Stormwater Management Technical Bulletin No. 8

VECTOR CONTROL
Mosquitoes & Stormwater Management

Introduction

Recently in Virginia, an increasing number of animals and humans have tested positive for the mosquito-borne West Nile virus. Mosquitoes are the world's most significant vectors (a "vector" refers to any organism that can transmit an infectious disease pathogen to another organism). Diseases transmitted by mosquitoes are responsible for the deaths of millions of people worldwide every year. Infections transferred by vectors are referred to as vector borne diseases, and include Eastern Equine Encephalitis, dog heartworm, and West Nile virus found in Virginia.

Statewide, questions have arisen on vector control ("vector control" refers to the process of eradicating or controlling the disease-carrying insects), especially in standing waters in ponds and stormwater ditches. Ponded waters, such as constructed stormwater management facilities (detention areas, storm sewers, and stormwater ditches), have the potential to foster mosquito reproduction. However, stormwater management is crucial to protect our environment and downstream properties and communities. Stormwater management practices are essential to protect stream banks from eroding, to remove pollutants from the waterways, to recharge groundwater, and to control flooding to protect downstream properties and people. Careful planning, design and maintenance of stormwater management practices are necessary to eliminate or to minimize the proliferation of disease-carrying mosquitoes.

This technical bulletin discusses stormwater management measures designed and maintained to eradicate or control mosquito habitat to prevent the spread of diseases carried by mosquitoes.

Background

There are approximately 55 species of mosquitoes present in Virginia. Currently, a survey of mosquito populations associated with stormwater management facilities has not been conducted. However, it is estimated that 6 mosquito species breed in temporary bodies of water, of which a majority are potential vectors of the West Nile virus. Also, it is estimated that 4 mosquito species breed in permanent bodies of water, of which none are known to carry the West Nile virus. Finally, there are 2 mosquito species that breed in both permanent and temporary bodies of water that may be vectors of the West Nile virus.

A mosquito's lifecycle has four stages – egg, larva, pupa, and adult. Mosquitoes need water to breed since all mosquitoes spend their larval and pupal states in water. Most mosquitoes breed in temporary standing waters that are less than one foot deep, when nutrients are available for feeding and the water temperature is acceptable. The lifecycle between egg and adult varies from 8 days to 2 weeks. Natural predators of mosquitoes include birds, dragonflies, many other aquatic insect species, fish and spiders.

Urban environments provide numerous mosquito breeding grounds: around homes (birdbaths, jars, flower pots, clogged rain gutters, neglected pools), in unregulated waste dumps (tires, barrels, bottles, cans), in shallow natural aquatic areas, and in improperly maintained or constructed stormwater management and flood control structures (storm drains, sewer systems, catch basins, settling ponds). The pervasiveness of these habitats allows many species of mosquitoes to extend in reach and numbers, thereby increasing the threat of mosquitoes as vectors of numerous diseases.

Stormwater management facilities (such as temporary erosion and sediment control basins and traps, permanent retention ponds, storm sewers and stormwater ditches to a lesser degree) may increase mosquito-breeding habitats. Improperly locating and designing new stormwater management facilities may increase the mosquito

population. Also, poor maintenance or improperly constructed stormwater management facilities (for both temporary erosion and sediment control and permanent stormwater management) may result in mosquito propagation. Since stormwater management practices are essential to protect our environment and properties, the method of designing, locating, and maintaining stormwater management structures is a vital step to minimize or eliminate mosquitoes.

Maintenance of Existing Stormwater Management Facilities for Mosquito Control

Some mosquito habitats may be fostered by the lack of maintenance and improper construction of stormwater management facilities (for both temporary erosion and sediment control structures and permanent stormwater management ponds and storm sewers and stormwater ditches). Vegetative overgrowth including floating algae, sediment, trash, dead grass, emergent aquatic grasses and weeds, and cattails, provides hiding places and a nutrient rich environment for mosquitoes. Clogged outlets that temporarily pond water will provide good mosquito breeding habitats. Small temporary bodies of water do not support the predator populations that keep mosquito populations in check. Inadequate drainage in constructed wetlands and dry ponds causes small puddles to remain at the base, especially adjacent to the outflow pipe. Corrugations in storm sewers may cause standing water. The following list itemizes some maintenance principles that may reduce the mosquito population.

