STORMWATER DRAINAGE SYSTEMS IN MIAMI-DADE COUNTY:

MOSQUITO CONCERNS, ALTERNATIVES AND PROPOSED ACTIONS

Miami-Dade County

DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

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Executive Summary

The presence of mosquitoes in two County neighborhoods, Westwood Lakes (vicinity of SW 42nd St. and 108th Ave.) and Winston Park (vicinity of SW 72 – 76 St. and 128 Ave.) has led to the perception that newly installed drainage inlets in these areas are associated with a possible increase in mosquito population.

The Department of Environmental Resources Management, Public Works and the State Health Department agreed on April 22, 2005 to undertake an evaluation of the mosquito problems first in the Westwood Lakes neighborhood and later the Winston Park area. Fieldwork was conducted to evaluate the conditions in the neighborhoods and the drainage designs standards and construction methods were reviewed in relation to their effect on mosquito populations. In any type of drainage evaluation, it needs to be understood that Miami Dade County is a subtropical area with an annual rainfall of approximately 60 inches, the majority occurring during the summer-fall period. So much rain combined with low land elevations and a high ground water table requires drainage systems that are specifically tailored to such tropical conditions. In addition, the County's location between large wetland areas in the Everglades and Biscayne Bay lead to the migration of very large mosquito populations into the urbanized areas, specifically during the summer months and are the main cause of mosquito problems in the County.

The evaluation of the newly constructed drainage systems in the Westwood Lakes and Winston Park neighborhood's concluded that those systems were designed and built according to standards. In addition, drainage methodologies from other states were reviewed, but were found not to be applicable to our subtropical climate and unique physical conditions such as high groundwater table and flat topography. It is a physical fact that catch basins will always contain water during the wet season (May to November) due to the occurrence of rain on a near daily basis and the subsequent high ground water table. However, the area occupied by all catch basins in unincorporated Dade County is extremely small when compared to the total county area and the vast areas of wetlands along the coast and western reaches that are prime habitat for mosquitoes. It needs to be understood that good drainage prevents mosquito problems by keeping large areas dry. Conversely, poor drainage results in flooded streets which increase the risk of property damage, traffic accidents and injuries.

There are a number of actions that can be taken to minimize the existence of mosquitoes in drainage catch basins. Those actions are as follows:

1. During portions of the dry season (February – April), there may be a very small number of catch basins with bottom elevations high enough where they may not intersect the groundwater table and which could therefore drain out of the bottom through weep holes. Accordingly, all new catch basins will be installed as high as possible and those structures with bottom elevations above the May water table will contain weep holes. In addition, existing catch basins within the Westwood Lakes and Winston Park neighborhoods that also are above the May water table will have their weep holes restored.

2. All catch basins in the County will be progressively evaluated and those that are high enough (above May water table) will have their weep holes restored.

3. Throughout the year and in particular during the summer, the Mosquito Control division will abate problems as they are reported. The County is actively seeking additional funding to enhance their mosquito control activities.

In conclusion, it needs to be understood that water in drainage catch basins during the wet season is inevitable due to our climate and geographical conditions. However, as a general principle, good drainage prevents mosquito problems by keeping large areas dry while preventing traffic hazards and property damage.

Introduction

Recent concerns about the proliferation of mosquitoes in certain areas of Miami-Dade County have led to the perception that newly installed drainage inlets in these areas are associated with a possible increase in the mosquito population. Claims have been made regarding water in the catch basins as mosquito-breeding habitats while the number of structures installed in the affected areas has been questioned. One major goal of an effective local government drainage plan is to establish drainage systems that are effective in handling the runoff generated during the wet season. Additionally, as more development occurs within the County, the need for additional drainage capacity becomes more critical. As the percentage of concrete or paved areas increases, the amount of pervious areas (vacant land) needed to help drain stormwater runoff is reduced.

