Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

ROOF RUNOFF STRUCTURE

CODE 558

(no)

DEFINITION

A structure that will collect, control, and convey precipitation runoff from a roof.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Protect surface water quality by excluding roof runoff from contaminated areas
- Protect a structure foundation from water damage or soil erosion from excess water runoff
- Increase infiltration of runoff water
- Capture water for other uses

CONDITIONS WHERE PRACTICE APPLIES

Where roof runoff from precipitation needs to be—

- Diverted away from a contaminated area or the foundation of a structure;
- Collected and conveyed to a stable outlet or infiltration area; or
- Collected and captured for other uses such as evaporative cooling systems, livestock water, and irrigation.

CRITERIA

General Criteria Applicable to All Purposes

Evaluate the condition of the existing roof structure prior to installation of a gutter. Install new fascia boards as needed to support gutters and downspouts for the practice life span. Mount gutters on plumb fascia boards. When rafters are open ended, cut the rafters so that the edge is vertical and install a fascia board. Install the roof gutter so that it is free floating to allow for expansion and contraction.

Ensure that the gutter support system will withstand the anticipated loading, including loads from snow and ice, as applicable. If structural support is missing or insufficient, design the required support for the selected gutter. Roof gutters may be installed below the projection of the roofline to further reduce gutter damage from snow and ice. As an alternative to increasing the structural supports, use a ground gutter design to convey the roof runoff.

Where snow and ice damage will occur, install the roof gutter below the projection of the roof line.

Use a pipe guard or pipe casing where necessary to protect the downspout, lateral, or cross-pipe pipelines of the roof runoff structure from damage by livestock or equipment.

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Gutter design capacity
When a roof runoff structure is used to protect roof runoff from contamination by manure, design the roof runoff structure to convey the flow rate generated from a 25-year, 5-minute rainfall event. (Refer to National Engineering Handbook (NEH) (Title 210), Part 651, "Agricultural Waste Management Field Handbook," Chapter 10, Appendix 10B.

For other applications, design the roof runoff structure to convey the flow rate generated from a 10-year, 5-minute rainfall event.

Table 01 - Rainfall Intensities

County	10-YR, 5-MIN (fps)	25-YR, 5-MIN (fps)
Allegany	0.00015	0.00017
Anne Arundel	0.00015	0.00019
Baltimore	0.00015	0.00018
Calvert	0.00015	0.00019
Caroline	0.00016	0.00019
Carroll	0.00015	0.00018
Cecil	0.00015	0.00018
Charles	0.00015	0.00019
Dorchester	0.00016	0.00019
Frederick	0.00015	0.00018
Garrett	0.00015	0.00017
Harford	0.00015	0.00018
Howard	0.00015	0.00018
Kent	0.00015	0.00019
Montgomery	0.00015	0.00018
Prince George's	0.00015	0.00019
Queen Anne's	0.00015	0.00019
Somerset	0.00016	0.00020
St. Mary's	0.00015	0.00019
Talbot	0.00016	0.00019
Washington	0.00015	0.00018
Wicomico	0.00016	0.00020
Worcester	0.00016	0.00020

Downspout
Use downspouts, collector pipes, lateral downspouts, or cross-pipes with a capacity equal or exceeding the roof gutter flow rate.

When a downspout outlets at the ground level, place an elbow and energy dissipation device at the outlet to provide erosion protection and direct water away from the foundation of the structure.

Protect the roof gutter and downspouts from damage by livestock and equipment. Position downspout outlets as to avoid contamination with animal waste. Use preformed downspout outlets. Use the largest size of preformed outlet that will fit the roof gutter. Determine the down spout size and number of outlets by the method found in Design Guide MD #1, Roof Runoff Structure or by the following procedure. The ratio of roof drainage area to down spout cross-sectional area shall not exceed 100 square feet of roof area per one square inch of downspout area.

Ground gutter
Where runoff from the roof eave drops onto the ground surface, provide a ground gutter with adequate provision to convey runoff away from the foundation of the structure.

Stone filled trenches with an underground outlet, under the roof dripline, may be used in lieu of roof gutter. Locate the trench so the trench centerline follows the roof dripline. The minimum width and depth for the collection trench is 24 inches. Line the trench with geotextile for soil separation to prevent soil movement into the stone and underground outlet.

The conduit for the underground outlet shall be perforated with and minimum diameter of 4 inches, and meet the requirements found in the underground outlets section of this standard. Size the conduit such that when combined with the temporary storage in the trench the trench will not overtop for the design storm of the system.

Ground gutter designs can use a rock pad, a rock-filled trench with a subsurface drain, a concrete channel, or a precast channel to convey the roof runoff water to a stable discharge location or infiltration area.

Outlet
Roof runoff can empty into a subsurface drain, underground outlet, a ground gutter, a storage tank, or onto stabilized soil.

