CITY OF FLAGSTAFF STORMWATER MANAGEMENT DESIGN MANUAL

DEFINITIONS

For the purposes of use in this manual, the following terms are defined as indicated:

AGGREGATION - a progressive buildup or raising of a channel or stream bed due to sediment deposition.

ARTERIAL STREET - a Type I or Type II street as defined in the City of Flagstaff Engineering Design and Construction Standards & Specifications.

ATTENUATION - a reduction in downstream peak flood discharges induced by storage provided within stormwater detention facilities, channels, and overbank areas.

BASE FLOOD - means that flood event having a one (1) percent chance of being equaled or exceeded in any given year. Also referred to as the 100-year flood event.

CARRYOVER FLOW - is that portion of gutter flow which bypasses an inlet on a continuous grade. Also referred to as "bypass flow".

CITY - shall mean the City of Flagstaff.

CHANNEL - a natural or man-made conveyance for water in which the water surface is exposed to the atmosphere and the gravity force component in the direction of motion is the driving force.

COMBINATION INLET - a pavement drainage structure typically comprised of a curb-opening and a grate inlet.

COLLECTOR STREET - a Type III street as defined in the City of Flagstaff Engineering Design and Construction Standards & Specifications.

CRITICAL DEPTH - is that depth of flow at which the specific energy of a given flow rate is at a minimum.

CROWN - synonymous with "soffit". Not to be confused with a street crown.

CURB - a concrete barrier found at the edge of the street pavement, usually six to eight inches in height.

CURB-OPENING INLET - a pavement drainage inlet consisting of an opening in the vertical curb of a roadway section.

CULVERT - a relatively short, closed conduit typically designed hydraulically to take advantage of submergence to increase hydraulic capacity used for the purpose of conveying surface runoff under an embankment or roadway fill section.

DEGRADATION - a progressive lowering of a channel bed due to scour.

DESIGN CRITERIA - are the standards by which a policy is carried out or placed into effect.

DETENTION FACILITY - a permanent flood control system or stormwater management facility whose primary purpose is to temporarily store stormwater and release the stored stormwater runoff

at controlled rates. Also used as a means of attenuating the effects of increased runoff caused by development by temporarily storing runoff and metering the discharge at pre-development rates, thereby lengthening the duration of flow.

DEVELOPMENT - means any land change, including but not limited to subdivisions, buildings, other structures, mining, dredging, clearing, grubbing, stripping, grading, paving, excavation, drilling, transporting and filling of land.

DROP INLET - a drainage inlet with a horizontal or nearly horizontal opening.

DROP STRUCTURE - a hydraulic structure used in an open channel or conduit for grade control or energy dissipation purposes.

EMBANKMENT - a man-made earth fill structure constructed for the purpose of roadway elevation, detention and/or impoundment of water.

ENERGY DISSIPATOR - any device designed to protect downstream areas from erosion by reducing the velocity of flow to acceptable limits.

ENGINEER - a registered professional engineer in the State of Arizona who demonstrates proficiency in the specific area of design.

EROSION - the process of removal and transport of soil particles or land surface by the action of wind, water, ice, gravity or any combination thereof.

EROSION AND SEDIMENT CONTROL - the control of solid material, both mineral and organic, during a land disturbing activity or development to prevent its transport out of the disturbed area or development.

FEMA - an abbreviation for the Federal Emergency Management Agency.

FILTER BLANKET (LAYER) - a layer of graded, intermediate size gravel placed between fine-grained (natural) material and riprap to prevent the erosion of the finer material. Also referred to as a "granular filter".

FILTER FABRIC - a layer of synthetic material that serves the same purpose as a filter blanket.

FLARED WINGWALLS - the part of a culvert headwall which serves as a retaining wall for the roadway embankment or channel banks. The walls form an angle to the centerline of the culvert.

FLOODPLAIN - is those areas adjoining the channel of a watercourse including areas where drainage is or may be restricted by man-made structures which have been or may be covered partially or wholly by floodwater from the one hundred year flood.

