

9. POST-CONSTRUCTION BEST MANAGEMENT PRACTICES

9.1 Overview

The physical and chemical characteristics of stormwater runoff change as urbanization occurs. As stormwater flows across roads, rooftops, and other hard surfaces, pollutants are picked up and then discharged to streams and lakes. Additionally, the increased frequency, flow rate, duration, and volume of stormwater discharges due to urbanization can result in the scouring of rivers and streams, degrading the physical integrity of aquatic habitats, stream function, and overall water quality.

The intent of this Chapter is the proper selection, design, implementation, and maintenance of post-construction stormwater quality Best Management Practices (BMPs) for new developments and redevelopment efforts. It should be noted that constructed stormwater controls may be referred to as Stormwater Treatment Facilities (STFs) and some references use these terms interchangeably. This Chapter provides information and guidance regarding the selection, design, and maintenance of selected BMPs. Implementation of BMPs is expected to reduce pollutants in stormwater runoff and receiving waters, improving the water quality and environment of the community.

9.1.1 Clean Water Act Requirements

The Federal Water Pollution Control Act of 1972, as amended is commonly known as the Clean Water Act and establishes minimum stormwater management requirements for urbanized areas in the United States. At the federal level, the EPA is responsible for administering and enforcing the requirements of the Clean Water Act. Section 402(p) of the Clean Water Act establishes minimum stormwater management requirements for urbanized areas in the United States. It requires urban and industrial stormwater be controlled through the National Pollutant Discharge Elimination System (NPDES) permit program. Requirements affect both construction and post-construction phases of development. As a result, urban areas must meet requirements of Municipal Separate Storm Sewer System (MS4) permits, and many industries and institutions must also meet NPDES stormwater permit requirements. MS4 permittees are required to develop a Stormwater Management Program that includes measurable goals and to implement stormwater management controls (i.e., BMPs). MS4 permittees are also required to assess controls and the effectiveness of their stormwater programs and to reduce the discharge of pollutants to the “maximum extent practicable.”

Although it is not the case for every state, the EPA has delegated Clean Water Act authority to the State of Nebraska. The State must meet the minimum requirements of the federal program. The state rules and regulations are promulgated under the Nebraska Environmental Protection Act, as amended (Neb. Rev. Stat. §81-1501 et seq).

9.2 Applicability

Post-construction stormwater program requirements shall be applicable to all construction activity and land developments including, but not limited to, site plan applications, subdivision applications, building applications, street projects, and right-of-way applications from the City, unless exempt below. These provisions apply to all portions of any common plan of development or sale that would cause the **disturbance of at least one acre of soil** even though multiple, separate, and distinct land development activities may occur at different times on different schedules.

Unless the master planning process has shown that stormwater treatment requirements can be transferred to a regional facility approved by the City, on-site BMPs are required for projects that disturb one acre of soil or more. Even if treatment requirements can be transferred to a regional facility, on-site facilities may still be necessary to protect downstream channels and the receiving stream.

The following activities are exempt from these requirements:

- Any emergency activity that is necessary for the immediate protection of life, property, or natural resources; and
- Construction activity that provides maintenance and repairs performed to maintain the original line and grade, hydraulic capacity, or original purpose of a facility.

9.3 General Planning and Design Guidelines

The following general planning and design guidelines for post-construction stormwater BMPs are recommended when developing a water quality control strategy:

- Promote natural infiltration of urban runoff by minimizing onsite impervious areas and preserving natural, broad drainageways.
- Minimize directly connected impervious areas by providing grassed buffer zones between impervious surfaces. Divert runoff from impervious areas to pervious surfaces before the flows enter surface drainageways.
- Locate BMPs in areas that avoid creating a nuisance and the need for increased maintenance.
- Provide multiple accesses to facilities to improve maintenance capabilities.
- Revegetate and/or stabilize all areas disturbed by construction activities and all drainageways created as a part of a development.
- Ensure the plantings (e.g., grass) are established before the initial owner's obligation is released and maintenance efforts begin.
- Select the appropriate option for the control objectives, specific conditions at the site, and proper implementation and maintenance for the most successful BMP.