Size the outlet to ensure adequate design capacity. Provide for a clean-out of the outlet as appropriate.

When runoff from roofs empties onto the ground surface, a stable outlet shall be provided. Surface or ground outlets such as rock pads, rock filled trenches with subsurface drains, concrete and other erosion-resistant pads, or preformed channels may be used, particularly where snow and ice are a significant load component on roofs.

Use NRCS Conservation Practice Standard (CPS) Subsurface Drain (Code 606) to design a subsurface drain used to dewater a ground gutter or infiltration ditch.

Use NRCS CPS Underground Outlet (Code 620) to design an underground outlet used to convey roof runoff to a stable outlet.

Materials
Roof runoff structures shall be made of durable materials with a minimum design life of ten years. Roof gutters and downspouts may be made of aluminum, galvanized steel, wood, or plastic. Use K-style, half round, or box type roof gutters. Aluminum gutters and downspouts require a minimum nominal thickness of 0.027 inches and 0.020 inches, respectively. Galvanized steel gutters and downspouts require a minimum 28 gauge. Wood may be redwood, cedar, cypress, or other species that has the desired longevity and will be free of knots. Plastics must contain ultraviolet stabilizers. Wood and plastic roof gutters shall be approved by a staff engineer on a case by case basis.

To prevent corrosion, avoid contact between components of dissimilar metals.

The minimum top width for roof gutters is 5-inches.

Use a maximum spacing of 24 inches for gutter supports (hangers) except when otherwise approved by the engineer. Mount roof gutters on fascia boards using hidden hangers, bolts and ferrules, gutter screws and ferrules, cradles, or by other approved methods. Spikes and ferrules are not acceptable.

All lumber used for fascia board and rafter end repair or replacement shall have a minimum nominal thickness of 2 inches. Nominal size as applied to timber or lumber, is the size by which it is known and sold in the market, and often differs from actual size. Pressure treated lumber shall not be used for fascia boards. Cover fascia boards with aluminum or vinyl flashing or paint prior to installation of roof gutter.

Replace fascia boards that are in poor condition. Rafters with unsound ends shall be repaired or replaced. Existing fascia boards with a nominal thickness less than 2 inches that meet the criteria found in Design Guide MD #1, Roof Runoff Structure need not be replaced.

Securely fasten down spouts at the top and bottom with intermediate supports (fasteners) at maximum 10 intervals. Install fasteners in accordance with manufacturer recommendations.

Where animals or equipment may come in contact with down spouts, steel pipe, Schedule 40 PVC pipe, or similar materials shall be used.

To enable infiltration with rock-filled trenches and rock pads use 'poorly graded rock' (rock fragments approximately all the same size) that is free of appreciable amounts of sand or soil particles. Do not use crushed limestone for backfill material unless it has been washed.

Backfill trenches with MSHA #57 aggregate stone along the sides and extending 6 inches over the drain conduit. Backfill the remaining trench with clean coarse aggregate meeting gradations found in Maryland State Highway Administration, Standard Specifications for Construction and Materials, Category 900 - Materials, Section 901. When computing the volume of storage in the coarse aggregate use 25 percent voids.

Gravel (aggregates) and rock riprap must meet the requirements of Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials, Category 900 - Materials, Sections 901.01 and 901.02 respectively or appropriate AASHTO Standards. Recycled concrete may be substituted if appropriately sized.

Use type I cement, 28-day compressive strength of 4000 psi, 5% to 7.5% air entrainment with a slump of 1.5 inches to 3 inches

Use NRCS National Engineering Manual (NEM) (Title 210), Part 536, Section 536.20, "Design Criteria for Reinforced Concrete," for design and installation of reinforced concrete channels, pads, or slabs.

For nonreinforced concrete channels or pads use the 210-NEH, Part 642, Construction Specification 32, "Structural Concrete."

Geotextile may be woven or nonwoven and must meet the requirements of Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials, Category 900 - Materials, Section 919 - Geotextiles, Class SE.

Additional Criteria to Increase Infiltration

Increase runoff infiltration by directing flow to existing landscapes (e.g., lawns, mass planting areas, infiltration trenches, rain gardens, or natural areas). Ensure these areas have the capacity to infiltrate the runoff without adversely affecting the desired plant species and without creating a soil erosion problem.

Additional Criteria to Protect the Foundation of a Structure

Direct runoff from structure foundations to avoid wetness and hydraulic loading on the foundation. For a design which outlets the roof runoff on the ground, slope the runoff discharge area away from the structure foundation. Use a minimum downspout extension of 5 feet to discharge runoff away from the foundation of a structure built on expansive soils or a building foundation placed on bedrock.

Additional Criteria to Capture Water for Other Uses

Design a water storage tank of adequate size, strength, and durability to hold water for the intended purpose. Install the tank on a firm, unyielding foundation. Anchor above-ground water storage tanks to prevent damage from wind loads.