FLOODWAY - is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

FLOODWAY FRINGE - is that portion of the Special Flood Hazard Area (100-year floodplain) located outside of the Regulatory Floodway.

FLUME - an open or closed channel used to convey water, typically down an embankment.

FREEBOARD - is the additional vertical distance between the calculated maximum level water surface in a culvert, reservoir, tank, detention basin, channel, canal, or wash and the top of the

confining structure.

FROUDE NUMBER - a dimensionless number that represents the ratio of inertial forces to gravitational forces. High Froude numbers are indicative of high velocity and high potential for scour.

GRADE CONTROL STRUCTURE - a hydraulic structure constructed across an open channel or stream from bank to bank to control bed slope and prevent channel degradation and headcutting.

GRADING AND DRAINAGE PLAN - the set of drawings and other documents that comprise all the information and specifications for the drainage system, structures, concepts and techniques that will be used to control stormwater runoff, erosion, and sediment transport.

GRATE INLET - a drainage structure consisting of an opening in the gutter, covered by one or more metal grates, set flush with the pavement or gutter or located at the roadside in a low point, swale or channel.

GUTTER - that portion of the roadway section adjacent to the curb which is utilized to convey stormwater runoff. It may include a portion or all of a traveled lane, shoulder or parking lane, and a limited width adjacent to the curb may be of different materials and have a different cross slope.

HEADCUTTING - is an abrupt vertical drop in an earthen channel bottom or embankment caused by erosive flows. This type of erosion typically moves upstream due to changes in discharge and sediment load characteristics.

HEADWALL - the structural appurtenance usually applied to the end of a culvert to control an adjacent roadway embankment and protect the culvert end.

HEADWATER - is that depth of water impounded upstream of a culvert due to the influence of the culvert constriction, friction, and configuration.

HYDRAULIC GRADE LINE (HGL) - a line which represents the static head plus the pressure head of flowing water and is equal to the total energy grade line minus the velocity head at any point along a storm drain. Typically referred to as the locus of elevations to which the water would rise in successive piezometer tubes if the tubes were installed along a pipe run.

HYDRAULIC JUMP - an abrupt rise in the water surface caused by abrupt transitions from supercritical flow regime to a subcritical flow regime in the flow direction.

IMPERVIOUS - the condition of being impenetrable to water.

IMPROVED INLET - a flared, depressed or tapered inlet that has entrance geometry that decreases the flow constriction at the inlet and thus increases the capacity of a culvert entrance.

INVERT - the floor, inside bottom or the lowest portion of a conduit or channel.

LAND DISTURBING ACTIVITY - any use of the land that results in a change in the natural cover or topography that may cause erosion and contribute to sediment and alter the quality and/or quantity of storm water runoff emanating from that land.

LOCAL SCOUR - erosion which occurs as the result of high velocity flow at a culvert, storm drain outlet, pier, or abutment which extends only a limited distance downstream.

LOW CHORD - the elevation of the lowest portion of a bridge deck structure used to determine the open area below the bridge available for freeboard and flow conveyance.

MANNING'S "n" - a coefficient of roughness, typically used in a formula for estimating the capacity of an open channel or conduit to convey water.

MILD SLOPE - a slope where the critical depth is less than the normal depth.

MUTLI-PURPOSE FACILITY - a detention facility which provides other benefits in addition to flood control, such as recreation, parking, visual buffers, and stormwater water treatment.

NORMAL FLOW - is open channel flow which occurs when the discharge, velocity, depth, slope, and channel cross-section are uniform throughout the reach. The water surface profile and channel bottom are parallel.

NPDES - acronym for the National Pollutant Discharge Elimination System program and permitting process administered by the Environmental Protection Agency for the purpose of improving the quality of the nation's waters by mitigating non-point source pollution in urban stormwater runoff.

OBSTRUCTION - is any physical alteration in, along, across or projecting into any channel, watercourse, or floodway which may impede or divert floodwaters, or may itself be carried downstream to cause damage to life or property. Examples include but are not limited to: any dam, wall, embankment, bridge, conduit, culvert, building, structure, levee, dike, abutment, projection, excavation, fill, stockpile, fence, wire, rock, gravel, refuse, vehicle, equipment, or vegetation.

