I-95 crossing the canal bifurcates, one channel extending to the east to connect to the North Fork of the Middle River and the other channel extending to the southeast to connect to the South Fork of the Middle River. The North Fork is the main channel for flows from C-13 to be discharged to the Intracoastal Waterway. The North Fork has been channelized while the South Fork remains in its natural state. The design criteria calls for 300 cfs to be discharged to the South Fork. Flow in the C-13 is to the east.

The L-36 borrow canal and C-42 form a continuous canal aligned north-south along the western side of the basin. The juncture of the two canals is at the intersection of L-36 and L-35A. Flow in these canals is to the south to C-13.

There is one other Project canal, the L-35A borrow canal, associated with the C-13 basin. The land drained by the L-35A borrow canal is in the North New River Canal (NNRC)

basin, however, under non-flood conditions, runoff and seepage to the L-35A borrow canal are drained to the C-13 basin by way of C-42. Under flooding conditions the L-35A borrow canal discharges to the NNRC by way of S-124. The operation of S-124 determines whether the L-35A borrow canal drains to the C-13 basin or to the NNRC basin. The L-35A borrow canal is aligned northeast-southwest along the northwest border of the NNRC basin. At its north end the L-35A borrow canal makes an open channel connection to C-42 at C-42's juncture with the L-36 borrow canal. At its south end the L-35A borrow canal connects to the NRC by way of S-124.

9. **North Fork Middle River Basin.** The North Fork Middle River Basin has an are of approximately 5 square miles and is located in eastern Broward County. The area drains into the North Fork of the Middle River and does not contain any canals or any other control structures.

10. **Plantation (C-12) Canal Basin.** The C-12 basin has an area of approximately 19 square miles and is located in eastern Broward County. The C-12 is the only Project canal in the C-12 basin. It is aligned east-west parallel to and one-mile north of Broward Boulevard from University Drive on the west to S-33 on the east. East of S-33, C-12 follows the old channel of the North Fork of the New River. Flow in the canal is to the east with discharge to the New River.

11. **North New River Canal Basin.** The North New River Canal (NNRC) basin has an area of approximately 30 square miles and is located in eastern Broward County. The NNRC basin is divided into an eastern basin (7 square miles) and a western basin (23 square miles). The boundary between the basins is approximately SR 817. There are three Project canals in the NNRC basin: the NNRC, the L-35A borrow canal, and the C-42.

The NNRC connects Lake Okeechobee to the Atlantic Ocean. It enters the NNRC basin at S-34 near the intersection of SR 84 and US 27. Within the NNRC basin, the canal is aligned parallel to and just to the north of SR 84. Flow in the canal is to the southeast with discharge to the South Fork of the New River about four miles east of Sewell Lock.

The L-35A borrow canal is aligned northeast-southwest along the northwestern border of the basin. The land drained by the L-35A borrow canal is in the NNRC basin, however, under non-flood conditions, runoff and seepage to the L-35A borrow canal are drained to the C-13 basin by way of C-42. Under flooding conditions the L-35A borrow canal discharges to the NNRC. The operation of S-124 determines whether the L-35A borrow canal drains to the C-13 basin or discharges to the NNRC basin.

The C-42 is aligned north-south parallel to and just east of Hiatus Road and is the continuation of the L-36 borrow canal south of L-35A. The canal enters the NNRC basin at S-125 just south of C-13. The C-42 makes an uncontrolled open-channel connection

with the NNRC one mile east of the intersection of SR 84 and SR 823. Flow in the canal is to the south to the NNRC.

12. **South New River Canal (C-11) Basin.** The C-11 basin has an area of approximately 104 square miles and is located in south central Broward County. The C-11 basin is divided into an eastern basin (23 square miles) and a western basin (81 square miles).There are four C&SF Project canals in the C-11 basin: the C-11, the C-11S, the section of the L-33 borrow canal between the C-11 and Hollywood Boulevard, and the L-37 borrow canal. The C-11 is aligned east-west parallel to and north of Griffin Road from the L-37 borrow canal on the west to S-13 at US 441. Direction of flow in the reach of the canal in the eastern basin is to the east with discharge to the South Fork of the New River. Direction of flow in the reach of C-13 in the western basin depends on the operation of the control structures S-13A and S-9 located at either end of the reach.

The C-11S is aligned north-south parallel to and three-tenths of a mile east of Flamingo Road from G-87 at Sheridan Street on the south to C-11 on the north. The canal is tributary to and makes an open channel connection with the C-11. Direction of flow in the C-11S is to the north.

The L-33 and L-37 borrow canals make up a continuous canal aligned north-south along the western boundary of the basin. The L-33 borrow canal is south of the C-11 and extends to and makes a connection with the C-9. The L-37 borrow canal is north of the C-11 and extends to but does not make a connection with the North New River Canal. Direction of flow in the L-33 borrow canal depends on the operation of the S-9XS, S-30, and the S-32 and may be either to the north to C-11 or to the south to the C-9. Flow in the L-37 borrow canal is to the south to the C-11.

13. **Hollywood (C-10) Canal Basin.** The C-10 basin has an area of approximately 15 square miles and is located in southeast Broward County. There are two C&SF Project canals in the C-10 basin: the C-10 and the C-10 Spur Canal.

The C-10 begins at Johnson Road one-quarter mile west of I-95. It extends to the north connecting to the Dania Cut-off Canal 2.6 miles west of the Intracoastal Waterway. Flow in the canal is to the north.

The C-10 Spur Canal begins one-quarter mile north of Sheridan Street and 1.6 miles west of I-95. It extends to the east connecting to the C-10 six-tenths of a mile north of Sheridan Street. Flow in the canal is to the east. There C-10 basin was constructed without a control structure in order to maintain the water surface elevation in the canal high enough to prevent salt water intrusion into local groundwater. Since there is no water supply to the C-10 from outside the basin, it would be impossible to maintain the required water surface elevation in the canal during periods of low flow even if a structure was in place.

14. **Snake Creek (C-9) Canal Basin.** The C-9 basin has an area of approximately 98 square miles and is located in southeastern Broward County (59 square miles) and northeastern Dade County (39 square miles). The basin is divided into an eastern basin (45 square miles) and a western basin (53 square miles). There are two C&SF Project canals in the C-9 basin: the C-9 canal and the L-33 borrow canal.

