Purpose

The City of Woodbury is working to achieve water quality goals and has developed stormwater design standards for residential and commercial development that occurs within the City. Consistent with City Ordinance, Chapter 27, this Administrative Directive serves as the design guide criteria for public and private development and redevelopment.

Policy

The City of Woodbury shall review all applicable development applications for the following stormwater design elements and require compliance to ensure that development and redevelopment stormwater designs meet the City’s criteria and natural resource protection goals.

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Wetland and Stormwater Management Ordinance

Chapter 27, Environmental Management, of Woodbury City Code contains ordinance requirements related to the design and construction guidance in this document. This document shall not be used without consultation of the ordinance, specifically Division 2, Wetlands, and Division 3, Stormwater Management.

Requirements from Other Organizations

The project proposer is responsible for obtaining all necessary permits, including but not limited to: Washington County, Minnesota Department of Transportation (MnDOT), Federal Emergency Management Agency (FEMA), Department of Natural Resources (DNR), and United States Army Corps of Engineers (USACE). Approval from all permitting or governing agencies shall be required prior to issuance of a City land disturbance permit. The City prefers the watershed and city review processes occur simultaneously. The project proposer is responsible for verification of the project’s district:

- South Washington Watershed District (SWWD)
  - The City coordinates reviews with SWWD as needed.
- Ramsey-Washington Metro Watershed District (RWMWD)
- Valley Branch Watershed District (VBWD)

Within the City of Woodbury, the three aforementioned watershed districts administer the Wetland Conservation Act (WCA) in accordance with guidance from the State’s Board of Water and Soil Resources. A current WCA determination shall be included with the development application.

The Developer shall be responsible for coordinating and obtaining any other permits necessary from other applicable agencies such as the Minnesota Pollution Control Agency (MPCA) National Pollution Discharge Elimination System (NPDES) Construction Stormwater permit, prior to commencement of any site activities and/or release of the City’s land disturbance permit.

Design Guidelines

Summary of Requirements (referenced detailed design guidelines below)

1. Flood and Rate Control Summary
   a. Minimum 3-feet separation from 100-year, 24-hour High Water Level (HWL) to Lowest Adjacent Grade (LAG).
   b. Minimum 1.5-feet separation from emergency Overflow (EOF) to LAG
   c. Proposed runoff rates shall be equal to or less than existing runoff rates for the 2-, 10- and 100-year 24-hour events
      i. Additional restrictions based on location of development and other entity requirements

2. Volume Control Summary
   a. 1.1 inch off new and redeveloped hard surfaces
   b. Infiltration/filtration rate restriction
i. Surface = 0.5 inches per hour (maximum 2-foot depth)
ii. Subsurface = 0.15 inches per hour (maximum 0.60-foot depth)
c. Follow Flexible Treatment Option (FTO) flowchart (Attachment A) if volume cannot be achieved
   i. Where infiltration is prohibited or not feasible, filtration practices shall be sized according to a 70% credit towards meeting the treatment requirements of a same-sized infiltration basin.

3. Water Quality Summary
   a. Pre-Treatment
      i. >2 acre tributary: stormwater pond required for pretreatment
      ii. NURP standards: 2.5" rainfall, dead storage required
      iii. <2 acre tributary: sumps, filter strips, etc, required for pretreatment
   b. Total Suspended Solids (TSS) and Total Phosphorus (TP)
      i. Shall meet restrictions held by watershed districts
      ii. Follow FTO flowchart if volume cannot be achieved (Attachment A)

4. Access for Inspection and Maintenance
   a. All Best Management Practices (BMPs) shall be designed for easy inspection at least annually. Access design must be submitted to the City for review and acceptance.
   b. Private owners shall be responsible for recording an Operations and Maintenance Plan against the property, and submitting annual inspection reports to the City.

