UNIVERSITY OF MICHIGAN

STORMWATER BEST MANAGEMENT PRACTICES

University Planner's Office

Architecture, Engineering & Construction
In Association with OSEH–EP3

University of Michigan

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http://www.umaec.umich.edu/

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The Stormwater Best Management Practices Manual is a companion OSEH's Stormwater Management Program Plan (http://www.oseh.umich.edu/stormwater/SWMP2010.pdf) and to the AEC Design Guidelines, which designers must also adhere to (http://www.umaec.umich.edu/desguide/index.html).

A. Abbreviations

1. U-M – University of Michigan
2. AEC – Architecture, Engineering & Construction
3. UPO – University Planner's Office
4. DPS – Department of Public Safety
5. Grounds – Plant Department/Grounds
6. OSEH – Occupational Safety and Environmental Health
7. BMP – Best Management Practices

B. Stormwater Management

Goals: Use site specific strategies to protect water quality and prevent flooding, erosion and other negative impacts to campus buildings, infrastructure and the natural environment; maintain hydraulic balance in each watershed (as required per the U-M stormwater NPDES permit) for site disturbance 1 acre or greater or sites less than 1 acre that are part of a common plan of development where the total development will disturb 1 acre or greater (http://www.oseh.umich.edu/stormwater/SWMP2010.pdf); minimize impervious coverage; and minimize infrastructure costs.

Non-Structural Strategies:

1. Limit site disturbance and soil compaction

It is important to minimize soil compaction and site disturbance caused by construction activities. Avoiding compaction increases soil infiltration capacity, maintains a healthy environment for vegetation and preserves drainage ways and natural catchment areas. Site specific strategies for minimizing disturbance through design and construction practices include:

a. Limit areas of heavy equipment access and staging/storage of materials.
b. Identify and protect high-quality and environmentally sensitive areas- do not allow any disturbance to take place in these areas.
c. Identify areas which will be vegetated after construction- avoid disturbance in these areas (clearing, but not grading).
d. Avoid extensive and unnecessary clearing and stockpiling of topsoil.
e. Restore soil permeability to compacted areas that occurs during construction.
f. Place temporary fencing around tree drip lines to avoid destruction of tree roots (following these guidelines: http://www.aec.bf.umich.edu/for.archs/details/general/01141001-Tree%20Protection.pdf).
g. Minimize grading by designing to the existing topography.

For additional detail refer to technical section 02215 (http://www.aec.bf.umich.edu/desguide/tech/02/02215.pdf) and Soil Erosion & Sedimentation Control (http://www.oseh.umich.edu/stormwater/SESCprogram.pdf).

2. **Protect natural and intermittent streams and swales; maintain as natural habitat and campus amenity**
   Identify, protect, and utilize natural drainage features, such as swales, low areas and watercourses as a means of protecting water quality. This maximizes the site's natural hydrological characteristics, reducing the need for structural management practices and minimizing construction and maintenance costs. Items to consider:

   a. Identify and map natural drainage features (e.g., swales, streams, low areas, wetland, etc.). Use signage and fencing for protection.
   b. Utilize natural topographic/drainage features to guide site design.
   c. Prevent erosion of natural drainage features by using upstream volume and rate control practices, such as level spreaders, erosion control matting, check dams, straw rolls, re-vegetation and outlet stabilization.

3. **Protect and restore buffer areas to promote filtration**
   Natural vegetated areas are important components of an integrated stormwater management system that help protect water quality by stabilizing banks, mitigating flow rates, and filtering of pollution and sediment. Items to consider:

   a. Plan wide planted buffer zones/setbacks (50' buffers are preferred) around drainage courses, ponds and wetland.
   b. Limit the amount of impervious surfaces and industrial uses allowed adjacent to buffer areas.
   c. Restrict clearing of vegetation within a 100-year floodplain.
   d. Restore buffer areas by revegetating it with native plantings, if possible.

4. **Reduce impervious surfaces**
   Reducing impervious surfaces includes minimizing the dimension or area required for roads, drives, walks and parking. When pavement is reduced, the rate of stormwater runoff is decreased while infiltration is increased. Items to consider:

   a. Evaluate traffic volumes and parking requirements taking into consideration average and peak use demand.
   b. Remove unutilized/underutilized impervious coverage.
   c. Consider minimizing impervious road and parking areas by incorporating pervious paving materials, where appropriate.
   d. Use pervious materials for plazas and sidewalks, and bike parking areas, where appropriate.

e. Reduce setbacks along roads to minimize length of access driveways and approach walks.
f. Analyze the site to determine if smaller parking spaces, slanted parking stalls, compact car spaces, and narrowed traffic lanes are appropriate.

