THE CITY OF BURNET

NONPOINT-SOURCE POLLUTION CONTROL ORDINANCE TECHNICAL MANUAL

Effective March 14, 2017 (Ordinance No. 2017-02)

FIRST EDITION

Table of Contents

Tables

Figures

1. Introduction

The City of Burnet considers it an advantage to protect its natural water resources. Nonpoint-Source Pollution (NPS) carried by stormwater runoff is considered a cause of degradation in water quality. Land development is considered a source of nonpoint-source pollution. This Technical Manual (TM) presents measures to provide for the protection of water quality for the City of Burnet. The following sections describe the process and requirements for implementing stormwater management for developments located within the jurisdiction of the City of Burnet Nonpoint-Source Pollution Control Ordinance.

2. Site Planning

In many cases sites have been planned before considering potential methods of stormwater treatment. This historical procedure could be problematic when implementing the requirements as set forth in this Ordinance. Consequently, familiarization with the requirements of this Technical Manual should precede any conceptual planning or layout work for a subdivision or other development project.

2.1 Stream Buffers

Natural buffer areas adjacent to streams and natural drainage ways play an important role in maintaining predevelopment water quality. The riparian vegetation stabilizes stream channels and floodplain areas, reducing erosion. In addition, they provide an area to filter overland flow from adjacent development. Consequently, all streams should have an undisturbed native vegetation buffer on each side as follows:

- Natural streams or swales draining 30 acres or greater should have a minimum buffer of 15 feet from the point at which the water surface elevation for the 1-year, 3-hour design storm meets natural ground. If the water surface elevation is not evaluated, then the top of the existing cut bank shall be used to delineate the beginning of the buffer. Buffer areas should have slopes of 12% or less. Instances where slopes for the proposed buffer areas exceed 12% must be specifically accepted on a case by case basis by the City Engineer

- Natural streams or swales draining less than 30 acres shall be evaluated on a case by case basis to determine the impact on water quality.

Figure 2-1 shows a typical buffer zone schematic.

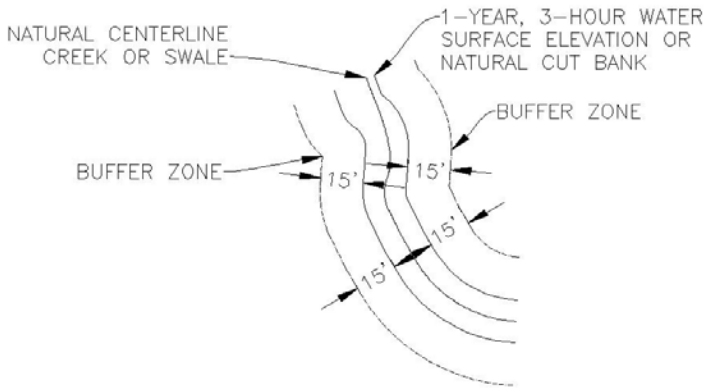


Figure 2-1 Typical buffer zone schematic

Site plans submitted to the City of Burnet for review must show the location of all stream buffers in addition to the plan elements required to reasonably assess the water quality of stormwater runoff from the site.

Buffer zones should generally remain free of construction, development, or other alterations, although stormwater treatment systems can be constructed there if the natural drainage to the site is less than 128 acres and an alternative location is not possible. The number of roadways crossing through the buffer zones should be minimized and constructed only when necessary, such as when a significant portion of the site can only be reached by crossing a buffer zone.

Other alterations within buffer zones could include utility crossings (only if necessary), fences, low impact parks, and open space. Roadways and utilities crossings should be approximately perpendicular to the buffer zone. Low impact park development within the buffer zone should be limited to trails, picnic facilities, and similar construction that do not significantly alter the existing vegetation. Parking lots and roads significantly alter existing vegetation and are not considered low impact. Neither golf course development nor wastewater effluent irrigation shall take place in the buffer zone.

3. Temporary and Permanent Erosion and Sedimentation Controls

Earthen disturbance that occurs during construction activities allows for the transportation of sediment through natural drainage paths having a detrimental affect on water quality. Due to the relative ease in displacement of disturbed earthen material during a rainfall event, steps must be taken to prevent sediment from leaving the site. As a result, temporary erosion and sedimentation control measures are incorporated into this Technical Manual to maintain acceptable water quality conditions.

3.1 Stormwater Pollution Prevention Plan (SWPPP)

The City of Burnet NPS Pollution Control Ordinance requires that a Stormwater Pollution Prevention Plan be prepared and submitted to the City Engineer for approval. The SWPPP shall be signed and sealed by a licensed Professional Engineer. Submittal information shall include all information necessary to determine the adequacy of proposed temporary erosion and sedimentation controls for the site. At minimum, the following information shall be submitted for review:

- SWPPP to an appropriate scale with existing site topography, proposed improvements, limits of construction, temporary erosion and sedimentation controls, construction equipment storage areas, sequence of construction, required creek and swale buffers, and permanent site stabilization requirements
- Temporary erosion and sedimentation control details and specifications
- Existing and proposed drainage patterns

If the City Engineer determines that additional information is necessary to complete the review for the SWPPP, then the applicant shall be notified.

When construction operations are ready to commence, all temporary erosion and sedimentation controls must be in place prior to any earthen disturbances on the site. An up-to-date copy of the SWPPP shall be readily available on site at all times during construction activity. If it is determined by the City Manager that the temporary erosion and sedimentation controls are insufficient, or are not effectively serving their intended purpose, then immediate measures shall be taken to correct the problem(s). It shall be the responsibility of the developer and/or contractor that these measures are implemented, as appropriate.

Table 3-1 is a list of approved temporary erosion and sedimentation controls along with selection criteria for each.

Table 3-1 Guidelines for Selection of Temporary Erosion and Sedimentation Controls				
Control Type	**Application**	**Drainage Area**	**Slope**	**Spacing**

Silt Fence (Interior)	Areas of sheet flow or very minor channel flow	2 acres	< 20%	200 ft
Silt Fence (Perimeter)	Downslope borders of site; upslope border if necessary to divert offsite drainage	N/A	N/A	200 ft
Triangular Filter Dike	Areas within site requiring frequent vehicular access	1 acre	< 10%	N/A
Rock Berm	Drainage swales and ditches within and below site	5 acres	< 30%	150 ft
High Service Rock Berm	Near critical features, high flow areas within and below site	5 acres	< 30%	150 ft
Inlet Protection	Storm sewer inlets receiving drainage	N/A	N/A	N/A
Sediment Basin	Appropriate for large disturbed areas	5-100 acres	N/A	N/A
Construction Exit	Should be used at all designated access points	N/A	N/A	N/A
Concrete Washout	Use on all concrete pouring operations	N/A	N/A	N/A

3.2 Temporary Erosion and Sedimentation Controls Requirements

A Silt Fence

1. Materials

- Silt fence material shall be polypropylene, polyethylene, or polyamide woven or non-woven fabric
- Filter fabric width shall be 36 inches with a minimum unit weight of 4 oz/yd^2, ultraviolet stability in excess of 70%, and maximum apparent opening size of U.S. Sieve No. 30
- Fence posts shall be made of hot rolled steel, a minimum of 4 feet long with Tee or Y-bar cross section, surface painted or galvanized, minimum nominal weight 1.25 lbs/ft^2
- Woven wire backing shall be used to support the filter fabric and shall be galvanized 2” x 4” welded wire, 12 gauge minimum

2. Installation

- Locate silt fencing down gradient of disturbance area, following the contour as closely as possible

- Steel posts used to support the fence should be driven a minimum of 1 foot into the ground and spaced a maximum of 8 feet on center
- Turn ends of silt fence upstream in areas where flow concentrates and at the ends of silt fence lines
- Silt fence fabric skirt must be buried to a depth of 6 inches or fastened to the ground so as to prevent runoff from flowing under the fence

Figure 3-1 shows typical installation requirements for silt fencing.

