Section 81. Stormwater Planning and Design:

A. STORMWATER MANAGEMENT GOALS: In order to ensure protection of the general health and welfare of the citizens of the City of Nixa, planning and design of stormwater management measures shall meet the following:

1. Prevent damage to residential dwellings and other building structures from flood waters.

2. Maintain emergency vehicle access to all areas during periods of high water.

3. Prevent damage to roads, bridges, utilities, and other valuable components of the community's infrastructure from damage due to flood waters and erosion.

4. Prevent degradation of surface and ground water quality from stormwater runoff; preserve and protect quality of the environment; and promote conservation of the City's natural resources.

5. Minimize flood water and erosion damage to lawns, recreational facilities, and other outdoor improvements.

6. Minimize traffic hazards from runoff carried in streets and roads.

7. Comply with applicable State and Federal laws and regulations.

8. Meet the foregoing goals in a manner which is cost effective and which minimizes the cost of housing and development while encouraging sound development.

9. Encourage innovative and cost effective planning and design of stormwater management facilities.

10. Encourage multiple purpose design of stormwater management facilities, to provide opportunities for recreational use, and other benefits to the community wherever possible.

The standards and criteria set forth herein provide the minimum standards for planning and design of stormwater facilities. Where a particular plan or design may be found to be in conflict with a specific standard, achievement of the goals set forth above will have precedence.

B. GENERAL PLANNING AND DESIGN PRINCIPLES: The City of Nixa recognizes that stormwater management is an important component of overall land use planning.

The City of Nixa further recognizes that proper stormwater planning significantly reduces the long term costs to the community both in terms of infrastructure cost and property losses due to flood damage. It is much more cost effective to prevent flood damage by proper design and construction, than to repair and remediate problems which have occurred through poor planning and design.

The following general principles must be followed in preparing the grading and storm drainage plans for all development sites.

1. Recognize the existing drainage systems. The storm drainage system differs from other utility systems in very important ways:

    a. There is an existing natural drainage system.

    b. It is only needed when runoff occurs.

    c. The capacity of the system varies greatly depending on the amount of rains.

    d. The system does not have to be constructed of man-made components in order to function.

Because of these characteristics, there has been a historic inclination for fragmented planning and design of storm drainage facilities. Proper planning of storm drainage facilities must begin with the recognition of the existing system, and include necessary provisions for preserving or altering the existing system to meet the needs of proposed development or construction. Methods of delineating existing watercourses are outlined under Stormwater Runoff Calculations.

2. Allow for increase in runoff rates due to future urbanization: As areas urbanize, peak rates of runoff increase significantly. The City of Nixa may require temporary detention and storage of increased volumes of urban runoff in order to minimize increases in flow rates as urbanization occurs. However, the cumulative effects of on-site detention are difficult to predict and control, and development of comprehensive basin-wide runoff models to determine these effects does not appear likely in the foreseeable future.

For this reason, design of storm drainage improvements must be based upon the assumption of fully urbanized conditions in the area under consideration. No reduction allowed in peak flow rates due to detention, unless an approved runoff model has been developed for the drainage basin under consideration. Any detention storage facilities, whose effects are considered, must be located within approved drainage easements.

3. Provide for acceptance of runoff from upstream drainage areas: It is critical that provisions must be made to receive runoff from upstream drainage areas. Drainage easements or public right-of- way must extend to a point where the upstream drainage areas is no greater than 5 acres. Drainage easements or public right-of-way must extend to the point where existing watercourses enter the site. Where the upstream drainage area is 5 acres or greater, but does not discharge onto the site through a defined watercourse, the drainage easement shall extend to the point of lowest elevation.

4. Provide a means to convey runoff across the site: Stormwater shall be conveyed across the site in a system of overland drainageways and storm sewers. Overland drainageways consists of streets, open channels, swales, and overland flow within drainage easements.