9.3.1 Ownership and Maintenance of Best Management Practices

Proposed BMPs, along with all inlet and outlet structures and/or channels, are to be owned and maintained by the developer or a property-owners' association unless the City has approved a different ownership or maintenance arrangement. Post-construction stormwater BMPs are part of the storm drainage system and shall remain permanently functional as such unless or until the City relieves the owner of such responsibility in writing. Documentation of the BMP and owner maintenance responsibility will be made in permanent records such as a plat, agreement, or other record acceptable to the City.

9.4 Design Criteria

The City will require new and redevelopment projects to satisfy minimum site performance standards that address water quality. The methodology for calculating the Water Quality Control Volume (WQCV) and/or Water Quality Volume Discharge Rate (Qwq) is based on average daily rainfall data applied to three zones across the state (Table 9-1). From that data the runoff amount is calculated and applied to the treatment drainage area to get the WQCV or Qwq.

9.4.1 New Development

For new development sites that have a land disturbance of one acre or greater, the WQCV shall be based on the 80th percentile rainfall event, at a minimum. WQCV shall be calculated using Equation 9.1.

New development requirements apply to those areas that are being platted for development or have been platted but not built and are within the extraterritorial jurisdiction of the City:

- Example 1: A parcel that had not been platted or zoned for development (i.e., agricultural land) is being platted as a subdivision for single family residential and is greater than one acre. The subdivision would be required to meet the minimum standard set forth herein for new development.
- Example 2: Several parcels that have never been built on are being re-platted for development and the total area being re-platted is greater than one acre. The re-platted parcels would be required to follow new development standards.
- Example 3: An undeveloped parcel is being rezoned for another use and is greater than one acre. The rezoned parcel would be required to follow new development standards.
- Example 4: A warehouse has been proposed on an undeveloped parcel in an industrial area. Site disturbance is greater than one acre. The proposed development would be required to follow new development standards.

9.4.2 Redevelopment

For redevelopment sites that have land disturbance of one acre or greater, the WQCV shall be based on the 70th percentile rainfall event, at a minimum. The WQCV shall be calculated using Equation 9.1.

Redevelopment requirements apply to those areas that have been platted and built on within an urban area prior to rezoning, re-platting, preliminary platting, or issuance of a building permit for the redevelopment:

- Example 1: A parcel that included a structure that was purchased and demolished by the City or other entity was sold or deeded over to a new property owner for constructing their own building. Site disturbance is greater than one acre. This site would be required to meet the minimum standard for redevelopment.
- Example 2: A parcel with a building has been sold and is being converted into a new use with expanded parking. Site disturbance is greater than one acre. This parcel would be subject to requirements for redevelopment.

9.4.3 Percentile Rainfall Event

The percentile rainfall event varies across the state. Three regional rainfall zones have been established to support the calculation of WQCV or Qwq for MS4s in Nebraska.

Rainfall amounts by region for new and redevelopment are provided in Table 9-1. These values will be used to calculate the WQCV.

Table 9-1. Rainfall Depth (P) By Region for Defined Percentile Rainfall Events

Applicable Region	Rainfall, P	
	80th Percentile Event (New Development)	70th Percentile Event (Redevelopment)
A (West) <ul style="list-style-type: none"> • Scottsbluff/Gering 	0.61"	0.44"
B (Central) <ul style="list-style-type: none"> • Hastings • Lexington 	0.72"	0.53"
C (East) <ul style="list-style-type: none"> • Beatrice • Columbus • Fremont • Norfolk 	0.83"	0.62"

9.4.4 Minimum Design Criteria

Post-construction stormwater BMPs must be sized to handle the appropriate WQCV or Qwq to properly treat stormwater. BMPs include retention-based stormwater treatment practices that typically require or encourage using infiltration, evapotranspiration, or harvest practices to control a specified volume of stormwater.