Drainage design in Miami-Dade County is a unique and challenging process. The low land elevations characteristic of the region, combined with a high water table and its flat topography, require a design approach consistent with standard engineering practices established by Miami-Dade County, the South Florida Water Management District (SFWMD), and the Florida Department of Transportation (FDOT). The development of areas that were previously considered swampland makes it difficult to maintain a balance between the needs of current residents and the geographical, geological and hydrological constraints characteristic of South Florida. Retrofitting existing drainage systems in Miami-Dade County is complicated even more by the existence of older subdivisions that have grade elevations lower than what is presently required by the Federal Emergency Management Agency (FEMA) and County code.

Additionally, the metropolitan area experiences a subtropical climate with an annual rainfall of approximately 60 inches, with a pattern of precipitation characterized by a dry winter-spring period and a wet summer-fall period. The intensity of the wet season requires a drainage infrastructure that can handle a typical storm event, the 5-year storm, which has a 20% statistical probability of occurring on a given year. Other states where annual rainfall is considerably less than that of South Florida, and where the geology and topography is different, require stormwater infrastructure and Best Management Practices (BMP's) that are different from those used in the metropolitan area of Miami-Dade County.

Westwood Lakes and Winston Park Areas

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Both the Westwood Lakes and the Winston Park areas are considered typical residential neighborhoods. Westwood Lakes was developed in the mid-1950's, and Winston Park in the late 1970's. In particular, the Westwood Lake area was developed when the County had limited drainage standards for levels of service for drainage, and both areas lie within flood zones. In addition, flood insurance companies in these two neighborhoods have paid out a total of nine (9) repetitive flood insurance claims over the past fifteen years. The Federal Emergency Management Agency (FEMA) defines a repetitive loss as a property where two (2) or more flood losses of $1,000.00 or more are paid within a ten-year period. The losses in both areas totaled over $98,000.00 (Attachment A). Since FEMA subsidizes flood insurance payouts, these losses present a continuous financial burden to federal authorities who in turn have asked Miami-Dade County to find ways to mitigate the flood damages. Additionally, both areas were documented as experiencing damages after two major flood events, one in 1999 and the other in 2000, leading to the federally funded improvements that were constructed. These improvements were designed and constructed after a carefully planned process was created in which all FEMA identified project areas were evaluated, designed, and built meeting established engineering standards

typical for these types of projects. A description of the federally funded program, known as the "Westwood Lakes and Winston Park FEMA Drainage Projects Report" can be found in Attachment B.

Drainage Inlets in Westwood Lakes, Winston Park and Unincorporated Miami Dade County

A review of records indicates that a total of 1,231 drainage structures were installed in the areas of Westwood Lakes and Winston Park. Specifically, in the Westwood Lakes area, the 856 recently installed inlets are equivalent to an area of approximately 0.14 acres. Of these catch basins, 152 have a bottom elevation above the May water table, (the time of the year when the groundwater is at its lowest level). These 152 structures are equivalent to an approximate area of 0.025 acres or 0.004% of the total square mile considered for the evaluation of Westwood Lakes.

The Winston Park area has 375 recently installed drainage inlets, which are equivalent to an area of approximately 0.06 acres. Of these structures 24 have a bottom elevation above the May water table. These 24 catch basins are equivalent to an approximate area of 0.004 acres or 0.0006% of the total square mile considered for the evaluation of Winston Park.

Currently, there are approximately 85,000 catch basins installed throughout unincorporated Miami-Dade County (UMDC). With an average diameter of 3 feet, these catch basins are equivalent to an area of approximately 14 acres. This represents 0.009% of the total 148,918 acres of green (pervious) area within the developed areas of UMDC. When compared with both green and developed (pervious and impervious) areas of the UMDC, these catch basins correspond to 0.007% of the total area. If the equivalent 14 acres of catch basins were compared to the total County area, including the vast areas of wetlands along the coast and western reaches, that are prime habitat for mosquitoes, the number would be miniscule. These large areas of wetlands generate very large mosquito populations that migrate into the urbanized areas during the summer months and are the main cause of mosquito problems in the County.

