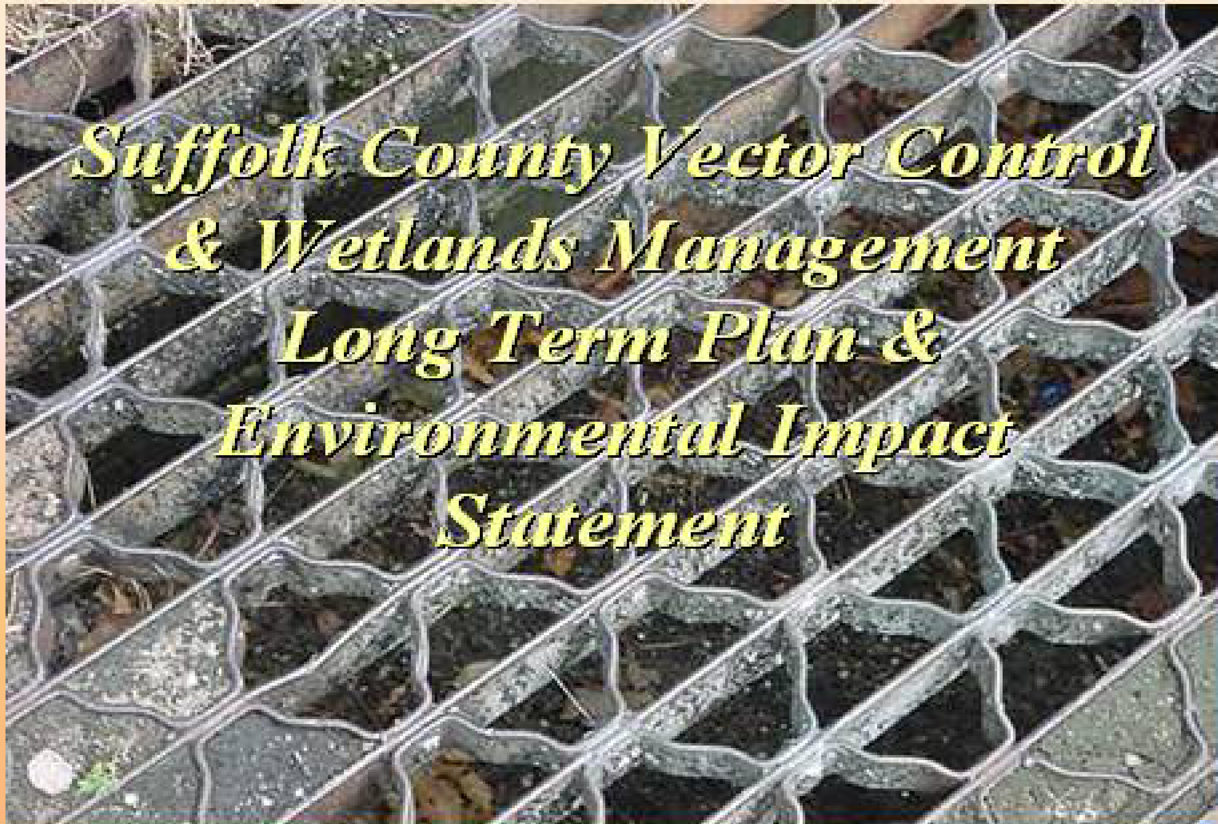

# Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

## Task 3 Literature Review
## Book 10 Part II: Stormwater Control and Mosquitoes

*Prepared for:*

**Suffolk County Department of Public Works**
**Suffolk County Department of Health Services**
**Suffolk County, New York**


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*December 2004*

**SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT**

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## List of Abbreviations and Acronyms

| | |
|---|---|
| Bti | *Bacillus thuringiensis israelensis* |
| BMPs | Best Management Practices |
| Caltrans | California Department of Transportation |
| CWA | Clean Water Act |
| EPA | Environmental Protection Agency |
| MS4s | Municipal Separate Storm Sewer Systems |
| NPDES | National Pollutant Discharge Elimination System |
| NYSDEC | New York State Department of Environmental Conservation |
| NOI | Notice of Intent |
| SPDES | State Pollution Discharge Elimination System |
| SMPs | Stormwater Management Practices |
| SWPP | Stormwater Pollution Prevention Plan |
| SCDPW | Suffolk County Department of Public Works |
| USEPA | United States Environmental Protection Agency |

## EXECUTIVE SUMMARY

The control of stormwater to minimize environmental impacts has been of increasing interest over the past fifteen years or so. The federal government established a permitting process that has been largely regulated by state environmental agencies. In New York State, the essential framework was achieved through the State Pollution Discharge Elimination System (SPDES) permits. Phase 1 of the federal implementation was restricted to larger municipalities and construction efforts; Phase 2, effective in 2003, made the rules more generally applicable.