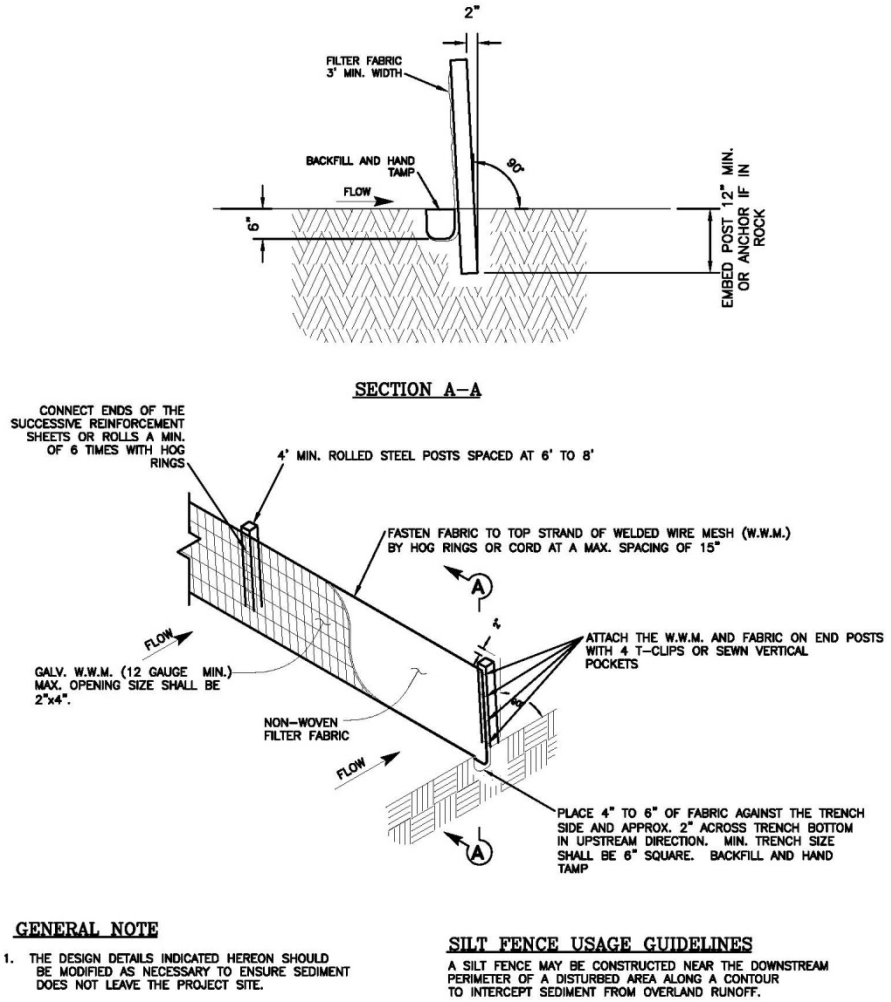


Figure 3–1 Typical installation requirements for silt fencing

A Triangular Filter Dikes

1. Materials

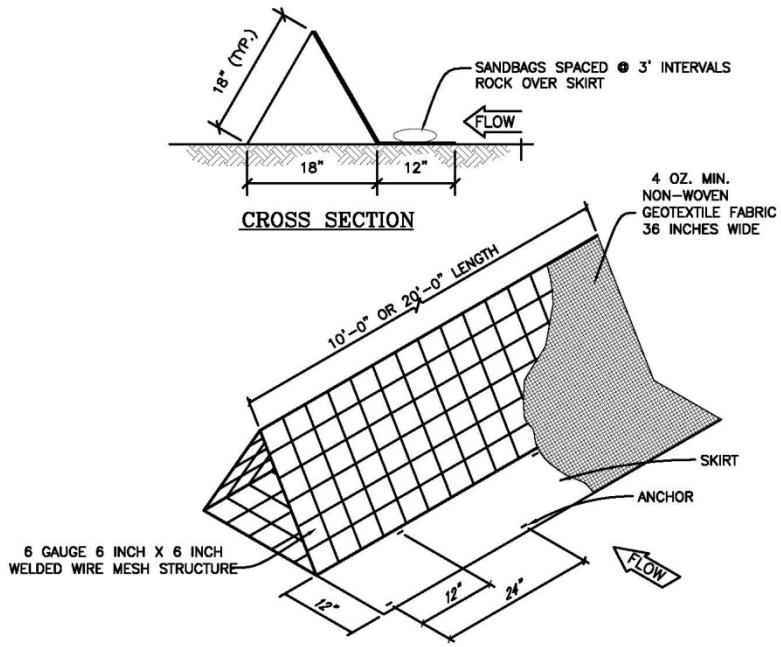
- Silt fence material shall be non-woven filter fabric
- Filter fabric width shall be 36 inches with a minimum unit weight of 4 oz/yd^2

- The dike structure shall be 6 gauge 6” x 6” wire mesh shaped into triangular form with 18” sides
- The sand bag material shall be polypropylene, polyethylene, polyamide, or cotton burlap woven fabric
- Filter fabric shall have a minimum unit weight of 4 oz/yd^2, mullen burst strength in excess of 300 psi and ultraviolet stability in excess of 70 percent
- The bag shall have a length of 24-30” with a width of 16-18” and a thickness of 6-8”
- The sandbags shall be filled with coarse grade sand and free of deleterious material
- The sand shall be capable of passing through a No. 10 Sieve
- The filled bag should have an approximate weight of 40 pounds and be sealed by staples or tied with cord

2. Installation

- Locate filter dike parallel to the contours with adjacent ends abutting one another
- Filter fabric shall overlap adjacent filter dikes at junctions
- Place sandbags on 3 foot intervals to fasten filter dike to the ground

Figure 3-2 shows typical installation requirements for triangular filter dikes.



INSTALLATION:

- LAYOUT THE FILTER DIKE FOLLOWING AS CLOSELY AS POSSIBLE TO THE CONTOUR.
- CLEAR THE GROUND OF DEBRIS, ROCKS OR PLANTS THAT WILL INTERFERE WITH INSTALLATION.
- PLACE THE FILTER DIKE SECTIONS ONE AT A TIME, WITH THE SKIRT ON THE UPHILL SIDE TOWARDS THE DIRECTION OF FLOW, ANCHORING EACH SECTION TO THE GROUND BEFORE THE NEXT SECTION IS PLACED.
- SANDBAGS SHOULD BE PLACED ON 3' CENTERS BETWEEN ANCHORS.
- SECURELY FASTEN THE SKIRT FROM ONE SECTION OF FILTER DIKE TO THE NEXT.
- FILTER DIKES MUST MAINTAIN CONTINUOUS CONTACT WITH THE GROUND.
- AFTER THE SITE IS COMPLETELY STABILIZED, THE DIKES AND ANY REMAINING SILT SHOULD BE REMOVED. SILT SHOULD BE DISPOSED OF IN A MANNER THAT WILL NOT CONTRIBUTE TO ADDITIONAL SILTATION.

INSPECTION AND MAINTENANCE GUIDELINES:

- INSPECTION SHOULD BE MADE WEEKLY OR AFTER EACH RAINFALL EVENT AND REPAIR OR REPLACEMENT SHOULD BE MADE PROMPTLY AS NEEDED BY THE CONTRACTOR.
- INSPECT AND REALIGN BERMS AS NEEDED TO PREVENT GAPS BETWEEN THE SECTIONS.
- ACCUMULATED SILT SHOULD BE REMOVED AFTER EACH RAINFALL EVENT, AND DISPOSED OF IN A MANNER WHICH WILL NOT CAUSE ADDITIONAL SILTATION.

Figure 3–2 Typical installation requirements for triangular filter dikes

A Rock Berm

1. Materials

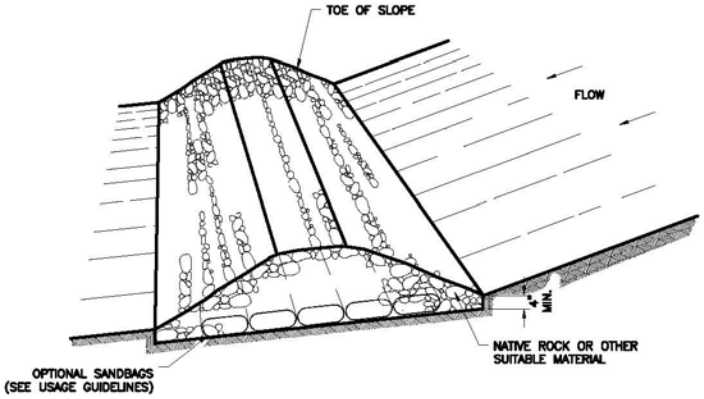
- Woven wire sheathing used to secure the berm shall have a minimum wire diameter of 20 gauge galvanized with a maximum opening of 1”
- 3-5” diameter aggregate shall be used where high velocities are not anticipated
- 5-8” diameter aggregate shall be used where high velocities are expected

2. Installation

- Locate woven wire sheathing perpendicular to the flow line
- Place aggregate along the sheathing to a minimum height of 18”
- Wrap the sheathing around the aggregate and secure the ends with tie wire (ends should overlap a minimum of 2”)

- Verify stability of berm by walking across it (if the berm moves when walked on, then it needs to be better stabilized)

Figure 3-3 shows typical installation requirements for rock berms.



GENERAL NOTES

1. IF SHOWN ON THE PLANS OR AS REQUIRED TO PREVENT OFF-SITE SEDIMENTATION, BERMS SHALL BE PLACED NEAR THE TOE OF SLOPES WHERE EROSION IS ANTICIPATED, UPSTREAM AND/OR DOWNSTREAM AT DRAINAGE STRUCTURES, AND IN ROADWAY DITCHES AND CHANNELS TO COLLECT SEDIMENT.
2. THE ROCK BERMS DIMENSIONS SHALL BE AS INDICATED ON THE DETAIL SHEETS.
3. SIDE SLOPES TO BE 2:1 OR FLATTER.
4. MAINTAIN A MIN. OF 1' BETWEEN TOP OF ROCK BERMS WEIR AND TOP OF EMBANKMENT FOR BERMS.
5. BERMS SHALL BE EMBEDDED A MINIMUM OF 4" INTO EXISTING GROUND.
6. ROCK BERMS TYPE 2 & 3 SHALL BE SECURED WITH 20 GAUGE GALVANIZED WOVEN WIRE MESH WITH 1" DIAMETER HEXAGONAL OPENINGS. THE AGGREGATE SHALL BE PLACED ON THE MESH TO THE HEIGHT & SLOPE SPECIFIED. THE MESH SHALL BE FOLDED AT THE UPSTREAM SIDE OVER THE AGGREGATE AND TIGHTLY SECURED TO ITSELF ON THE DOWNSTREAM SIDE USING WIRE TIES OR HOG RINGS. IN STREAM USE THE MESH SHOULD BE SECURED OR STAKED TO THE STREAM BED PRIOR TO AGGREGATE PLACEMENT.
7. SACK GABIONS SHOULD BE STAKED DOWN WITH 3/4" DIA. REBAR STAKES.
8. FLOW OUTLET SHOULD BE ON A STABILIZED AREA (VEGETATION, ROCK, ETC.)
9. THE DESIGN DETAILS INDICATED HEREON SHOULD BE MODIFIED AS NECESSARY TO ENSURE SEDIMENT DOES NOT LEAVE THE PROJECT SITE.

ROCK BERMS SHOULD BE CONSTRUCTED DOWNSTREAM FROM UNDISTURBED AREAS TO INTERCEPT SEDIMENT FROM OVERLAND RUNOFF AND/OR CONCENTRATED FLOW.