The C-9 is aligned east-west extending from the L-33 on the west to Dumfoundling Bay on the east. The C-9 makes an open channel connection with the L-33 borrow canal one mile north of the intersection of L-30 and L-33 and one-half mile west of US 27. Flow in the C-9 is to the east with discharge by way of S-29 to Dumfoundling Bay.

The L-33 borrow canal is aligned north-south along the western boundary of the C-9 basin. It makes an open channel connection to the west end of the C-9 and is connected to the C-6 by way of S-32. Flow in the borrow canal depends upon the operation of S-30, S-32, and S-9XS, and may be either to the C-9 or the C-11.

There is one small non-Project canal of interest. The Flamingo Road Canal is aligned north-south, west of and parallel to Flamingo Road. It makes an open channel connection with the C-9. Normal flows in this canal are to the south to the C-9. Flows of 110 to 140 cfs are pumped to this canal from a portion of the C-11 basin in the Pembroke Pines area. Without pumping, the runoff from the Pembroke Pines area would flow north to the C-11S. Of the flow entering the C-9 from the Flamingo Canal, 40 - 50 cfs may subsequently be diverted to the C-8 by way of the west borrow canal of NW 67th Avenue.

C. Major aquifers. Broward County is underlain by two major aquifers: the Biscayne aquifer and the Floridan aquifer. The Biscayne aquifer is currently the principlesource of potable water in the County. It is one of the most productive unconfined aquifers in the United States and one of the most permeable aquifers in the world. It underlies all of Broward County except the most westerly sections. The Biscayne aquifer is wedge-shaped being more than 300 feet thick in eastern Broward County and thinning to an edge in the Florida Everglades. The Floridan aquifer is located below the Biscayne aquifer at a depth of 1,200 feet. It is composed of a system of limestones of variable permeability and is approximately 1,000 feet thick. The upper part of the Floridan aquifer is brackish and can be treated to potable standards through membrane treatment, however the lower Floridan water is hard, sulfurous, corrosive, and too saline for potable water use with standard treatment methods, thereby requiring the use of reverse osmosis membrane technology to meet drinking water standards.

The top of the Floridan aquifer system in Broward County is about 950 to 1000 feet below sea level and is considered to be a relatively confined surface overlain by a 550 to 800 foot thick sequence of clay, silt, limestone and sand referred to as the intermediate confining unit. Unlike the Biscayne Aquifer, which receives recharge through surface water seepage, there is no direct recharge to the Floridan aquifer system in Broward County. Consequently, wells drilled into the

Floridan aquifer system in Broward County yield highly mineralized water which is not suitable for most purposes without undergoing advanced water treatment.

Overlying the intermediate confining unit is the surficial aquifer system (of which the Biscayne aquifer is the only formally named unit in Broward County). Although there are significant differences in the water-bearing characteristics and transmissivity of the surficial aquifer system throughout the County, the entire remaining pervious surface of Broward County is the recharge area. Included as part of the pervious surface in Broward County are the water conservation areas (2A, 2B, and 3A). These areas include highly regulated and protected areas of levees, canals, dikes and berms used for storing and recharging water, and they cover approximately the western two-thirds of the county. Because the upper surface of the surficial aquifer system is so close to land surface, and recharge readily occurs on any pervious surface, the few remaining and aerially-limited natural recharge areas are not particularly significant in the overall protection of the surficial aquifer system.

The top of the surficial aquifer system may be considered to be land surface because virtually all of Broward County formerly was seasonally or perennially flooded, although drainage by canals has reduced the occurrence of flooding in east and south-central Broward County. The oolitic limestone and sand that form the upper surface of the surficial aquifer readily absorb rainfall; their porosity provides the principal recharge mechanism to the aquifer. Observation wells generally show rapid response to rainfall and the same phenomenon occurs wherever there are thin, sandy or slightly organic soils overlying the upper surface of the aquifer.

D. Major natural groundwater aquifer recharge areas. The SFWMD has not designated any area within Broward County as a "prime groundwater recharge area." Nonetheless, rainfall within the urban portion of Broward County represents a significant source of groundwater recharge to the superficial aquifer, along with recharge from the four Water Conservation Areas (WCAs). The WCAs (2A, 2B, 3A, and 3B) within Broward County, remnants of the original Everglades, total 719 square miles and comprise approximately two-thirds of the County's area. The SFWMD measures water storage in the Conservation Areas by a network of water depth gauges. The level of water stored in the Conservation Areas is a prime consideration in the decision by SFWMD to release water from Lake Okeechobee into the canals for aquifer recharge and/or to declare a condition of water shortage.

Other major sources of recharge include the system of canals in the developable areas of the County. The land surface, itself, is also a major source of aquifer recharge. Generally soil conditions in the County are conducive to recharge of the aquifer (See the Natural Resource Map Series). Except for those areas in the Southwest Sector with thick muck soils, movement of water into the ground is rapid. Recharge also may be obtained through injection and spray irrigation. While the County does not currently engage in either of these two recharge methods, the County is exploring alternative water supply projects that could enhance aquifer recharge via infiltration trenches.

In addition to their drainage and aquifer recharge functions, some canals are operated so as to increase the water level of the aquifer between the wellfield and the ocean and, thereby, prevent saltwater intrusion to well fields. The County's North Regional Recharge System, constructed as part of the County's Integrated Water Resources Plan, is an example of how the canals are used not only to address saltwater intrusion, but to also provide recharge benefits for the County's wellfield system, natural areas, and potential downstream benefits for municipalities such as Pompano, Fort Lauderdale and Hallandale. The interconnectivity of northern Broward County drainage districts also allows for west-east hydrologic connectivity.

Relatively few acres of wetlands are left in the developable area of the County (See Conservation Element and the Natural Resource Map Series). As a result, wetlands, other than the WCAs, are not a major source of recharge to the Biscayne aquifer, although there are ongoing efforts to enhance surface water deliveries to various urban wetlands to improve natural system function. While natural system recovery is the primary objective, it is estimated that through seepage, 80% of the surface water recharge will reach the groundwater with indirect benefits for downstream wellfields.

E. Level of service (LOS) Standard. Broward County has expressed its drainage concurrency level of service (LOS) standard in terms of performance based criteria which recognize the discharge limitation set by the SFWMD upon its primary canals as the effective limitation upon water management systems. The level of service standard for the stormwater management basins controlled by the SFWMD is shown in Appendix 7-B.