Modeling and Runoff Calculations
1. All runoff calculations shall be according to the methodology described in the Natural Resources Conservation Service’s Technical Release 55, “Urban Hydrology for Small Watersheds” (commonly referred to as TR-55). Acceptable modeling software includes HydroCAD and XP-SWMM. Other methodology may be used with prior approval by the City.
2. Curve numbers (CN) for each land use shall be chosen based on TR-55, except that under no circumstances shall predevelopment conditions exceed a curve number of 72 (with the exception of redevelopment on existing highly impervious surface). The City shall review the appropriateness of the design curve numbers for the site. As defined by Woodbury City Code, “predevelopment” means the land use that was predominant over the 10 year period preceding a development application, based on review of available aerial photos. In the event previous land use cannot be reasonably determined, the predevelopment land use shall be considered row crop agricultural at peak growth.
3. Where existing conditions is characterized by agricultural land use, the peak growth curve number shall be utilized. Calculation of the peak growth curve number is based on the following formula:
   \[
   \text{CN peak growth} = 2 \times (\text{CN average}) - \text{CN fallow}
   \]
   For example, for row crop agriculture, hydrologic soil group B, the peak growth curve number is 64. This is based on an average and fallow curve number of 75 and 86, respectively.
4. Distributed curve numbers shall be utilized in calculating runoff.
5. An MSE III, 24-hour nested rainfall distribution based on Atlas 14, Volume 8 (including subsequent updates) shall be utilized for runoff calculations.

Ponds and Volume Management
1. As-builds and electronic CAD or GIS files are required for all BMPs.
2. All BMPs that receive public water shall be public infrastructure and placed within an outlot dedicated to the city as required by ordinance. If, at the City's sole discretion, it is determined that as an overall percentage, the public water to the BMP is minimal and that an easement dedicated to the City is sufficient and preferable to an outlot; an easement shall be granted to the City. In this case, the pond(s) shall be considered private and maintenance shall be the responsibility of the owner.

3. BMPs and associated pre-treatment devices shall be entirely placed in a location on the site that allows for inspection, maintenance, and replacement, as needed.

4. Inspection and maintenance agreements as described in ordinance and subsequent Maintenance of Best Management Practices section of this guide are required for all private ponds and volume management BMPs.

5. All BMPs shall be planted with the City-Approved seed mix. Seed shall be applied by the use of hydromulch to reduce soil compaction. Trees and bushes on the side slopes are permitted upon approval of the City.

6. City Standard Detail Plate STO-42 shall be used for standard cross section design of wet ponds, infiltration and filtration basins.

**Soil Boring Requirements**

1. Soil borings are required whenever stormwater ponding or infiltration/filtration BMPs are proposed on-site. The number of borings required and boring depth requirements are listed in the table below.

2. One soil boring is required per quarter acre of surface area with a minimum of two borings per basin. Boring locations must be shown on the proposed grading plan.

<table>
<thead>
<tr>
<th>Purpose of Soil Boring</th>
<th>Soil Boring Requirements</th>
<th>Volume Management BMP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stormwater Pond</td>
<td>&gt;2 ac tributary area: 10-feet below proposed basin bottom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;2 ac tributary area: 3-feet below proposed basin bottom</td>
</tr>
<tr>
<td>Depth to bedrock and/or groundwater</td>
<td>10-feet below proposed pond bottom</td>
<td>5-feet below proposed basin bottom</td>
</tr>
<tr>
<td>Infiltration Rate</td>
<td>--</td>
<td>Minimum 2 borings per basin</td>
</tr>
<tr>
<td>Required # borings</td>
<td>1 per quarter acre surface area;</td>
<td></td>
</tr>
</tbody>
</table>

1Additional borings, deeper borings, and geotechnical reports or investigations may be required at the City’s discretion; particularly in areas of suspected active karst, or where initial borings indicate concern of bedrock, groundwater, or other environmental factors. Further investigation may include borings at least 50 feet below the proposed grade.

**Surface Pond Design and Construction**

1. Ponds shall be designed according to the standards in the MPCA’s Protecting Water Quality in Urban Areas and design criteria from the Minnesota Stormwater Manual (MSM). Water quality treatment will be designed and constructed to provide dead storage equivalent to the runoff from a 2.5-inch rainfall event or the requirements of the NPDES construction site permit, whichever leads to higher treatment capacity.

