STORMWATER MANAGEMENT POLICIES AND DESIGN CRITERIA

FOR THE

CITY OF

McPHERSON

KANSAS

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INTRODUCTION

This document covers policies and design procedures for stormwater management in the City of McPherson. The primary goal of stormwater management from a quantity standpoint is to provide stormwater conveyance in such a manner that life and property are protected and that reasonable emergency access is provided during major storm events. Secondary goals address erosion control, maintenance of the stormwater system and aesthetic considerations.

Stormwater management must address the existing capacity of the infrastructure, the potential for flooding based on current land use and the necessary controls for future development. Uniform policies and procedures for planning, designing and constructing stormwater systems are necessary to achieve the overall management goals.

The stormwater management process begins with an overall assessment of the existing system and addresses the need for major and minor improvements necessary to meet the current needs. The next step is to assess the potential impacts of new development to the system and to outline the controls necessary to protect the investment in the stormwater infrastructure. Finally, procedures and criteria are developed and compiled in a manner that will allow those involved in the planning and design of a new development to meet the requirements of the stormwater management plan and to design their improvements to meet the standards of the City of McPherson.

The following document presents the stormwater policies and design criteria for the City of McPherson from the platting process through the design of stormwater systems. This document is not meant to cover all conceivable situations that may be encountered and is meant to supplement the guidelines already adopted in the City of McPherson subdivision regulations. Design criteria must not consist of rigid or inflexible rules, but shall allow for minor deviations depending upon individual design situations.

No drainage project responsibility begins or ends within the boundary of a particular subdivision. Each solution to a drainage problem must be reviewed to determine its affect upon adjacent and downstream lands and general conformance with established storm drainage patterns and systems.

It is recognized that development has resulted in increasing peak flows above historic (pre-development) conditions, and this has, in many instances, overloaded existing storm water conveyance facilities and adversely impacted downstream property. The intent of this policy is to limit peak flows to historic 10-year values and to safely convey the 100-year flows.

Drainage must be considered at several points during the development process, Figure I-1. Typically, drainage is first addressed during the platting process. Drainage reports that address conveyance of off-site drainage, increase in runoff due to development and drainage easement requirements must be submitted with the preliminary plat. Following the guidelines in this document under Sections 200, 300, 400 and 500 will address the drainage information necessary to comply with the City of McPherson's:

Subdivision Regulations (1997)

- Article 5, Section 100 – C.3 and C.4,
- Article 6, Section 111 – B
- Article 7, Section 102 – B

Zoning Regulations

- Section 3-105 Site Plan Approval
- Section 4-117 F-P Floodplain District

Drainage is again addressed when the development infrastructure is designed. In some cases where development is planned, the platting process may already have occurred prior to the creation of this document, or the existing drainage report may be out of date. In those instances, a new drainage report will be required. The design criteria necessary to complete uniform design of stormwater systems is addressed under Section 600 of this document.

Finally, drainage must be addressed as each individual site is developed. During the site design, the engineer must adhere to the drainage parameters outlined in the approved drainage report for the associated subdivision as well as the design of the storm drainage system that serves the site. Design of specific elements of the on-site system must follow the applicable sections of Section 600 of this document. If no existing drainage report covers the site, a report following the guidelines of Sections 200-500 of this document will be required by the City Engineer.

There are six actions which typically precede any legal development within the City of McPherson. These are: Platting; Zoning Permit Request; Site Plan Submittal; Building Permit Request; Petition for Public Improvements; and Floodplain Development Permit Request. Specific drainage report requirements are covered in detail in Section 200. The following flow chart, Figure I-1, indicates the steps that must be taken prior to development for any of the six actions listed above.