Stormwater impacts are to be mitigated through the implementation of Best Management Practices. These practices largely require the retention and/or detention of stormwater to reduce its environmental impacts to receiving bodies' water quality. However, a potential impact from standing water is a general increase in the extent of mosquito breeding habitat, as mosquitoes generally breed in stagnant water.

It is recognized that mosquito control is most effective when applied to the insect's immature stages, which are aquatic phases of the life cycle requiring stagnant, standing water. Control measures include physical, chemical and biological techniques. Knowing that increased mosquito populations can lead to increased disease risk, many states have adapted their stormwater Best Management Practices to include appropriate mosquito control techniques.

New York's Stormwater Management Practices (which is how New York has promulgated the federal Best Management Practices) rely on community education, community participation, proper practice design, and sufficient maintenance practices. The control of mosquito vectors should be incorporated within these practices. The draft Notice of Intent (NOI) developed by Suffolk County to comply with the State regulations could address this if it were augmented with selected mosquito control practices.

Public education and outreach on stormwater impacts may include information on preventing mosquito propagation as well as information regarding awareness of water pollution prevention and stormwater issues. The public outreach targeting audiences and citizen groups should be the same for pollution awareness, as well as for public health concerns, associated with stagnant water and mosquito propagation environments. The storm drain stenciling program, identified in the County's NOI, may include an opportunity to obtain initial stormwater basin characteristics data with respect to possible mosquito breeding sites, with a simple inspection checklist form reporting observable accumulated trash and/or standing water.

The County's NOI public participation/involvement practices can incorporate measures to increase mosquito breeding site awareness with the same network that is proposed to be established for this Stormwater Management Practice. The coordination of volunteers and local municipality groups, supplementing existing data collection efforts for monitoring water quality can also include procedures for evaluating possible mosquito breeding sites. The County's proposed identification of existing system outfalls may include routine inspections for identifying and collecting information regarding mosquito propagation sites associated with stormwater structures.

The County's proposed illicit discharge, detection and elimination Stormwater Management Practice may also include inspections for possible mosquito breeding sites found in building rubble piles and illegal trash dumping locations. Improperly connected sanitary waste discharges to storm water systems, illegal dumping of trash in stormwater basins, and waste spill sites may also contain features that promote mosquito breeding sites.

An important feature of the County's proposed Stormwater Management Practice program is the creation of a stormwater system map by March, 2006. This mapping task will provide a useful county-wide inventory of the number and types of stormwater structures and features. This information can also serve as a baseline for developing a program for system inspections, system ranking, response actions, periodic monitoring, and maintenance of potential breeding sites.

## 1.0 INTRODUCTION

The control of stormwater to minimize environmental impacts has been of increasing interest over the past fifteen years or so. The primary means of accomplishing this has been described as "retention and detention". However, standing water environments can also be prime mosquito breeding grounds. This means that fostering the environmental goals of stormwater treatment could lead to increased mosquito breeding and potential disease transmission. This issue was recognized in the Scoping for the Draft Generic Environmental Impact Statement for the Suffolk County Vector Control and Wetlands Management Long-Term Plan.

## 2.0 GENERAL REGULATORY SETTING FOR STORMWATER MANAGEMENT

Under the federal Clean Water Act amendments of 1987, Congress empowered the United States Environmental Protection Agency (USEPA) to regulate polluted stormwater, termed nonpoint discharges, from municipal separate storm sewer systems (MS4s). MS4s are further defined as stormwater sewers owned and operated by federal, state, or local government that collect and convey stormwater, and are not part of a publicly owned sewage treatment facility (USEPA, 2000). Generally, nonpoint sources of pollution in urban areas include rooftops, parking lots, commercial/industrial properties, residential properties, and roadways (Pitt, 1996). USEPA, in turn, requires the states to develop and institute their own programs to manage nonpoint source pollution resulting from precipitation falling and washing over developed, disturbed and cultivated land surfaces, picking up contaminants and depositing pollutants in natural water bodies, ultimately exposing certain biological receptors to these contaminants (Metzger, 2004).

