Checklist for Minimizing Vector Production in Stormwater Management Structures

Management of mosquitoes and other vectors in stormwater management structures, such as flood control basins and Best Management Practices, is critical for protecting public health. With careful planning, such structures can be designed, built, operated, and maintained in a manner that minimizes opportunities for the proliferation of vectors. This publication provides checklists of action items intended to lessen the short and long-term potential for vector production in stormwater management structures while reducing dependence on pesticides to the maximum extent possible. With the wide variety of structures and build locations, it is anticipated that not all action items will apply to every project. Answers to frequently asked questions follow the checklist.

For simplicity, stormwater management structures have been divided into three categories, each with specific considerations. Certain structures may require reference to more than one checklist.

Dry Systems. Any structure designed to drain completely following capture and/or treatment of runoff. Examples include flood control basins, extended detention basins, infiltration basins and trenches, Austin sand filters, swales and strips, drain inlet inserts, linear-radial gross solids removal devices. Permanent-water features sometimes included as part of dry system design, such as micropools, should be considered separately using the checklist for “wetlands”.

Wet Systems. Any structure designed with features such as sumps, vaults, and/or basins that hold water permanently, or longer than 4 days. Examples include open catch basins, concrete retention basins, Delaware sand filters, and a variety of belowground proprietary devices.

Wetlands. Any structure constructed as a naturalistic system with permanent surface waters, regardless of the formal given name (e.g., stormwater pond, retention basin, wet basin, constructed wetlands, treatment wetlands, etc.). This section also applies to permanent-water features sometimes included as part of dry system design such as micropools.

Additional information is available on the California Department of Public Health (CDPH) Mosquito-borne Diseases webpage (https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/MosquitoesandMosquitoBorneDiseases.aspx) and in the University of California, Division of Agriculture and Natural Resources (UCANR) stormwater publication (http://www.ipm.ucdavis.edu/PDF/MOSQ/mosquitostormwater.pdf)

To facilitate public health mosquito control, it is strongly recommended that project locations be provided to the local vector control agency. To locate your local mosquito and vector control agency, visit the CDPH West Nile virus webpage (http://westnile.ca.gov) and search by zip code.

DRY SYSTEMS

Recommended strategy: Complete discharge of all captured water in 4 days or less.

- ☐ Is the structure designed to discharge all captured water in 4 days or less?
- ☐ Has every effort been made to trace and eliminate persistent non-stormwater flows (e.g. irrigation runoff) that may enter the system and jeopardize non-chemical vector control efforts?
- ☐ Has groundwater depth been carefully evaluated to ensure that the structure will not be permanently or seasonally flooded (i.e. is the base of the basin higher than the local groundwater table)?
- ☐ Does the design provide an adequate slope between the inlets and outlets, with special attention given to ensure corners are above grade?
- ☐ Has soil been compacted adequately during grading to minimize subsidence, which can result in pools of standing water?
- ☐ Does the design slope take into consideration the inevitable accumulation of sediment and debris between maintenance periods that can result in standing water, especially in and around the inlet?
- ☐ Does the design minimize the use of features that increase the potential for standing water, such as loose riprap and concrete curbs?
- ☐ Does the structure include a concrete or earthen low-flow channel to concentrate (i.e. minimize available surface area) and direct non-stormwater flows to the outlet?
- ☐ Is the distribution piping sloped adequately and smooth (not corrugated) on the inside to prevent standing water?
- ☐ Are the inlet structures and energy dissipaters designed and sloped sufficiently to prevent scour depressions?
- ☐ Are the outlets designed with debris screens or other features that reduce the potential for clogging?
- ☐ Is the structure designed with safe and sufficient access for inspection, maintenance, and/or vector control activities when needed?
- ☐ Does the operation and maintenance plan include a minimum of quarterly inspections to ensure that vegetation overgrowth, sediment accumulation, or other factors have not created areas of standing water?

- ☐ Does the operation and maintenance plan include a minimum annual maintenance to remove vegetation overgrowth, remove sediment and debris accumulation, and otherwise return the structure to “as-designed” conditions?

- ☐ Is signage provided and clearly visible with minimum information indicating the type of structure (e.g. extended detention basin), ownership, and contact information?

WET SYSTEMS

Recommended strategy: Deny mosquito access to standing water by using covers, screens, and/or other barriers.

- ☐ Have sumps, vaults, or basins that hold water permanently, or longer than 4 days, been completely or partially sealed against adult mosquito entry?

- ☐ If used, are covers tight fitting, with gaps or holes of no greater than 1/16” (2 mm)?

- ☐ If used, are aluminum or nylon screens for sealing small openings secured with gaps or holes of no greater than 1/16” (2 mm)?