9.4.4.1 Water Quality Control Volume

Design criteria to meet minimum site performance standards for new and redevelopment are expressed as the runoff from a specified percentile rainfall event applied across the treatment drainage area. The minimum WQCV for new and redevelopment can be calculated as follows:

$$WQCV = P \times (0.05 + 0.009 \times \%Imp) \times A \times 1/12 \times 43,560$$

Where:

$$WQCV = \text{Water Quality Control Volume, cubic feet}$$

$$P = \text{Rainfall Depth, inches}$$

$$A = \text{Treatment Drainage Area, acres}$$

$$\%Imp = \text{Maximum Percent Impervious Expressed as a Whole Number (1)}$$

(1) The maximum percent imperviousness should be selected for the proposed zoning type if established by the City. If these values are not established by the zoning regulations, maximum percent imperviousness should be selected according to the percent impervious for urban districts and residential districts by average lot sizes provided in Chapter 2, Table 2.7 within the NRCS Curve Number Method procedure.

The following example illustrates use of the WQCV equation:

Example 1) A 4.2-acre parcel was purchased to construct a storage facility. The parcel is one of four in a new development that was zoned limited industrial district (M-I). Light industrial zoning has a maximum impervious percentage of 90 percent. On that parcel, 2.4 acres will be disturbed to construct the facility. An additional 0.4 acres, also zoned M-I, drain directly onto the site from adjacent property. The WQCV for the site is calculated as follows:

$$WQCV = 0.72 \times (0.05 + 0.009 \times 90) \times (2.4 + 0.4) \times 1/12 \times 43,560 = 6,294 \text{ cubic feet}$$

If there are multiple land uses within the treatment drainage area, the effective maximum percent imperviousness should be weighted based on the area of each zone as a percentage of the total area.

Stormwater runoff from all disturbed areas shall be treated before leaving the site. The treatment drainage area shall include all disturbed areas on the site and upstream drainage or “run-on” unless the run-on is diverted or bypasses the disturbed site (i.e., by pipe or swale) so that BMPs are not overwhelmed. BMPs may be distributed across the site to provide the required treatment.

Additional storage in the BMP may be allowed, depending on the type of BMP selected, to address stormwater detention requirements to control runoff from larger storm events such as the 2-, 10-, or 100-year event as described in Chapter 7.

9.4.4.2 Storage Volume

Storage volume of BMPs shall be adequate to hold the WQCV. To maintain the design WQCV, proper implementation of site erosion and sediment measures is necessary to prevent clogging and failure of Structural BMPs. Phasing is also critical as Structural BMPs should typically be the last infrastructure constructed.

9.4.4.3 Water Quality Volume Discharge Rate

BMPs that are sized based on a flow rate (i.e., swales, filter strips, manufactured systems, etc.) shall use the water quality volume discharge rate (Qwq). The Qwq is the peak runoff from the design water quality volume rainfall event. This peak runoff equivalent shall be calculated using the Natural Resources Conservation Service (NRCS) Curve Number (CN) procedure. The calculation is based on the 80th percentile rainfall event depth by region, a 24-hour duration storm event, and a time of concentration of 5 minutes. The area used is the impervious surface only within the treatment drainage area.

Table 9-2 has been prepared to provide the Qwq in each Region for sites with up to 6 acres of impervious area. These values shall be used to size BMPs for the area of impervious surface within a given treatment drainage area. For sites greater than 6 acres, the designer shall use the methods and criteria specified above in a suitable model to calculate the discharge rate.

Table 9-2. Water Quality Discharge Rate (Qwq) for Selected Impervious Areas by Region

Impervious Area (Acres)	Qwq (cfs)			Impervious Area (Acres)	Qwq (cfs)			Impervious Area (Acres)	Qwq (cfs)		
	West	Central	East		West	Central	East		West	Central	East
0.2	0.1	0.2	0.2	2.2	1.5	1.9	2.2	4.2	2.9	3.6	4.2
0.4	0.3	0.3	0.4	2.4	1.6	2.0	2.4	4.4	3.0	3.7	4.4
0.6	0.4	0.5	0.6	2.6	1.8	2.2	2.6	4.6	3.2	3.9	4.6
0.8	0.5	0.7	0.8	2.8	1.9	2.4	2.8	4.8	3.3	4.1	4.8
1.0	0.7	0.8	1.0	3.0	2.1	2.5	3.0	5.0	3.4	4.2	5.0
1.2	0.8	1.0	1.2	3.2	2.2	2.7	3.2	5.2	3.6	4.4	5.2
1.4	1.0	1.2	1.4	3.4	2.3	2.9	3.4	5.4	3.7	4.6	5.4
1.6	1.1	1.4	1.6	3.6	2.5	3.0	3.6	5.6	3.8	4.7	5.6
1.8	1.2	1.5	1.8	3.8	2.6	3.2	3.8	5.8	4.0	4.9	5.8
2.0	1.4	1.7	2.0	4.0	2.7	3.4	4.0	6.0	4.1	5.1	6.0

