

Chapter Three

STORM DRAIN DESIGN STANDARDS

- 1.01 **GENERAL** - It is the intent of this section to define West Jordan City's policy regarding surface and storm water management; to explain city review requirements and procedures; and to promote the general health, safety, and the welfare of West Jordan City residents by minimizing or eliminating potential dangers of flooding to life and property. Any variance from this document shall be subject to approval of the City Engineer.
- 1.02 **DEFINITIONS** - To shorten this document certain words or phrases are defined as follows unless stated otherwise in said document.
- A. **Detention Storage:** The storage of storm water runoff for controlled release during or immediately following the design storm event.
 - B. **Discharge Point:** A point or location where surface or storm water runoff is concentrated before being released from the project area.
 - C. **Emergency:** Unforeseen circumstance that presents immediate danger to persons or property. This also includes loss of utility services.
 - D. **Erosion Control:** Controlling the unwanted movement of soil from a project's boundaries.
 - E. **Freeboard:** The distance from the top of a bank or embankment to the highwater elevation during a design storm.
 - F. **Groundwater:** Concentrated water beneath the earth's surface in aquifers of saturated soil and rock that supplies wells and springs.
 - G. **Intensity-Duration-Frequency-Curve: (IDF Curve)** a summary of the site's rainfall characteristics comparing storm duration and rainfall intensity.
 - H. **Natural Drainage Channel:** Drainage structures which naturally occur on a project prior to disturbance that convey storm water to a stream, creek, canal, or river.
 - I. **Peak Flow:** Maximum rate of storm water runoff at a point under investigation.
 - J. **Permissible Shear Stress:** The force required to begin movement of the channel bottom or side slopes.
 - K. **Roughness Coefficient:** Used in Manning's equation to estimate a material's resistance to the flow of water.
 - L. **Runoff Coefficient:** Used in the rational method to estimate the permeability of ground cover to water runoff.
 - M. **Runoff Curve Number:** Used in SCS peak runoff method to estimate the amount of water that will not infiltrate into the ground.

- N. Shallow Concentrated Flow: Storm water runoff concentrated in rills or gullies.
- O. Sheet Flow: A shallow mass of storm water runoff in the upper reaches of a sub-basin.
- P. Spillway: A waterway in or about an hydraulic structure, for the release of excess water.
- Q. Spread: A measure of the transverse lateral distance from the curb face to the limit of the water flowing on the roadway.
- R. Storm Water Pollution Prevention Plan: Drawing that pictorially displays erosion control information to a contractor regarding a particular site.
- S. Storm Water Runoff: Storm water runoff shall mean that water resulting from precipitation running off from the surface of a drainage area during and immediately following a cloudburst event.
- T. Time of Concentration: The time for storm water runoff to travel from the hydraulically most remote point in a drainage sub-basin to the point of investigation.
- U. Tributary Drainage Area: Tributary drainage area shall mean the entire catchment area that contributes surface and storm water runoff to a given impact point under investigation.

1.03 REFERENCES

- A. U.S. Department of Transportation, Federal Highway Administration, 2001. Urban Drainage Design Manual. Washington D.C., U.S. Department of Transportation.
- B. Soil Conservation Service, 1986. Urban Hydrology for Small Watersheds. Technical Release No. 55, U.S. Department of Agriculture.
- C. TRC North American Weather Consultants, 1999. Rainfall Intensity Duration Analysis Salt Lake County, Utah.
- D. Federal Emergency Management Agency. Flood Insurance Study Guidelines and Specifications for Study Contractors. Washington, D.C., Federal Emergency Management Agency.
- E. U.S. Department of Transportation, Federal Highway Administration, 1985. Hydraulic Design of Highway Culverts. Washington D.C., U.S. Department of Transportation.
- F. Virginia Department of Conservation and Historic Resources, 1992. Virginia Erosion and Sediment Control Handbook. 3rd ed. Richmond, Virginia. Virginia Department of Conservation and Historic Resources.