It is evident that the drainage inlets installed occupy a very small percentage of the land area within Miami-Dade and the Westwood Lakes and Winston Park areas, yet they provide a valuable service in reducing flooding. The drainage design process considered all critical low points identified by the topographic survey to ensure that the highest possible flood levels of service were provided to the residents of the Winston Park and Westwood Lakes. The installation and location of these drainage inlets is the result of a process that involved the evaluation of the existing drainage systems, past flood claims, the effects of Hurricane Irene in 1999 and the storm of 2000, and the existing topography of the sites. All design plans and supporting calculations were subjected to a rigorous review process for compliance with regulations established by local and state agencies.

Swales as an Alternative to the Construction of Drainage Systems with Catch Basins

Based on a detailed evaluation of the topography of the area and standard engineering practices, the design engineer determines the necessary number of inlets required for a particular area. This evaluation is critical to the implementation of every drainage system in Miami-Dade County due to the flat nature of the terrain. Neighborhoods such as Westwood Lakes and Winston Park were developed using swales as the primary and, in many cases, only drainage system. Grass swales are the least expensive method of stormwater treatment and conveyance. When not used as a conveyance, swales serve as linear retention ponds that store stormwater runoff until it infiltrates into the ground. Being similar to retention ponds, swales are the next choice for stormwater treatment. Often called ditches, swales have a depth of 2 feet or less, side

slopes of 4:1 or flatter, and a vegetative lining to prevent erosion. While swales play an important role in water quality as they help remove pollutants from stormwater runoff, over time they can become compacted, and lose their ability to infiltrate runoff. In addition, as areas become more developed and population increases, the numbers of vehicles per household also increases, leading to more vehicles parked in the swales. This exacerbates the compaction problem and increases the probability of standing water for prolonged periods of time.

Although they are an integral part of drainage systems, swales alone do not have enough capacity to handle the runoff generated during the typical summer storm event. Therefore, all drainage systems implemented in Miami-Dade County include swales, exfiltration trenches and drainage inlets to effectively drain public roads. It needs to be understood that the lack of effective drainage systems can result in flooded streets, and standing water in larger areas over longer periods of time, which can lead to greater mosquito problems. Specifically, good drainage prevents mosquito problems by keeping larger areas dry. Additionally, flooded streets increase the risk of traffic accidents, injuries and property damage. Furthermore, flooding can render streets impassable to emergency vehicles and cause potential health and safety hazards due to sanitary sewage overflows.

Alternative Stormwater Best Management Practices for Vector Control

An evaluation of alternative Stormwater Best Management Practices for vector control, such as those implemented by the California Department of Transportation (Caltrans) and the State of Virginia, was conducted in order to determine their feasibility within the economic, geographical, geological and hydrological constraints typical of Miami-Dade County.

Different Best Management Practices (BMP's) have been evaluated as possible alternatives to the standard stormwater management structures used to maintain or improve water quality and water quantity levels of service. The alternatives evaluated are as follows:

Alternative: Install drainage pipes at a minimum slope of 2% as recommended by the State of Virginia.

Advantage: Prevents the buildup of sediment and keeps water from backing up into the pipe.

Disadvantage: Due to the flat topography in South Florida, where the groundwater table is so close to the ground surface, it is unfeasible to install drainage pipes at a slope of 2% without completely submerging the pipe. The purpose of providing a slope to the pipe so that it drains out is defeated as the pipe will always be under water during the wet season. Additionally, all drainage retrofit projects must contend with the presence of underground utilities, which prevents the installation of pipes at a predetermined slope. Furthermore, the excavation cost associated with sloping the pipe would become prohibitive due to the need for special equipment and low production associated with rocky soils. In sandy soils, the increase in cost becomes exponential as a result of the need for trench shoring using sheet piles after 100 feet of sloped pipe. This measure would invariably result in deeper structures where one end of the pipe is dropped to lower than normal depth by the slope used, without any benefit since the pipe will be submerged during the wet season.