2. All constructed ponds shall:
a. Comply with City Standard Detail Plate STO-35, Typical Nurp Pond Design
b. Have an unobstructed maintenance access from an adjacent roadway. The
maintenance access shall be provided in the form of an outlot (preferred),
easement, or a combination of the two, minimum width of 20 feet. Maintenance
access routes shall serve as EOF routes where feasible.
c. Have a maintenance bench around a sufficient portion of the perimeter to
provide access to all inlets and outlets. The maintenance bench shall extend from
the Normal Water Level (NWL) to 1 foot above the NWL and its cross slope shall
be no steeper than 10H: 1V (horizontal to vertical). The maintenance bench shall
connect to the maintenance access.

3. Pond depth below the NWL shall be designed between 4 and 10 feet. Pond depth shall be
reviewed based on pond size and ability to access pond bottom during future
maintenance. The bottom surface shall be a minimum of 15 feet of flat area in
comparison to pond surface area at NWL.

4. Flood storage bounce shall be designed to a minimum depth of 4 feet unless otherwise
approved by City staff.

5. The EOF of ponds shall be a minimum of 1-foot above the 100-year 24-hour event HWL.

Volume Management Design and Construction
All basins (private, public, and all tributary area sizes)
   a) Soil borings must be completed per the soil boring section above. The design
infiltration rate shall be one-half of the on-site infiltration rate referenced in the
Minnesota Stormwater Manual and based on the Unified Soil Classification, not
to exceed 0.5 inches per hour. This correlates to an infiltration depth of 2.0 feet,
and will be applied to both surface infiltration and filtration practices.
   b) Infiltration/Filtration BMPs shall be designed to infiltrate all water in 48 hours
from the end of event. The table below provides the maximum infiltration depth
of features based on common infiltration rates that will be used in the city and
the corresponding 48 hour drawdown:

<table>
<thead>
<tr>
<th>Infiltration rate (in/hr)</th>
<th>Maximum depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.15</td>
<td>.6</td>
</tr>
<tr>
<td>.2</td>
<td>.8</td>
</tr>
<tr>
<td>.3</td>
<td>1.2</td>
</tr>
<tr>
<td>.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

c) The design infiltration rate for underground infiltration/filtration BMPs will not
exceed 0.15 in/hr due to the fact that the systems cannot be easily tested after
construction to confirm infiltration rate and cannot be easily maintained.
d) The bottom of infiltration basins shall be at least 10 feet above seasonally
saturated soils and/or bedrock and 3 feet above the NWL of any adjacent
wetland. Proposed basins that do not meet this separation but are at least 3 feet
above seasonally saturated soils and/or bedrock may be approved at the city's
sole discretion.
e) The Minnesota Stormwater Manual shall be referenced for soil mixes, infiltration or filtration media.

f) Construction
   a. Infiltration BMPs shall have maximum slopes of 3H: 1V.
   b. During site grading the basin shall be finished to final grade using equipment that minimizes soil compaction at the bottom of the basin. After grading, the basin will be protected from soil erosion throughout the remainder of the development process. Failure to prevent soil erosion into the basin will trigger remedial action completed by the developer or by the city using project securities.
   c. During development, a flap valve shall be installed on the pipe from the pretreatment pond that will allow water from the infiltration basin to drain into the pond but not from the pond into the basin. After vegetation has been established and construction in the drainage area is significantly complete, the flap valve shall be removed or disabled.
   d. Prior to the initial reduction of land disturbance securities, the infiltration rate shall be measured in the basin by the city or its designee using a modified Phillip Dunn infiltrometer or approved equal. The measured infiltration rate must be equal to or greater than twice the design rate. If the measured rate is less than this, remedial action such as soil ripping or expanding the size of the basin shall be required at the discretion of the city. Land disturbance securities shall be drawn on to complete this work, if necessary.
   e. Prior to release of Plan A securities and when construction is largely complete in the drainage area; the city will confirm that the basin is still infiltrating at the design infiltration rate, vegetation is established and as-built requirements have been provided to the city. At the time that all of these requirements are met, the city will accept the basin as public infrastructure and release Plan A securities being held for stormwater purposes.

   g) All volume management BMPs shall be designed off-line and in a way that water can be routed around them during project construction and until site is stabilized, as appropriate.