TYPE 1 (18" HIGH WITH NO WIRE MESH): TYPE 1 MAY BE USED AT THE TOE OF SLOPES, AROUND INLETS, IN SMALL DITCHES, AND AT DIKE OR SWALE OUTLETS. THIS TYPE OF DAM IS RECOMMENDED TO CONTROL EROSION FROM DRAINAGE AREA OF 5 ACRES OR LESS. TYPE 1 SHOULD NOT BE USED IN CONCENTRATED HIGH VELOCITY FLOWS (APPROX. 8 FT/SEC OR MORE) IN WHICH AGGREGATE WASH OUT MAY OCCUR. SANDBAGS SHOULD BE USED AT THE EMBEDDED FOUNDATION (4" DEEP MIN.) FOR BETTER FILTERING EFFICIENCY OF LOW FLOWS IF CALLED FOR ON THE PLANS OR AS A RESULT OF ROUTINE INSPECTIONS

TYPE 2 (18" HIGH WITH WIRE MESH): TYPE 2 MAY BE USED IN DITCHES AND AT DIKE OR SWALE OUTLETS.

TYPE 3 (36" HIGH WITH WIRE MESH): TYPE 3 MAY BE USED IN STREAM FLOW AND SHOULD BE SECURED TO THE STREAM BED.

TYPE 4 (SACK GABIONS): TYPE 4 MAY BE USED IN DITCHES AND SMALLER CHANNELS TO FORM AN EROSION CONTROL DAM.

Figure 3-3 Typical installation requirements for rock berms (Type 1 or 2)

A High Service Rock Berm

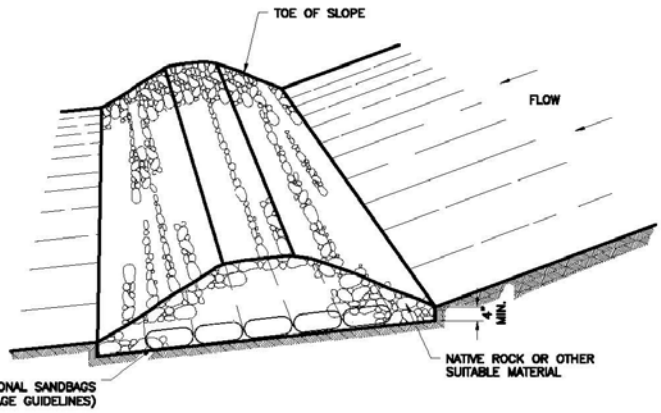
1. Materials

- Silt fence shall be non-woven fabric 36 inches in width with a minimum unit weight of 4 oz/yd^2
- Fence posts shall be made of hot rolled steel, a minimum of 4 feet long with Tee or Y-bar cross section, surface painted or galvanized, minimum nominal weight 1.25 lbs/ft^2
- Woven wire backing used to support the filter fabric shall be galvanized 2" x 4" welded wire, 12 gauge minimum
- Woven wire sheathing used to secure the berm shall have a minimum wire diameter of 20 gauge galvanized with a maximum opening of 1"
- 3-5" diameter aggregate shall be used where high velocities are not anticipated
- 5-8" diameter aggregate shall be used where high velocities are expected

2. Installation

- Locate woven wire sheathing perpendicular to the flow line
- Install silt fence along the center of the berm
- Place aggregate along the sheathing to a minimum height of 24"
- Wrap the sheathing around the aggregate and secure the ends with tie wire (ends should overlap a minimum of 2")
- The high service rock berm may be removed only after the site is stabilized

Figure 3-4 shows typical installation requirements for high service rock berms.



GENERAL NOTES

1. IF SHOWN ON THE PLANS OR AS REQUIRED TO PREVENT OFF–SITE SEDIMENTATION, BERMS SHALL BE PLACED NEAR THE TOE OF SLOPES WHERE EROSION IS ANTICIPATED, UPSTREAM AND/OR DOWNSTREAM AT DRAINAGE STRUCTURES, AND IN ROADWAY DITCHES AND CHANNELS TO COLLECT SEDIMENT.
2. THE ROCK BERMS DIMENSIONS SHALL BE AS INDICATED ON THE DETAIL SHEETS.
3. SIDE SLOPES TO BE 2:1 OR FLATTER.
4. MAINTAIN A MIN. OF 1' BETWEEN TOP OF ROCK BERMS WEIR AND TOP OF EMBANKMENT FOR BERMS.
5. BERMS SHALL BE EMBEDDED A MINIMUM OF 4" INTO EXISTING GROUND.
6. ROCK BERMS TYPE 2 & 3 SHALL BE SECURED WITH 20 GAUGE GALVANIZED WOVEN WIRE MESH WITH 1" DIAMETER HEXAGONAL OPENINGS. THE AGGREGATE SHALL BE PLACED ON THE MESH TO THE HEIGHT & SLOPE SPECIFIED. THE MESH SHALL BE FOLDED AT THE UPSTREAM SIDE OVER THE AGGREGATE AND TIGHTLY SECURED TO ITSELF ON THE DOWNSTREAM SIDE USING WIRE TIES OR HOG RINGS. IN STREAM USE THE MESH SHOULD BE SECURED OR STAKED TO THE STREAM BED PRIOR TO AGGREGATE PLACEMENT.
7. SACK GABIONS SHOULD BE STAKED DOWN WITH 3/4" DIA. REBAR STAKES.
8. FLOW OUTLET SHOULD BE ON A STABILIZED AREA (VEGETATION, ROCK, ETC.)
9. THE DESIGN DETAILS INDICATED HEREON SHOULD BE MODIFIED AS NECESSARY TO ENSURE SEDIMENT DOES NOT LEAVE THE PROJECT SITE.

ROCK BERMS SHOULD BE CONSTRUCTED DOWNSTREAM FROM UNDISTURBED AREAS TO INTERCEPT SEDIMENT FROM OVERLAND RUNOFF AND/OR CONCENTRATED FLOW.

TYPE 1 (18" HIGH WITH NO WIRE MESH): TYPE 1 MAY BE USED AT THE TOE OF SLOPES, AROUND INLETS, IN SMALL DITCHES, AND AT DIKE OR SWALE OUTLETS. THIS TYPE OF DAM IS RECOMMENDED TO CONTROL EROSION FROM DRAINAGE AREA OF 5 ACRES OR LESS. TYPE 1 SHOULD NOT BE USED IN CONCENTRATED HIGH VELOCITY FLOWS (APPROX. 8 FT/SEC OR MORE) IN WHICH AGGREGATE WASH OUT MAY OCCUR. SANDBAGS SHOULD BE USED AT THE EMBEDDED FOUNDATION (4" DEEP MIN.) FOR BETTER FILTERING EFFICIENCY OF LOW FLOWS IF CALLED FOR ON THE PLANS OR AS A RESULT OF ROUTINE INSPECTIONS

TYPE 2 (18" HIGH WITH WIRE MESH): TYPE 2 MAY BE USED IN DITCHES AND AT DIKE OR SWALE OUTLETS.

TYPE 3 (36" HIGH WITH WIRE MESH): TYPE 3 MAY BE USED IN STREAM FLOW AND SHOULD BE SECURED TO THE STREAM BED.

TYPE 4 (SACK GABIONS): TYPE 4 MAY BE USED IN DITCHES AND SMALLER CHANNELS TO FORM AN EROSION CONTROL DAM.

Figure 3–4 Typical installation requirements for high service rock berms (Type 3 or 4)

A Inlet Protection

1. Materials

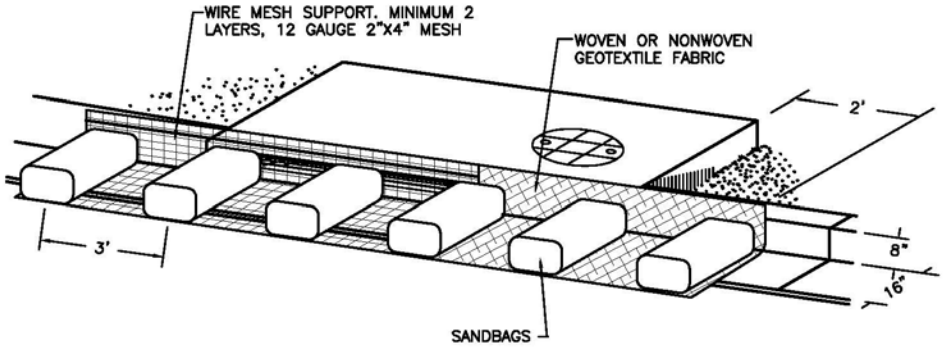
- Filter fabric width shall be non-woven with a minimum unit weight of 4 oz/yd^2
- Woven wire backing used to support the filter fabric shall be galvanized 2” x 4” welded wire, 12 gauge minimum
- The sand bag material shall be polypropylene, polyethylene, polyamide, or cotton burlap woven fabric

- Filter fabric shall have a minimum unit weight of 4 oz/yd^2, mullen burst strength in excess of 300 psi and ultraviolet stability in excess of 70 percent
- The bag shall have a length of 24-30" with a width of 16-18" and a thickness of 6-8"
- The sandbags shall be filled with coarse grade sand and free of deleterious material
- The sand shall be capable of passing through a No. 10 Sieve

- The filled bag should have an approximate weight of 40 pounds and be sealed by staples or tied with cord

2. Installation

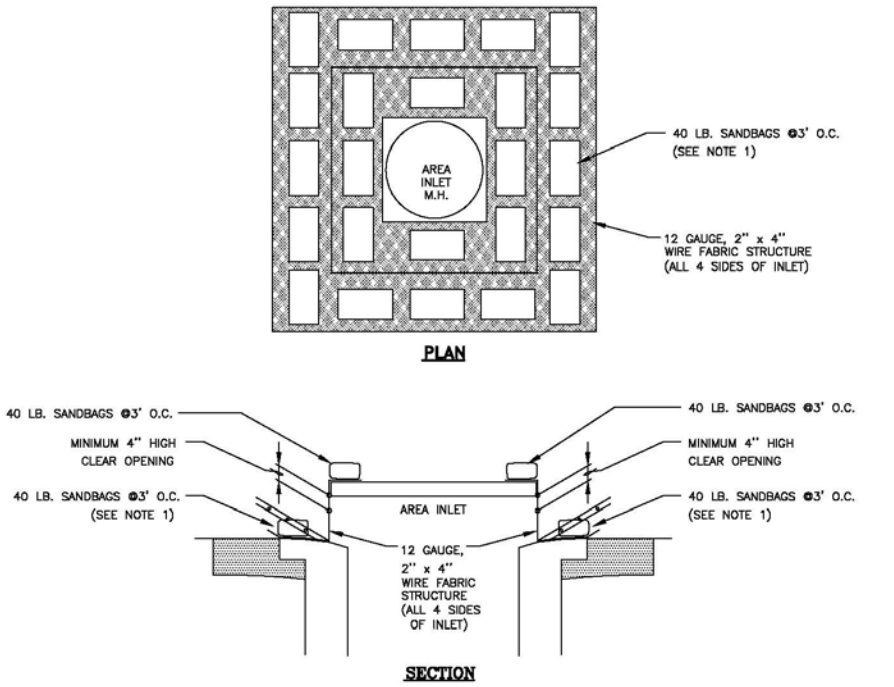
   See figures 3-5 and 3-6 for typical installation guidelines for curb inlet and area/grate inlet protection.