- 1.04 **QUALITY ASSURANCE** - Perform work in accordance with City drafting/submittal requirements as described herein. Design work shall be accomplished under the direct supervision of a Utah Registered Professional Engineer, and shall carry the seal of the same supervising Professional Engineer.

1.05 SUBMITTALS

- A. Completed Checklist: A checklist is provided by the city and should be used as a guide in the preparation of all submittals required for drainage review and approval. These checklists are used by the reviewing agent to determine regulation compliance and plan and construction drawing completeness.
- B. Overall Drainage Plan: This plan shall be prepared in accordance with the items outlined in the Approval Checklist. Adherence to this list is strongly recommended to avoid delay in the Plan approval stage of the City's drainage review.
- C. Overall Grading Plan: Developer must submit a plan providing grading information for each individual lot. Execution of plan will be required of each individual home builder. See sample provided at the end of the chapter.
- D. Construction Drawings: The Drainage Plan shall be accompanied by a copy of all plan and profile drawings pertaining to all proposed storm drains or storm drain facilities to be constructed in connection with the project. Similarly, detail drawings of special structures or appurtenances shall also be submitted when required.
- E. Detail Drawings: When required, these drawings will give additional information regarding the construction of products not standard in the city of West Jordan.
- F. Storm Water Pollution Prevention Plan (SWPPP): Detailed plans and instructions to the contractor outlining the erosion control measures for the project.
- G. Calculation Packet: An 8 ½" x 11" bound packet of hydrologic information and calculations, pavement drainage, hydraulic calculations of storm drains, stable channel design, storm water quantity control, storm water quality, additional design procedure information, and all supporting charts, tables, curves, figures, and certificates used in the overall drainage design shall be submitted.
- H. Easements and Land Acquisition: Do not discharge storm water onto or through private property without the appropriate easement. An access easement will be required whenever public storm drains are constructed in lands of private ownership. Easement agreement forms and procedures may be obtained by contacting the City Attorney's Office. The following requirements will also apply.
 - 1. All easements must be a minimum of 20 feet wide.
 - 2. Easements shall extend 10 feet beyond the last manhole on a line.
 - 3. All easements shall be submitted and approved by the City Engineer before Final approval shall be granted.

- I. Required permits: May include but are not limited to state and county flood control permits, Railroad crossing permits, United States Army Corp. of Engineer permits, Utah Division of Water Quality permits, Utah Division of Water Rights permits, etc.
- J. Letters From Irrigation Users: Prior to approval of the development, the developer shall obtain the written approval of the water users of any ditch to be piped, or abandoned.

1.06 POLICIES

- A. Drainage Review Policy: Any proposed construction on public or private property within the limits of West Jordan City requiring either a building permit application or formal approval by the City shall be subject to review and approval by the City Engineering Department. Sufficient information shall be provided to determine drainage characteristics inside and outside the project boundaries. If surrounding areas contribute surface and/or storm water runoff to the project area, this additional runoff must be addressed in the project design.
- B. Drainage Approvals from other Governing Authorities: In the event that proposed construction shall direct surface and/or storm water runoff to properties or facilities owned and maintained by agents other than West Jordan City, written proof or permission or approval from these agents must be provided prior to acceptance of drainage concepts and subsequent issuance of City drainage approval.
- C. Restrictive Discharge Policy: the restrictive discharge policy requires on-site detention of all surface and storm water runoff within a commercial, industrial, or multi-family project area, and restricts the eventual discharge of this runoff to a maximum allowable discharge rate of *0.20 cubic feet* per second per acre of development. The amount of storm water may be further restricted by the capacity of existing storm drains, or drainage facilities, as determined by the City Engineer. In the event such additional restrictions are necessary, the Developer shall provide additional detention storage of a capacity designated by the City Engineer. The requirements of collection and the restriction of the quantity of runoff discharge necessitates the engineering design of on-site storage facilities, and encourages water quality treatment, as well as controlled runoff discharge through storm drain piping.
- D. Design Discharge Point: Design discharge points shall be agreed upon prior to Plan approval. For projects where the Restrictive Discharge Policy is not applicable, there is no established discharge rate restriction. However, pipe or channel discharge connections shall be limited to the capacity available for the project as determined in the review process. All development is required to connect to an a approved storm water system.
- E. Natural Drainage Channels: During the course of the development the developer shall not alter any natural drainage channel without obtaining permission therefor from the appropriate agency having jurisdiction over the drainage channel. As a rule, natural drainage channels will not be piped except at road crossings.
- F. Storm Water Pollution Prevention: Any proposed construction on public or private property within the limits of West Jordan City requiring either a building permit application or formal approval by the City shall submit an Storm Water Pollution Prevention Plan for review by the City Engineer.