Surface Infiltration basin (>2 tributary acres)
   a. Design
      i. Stormwater ponds must be used for sediment pretreatment of regional infiltration basins.

Surface Infiltration basins (<2 tributary acres)
   a. Design
      a. Pretreatment may be provided in the form of sumps, filter strips or other methods approved by the city.
      b. The bottom of the local infiltration basin (defined as having a tributary area less than 2 acres) must be at least 3-feet above seasonally saturated soils, bedrock and the NWL of any adjacent wetland. A minimum of 2 soil borings are required.
      c. Local infiltration basins shall have a maximum bounce of 2-feet during the 100-year 24-hour event.
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d. Local infiltration basins shall be designed with a valved underdrain that is utilized during the plant establishment phase. The underdrain must be closed after plant establishment.

Surface Volume Management BMPs

a. Design
   a. Porous pavement or pavers shall be considered pervious surface for the purposes of infiltration calculations. Porous pavement shall be designed to infiltrate water off impermeable surfaces at a maximum ratio of 5:1 (impermeable surface area to BMP area). If a lesser ratio is prescribed by the manufacturer’s recommendations, the manufacturer’s recommendations shall be used. If used as a component of a BMP the same design requirements shall apply.

Reuse Requirements

a. Site Suitability
   a. Map of irrigable area shall be submitted and reviewed for proper use of irrigation as a BMP, including landscape plan and trail networks.
   b. Areas that do not need irrigation will not be considered for reuse credit.
   c. If additional water treatment is required or recommended by state or federal agencies in the future, it will be the owner’s responsibility to provide proper treatment or supplemental stormwater management.
   d. Irrigation is prohibited when conditions are one or more of the following:
      i. Slopes steeper than 4:1.
      ii. Over hard surfaces like sidewalks.
      iii. Within the 25 foot pond buffer.
      iv. On any vegetation that does not need irrigation after establishment.

b. Plan Requirements
   a. Utilize and submit the most recent Ramsey Washington Metro Watershed District Reuse Calculator, or its equivalent as directed by staff
   b. Plan shall be submitted and approved by City Environmental Division and in compliance with AD-ENGPW-3.8.

c. Design
   a. Consider plant material and hardscaping while maintaining access to all major structures for improved aesthetics given the assumed bounce of the normal pond level.
   b. Ponds used for irrigation shall be lined with at least 1 foot of clay.
   c. A license agreement shall be required if the pump station and/or irrigation lines will be housed within City-owned property.
   d. If submittal is the start of a regional reuse network, the following shall be provided by the developer:
      i. Irrigable acres identified prior to grading.
      ii. A map that shows irrigable areas and location of pumps.
      iii. Location of mainlines and connections for future developments shall be provided prior to release of any land disturbance security for future connections.
Underground Basin Requirements

a. Site Suitability
   a. Surface BMP’s should be used to the extent practical
   b. Preference to route roof runoff to underground systems over runoff from parking lots and drive lanes
   c. Compliance with the City pretreatment requirements is critical to long-term function

b. Plan Requirements
   a. Provide a detail for all underground basins that calls out pertinent elevations (outlet, bottom of chambers, bottom of media, drain tile if applicable, etc.), materials, and dimensions
   b. Include gradation and/or applicable ASTM/AASHTO standards for all filtration and backfill materials
   c. Include ASTM/AASHTO standards for all underground structures, geotextile fabric, impermeable liners, and under-drain piping
      i. MSM specifications found at
         https://stormwater.pca.state.mn.us/index.php?title=Infiltration_media_and_material_specifications and
         https://stormwater.pca.state.mn.us/index.php?title=Sand_material_specifications
   d. Clearly identify all cleanouts, access ports, and view ports on the plans

