F.18 Outlet Controls

F.18.1 General Design Standards

1. Verify that outlet controls provide positive overflow for their associated SMP, allowing stormwater to flow out of the SMP when the water level reaches a maximum design elevation in a subsurface feature or a maximum ponding depth in a surface feature without surcharging the SMP. Positive overflow from an SMP can either flow to another SMP or to an approved point of discharge. [Section 4.12.1, 2]
2. Verify that outlet control structures are sized to convey at least the ten-year, 24-hour storm event without surcharging the structure. [Section 4.12.1, 2]
3. Verify that the outlet controls are designed to convey flows from the SMP up to the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm, without surcharging the SMP. If flow reaches the SMP via a flow splitter, this structure can provide the positive overflow. [Section 4.12.1, 2]
4. Verify that outlet controls are located so as to be easily and readily accessible for maintenance purposes. [Section 4.12.1, 3]
5. Verify that all outlet control structures in combined sewer areas include a sump and trap or sump and hood. The sump depth must be at least 15 inches below the bottom of the trap or at least 12 inches below the bottom of the hood, and the traps or hoods must be air-tight. [Section 4.12.1, 4]
6. Verify that ladder bars are included within all outlet control structures. [Section 4.12.1, 5]
7. Verify that any manholes between outlet structures and sewer connections in combined sewer areas have sanitary, non-vented covers. [Section 4.12.1, 6]
8. Verify that outlet control structures have solid, non-grated, tops. [Section 4.12.1, 7]
9. Verify that the outlet pipe of an outlet control structure has an invert at or below the invert of the inlet pipe(s). Setting the outlet pipe invert at a minimum of 7.5 inches below that of the inlet pipe(s) is recommended. [Section 4.12.1, 8]

F.18.2 Orifice Design and Material Standards

1. Verify that the orifice diameter for a traditional orifice (i.e., that which is not part of an underdrain) is no smaller than one inch. [Section 4.12.2, 1]
2. Verify that the orifice diameter for an underdrain orifice (i.e., that which is located at the capped end of an underdrain) is no smaller than 0.5 inch. [Section 4.12.2, 1]
3. Verify that a trash rack is provided for any orifice draining surface basins. [Section 4.12.2, 2]

4. For any traditional orifice three inches in diameter or smaller, verify the following:
    a. To prevent clogging, verify that screening is provided over the orifice. The dimensions of the openings within the screening must be half the diameter of the orifice. The screening should be separated from the orifice, not placed directly over the orifice. A minimum 12-inch sump must be provided beneath the invert of the orifice to prevent the collection of debris. [Section 4.12.2, 3]
    b. Verify that an outlet structure box with one manhole access lid on each side of the weir wall is proposed for maintenance access. Adequate space to perform maintenance on the orifice must be provided on each side of the weir wall; it is recommended that at least four feet by three feet of space be provided on each side of the weir wall [Section 4.12.2, 4]
5. Verify that suitable access is provided to inspect and maintain all orifices. [Section 4.12.2, 6]

F.18.3 Weir Design and Material Standards

1. For impermeable weirs, verify the following:
    a. Verify that check dams, when placed within swales, are evenly spaced and no more than six to 12 inches high. [Section 4.12.3, 3a]
    b. Verify that check dams that provide ponding in swales and are designed for infiltration are not porous, as water should be ponded behind each check dam and forced to infiltrate. [Section 4.12.3, 3b]
2. Verify that permeable weirs are not proposed in areas that receive high sediment loads. [Section 4.12.3, 4]
3. For spillways, verify the following:
    a. Verify that, during the 100-year, 24-hour storm event—or, if project is exempt from Flood Control, the ten-year, 24-hour storm event—a minimum of one foot of freeboard is provided between the ponding elevation and the invert elevation of the emergency spillway. [Section 4.12.3, 5a]
    b. Verify that a minimum of one foot is provided between the invert elevation of the emergency spillway and the top-of-berm elevation. [Section 4.12.3, 5b]
    c. Verify that all emergency spillways are stabilized with stone, geotextile, or plant material that can withstand strong flows. [Section 4.12.3, 5c]
    d. Verify that spillway flow is not directed toward neighboring properties. [Section 4.12.3, 5d]
4. Verify that weir walls within outlet control structures are proposed to be poured monolithically. [Section 4.12.3, 6]