- G. Water Quality: It is City policy and the developer's responsibility wherever attainable to restore, protect and maintain the chemical, physical, and biological integrity of City and State waters and to restore their beneficial uses. To do so, drainage design shall address the treatment of surface and storm water runoff, both wet-weather and dry-weather discharges.
- H. High Ground Water Table: West Jordan City requires that "if a water table problem exists, provisions will be made to control the water to ensure dry basements." Every effort should be made to ensure dry basements even so far to construct homes with limited or no basements.
- I. Special Flood Hazard: Must adhere to sections 88-6-(401-409) of city code.

1.07 HYDROLOGIC INFORMATION

- A. Rainfall Data -The project engineer shall create an intensity-duration-frequency curve to place in the calculations folder. In the absence of approved rainfall storm frequency information, the following table provides conservative rainfall data for West Jordan City.

Table 3.1 Rainfall Data		
Storm Duration	Rainfall Intensity	
	10 Year Design Storm	100 Year Design Storm
15 min	2.16 in / hr	3.6 in / hr
30 min	1.50 in / hr	2.5 in / hr
60 min	0.90 in / hr	1.45 in / hr
360 min	0.25 in / hr	0.33 in / hr
720 min	0.15 in /hr	0.225 in / hr
1440 min	0.10 in / hr	0.125 in / hr

- B. Peak Flow (Rational Method)For projects under 200 acres, peak storm water flow may be calculated using the rational method when the following assumptions apply:
 1. the entire watershed is contributing to the storm water flow,
 2. the rainfall is uniform over the entire watershed,
 3. the rainfall is uniform over the a duration of time equal to the time of concentration,
 4. and when the coefficient of runoff is the same for all design storms.
 5. Peak flow $Q_p = C * I * A$

Where C = weighted runoff coefficient, See Table 3.2,

I = rainfall intensity for design storm at time of concentration (in/hr),

A = tributary watershed area (acres)

- C. Runoff Coefficient: Acceptable values for the runoff coefficient “C” is shown in Table 3.2. If a basin contains different types of ground cover a composited or weighted runoff coefficient can be calculated using the following formula:

1.

Table 3.2 Minimum Runoff Coefficient “C” for Rational Method (Urban Drainage Design Manual)	
Type of Drainage Area	Minimum Runoff Coefficient, “C”
Business:	
Downtown Area	0.70 - 0.95
Neighborhood Area	0.50 - 0.70
Residential:	
Single Family	0.30 - 0.50
Multi-Family	0.60 - 0.75
Apartment	0.50 - 0.70
Industrial:	
Light Area	0.50 - 0.80
Heavy Area	0.60 - 0.90
Lawns:	
Heavy Soil, flat, 2 %	0.13 - 0.17
Heavy Soil, average 2 - 7 %	0.18 - 0.22
Heavy Soil, steep, 7 %	0.25 - 0.35
Asphalt	0.85
Drives, walks	0.90

Roofs	0.85
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D. Rainfall Intensity (Time of Concentration): Rainfall intensity for the appropriate design storm may be chosen from an intensity-duration-frequency curve when a time of concentration for the point under investigation is known. An acceptable method for calculating the time of concentration includes calculations for the flow velocity of individual segments of the flow path, (e.g., sheet flow, shallow concentrated flow, open channel flow, pipe flow, etc.). The sum of the travel times within the flow path will equal the time of concentration. All calculations and equations used to calculate the time of concentration shall be provided in the storm drain calculation report.