Alternative: Eliminate sumps in drainage structures below the invert of the pipe as recommended by the State of Virginia.

Advantage: Bottom of structure located at the same elevation as the drainage pipe prevents water from accumulating within the inlet at locations where the water table is below the invert of the pipe.

Disadvantage: The presence of the sumps in drainage structures is necessary for the accumulation of silt which would otherwise be flushed into the perforated pipe of the exfiltration trench and clog it, thus reducing significantly the system's life. A sump is critical for the installation of pollution retardant baffles, which must extend a minimum of 18 inches below the invert of the pipe. In the great majority of the cases, the bottom of a catch basin would be below the groundwater level for at least half of the year at the height of mosquito season.

Alternative: Implement positive drainage systems as recommended by the State of Virginia.

Advantage: Positive drainage systems do not retain runoff. Instead, they discharge it directly to surface waters, preventing water from accumulating in the system.

Disadvantage: Positive drainage systems are a direct link between the land and surface water bodies; they do not attenuate the chemical pollutants that pass through them. As such, they are considered a major source of surface water degradation by both the federal and local governments. Current local and state regulations prohibit the construction of positive drainage systems.

Alternative: Fill catch basins with large rocks.

Advantage: Large rocks within catch basins prevent mosquitoes from reaching the water surface where they can lay their eggs.

Disadvantage: Crevices between the rocks can still allow mosquitoes access to the water within the drainage system. Additionally, these crevices are more likely to clog up due to silting and vegetation within the structure. Large rocks interfere with the volume capacity of the structure, inhibit stormwater flow and diminish water quality benefits. Eventually, maintenance of these structures becomes more difficult and later becomes cost prohibitive as the silt and vegetation within the crevices of the rocks tend to compact and build up within the sump of the structure.

Alternative: Drill bottoms of catch basins through existing weep holes.

Advantage: Drilling through weep holes will loosen ground below catch basin to restore functionality.

Disadvantage: For most of the year, the high level of the groundwater will keep water in most catch basins. Only during the dry season will the few weep holes that are above the groundwater level drain the catch basins. A case-by-case evaluation of the weep hole effectiveness will be required based on the location of the catch basin, its depth, the ground elevation and the level of the groundwater during the dry season.

Alternative: Biofiltration strips and swales studied by Caltrans.

Advantage: Filtration of stormwater runoff through densely vegetated, trapezoidal surfaces excavated into the ground prevents standing water.

Disadvantage: In California, where the average yearly rainfall is 23 inches, large structures are required for a 1-year storm event. Conversely, in Miami-Dade County the average yearly rainfall is approximately 60 inches and the design storm is a 5-year storm event. Therefore, implementation of these swales is not feasible due to the dimensions of the swale that would be necessary to handle a 5-year storm event. Additionally, due to the the proximity of the groundwater to the land surface, which significantly reduces the swale depth and width; as well as the high cost of land, the use of swale areas in Miami-Dade County is limited to providing pre-treatment for water quality purposes.

Alternative: Media filters studied by Caltrans.

Advantage: Filtration of stormwater runoff through sedimentation or settling vaults prevents standing water.

Disadvantage: In southern California, large sedimentation vaults are sized to handle a 1-year, 24-hour storm event due to the low average yearly rainfall of 23 inches. In Miami-Dade County, an extremely large media filter would be required to handle the required 5-year, 24-hour design storm event standard. Exfiltration trenches used in Miami-Dade County are more efficient in the treatment of runoff generated by the design storm event since they discharge it into the groundwater.

Alternative: Extended detention basins studied by Caltrans.

Advantage: Shallow depressions lined with bare soil, vegetation or concrete prevent standing water as runoff slowly drains out through an outlet structure.