### 2.1 National Pollutant Discharge Elimination System (NPDES)

The USEPA published regulations in 1990 concerning urban stormwater runoff, establishing the National Pollutant Discharge Elimination System (NPDES) Storm Water Program (USEPA, 2000). This program outlines a permit application procedure to meet the stated objectives to reduce the level of runoff pollutants to the maximum extent practicable, utilizing best management practices (BMPs). Although the statutory standard of reducing pollutants to "maximum extent practicable" is not further defined in the CWA, typical BMPs may include street sweeping, pet waste control, and stormwater structure cleaning (Hayes et al., 2003).

#### 2.1.1 NPDES Phase I Rule

The first phase of the MS4 program, Phase I, requires municipalities with populations of 100,000 or more to be permitted. Also, private construction projects disturbing more than five acres require permitting. As part of the permitting requirements, MS4s and large construction-site operators are required to develop an extensive database of measurements and characteristics such as meteorological information, estimated point sources, receiving water bodies, flow volumes, flow areas, pollutants loads, concentration monitoring programs, and maintenance plans (USEPA, 2000).

### 2.1.2 NPDES Phase II Rule

Phase II of the program, instituted under final rules in 1999, required MS4s not already covered under the Phase I program, ones with populations less than 100,000, to be permitted. Also under the Phase II program, construction projects that disturb equal to or more than one acre in land area are to be permitted. Therefore, the Phase II program significantly expands the program's control over thousands of local governments, and over 100,000 construction sites annually. Additionally, the program enlists the states in designating additional communities to be included within their own regulatory systems. Part of this scheme includes promoting citizen group participation (USEPA, 2000).

Instead of requiring the generation of an extensive database, required by the Phase I program, permittees under the Phase II program operate under a more qualitative approach. This approach is considered sufficient in order to reach the Clean Water Act goals for reducing the number of polluted water bodies affected either directly or indirectly by contaminated storm water runoff (USEPA, 2000).

Whereas under the Phase I program, large MS4s are constrained under a single individual permit system, small MS4s under the Phase II program can choose any one of three options for obtaining a permit. Under the Phase II program the three options include a general permit, an individual permit and a modified Phase I permit (USEPA, 2000).

#### 2.1.2.1 General Permit

A general permit is the preferred option, designed intentionally for Phase II compliance. The general permit is drafted by the NPDES permitting authority (USEPA or a designated state authority). The general permit requirements are drafted, and finalized after a public comment procedure. Individual permittees follow their own individualized BMP, and more than one MS4 may share responsibilities under a joint permit as long as the general permit requirements are followed (USEPA, 2000).

The application for a general permit is initiated by submitting a NOI to the NPDES permitting authority. The NOI outlines the goals of the storm water management plan, and proposed BMPs. The permittee may individualize this plan to address the MS4s for any co-permittee's basic requirements to meet their goals (USEPA, 2000).

The NPDES permitting authority may allow one or more MS4s to apply under the conditions of an existing permit, such as a village holding an existing county permit, and can relinquish its responsibilities to regulate the permit measures to the governmental agency holding prior authority. Also, the NPDES authority may draft conditions in the general permit, directing any permittee to follow an existing qualifying program. These measures have been designed under the Phase II program to minimize the duplication of efforts for particular municipalities (USEPA, 2000).

#### 2.1.2.2 Individual Permit

One or more MS4s may submit an individual application to the NPDES permitting authority, describing the square mileage area served by the system and any other information required by the permitting authority. The individual permit applications may also request inclusion in the programs as described above for minimizing duplication of efforts (USEPA, 2000).

#### 2.1.2.3 Modified Phase I Permit

A small MS4 may apply to the NPDES permitting authority to participate as a co-permittee in an existing neighboring Phase I MS4 program. The small MS4 applicant seeking modification of the existing Phase I permit and would have to comply with all of the existing Phase I permit requirements (USEPA, 2000).