POLICY - is a set of goals that establish a definite course or method of action and that are established to guide and determine present and future decisions. Policy is implemented through design criteria established as standards for making decisions.

PRESSURE FLOW - the flow of water within a closed conduit without a free surface open to atmospheric pressure.

Add the following Definition:

REGISTRANT - a person registered or certified by the Arizona State Board of Technical Registration

RESERVOIR ROUTING - flood routing of inflow and outflow hydrographs through a reservoir or detention basin.

RETENTION BASIN - is a stormwater storage facility which is drained by subsurface infiltration instead of a positive outlet.

RIPRAP - rock or stones placed in a loose assemblage along the banks/bed of a channel or outlet of a conduit to inhibit erosion and scour.

RIVERINE - means relating to, formed by, or resembling a river (including tributaries), stream, wash, or brook.

SAG - synonymous with "sump".

SEDIMENT TRAP - an area within a stormwater detention facility or construction site which is designed to trap incoming sediments for the purpose of facilitating maintenance.

SEDIMENTATION - the process involving the deposition of soil particles which have been carried by flood waters or stormwater runoff.

SEEPAGE - the movement of water through pores and voids of pervious material such as soil, gravel, filter fabric, etc.

SETBACK - the minimum horizontal distance between a structure and a channel, stream, wash, riverine, natural watercourse, or detention basin as measured from the top edge of the highest bank.

SHALL - means a required element.

SHEET FLOW - shallow, diffuse runoff typically characterized by an approximately equal depth of runoff across a broad width of flow without concentrating in gullies and streams (often referred to as overland flow).

SHOULD - means a recommended element.

SLOTTED DRAIN INLET - a pavement drainage inlet composed of a continuous slot built into the soffit of a pipe which serves to intercept, collect and transport the flow.

SOFFIT – is the inside top of a culvert or storm drain conduit. Also refereed to as the "crown".

SOIL STABILIZATION - the installation of vegetative, synthetic, or structural measures to protect soil from erosive forces of raindrop impact and flowing water.

SPREAD - the width of flow measured laterally from the roadway face of curb.

STEADY FLOW - flow characteristic in which the discharge passing a given cross section remains constant in time.

STEEP SLOPE - a slope where the critical depth is greater than the normal depth.

STORM DRAIN - a combination of underground conduits (laterals, trunks, pipes) and surface inlet structures utilized for the purpose of removing stormwater runoff from the ground surface or street pavement and conveying it to a downstream discharge point.

STORM DURATION - the period or length of a storm event.

STORMWATER MANAGEMENT - the collection, conveyance, storage, treatment and disposal of stormwater runoff in a manner to minimize channel erosion, flood damage, and/or degradation of water quality and in a manner to enhance and ensure public health, safety, and general welfare, which shall include a system of vegetative or structural measures, or both, that control the increased volume and rate of runoff caused by manmade changes to the land.

STORMWATER MANAGER - is the duly designated head of the City of Flagstaff Stormwater Management Section, or his/her duly authorized representative or agent.

STORMWATER RUNOFF - is the direct response of a watershed or drainage area to precipitation from a storm event and/or snow melt and includes surface and subsurface runoff or drainage that enters a watercourse, street, storm drain or other concentrated flow during and following precipitation.

SUBCRITICAL FLOW - flow regime which occurs when the Froude number is less than one (1), flow depths are greater than critical depth, small water surface disturbances travel both up and downstream, and the control of the flow depth is always located downstream.

SUMP - a low point typically found within a street profile where stormwater runoff collects.

Also referred to as a "sag".

SUPERCRITICAL FLOW - flow regime which occurs when the Froude number is greater than one (1), depths are less than critical depth, small water surface disturbances are always swept downstream, and the location of the flow control is always upstream.

TAILWATER - the water surface elevation or depth of flow in a channel, watercourse, or other receiving water body directly downstream of a culvert or storm drain outlet.