Disadvantage: Due to the high water table, it is almost impossible to construct extended detention basins in areas such as Miami-Dade County. This option is used in highways and interstate roadways by the State of California. In Miami-Dade County, extended detention basins are not a viable option due to the elevated price of real estate in South Florida and the high level of development, which would not make it feasible to purchase land for conversion into stormwater detention areas. In addition, most County projects are retrofit projects in existing developed areas. The purchase or condemnation of property for this purpose is not feasible.

Alternative: Infiltration basins studied by Caltrans.

Advantage: Depressions in the form of dry ponds detain stormwater. As water infiltrates into the ground, pollutants are captured by the soil and vegetation.

Disadvantage: Permeability must be restored periodically by removing trapped sediments. The high water table characteristic of South Florida makes it difficult for stormwater runoff to percolate completely into the ground to prevent standing water. This measure is cost prohibitive due to the elevated price of real estate in South Florida, the high level of development in Miami-Dade County and the fact that most County projects are retrofit projects in existing developed areas. The purchase or condemnation of property or this purpose is not feasible.

Alternative: Infiltration trenches studied by Caltrans.

Advantage: Open trenches filled with gravel to detain stormwater runoff and to prevent standing water. As water infiltrates into the ground, pollutants are captured by the soil and vegetation.

Disadvantage: Permeability must be restored periodically by removing trapped sediments. Percolation varies according to geographic location. Covered exfiltration trenches used in Miami-Dade County are more efficient in the treatment of runoff generated by the design storm event.

Alternative: *C*ontinuous deflective separators studied by Caltrans.

Advantage: Cylindrical underground devices which use a vortex, a screen and a sump to remove trash, debris, sand and sediments from stormwater runoff.

Disadvantage: Extensive additional mosquito-proofing measures make this device unfeasible as a best management practice. Additionally, it is too unwieldy as a retrofit device and too maintenance intensive to be cost effective.

Alternative: Oil/water separators studied by Caltrans.

Advantage: Cylindrical atmospheric vessel that contains three compartments to diffuse energy, settle solids and intercept oil.

Disadvantage: This large metal cylinder may be impractical to install at retrofit projects. The use of three-chamber pollution control structures is already standard engineering practice in Miami-Dade County prior to discharging stormwater into open bodies of water.

Alternative: Drain inlet inserts studied by Caltrans.

Advantage: Devices filled with filtering media to remove sediment, oil and grease. Located at the inlet entrance, they filter stormwater runoff while preventing mosquitoes from reaching the water surface inside the catch basin.

Disadvantage: These devices are maintenance intensive as they tend to clog with debris. The maintenance schedule required (removal of debris before and during each storm event) makes them economically unfeasible as a BMP for widespread use.

Alternative: Wet basins studied by Caltrans.

Advantage: These permanent pools of water, surrounded by wetland plants, treat stormwater runoff through physical and biological processes. Wet ponds provide both flood control and water quality enhancements.

Disadvantage: Accumulation of invasive emergent vegetation, which creates mosquito habitats, requires periodic maintenance. Additionally, due to the elevated price of real estate in South

Florida, along with the high level of development, the purchase or condemnation of privately developed land for conversion into wet ponds is not feasible for retrofit projects.

The evaluation of Best Management Practices being used in other states, such as Virginia and California, indicates that based on the economic, geographic, geological and hydrological constraints typical of Miami-Dade County, they are either inadequate to solve the problem, or create other undesirable, negative consequences.