F.18.4 Riser Design and Material Standards

1. Verify that riser design balances providing positive overflow with allowing for adequate static storage. Overflow must be provided at the maximum Water Quality storm ponding depth for all SMPs and, for bioinfiltration/bioretention basins, at the minimum height to provide sufficient static storage of the Water Quality Volume (WQv). [Section 4.12.4, 1]
2. Verify that riser pipes are specified on the plans to be constructed of high-density polyethylene (HDPE) plastic, corrugated metal, concrete, or other weather resistant material. [Section 4.12.4, 2]

3. Verify that riser boxes are constructed of precast or cast-in-place concrete with reinforcing as warranted. All concrete must be specified on the plans to be Class C, conforming to the specifications of the *City of Philadelphia Department of Streets, Standard Construction Items (1997)*. [Section 4.12.4, 3]
4. Verify that trash racks or screens are proposed with the riser and that they are specified on the plans to be constructed of durable, weather-resistant materials resistant to photo-degradation, weathering, oxidation, or other corrosive impacts. [Section 4.12.4, 4]

F.18.5 Underdrain Design and Material Standards

1. Verify that capped underdrains are provided for all proposed bioinfiltration/bioretention basins. For bioinfiltration SMPs, the cap at the end located within the outlet control structure must be a solid cover to promote infiltration. For bioretention SMPs, the cap within the outlet control structure must be outfitted with an orifice, sized appropriately to meet all applicable release rate requirements. [Section 4.12.5, 1]
2. Verify that all underdrains are designed to be level (i.e., with no slope). [Section 4.12.5, 2]
3. Verify that all underdrains are constructed of continuously perforated HDPE plastic piping with a smooth interior and a minimum inner diameter of four inches. HDPE pipe must be specified on the plans to meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.12.5, 3]
4. Verify that all underdrains are surrounded by a sand or stone layer to filter sediment and facilitate drainage. [Section 4.12.5, 4]
5. Verify that the sand or stone layer surrounding the underdrain is specified on the plans to be at least six inches both above and beneath the underdrain. [Section 4.12.5, 5]
6. If a sand layer is proposed, verify that the underdrain is surrounded by geotextile fabric to prevent clogging. [Section 4.12.5, 6]
7. Verify that stone surrounding an underdrain is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.12.5, 7]
8. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.12.5, 8]
9. Verify that geotextile fabric is placed between the stone layer and surrounding soil to prevent sediment contamination. [Section 4.12.5, 9]
10. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.12.5, 10]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted
11. Verify that cleanouts or maintenance access structures are provided at the end of all underdrain pipes and that a cleanout detail is provided on the plans. [Section 4.12.5, 11]

12. Verify that cleanouts are provided for all 90-degree bends, located upstream of complicated bends, and evenly spaced during straight pipe runs and that a cleanout detail is provided on the plans. [Section 4.12.5, 12]
13. Verify that all intermediate cleanouts and domed riser pipe connections are located upstream of the connected outlet control structure to allow for cleaning equipment to flush in the direction of the structure. [Section 4.12.5, 13]
14. Verify that an anti-seep collar is installed around outlet pipes passing through embankments. Anti-seep collars must be constructed in accordance with the latest edition of the *PA DEP Erosion and Sediment Pollution Control Program Manual*. [Section 4.12.5, 14]
15. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.12.5, 15]
16. Verify that the outlet pipe of an outlet control structure has an invert at or below the invert of the underdrain. Setting the outlet pipe invert at a minimum of 7.5 inches below that of the underdrain is recommended. [Section 4.12.5, 16]

