

Appendix F - Mosquitoes and Stormwater Management

1.0 Introduction

This appendix discusses stormwater management measures designed and maintained to eradicate or control mosquito habitat to prevent the spread of diseases carried by mosquitoes. Recently, some concerns have been raised about disease vectors associated with structural stormwater BMPs. Specifically of interest is the mosquito which is known to be a potential carrier of the West Nile Virus. Various studies have found, as would be expected, that some structural water quality BMPs can support mosquito production. However, the significance of these BMPs as a risk of West Nile Virus is debatable, and many municipalities may make the determination that further action is not required. However, if a municipality determines that further efforts to control mosquito production in structural BMPs are needed, certain measures can be taken while still maintaining compliance with the requirements of the federal stormwater regulations.

In order for mosquitoes to breed, specific conditions must be present. A mosquito's life cycle consists of four stages: egg, larvae, pupa, and adult. Mosquitoes must lay their eggs in stagnant water, or on damp soil that will soon be flooded with water. 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. It will take 24-48 hours for the eggs to 'hatch' into larvae. The larvae and pupa must have standing water in order to survive, and this stage will typically take 5 to 18 days before the production of an adult mosquito (Floore, 2002).

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. Therefore, there are several steps that a stormwater system operator may take to reduce the risk of mosquito production in structural BMPs, with the primary focus being on preventing standing water for prolonged periods. Proper design and maintenance of structural BMPs is key to meeting this goal.

To prevent production of mosquitoes, most sources indicate that water should not be allowed to remain stagnant for over 48 hours. This appears to be a conservative estimate. When a new stormwater BMP is being installed, a design that does not rely on extended retention of stormwater without flushing (exceeding 48 hours) should be considered. There are many options for structural BMPs that meet these criteria. Examples include, but are not limited to, grass swales, porous pavement, landscape detention, extended detention basins, sand filters, and reducing directly connected impervious areas. Proper design and maintenance are important to ensure the ponds continue to operate as intended to prevent stagnant water being available for mosquito production. Designing BMPs with the proper slope, using easily accessed forebays to allow for removal of accumulated materials, and adequately inspecting and maintaining basins are some key practices that should be considered.

For existing basins that include retention of stormwater sufficient to promote mosquito production, it may be possible to retrofit these designs to allow for complete drainage in a shorter period. However, it should first be determined if the BMP in its current state is actually allowing for mosquito production.

For wet detention basins or wetlands where retrofitting is not an option, stocking these BMPs with a population of minnows is recommended. A healthy population of minnows will feed on the mosquito larvae and prevent them from reaching the hatching stage. However, only a species of minnow native to the area should be used. Contact the Idaho Department of Fish and Game for stocking and species information. Other natural predators of mosquitoes include birds, dragonflies, many other aquatic insect species, fish, and spiders.

1.0 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 take longer to drain than they are designed to, and pools of water in storm drains. These areas can create stagnant pools without a resident predator population to keep mosquitoes under control naturally.

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, discussed in Volume 3 of this BMP catalog) 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.

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 a pond, 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.
3. Select stormwater management measures based on site-specific conditions. Site conditions, such as soils, topography, depth to rock, and depth of seasonal high groundwater table significantly affect the performance of stormwater management facilities. Designs that take the site conditions into account will improve drainage and limit the occurrence of stagnant water.
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. 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 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 allow). 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 and that standing water does not exist inside the system. Corrugations in storm sewers may cause standing water.
6. Require "as -built drawings." 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 should indicate the slope of the ground. For example, the as-built confirms that dry ponds are draining and permanent pools have the necessary depth.
7. Require a written maintenance agreement and compliance with the agreement. 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.

1.1 Maintenance

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 provide 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.

- Maintain and clean out temporary erosion and sediment control traps and basins.
- Maintain stormwater ditches (such as road side ditches) to ensure positive drainage.
- Conduct annual vegetative management, such as removing weeds and restricting growth of aquatic vegetation to the periphery of wet ponds.
- Remove grass cuttings, trash and other debris, especially at outlet structures.
- Avoid producing ruts when mowing (water may pool in ruts).
- 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.
- Infiltration trenches and sand filter structures should not hold water for longer than 24 hours. If they retain water for longer than 48 hours, they are poorly maintained.

1.2 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 health district or mosquito abatement district for more information about programs to control disease-carrying mosquitoes in your area.

References

Floore, T. 2002. Mosquito Information. The American Mosquito Control Association. Eatontown, NJ. <http://www.mosquito.org/mosquito.html>.

“Public Works and Public Health Are Dependent Upon One Another”, Dean F. Messer [Stormwater, The Journal for Surface Water Quality Professionals, March/April 2002]

“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]