TIME OF CONCENTRATION (T_C) - is the time required for stormwater runoff to flow from the hydraulically most remote point of a watershed or drainage area to the point of interest or watershed outlet. The most remote point is the point from which the time of runoff is the greatest. Thus, the T_C is the maximum time for water to travel through the watershed, which is not always the maximum distance from the outlet to any point in the watershed.

UNIFORM FLOW - flow characteristic in which the flow rate and depth remain constant along the length of the channel reach.

WASH - is a natural watercourse which is essentially undisturbed by development.

WATERCOURSE - is a naturally occurring river, riverine, stream, creek, wash, lake or other body of water or channel consisting of banks and bed through which continuous or periodic flows occur. This may include any depression serving as a conveyor of stormwater.

WATERSHED - the catchment area for rainfall which is delineated as the drainage area producing stormwater runoff to a given point. It is assumed that the base flow in a stream also originates from the same area.

WEIR - is a depression or notch in the side or top of an outlet structure or a depression of specific shape in the embankment of a stormwater detention facility. Weirs are classified in accordance with the specific shape of the notch such as rectangular, V-notch, trapezoidal, parabolic, or proportional.

CHAPTER 1: INTRODUCTION

1.3. USE OF THIS MANUAL

The policies, design criteria, and procedures presented in this manual are to be utilized in the preparation of drainage reports, flood studies, grading and drainage plans, and public improvement plans required by the City of Flagstaff.

The use of this manual is intended to act as guidance to the policies and design criteria specific to the City of Flagstaff. There is no intent to inhibit sound innovative engineering design or use of new techniques, procedures, or data.

It is the responsibility of the registrant ~~design engineer~~ to utilize proper engineering judgement when applying any procedure or criteria contained in this manual to a specific site or condition.

This manual is dynamic in nature and shall be periodically reviewed and updated to keep it up-to- date with new legal and technical developments in the field of stormwater management. It is the intent of the City of Flagstaff to periodically issue revisions to this manual which incorporate new data, methods, criteria and such other information as may be deemed appropriate.

Use of this manual does not supersede the need for acquiring various permits or authorizations required by the Federal Emergency Management Agency, Environmental Protection Agency, U.S. Army Corps of Engineers, State of Arizona, Coconino County, or the City of Flagstaff.

CHAPTER 2: DRAINAGE REPORTS AND PLANS

2.1. DRAINAGE REPORT REQUIREMENTS

Drainage reports will be required for the following land development activities:

1. Residential, commercial, and industrial subdivisions.
2. Application for rezoning.
3. Any multi-family residential, commercial, or industrial development; parking lot; or park.
4. Public improvements involving new streets, culverts, storm drains, open channels, and private/public detention facilities or other drainage infrastructure.
5. Application for Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR) to the Federal Emergency Management Agency (FEMA).

A drainage report may also be required for application for a building permit, floodplain use permit, or grading permit if site conditions warrant or if drainage dictates the development of the site.

Drainage reports submitted to the City for review and approval shall be prepared and sealed by an Arizona ~~Registered Professional Civil Engineer.~~Qualified Registrant at a minimum. An Arizona Professional Engineer is required to prepare all:

1. Flood Studies,
2. Drainage reports for detention facilities. This does not include retention facilities.
3. Drainage reports for subsurface hydraulic routing, excluding:
    a. Lateral subsurface piping connections of building roof or gutter downspouts,
    b. Single segment drop inlets to retention basins,
    c. Retention basin outlet piping, including basin outlet orifice calculations.
    d. Other Piping not used for peak flow conveyance and solely used for ponding drain requirements. Example – Underdrains.

2.1.3. Drainage Report Content and Format

Drainage reports shall contain the following information, at a minimum, and shall be presented in the format outlined below:

1. Cover Sheet
   - Title of report.
   - Date of report completion/submittal and any revisions.
   - Project name, address, and COF File number.
   - Name, address, and phone number of client.
   - Name, address, and phone number of ~~engineering~~ firm responsible for report.
   - Seal/signature of the Arizona Qualified Registrant ~~Registered Professional Civil Engineer~~ responsible for preparing the report.