F.18.6 Level Spreader Design and Material Standards

1. Verify the level spreader length. Level spreader length for a dense grass ground cover condition must be 13 linear feet for every one cubic feet per second (cfs) of flow during the ten-year, 24-hour storm event. Level spreader length for forested areas with no ground cover must be 100 linear feet for every one cfs of flow during the ten-year, 24-hour storm event. [Section 4.12.6, 1]
2. Verify that all level spreaders are designed to safely diffuse flows up to, and including, the 100-year, 24-hour storm event. [Section 4.12.6, 2]
3. Verify that the edge of the level spreader over which flow is distributed is specified on the plans to be exactly level. If there are small variations in height on the downstream lip, small rivulets will form. Experience suggests that variations of more than 0.25 inch can cause water to re-concentrate and potentially cause erosion downstream of the level spreader. The site selected for the installation of a level spreader must be a level grade (a constant horizontal elevation, to within +/- four inches). [Section 4.12.6, 3]
4. Verify that the downslope side of the level spreader is clear of debris. [Section 4.12.6, 4]
5. Verify that the first three feet downslope of the level spreader is stabilized with soil/turf reinforcement matting and grass or other approved vegetation and that matting specifications are provided on the plans. [Section 4.12.6, 5]
6. Verify that level spreaders are not constructed in newly deposited fill. [Section 4.12.6, 6]
7. For level spreaders that do not direct discharge to a receiving stream or sewer, verify that the distance between the level spreader and any downslope property boundary is no less than 15 feet. If this requirement cannot be met, a drainage easement may be required. [Section 4.12.6, 7]
8. For level spreaders that direct discharge to a receiving stream or sewer via overland flow, verify that the distance between the level spreader and any receiving stream or sewer is no greater than 100 feet. Distances greater than 100 feet but less than 150 feet may be considered on a case-by-case basis for very mild slopes (less than or equal to 1%) and heavily vegetated (grassy) areas. [Section 4.12.6, 8]

9. Verify that the first ten feet downslope of the level spreader does not exceed a slope of 4%. [Section 4.12.6, 9]
10. Verify that earthen berms, treated lumber, and geotextile-covered berms are not used as level spreaders. [Section 4.12.6, 10, 11, 12]
11. For concrete curbs, troughs, and half-pipes, verify the following:
    a. Verify that concrete curbs, troughs, and half-sections of pipe are between four and 12 inches deep. [Section 4.12.6, 13a]
    b. Verify that curbs and troughs are specified on the plans to be constructed of Class C concrete or reinforced concrete, conforming to the specifications of the *City of Philadelphia Department of Streets, Standard Construction Items (1997)*. [Section 4.12.6, 13b]
    c. Verify that half-pipes are specified on the plans to be either Class C concrete or reinforced concrete, conforming to the specifications of the *City of Philadelphia Department of Streets, Standard Construction Items (1997)* or HDPE plastic meeting the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.12.6, 13c]
12. For subsurface discharge through level perforated pipes (bubble-up level spreaders), verify the following:
    a. Verify that perforated pipes are between four and 12 inches in diameter. HDPE pipe must be specified on the plans to meet AASHTO M252, Type S or AASHTO M294, Type S standards. [Section 4.12.6, 14a]
    b. Verify that the pipes are enveloped in stone and that the stone is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.12.6, 14b]
    c. Verify that geotextile is placed between the stone aggregate and soil. [Section 4.12.6, 14c]
    d. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.12.6, 14d]
        i. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
        ii. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
        iii. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
        iv. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
        v. Heat-set or heat-calendared fabrics are not permitted
13. For surface discharge to plunge pools, verify the following:
    a. Verify that the plans specify that underlying soils within plunge pools remain undisturbed, uncompacted, and protected from heavy equipment to preserve infiltration capacities. [Section 4.12.6, 15a]
    b. Verify that riprap stone is sized in accordance with the riprap apron design procedures in the latest edition of the *PA DEP Erosion and Sediment Pollution Control Program Manual*. [Section 4.12.6, 15b]