The LOS criteria for the Unincorporated Area are based on adopted standards and criteria for water management works. The minimum standards shown in Table 7-1 are implemented through the development review process of the Broward County Land Development Code.

The submission of detailed drainage plans and calculations is required to show how conformance is to be achieved. The plans and calculations are reviewed for compliance. If they are found not to be in compliance additional information or revision is requested. Permits are not issued until the plans and calculations are brought into conformance. After permitting, the regulatory programs include inspection and certification to assure construction is conducted in accordance with the standards. Application of the LOS standards through the regulatory systems of the SFWMD, Broward County, and local water control districts assure that a development order shall not be issued unless the necessary drainage facilities either exist at the time of application or are provided for through an approved plan of concurrent construction with financial assurance in the form of a bond, letter of credit, cash deposit of similar mechanism. Policies 7.2.1 and 7.2.4 address drainage concurrency LOS standards.

In terms of impervious area for developments in the Unincorporated Area, impervious surfaces cannot exceed seventy-five percent for an industrial development, seventy percent for commercial, and sixty percent for residential. Variations are allowed if mitigating design improvements are utilized, but under no circumstances can the percentage of impervious area

exceed eighty-five percent for industrial, eighty percent for commercial, and seventy percent for residential uses. Municipalities regulate impervious areas according to their respective municipal ordinances.

TABLE 7-1
DRAINAGE LEVEL OF SERVICE STANDARD

Subject	**Adopted Drainage Level of Service Standard Standards**
Road Protection	Residential streets not greater than fifty feet wide rights-of-way to have crown elevations no lower than the elevation for the respective area depicted on the ten year "Flood Criteria Map." Rights-of-way greater than fifty feet wide to have an ultimate edge of pavement no lower than the elevation for the respective area depicted on the ten year "Flood Criteria Map."
Building Elevations	To have the lowest floor elevation no lower than the elevation for the respective area depicted on the "100 Year Flood Elevation Map", the FEMA Base Flood Elevation for the area or the site-specific 100-yr, 3-day design storm stage, whichever is highest. Off Site Discharge Not to exceed the inflow limit of SFWMD primary receiving canal or the local conveyance system, whichever is less.
Storm Sewers	Design frequency minimum to be three year rainfall intensity of the State Department of Transportation Zone 10 rainfall curves.
Flood Plain Routing	Calculated flood elevations based on the ten year and one hundred year return frequency rainfall of three day duration shall not exceed the corresponding elevations of the ten year "Flood Criteria Map" and the "100 Year Flood Elevation Map."
Antecedent Water Level	The elevation depicted on the map "Average Wet Season Water Levels".
On Site Storage	Minimum capacity above antecedent water level and below flood plain routing elevations to be design rainfall volume minus off site discharge occurring during design rainfall, except for the 100-yr, 3-day design storm event, which is zero discharge.
Water Quality	Prior to discharge to surface or ground water, 80% or 95% reductions in pollutant load must be achieved based on the rebuttable presumptions of the water quality treatment criteria..

F. Existing drainage facility needs. Drainage facility needs in the areas under the County's jurisdiction are being met through Broward County's Neighborhood Improvement Program (NIP). Originally authorized in 1993, the NIP is a set of public works projects in eight major communities, representing 25 neighborhoods in mostly unincorporated Broward County. While the NIP started as drainage improvement projects designed to alleviate flooding in low-lying areas of the County, it has expanded to include a number of infrastructure improvements in the right-of-way of a number of communities. The NIP areas encompass 8,812 acres, 92,000 people, and 28,200 homes. Construction, currently estimated at $658 million, began in 1996 and is scheduled to be completed in 2011. Completion of the drainage improvements associated with the NIP will address Objective 7.1 and Policy 7.1.1 of the DANGAR Element.

G. Adequacy of current level of service. The effectiveness of a drainage system is frequently measured by the extent to which it reduces damage and inconvenience from flooding. The primary canal system, operated by the SFWMD, is generally adequate to meet the Standard Project Flood. Further, the County's regulatory procedures ensure that discharges from the secondary canal system do not exceed design capacities of the primary canal system.

The secondary canal system generally provides an adequate level of service. Discharges from the secondary system to the primary system are limited to the SFWMD allowable discharge criteria by control structures placed between the two systems. However, uncontrolled connections exist that discharge in excess of the drainage area's pro rata share of the receiving primary canal. Such conditions reduce the capacity available to a property that is served by controlled secondary canals, thus increasing the effect of rainfall on the property. In addition, canals such as the western reach of the C-9 and the C-11 have such limited capacity that agricultural uses are often precluded or severely restricted and the effects of flooding on developed land are excessive. Similar conditions but of differing extent also exist within other primary canal basins. These conditions could be reduced and water management could be enhanced if unrestricted connections were to be brought into conformance and inadequate primary canals were improved to a capacity corresponding to reasonable land use expectations.

Proposed development, in accordance with the LDC, will not receive a development order without having received approval, from the appropriate approval authority, of a water management plan that meets the LDC Requirements. Thus, the two are an inseparable part of the review mechanism with each assuring conformance to adopted standards. Policy 7.2.1 addresses the ensurance of proper drainage by the EPGMD.

The drainage level of service standards are based on rainfalls with predicted return frequency but they do not define the frequency of flooding due to other effects or due to other rainfall events. The design rainfall for determining minimum road crown elevations has a ten percent annual change of occurrence. In certain areas, including southwest Broward County, other design considerations necessitated an upward adjustment to the criteria depicted on the "Flood Criteria Map". When normal groundwater levels were found to be high enough to saturate road base material the minimum road crown elevation was adjusted upward sufficiently to place the base

material above the groundwater. Also when the design flood condition did not recede below the base material within a reasonable period of time the road crown elevation was adjusted upward. Building protection is based on a design rainfall that has a one percent annual chance of occurrence. The flood elevations predicted as a result of the one percent design rainfall are depicted on Broward County's "100 Year Flood Elevation Map." Design storms have not been adopted for the protection of other areas such as parking lots and yards. In general, yards and other open space, and to a lesser extent parking lots, are allowed to be used for stormwater storage on an as-needed basis. The need has been found to be greatest in lower density residential development and in higher coverage non-residential development.