- ☐ If cast iron manhole covers are used, are pick holes sealed or is a mosquito-proof insert provided below?

- ☐ Where feasible, are the inlet and/or outlet conveyance pipes submerged to prevent adult mosquito entry into the main water storage area?

- ☐ Where feasible, are conveyance pipes fitted with flapper valves, collapsible fabric tubes, or other barriers to prevent adult mosquito entry into the main water storage area?

- ☐ Is the structure designed with safe and sufficient access to permanent water areas for inspection, maintenance, and/or vector control activities when needed?

- ☐ Does the operation and maintenance plan include a minimum of quarterly inspections to ensure that barriers to mosquito entry are intact and in place as designed?

- ☐ Where possible, is signage provided with minimum information indicating type of structure (e.g. CDS™), ownership, and contact information?

WETLANDS

Recommended strategy: Create and maintain habitat least-suitable for mosquito breeding.

- ☐ Is the system designed with features that minimize the areas suitable for mosquito production?

- ☐ Does the design discourage emergent vegetation in shallow water zones where vegetation is not needed or desired, for example by using concrete liners in sediment forebays?

- ☐ Are slopes designed as steep and uniform as possible to discourage invasive, emergent vegetation?

- ☐ Does the system include deep water zones, in excess of 4 ft, to reduce available area for emergent vegetation and provide refuge for natural mosquito predators such as mosquitofish and certain invertebrates?

- ☐ Where permitted, have mosquitofish been introduced to help control mosquitoes?

- ☐ Does the system include provisions for rapid dewatering if needed for emergency control of mosquitoes?

- ☐ Is the structure designed with safe and sufficient access for inspection, maintenance, and/or vector control activities when needed?

- ☐ Are access roads built close to the shoreline and around the perimeter of the wetland to the extent feasible?

- ☐ Are access points incorporated at regular intervals along the perimeter to allow for vector monitoring and control when necessary.

- ☐ Does the operation and maintenance plan include a minimum of quarterly inspections to ensure that vegetation overgrowth, sediment accumulation, or other factors have not created areas suitable for mosquito production?

- ☐ Does the operation and maintenance plan include a minimum annual maintenance to remove vegetation overgrowth, remove sediment and debris accumulation, and otherwise return the structure to “as-designed” conditions?

- ☐ Is signage provided and clearly visible with minimum information indicating type of structure (e.g. stormwater treatment pond), ownership, and contact information?

Frequently Asked Questions

DRY SYSTEMS

1. Why is it important to drain all captured water in 4 days or less?
2. Most mosquito species important to public health require at least 6 days to develop from egg to adult. Designing dry systems to drain completely in 4 days ensures that no mosquitoes will be produced with a built-in margin of safety of several days.
3. Our stormwater treatment BMPs were designed to dewater in 4 days, but persistent non-stormwater flows result in areas of standing water that routinely produce mosquitoes. How do we address this problem?
4. Dry-weather urban runoff is a major contributor to mosquito production in urban areas everywhere. If the source(s) cannot be traced and eliminated, the best alternate solution is to minimize the surface area available to mosquitoes by cutting a low-flow channel through the BMP to direct the water to the outlet as efficiently as possible.
5. Will very shallow areas of standing water that remain in our detention basins after a storm event provide a potential source of mosquito production?
6. Certain species of mosquitoes important to public health are very adaptable. Water as shallow as 1/16”, and sometimes less, can be sufficient to allow mosquito larvae to develop.

WET SYSTEMS

1. Our stormwater treatment BMPs are installed belowground and covered. Why should we be concerned about mosquitoes?
2. Unfortunately, certain species of mosquitoes capable of transmitting disease are well-adapted for finding and breeding in belowground habitats. These mosquitoes can access belowground sources through openings as small as 1/16” (2mm) and they can fly great distances through pipes.
3. We wish to install a belowground proprietary BMP in a new housing development. If we seal the access covers against mosquitoes, how far away should we design the inlet grates to keep mosquitoes from accessing the permanent-water sump?
4. The absolute flight limits of mosquitoes that can breed belowground are unknown; however, recent studies found that females could fly at least 80 feet through 4” diameter pipe to reach a source of standing water and were unaffected by changes in pipe course. It is unlikely that mosquitoes can be excluded from underground sources using conveyance pipe length alone.
5. We are considering the addition of weep holes to our belowground sumps to allow them to dewater between storms so they do not produce mosquitoes. Will this work?
6. Weep holes are typically not a reliable choice for preventing mosquito production due to their high probability of failure due to clogging.

7. I was told that mosquitoes cannot breed in water with a visible oil sheen on the water surface. Is this true or false?