F.18.7 Impervious Liner Design and Material Standards

1. Verify that the impervious liner is specified on the plans to have a permeability of less than, or equal to, 10^{-6} cm/sec. [Section 4.12.7, 3]
2. Verify that the plans indicate that the impervious liner is to be continuous and extend completely up the sides of any structures that are located within the lined basin footprint to the ground surface. If additional liner material must be added to extend up the structures, the additional liner sections are to be joined to the rest of the liner with an impervious seam per the manufacturers' recommendation. [Section 4.12.7, 4]
3. For compacted till liners, verify the following:
    a. Verify that the compacted till liner thickness is no less than 18 inches (after compaction). [Section 4.12.7, 5a]
    b. Verify that soil is compacted to 95% minimum dry density, modified proctor method (ASTM D-1557). [Section 4.12.7, 5b]
    c. Verify that soil is placed in six-inch lifts. [Section 4.12.7, 5c]
    d. Verify that the proposed soils are specified on the plans as meeting the gradation listed in Table 4.12-3 of the Manual. [Section 4.12.7, 5d]
4. For clay liners, verify the following:
    a. Verify that the clay liner thickness is no less than 12 inches (after compaction). [Section 4.12.7, 6a]
    b. Verify that the clay liner is specified on the plans as meeting the specifications listed in Table 4.12-4 of the Manual. [Section 4.12.7, 6b]
5. For geomembrane liners, verify the following:
    a. Verify that the geomembrane liner material is specified on the plans to be smooth high-density polyethylene (HDPE) or linear low-density polyethylene (LLDPE) with a minimum thickness of 30 mil. [Section 4.12.7, 7a]
    b. Verify that the geomembrane liner material is specified on the plans to be resistant to mildew, rot, ultraviolet radiation, insects, and rodents. [Section 4.12.7, 7b]
    c. Verify that a geotextile is placed between the geomembrane liner and the stone storage layer, and it is specified on the plans to meet, or exceed, the strength properties listed in Table 4.12-5 of the Manual. [Section 4.12.7, 7c]
    d. Verify that a sand layer is placed beneath the geomembrane liner to prevent puncture of the liner. [Section 4.12.7, 7d]
    e. Verify that smooth HDPE and LLDPE geomembrane liners are specified on the plans to conform to the physical requirements stipulated in the Geosynthetic Research Institute (GRI) GM13 and GM17 Standard Specifications for HDPE and LLDPE geomembranes, respectively. [Section 4.12.7, 7e]
    f. Verify that boot collars are included at any point where a pipe penetrates a geomembrane liner. This includes utility crossings, distribution pipes, and underdrain pipes. [Section 4.12.7, 7f]

6. For concrete liners, verify the following:
    a. Verify that the concrete is no less than five inches thick, Class A or better, with ordinary surface finish. [Section 4.12.7, 8a]
    b. When underlying soil is clay or if it has an unconfined compressive strength of 0.25 ton per square foot or less, verify that the concrete has a minimum six-inch compacted aggregate base composed of coarse sand and river stone, crushed stone, or equivalent, with diameter of 0.75 inch to one inch. [Section 4.12.7, 8b]
7. Verify that anti-seep collars are provided on all pipes entering or exiting the storage media of infiltrating SMPs where infiltration is not desired outside of the system (e.g. pipes that cross utilities and underdrain connections to the sewer-connected inlet). Where space allows, anti-seep collar should be placed offset from the SMP. [Section 4.12.7, 9]

F.18.8 Micro Siphon Drain Belt Design and Material Standards

1. Verify that the micro siphon drain belt connects to a downslope underdrain or collector pipe and that the elevation of the belt in the immediate vicinity of the downslope connection is at least four inches above the top of the underdrain or collector pipe. [Section 4.12.8, 1]
2. Verify that the end of the micro siphon drain belt that is not connected to the collector pipe is sealed to prevent the intrusion of solids or other clogging materials. The sealant must be suitable for use in submerged environments. [Section 4.12.8, 2]
3. Verify that a minimum belt slope of 1% is proposed. A belt slope of 3% to 5% is recommended to maintain laminar flow within the micro channels. [Section 4.12.8, 3]
4. Verify that the micro siphon drain belt is proposed to be installed in a layer of sand. [Section 4.12.8, 4]
5. Verify that sand is specified on the plans to be ASTM C-33 aggregate concrete sand and to have a grain size of 0.02 inches to 0.08 inches. [Section 4.12.8, 4]
6. Verify that manufacturer's recommendations are followed to determine the number, size, and specific configuration of belts required to provide adequate flow capacity for specific applications. [Section 4.12.8, 5]
7. Verify that the micro siphon drain belt is spaced around the underdrain or collector drain pipe at a maximum of alternating five-foot centers. [Section 4.12.8, 6]

F.18.9 Low Flow Device Design and Material Standards

1. Verify that the following information is submitted for each proposed low flow device as part of the applicant's Post-Construction Stormwater Management Plan (PCSMP) Review Phase Submission Package. [Section 4.12.9, 1]
   a. Performance/discharge curves;
   b. Third-party certifications;
   c. Hydrologic and hydraulic model files, if applicable;
   d. Product specifications;
   e. Manufacturer's guidelines for installation;
   f. Construction sequence; and
   g. Maintenance requirements, including product life and replacement schedule, if applicable.
2. Verify that appropriate design measures are taken to prevent clogging for all orifices. [Section 4.12.9, 2]
3. Verify that suitable access is provided to inspect and maintain all orifices. [Section 4.12.9, 3]