Sample time of concentration equations from Federal Highway Administration's Urban Drainage Design Manual:

1. Sheet Flow Travel Time:

- Where T = travel time for segment (min)
- n = manning's roughness coefficient (see table 3.4)
- L = flow length (ft) (limited to 300 feet)
- I = rainfall intensity (in/hr)
- S = slope (ft/ft)
- $K_c = 0.933$

2. Shallow Concentrated Flow: $V = k * S_p^{0.5}$

- Where V = velocity
- k = intercept coefficient (See table 3.3)
- S_p = slope, percent

Table 3.3 Intercept Coefficients - k (Urban Drainage Design Manual)	
Description	k - value
Short grass pasture	0.213
Cultivated	0.274
Nearly bare (untilled)	0.305
Grass waterway	0.457
Paved area	0.619

3. Open Channel or Pipe Flow:

Where T = travel time for segment (min)
 L = flow length for segment (ft)
 V = velocity for segment (ft/s) (use Manning's equation)

Manning's equation

Where V = velocity (ft / s)

n = manning's roughness coefficient (See Table 3.4)

R = hydraulic radius (ft)

S = Slope (ft/ft)

Table 3.4 Manning's Roughness Coefficient (Urban Drainage Design Manual)	
Surface	Overland Sheet Flow
Smooth Asphalt	0.011
Smooth Concrete	0.012
Cement Rubble Surface	0.024
Cultivated soils	0.17
Grass (Prairie)	0.15
Grass (Bermuda)	0.41
Surface	Channel & Pipes
Concrete Pipe or Plastic Pipe	0.013
Concrete Channel	0.011 - 0.020
Vegetation	0.030 -0.40

- E. Tributary Drainage Areas: The project engineer shall include the entire catchment area that contributes surface and storm water runoff to a given impact point under investigation.
- F. Peak Flow (SCS Method): For projects greater than 200 acres, peak storm water flow may be calculated using the SCS method. The project engineer is encouraged to obtain Technical Release 55 (TR-55), *Urban Hydrology for Small Watersheds*, for more informational regarding its use. The project engineer will need to provide as a minimum, in the calculations packet, the following information:
 - 1. Maps showing project layout, streets, hydraulic structures, watershed, sub-basins, soil group, land use, contours, etc.

2. Runoff Curve Number
3. Rainfall Data - For more information regarding this data contact the engineering department.
4. Time of Concentration information
5. Any other applicable data necessary to determine Q_p

1.08 PAVEMENT DRAINAGE

- A. Design Spread: The project engineer for the developer shall check the design spread of water on the roadway surface during a design and check storm to make sure that it complies with the following table.

Table 3.5 Design Frequency and Spread		
Road Classification	Design Frequency	Design Spread
Arterial (106' -130' R.O.W)	10 year	Shoulder
	50 year (sag vertical curve)	Shoulder +3 ft
Collector Streets (66' - 80' R.O.W.)	10 year	Shoulder
	50 year (sag vertical curve)	½ Driving Lane
Residential Street	10 year	½ Driving Lane
Check Storm for all Road Classifications - 100 year frequency, water level to remain 1.5 ft below finished floor elevation of building		

- B. Inlet Capacity: Inlet capacity must be calculated by the project engineer taking into account slope across the inlet , road cross slope, inlet area, inlet shape, and efficiency.
- C. Inlet Box: Construct inlet boxes as shown in plan SD-10 through SD-12. Place inlet boxes as follows.
1. No more than 700 feet apart if street surface is allowed to sheet flow, unless otherwise demonstrated by a licensed and qualified engineer and approved by the City Engineer.
 2. A double inlet box at low points in vertical curves.
 3. Locate all inlet boxes in the secondary street before the corner curb except where grade does not permit. Traffic on the secondary street yields or stops for traffic on the primary street. (See SD-01)
 4. With adequate inlet capacity to collect all storm water generated in the submitted drainage basins.