5. **Promote overland flow**

Promote overland flow (where appropriate) to minimize need to costly infrastructure/reduce downstream impacts. When utilizing overland flow, consideration must be given to prevent erosion, wash-out, and to identify the water flow path that will occur. Water should be directed away from buildings and sensitive areas to prevent water from entering buildings, entrances, washing out landscaping beds, etc.

6. **Work with existing terrain**

Work with the site's existing terrain to mitigate negative environmental effects. Items to consider:

a. Orient site surface features (roads, parking, walks, etc.) along existing contours to reduce need for cut/fill operations.
b. Avoid increasing run-off on adjacent non-university properties, as well as avoid impacting neighboring site overland flow.

<u>Structural Strategies</u>

7. **Incorporate bio-retention areas**

Bio-retention areas, also referred to as rain gardens, are depressed surface areas – typically no more than one acre in size – that are planted with carefully selected native plantings whose function is to capture and treat stormwater runoff from rooftops, streets and parking lots. These areas help to moderate stormwater runoff, promote groundwater recharge and infiltration, create an aesthetically pleasing setting, provide wildlife habitat, and mitigate heat island effect if properly designed and located. Items to consider:

a. A commitment to regular maintenance is necessary so that the rain garden does not become over-run by weeds and non-native vegetation.
b. In order to prevent clogging, a vegetated buffer strip, inlet or sediment trap should be installed prior to the runoff entry into the garden.
c. Surface area should not exceed 5:1 impervious drainage area to bio-retention; ponding depth is recommended at 6 inches.
d. Planting live material is preferred to seeding.

8. **Utilize forebays and detention basins**

   Detention basins are temporary stormwater storage areas that are used to help prevent downstream flooding by moderating stormwater runoff peaks. There are four different types: dry ponds, wet ponds, constructed wetlands and underground detention. Forebays are smaller basins designed to take the initial "flush" of stormwater and slow the rate of flow before releasing into the detention basin. They are separated from the basin. Items to consider:

   a. Assess storage capacity of basin in lieu of available site area and soil/subsurface conditions.
   b. Consider combining with other BMPs for an integrated solution.
   c. Plan for regular maintenance – vegetation and sediment removal. Maintenance may require the use of heavy equipment; plan for access routes, etc. accordingly.
   d. Evaluate surrounding sites when considering the development of a detention basin. Consider strategically locating a larger detention basin as opposed to constructing several smaller basins.
   e. Detention basins should be designed to accommodate a one-hundred year rainfall. Basins should meet U-M's stormwater NPDES permit requirement.
   f. A minimum length to width ratio of 2:1 is recommended; the shape should maximize stormwater flow pathway and irregularly shaped basins are acceptable. Slopes in and around the basin should be horizontal to vertical, 4:1 to 5:1; the maximum water depth should not exceed 10 feet.
   g. Forebays should be vegetated to improve runoff and stabilize the soils. They should have a minimum length of 10 feet and be physically separated from the basin by a wall or berm.

9. **Create vegetated swales/filter strips**

   Vegetated swales/filter strips are permanent, maintained strips of vegetation designed to slow runoff and filter out sediment and other pollutants from stormwater. Sheet flow must be maintained across filter strips. Appropriate applications for filter strips are where runoff is directed from impervious areas such as roads and parking. Items to consider:

   a. Use level spreaders to promote even flow/filtering capability across the filter strip.
   b. To ensure that large storms safely bypass the filter, install flow splitters or multi-stage chambers.
   c. Maintain relatively level slope to ensure optimum filtering.
   d. In areas with high level of debris, pretreatment such as oil/grit separators may be necessary in lieu of vegetated filter strips.
   e. Ensure that the ratio of drainage area to filter strip is in balance (not to exceed 6:1).

f. Create a dense plant filter strip with a mix of salt and drought-tolerant plant material. Refer to U-M Grounds for a list of recommended plants (http://www.plantops.umich.edu/grounds/landscape).

10. Incorporate underground filter chambers

An underground filter chamber is a large subsurface structure with at least two chambers capable of receiving relatively large amounts of stormwater flow. One chamber of the filter settles large particles while the other contains material that is capable of filtering small particulate matter. Filtered water discharges through an outlet pipe. Once installed, the system must meet the requirements of post-construction stormwater management per the U-M NPDES permit (http://www.oseh.umich.edu/pdf/guideline/guidePCSW.pdf).