9.4.4.4 Infiltration and Release Rates

For facilities that function just for water quality control, the WQCV will be stored for a duration between 24 and 40 hours. For facilities that combine water quality control with flood control, the runoff from the design storms for the flood control criteria shall be “stacked” on top of the WQCV. In this case, the facility shall be drained within 72 hours. These types of facilities may be required to have multi-stage control structures to control runoff from the WQCV, as well as the flood control design storms. Refer to Chapter 7 for further guidance.

For BMPs that are designed for subsurface storage (e.g., pervious pavements, underground stormwater chambers, etc.), the subsurface storage must hold the WQCV for the required period and release or infiltrate into the underlying soil.

Infiltration tests shall be done to determine the local infiltration rates if infiltration is a critical part of the Structural BMP facility. An underdrain is needed if the infiltration rate is inadequate or if infiltration is not desired, as well as for maintenance and cleanout purposes.

9.5 Platting and Site Plan Review

Land development that meets the land disturbance criteria of this memorandum must address storm water runoff quality through the use of BMPs. BMPs shall be provided for in the drainage plan for any subdivision plat, annexation plat, development agreement, subdivision agreement or other local development plan.

9.5.1 Procedures

9.5.1.1 Platting

For major subdivision applications, drainage and post-construction shall be discussed at the pre-application conference. This would be followed by an initial review of the general design at the preliminary platting stage and detailed design carrying over into final design review.

The plat applicant shall identify, through the Subdivision Agreement or other City-approved means, whether post-construction stormwater management facilities will be (1) constructed by each lot owner on their own lot (Lot Level BMPs); (2) constructed for the subdivision by the developer with reimbursement sought from individual lot builders (Neighborhood BMPs); (3) mitigated off-site at regional facilities (Regional BMPs), or (4) addressed by other means approved by the City. Any other conditions agreed to between the two parties, including inspections, maintenance, and funding of maintenance, shall be included in that agreement.

9.5.1.2 Building Permits

If Lot Level BMPs are required per the Subdivision Agreement or other agreement, then the lot builder will need to develop and have approved a drainage study, post-construction stormwater management plan, and maintenance agreement. A maintenance agreement for an individual lot shall include provisions for maintenance that shall be binding on all subsequent owners.

9.5.2 Submittals

The PCSMP submittal will include the following components: plans, calculations, certifications of permanent BMPs, ongoing inspection and maintenance of BMPs, and PCSMP submittal checklist.

9.5.2.1 Plans

Plans showing topographic survey information, along with proposed, grading, stormwater infrastructure (including BMPs), pavement, and structures, shall accompany any PCSMP submittal. Specifically, plans shall include the following information:

- Site topography including existing contours, property lines and easements, utilities, and site features such as existing water bodies, trees and shrubs, pavement and other structures
- Proposed contours
- Proposed inlets, storm sewer, culverts, and drainageways
- Proposed BMPs and/or detention facilities
- Proposed roadways, parking, building footprints, and other structures

Construction drawings shall provide a table that includes, for each BMP, (1) a location identifier, (2) the type of BMP, (3) the location for each BMP in latitude/longitude format, (4) the drainage area, and (5) the water quality volume/water quality volume discharge rate. The designer shall differentiate between the amount required by design and the amount that will be provided. Any discrepancies should be discussed with and approved by the City. The information shall be provided on drawings in a format that is consistent with the following:

BMP Identification Number	BMP Type	BMP Location (Lat/Long)	Drainage Area (Acres)	Design WQCV (cu ft) or Qwq (cfs)	WQCV (cu ft) or Qwq (cfs) Provided

9.5.2.2 Calculations

All calculations for water quality volume and water quality volume discharge rate shall be submitted to the City as part of the site development drainage study. Calculations shall be completed as described herein for the appropriate BMPs. Design criteria specific to the various BMPs shall also be shown in the drainage study (i.e., calculations for drain down and infiltration).