5. Prior to pedestrian ramps in high use pedestrian traffic areas.

1.09 HYDRAULIC STORM DRAIN DESIGN

- A. Design Criteria: For drainage design of construction projects within West Jordan City, standard engineering practice will be followed. The following table governs the criteria for storm frequencies to be used in the design of storm drains:

Table 3.6 Storm Frequencies For Design	
Type of Structure	Minimum Design Storm Frequency
Gutters, inlets, pipes, boxes, roadside ditches,	10 year storm 24 hour storm
Streets, streams, natural channels, creeks, or rivers	100 year flood routing, 1 foot of freeboard for streams, creeks or channels during the 100 year event
Culvert	100 year storm (In addition to the design flow please give consideration to free board necessary to debris. Provide for bed load and debris bulking.)
Bridge	100 year storm (In addition to the design flow please give consideration to free board necessary to debris. Provide for bed load and debris bulking.)

- B. Location: Storm drain lines should be placed as follows.

1. For a preferred street location see plan SD-01.
2. Side lot or rear lot property lines only if no other alternatives exist and as approved by the City Engineer. If necessary, change street alignment to accommodate storm drain line placement.
3. Storm drain lines that are approved for side lot or rear lot installation shall have a minimum 20 feet wide easement provided.
4. If storm drain lines are approved for side lot or rear lot installation, developer shall provide for vehicular access at all clean-out boxes, or manholes.
5. Extend storm drain lines beyond the boundary of the site development to meet the system in the city's storm drain master plan.

C. Pipe Material, Size, and Construction:

1. All storm drain lines in the public right of way shall be reinforced concrete. Other types of pipe may be acceptable under certain conditions and must be approved by the City Engineer in writing.
2. The minimum diameter size of storm drain pipes within the public right-of-way shall be 15 inch.
3. If the City Master Plan shows a storm drain passing through the proposed development, which will service other areas, the developer will install the line of proper diameter. Credits may be given for the difference in cost of pipe material as defined in city code.
4. If easements are required across abutting property to permit construction of storm sewers, the developer shall obtain such easements.
5. The storm drain line shall be constructed according to Plan SD-02.

D. Minimum Depth: As a rule, storm drain pipe shall be installed with a minimum cover of 2 foot from the top of the pipe to the roadway surface, however, written exceptions may be granted by the City Engineer.

E. Velocity Requirements: All sewer lines shall be designed and constructed for mean flow velocities, when flowing full, of not less than 2.5 fps.

1. Manholes (or Clean-out Boxes) : Construct manholes, and clean-out boxes according to plans SD-04 through SD-14 and as follows.

1. All storm drain manholes in the public right-of -way shall be 5 feet in diameter.
2. Manholes shall be installed:
 1. at the end of each line,
 2. at all changes in pipe size, slope, or alignment;
 3. at junctions with other lines,
 4. within 10 feet of the upstream and downstream ends of an augured or trenched casing,
 5. and at intervals not to exceed 400 feet.

2. Cross Drain: Replacement only. Construct as per PLAN RD-12 and RD-13.

1.02 CHANNEL DESIGN

1. Channel Capacity - All channels shall be designed to convey the 100 year storm event with

a minimum 1 foot of freeboard. The freeboard of a channel is defined as the vertical distance from the water surface to the top of the channel.