11. Consider a green roof

Green roofs, also referred to as vegetated roofs or roof gardens/terraces, are conventional roof top structures that are overlain with a layer of vegetation that allows the roof to function like a vegetated ground surface. The overall thickness of the vegetated roof can range from two inches to several feet depending upon the structural integrity of the roof system. A green roof profile typically consists of many layers, including waterproofing, insulation, specialized soil, filter fabric, and vegetation. Items to consider:

a. Analyze structural integrity/load bearing capability of the roof to ensure proper design.
b. Ensure the roof does not exceed a 2:12 slope to prevent slippage; roofs with slopes greater than 2:12 must incorporate supplemental measures.
c. Separation fabric should be readily penetrated by roots, but provide a durable separation between the drainage and growth media layers.
d. Use drought resistant plants.
e. Incorporate means of watering roof during times of extreme drought.
f. Ensure safe/adequate access for maintenance personnel and equipment.
g. During plant establishment, several weedings, fertilizations and infill plantings should occur. Once the plants are established, only annual maintenance is necessary.
h. Check roof warranty to ensure green roof installation does not terminate its validity.

12. Restore developed areas with native vegetation

Native revegetation can occur in a woodland, no-mow lawn area, buffer area, prairie and constructed wetlands. There are many benefits including reduced maintenance needs, beautification, improved water quality and reduced volume of runoff. Items to consider:

a. The site's soil type and topology will guide plant selection. Performing a soil survey is necessary.
b. Perform a thorough weeding before planting the native vegetation.
c. Adequate stabilization will help to establish the native plantings.
d. The first year will require more maintenance (weeding and watering) than subsequent years.

For detailed instructions refer to SID-T (http://www.aec.bf.umich.edu/desguide/sid/sid_t.pdf).

13. Institute a soil restoration program

Soil restoration is a technique used to restore soils by physical treating and/or mixing natural additives into the soil where it has been compacted by construction activities or general use over an extended period of time. By employing de-compacting measures, water retention capacity of the soil is increased, erosion is reduced and the overall soil structure and composition is improved to support healthy plant growth. Items to consider:

a. Evaluate existing soil conditions before implementing a restoration strategy to determine amount of soil compaction. A density test will need to be conducted.
b. Tilling the soil should only be used on dry soils. This should be performed before any soil amendment is applied.
c. For major compaction, till to a depth of 20 inches; for minor, 8 inches.
d. Soil media should not be applied on slopes greater than 30%.
e. Restoration should not take place within the critical root zone of trees.
f. The tilling should create a two-directional grid, spaced 12 -36 inches apart.

14. Encourage use of porous pavement

Porous pavement is utilized to promote stormwater infiltration. There are many different types including: porous concrete, porous asphalt, porous concrete unit paver and grass-crete (or equivalent). The potential use of a pervious pavement system should be evaluated early in the design process. The design of these systems should allow for water to infiltrate before any outlet of excess volumes to the sub-drain and/or stormwater system.

a. Systems
    i. Porous concrete, or pervious concrete, is created by reducing the number of fines added to a standard mix in order to establish drainage voids.
        - Underlay pervious pavement with a stone sub-base for cold climate areas
        - Installation methods and outcomes should be carefully observed where grading requirements are stringent. Installation involves rolling the

concrete instead of vibrating and currently has been observed to leave the finished surface slightly 'sagged' in the center of the roller.

- There is a distinct difference in color between concrete batch installations.

ii. Porous or pervious asphalt is essentially standard bituminous asphalt into which fines have been screened and reduced, allowing water to pass through small voids. Pervious asphalt is typically placed directly on the stone sub-base in a single layer and rolled into a finished surface. Porous asphalt is typically used for parking lots; however, applications could include walkways in natural areas.

iii. Porous concrete unit pavers, or permeable paver blocks, are interlocking units (often concrete material) that, when placed together in a system, allow water to drain through and into the sub-base zone or directly into the soil. The paving units themselves come in all sizes and colors and are particularly suited for high images areas such as courtyards and plazas. Units can be specified that are capable of taking heavy loads, such as parking lots, service areas and low-speed drives.

- Accessible ramps within porous paver areas should be considered as standard concrete pavement to achieve and maintain the required grades.

For detailed instructions refer to technical section 02510 (http://www.aec.bf.umich.edu/desguide/tech/02/02510.pdf).

C. Compliance

1. AEC - Civil Design Guidelines and Specifications
2. U-M Soil Erosion and Sedimentation Control Procedures (OSEH)
3. Tree Protection Policy
4. U-M Storm Water Management Program Plan (OSEH)
5. U-M Post Construction Guideline
6. OSEH Plan Review
7. American with Disabilities Act
8. Wayfinding and Signage Guidelines
9. All applicable building codes http://www.umaec.umich.edu/desguide/sid/sid_f.pdf
10. Campus Exterior Operations Review
11. Exterior Elements Design Review
12. AEC Plan Review Process