## 2.2 Stormwater Management Program

A permitted MS4 operator is required to comply with the appropriate water quality standards of the Clean Water Act developing its stormwater management program to reduce discharges of pollutants to the maximum extent practicable (MEP). However, as stated above, rather than comply with numerical standards, the Phase II program allows a small MS4 to achieve its protection of water quality through narrative effluent limitations that require the implementation of BMP and the achievement of measurable goals. As part of the permit application process, a MS4 must submit a NOI or individual permit application to the permitting authority, which is USEPA or a qualifying state authority. The submittal includes the following program information:

1. Best Management Practices.
2. Measurable goals for each minimum control measure to gauge program effectiveness.

3. Estimate of time for implementation of each measure.
4. Contact information for responsible parties and program coordinators.

(USEPA, 2000)

BMPs are the appropriate measures to be employed by a Phase II MS4 permittee, to achieve the measurable goals, reducing the discharge of pollutants to the maximum extent possible, and satisfying the appropriate requirements of the Clean Water Act. All BMPs include public education about the program and ways to reduce pollution of stormwater runoff, and soliciting active public participation in the program. The NPDES permitting authority also develops a menu of adequate or approved BMPs to satisfy minimum controls under the Phase II program in areas that address:

1. Illicit discharge detection and elimination;
2. Construction site stormwater runoff control facilities;
3. Post-construction stormwater management in new development or redeveloped sites; and
4. Pollution prevention/good housekeeping for municipal operations.

Initiation of the Phase II program required applications by small MS4s by March 2003. Subsequent annual reports are required for the first five-year term, with later reports to be submitted during years two and four of subsequent terms (USEPA, 2000).

## 2.3 New York State Department of Environmental Conservation, State Pollutant Discharge Elimination System (SPDES)

New York State's permitting authority under the Federal NPDES stormwater regulations is administered by the New York State Department of Environmental Conservation (NYSDEC). NYSDEC instituted its own stormwater runoff control program, the State Pollution Discharge Elimination System (SPDES). In 1993, NYSDEC, under their own Phase I program promulgated two general permits, GP-93-05 for industrial activities, and GP-93-06 for large construction sites (NYSDEC, 2001).

In response to the National Phase II program, NYSDEC later expanded its SPDES program to cover small MS4s and smaller construction sites, mirroring the scope of the corresponding federal program. Under the SPDES, Phase II program, MS4s and activities on construction sites (including small, medium and large area sites after August 1, 2003) must obtain approval for compliance under the state's newer general permits by filing a NOI. Small MS4s must apply for general permit GP-02-02. Construction sites must apply for general permit GP-02-01. As part of this expansive program, in order to develop verification with the State's Stormwater Pollution Prevention Plan (SWPP), NYSDEC provides guidance for the temporary control of sedimentation and erosion from construction site activities in the document entitled, "Reducing the Impacts of Runoff from New Development" (NYSDEC, 2002).

Furthermore, NYSDEC developed guidance for the state pollution prevention plans in the document, "New York State Guidelines for Urban Erosion and Sediment Control". Also, NYSDEC provides guidance to engineers and other professionals involved with designing storm water control structures, outlining specifications and uniform practices in the document entitled, "Stormwater Management Design Manual". This manual standardizes the state's version of BMP, known as Stormwater Management Practices (SMPs), specifically to that subset of SMP, stormwater control structures for new developments (NYSDEC, 2001).

These manuals provide recommended standards based on proven technologies, as guidance for preparing plans and specifications for implementing SMPs. It is intended by the state that proper facility design and effective maintenances programs, which follow the published state standards will ensure a successful overall stormwater management program in the New York (NYSDEC, 2001).

## 3.0 STRUCTURAL PRACTICES

The Stormwater Management Design Manual provides guidance with standardized structural design to control stormwater discharge quality applying proven treatment technologies for stormwater prior to discharge to receiving water bodies, such as streams, estuaries, and groundwater. Acceptable designs for facilities are grouped according to five broad categories:

1. Stormwater Ponds;
2. Stormwater Wetlands;
3. Infiltration Practices;
4. Filtering Practices; and
5. Open Channel Practices.