III. ANALYSIS REQUIREMENTS

Part III of this component primarily focuses on the projected drainage facility needs. It includes a facility capacity analysis by drainage district boundaries; the general expected life of the drainage facilities; the impact of drainage facilities on adjacent natural resources; an analysis of the problems and opportunities for drainage facilities replacement, expansion and new facility siting; and an assessment of the strengths and deficiencies in regulations and programs used to maintain the functions of natural drainage features and groundwater recharge areas.

A. Facility capacity analysis. The primary and secondary drainage systems should continue to be able to meet future demands in accordance with the design storm criteria established by the SFWMD and the WMD. The systems within the western three sectors, however, may need to be expanded to accommodate drainage needs as development occurs.

The regulatory process working in concert with the development review process of the LDC will reduce the probability of future development that does not conform to the adopted level of service standards for drainage.

B. Expected life of drainage facilities. Since the expected life of drainage facilities varies, depending upon such factors as the type of facility, the amount of use, and the age of the facility, it is often difficult to estimate the expected life of the facilities. Consequently, the approach used by both the SFWMD and the WMD is to allocate funds for other drainage improvements. This approach allows for the gradual replacement of drainage facilities as the facilities start to deteriorate.

C. Impact of drainage facilities on adjacent natural resources. The landscape has been dramatically altered from its original state. Installation of the elaborate system of canals, levees, and other water control structures drained eastern portions of the Everglades, opening the land for development. Nearly all of the developable land in Broward County is attributable to drainage. Impacts upon surface water, groundwater, fisheries and wetlands have occurred as a result.

Nonpoint source pollution is one of the major causes of water quality degradation. One of the primary ways nonpoint source pollution reaches surface water and groundwater is through the flow of stormwater runoff. Pollutants are often dissolved in the water or absorbed to sediments suspended in the water. There are many types of nonpoint source pollutants which result from different types of land uses. Common types of contaminants include pesticides, sediments, heavy metals, bacteria and nitrates. These contaminates can originate from residential lawns, construction sites, urban streets and parking lots, and agricultural activities.

The few natural rivers which exist in the county have been incorporated into the primary drainage system. Concurrently, the water carrying capacities in these rivers has been increased to accommodate greater quantities of stormwater runoff received from the secondary and tertiary drainage systems. Several negative effects on rivers include dredging, channel alterations, and nonpoint source pollution.

Alterations in the natural drainage system, increasing demands on the aquifer system, and threats to coastal wellfields from saltwater intrusion have prompted changes in the way water is managed in the County. Improved operation of the canal system and efforts to enhance recharge through these improved operations have helped to maintain groundwater levels and protect wellfields against saltwater intrusion, particularly during dry periods and times of drought when increasing demands are placed on wells for irrigation.

The drainage system has also had negative effects upon fisheries. The introduction of nutrients into the marine environment stimulates the growth of algae and other aquatic vegetation at inflated rates. As the plant life dies and decays, it consumes oxygen dissolved in the water. Occurrences of low dissolved oxygen or no dissolved oxygen result in kills of fin fish and shell fish. The input of toxics into the aquatic eco-system also poses risks to aquatic animals. Some toxins can bio-accumulate, which is the process whereby the concentration of a toxin increases at higher levels in the food chain, with associated harmful effects. Marine life may also become diseased by pathogens found in stormwater runoff.

Wetlands dominated the landscape prior to drainage and provided habitat for flora and fauna. Drainage has significantly reduced the quality and quantity of wetland habitat. Most remaining wetlands in the developable area are severely degraded from nonpoint source pollution and physical alterations and simply do not serve the same functions they did at one time. Programs are effectuating the protection of high quality wetlands which still exist (See Conservation Element).

Policy 7.2.8 addresses the impacts of stormwater management facilities on adjacent natural resources.

D. Problems and opportunities for drainage facilities replacement, expansion and new facility siting. There are several problems which have been identified regarding the replacement and expansion of existing drainage facilities and the siting of new facilities. Some developed

areas are maintaining exiting LOS standards rather than using adopted LOS standards. The purpose behind the policy is for accommodation of desirable infill development, which could be financially feasible if compliance with adopted level of service standards was compulsory. Expansion and siting of facilities in these developed areas is difficult because a predominance of the land has been consumed. Existing uncontrolled connections from older stormwater systems input an unquantifiable amount of storm water into the drainage system. These uncontrolled connections from older stormwater systems reduce the amount of input allowable for permitted connections. Capital facilities planning is difficult as well because it is difficult to estimate the longevity of drainage facilities and structures.

Opportunities for replacing and expanding drainage facilities do exist. Priority expenditures for capital improvements which are necessary to ensure facilities are adequate have been identified through the year 2012. Deficiencies in areas complying with existing LOS standards are expected to have facilities upgraded to meet adopted LOS over the next thirteen years. Spending projections allow for the difficulty in estimating facility longevity by including a category of spending called 'other' in the capital facilities plan. Growth in the undeveloped areas of the county is being closely scrutinized during the permitting process to ensure adopted LOS standards will be met. Concurrency is more easily achieved in the undeveloped areas of the county because land is more readily available for facility siting.

E. Assessment of regulations and programs. Providing good drainage while, at the same time, promoting aquifer recharge with water of desirable quality, requires careful design and placement of drainage systems. Section 5-182(d) of The Broward County Land Development Code (LDC), requires adequacy of water management works prior to the issuance of any development permit in the unincorporated area. Section 5-198(d) of the LDC requires adequacy of water management works for developments within municipalities which are required to plat. Adequacy of water management is based upon compliance with applicable provisions of the Broward County Code of Ordinances, Broward County Administrative Code, Water Resource Management Regulations, and Drainage Design Criteria and the "Minimum Standards Applicable to Public Right-of-Way Under Broward County Jurisdiction" of the Broward County Engineering Division in conjunction with the adopted drainage or Water Resources Management Master Plans of the County, and of any other governmental agency having jurisdiction over the area.

IV. IMPLEMENTATION

A. Authority. The Broward County Water Management Division (WMD) was created in 1983 by merging the Broward County Water Management Division with the Section 208 staff of the Broward County Planning Council. Established by Section 40.11 of the Broward County Administrative Code, the WMD was vested with the responsibilities of the Water Management Division created by Chapter 61-1969, Special Acts, Laws of Florida. This included the responsibility for county-wide issuance of water management works permits, in accordance with the "Water Management Regulations and Standards" manual, July, 1977. Following another

reorganization, that authority is now exercised by the EPGMD. The WMD also acts as the staff to various dependent water management districts.