c. Design
   a. To reduce potential for resuspension of sediment in isolator rows, provide high flow bypass/diversion structure(s) to bypass large storm events around the system when feasible
   b. Model the high flow bypass/diversion structures to ensure design water quality event is captured by BMP and not bypassed downstream
   c. Design for non-erose velocities (less than 6 fps) at the discharge point into the underground chamber to reduce resuspension of settled material
   d. Treatment depth for underground basins must not exceed 0.60 feet (0.15 in/hr x 48 hours / 12)
   e. Piped connections between the isolator rows and chambers are highly recommended over permeable isolator rows
      i. Permeable isolator rows are a concern for failure and surface flooding and the filter fabric around the permeable pipe is likely to elog, causing routine cleaning of the isolator rows to not benefit the system after a certain point
   f. Follow manufacturer recommendations for design, installation, and maintenance

d. Pretreatment
   a. Provide sump manholes at each inflow point
   b. Provide an isolator or pre-treatment row within the system to concentrate sedimentation in one area and reduce maintenance needs of the chambers.
      i. In lieu of an isolator row, the design may utilize an enhanced pretreatment structure such as a hydrodynamic separator with City approval

e. Underdrains
   a. Install underdrains with a minimum slope of 0.5 percent
b. Minimum underdrain pipe diameter is 6 inches

c. To promote drainage and decrease clogging potential, surround underdrains with AASHTO M-43 gravel or MnDOT 3149.2.H Coarse Filter Aggregate

d. Construct underdrains with perforated Schedule 40, SDR 35 Smooth Wall PVC pipe, or Dual Wall HDPE pipe

e. Include at least 2 observation/cleanouts for each underdrain; cleanouts should be installed every 200 feet or at all corners for systems with an underdrain

f. Filter sock around underdrains is not recommended due to clogging potential

g. Filter fabric between the rock or sand layers is not recommended due to clogging potential

h. Additional underdrain recommendations in MSM: https://stormwater.pca.state.mn.us/index.php/Design_criteria_for_filtration

f. Maintenance Access/Safety

a. Maintenance access locations need to be accessible by vactor truck and have pavement section rated for maintenance truck loads

b. 48-inch manholes are recommended at each end of isolator rows

c. Cleanouts or access ports are required strategically throughout the system on non-isolator rows. These must be larger than 20 inches in diameter to provide proper inspection and be located out of the drive lane. If non-isolator rows are longer than 200-feet, access ports or cleanouts are recommended at the mid-point in addition to the ends.

d. Isolator rows must be solid wall pipe and be sumped (preferable sump depth is a minimum of 3-feet)

e. Maintenance of the isolator rows must be clearly outlined in the Operation and Maintenance plan

g. Shop Drawing Review, Inspection and Testing Requirements

a. Prior to issuance of a land disturbance permit, the developer shall post a cash escrow with the City for inspection of the system during installation.

b. The developer shall provide a detailed as built of the underground system and all contributing infrastructure.

c. The design engineer or manufacturer shall certify that the system was installed per the approved plan set and is in working condition.

Storm sewer design guidelines

1. Manhole spacing shall not exceed 400 feet.

2. Where more than one pipe enters a structure, a catch basin/manhole with a minimum 4-foot diameter shall be used.

3. Storm sewer shall match top of pipe to top of pipe unless grade constraints prevent this. In that case, hydraulic calculations will be necessary to verify that excessive surcharging will not occur.

4. Storm sewer pipes shall be designed utilizing the rational method or NRCS TR-20 methodologies. Channel design shall be by hydrograph method.

5. Lateral systems shall be designed for the 5-year rainfall using the rational method. State Aid roadway storm sewer shall be designed per the State Aid requirements. Low areas
shall have an acceptable overland drainage route, as determined by the city, with the proper transfer capacity when the event is exceeded.

6. The minimum full flow velocity within the storm sewer shall be 3 feet per second (fps). The maximum velocity shall be 10 fps; except when entering a pond, where the maximum velocity shall be limited to 6 fps.