NOTES:

1. WHEN A SANDBAG IS FILLED WITH MATERIAL, THE OPEN END OF THE SANDBAG SHOULD BE STAPLED OR TIED WITH NYLON OR POLY CHORD.
2. INLET PROTECTION SHALL BE PLACED OVER THE MOUTH OF THE INLET WITH A 2 FOOT OVERLAP ON EITHER SIDE.
3. THE FABRIC COVER AND SHALL BE A CONTINUOUS WRAPPING OF GEOTEXTILE.
4. THE SKIRT SHALL BE WEIGHTED WITH ONE MINIMUM 18"x24"x6" SANDBAG EVERY 3 FEET.
5. INSPECTION SHALL BE MADE WEEKLY OR AFTER EACH RAINFALL EVENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED BY THE CONTRACTOR.
6. ACCUMULATED SILT SHALL BE REMOVED WHEN IT REACHES A DEPTH OF FOUR INCHES, AND DISPOSED OF IN A MANNER WHICH WILL NOT CAUSE ADDITIONAL SILTATION.
7. AFTER THE DEVELOPMENT SITE IS COMPLETELY STABILIZED, THE INLET PROTECTION AND ANY REMAINING SILT SHALL BE REMOVED. SILT SHALL BE DISPOSED OF AS INDICATED IN NOTE 6 ABOVE.

Figure 3–5 Typical installation guidelines for curb inlet protection



NOTES:

1. WHERE MINIMUM CLEARANCES CAUSE TRAFFIC TO DRIVE IN THE GUTTER, THE CONTRACTOR MAY SUBSTITUTE A 1" X 4" BOARD SECURED WITH CONCRETE NAILS 3' O.C. NAILED INTO THE GUTTER IN LIEU OF SANDBAGS TO HOLD THE FILTER DIKE IN PLACE. UPON REMOVAL, CLEAN ANY DIRT/DEBRIS FROM NAILING LOCATIONS, APPLY CHEMICAL SANDING AGENT AND APPLY NON-SHRINK GROUT FLUSH WITH SURFACE OF GUTTER.
2. A SECTION OF FILTER FABRIC SHALL BE REMOVED AS SHOWN ON THIS DETAIL OR AS DIRECTED BY THE ENGINEER OR DESIGNATED REPRESENTATIVE. FABRIC MUST BE SECURED TO WIRE BACKING WITH CLIPS OR HOG RINGS AT THIS LOCATION.
3. DAILY INSPECTION SHALL BE MADE BY THE CONTRACTOR AND SILT ACCUMULATION MUST BE REMOVED WHEN DEPTH REACHES 2".
4. CONTRACTOR SHALL MONITOR THE PERFORMANCE OF INLET PROTECTION DURING EACH RAINFALL EVENT AND IMMEDIATELY REMOVE THE INLET PROTECTIONS IF THE STORM-WATER BEGINS TO OVERTOP THE CURB.
5. INLET PROTECTIONS SHALL BE REMOVED AS SOON AS THE SOURCE OF SEDIMENT IS STABILIZED.

Figure 3-6 Typical installation guidelines for area/grate inlet protection

A Sediment Basin

1. Materials

   - Suitable outfall structure(s) as approved by the City Engineer

2. Design Requirements

   - Side slopes of basins shall not exceed 3:1
   - Basins shall be graded to drain to the outfall structure(s)
   - Basins and outfall structure(s) shall be sized to pass the 10-year design storm
   - A 48 hour drawdown time is required to effectively detain the 1-year 3 hour storm event

3. Required submittal information for sediment basins to be submitted to the City Engineer for review:

    - Contributing drainage area
    - Design flow rates and sizing calculations
    - Details for outfall structure(s)
    - Other information and details required to reasonably construct the sediment basin as determined by the City Engineer

A Construction Exit

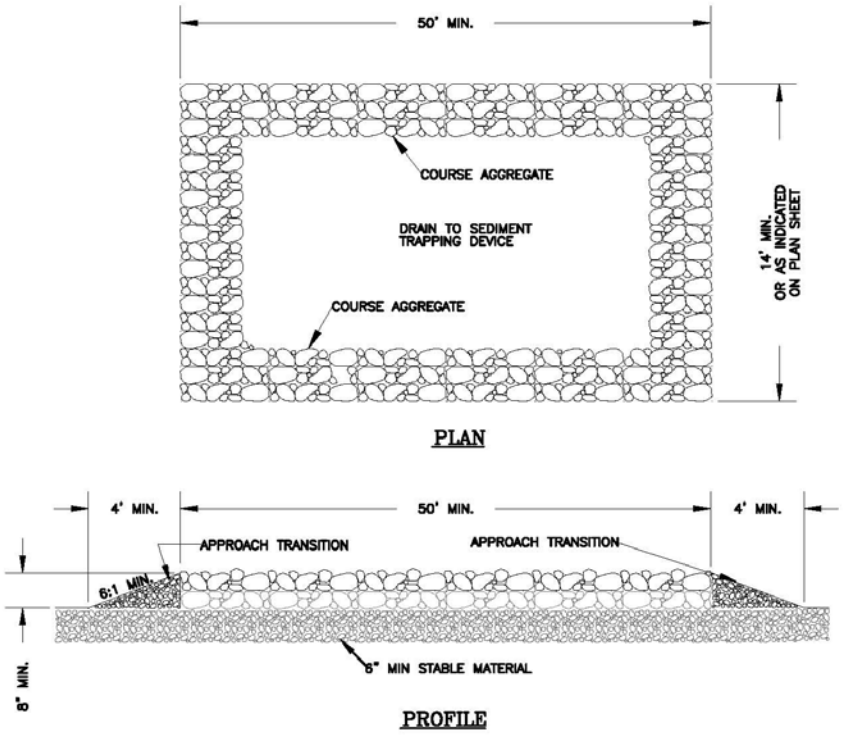
1. Materials

    - Aggregate shall consist of 4” to 8” diameter washed stone

2. Installation

    - Avoid areas with steep slopes
    - Clear vegetation and other objectionable material from foundation area
    - Grade back to site (where possible), otherwise install a 6” tall rock berm on the downstream side
    - Install aggregate to a minimum thickness of 8”
    - The construction exit shall be the full width of the proposed roadway, or a minimum of 12 feet if no roadway is proposed
    - The construction exit shall be a minimum of 50 feet in length
    - Install culvert pipe as necessary to maintain proper drainage for existing roadway

    Figure 3-7 shows typical installation requirements for construction exits.



GENERAL NOTES

1. THE LENGTH OF THE ROCK CONSTRUCTION EXIT SHALL BE AS INDICATED ON THE PLANS, BUT NOT LESS THAN 50'.
2. THE COARSE AGGREGATE SHOULD BE OPEN GRADED WITH A SIZE OF 4" TO 8".
3. THE APPROACH TRANSITION SHOULD BE NO STEEPER THAN 6:1.
4. THE CONSTRUCTION EXIT SHALL BE GRADED TO ALLOW FOR POSITIVE DRAINAGE.
5. THE DESIGN DETAILS INDICATED HEREON SHOULD BE MODIFIED AS NECESSARY TO ENSURE SEDIMENT DOES NOT LEAVE PROJECT SITE.

Figure 3–7 Typical installation requirements for construction exits

A Concrete Washout

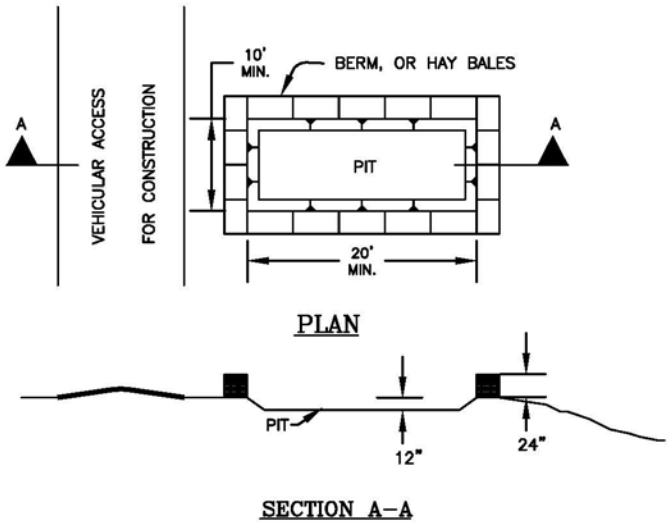
1. Materials

   - Standard hay bales or 24” tall earthen berms shall be used

2. Installation

   - Excavate pit to a depth of 12” with a minimum width of 10 feet and a minimum length of 20 feet
   - Establish hay bales or 24” tall earthen berms around the bank of the excavated pit

   Figure 3-8 shows typical installation requirements for concrete washouts.