The DNRP was established in 1991 pursuant to Section 8.17 of the Charter of Broward County. The County Charter transferred and vested County Government (DNRP) the authority of the Broward County Environmental Quality Control Board (EQCB) originally created by the Broward County Charter. DNRP's successor agency, first DPEP and currently EPGMD, has the power to adopt regulations which must then be ratified by the Board of County Commissioners. The EPGMD exercises jurisdiction over all of Broward County through existing regulations. Water quality standards for both surface waters and groundwaters are established and enforced by the EPGMD as part of its responsibilities for water pollution control and abatement. The EPGMD maintains a surface water quality and ground water monitoring network throughout the County and regulates wastewater discharge. Also, the EPGMD has promulgated storage tank and hazardous materials regulations intended to prevent contamination of the aquifer. A license is required from the EPGMD for any dredging and filling within the "regulated aquatic and wetland resources" as defined in Chapter 27 Article 11 of the Broward County Code of Ordinances.

There are fourteen independent and nine dependent special taxing districts within Broward County which are responsible for operating and maintaining drainage systems within their boundaries. Independent special taxing districts have final authority for decisions regarding taxes levied against property owners. Four of the dependent special taxing districts are reliant upon the Broward County Board of Commissioners for taxing authority, while the Bonaventure Development District, Indian Trace Development District, Lauderdale Isles Water Management District, North Lauderdale Water Control District, and Twin Lakes Water Control District rely upon the local municipal commissions in which they are located. The independent water management districts issue surface water management permits within their respective districts. The EPGMD exercises jurisdiction for surface water management in all other areas of the County, including the County's dependent drainage districts.

The South Florida Water Management District (SFWMD), formerly known as the Central and Southern Florida Flood Control District, is the primary drainage permitting authority for South Florida. Its water management permitting program was initiated in 1976 through Chapter 373, Florida Statutes. Permitting rules and permitting criteria are contained within Chapters 40E-4, 40E-40, and 40E-41 Florida Administrative Code (FAC) with detailed information and criteria contained within "Management and Storage of Surface Waters - Permit Information Manual Volume IV".

The Florida Department of Environmental Protection and the South Florida Water Management District have delegated authority to the Broward County Environmental Protection and Growth Management Department (EPGMD) for certain permitting, compliance and enforcement responsibilities, in the geographical areas of Broward County outside of the independent drainage districts, associated with the implementation of the Environmental Resource Permit

(ERP) program under the authority of Chapter 373 Florida Statutes. There is no project acreage limitation on EPGMD's delegated authority.

The SFWMD may also delegate its water management permitting functions for projects less than forty acres to local governments under the authority of Chapter 373 Florida Statutes. Three independent drainage districts have obtained this permitting authority. The Coral Springs Improvement District, North Springs Improvement District, and Old Plantation Water Control District may review and approve permits for projects under 40 acres, without SFWMD review. The Plantation Acres Improvement District has the same condition, but with a 10 acres threshold.

The U.S. Army Corps of Engineers (COE) permitting authority emanates from the Rivers and Harbors Act of 1899 and the Federal Water Pollution Control Amendments of 1972 and 1977. Current permitting authority extends to dredge and fill activities in waters of the United States. The Florida Department of Environmental Protection (DEP) also has permitting authority with regard to dredge and fill activities in state waters, although Broward County ha been given authority to issue these permits within certain areas of the County. Policy 7.2.9 addresses FDEP issuance of environmental resource permits.

Most municipalities conduct limited water management reviews and issue permits in accordance with Section 4605 of the South Florida Building Code which states, that it is unlawful to commence any work involving surface or other drainage work without a permit. The Broward County Development and Environmental Regulation Division routes all approvals for projects located outside of the boundaries of the independent drainage districts through the WRD for review and permitting of water management facilities.

B. Sources. The primary document used to develop this Element is the Analysis of Water Management Review and Permitting in Broward County, Florida, 1986, prepared by the Economic Development Council of Broward County and the Broward County Water Resources Management Division, and the SFWMD's Atlas.

V. APPENDICES

APPENDIX 7-A
Water Control Districts
Broward County (2006)

District Name	Type	Local Government Authority	Creation Documents	Statutory Authority	Permitting Program
Bonaventure Development District	Dependent	City of Weston	City Ordinance 98-61 Ch 2001-303 LOF	189.4041 F.S.	Permitting of district facility usage
Central Broward Water Control District	Independent	Broward County	Ch. 61-1439, 65-1006, 70-479, 91-350, 94-426 LOF	Section 298.01 F.S.	Permitting of district facility usage
Cocomar Water Control District	Dependent	Broward County	Margate City Ordinance 80-23, Coconut Creek City Ordinance 109-80	Section 298.01 F.S.	Permitting of all water facilities within district
Coral Bay Community Development District	Independent	City of Margate	City Ordinance 89-22	Chapter 190, F.S.	Permitting of district facility usage
Coral Springs Improvement District	Independent	Broward County	Ch. 70-617, LOF	Chapter 298, F.S.	Surface water management; permitting projects less than 40 acres (by delegation of SFWMD); permitting facility usage
Cypress Cove Community Development District	Independent	City of Margate	City Ordinance 90-7	Chapter 190, F.S.	Permitting of district facility usage
Indian Trace Community Development District	Dependent	City of Weston	City Ordinance 18	189.4041 F.S.	Permitting of district facility usage
Lauderdale Isles Water Management District	Dependent	City of Fort Lauderdale	County Resolution 11/17/70; Ch. 77-518 LOF	Ch 298 F.S.	Permitting of district facility usage

APPENDIX 7-A
Water Control Districts
Broward County (2006)

District Name	Type	Local Government Authority	Creation Documents	Statutory Authority	Permitting Program
North Springs Improvement District	Independent	Broward County	Ch. 71-580, LOF	Ch 298 F.S.	Surface water management; permitting projects less than 40 acres (by delegation of SFWMD); permitting facility usage
North Lauderdale Water Control District	Dependent	City of North Lauderdale	Ch. 63-661 LOF	Ch 298 F.S.	Permitting of district facility usage
Oakridge Community Development District	Independent	City of Hollywood	City Ordinance 95-71	Chapter 190, F.S.	Permitting of district facility usage
Old Plantation Water Control District	Independent	Broward County	Ch. 99-435, LOF	Section 298.01 F.S.	Surface water management; permitting projects less than 40 acres (by delegation of SFWMD); permitting facility usage
Pine Tree Water Control District	Independent	Broward County	Ch. 61-1979, 85-391, 93-372, 94-430, LOF	Ch 298 F.S.	Permitting of district facility usage
Plantation Acres Improvement District	Independent	Broward County	Ch. 2002-367, LOF	189.404 F.S.	Surface water management; permitting projects less than 40 acres (by delegation of SFWMD); permitting facility usage