2. Table of Contents
   - All report pages shall be numbered sequentially including any appendices.
   - List of all tables and illustrations.
   - Table of contents sealed by ~~responsible engineer~~Qualified Registrant.

3. Introduction
   - Location map showing the project in relation to adjacent properties, streets, and nearby watercourses.
   - Legal description of subject property (can be placed in Appendix if too lengthy).
   - Description of the existing and proposed land use/project, drainage patterns, natural watercourses, drainage problems, and floodplain status within the development.
   - Summary of any previous hydrologic/hydraulic studies or other information which pertain to the development.
   - Description of potential impacts both upstream and downstream.
   - Effect of proposed construction on major drainage conveyances.

4. Objectives and Procedures Section
   - Brief summary of the purpose of the report in relation to the project (e.g., rezoning, Preliminary plat, subdivision, commercial development, etc.)
   - Description of the methodologies, assumptions, and procedures used in preparing the report.
   - Description of all applicable development standards, policies, detention requirements, and floodplain regulations to which the proposed development must adhere.

5. Hydrology Section
   - Drainage maps (drawn to scale) for pre and post-development conditions which clearly depict contributing watersheds, sub-basins, concentration points, flow patterns, measured flow lengths, elevations, and contours.
   - Hydrologic data sheets, for both pre and post-development conditions, for each concentration point including time of concentration calculations, rainfall intensities, runoff coefficients or curve numbers, and peak discharges.
   - Pre and post-development hydrology.
   - Summary table listing all concentration points, corresponding drainage areas, calculated peak discharges for pre and post-development conditions, and differences in discharges.

6. Hydraulics Section
   - Open channel design and capacity computations in accordance with the policies and criteria outlined in Chapter 4.
   - Design computations for all culverts in accordance with the policies and criteria outlined in Chapter 5.

- Design computations for all storm drains, inlets, and street sections in accordance with policies and criteria outlined in Chapter 7. Storm drain design shall include a labeled schematic of storm drain network, design discharges, pipe capacities, profiles, outlet velocity, and hydraulic grade line.
- All supporting data, printouts, tables, nomograph, etc., which are referenced in report.

7. Detention Design Section
   - Site plan (to scale) which clearly shows dimensions and locations of all proposed development and detention system(s) including but not limited to the following:
     a. Location, size, and type(s) of inflow and outflow structures.
     b. Location and size of access and maintenance access ramps and roadways, if applicable.
     c. Boundaries of Common Areas or private drainage easements, if applicable.
     d. Maximum water surface elevations, limits of ponding, and typical facility cross-section(s).
     e. Flow arrows, drainage divides, contours, and finished grades.
     f. Roof drainage direction(s) and finish floor elevations of all buildings.
   - Description of how the overall detention design will comply with grading criteria, resource preservation, and landscaping requirements.
   - Description of maintenance schedule and responsibility.
   - Detention volume estimate computation(s).
   - Detailed reservoir-routing calculation sheets for all required design storms.
   - Plotted inflow and outflow hydrographs (preferably superimposed).
   - If retaining walls are utilized, include free-body diagrams showing all forces, moments and computations required for determining factors of safety against sliding and overturning.

8. Summary and Conclusions
   - A brief summary of the analyses and conclusions presented in the report.
   - A brief description of how the proposed development and/or public improvements will adhere to applicable stormwater detention and/or floodplain regulations and mitigate any impacts created by the development.

9. References
   - Provide a listing of pertinent sources of analysis and design procedures used.

10. Appendices
    - Appendices may be used for hydrologic, hydraulic, reservoir-routing calculations, etc., and other material not suited for inclusion in the main body of the report.

2.3. GRADING AND DRAINAGE PLANS

Grading and Drainage plans, prepared and sealed by an Arizona ~~Registered Civil Engineer~~ Qualified Registrant, are required for the following land development activities:

1. Residential, commercial, and industrial subdivisions.
2. Any multi-family residential, commercial, or industrial development; parking lot; or park.
~~3. Public improvements involving new streets and/or drainage facilities.~~
~~4. Application for CLOMR or LOMR.~~
~~5~~3. Application for grading permit.