Field Inspection of Drainage Inlets within Westwood Lakes and Winston Park

During May of 2005, staff from the Public Works Road Bridge and Canal Maintenance Division, the State of Florida Health Department and DERM inspected randomly selected drainage inlets within the Westwood Lakes area.
The following is a summary of the inspection findings:

- All catch basins had standing water inside, approximately up to the invert of the lowest pipe, prior to the cleaning by the Public Works maintenance crew.
- All ten structures had a weep hole present at the bottom of the structure.
- Eight of the ten structures had the weep hole blocked by a concrete knock-out, which apparently was not removed during construction. The remaining two structures had a functional weep hole
- No groundwater was observed re-entering the structures after cleaning, even the two structures with a functional weep hole. This is due to the time of year during which the cleaning took place, May, which is the month when the groundwater is at its lowest level.
- One more structure was added to the list of inlets to be studied. This inlet is located in front of 10850 SW 42 Street. This structure also had standing water inside prior to the cleaning and had a weep hole blocked with a concrete knock out.
- On June 2, 2005, a crew from the Public Works Road Bridge and Canal Maintenance Division re-established the weep holes on all nine structures studied. DERM staff was present during the establishment of the weep-holes.
- Upon establishment of the weep holes, and because of the start of the wet season, groundwater was observed seeping into all nine catch basins. This is due to the bottom of the catch basins being below the groundwater level.

On June of 2005, the Public Works Road, Bridge and Canal Maintenance Division inspected and cleaned nine (9) drainage inlets within the area of Winston Park. These inlets are located along SW 128 Avenue between SW 72 Street and SW 76 Terrace.

- The weep holes for these nine structures were established a day after the inspection.
- Groundwater was also observed seeping back into the catch basins as a result of the bottom of the structures being below the groundwater level.

Conclusions and Proposed Actions

After the inspection of the structures within Westwood Lakes and Winston Park, an evaluation of all 1,231 drainage structures installed in these two areas was conducted. The results indicate that 14% of the structures (176 inlets) had a bottom elevation above the May water table. May is the time of the year during which the groundwater is at its lowest level. County staff is currently working with contractors to inspect and re-establish the weep holes of these 176 structures so

that water accumulated in the sump can drain out during the limited dry season, from December to May.

It is important to note that during the wet season, a period of almost daily rainfall from May through November, the bottoms of the vast majority of catch basins within Miami-Dade County are submerged due to the rapid rise of the groundwater level, which renders weep holes ineffective. Unfortunately, the arrival of the wet season coincides with the onset of the mosquito season.

In order to address the increased concerns over mosquito breeding in newly installed drainage structures, DERM is implementing a new design criteria where installation of weep holes will be required for drainage structures whose bottom elevations are at, or above, the low month (May) water table elevation. This new criteria will reduce the amount of cases where water is present in catch basins during the dry season only. However, the weep hole will be rendered ineffective during the wet season, as the bottom of the catch basins will be submerged due to the rise of the groundwater level.

DERM will also implement a program to evaluate all existing drainage inlets to determine which catch basins have bottom elevations high enough to drain out during the dry season. Weep holes will be re-established on those existing drainage inlets that have the appropriate bottom elevation but may have been installed without a weep hole.

During the wet season, it is recognized that the vast majority of inlets will be submerged, rendering weep holes ineffective. For these situations, the County's Mosquito Control Division will abate problems as they are reported. Mosquito control should continue to implement treatment for abating mosquito breeding in drainage inlets through the use of Altosid tablets upon the receipt of complaints and field verification. According to Environmental Protection Agency (EPA) and the manufacturer's literature, the larvicide product is biodegradable, non-toxic, and will not affect humans, animals or the environment (See Attachment C). Due to the different types of available treatment duration options, the Public Works Department Mosquito Control Division should determine the most appropriate and effective methodology. The County is actively seeking additional funding to enhance their mosquito control activities.

Based on the economic, geographic, geological and hydrological constraints typical of Miami-Dade County, Best Management Practices used in other states are inadequate to solve local drainage problems. Therefore, the bulk of the efforts will be concentrated on ensuring that all new catch basins are installed as high as possible and that those structures with bottom elevations above the May water table contain weep holes. Once again, it needs to be understood that the ability to drain catch basins through bottom weep holes will be a function of the groundwater levels at the specific project locations. In most cases, catch basins may only drain out during the dry season (December - May).

As a general principle, good drainage prevents mosquito problems by keeping large areas dry, while preventing traffic hazards and property damage.