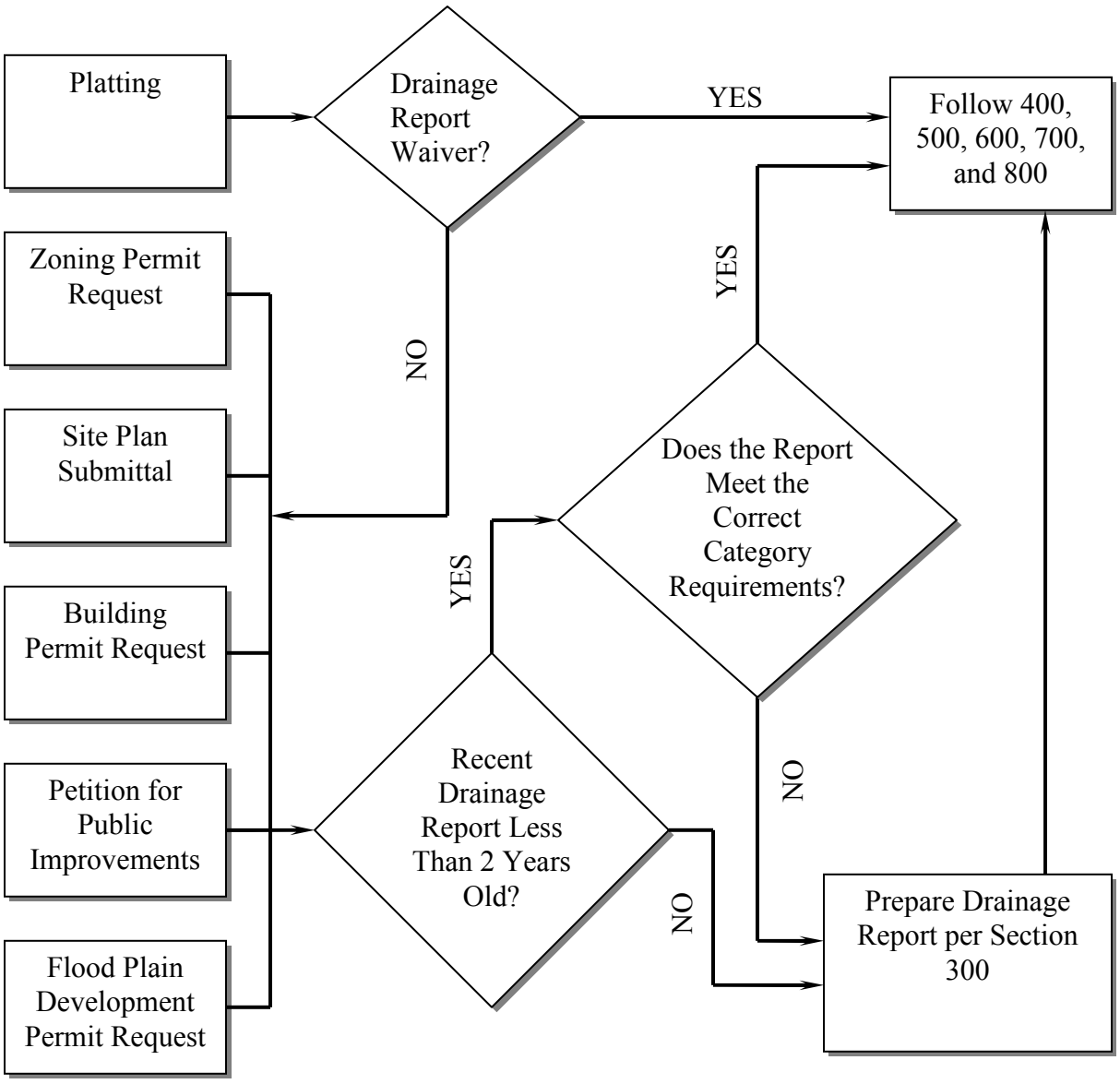


Figure I-1
Drainage Report Requirement Flowchart

SECTION 100
GENERAL DESIGN REQUIREMENTS / OVERVIEW

110 Design

Drainage design in the City of McPherson shall conform to generally accepted engineering practices, and shall be prepared under direction of a Registered Professional Engineer licensed to practice in the State of Kansas. The design data shall be submitted to the City Engineer for approval before any storm sewer system can be constructed.

Requirements set forth by the City of McPherson Subdivision Regulations, shall also be considered in the design and submittal of any plat. Any requirements set forth by the Subdivision Regulations shall also be included for the approval process. Any deviations from these two policies shall be approved by the City Engineer.

Stormwater runoff shall generally be carried in a storm drainage system on the basis of the criteria established in this report and is subject to final determination and approval of the City Engineer. The design shall be based on land use in the tributary area as zoned, actual development, or as indicated by the City's current comprehensive land use plan, whichever basis produces the greatest amount of runoff.

Open or enclosed drainage systems, consisting of pipes, concrete boxes, natural or improved channels or swales may be used to convey stormwater. Enclosed systems consisting of pipes, reinforced concrete boxes or other approved structures shall be used where: the design peak discharge of a 10 year design storm can be contained in a 48 inch RCP or less (n = 0.012); the storm sewer is within the right-of-way of a platted street; or the design peak discharge of a 10 year design storm is greater than 5 cfs.

120 Design Storms

Elements of the storm sewer system shall be designed for the following return frequencies:

Table 100
Design Storm Requirements

System Type	Design Storm
Storm Sewers and Structures under minor streets	10 year
Structures under major streets	50 year
Channels	100 year
Overflow channels and swales	100 year

130 Overflow

All drainage systems shall be designed so as to convey the excess flow above the design storm. The overflow system shall have the capacity to convey the flow from the 100-year design storm with one foot of freeboard. The flow from the 100-year design storm shall not extend beyond the limits of the right-of-way or drainage easements.

The 100-year design storm overflow for any structure crossing a street shall not exceed a depth of 6 inches measured at the crown of the street.

140 Detention

Detention or retention shall be provided to limit downstream discharge to not more than the historic undeveloped 10 year flow or to some lesser value where downstream problem areas have been identified by the City Engineer or the current *Stormwater Management Policy*; where development will increase downstream problems; where development will overload an existing storm sewer system, or in conformance with a basin-wide drainage management plan. Section 660 provides more detail on detention design.

In general, the objective is to limit downstream flows to values equal to or less than than historic 10 year flow.