5. Discharge of runoff to downstream properties: Concentrated runoff shall be discharged only into existing watercourses, drainage easements, or public road rights-of-way. Where none of these exist, a drainage easement which extends to the nearest watercourse, drainage easement or public road right-of-way must be obtained from the downstream property owner, and proper provisions made for conveyance of the peak flow from the 4 percent Annual Probability storm within the drainage easement.

One of the typical results of urbanization is that diffuse surface flow or "sheet flow" is replaced with concentrated points of discharge. Where concentrated flows are discharged to downstream properties proper provisions must be made to:

a. Allow the flow to spread over the same area as would have occurred for the same rate of flow prior to the development, and

b. Reduce the rate of velocity to rates at least equal to the predevelopment values at the same rate of flow.

6. Assess potential downstream flooding problems: It is important that a determination be made of conditions in the watershed downstream of each development site to determine whether there are existing structures which are subject to an unacceptable flooding hazard (10 percent annual probability or greater).

If areas having an unacceptable flooding hazard occur downstream of a development site, either on-site detention for peak flow control, or mutually agreed off-site improvements will be required, as set forth in Part V Detention.

7. Assess potential water quality impacts on receiving water: Sediment, erosion and other water quality controls are required as set forth in the Detention Section.

8. Provide for operation and maintenance of drainage facilities.

C. THE MAJOR-MINOR STORM APPROACH: The amount of water that the storm drainage system must carry varies greatly depending upon the amount of precipitation which may occur. The degree of flooding protection desired and the cost of providing that level of protection must be balanced against the risk and potential costs to life and property. The City of Nixa recognizes that it is neither cost effective nor necessary to require construction of a conveyance system for large infrequent floods in all cases.

Design of storm drainage systems can be made much more cost effective while providing desired levels of property protection by taking a major-minor storm approach to design of drainage facilities.

1. Major storm: The major storm is defined as a storm with an annual probability of 4 percent (a "25-year storm"). The combination of all overland and underground conveyance systems shall have sufficient capacity to convey the peak flow from the major storm without resulting in flooding of any new building structures, and without exceeding maximum flooding depths in streets necessary to allow passage of emergency vehicles.

It is recommended that the floor elevations of all new structures be located at least 1 foot above the estimated high water elevation resulting from the peak flow from the 4 percent annual probability storm.

2. Minor storm: The minor storm is defined as a storm with an annual probability of 20 percent (a"5-year storm"). Inlets and storm sewers must have sufficient capacity to maintain acceptable flooding depths in street and road rights-of-way during the minor storm as required in “Drainage of Streets & Roadway“ Section.

D. DRAINAGE EASEMENTS: All areas subject to inundation during the major storm must be included in drainage easements, Specific standards for drainage easements to be provided for storm sewers, open channels, and detention facilities are set forth under Storm Sewers; Open Channels; and Detention Facilities respectively.

Section 82. Storm Water Runoff Calculations.

This section outlines acceptable methods of determining storm water runoff.

A. GENERAL GUIDELINES: For watersheds with a total tributary area less than 200 acres and a one percent annual probability fully developed discharge less than 300 cfs, the design storm runoff may be analyzed using the rational formula. For watersheds with a total tributary area greater than 200 acres or with a one percent annual probability fully developed discharge greater than 300 cfs, the design storm runoff shall be analyzed using an approved hydrographic method.

B. RATIONAL FORMULA: The rational formula, when properly understood and applied, can produce satisfactory results for urban storm sewer design. The rational formula is as follows:

$$Q = CIA$$

Where: Q = Peak discharge in cubic feet per second
C = Runoff coefficient which is the ratio of the maximum rate of runoff from the area to the average rate of rainfall intensity for the time of concentration.
I = Average rainfall intensity in inches per hour for a duration equal to the time of concentration.
A = Contributing watershed area in acres.

The basic assumptions made when applying the rational formula are:

1. The rainfall intensity is uniform over the basin during the entire storm duration

2. The maximum runoff rate occurs when the rainfall lasts as long or longer than the basin time of concentration.

3. Runoff response characteristics are relatively uniform over the entire basin.

4. The time of concentration is the time required for the runoff from the most hydraulically remote part of the basin to reach the point of interest.