Prohibit access to water storage tanks by children and animals to prevent drowning. Protect the area around the tank from erosion caused by overflow from the tank.

Construct or select water storage tanks of materials and in a manner that will not degrade the quality of the stored water. Design water supply attachments to meet system needs. Include a first flush diverter as necessary to reduce sediment, pathogens, and chemical pollutants in the collected water.

The water quality must be suitable for the intended use. Design storage structures for non-potable purposes such as irrigation water in accordance with appropriate NRCS Conservation Practice Standards (CPS). Design and construct potable water storage structures of materials and in a manner that will not increase the contamination of the stored water. Roof runoff collected and stored for potable uses must be treated prior to consumption and shall be tested periodically to assure that adequate quality is maintained for human consumption. The landowner is responsible for any water quality testing and treatment.

CONSIDERATIONS

Consider the use of multiple downspouts to reduce gutter size.

Discharge of outlets near wells and sinkholes or directly into drainage ditches, streams, or ponds can cause point source pollution.

Consider installation of rain gardens at the outlets to clean, transpire, and infiltrate runoff water.

When underground outlets are used, consider either a strainer at the head of the downspout, or a clean-out port on the riser pipe.

Consider the use of wrap-around straps in lieu of rigid supports on steep roofs where the outer edge of the gutter cannot be placed below the projected roof line.

On roofs subject to snow and ice slides, consider additional supports even if the gutter is installed below the projected roof line.

For cold climates, ensure the underground outlet is deep enough to avoid freezing or include a method to bypass the outlet without damage to the downspout.

Consider potential secondary benefits of design, e.g. rock pads may also reduce rodent problems around livestock and poultry barns.

PLANS AND SPECIFICATIONS

Provide plans and specifications for installing a roof runoff structure that describe the requirements for applying this practice to achieve its intended purpose. At a minimum, include the location, size, and any specific installation instructions of all gutters and spacing of downspouts, type of ground gutters, outlets, and the types and quality of material to be used.

Include plans and specifications for other practices essential for the proper functioning of the roof runoff structure.

Instruct landowner and contractor of responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures.

SUPPORTING DATA AND DOCUMENTATION

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. System plan sketch;
2. Dimensions of buildings, and proposed locations of downspout and underground outlets.

Design Data

For guidance on the preparation of engineering plans see Chapter 5 of the EFH, Part 650 and National Engineering Handbook Part 641. The following is a list of the minimum required design data:

1. Design summary presenting in narrative form the objectives, data, criteria, assumptions, procedures, and decisions used in the design. The summary should provide relevant site history and background information as well as a brief description of major features, job classification, drainage area, storm frequencies, landscape resources, capacities, etc. as appropriate.
2. Plan view showing roofs that need roof runoff control and where the systems may safely outlet and construction specifications;
3. The peak runoff from each roof for the design storm selected, roof gutter and outlet design as found in Design Guide MD #1, Worksheet 1;
4. Underground outlet systems shall be sized as found in Design Guide MD #1, Worksheet 2;
5. Job class on plans;
6. Quantities estimate;
7. Planting plan. This must meet the criteria, specifications, and documentation requirements of the Maryland Conservation Practice Standard, Critical Area Planting (Code 342);
8. Drawings to include the following as a minimum: Plan view; roof gutter location, gage, type, size, slope, direction, and mounting instructions, underground outlet type, size direction and installation instructions, and construction specifications;
9. Written Operation and Maintenance plan.

Construction Check Data/As-Built

Record on survey notepaper, SCS-ENG-28 or other as appropriate. Plot survey data in red. The following is a list of minimum data needed for As-builts:

1. Documentation of site visits on CPA-6. Include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed, and decisions made and by whom;
2. Actual location, length, size, and dimensions of the installed roof gutter and downspouts;
3. Verification of the method of mounting;
4. When applicable verify the underground outlet size, type, location, outlet type, rodent guard type, vertical distance between invert of outlet pipe and normal water in outlet stream or ditch bottom, and vertical distance between invert of outlet pipe and top of bank;
5. Final quantities, documentation for quantity changes, and materials certification;
6. Sign and date plans to include statement that practice meets or exceeds NRCS practice standards.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan that is consistent with the purposes of the practice, site conditions, and safety requirements. The plan will contain, but not be limited to, the following provisions:

- Keep roof runoff structures clean and free of obstructions that reduce flow.
- Make regular inspections and perform cleaning and maintenance as needed.

REFERENCES

MDOT, State Highway Administration. 2020. Standard Specifications for Construction and Materials. Baltimore, MD. https://roads.maryland.gov/ohd2/2020_Standard_Specifications.pdf

USDA NRCS. 2009. National Engineering Handbook (Title 210), Part 651, Agricultural Waste Management Field Handbook, Chapter 10, Agricultural Waste Management System Component Design. Washington, D.C. https://directives.sc.egov.usda.gov

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