APPENDIX 7-A
Water Control Districts
Broward County (2006)

District Name	Type	Local Government Authority	Creation Documents	Statutory Authority	Permitting Program
South Broward Drainage District	Independent	Broward County	Ch. 98-524, LOF	Section 298.01 F.S.	Permitting of district facility usage
Sunshine Water Control District	Independent	Broward County	Ch. 63-661 LOF	Section 298.01 F.S.	Permitting of district facility usage
Tindall Hammock Irrigation & Soil Conservation District	Independent	Broward County	Ch. 98-523 LOF	189.404 F.S.	Work within the District (rights-of-way) and surface water management
Turtle Run Community Development District	Independent	City of Coral Springs	City Ordinance 86-163	Ch. 190, F.S.	Surface water management
Twin Lakes Water Control District	Dependent	City of West Park	County Resolution 12/29/70	Section 298.01 F.S.	Permitting of district facility usage
West Lake Community Development District	Independent	City of Hollywood	City Ordinance 93-15	Ch. 190, F.S.	Permitting of district facility usage
Broward County Water Control District # 2	Dependent	Broward County	Chapter 61-1969; LOF	Section 298.01 F.S.	Permitting of all water facilities within district
Broward County Water Control District # 3	Dependent	Broward County	Chapter 61-1969; 90- 487; 91-348, LOF	Section 298.01 F.S.	Permitting of all water facilities within district
Broward County Water Control District # 4	Dependent	Broward County	County Resolution # 1998-850	Section 298.01 F.S.	Permitting of all water facilities within district

Source: http://www.floridaspecialdistricts.org/OfficialList/by_distr.asp

APPENDIX 7-B
Broward County Water Basins
Functions and Level of Service Standards

WCA 2A	To provide viable wetland habitat; to detain and store flood and drainage water during the wet season for water supply during the dry season; to prevent water accumulating in the Everglades from overflowing into urban and North New River and Miami lands in eastern Broward County; to receive and store regulatory releases from Lake Okeechobee and WCA 1; to provide conveyance for water supply releases from Lake Okeechobee to eastern Broward County; and to supply water to eastern Broward County and WCA 2B.	Designed to pass the Standard Project Flood.
WCA 2B	To provide viable wetland habitat; to recharge regional groundwater (i.e., the Biscayne Aquifer);to supply water to adjacent basins in Broward County; to receive and store regulatory discharges from WCA 2A; and to prevent water accumulating in the Everglades from overflowing into urban and agricultural lands in eastern Broward County.	Designed to pass the Standard Project Flood.
WCA 3A	To provide viable wetland habitat; to detain and store flood and drainage water during the wet season for water supply during the dry season; to prevent water accumulating in the Everglades from overflowing into urban and agricultural lands in eastern Dade and Broward counties; to receive and store regulatory releases from Lake Okeechobee and WCA 2A; to provide conveyance for water supply releases from Lake Okeechobee to eastern Dade County and Everglades National Park (ENP); and to supply water to eastern Dade County and ENP.	Designed to pass the Standard Project Flood.

APPENDIX 7-B
Broward County Water Basins
Functions and Level of Service Standards

WCA 3B	To provide viable wetland habitat; to recharge regional groundwater (i.e., the Biscayne Aquifer);to supply water to adjacent basins in Dade County; to provide conveyance for water supply releases from Lake Okeechobee and WCA 3A to eastern Dade County and southeastern Everglades National Park (ENP) to receive and store regulatory discharges from WCA 3A; to prevent water accumulating in the Everglades from overflowing into urban and agricultural lands in eastern Dade County; and when WCA 3B can not store the regulatory discharges from WCA 3A, to provide conveyance for the discharges through the WCA for subsequent discharge to tidewater.	Designed to pass the Standard Project Flood.
Hillsboro Canal	To provide flood protection and drainage for the basin; to supply water to the basin during periods of low natural flow; to convey excess water from WCA 1 to tidewater; to intercept and control seepage from WCA 2A; and to maintain a groundwater surface elevation west of the Deerfield Lock adequate to prevent saltwater intrusion into local groundwater.	There is no design storm for the Hillsboro Canal as it was constructed prior to the Project. The Hillsboro Canal above the Deerfield Lock provides flood protection of approximately three-quarters of an inch of run-off per day; however, allowable runoff into the canal above Deerfield Lock is 1.3 inches of runoff per day.
Cypress Creek (C-14) Canal	To provide flood protection and drainage for the basin; to supply water to the C-14, the Pompano Canal and the C-13 basins during periods of low natural flow; to convey excess water from WCA 2A to tidewater; to intercept and control seepage from WCA 2A; and to maintain a groundwater surface elevation west of the S-37A adequate to prevent saltwater intrusion into local groundwater.	The eastern basin was designed for 1 - 30 year flood protection; the western basin was designed for 1 -10 year flood protection.

APPENDIX 7-B
Broward County Water Basins
Functions and Level of Service Standards

Pompano Canal	To provide flood protection and drainage for the basin; to supply water to the basin during periods of low natural flow; and to maintain a groundwater surface elevation west of the G-57 adequate to prevent saltwater intrusion into local groundwater.	Designed for 1 - 25 year flood protection.
Middle River (C-13) Canal	To provide flood protection and drainage for the basin; to supply water to the basin during periods of low natural flow; to intercept and control seepage from WCA 2B; to supply water to the City of Plantation in the North New River Canal basin; and to maintain a groundwater surface elevation west of the S-36 adequate to prevent saltwater intrusion into local groundwater.	The C-13 was designed to provide 1 - 25 year flood protection.
Plantation (C-12) Canal	To provide flood protection and drainage for the basin; to supply water to the basin during periods of low natural flow; and to maintain a groundwater surface elevation west of the S-33 adequate to prevent saltwater intrusion into local groundwater.	The C-12 was designed to provide 1 -25 year flood protection.
North New River Canal	To provide flood protection and drainage for the basin; to supply water to the basin during periods of low natural flow; to convey excess water from WCAs 2A, 2B, and 3A to tidewater; and to intercept and control seepage from WCA 2B.	Adequate for 1 -25 year protection.