2. Channel Geometry - A typical channel cross section will consist of low flow area capable of conveying a low flow storm event as well as a greater cross sectional area designed to carry the 100 year storm event.
3. Side Slopes - Maximum permissible side slopes without structural protection measures are 3 feet horizontal to 1 foot vertical.
4. Channel Slope - is typically dictated by the natural slope of the earth, however, if channel stability conditions warrant, it may be feasible to adjust the channel slope and location to achieve a stable condition. Drop structures, flexible linings, etc. may be required to protect against erosion.
5. Permissible Shear Stress - To create a stable channel, the permissible shear stress of a channel may not be exceeded unless a flexible lining is provided as protection. Such lining may consist of grass, rip rap, concrete, etc. Provide information in the project calculation packet documenting assumptions, equations, and results of the shear stress comparison at critical locations in the channel.
6. Access: Access areas including access ramps shall be provided at intersection and road crossings.

1.03 STORM WATER QUANTITY CONTROL FACILITIES

1. Design Frequency:

Storm Frequency for Storm Water Quantity Control Facility	
Type of Structure	Minimum Design Storm Frequency
On-site Detention Facility (Commercial, Industrial, Multi-family)	100 year 24 hour storm
Regional or Residential Detention	100 year 24 hour storm
Outlet Design	Multi-stage release (0.2 cfs per acre max.)
Spillway Design	100 year flood routing
Freeboard required	1 foot minimum

2. 100 Year Detention Capacity: All commercial, industrial, or multiple unit residential development shall structurally provide:

The capacity of all design areas shall be sufficient to contain the estimated runoff volume from a 100 year, 24 hour storm event over those portions of the total project construction area under design. Adequate spillway provisions must be constructed to pass the peak rate

of runoff from the 100 year, 24 hour storm event over the entire upstream tributary watershed assuming the outlet pipe for the detention facility to be inoperative.

3. 100 Year Detention Capacity: All regional or residential development shall structurally provide:

The capacity of all design areas shall be sufficient to contain the estimated runoff volume from a 100 year, 24 hour storm event over those portions of the total project construction area under design. Adequate spillway provisions must be constructed to pass the peak rate of runoff from this 100 year, 24 hour storm event over the entire upstream tributary watershed assuming the outlet pipe for the detention facility to be inoperative.

4. Detention Pond Design:

1. When a pond is designed as multiple use, slopes on the ponds are not to exceed 4:1 to allow neighborhood park development.
 2. A landscaping plan, or maintenance plan must be included with all public detention pond submittals.
 3. New detention basins are not to be located within 20 feet of residential property unless no other options exist.
 4. When located within 20 feet of a residential lot, a water barrier is to be installed on the edge of the pond to prevent water from saturating the footing area.
 5. A fire hydrant shall be constructed within 100 feet from the outlet structure to facilitate cleaning.
 6. The detention pond shall be designed such that it may remain free of nuisance water.
 7. All detention ponds shall be clay lined, unless approved otherwise by the City Engineer in writing.
 8. All public detention facilities shall have a spillway to pass the check storm into a public street.
 9. Outlet structures shall be designed to be self cleaning.
 10. Fencing may be required when depths exceed four feet.
 11. Submission of an "As Built" Drawing of all public detention facilities is required.
5. Release Rate: The storage release rate of 0.20 cfs/acre of the gross aggregate project area shall be used to compute the required size of the discharge pipe when the detention storage facility is fifty (50%) full. The amount of storm water may be further restricted by the capacity of existing storm drains, or drainage facilities, as determined by the City Engineer. In the event such additional restrictions are necessary, the Developer shall provide additional

detention storage of a capacity designated by the Director of Developmental Services.

6. Access: all detention facilities shall include access ramps that shall be a minimum of fifteen (15) feet in width and have a slope no greater than ten percent.
7. Temporary Facilities: The City may approve temporary drainage facilities providing for on-site detention that will allow development to continue pending completion of the permanent storm drainage improvements. The temporary facilities shall provide the same level of flood protection at all times that will be provided by the completed systems. All costs of temporary facilities shall be paid by the developer in addition to the other costs and fees.