The drainage basin should be divided into sub-basins of a size where all of the basic assumptions apply.

C. TIME OF CONCENTRATION:

Time of concentration, tc, is calculated by:

tc	=	ti where
ti	=	initial, inlet or overland flow times in minutes,
tt	=	shallow channel and open channel flow time in minutes

Overland flow (sheet flow) time shall be calculated as:

$$ti = \frac{(n \times l)^{0.8}}{4.64 \times s^{0.4}}$$ where

ti	=	initial, inlet or overland flow times in minutes,
n	=	Manning's n for sheet flow (from the following table)
L	=	Overland flow length in feet, (maximum 300 feet)
S	=	Slope of feet per foot

Roughness coefficients (Manning's n for sheet flow

D. SURFACE DESCRIPTION:

Smooth surfaces (concrete, asphalt, gravel or bare soil)............................0.011

Fallow (no residue)..0.05

Cultivated soils:
- Residue cover less than or equal to 20 percent................................ 0.06
- Residue cover greater than or equal to 20 percent............................ 0.10

Grass:
- Short grass prairie... 0.15
- Dense Grasses*...0.24
- Bermuda Grass.. 0.41

Range (natural).. 0.13

Woods: **
- Light underbrush.. 0.40
- Dense underbrush... 0.80

* Includes species such as weeping lovegrass, blue grass, buffalo grass, glue grama grass and native grass mixtures.

** When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

Shallow channel velocities may be estimated from Figure 3-1 in Reference 11.

Open channel flow velocities may be estimated from Manning's equation. Open channel velocities are generally estimated under bank full conditions.

The basin time of concentration calculation techniques are described in detain in TR-55, Chapter 3 (Reference 11).

E. HYDROGRAPHIC METHODS:

Methodologies. The most common hydrographic techniques are those developed by Corps of Engineers and the Soil Conservation Service. These methods are preferred; however other proven techniques will be accepted.

The Corps of Engineers HEC-1 Flood Hydrographic Package (Reference 18) and Soil Conservation Service TR-55 computer models (Reference 11) are the preferred runoff models. Other models may be used with approval from the City Planner.

The runoff model must include the entire drainage basin upstream of the proposed development. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate.

The runoff model shall be developed for the following cases:

Case 1: Existing conditions in the drainage basin prior to development of the applicant's property.

Case 2: Existing conditions in the drainage basin with developed conditions on the applicant's property.

Case 3: Fully developed conditions in the entire drainage basin.

F. RAINFALL: Rainfall depth-duration-frequency and intensity-duration-frequency curves for the Nixa area are included in the Standard Drawing Section of this document. The design rainfall intensities were developed from the U.S. Department of Commerce, National Weather Service, Technical Paper 40 (Reference 19) and the National Oceanic and Atmospheric Administration Publication "HYDRO-35" (Reference 9).

Rainfall shall be distributed in time using the SCS Type II distribution (Reference 11) or the Pilgrim-Cordery Distribution adapted to local rainfall data (References 20 and 21) as shown in the following table. Other distributions may be used upon approval from the City Planner.

PILGRIM-CORDERY METHOD SYNTHETIC RAINFALL MASS CURVES

Cumulative
Fraction of

Storm Duration Cumulative Fraction of Storm Duration

	1-Hour	2-Hour	3-Hour	4-hour	6-Hour
.00	.00	.00	.00	.00	.00
.05	.03	.03	.03	.02	.05
.10	.07	.05	.05	.03	.09
.15	.11	.10	.06	.05	.14
.20	.14	.17	.09	.06	.20
.25	.17	.22	.11	.08	.28
.30	.23	.25	.13	.14	.35
.35	.29	.27	.19	.20	.41
.40	.35	.29	.31	.27	.43
.45	.41	.30	.39	.33	.46
.50	.47	.31	.44	.38	.49