7. Trunk storm sewer shall be designed at a 100-year pond discharge capacity, in addition to the 5-year design flow for direct tributary areas.

8. For storms greater than the 5-year event, and in the case of blocked inlets, transient street ponding may occur. For safety reasons, the maximum ponding depth shall not exceed 1.0 foot at the deepest point, provide EOF to meet this requirement.

9. To promote efficient hydraulics within manholes, manhole benching shall be provided to 1/2 diameter of the largest pipe entering or leaving the manhole.

10. Vaned grate (R-3067-VB or R-3067-V) catch basin castings shall be used on all streets.

11. The maximum design flow at a catch basin for the 5-year storm event shall be 3 cubic feet per second (cfs), unless high capacity grates are provided.

12. All storm structures shall be designed to the following:
   - Structure within roadways shall be a minimum of 4 feet deep (rim to invert).
   - Area inlets shall be a minimum of 3.5 feet in depth
   - 2x3 catch basins shall only be located at the top of the storm pipe segment.

13. Wherever possible, pipes parallel to the street shall be contained within the street (i.e. not the boulevard).

14. Catch basin manholes shall be a maximum depth of 8 feet, when feasible. Catch basin manholes shall be utilized only where needed for capacity.

15. The storm sewer main shall be placed on the east and/or south side of street opposite the water main with 10 feet of horizontal separation.

16. A minimum of 18 inches of vertical separation shall be provided between the storm sewer and/water main pipe, with insulation, where crossings occur.

17. Design and location of catch basins shall take into consideration pedestrian ramps, gate valves and hydrant locations.

18. Catch basins shall not be located on top of sanitary sewer and water service laterals.

19. Rear yard storm sewer pipe runs shall be avoided. Where this is not possible, the length shall be minimized (300 feet maximum) and approved by the city.

20. Rear yard drainage swales should be intercepted with catch basins at a minimum distance of 300-feet

21. The last structure in the street prior to discharging into a pond shall be constructed with a minimum 4-foot deep and 5-foot diameter sump.

22. A concrete frame is required around all beehive castings per city Standard Detail Plate STO-38 unless approved by the city.

Inlets and outlets

1. City standard detail plates shall be utilized for pond outlet structures. The outlet structures shall be designed with a primary outlet structure and secondary overflow structure routed to the storm sewer and a defined overland EOF as the tertiary outlet structure.

2. Submerged pipes are not allowed.

3. Inlets and outlets shall be designed and located to prevent short-circuiting of the pond’s treatment capacity.

4. The minimum outlet diameter shall be 6 inches to reduce the potential for plugging.
5. Discharges shall have a stable outlet capable of carrying design flow at a non-erosive velocity. Outlet design shall consider flow capacity and flow duration. This requirement applies to both the site outlet and the ultimate outlet to the storm sewer system or water body.

6. Outlets with velocities greater than 4 fps into channels, where the angle of the outlet to the channel flow direction is greater than 30 degrees, require energy dissipation or stilling basins.

7. Outlets with velocities of less than 4 fps that project flows downstream into a channel in a direction 30 degrees or less from the channel flow direction will require riprap protection.

8. Riprap shall be provided from the channel bottom to a height above the outlet. Riprap shall be placed over a suitably graded filter material and filter fabric to ensure that soil particles do not migrate through the riprap and reduce its stability. Riprap shall be placed to a thickness at least 2.5 times the mean rock diameter to ensure that it will not be undermined or rendered ineffective by displacement. Refer to City Standard Detail Plate STO-14.

9. Discharge velocity into a pond at the NWL shall be 6 fps or less. Riprap protection shall be required at all inlet pipes into ponds from the inlet to the pond bottom.

Regional Channels, swales, overland drainage and emergency overflows (EOFs)

1. Overland drainage routes where velocities exceed 4 fps shall be reviewed by the city and approved only when suitable stabilization measures are proposed.

2. Open channels and swales are recommended only where flows and small grade differences prohibit the use of storm sewer.