Grading and Drainage plans, prepared and sealed by an Arizona Professional Engineer are required for the following land development activities:
1. Public improvements involving new streets and/or drainage facilities.
2. Application for CLOMR or LOMR

Grading and drainage plans may also be required by the Stormwater Manager or Building and Safety Director for building permit or floodplain use permit applications if site conditions warrant.

The ~~engineer~~ registrant shall submit one reproducible (mylar) copy of the approved grading and drainage plan(s) as permanent public record.

2.3.1. Grading and Drainage Plan Requirements

Grading and Drainage Plans shall include the following information at a minimum:

- Vicinity map including north arrow, scale, boundary lines of site, and other information necessary to locate the development site.
- Name of subdivision or project and COF Project Number.
- Date(s) of preparation and revisions.
- Seal/signature of responsible ~~engineer~~registrant.
- Property lines, lot lines, right-of-way lines of streets, easements, and other rights-of-way, with accurate bearings and distances.
- Existing and proposed contours at 2' intervals. Spot elevations or 1' contour intervals where 2' contours do not show on the property or where needed to depict the grading.
- Floodplain and floodway locations, if applicable.
- Existing and proposed buildings or structures on the property and within 15 feet of the property limits, roof drainage directions, paved and landscaped areas, and dimensions of same.
- Finished floor and grade at foundation elevations of all structures.
- Location, dimensions, elevations, contours, characteristics, cross sections, profiles, and details for all existing and proposed drainage facilities, retaining walls, cribings, and other protective devices.
- Construction notes, specifications, and design details.
- Cross-sections of all open channels and detention basins, including design water surface elevation(s).
- Detention basins which show capacity, discharge(s), spillways, and the 100-year water surface elevation (WSE). Shading of the area inundated by the 100-year WSE is recommended.
- Recommendations included in the soils engineering or engineering geology report incorporated in the plans and/or specifications, if applicable.
- Dates and reference number of the soils report(s) together with the names, addresses and phone numbers of the firm(s) or individual(s) who prepared the report(s).
- Cut slopes no steeper than 2 horizontal (H):1 vertical (V) unless soils report states that the cut slope will be stable and will not create a hazard to public or private property.
- Fill slopes not constructed on natural slopes steeper than 2H:1V unless soils report recommends otherwise. Fill slopes shall not exceed 2H:1V.
- Top of cut slopes no nearer to the site boundary line than one fifth the vertical height of cut with a minimum of 2 feet and a maximum of 10 feet.
- Toe of fill slope(s) no nearer to the site boundary line than one half the height of the slope with a minimum of 2 feet and a maximum of 20 feet.
- Erosion control measures for all cut and fill slopes. (Note: referencing the landscape plan does not meet this requirement).
- Detention facility design details and cross-sections.
- Cut and fill quantities.
- Limits of grading or disturbance.
- Established benchmark of known elevation to which every other elevation is referenced.
- Horizontal control.
- Landscape Designer review block with signature.
- The ~~engineer~~ registrant must review and sign the landscape plan for potential conflicts with grading and drainage plan.
- The following statement is required on all grading & drainage plans:

"Adequate drainage, erosion and sediment control measures, best management

practices, and/or other stormwater management facilities shall be provided and maintained at all times during construction. Damages to adjacent property and/or the construction site caused by the contractor's or property owner's failure to provide and maintain adequate drainage and erosion/sediment control for the construction area shall be the responsibility of the contractor and/or property owner."

2.5. QUALITY OF SUBMITTALS

All drainage report and plan submittals presented to the City of Flagstaff for review shall be prepared and sealed by an Arizona Registered Professional ~~Civil Engineer~~per Sections 2.1 and 2.3.

The ~~engineer~~ registrant shall be held solely responsible for the correctness and adequacy of all data, drawings, calculations, and reports submitted to the City for review and approval. In addition, the ~~engineer~~ registrant shall comply with all local, state, and federal floodplain regulations in the design of a development.