State SMPs utilizing one or more of these structural features are presumed to meet the established water quality criteria goals (NYSDEC, 2001).

The manual also identifies certain structures for stormwater collection and control that do not meet water quality goals, and may be used as pretreatment systems associated with any of the five acceptable structure practices. Some of the practices deemed not currently effective include:

- Catch basin inserts,
- Dry ponds,
- Underground vaults,
- Oil/grid separators,
- Filter Strips,
- Grass Channels,
- Deep sump catch basins,
- Outline storage within a storm drain network, and
- Porous pavement.

The manual describes the features and limitations for these common technologies. A municipal permittee may be allowed to obtain approval to use any one of these systems with no other treatment feature, but only after detailed studies and monitoring of field applications has proved the technology to be an acceptable stand-alone practice (NYSDEC, 2001).

## 4.0 SUFFOLK COUNTY SMP

As of this writing, Suffolk County developed a draft NOI under the SPDES Phase II general permit program (Jim Peterman, Suffolk County Department of Public Works, Personal Communication, 2004). This draft is reportedly under review by the NYSDEC. The general outline of the County's SMP follows the Federal BMP and State's SMP. The proposed County SMP and measurable goals include:

**Public Education and Outreach on Storm Water Impacts**

An informed and knowledgeable community is crucial to the success of our storm water management program, since it helps to ensure greater support for the program as the public gains a greater understanding of the reasons why it is necessary and important.

Measurable Goals:

1. Develop educational resources by March 2004.
2. Expand educational resources by March 2005.
3. Storm Drain Stenciling throughout first permit term (March 2008).

**Public Participation/Involvement**

The public can provide valuable input and assistance to a regulated, small MS4's municipal storm water management program and will be given opportunities to play an active role in both the development and implementation of the program.

Measurable Goals:

1. Create a volunteer network by March 2004.
2. Establish a Citizen panel by March 2005.
3. Public Meetings and Print Media by March 2004.
4. Finalize Citizen Panel Recommendations by March 2006.
5. Public Meetings and Radio Media by March 2005.
6. Community Clean-Ups Every Summer Through 2008.

**Illicit Discharge Detection and Elimination**

Discharges from MS4s often include wastes and wastewater from non-storm water sources. Illicit discharges enter the system through either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the MS4 from cracked sanitary systems, spills collected by drain outlets, or paint or used oil dumped directly into a drain). The result is untreated discharges that contribute high levels of pollutants, including heavy metals, toxics, oil and grease, solvents, nutrients, viruses, and bacteria to receiving water bodies. Pollutant levels from these illicit discharges have been shown in EPA studies to be high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health.

Measurable Goals:

1. Implement an Information Management System for Tracking Illicit Discharges by March 2005.
2. Encourage Recycling Program by March 2004.
3. Create a Storm Sewer System Map by March 2006.
4. Initial Identification of Illicit Discharge Sources by March 2004.
5. Stormwater Ordinance in Place by March 2004.
6. Train 50% of Applicable Employees by March 2005.
7. Detection and Elimination throughout the first permit term (March 2008).
8. Continuation of Detection and Elimination Efforts

In addition to the County's draft NOI, the Suffolk County Department of Public Works (SCDPW) has standard design specifications for new development projects. These include acceptable stormwater collection, control and discharge systems that developers and County contractors must comply with for all County public works projects and private property development. The New York State Department of Transportation also has similar storm water collection, control, and discharge standards design specifications for state roadway and flood control projects.

## 5.0 IDENTIFICATION OF STORMWATER FACILITIES AS MOSQUITO HABITAT

The goal of stormwater management under New York's SMP is the reduction of pollutant discharges to surface and groundwater bodies, to the maximum extent practicable, in compliance with the Clean Water Act. The SMPs necessary to obtain this goal require the treatment of stormwater runoff to eliminate or minimize sediments of pollutants from urban land surfaces and construction sites. Proper stormwater management practices are also necessary to mitigate flooding. These practices are at odds with mosquito vector control because they may retain water under conditions that promote and increases in mosquito populations. However, since the federal BMPs and State SMPs are designed to improve the overall public health and safety of our water resources, it should also be recognized that any stormwater control practice should include careful planning, design, and maintenance of stormwater systems to minimize or eliminate the spread of disease-carrying mosquitoes.