8. With some exceptions, this is false. In most cases, the oil sheen visible on the water surface is not uniform, but is broken. Certain species of mosquitoes capable of transmitting disease can exploit these habitats by using the oil-free areas for egg laying and larval development. In addition, surface oils are broken down over time, disappearing altogether if not regularly replenished by oily runoff.

9. We are considering a provision to dewater our belowground sumps after every storm event to prevent mosquito production. Will this be effective?

10. It has the potential to be effective, but there are several complicating factors to consider:
    1) dry-weather urban runoff frequently replenishes belowground sumps making pumping efforts futile, and
    2) pumps often leave a small amount of residual water in the bottom of the sumps, and water as shallow as 1/16" or less can be sufficient to allow mosquito larvae to develop.

11. Our stormwater sumps contain very deep water. Will this prevent mosquito production? Unlike deep water zones in ponds and wetlands where mosquitoes generally do not develop due to predators, wind, and wave action, mosquitoes are unaffected by water depth and/or surface area in belowground systems.

12. Will flowing water prevent mosquito production?

13. Flowing water will discourage females from laying eggs and can kill larvae. For example, a vortex separator receiving year-round flow from an urban stream should not produce mosquitoes due to constant movement of the entire water surface area. However, water flow through systems with square sumps (or sumps of other geometrical shapes) may not completely eliminate mosquito production due to the stagnant zones created in the corners where water movement is minimal.

14. Will surface agitators prevent mosquito production?

15. Agitators, sprinklers, or other means of disturbing the water surface will discourage females from laying eggs and can kill larvae, however, in order to be effective the <u>entire</u> surface must be disturbed.

16. It seems that controlling mosquitoes in belowground stormwater systems without resorting to chemical treatment is rarely successful. How do we deal with this problem? Field research has documented the difficulty in controlling mosquitoes in belowground stormwater systems without chemicals (i.e. exclusion of mosquitoes was successful in a few systems studied, but the vast majority of attempts resulted in only marginal reductions). However, for reasons that are not entirely understood, not all belowground systems produce mosquitoes equally; some are sporadic and some are year-round producers. It is strongly recommended that the local vector control agency be consulted to determine site-specific monitoring and control needs.

WETLANDS

1. Why are mosquitoes still being detected in well designed and maintained wetlands? Mosquitoes are difficult to eliminate completely from wetlands due to the complexity of the created environment. The goal should be to minimize mosquito production by making the habitat less desirable for them.

2. Will the deep areas of stormwater ponds where no emergent vegetation can grow produce mosquitoes?

3. Deep, open areas of water are typically unsuitable for mosquito production due to surface disturbance caused by wind and exposure to predators. However, if the deep zones become colonized by floating vegetation such as water hyacinth or by clumps of floating filamentous algae, mosquitoes may breed in the shelters created among these plants.

4. Why is it important to keep emergent vegetation such as cattails and bulrush from getting overly dense?

5. Dense emergent vegetation, especially along perimeter margins, will prevent predators such as mosquitofish from accessing these areas, creating ideal habitats for mosquitoes.

6. Why is it important to eliminate floating vegetation such as water hyacinth and maintain water quality to discourage clumps of floating filamentous algae?

7. Not only are certain floating plants such as water hyacinth considered exotic invasive species harmful to North American ecosystems, but these plants provide excellent habitats for mosquitoes sheltered from predators.

8. How do I determine if mosquitofish are permissible for use in my area?

9. As a general rule, if the stormwater wetland is self contained, and does not empty into a natural waterway, mosquitofish can be used to control mosquitoes. If in doubt, it is best to consult with the local office of the Department of Fish and Game before stocking fish.

10. How often should mosquitofish be restocked to reduce mosquito numbers?

11. In general, mosquitofish are very hardy and will rapidly increase in numbers to form a stable population. Large game fish such as bluegill and bass may negatively impact or eradicate mosquitofish populations, as can large numbers of fishing birds; however, low temperatures are the leading cause of population failures. In cold climates, mosquitofish may need to be restocked each spring following the last frost.

12. Do we need to be concerned with mosquito production during “cold snaps” or winter periods?

13. Most mosquitoes important to public health can develop successfully in water ranging from approximately 45 to 100°F, with the ability to survive short periods outside this spectrum. Short cold snaps may not be lethal to larvae if the habitat provides a buffer area, however, extended periods of cold below 45°F will halt mosquito production.

14. Will encouraging nesting and roosting habitat for certain birds and bats

around our stormwater wetland reduce the population of adult mosquitoes appreciatively?

15. Although certain birds (e.g. swallows, martins) and bats have been reported to consume large numbers of adult mosquitoes, these animals do not preferentially feed on mosquitoes and there is no evidence to show that they substantially reduce mosquito populations.

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