GENERAL NOTES:

1. DETAIL ILLUSTRATES MINIMUM DIMENSIONS. PIT CAN BE INCREASED IN SIZE DEPENDING ON EXPECTED FREQUENCY OF USE.
2. IF HAY BALES ARE USED, THEY SHALL BE PLACED IN ACCORDANCE WITH DETAILS SHOWN ON EXHIBIT FOR HAY BALES.
3. WASHOUT PIT SHALL BE LOCATED IN AN AREA EASILY ACCESSIBLE TO CONSTRUCTION TRAFFIC.
4. WASHOUT PIT SHALL NOT BE LOCATED IN AREAS SUBJECT TO INUNDATION FROM STORM WATER RUNOFF.

Figure 3–8 Typical installation requirements for concrete washouts

3.3 Buffer Zone Crossings

When roadway, utility, or other disturbance activities located in buffer zones are necessary, special accommodations must be made to protect these environmentally sensitive areas.

B. General Considerations

- Buffer zone crossings should be made as close to perpendicular to the flow line of the drainage way as practical
- If baseflow exists, temporary diversion or pumping techniques may be required during construction as is necessary to prevent displacement of sediment and obstruction of flow through the channel. Adequacy of design shall be determined by the City Engineer
- If pumping is required, discharges shall be released downstream of the construction area but upstream of erosion control measures; if velocities have potential for inducing erosion, or discharge is in an area that is susceptible to erosion, then energy

dissipating devices shall be implemented with aggregate 6" in diameter and buried to a depth of 12"

- The construction area shall be kept free of surface and ground water
- Energy dissipaters, flow spreaders, and appropriate stabilization procedures shall be implemented as necessary to limit erosion potential

B. Utility Crossings and Excavation

- Prior to any disturbance activities, install two high service rock berms at 100 foot spacing across the channel downstream of the disturbance area. The first berm should be located approximately 100 feet downstream of the disturbance area. Alternative measures may be required due to property constraints. The City Engineer shall determine the adequacy of proposed alternative methods.
- After completion of activities (or at end of work day) install silt fence along disturbance area parallel to the flow line of the channel at 25 foot spacing.
- All excess excavated material must be removed from the channel and buffer zone at the end of the work day.

3.4 Permanent Erosion Controls

A Vegetation

- All vegetation work shall comply with TxDOT standard specification item numbers 160, 162, 164, 166, and 168
- All areas disturbed by construction shall be permanently stabilized with perennial vegetation
- Cellulose fiber or paper mulch used for erosion control shall be applied at a rate of 2,500 pounds per acre
- The seedbed shall be maintained in a condition favorable for the growth of grass
- It is recommended that the seedbed receive at least one-half inch of water per week
- Stabilization measures shall be initiated as soon as practicable, but no more than 14 days after construction activity has temporarily or permanently ceased
- Where construction activity on a portion of a site has temporarily ceased, and earth disturbing activities will resume within 21 days, that area does not require temporary stabilization
- Sod can be used as an immediate manner to stabilize a disturbed area
- Seeding activities shall consist of broadcast seeding or hydro-mulching
- Hydro-mulch shall consist of either wood or paper mulch and be applied at a rate of 2,500 pounds per acre. Fertilizer of the 13-13-13 analysis shall be included in the mixture at the manufacturer's recommended rate. Each bag of seed shall comply with the requirements of the Texas Seed Law including the labeling requirements for showing pure live seed (pls = purity x germination)
- Recommended seeding requirements and applicable dates are as follows:
  a. January 16 – May 15: 1 pound per 1,000 ft^2 of hulled Bermuda Grass
  b. May 16 – September 15: 1 pound per 1,000 ft^2 of hulled Bermuda Grass and 2 pounds per 1,000 ft^2 of Fox Tail Millet
  c. September 16 – January 15: 1 pound per 1,000 ft^2 of unhulled Bermuda Grass and 3 pounds per 1,000 ft^2 of wheat (red, winter) or oats

- Fertilizer for seeding activities shall be of an 15-15-15 analysis and applied at a rate of 1 to 1.5 pounds per 1,000 ft^2 (45-65 pounds per acre)
- Mulch type used shall be hay, straw, or mulch applied at a rate of 45 pounds per 1,000 ft^2 with a soil tackifier at a rate of 1.4 pounds per 1,000 ft^2
- The planted area shall be irrigated or sprinkled at 10 day intervals for the first 2 months to sufficiently soak the soil to a depth of 6", but not so as to erode the topsoil (rainfall occurrences of 0.5" or more shall postpone the watering for one week
- Restoration shall be accepted when the grass has reached a height of 1.5" with 80% coverage and no bare areas in excess of 16 ft^2

B. Other Permanent Erosion Controls

Areas with high potential for erosion such as channels, culverts, storm sewer outlets, etc. shall be protected against erosion with appropriate energy dissipating devices, flow spreading devices, erosion control matting, rock riprap, etc. The City of Burnet most recently adopted Drainage Criteria Manual provides some direction on when additional erosion protection is necessary. Geotechnical reports may be required in some instances to evaluate soil conditions. The adequacy of erosion protection shall be subject to review by the City Engineer.

4. Permanent BMP Implementation

This section describes the configuration, sizing, and design guidelines of permanent Best Management Practices (BMPs) to meet the requirements of the City of Burnet NPS Pollution Control Ordinance.

Permanent BMP submittal requirements:

- Location map
- Slopes map for proposed flow through type devices (vegetated filter strips)
- Vegetative cover map
- Location, sizing calculations, and description of all proposed permanent BMPs

4.1 Water Quality BMP Sizing

Permanent water quality BMP's are required for all new development or redevelopment, providing that one of the conditions for exemption cannot be met as outlined in Sec. 98-110 under the heading: "Projects Exempt from Article 4."

Step 1: Calculate Impervious Cover

Imperviousness is the percent, or decimal fraction, of the total site area covered by the sum of roads, parking lots, sidewalks, rooftops and other impermeable surfaces. Roof areas directed to rainwater harvesting systems are exempt from the treatment requirement. Table 4-1 shows the relation between lot size and impervious cover. When calculating the impervious area of a residential development, use the values from Table 4-1, unless the actual future impervious cover is known.

Table 4-1 Impervious Cover Assumptions for Residential Tracts

Lot Size	Assumed Impervious Cover (ft^2)
> 3 acres	10,000
Between 1 and 3 acres	7,000
Between 15,000 ft^2 and 1 acre	5,000
Between 10,000 and 15,000 ft^2	3,500
<10,000 ft^2	2,500

Step 2: Determine Drainage Area to BMP

Contributing on site drainage areas shall be determined using existing and proposed topography. Topography to be used for on site design must include at a minimum 2-foot contour intervals based on current survey information. Offsite contributing drainage areas shall not be required to be treated, but flows shall be diverted to largest extent practical. Offsite contributing drainage areas, when applicable, must be accounted for in drainage and water quality outfall structure sizing. Minimum contour intervals for offsite drainage areas are 20 feet (USGS maps are allowable).

Step 3: Select an Appropriate BMP

Select an appropriate BMP or series of BMPs for the site. BMPs should be chosen based on contributing drainage area to the BMP, as well as based on the required pollutant removal requirements.

Sites with 10 acres or less of total on site area, and that are not part of a larger common plan of development, shall require the use of at least one BMP for each on site drainage area provided that the sizing and design criteria as outlined later in this manual are met.

Sites with total areas in excess of 10 acres, shall require a higher standard for pollutant removal than for smaller sites. For sites in excess of 10 acres, BMPs that can achieve an annual removal rate of 70% or more for the increase in Total Suspended Solids (TSS) and increase in Total Phosphorus (TP) due to development or redevelopment shall require treatment by at least one BMP provided that all sizing and design criteria are met for that BMP in accordance with this manual. In the event that a single BMP cannot achieve the abovementioned removal rates for sites in excess of 10 acres, then treatment with additional BMP(s) shall be required. Pollutant removal efficiencies and allowable contributing drainage areas for each approved BMP are listed in Table 4-2.

Table 4-2 Approved BMPs, Pollutant Removal Efficiencies, and Recommended Contributing Drainage Areas

BMP	TSS Removal (%)	TP Removal (%)	Contributing Drainage Area Limits
Retention/Irrigation	90	90	Less than 128 acres
Wet Basins	83	58	20 to 128 acres
Constructed Wetlands	83	58	20 to 128 acres
Sand Filters	80	55	Less than 20 acres
Bioretention	80	72	Less than 10 acres
Vegetated Filter Strips	85	70	Less than 3 acres
Extended Detention	68	45	5 to 128 acres

Basin			
Infiltration Trench	90	90	* Downstream of BMP

* Note: Infiltration Trenches must be designed as offline BMPs.

Step 4: Calculate Runoff Coefficient

Based on the impervious cover calculated for each drainage area contributing to each of the BMPs installed at the site, calculate the runoff coefficient using equation 4.1 or figure 4-1.