### 5.1 California Study

A very comprehensive study of stormwater BMPs as potential vector breeding sites was conducted in California. In 1998, the California Department of Health Services' Vector-Borne Disease Section and the California Department of Transportation (Caltrans) reached an agreement to coordinate their efforts with respect to stormwater BMPs, in Caltrans' BMP Retrofit Pilot Study. The study included a preliminary assessment of potential health risks from mosquitoes, and other vectors, associated with stormwater facilities and BMPs. The Caltrans study included a nationwide survey of stormwater BMPs and vectors, and the various solutions applied in other jurisdictions. Caltrans contacted more than 28 states and 150 agencies (Metzger et al., 2002).

The study provided an understanding of the factors in stormwater facility design that encourage vector production, and it was found that mosquito species readily adapted and exploited certain BMP structural features. Other vectors and significant "pioneers" of stormwater facilities were found by the study to include midges, rodents, black flies, snakes, and alligators (Metzger et al., 2002).

The two-year Caltrans study included a program of structure refurbishing, maintaining, and periodically monitoring facilities of eight specific stormwater treatment design types:

1. biofiltration strips and swales,
2. filtration devices (various subsets of design within this group),
3. extended detention basins,
4. infiltration devices,
5. continuous deflective separators,
6. oil-water separators,
7. drain-inlet inserts, and
8. constructed wetlands.

Of these eight designs, Caltrans found that those that maintained standing water were particularly fertile for mosquito vectors, and in some cases greatly promoted large breeding populations. In contrast, structures that drained rapidly provided less successful habitats, with little to no mosquitoes (Metzger et al., 2002).

Another important feature of the study was the reported focus on identifying those factors that prevent proper system monitoring/vector surveillance and ways to effectively implement abatement efforts in and around BMP facilities. It was found that breakdowns in the maintenance programs and degradation of the structures themselves lead to standing water, invariably allowing significant amounts of vector propagation in a matter of several days. The Caltrans study developed several "vector-proofing" operational methods that it considered promising and effective in mitigating mosquito breeding sites; the agency has continued to monitor these practices over the long-term (Metzger et al., 2002).

Some of the effective vector-reducing practices found through Caltrans' survey of its own state programs, and those of other states, may be summarized with respect to certain facility types.

**Dry Systems, such as Retention Basins**

The design of these facilities should drain collected stormwater within 72 hours to prevent mosquito breeding, particularly those "flood-mosquito" varieties that are prone to carry the West

Nile Virus. Discharge outlets should not be screened, diverted, or otherwise designed in a manner that may result in rapid clogging with sediment and debris. System piping should be adequately sloped for rapid draining. Rip-rap features at the discharge points should be avoided. Piping/culverts should not contain depressions or corrugations where stagnant water could pond. Regular maintenance should include removing built-up debris/sediment, repairing washouts, maintaining design slopes, and constructing access to piping/culverts, while avoiding special safety precautions such as confined space operations (Metzger et al., 2002).

**Catch Basins and Sump Facilities**

These structures collect stormwater and retain it for more than 72 hours, and should, therefore, be designed to seal, with no opening greater than 1/16-inch. Screening is permissible, although consideration should be given to the fact that such screening may be easily subject to damage. Structure inlet and outlet points should be designed to be submerged under collected water to protect against mosquitoes flying through the piping to access the standing water. Structures should also be designed, where appropriate, with proper pumping equipment for draining standing water (Metzger et al., 2002).

**Stormwater Retention Basins**

BMP designs should include adequate percolation through the basin bottoms to avoid flooding during usually heavy storm events. The entire basin shoreline should be accessible at all times for proper maintenance. Emergent vegetation growth along the shoreline should be avoided to prevent mosquito egg rafts and allow mosquito predators, such as fish and larvae-eating insects, to access any larvae. Vegetation may be reduced by designing water depths along the shore to be greater than four feet, or construction of shorelines with concrete liners. Emergent vegetation may also be cropped through regular maintenance (Metzger et al., 2002).