APPENDIX 7-B
Broward County Water Basins
Functions and Level of Service Standards

South New River (C-11) Canal	To provide flood protection and drainage for the basin; to supply water to the basin during periods of low natural flow; to intercept and control seepage from WCA 3A; and to maintain a groundwater surface elevation west of the S-13 adequate to prevent saltwater intrusion into local groundwater.	The C-11 system was designed to provide flood protection of up to three-quarters of an inch of runoff per day from the western basin. The pumping station at S-13 was designed to provide the eastern basin with flood protection of up to three-quarters of an inch of runoff per day. Depending on the headwater and tailwater stages at the S-13 spillway, gravity flow from the eastern C-11 basin to the east may provide additional flood protection of up to three-quarters of an inch of runoff per day.
Hollywood (C-10) Canal	To provide flood protection and drainage for the basin.	The C-10 was designed to pass the Standard Project Flood.
Snake Creek (C-9) Canal	To provide flood protection and drainage for the basin; to supply water to the C-9 basin for irrigation and municipal water supply during periods of low natural flow; to intercept and control seepage from WCA 3B; and to prevent saltwater intrusion into local groundwater.	The C-9 in the eastern basin was designed to pass the Standard Project Flood. The western subbasin is prone to flooding because of low ground surface elevations relative to the eastern subbasin.

APPENDIX 7-C
Broward County Water Structures
Design Criteria

Basin	Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Q (cfs)	Peak Stage (ft NGVD) and Q (cfs)
Hillsboro	Deerfield Lock (G-56) Stage divide	Weir with flashboards 5-bays, 12 ft each Crest lgth = 60 ft Crest elev = 1.0 ft NGVD gated Spillway Crest lgth = 25 ft Crest elev = 4.5 ft NGVD	4.0	3.5	HW=7.7	1,600	HW = 10.86 TW + 9.2 Q = 3,700
	S-39 Water supply, regulatory releases to Hillsboro Canal from WCA-1	Spillway Taintor gate 16 ft x 9.2 ft Weir lgth = 15 ft Crest elev = 2.5 ft NGVD	11.0	9.0	TW = 9.0 max HW = WCA 1 Regulation schedule	800	TW=12.39
	S-39A Stage divide	Culvert with riser and stop logs 3 - 72 in x 54 ft CMP			HW =7.0 to 7.5		
	S-38B Divide C-14 and Hillsboro basins	Gated Culvert 1 - 66 in x 72 ft CMP Invert elev = 0 ft NGVD	9.0	7.65			
C-14	S-37A Stage divide	Spillway, 2 gates 25 ft x 12.8 ft Crest lgth = 50 ft Crest elev = 7.7 ft NGVD	3.0	2.0	HW=3.5	3,890	HW = 5.19 TW = 4.28 Q = 3,800 Q = 3,060 (measured)

APPENDIX 7-C
Broward County Water Structures
Design Criteria

Basin	Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Q (cfs)	Peak Stage (ft NGVD) and Q (cfs)
C-14	S-37B Stage divide	Spillway, 2 gates 25 ft x 6.6 ft Crest lgth = 50 ft Crest elev = 0 ft NGVD	7.2	4.7	HW=7.5	3,390	HW = 8.99 TW = 6.14 Q = 3,108 (measured)
	G-65 Divide C-14 and Pompano Canal	Gated Culvert 1 - 54 in x 1,500 ft RCP Invert elev = 0 ft NGVD			TW = 4.5 (at G-57)	50 - 55 (water supply)	
	S-38C Stage divide, C-13 and C-14 water supply C-13	Culvert with risers and stop logs 2 - 72 in x 35 ft CMP Invert elev = 1.55 ft NGVD					
	S-38A Stage divide, L-36 stage and C-14 stage	Culvert with risers and stop logs 2 - 60 in x 70 ft CMP Invert elev = 1.55 ft NGVD	9.0	8.0	HW = 7.65	190	
	S-38 Water supply, C-13 and C-14	Gated Culvert 2 - 72 in x 52 ft Invert elev =2 ft to 3 ft NGVD	9.8	7.0	TW = 8.2 max (not to exceed 8.2)	500	HW = 15.47 TW = 10.47 Q = 586
Pompano	G-57 Stage divide	Steel sheet - pile dam with 6-bay, flashboard controlled weir Net lgth = 31.5 ft Crest elev = 2.5 ft NGVD			HW = 4.5 (dry season) HW = 2.5 (flood conditions)	375	HW = ~5.5

APPENDIX 7-C
Broward County Water Structures
Design Criteria

Basin	Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Q (cfs)	Peak Stage (ft NGVD) and Q (cfs)
Pompano	G-65 Divide C-14 and Pompano Canal	Gated Culvert 1 - 54 in x 1500 ft RCP Invert elev = 0 ft NGVD			TW = 4.5 (at G-57)	50 - 55 (water supply)	
C-13	S-36	Spillway, 1-gate 25 ft x 14 ft Crest lgth = 25 ft Crest elev = 7 ft NGVD	5.6	5.0	HW = 4.5	1,560	HW = 7.38 TW = 5.71 Q = 2390
	S-125 Divide C-13 and North New River Canal (Water supply to City of Plantation)	Gated Culvert 1 - 48 in x 40 ft CMP Invert elev = 2 ft NGVD	6.5	6.0	HW = 6.0 TW = 3.5 - 4.5 (at Sewell Lock)	40 (Regulatory releases)	HW = 8+
	S-38C Stage divide, C-13 and C-14 water supply C-13	Culvert with risers and stop logs 2 - 72 in x 35 ft CMP Invert elev = 1.55 ft NGVD					
	S-38 Water supply, C-13 and C-14	Gated Culvert 2 - 72 in x 52 ft CMP Invert elev = 2 - 3 ft NGVD	9.8	7.0	TW = 8.2 Maximum	500	HW = 15.47 TW = 10.47 Q = 586
	S-124 Normal flow-closed Flood conditions - open	Gated Culvert 5 - 72 in x 48 ft CMP Invert elev = 1 ft NGVD	7.02	6.57	HW =5.0 - 5.5	490	*HW = 7.8+ TW = 6.86 *HW may have been above 8.0