3. The minimum channel or swale grade in all unpaved areas shall be 2%.

4. Channel side slopes shall be a maximum of 4H: 1V with gentler slopes being desirable.

5. Riprap shall be provided at all points of juncture between two open channels and where storm sewer pipes discharge into a channel.

6. Open channels shall be designed to handle the expected velocity from a 10-year design storm without erosion. Riprap or other stabilization may be necessary.

7. All channels shall be designed to allow easy access for inspections and maintenance.

8. Project grading shall not block or raise previously constructed EOFs or existing natural overland drainage patterns from adjoining properties unless provisions have been made for the altered pattern of runoff.

9. Overland EOFs shall be designed so a minimum of 1.5 feet of separation from the EOF to the lowest ground elevation adjacent to the structure shall be provided.

10. The EOF shall be sized with a capacity to handle the 100-year primary discharge (assuming primary outlet is blocked) and have a minimum bottom width of 5 feet and 4H: 1V side slopes and a maximum depth of flow of 1.5 ft. The emergency overflow sizing matrix provided below shall be used for design of the EOF.

EOF Sizing

<table>
<thead>
<tr>
<th>Capacity (cfs)</th>
<th>Top Width (ft)</th>
<th>Bottom Width (ft)</th>
<th>Cross Sectional Area (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>17</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>70</td>
<td>22</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>100</td>
<td>27</td>
<td>15</td>
<td>32</td>
</tr>
</tbody>
</table>
Any pond that is designed with a peak discharge of 130 cfs or greater should be designed with guidance by the city. The minimum 1.5 feet of separation to structure may also be increased for EOFs that have significant peak discharge rates.

Appendix
1. Flexible Treatment Options Flowchart
The Flexible Treatment Options (FTO) alternatives presented here should be employed when the ordinance requirement is not feasible and/or allowed. The designer should document the reasons why the ordinance requirement and rejected FTO Alternatives are not feasible and/or allowed.

**FTO ALTERNATIVE 1**
Applicant attempts to comply with the following conditions:
1. a. Achieve at least 0.55" volume reduction goal, and
1. b. Remove 75% of the annual TP load, and
1. c. Options considered and presented shall examine the merits of relocating project elements to

**FTO ALTERNATIVE 2**
Applicant attempts to comply with the following conditions:
2. a. Achieve volume reduction to the maximum extent practicable as determined by the city, and
2. b. Remove 60% of the annual TP load, and
2. c. Options considered and presented shall examine the merits of relocating project elements to address, varying soil conditions and other constraints across the site.

**FTO ALTERNATIVE 3**
Off-site mitigation, including banking or cash or treatment on another project as determined by the city, equivalent to the volume reduction goal can be used in areas selected in the following order of preference:
1. Locations that yield benefits to the same receiving water that anywhere within the city
2. Locations within the same Department of Natural Resource (DNR) catchment area up-stream
3. Locations in the next adjacent DNR catchment area

**NOTES:**
- Volume reduction techniques considered shall include infiltration, rainwater harvesting & reuse, bioretention, permeable pavement, tree boxes, grass swales and/or additional techniques included in the MPCA. 4.
- Applicant shall document the flexible treatment options decision sequence, following the order of alternatives presented here.
- For Alternative 2, the applicant is encouraged to use BMPs that reduce volume. Secondary preference is to employ filtration techniques followed by rate control BMPs.
- Fully reconstructed impervious surfaces: Areas where impervious surfaces have been removed down to the underlying soils. Activities such as structure renovation, mill and overlay projects and other pavement rehabilitation projects that do not alter the underlying soil material beneath the structure, pavement or activity are not considered fully reconstructed. In addition, other maintenance activities such as catch basin and pipe repair/replacement, lighting, and pedestrian ramp improvements shall not be considered fully reconstructed impervious surfaces. Reusing an existing building foundation and re-roofing of an existing building are not considered fully reconstructed.
- Hotspots includes any portion of a facility where infiltration is prohibited under an NPDES/SDS industrial stormwater permit issued by the MPCA.