Equation 4.1 $R_v = 0.05 + 0.0085(IC)$

Where:

IC = Percent impervious cover

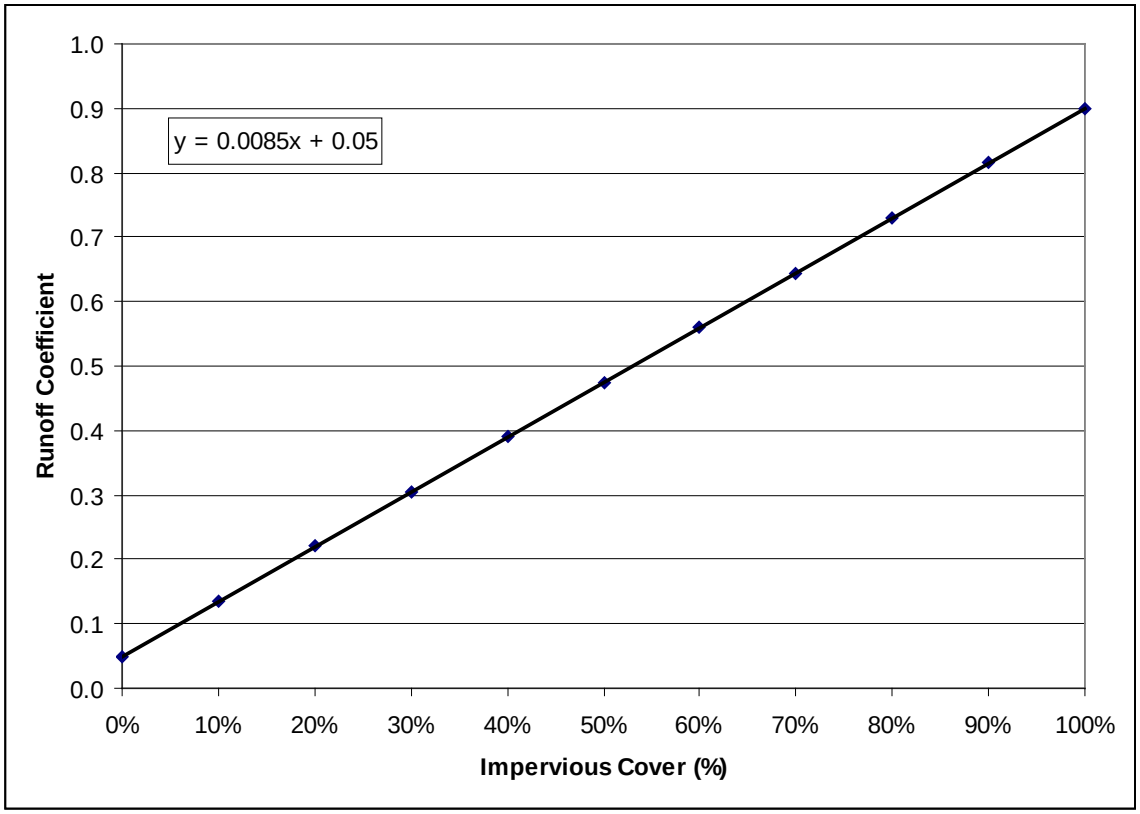


Figure 4-1 Relationship Between Runoff Coefficient and Impervious Cover

Step 5: Calculate Water Quality Volume

This step calculates the required Water Quality Volume (WQV) for each regulated area. Correlations between WQV and BMP sizing are addressed later in this manual. The WQV is calculated using equation 4.2:

Equation 4.2 WQV = Runoff Coefficient x Area x 43,560 x 1.93 / 12

Where:

WQV = Water quality volume (ft^3)
R_v = Runoff Coefficient determined in Step 4 (in.)
Area = Site area contributing to the BMP (ac)
1.93 = Rainfall Depth for 1-Year, 3-Hour Rainfall Event

Step 6: BMP Sizing

After determining the appropriate BMP(s) for each on site drainage area, and calculating the WQV, use Tables 4-3, 4-4 and 4-5 to establish the sizing criteria for each BMP. Additional BMP design criteria are included in section 4.2. Table 4-3 gives BMP sizing criteria based on WQV for sites with a total area of 10 acres or less. Table 4-4 corresponds to single BMP sizing criteria for sites in excess of 10 acres. Table 4-5 gives primary and secondary BMP sizing criteria for sites in excess of 10 acres.

Table 4-3 Stand Alone BMP Sizing Criteria for Sites of 10 Total Acres or Less

BMP	BMP Sizing (ft^3)	Sediment Forebay (ft^3)
Retention/Irrigation	WQV x 1.55	WQV x 0.2
Wet Basins	WQV x 1.05	See "Wet Basins"
Constructed Wetlands	WQV x 1.05	See "Constructed Wetlands"
Sand Filters	* D x WQV / 18	WQV x 1.05
Bioretention	WQV x 1.05	WQV x 0.2
Vegetated Filter Strips	WQV / 0.44	N/A
Extended Detention Basin	WQV x 1.05	WQV x 0.2

*Note: D = Depth of pond over the sand filter

Table 4-4 Stand Alone BMP Sizing Criteria for Sites Greater Than 10 Total Acres

BMP	BMP Sizing (ft^3)	Sediment Forebay (ft^3)
Retention/Irrigation	WQV x 1.55	WQV x 0.2
Bioretention	WQV x 1.05	WQV x 0.2
Vegetated Filter Strips	WQV / 0.44	N/A

Table 4-5 Dual BMP Sizing Criteria for Sites Greater Than 10 Total Acres

Primary BMP	Secondary BMP Sizing				
	Vegetated Filter Strip Upgradient (ft^2)	Vegetated Filter Strip Downgradient (ft^2)	Bioretention (ft^3)	Infiltration Trench (ft^2)	Infiltration Trench/Vegetated Filter Strip Combo
Wet Basins	WQV x	WQV x 0.26	WQV x	WQV x	WQV x 0.0043

	0.69		0.029	0.023	
Sand Filters	WQV x 0.77	WQV x 0.3	WQV x 0.033	WQV x 0.023	WQV x 0.0045
Extended Detention Basin	WQV x 1.05	WQV x 0.4	WQV x 0.044	WQV x 0.03	WQV x 0.006

Note: Refer to Table 4-3 for sediment forebay sizing and primary BMP sizing.
For infiltration trench/vegetated filter strip combo, trench must be a minimum of 8 ft^2 in cross-sectional area and the strip must be a minimum of 30 ft in width.

4.2 BMP Design Criteria

Some of the methods of implementation of permanent BMPs described in this section include regrading and reshaping existing watershed surfaces, modifying drainage channels, and in some cases, construction of control structures and/or berms. In many cases, the facilities required for implementation of permanent BMPs will be constructed in areas where there may be conflict with existing drainage patterns. All constructed facilities associated with the implementation of permanent BMPs are subject to the same restrictions as other planned structures. That is, the addition of the permanent BMPs must not produce any adverse impact on existing drainage systems or patterns outside the property boundaries or easement lines of the proposed site. Adverse impact includes, but is not limited to:

- Increase in runoff from a developed property
- Concentration of flow
- Blockage of flow (backwater effects)
- Change in existing flow patterns, including redirection or diversion of flow
- Placement of fill in the flood plain (The volume of a raised berm and all water ponded behind the raised berm has the same effect on displacement of flood storage as placement of earthen fill of equal volume.)
- Placement of structures in the floodway

Obviously, the BMP structure(s) may produce any or a combination of the above listed effects in the immediate vicinity of the constructed facilities; however, all adverse impacts must be completely mitigated within the confines of the property lines of the site (including easements).

This section gives general design requirements for each of the approved BMPs. All pond bottoms, side slopes, and earthen embankments shall be designed and constructed to be independently stable and compacted to 95% of optimum density. Side slopes for earthen embankments shall not be steeper than 3' horizontal to 1' vertical (3:1) without appropriate erosion protection measures. All slopes in excess of 3:1 shall be stabilized with erosion control matting, rock riprap, retaining walls, or other methods as approved by the City Engineer. All earthen BMPs shall be permanently stabilized with perennial vegetation to a minimum coverage of 80% with no bare areas exceeding 16 ft^2.

A. BMP Design Requirements

1. General Basin Requirements

- A minimum of 1 foot of freeboard is required above the proposed maximum water surface elevation of the basin

2. Sediment Forebays

- If required, sediment forebays shall be sized in accordance with the General Requirements for each approved BMP
- Sediment forebays shall maintain a minimum length to width ratio of 1:1
- Sediment forebays shall be separated from the remainder of the BMP by rock gabion mattresses or loose rock riprap (dependant on flow rates)
- Acceptable aggregate diameters for rock gabion mattresses and loose rock riprap is 4" to 8"

3. Flow Splitting Devices and Outfall Structures

- All flow splitting devices, outfall structures, or other drainage structures associated with a proposed BMP shall be designed in accordance with the City of Burnet most recently adopted Drainage Criteria Manual.

4. Flow Spreading Devices

- Flow spreading devices shall be required for basin discharges to establish sheet flow for the 1-year, 3-hour storm event. Sheet flow is defined to have a depth of flow of 0.2 feet or less and a velocity of 1 foot per second or less. This can be approximated using the following relationship:

$$\mathbf{L = 5 \times Q_{1\text{-year, 3-hour developed}}}$$

Where: L = Length of spreader in the direction of flow (ft)
$Q_{1\text{-year, 3-hour developed}}$ = Peak discharge for the 1-year, 3-hour storm event under proposed conditions (cfs, see section 6 for rainfall data)

B. Retention/Irrigation

1. General Requirements

- The required volume of the pond is the WQV + 55% to account for reductions in volume due to deposition of solids and to protect against streambank erosion
- A fixed vertical marker shall be installed in the basin to indicate sediment accumulation
- A pump, wet well, and irrigation system must be designed to distribute the water quality volume (systems should be designed similarly to wastewater effluent irrigation systems)
- If the basin is to be designed as an offline pond, then a flow splitting device shall be required.
- The irrigation schedule shall insure complete drawdown of the water quality volume within 72 hours, however, irrigation is not permitted within 12 hours of the completion of a rainfall event (effective time allowed for distribution of the water quality volume is consequently 60 hours)

- Irrigation areas must be pervious with slopes of 12% or less to receive credit
- The minimum required irrigation area is calculated by equation 4.8:

Equation 4.8 $$A = \frac{12 \times V}{T \times \gamma}$$

Where:

A = Area required for irrigation (ft^2)
V = Water quality volume (ft^3)
T = Period of active irrigation (60 hr)
γ = Soil permeability (in/hr)

2. Soil permeability information should be obtained from the most recent county soil survey or from testing information (if available); if no information is submitted, an assumed value of 0.1 in/hr shall be assumed