1. Maintain and clean-out temporary erosion and sediment control traps and basins.
2. Maintain stormwater ditches (such as road side ditches) to ensure positive drainage.
3. Conduct annual vegetative management, such as removing weeds and restricting growth of aquatic vegetation to the periphery of wet ponds.
4. Remove grass cuttings, trash and other debris, especially at outlet structures.
5. Avoid producing ruts when mowing (water may pool in ruts).
6. CAUTION: Dry ponds and underground structures usually detain water for periods less than 30 hours. If they retain water for longer than five days, they are poorly maintained.
7. CAUTION: Infiltration trenches and sand filters structures should not hold water for longer than 24 hours. If they retain water for longer than 48 hours, they are poorly maintained.
8. Contact the Virginia Department of Transportation (Tel. 800-367-7623) to report standing water in ditches along state roads or suspected standing water in storm sewer systems along state roads.

Site Design for Mosquito Control

New stormwater management structures that may foster mosquito propagation include: the vegetative fringe encircling ponds where mosquitoes breed and avoid predators; shallow or semi-permanent ponds such as catch basins and riprap settling basins; structures that drain longer than designed, these areas can create stagnant pools without a resident predator population to keep mosquitoes under control naturally; and pools of water in storm drains.

The following stormwater management design tips may limit mosquito-breeding potential.

1. Reduce the need for stormwater management facilities. Design sites to preserve natural drainage and natural treatment systems to reduce the need for additional structural stormwater management facilities. Urban development impacts on natural hydrology and water quality can be reduced significantly when better site design (such as Low Impact Development) is utilized. Better site design reduces the amount of stormwater runoff, provides for natural on-site control of runoff, and thereby reduces the number of structural measures needed. Examples and design procedures may be found in the Virginia Stormwater Management Handbook, Northern

Virginia's Regional Commission's Nonstructural Urban BMP Handbook, and the Center for Watershed Protection Better Site Design Manual (see website links below).

2. Improve designs of permanent pools. There are two methods for designing a permanent pool pond to reduce mosquito propagation: minimizing shallow depths (1.0 foot or less) and increasing circulation in ponds. Deep pools of water are preferable to shallow ones for mosquito control. Wet ponds and man-made wetlands should be designed to support continuous water flow to prevent stagnation and vegetative growth. Prevent shallow water by steeply grading both the banks of the pond and the impoundment. Include mechanical aerators in wet ponds, such as a fountain in the middle of the ponds, which make the site more attractive, deter the growth of unwanted vegetations, and improve the habitat for predators of mosquitoes. The principal outlet, such as a weir or riser, should have positive drainage, such as a 0.1 foot vertical drop from the low flow inlet to the outlet barrel. Also, 'inlet shaping' should be utilized in risers and junctions. Inlet shaping (or a sweep) is a construction method that installs concrete at a curve at the junctions of drop inlets or risers and storm sewer pipe and helps maintain hydraulic efficiency of risers and pipes while preventing stagnant pools of water. Please note: narrow vegetative fringes around permanent ponds will not produce significant numbers of mosquitoes, and most of the mosquito species that utilize these fringe habitats are not recognized as important West Nile virus vectors.

3. Select stormwater management measures based on site-specific conditions. Site conditions, such as soils, topography, depth to rock, depth of seasonal high groundwater table, and Karst, significantly affect the performance of stormwater management facilities. Designs that take into account the site conditions will improve drainage and limit the occurrence of stagnant water. Chapter 3 of the Virginia Stormwater Management Handbook details the site requirements for various stormwater management structures. This document can be obtained on DCR's website, provided below.

4. Take special care for ponds that temporarily impound water. Some stormwater management measures, such as dry ponds and man-made wetlands, pond water for an extended period. These facilities must drain the water completely within 30 hours of the storm event. The bottoms of the ponds must have positive drainage and be free of depressions. Avoid the placement of dry ponds and underground structures in areas where they are likely to remain wet (i.e., high water tables). Ensure that pond bottoms have a low-flow channel and a minimum of 1 to 2% bottom slope to prevent scour and stagnation. The principal outlet, such as a weir or riser, should have positive drainage, such as a 0.1 foot vertical drop from the low flow inlet to the outlet barrel. Also, if water quality orifices are required in the principal outlet structure, ensure that the minimum size is greater than 2"-3", to prevent clogging and stagnant pools of water ponding at the outlet structure. If the orifice required is less than 2" to meet water quality requirements, then another type of stormwater management facility should be considered. Also, there are manufactured methods to prevent clogging of the primary water quality outlet without restricting the hydraulic capacity of the outlet control orifices, including the installation of a trash racks.

5. Take care in the design of storm sewer systems. The sheltered environment inside storm drains can be ideal for mosquito breeding. Design and construct pipes at a rate of flow that flushes the system of sediment and prevents water backing up in the pipe (an acceptable minimum slope is 2%, as site conditions allows). Construct storm drains (such as manholes, inlets and boxes) so that the invert out is at the same elevation as interior bottom to prevent standing water. Also, 'inlet shaping' should be utilized in risers and junctions. Inlet shaping (or a sweep) is a construction method that installs concrete at a curve at the junctions of drop inlets or risers and storm sewer pipe and helps maintain hydraulic efficiency of risers and pipes while preventing stagnant pools of water. Verify that newly constructed storm sewer systems have positive drainage (see section below) and that standing water does not exist inside the system. Corrugations in storm sewers may cause standing water Contact the Virginia Department of Transportation or the local government regarding specific locality requirements for designing and maintaining storm sewer systems.