APPENDIX 7-C
Broward County Water Structures
Design Criteria

Basin	Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Q (cfs)	Peak Stage (ft NGVD) and Q (cfs)
C-12	S-33 Stage divide	Spillway, 1-gate 20 ft x 9 ft Crest lgth = 20 ft Crest elev = 2 ft NGVD	5.9	4.9	HW=35	920	HW = 6.13 TW = 5.89 Q = 614
North New River	Sewell Lock (G-54) Stage divide	Flash board spillway 8 bays Net lgth = ~ 45 ft Weir elev = 3.6 ft NGVD	3.5	3.0	HW=3.5- 4.0	1,300	HW = 5.97 TW = 4.66 Q = 2040
	S-124 Normal flow - closed Flood conditions - open	Gated Culvert 5 - 72 in x 49 ft CMP Invert elev = 1 ft NGVD	7.02	6.57	HW = 5.0 - 5.5	490	*HW = 7.8+ TW = 6.86 *HW may have been above 8.0
	S-34 Water supply to NNR Canal	Gated Culvert 2 - 72 in x 133 ft CMP Invert elev = 3 to -4 ft NGVD	16.9	6.0	HW = ~ 11 - 11.5 TW = 3.5 - 4.0 TW = 6.0 max	350	HW = 13.08 TW = 7.05 Q = 728
	S-125 Divide C-13 and North New River Canal (Regulatory releases to NNRC from C-13	Gated Culvert 1 - 48 in x 40 ft CMP Invert elev = 2 ft NGVD	6.5	6.0	HW = 6.0 TW = 3.5 - 4.5 (at Sewell Lock)	40 (Regulatory releases)	HW = 8+
	G-123 Pumps from NNRC to WCA-3A	Pumping Station 4 units: 100 cfs each	2.0	12.0	HW = 3.5 HW = 11.0	400	

APPENDIX 7-C
Broward County Water Structures
Design Criteria

Basin	Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Q (cfs)	Peak Stage (ft NGVD) and Q (cfs)
North New River	S-141 Stage divide	Sheet-pile overflow weir in L-38E Flashboard control Crest lgth = 30 ft Crest elev = 7 ft NGVD	10.0	8.0	Regulation Schedule in WCA 2B	435	
	S-142 Stage divide Water supply	Gated Culvert 2 - 72 in x 42 ft CMP Invert elev = 2 ft NGVD	11.0	9.0	Regulation Schedule in WCA 3A	500	
	S-143 Stage divide Water supply	Gated Culvert 2 - 72 in x 70 ft CMP Invert elev = 2 ft NGVD	13.0	10.0	Regulation Schedule in WCA 2A	500	
C-11	S-13 Stage divide	Pump and spillway, 3 units, 180 cfs each 1 - 16 ft x 11.3 ft gate Weir lgth = 16 ft Weir crest elev = -8 ft NGVD	1.2 (gravity) 2.2 - 2.5 (pump)	1.0 (gravity) 6.2 - 6.5 (pump)	HW = 1.6 (gravity) HW = 2.2 (gravity)	540 (gravity) 540 (pumped)	HW = 4.02 TW = 4.85 Q = 1050
	S-13A Divide structure during flooding	Gated Culvert 2 - 72 in x 66 ft CMP 2 - 54 in x 60 ft CMP	2.5	2.0	3.0 to west	120	HW (west) 6.27 TW (east) 4.79
	S-9	Pump, 3 units 960 cfs each	4.0	14.4	HW = 3.0 - 3.5	2,880	Intake = 6.1 Q = 2060

APPENDIX 7-C
Broward County Water Structures
Design Criteria

Basin	Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Q (cfs)	Peak Stage (ft NGVD) and Q (cfs)
C-11	S-9XS Stage divide	Culvert with risers and stop logs 2 - 72 in x 42 ft CMP Invert elev = -1 ft NGVD			HW = 6.8		
	S-9XN Stage divide	Culvert with risers and stop logs 2 - 72 in x 84 ft CMP Invert elev = -4.8 ft NGVD			HW=6.0		
	G-86S Stage divide	Culvert with risers and stop logs 1 - 60 in x 135 ft CMP Invert elev = -1.14 ft NGVD			HW = 5.5		
	G-86N Stage divide	Culvert with risers and stop log 1 - 60 in x 135 CMP Invert elev = -1 ft NGVD			HW = 5.5		
	G-87 Presently used as a drainage divide between C-11 and C-9 basins	Gated Culvert 1 - 84 in x 75 ft CMP Invert elev = -5 ft NGVD				(Divide structures)	
C-9	S-29 Stage divide	Spillway, 4 gates 22 ft x 15 ft Crest lgth = 88 ft Crest elev = -11 ft NGVD	3.0	2.5	HW = ~2.0	4,780	HW = 3.88 Q = 4,100

APPENDIX 7-C
Broward County Water Structures
Design Criteria

Basin	Structure	Type	Design HW Stage (ft NGVD)	Design TW Stage (ft NGVD)	Optimum Stage (ft NGVD)	Design Q (cfs)	Peak Stage (ft NGVD) and Q (cfs)
C-9	S-31 Controls outflows from CA-3B to C-6	Gated Culvert 3 - 84 in x 172 ft CMP Invert elev = -3 ft NGVD	6.0	4.0		700	TW = 6.59 Q = 1090
	S-30 Controls water stored between L-30 and SR 27	Gated Culverts 3 - 84 in x 288 ft Invert elev = -5 ft NGVD					
	S-32 Water supply to C-9	Gated Culvert 2 - 72 in x 40 ft CMP Invert elev = -2 ft NGVD	2.5	~1.60	TW = 2.0 HW = 6.0	2	HW = 6.59
WCA 2A							
WCA 2B							
WCA 3A							
WCA 3B							

KEY TO ABBREVIATIONS USED IN APPENDIX 14-B

in = inches
ups = upstream
cfs = Cubic feet per second
ft NGVD = Feet relative to National Geodetic Vertical Datum
Lgth = length
ft = feet
elev = elevation
CMP = Corrugated metal pipe
TW = Tail water
Q = discharge in cfs
HW = Head water
RCP = Reinforced concrete pipe
ds = downstream

SOURCE: An Atlas of Eastern Broward County Surface Water Management Basins, by Richard M. Cooper and Jim Lane (November 1987), South Florida Water Management District.