C. Wet Basins

1. General Requirements

- The required volume of the pond is the WQV + 5% to account for reductions in volume due to deposition of solids
- The volume of the permanent pool shall be greater than or equal to the water quality volume
- A sediment forebay shall be sized to contain 20% of the permanent pool volume and be at least 3 feet deep
- The sediment forebay shall be separated from the rest of the permanent pool by a gabion or loose riprap wall
- The pond should be narrowest at the inlet and widest at the outlet, with a minimum length to width ratio of 2.0
- An aquatic bench 10 feet wide from the perimeter of the permanent pool and no more than 18" below normal depth is required
- All permanent pools with a depth of 4 feet or more shall require a safety bench with a minimum width of 10 feet from the water surface elevation of the maximum pool elevation and with a maximum allowable slope of 3%
- A fixed vertical marker shall be installed in the forebay to measure sediment accumulation
- The low flow orifice outfall shall be sized to a minimum diameter of 4" and shall discharge the water quality volume over a period of 40-48 hours
- The facility shall require a separate drain pipe with a manual valve to allow for draining of the facility for maintenance purposes
- If the basin is to be designed as an offline pond, then a flow splitting device shall be required.
- Some of the appropriate wetland species for warm weather climates along with planting guidelines are listed in Tables 4-6 through 4-10 below

- A pond buffer zone of 25 feet that extends outward from the maximum water surface elevation is required
- The permanent pool shall not exceed 8 feet in depth and should average 4-6 feet deep
- The pond must maintain a permanent pool, therefore a 12" clay, or approved alternative, impermeable liner and a constant source of water must be provided for in order to maintain the facilities condition as a wet basin

Table 4-6 Appropriate Bulrush Species		
Bulrush	**Water Depth**	**Notes**
Scirpus validus, Bulrush	1-3'	8' tall evergreen, resists cattail encroachment
Scirpus californicus, Bulrush	1-3'	8' tall evergreen, resists cattail encroachment
Scirpus americanus, Three-square Bulrush	2-6"	2-4' tall, with 3 distinct edges

Note: Bulrush species should be installed in clumps with individual plants spaced approximately 3 to 4 feet on center. At least 2 species should be used.

Table 4-7 Appropriate Marsh Species		
Marsh Diversity	**Water Depth**	**Notes**
Cyperus ochraeus, Flatsedge	2-6"	1-2' tall, clump-forming, common to central Texas
Dichromena colorata, White-topped Sedge	2-6"	1-2' tall, white bracts during warm season
Echinodorus rostratus, Burhead	3"-1'	1-2' tall, annual, heart-shaped leaves, flower similar to arrowhead
Eleocharis quadrangulata, Four-square Spikerush	6"-1'	1-2' tall, colonizes, inhabits deeper water than other Spikerushes
Iris Pseudacorus, Yellow Flag Iris	1-2'	3-4' tall, can be invasive, dense growth, yellow flowers
Junctus effuses, Soft Rush	6"-1'	3-4' tall, forms a tight clump, evergreen, very attractive
Justicia Americana, Water Willow	2-6"	2-3' tall, common, white flowers, herbaceous, colonizes
Marsilea macropoda, Water Clover	2-6"	Looks like floating four-leaf clover, endemic to Texas
Najas guadalupensis, Water-Naiad	1-4'	Submergent, valuable to fish and wildlife
Pontederia cordata, Pickerelweed	2"-1'	3' tall, colonizes, cosmopolitan, purple flowers
Rhynchospora corniculata, Horned-rush	2-6"	2-3' tall, brass-colored flowers in May

Note: Marsh species should be installed in clumps in shallow water, with individual plants spaced approximately 3 feet on center. At least 2 species should be used.

Table 4-8 Appropriate Spikerush Species		
Spikerush	**Water Depth**	**Notes**
Eleocharis montevidensis, Spikerush	0-6"	1' tall, rhizomatous, reduces erosion at the pond edge

Eleocharis macrostachys, Spikerush	0-6”	1’ tall, rhizomatous, reduces erosion at the pond edge
Eleocharis quadrangulata, Spikerush	3”-1’	2-2.5’ tall, rhizomatous, can accommodate deeper water, 4-angled

Note: Spikerush species should be installed at or near the water’s edge, with individual plants spaced approximately 3 to 6 feet on center. At least 2 species should be used.

Table 4-9 Appropriate Arrowhead Species		
Arrowhead	**Water Depth**	**Notes**
Saggitaria latifolia, Arrowhead	2”-1’	2’ height, wildlife value, white flowers, proven water quality performer

Note: Arrowhead species should be installed in clumps in shallow water, with individual plants spaced approximately 3 feet on center.

Table 4-10 Appropriate Aquatic Species		
Aquatics	**Water Depth**	**Notes**
Cabomba caroliniana, Fanwort	1-4’	Approximately 6’ length underwater, submergent
Ceratophyllum spp., Coon-tail	1-4’	Maximum 8’ length, tolerant of turbidity and water fluctuation, wildlife food
Nymphaea odorata, Fanwort	6”-2’	A native, reliably hardy, floating-leaved aquatic, with white flowers
Potomageton pectinatus, Sago Pondweed	8”-3’	Colonizes quickly, valuable to fish and wildlife; floating-leaved aquatic

Note: Floating-leafed aquatic species are rooted in the sediment of the pond, and have leaves that float on the water, providing shade which limits the potential for algae growth. At least 2 species should be used.

2. Considerations

- Stocking the facility with Gambusia affinis (mosquito fish) to a minimum initial density of 200 individuals per surface acre should be considered to minimize problems with mosquitoes
- The performance and appearance of the facility may be improved by providing aeration of the permanent pool

D. Constructed Wetlands

1. General Requirements

- The design requirements are the same for constructed wetlands as for wet basins with the exception of the following items
- A minimum 10 foot wide flat area around the perimeter of the facility is required
- Where possible, a 30 foot wide landscaped buffer shall surround the entire facility
- The permanent pool should comprise 30-50% of the pond’s surface area and should range between 2-4 feet in depth

- The remaining wetland zone should make up 50-70% of the pond's surface area and range from 6-12" in depth
- The basin should be designed as an offline pond with a flow splitting device so as to isolate the WQV
- The depth of any designated micropools shall not exceed 4 feet

E. Sand Filters

1. General Requirements

- The required volume of the sedimentation forebay in the pond is the WQV + 5% to account for reductions in volume due to deposition of solids
- The total required pond volume is (WQV x 1.05) + (Depth of pond over sand filter x WQV / 18)
- The depth of water in the sedimentation basin when full should be no less than 2 feet and no more than 8 feet
- A fixed vertical marker shall be installed in the sedimentation basin to indicate sediment accumulation
- The minimum average surface area for the filtration basin is calculated by equation 4.9:

Equation 4.9 $$A_f = \frac{WQV}{18}$$

Where:

A_f = Minimum surface area for the filtration basin (ft^2)
WQV = Water Quality Volume (ft^3)

- The sand filter consists of 18" of sand over 6" of gravel separated by a permeable geotextile fabric
- Minimum 4" SCH. 40 PVC pipe, with perforations spaced 6" apart or less, located beneath the gravel layer is used to drain the capture volume
- The underdrain piping shall consist of a collector pipe and at least 2 lateral branch pipes, each minimum 4" SCH. 40 PVC
- The pipes shall maintain a minimum slope of 0.5% with the laterals spaced at a maximum of 10 feet
- Each underdrain pipe shall require a cleanout that is accessible when the basin is completely full
- If the pond is designed as offline, then a flow-splitting device shall be incorporated into the design of the sedimentation basin.
- Energy dissipation at the inlet to the sedimentation basin is required so as to produce uniform distribution and reduced flow velocities
- The outflow structure from the sedimentation chamber shall consist of a concrete wall or a rock gabion (if rock gabion is used, aggregate shall be a minimum of 4" in diameter)
- The sand filter shall be protected against erosion via splash pad, riprap, etc. from the flows released from the upstream sedimentation basin
- The overall sand filtration BMP shall be designed to drawdown in 40-48 hours

F. Bioretention

1. General Requirements

- The required volume of the pond is the WQV + 5% to account for reductions in volume due to deposition of solids
- A sediment forebay shall be sized to contain 20% of the of the water quality volume
- The sediment forebay shall be separated from the rest of the facility by a gabion or loose riprap wall
- A fixed vertical marker shall be installed in the sedimentation basin to indicate sediment accumulation
- The bottom of the facility shall be graded out to be as flat as possible to allow for uniform ponding and infiltration
- Due to the dependence on infiltration for this BMP, soil permeability information should be obtained from the most recent county soil survey or from soil testing information (if available); if no information is submitted, an assumed value of 0.1 in/hr shall be assumed
- Infiltration rates of less than 1 in/hr shall require underdrain piping wrapped in geotextile fabric in a gravel bedding material
- If underdrain piping is necessary, a minimum pipe diameter of 6" and a minimum slope of 0.5% is allowed; a cleanout shall be required for all underdrain pipes that is accessible when the basin is completely full
- The water depth above the soil media shall not exceed 12" unless a sand filter overflow is included in the design; if a sand filter overflow is implemented, then a water depth of 24" over the soil media and 12" over the sand filter is acceptable
- If a sand filter overflow is used, it must be separated from the remainder of the facility with a concrete wall or a rock gabion (if rock gabion is used, aggregate shall be a minimum of 4" in diameter)
- The area of the sand filter overflow (if included) shall be sized by dividing the water quality volume by 18 (Area = WQV/18)
- The minimum thickness of the sand filter overflow (if included) is 18" with 2-3" of topsoil and the remainder of the subsurface material being comprised of sand
- The filtration media shall require an overall minimum depth of 30" consisting of 18-24" of soil mixture over 6-12" of sand
- Install soil in 8-12" lifts to protect against excessive settlement (lifts are not to be compacted)

G. Vegetated Filter Strips

1. General Requirements

- Sheet flow is required across the filter strip as defined in Flow Spreading Devices under the Basin Design Requirements heading (flow spreading devices shall be required as necessary)

- Areas with slopes up to 12% shall be given full credit as a filter strip
- Areas with slopes in excess of 12%, but less than 20% shall receive a 25% credit as a filter strip
- Areas with slopes that exceed 20% will receive no credit as a filter strip
- The minimum allowable flow length in the direction of flow shall be 12 feet as measured perpendicular to the contours
- Vegetated filter strips shall require a soil depth of at least 4" with a minimum vegetative coverage of 80% with no bare areas exceeding 16 ft^2

H. Extended Detention Basin

1. General Requirements

- The required volume of the pond is the WQV + 5% to account for reductions in volume due to deposition of solids
- The ratio of flow path length (distance between inlet and outfall) to the average width in the basin should be at least 2:1
- A sediment forebay sized to approximately 20% of the water quality volume is required (known as Stage I)
- The sediment forebay shall be separated from the rest of the facility by a gabion or loose riprap wall
- The basin depth for Stage I should range from 2-5 feet
- A fixed vertical marker shall be installed in the sediment forebay to indicate sediment accumulation
- Stage II of the pond is required to contain vegetation adaptable to periodic inundation
- A rock-lined low flow channel with a longitudinal slope of 1-5% is required to connect Stage I to Stage II of the basin
- The lateral slope of Stage I toward the low flow channel should have a slope of approximately 1-1.5%
- The bottom of Stage II should range from 1.5-3 feet below that of Stage I
- Energy dissipation and flow spreading is required at the inlet to the basin
- The outfall structure(s) shall be designed so as to allow for complete drawdown of the water quality volume in 40-48 hours
- If the pond is designed as offline, then a flow-splitting device shall be incorporated into the design of the sedimentation basin.