6. Require "as-builts". As-builts are survey drawings of stormwater management facilities after construction and provide sufficient information to demonstrate that the facility as constructed conforms to all specifications and requirements of the approved design plan. As-builts provide assurance that stormwater management facilities are effectively minimizing mosquito propagation. At a minimum, as-builts should include spot elevations (high and low points), contour lines, and indicate the slope of the ground. For example, the as-built confirms that dry ponds are draining and permanent pools have the necessary depth. The appendix of Chapter 3 of the Virginia Stormwater Management Handbook outlines the minimum requirements for completing an as-built. This document can be obtained on DCR's website, provided below.

7. Require and comply with a written maintenance agreement. City, County and State governments require owners to develop a written maintenance agreement for all stormwater management facilities. The maintenance agreement should require weed control and the removal of grass cuttings and other debris from the outlet structures. Also, the agreement should identify landowners and successors to maintenance requirements and obligations. The appendix of Chapter 3 of the Virginia Stormwater Management Handbook outlines the minimum requirements for a complete plan. This document can be obtained on DCR's website, provided below.

Mosquito Control Using Pesticides

When source reduction and water management are not feasible or have failed, the judicious application of insecticides, including larvicides and adulticides, may be used to control both immature and adult mosquito populations. "Larvicides" are used to kill immature mosquitoes (larvae) when applied to standing water where larvae are present. "Adulticides" are used to kill adult mosquito populations in an area where a vector population has escaped larval control. **Pesticides generally do not provide long-term solutions to controlling mosquitoes, but may be the only choice available to control mosquitoes from some habitats**. Contact your local government for more information about programs to control disease-carrying mosquitoes in your area. Contact the Virginia Department of Agricultural & Consumer Services (VDACS) for any other pesticide application questions. Also, the Virginia Department of Health has developed a West Nile Virus Surveillance and Response Plan, now on their website, that provides mosquito control guidelines for the reduction or prevention of disease transmission to humans and their domestic animals by mosquito vectors.

Further Information

For further information, please contact the following agencies:

- Virginia Department of Conservation and Recreation (www.dcr.state.va.us) 1-877-42WATER
- Virginia Department of Health (www.vdh.state.va.us) 804-786-6261
- Virginia's West Nile Virus Surveillance and Response Plan (http://www.vdh.state.va.us/epi/wnvsrplan/AvianPlan.asp)
- Your local health department
- The Virginia Department of Agricultural & Consumer Services (http://www.vdacs.state.va.us/) 804-371-6560
- Virginia Mosquito Control Association (VMCA) (http://www.mosquito-va.org/)
- U. S. Centers for Disease Control and Prevention www.cdc.gov/ncidod/dvbid/westnile/index.htm
- American Mosquito Prevention and Control Association http://www.mosquito.org/
- EPA Pesticides & Mosquito Control www.epa.gov/pesticides
- Chesapeake Bay Local Assistance Department – Better Site Design Manual http://www.cblad.state.va.us/publica.cfm

- Low Impact Development (LID) Center - http://www.lowimpactdevelopment.org/ (301-982-5559)
- Hampton Road Planning District Commission - http://www.hrpdc.org/publications/techreports/pep.shtml
- Northern Virginia Regional Commission - http://www.novaregion.org/bmp.htm

Bibliography

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- "Disease Vectors Associated with Structural BMPs", Dean F. Messer, et al [Stormwater, The Journal for Surface Water Quality Professionals, March/April 2002]
- "More Than One Risk From Mosquitoes", Janice Kaspersen [Stormwater, The Journal for Surface Water Quality Professionals, March/April 2002]
- University of Florida Extension, http://disaster.ifas.ufl.edu/PDFS/CHAP04/D04-21.PDF
- Maryland Department of the Environment, http://www.mde.state.md.us/assets/document/sedimentStormwater/BMP_westnile.pdf
- Montgomery County, Maryland – Department of Environmental Protection, http://www.montgomerycountymd.gov/mc/services/dep/Mosquito/facts.pdf
- Rhode Island Office of Mosquito Abatement Coordination, http://www.uri.edu/research/eee/mosquito.html
- California Department of Health Services, Vector-Borne Disease Section, http://www.caltrans.ca.gov/hq/env/stormwater/workshop/12_01/description/metzger.htm