The Engineering Division will review drainage report and plan submittals for completeness and general compliance with all applicable local, state, and federal requirements. Approval by the City does not necessarily imply that the design is appropriate, nor that the development is in strict compliance with all applicable regulations and standards. Review and approval of drainage submittals shall not create liability on the part of the City or its employees for any flood damages that may result from reliance upon any administrative decision made by the City or its employees. When design procedures, equations, and data not included in this manual are used, the engineer must provide the City enough information on the methods and data to enable City staff to evaluate their applicability.

CHAPTER 3: HYDROLOGY

This chapter provides an overview of urban hydrologic methods and procedures used in the City of Flagstaff. The information presented herein is intended to provide the registrant~~design engineer~~ with guidance to the methods and procedures, their data requirements, and their applicability and limitations. Most of these methods and procedures can be applied using commonly available computer programs.

Rational Runoff Coefficient

Perhaps the most important variable in the Rational Equation is selection of the dimensionless runoff coefficient (C) which represents that fraction of rainfall that appears as surface runoff from a tributary area. This fraction of rainfall runoff is independent of rainfall intensity or volume for impervious areas, such as streets, rooftops, and parking lots. However, for pervious areas, the fraction of runoff varies with rainfall intensity and the accumulated volume of runoff. Therefore, the selection of a coefficient that is appropriate for the storm, soil type, slope, and land use conditions is critical. The ~~design engineer~~registrant should always document how and why a particular runoff coefficient
was chosen. Thought should also be given to future changes in land use that might occur during the service life of the proposed drainage facility which can result in an inadequate drainage system.

Runoff coefficients based on surface type can be found in Table 3-4. Runoff coefficients based on land use, slope, and soil type are to be chosen from Table 3-5. The Hydrologic Soil Groups (HSG) used in Table 3-5 were developed by the Soil Conservation Service (now the Natural Resources Conservation Service) based on infiltration rates and are described as follows:

Group A - Soils having low runoff potential due to high infiltration rates even when thoroughly wetted. These soils consist primarily of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.3 in/hr).

Group B - Soils having moderate infiltration rates when thoroughly wetted and consist primarily of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of transmission (0.15 - 0.30 in/hr).

Group C - Soils having low infiltration rates when thoroughly wetted and consist primarily of soils with a layer that impedes downward movement of water and soils moderately fine to fine textures. These soils have a low rate of water transmission (0.05 - 0.15 in/hr).

Group D - Soils having high runoff potential. They have very low infiltration rates when thoroughly wetted and consist primarily of clay soils with high swelling potential, soils with permanently high water tables, soils with a claypan or clayey layer at or near the surface, and shallow soils over nearly impervious parent material. These soils have a very low rate of water transmission (0 - 0.05 in/hr).

HSG soils textures can be classified as:

A - Sand, loamy sand, or sandy
loam B - Silt loam or loam
C - Sandy clay loam
D - Clay loam, silty clay loam, sandy clay, silty clay, or clay

CHAPTER 11: EROSION AND SEDIMENT CONTROL

11.1. POLICIES

a. The effects of erosion shall be considered in the location and design stages of new development, since erosion can be controlled to a considerable degree by geometric design particularly relating to cross-section.

b. The level of effort by the ~~engineer~~ designer and use of erosion control measures shall be commensurate with the potential for erosion.

c. On-site erosion control measures shall be applied to reduce the gross erosion (e.g., gullies or rilling) and sediment transport from the site.

d. Sediment control shall be used whenever possible or necessary, to prevent offsite damage or sediment deposition on public streets.

e. Special consideration shall be given to the maintenance of existing and proposed vegetative cover on areas of high erosion potential such as erodible soils, steep slopes, drainageways, and banks of streams.

f. Storm Water Pollution Prevention Plans (SWPPP) are required for any land disturbing activity between one (1) and five (5) acres. Developers are responsible for complying with NPDES Phase I requirements for land disturbing activities greater than 5 acres. ~~SWPPP's should be prepared by an engineer.~~