When combining stormwater detention with BMPs, the designer shall provide calculations that address both water quality volume and stormwater detention requirements using methodology found in Chapter 7 of this manual.

BMPs shall be clearly shown on the drainage map, along with other stormwater infrastructure and drainage basin boundaries.

9.5.2.3 Certification of Permanent BMPs

Upon completion of a project, the City shall be provided a written certification, by qualified personnel, stating that the completed project is in compliance with the approved Final Drainage Plan. Qualified personnel shall be a professional civil engineer licensed in the State of Nebraska or person(s) under the direct supervision of a professional engineer licensed in the State of Nebraska.

For commercial and industrial construction, certification will be required before a Certificate of Occupancy is granted (unless authorized by the City). All applicants shall submit “as built” plans certified by a professional engineer licensed in the State of Nebraska once final construction is completed. A final inspection by the City of all post-construction BMPs shall be required before a Certificate of Occupancy will be issued or any public infrastructure is accepted.

9.5.2.4 Ongoing Inspection and Maintenance of BMPs

A maintenance agreement will be required by the developer or builder for proposed BMPs. The maintenance agreement shall include provisions that outline regular maintenance activity, and a schedule of periodic inspections by the Owner or Designees. Inspection frequency shall be consistent with the design criteria manual used and generally includes quarterly inspections during the first year of establishment following construction and annually thereafter.

The Owner or Designees providing routine inspections shall document all inspections and maintenance and repair needs to ensure compliance with the requirements of the agreement and the plan. The agreement shall allow access to City personnel for inspection and maintenance should the owner default in their responsibilities with the intent to invoice the owner for said work, if needed. The Owner shall provide the City information about inspections and maintenance upon request.

9.5.2.5 PCSMP Submittal Checklist

A PCSMP checklist shall be submitted with design plans and be recorded by the City with the project record. The PCSMP checklist can be provided by the City and may be used for reference by developers, designers, and builders.

9.5.3 Off-Site Stormwater Mitigation

In some cases, it may not be practicable to provide the required treatment within project limits due to various constraints such as site limitations, costs, or other obstacles. If shown by the Owner that it is not practicable, off-site mitigation may be allowed at the discretion of the City.

Offsite mitigation may be provided by a private landowner in a City-approved stormwater treatment facility or within a City-approved publicly owned stormwater treatment facility provided the proposed mitigation location meets the following minimum criteria.

- A drainage study confirms that the proposed mitigation location provides excess stormwater treatment that is not required to provide treatment for the drainage area.
- The excess treatment capacity in the proposed mitigation location is not already providing mitigation of required stormwater treatment for another development or redevelopment project.
- The owner of the proposed mitigation location maintains or enters into a maintenance agreement that shall be binding on all subsequent owners and includes all required inspection and maintenance requirements for stormwater treatment practices.

Offsite mitigation requires additional documentation, tracking of water quality debits/credits and an additional fee structure to fund any available BMPs. For these reasons offsite mitigation may or may not be available so the City should be consulted to determine if offsite mitigation is available.

9.6 Post-Construction Stormwater BMPs

BMPs shall be designed using an approved design guidance manual that provides minimum design criteria and considerations. A selection of regional design guides is recommended for design within the City. The most recent versions of the following design guides and manuals are approved for general use in the design of BMPs:

- City of Omaha, “Omaha Regional Stormwater Design Manual – Chapter 8: Stormwater Best Management Practices”
- City of Lincoln, “Drainage Criteria Manual - Chapter 8: Stormwater Best Management Practices”

- NDOR, “Drainage and Erosion Control Manual – Chapter 3: Stormwater Treatment within MS4 Communities”
- Mile High Flood District (formerly Urban Drainage and Flood Control District), “Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices”

The designer is encouraged to adopt one design guide/manual for use on a project to the extent practicable. Other approved design guides and manuals may be used if design criteria for the desired BMP are not provided in the primary design guide/manual. Any variances from these manuals will require approval of the City. The City may evaluate the suitability of other types of BMPs not referenced in the approved design guides and manuals on a case-by-case basis.