I. Infiltration Trench

1. General Requirements

- Infiltration trenches must be the second BMP in series located downstream of the water quality basin
- Due to the dependence on infiltration for this BMP, soil permeability information should be obtained from the most recent county soil survey or from soil testing

information (if available); if no information is submitted, an assumed permeability of 0.1 inches per hour shall be used
- Acceptable infiltration rates range from 0.3-5.0 inches per hour
- A minimum of 3 feet of soil separation is required between the basin invert and the bedrock and the high water table
- Trench sizing is based on the type of structural BMP upstream as indicated below:

Wet Basin: $V_{IT} = WQV \times 0.023 \times (1 - VR\%)$
Sand Filter: $V_{IT} = WQV \times 0.023 \times (1 - VR\%)$
Extended Detention: $V_{IT} = WQV \times 0.03 \times (1 - VR\%)$

Where: V_{IT} = Required volume for infiltration trench (ft^3)
WQV = Required Water Quality Volume (ft^3)
VR% = Volume reduction % (See Table 4-11)

Table 4-11 Soil Permeability Allowances

k (inches/hour)	Infiltration Trench Volume Reduction
0.4	0%
0.6	24%
0.8	39%
1.0	49%
1.2	56%
1.4	62%
1.6	65%

- The ratio of infiltration volume to infiltration surface area (V_{IT}/A_I) should be no greater than 1.0
- The trench shall be no greater than 8 feet in depth
- Infiltration trenches in parallel shall be separated by a distance of twice the trench depth
- An overflow shall be provided for parallel to a contour with erosion protection as necessary
- Trench backfill shall consist of 1.5-3 inch washed bank run gravel aggregate with no fines material
- A top filter layer consisting of 3 inch thick pea gravel or coarse sand is required
- Filter fabric is required on the bottom, sides, and below the top filter layer
- Two observation wells are required with 6" perforated schedule 40 PVC

J. Alternative BMPs

Any proposed BMPs not discussed in this Technical Manual must be approved by the City Engineer prior to implementation. Approval will be subject to review of the submitted information and shall be comprised of objective, reliable, and verifiable data that indicates that the TSS removal requirements will be met. All such BMPs, if approved, shall require that a monitoring program be initiated for the first year after installation is complete. All monitoring expenses shall be paid for by the developer.

1. Additional submittal requirements for alternative BMPs:

    - Documentation of mechanism(s) by which TSS is removed
    - Documentation and/or discussion of potential causes of poor performance or failure of the BMP
    - Key design specifications or considerations
    - Specific installation requirements
    - Specific maintenance requirements
    - Data in support of declared TSS removal efficiencies
    - Detailed monitoring plan to assess TSS removal

5. Measures to Protect Streambanks

Increases in sediment and other pollutants in waterways are often caused by the accelerated rate of channel erosion due to the increase in rate and volume of stormwater runoff from impervious cover associated with development. To reduce the rate of channel erosion, stormwater runoff must be controlled. This section outlines regulation requirements for stormwater runoff rates.

In accordance with the City of Burnet most recently adopted Drainage Criteria Manual, detention requirements for flood control purposes may be required whether BMPs are required or not. In addition to detention requirements as set forth by the most recently adopted City of Burnet Drainage Criteria Manual, streambank erosion control requirements are set forth in this manual. In an effort to prevent erosion of natural and man-made drainage swales, the design criteria for BMPs in this manual incorporates infiltration and releasing of stormwater over an extended period of time for the 1-year, 3-hour rainfall event. The design requirements as specified in this manual and the City of Burnet most recently adopted Drainage Criteria Manual must be upheld simultaneously for all applicable projects in order to prevent adverse impacts from both a water quality and quantity standpoint. All such information must be submitted to the City Engineer for review and approval.

Existing and proposed developed condition runoff volumes and flow rates shall be estimated using Rational Method, TR-55, HEC-1, HEC-HMS or approved equivalent methods as outlined in the City of Burnet most recently adopted Drainage Criteria Manual. The use of appropriate hydrologic and hydraulic modeling techniques and software should be chosen and its acceptability will be reviewed on case by case basis.

6. Rainfall Data

Table 6-1 below gives the average annual rainfall depth for the 1-year, 3-hour storm event (Source: 2006 Lower Colorado River Authority Highland Lakes Watershed Ordinance Water Quality Management Technical Manual).

Table 6-1 Average Annual Rainfall Events
1-Year, 3-Hour
1.93

Table 6-2 lists the runoff coefficients to be used when performing hydrologic analysis using the Rational Method for the 1-year, 3-hour storm event (Source: 2006 Lower Colorado River Authority Highland Lakes Watershed Ordinance Water Quality Management Technical Manual).

Table 6-2 Rational Method Runoff Coefficients	
	1-Year, 3-Hour
Streets	
Asphaltic	0.69
Concrete	0.75
Drives and Walks	
(Concrete)	0.75
Roofs	0.75
Lawns, Sandy Soil	
Flat, 0-2%	0.05
Average, 2-7%	0.10
Steep, 7+%	0.14
Lawns, Clay Soil	
Flat, 0-2%	0.15
Average, 2-7%	0.18
Steep, 7+%	0.25
Undeveloped Woodlands and Pastureland, Sandy Soil	
Flat, 0-2%	0.10
Average, 2-7%	0.16
Steep, 7+%	0.25
Undeveloped Woodlands and Pastureland, Clay Soil	
Flat, 0-2%	0.25
Average, 2-7%	0.32
Steep, 7+%	0.41

Table 6-3 provides the rainfall intensities to be used when performing hydrologic analysis for the 1-year, 3-hour storm event (Source: 2006 Lower Colorado River Authority Highland Lakes Watershed Ordinance Water Quality Management Technical Manual).

Table 6-3 Rainfall Intensity Values	
	1-Year, 3-Hour
T_c	**(in/hr)**
5	5.5
10	4.3
15	3.7
30	2.6
60	1.65

Table 6-4 on the following page presents the 1-year, 3-hour design storm rainfall distribution cumulative values to be applied for hydrologic modeling of a drainage area (Source: 2006 Lower Colorado River Authority Highland Lakes Watershed Ordinance Water Quality Management Technical Manual).

Table 6-4 Design Storm Rainfall Distribution Cumulative Values	
Time (min.)	**1-Year, 3-Hour**
5	0.006
10	0.012
15	0.019
20	0.026
25	0.034
30	0.043
35	0.053
40	0.064
45	0.077
50	0.092
55	0.110
60	0.134
65	0.166
70	0.212
75	0.287
80	0.384
85	0.542
90	0.802

95	1.262
100	1.462
105	1.587
110	1.688
115	1.746
120	1.784
125	1.811
130	1.832
135	1.849
140	1.863
145	1.875
150	1.885
155	1.894
160	1.902
165	1.910
170	1.917
175	1.924
180	1.930

As an alternative to the tabulated intensities and depths provided by LCRA, the designer may determine rainfall intensities for the 1-year, 3-hour storm with the rational method using Equation 6.1 as defined in the current City of Burnet Drainage Criteria Manual.

Equation 6.1

$$I_1 = \frac{135.827}{(T_c + 20.232)^{1.010}}$$

Where:

I_1 = Rainfall Intensity for the 1-Year, 3-Hour Storm Event (in/hr)
T_c = Time of Concentration (min.)

For Structural BMPs, the configuration of stormwater treatment and detention facilities is at the design engineer's discretion as to whether one or two components shall be required. The required water quality volume as calculated according to the methodology in Section 4 is directed to a capture and treat device. If the capture and treat device is to be constructed as offline, then the runoff in excess of the water quality volume is bypassed to the detention facility for peak runoff control as necessary. On the other hand, a combination water quality and detention facility can be incorporated into a capture and treat device with the appropriate outlet configuration to provide the required peak control.

7. Maintenance Requirements

A maintenance plan developed by the design engineer must be submitted for review by the City Engineer. At minimum, the following information shall be included:

- Specification of routine and non-routine maintenance activities to be performed

- A schedule for maintenance activities
- Provision for access to the site by the City of Burnet and any of their designated representatives
- Name(s) and contact information for the party(ies) responsible for maintaining the BMPs
- The maintenance plan is required to be signed and dated by the party(ies) responsible for maintenance.

8. References

Lower Colorado River Authority, 1998, *Nonpoint Source Pollution Control Technical Manual*, Austin, Texas.

Lower Colorado River Authority, 2006, *Highland Lakes Watershed Ordinance Water Quality Management Technical Manual*, Austin, Texas.

Texas Commission on Environmental Quality, 2005, *Optional Enhanced Measures for the Protection of Water Quality in the Edwards Aquifer*

Texas Commission on Environmental Quality, 1999, *Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices, RG-348*

Texas Commission on Environmental Quality, 2003, *TPDES Genera*