The University of California, Division of Agriculture and Natural Resources, for the California Department of Health Services, Vector-Borne Diseases Section, recently reaffirmed these findings of its joint study with Caltrans. The study emphasizes that any BMP facility should be adequately designed, sufficiently maintained and periodically monitored by vector control professionals to effectively reduce mosquito habitats. Standing water should not be available for sufficient time to permit emergence of adult mosquitoes. The 72-hour rule for maximum residence time in dry systems and catch basins should be closely followed to eliminate mosquito vector production, while maintaining the local water quality goals. Long-term management of stormwater retention basins and ponds must integrate physical features, biological controls, vegetation management, and chemical/larvicide control as appropriate. Adequate budgetary considerations should provide the necessary institutional controls, periodic monitoring and adequate maintenance (Metzger, 2004).

### 5.2 Florida Programs

The University of Florida Institute of Food and Agricultural Sciences (Florida Institute) recognizes the importance of the coordination of their state's stormwater drainage and flood control/pollution prevention programs. The Florida Institute states that the importance of BMPs including mosquito control programs is necessary to control the propagation of mosquito vectors, calling for Florida city and county governments to require adequate BMP design and maintenance procedures to comply with stormwater BMPs and vector control (O'Meara, 1997).

### 5.3 Virginia Guidelines

The State of Virginia published acceptable vector control procedures for proper stormwater BMP, in its Stormwater Management Technical Bulletin No. 8. This document echoes the existing practices for adequate design and maintenance practices in the other states. The bulletin notes that it is well known that the application of pesticides alone is not enough, and is ineffective in the long run. Proper public education and awareness for source elimination, and the incorporation of vector control practices in stormwater facilities are stated to be the only effective means for minimizing the spread of mosquito-borne diseases (Virginia DCR, 2003).

### 5.4 The Denton, Texas Program

One BMP program incorporating successful mosquito vector control practices is being implemented in Denton, Texas. This municipality instituted their program recognizing that a proactive, consistent, and targeted approach is more desirable as an appropriate response to the recent finding of mosquitoes containing the West Nile virus in their area, rather than responding with general area-wide pesticide applications when outbreaks occur. The goal for their program is to mobilize technical knowledge, municipal resources and citizen involvement in gathering field data, engineering vector controls with BMP facilities, and implementing these controls in the community (Banks, 2004).

In the Denton program, emphasis is placed on vector source control because of the recognition of the uncertainties associated with the efficacy of ultra-low volume applications of pesticides, via the broadcast spraying method. The limitations of this method were found to be significant because in order to be effective, the pesticide droplets must actually contact the target mosquito, and the insect is able to avoid contact by hiding or being obstructed by many features in an urban environment. Also, the mosquito's rapid breeding cycle far out-strip the all too infrequent pesticide applications (Banks, 2004).

The Denton program is stated to be a "top-down" approach, which is reportedly successful in controlling mosquito breeding in BMP facilities. The municipality utilizes their public information office to distribute information regarding reducing stormwater runoff pollution, while at the same time educating the public about the public health risks associated with stagnant water in their back yards and within their own neighborhoods. Citizen involvement is encouraged, in notifying about and eliminating stormwater collection system pollution, sources of mosquito breeding sites, and reporting dead birds. The public information office distributes information in fliers, notices and over the broadcast media. The Denton program provides training to their staff for making regular inspections of stormwater collection facilities, identifying features and structures that require maintenance, and implementing response actions to eliminate mosquito breeding sites. The BMP structures used in Denton are similar to those in other parts of the state and country. The program goals are to maintain those stormwater detention facilities, catch basins and sumps free of standing water for more than 72 hours. The stormwater retention basins and ponds, an important freshwater resource in this part of the country, are maintained to reduce potential vector breeding through biological controls, emergent vegetation control, and larvicide and pesticide control where necessary (Banks, 2004).

The Denton program includes a reliance on larvicide treatment through the use of Bti, a soil bacterium, which produces a toxin that is specific to mosquito larvae. This bacterium is desirable, because it fatally attacks the larvae's digestive system within a few hours of contact, and is generally recognized as nontoxic to other organisms. It is relatively inexpensive and available in many different forms for various applications. The city of Denton provides this larvicide to the public free of charge. Denton's municipal program also applies the larvicide, when necessary, during stormwater facility inspections and maintenance (Banks, 2004).

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