The designer shall discuss the use of the alternative design guidance manuals before starting design along with any variance in BMP design. The designer shall also discuss other requirements for stormwater management within the City including the potential need for stormwater detention. Where one manual conflicts with another, the Engineer shall use sound, cost-effective design practices to resolve the issue. The following minimum design standards are provided to help resolve some identified conflicts.

9.6.1 BMP Selection

Each design guidance manual includes a unique selection of BMPs and what is included in one may not be included in another. Furthermore, two manuals may use different names for BMPs with the same or similar function. The function, criteria, and considerations of a specific BMP is what shall be used to determine its use by a design engineer. Table 9-3 provides a general comparison of the types of BMPs included in the approved design guidance manuals.

Table 9-3. BMP Design Guidance for Various Regulatory Agencies

BMP Type	Omaha	Lincoln	NDOR	UDFCD
Vegetated Filter Strip	X		X	X
Grass Swale	X		X	X
Infiltration Trench			X	
Infiltration Basin			X	
Bioretention Basin	X	X	X	X
Media Filter			X	
Sand Filter				X
Extended Dry Detention	X	X	X	X
Wet Detention Ponds	X	X	X	X
Stormwater Wetland	X	X	X	X
Underground Detention		X		X
Pervious Pavement	X	X	X	X
Proprietary Structural Treatment Controls	X		X	X
Green Roofs	X	X		X
Soil Conditioning	X			

NOTE: All BMPs must be sized using WQCV or Qwq design criteria provided in Section 9.4 of this Chapter.

9.7 Maintenance of Controls

BMPs located on private property shall be owned and operated by the owner(s) of the property on which the BMP is located; unless the City agrees in writing that a person or entity other than the Owner shall own or operate such BMP. As a condition of approval of the BMP, the Owner shall also maintain the BMP in perpetuity to its design capacity unless or until the City shall relieve the property owner of that responsibility in writing. The obligation to maintain the BMP shall have been memorialized on a subdivision plat, annexation plat, development agreement, subdivision agreement, or other form acceptable to the City and recorded by the City with the project records.

The City shall continue to maintain public storm sewer infrastructure including public BMPs. Each homeowner's association of a subdivision or individual lot owner shall maintain post-construction BMPs. When the City constructs public infrastructure improvements, such as with the widening of a major arterial or other public improvement, the City shall take responsibility for maintenance of the BMP unless otherwise specified in a maintenance agreement.

9.8 Landscaping

The following resources have been provided to assist in the design of landscaping for a project. It is strongly suggested that a landscape architect or designer assist with plant selection and landscape design.

- UNL Extension, *Stormwater Management: Plant Selection for Rain Gardens in Nebraska*
- UNL Extension, *Nebraska Bioretention and Rain Garden Plants Guide*
- NDOR, *Plan for the Roadside Environment*
- NDOR, *Roadside Flowers and Grasses*
- NDOR, *Roadside Vegetation Establishment and Maintenance*
- Nebraska Statewide Arboretum, Fall 2008. *The Seed*

These documents may contain other references to sources that may be helpful in plant selection and suitability for use with BMPs. Keep in mind regional difference in your selection of plants, along with differences in soil, light, and moisture within the stormwater BMP itself.

9.9 References

- City of Lincoln Public Works and Utilities Department, 2014. *Drainage Criteria Manual*.
- City of Omaha Environmental Quality Control Division, 2014. *Omaha Regional Stormwater Design Manual*.
- Iowa Department of Natural Resources, 2009. *Iowa Storm Water Management Manual*.
- Nebraska H₂O, 2015. *Final Post-Construction Stormwater Program Design Standards and Procedures Memorandum*.
- Mile High Flood District (formerly Urban Drainage and Flood Control District), 2016. *Urban Storm Drainage Criteria Manual*.