1.04 **STORM WATER QUALITY**

1. Best Management Practices : The project engineer shall also use Best Management practices in the design of storm water quality facilities in West Jordan. An example of said facilities may include but not be limited to:

1. Extended Detention Pond - similar to conventional detention ponds except storage times are extended to allow sediments to settle out. A modification to the extended detention pond may be a two stage extended detention pond. It is designed so that a small portion of the pond is used for water quality, and a larger portion is used for water quantity control.

2. Oil & Grease Separators - All residential detention ponds as well as commercial, industrial, or multi-family developments shall be required as a minimum to install an oil, water, and grease separator immediately before they release storm water to the public system. Construct as per plan SD-17, or as approved by the City Engineer.

3. Pocket Wetlands - Wetland areas before discharge into a natural stream or channel will use biological agents to clean storm water before it reaches a natural water course.

2. Storm Water Pollution Prevention: Prepare a Storm Water Pollution Prevention Plan as described in the end of the chapter. Please include a graphical representation of the proposed plan, as well as a sequence for the construction of erosion control elements. Such a plan should consider site management measures, structural erosion control measures, and soil stabilization measures. As a rule the general goals are to

1. Keep the soil at its original location,
2. Keep the soil close to its original location,
3. Keep the soil on-site.

3. Site Management Measures: May include:

1. A limit to the amount of disturbed area.

2. A sequence of disturbance.
3. Identify specific areas that can be stabilized immediately after construction takes place.
4. Specify a maintenance schedule.
4. Soil Stabilization Measures: Include planting ground cover such as grasses, mulches, straw, etc. and temporary soil binders that must be sprayed onto soil.
5. Structural Erosion Control Measures: Structural controls typically intercept runoff before it flows over disturbed areas, or divert it to a controlled area after it flows through a disturbed area. Such devices may consist of but not be limited to:
 1. Check Dams- Intercept and ponds runoff allowing sediment to settle to the bottom of the pond. May be made of a variety of materials including straw, stone, vegetated berm, etc.
 2. Filter Fabric Fence - Also act to intercept and pond surface runoff. Allows water to exit through the silt fence leaving the sediment behind. Works well along a project boundary and on slopes.
 3. Mulch - temporary stabilization of disturbed surfaces using mulch. It can protect the soil from rainfall impacts and inhibits sheet flow. Will also protect re-seeded areas until natural vegetation has the chance to grow. Best used on slopes.
 4. Slope Drains - collects storm water and transports it safely down a steep slope. Used in connection with a check dam to prevent erosion of the slope.
 5. Curb Inlet Barrier - last chance to prevent sediment from reaching the storm drain system. Sediment is typically removed by a filter which may be gravel, filter fabric, or other approved material before it is allowed to reach the inlet.
 6. Inlet / Outlet Protection for Channels, Pipes, Inlets - Prevents erosion of channels, streams, and ditches when a point discharge enters a natural system. Typically consists of rip rap, or concrete structure to absorb the energy of the discharge.
 7. Sediment Basins- collect and store sediment transported by streams and ditches. Works by reducing storm water velocity so that sediment will settle out. Used primarily when near a natural stream, channel , or waters of the United States of America.
 8. Construction Entrances and Wash Down Pads - Prevent construction vehicles from transporting sediment from the job site to a city street. Typically consist of gravel and a filter fabric.
 9. Dust Control Measures - Prevent erosion of disturbed area by wind.
6. Rip Rap Design: The project engineer shall present separate design details regarding erosion control at inlet and outlet's of storm water systems. Proper rip rap design shall include:

1. Depth of embedment (in.)
2. D_{50} design size (in.)
3. Length of apron (ft)
4. Width of apron at outlet (ft)
5. Width of apron at end of apron (ft)
6. Design discharge (cfs)

End of Section