SECTION 200
STORMWATER
INFORMATION
REQUIREMENTS

210 General

As discussed briefly in the Introduction, there are six actions which typically precede any legal development within the City of McPherson. These are: Platting; Zoning Permit Request; Site Plan Submittal; Building Permit Request; Petition for Public Improvements; and Floodplain Development Permit Request. At each of these points, sufficient information must be prepared which will allow the City Engineer to review and determine if stormwater will be conveyed in a manner that life and property are protected and that reasonable emergency access is provided during major storm events.

Category "A", "B", and "C" drainage reports shall be submitted to the McPherson City Planning agency and Public Works and must be signed and sealed by a Professional Engineer, licensed to practice in the State of Kansas. Category "D" drainage reports shall be submitted to Public Works, and are not required to be prepared by a Professional Engineer. Drainage reports shall fall under one of the following categories. Information shall be presented in a report format with attachments as required.

220 Category "A"

The minimum requirements for Category "A" shall be used if one of the following applies:

- The subject development covers an area that is presently unplatted.
- No drainage report was submitted with original plat or site development plan.
- The original drainage report is more than two years old.
- The proposed land use varies from the original plat, zoning, or site development plan.
- A site is being redeveloped, substantially altering its existing configuration or use.

230 Category "B"

The minimum requirements for Category "B: shall be used if ;

- The subject development is in an area covered by a previous drainage report where conditions have not substantially changed, or
- The subject development is in an area that is covered by an existing, comprehensive drainage study or stormwater management plan.

240 Category "C"

Category "C" covers lot splits and minor replats of areas covered by recent drainage reports.

250 Category "D"

Category "D" covers single family or duplex development.

260 Drainage Report Exemptions

If a property is being replatted for the purpose of changing setback lines or easements other than drainage easements, the City Engineer may waive the drainage report requirements.

SECTION 300
DRAINAGE REPORTS

310 Category "A" Drainage Report – Minimum Information Required

1. Development Data

   A. Location of tract using street names, adjacent subdivisions, landmarks and other features.

   B. Size of the proposed development, in acres.

   C. General description of the existing tract and the surrounding topography, including cover, existing development and other prominent features.

   D. Detailed description of the proposed development.

2. Watershed Data

   A. Existing Waterways – The report shall discuss existing systems and address the following:

      (1) Does water enter the development from off site: If so, how – streams, channels, storm sewer, overland flow, etc and what are the peak flows?

      (2) Does water currently leave the proposed development? If so, how and where and what are the peak flows?

      (3) Is any of the proposed development covered by a FEMA map?

   B. Existing Hydrological Data – Discuss areas, lengths, times of concentration, runoff factors and intensities, and determine 10 year and 100 year flows and 50 year flow when applicable (Section 120). This shall be done for off-site flows tributary to the site and for on-site flows. The Rational Formula may be used for areas of less than 320 acres; HEC-1, TR-20, TR-55 or any other recognized computer model may be used for areas greater than 320 acres. Show calculations for T_c and break into homogeneous sections, i.e. overland flow, gutter flow, pipe flow, etc. Note any drainage reports covering adjacent developments and, if possible, incorporate information and flow calculations form those reports.

   C. Future Hydrological Data – Calculate and discuss parameters noted in 2.B. for the future conditions, including areas upstream from the proposed development if appropriate.

   D. Hydraulic Discussion – Compare historic flows to future flows and calculate the difference and discuss in detail the following:

      (1) What is the increase in discharge from the site?

      (2) For each location where runoff is discharged, will the downstream system handle the increase?

a. If analysis determines that the downstream system is inadequate, give preliminary detention details.

b. Is detention required based on an existing stormwater management study or an area wide drainage plan?

(3) Will runoff discharge into unplatted private property or an area not covered by drainage easements? If so, indicate how drainage agreements will be handled.

(4) Discuss methods of conveying stormwater across the proposed development:

a. Channels – If channels are involved, the information shall be presented in accordance with the criteria outlined in Section 400 Channel Report Requirements.

b. Storm Sewers – Show preliminary storm sewer layouts. At appropriate points, calculate flows and show preliminary pipe sizes and size overflow swales. Determine necessary easement widths.

c. Minimum openings – If channels or overflow swales are involved, calculate the 100 year water surface profile and indicate which lots should be covered by minimum opening elevations and calculate those elevations.

3. Conclusions

Briefly summarize the impact of development, whether any problems exist or will exist after development and whether detention, retention, or any other structural control will be necessary, and demonstrate how 10 year discharge will not exceed historic peak flows.

4. Category "A" Required Exhibits

(1) Preliminary plat, development plan or site plan with contours and suggested drainage easements.

(2) Figure showing all existing drainage areas including those adjacent to the development that drain into the subject area.

(3) Figure showing future drainage areas due to development of the tract.

(4) Preliminary plans or other exhibit showing proposed storm sewer system alignment, sizes, channels, detention ponds, outlets, etc.

(5) Existing and proposed topography. Existing topography shall extend not less than 50 feet beyond the property that is the subject of the report.

320 Category "B" Drainage Report – Minimum Information Required

1. Development Data

   A. Location of tract using street names, adjacent subdivisions, landmarks and other features.

   B. Size of the proposed development, in acres.

   C. General description of the existing tract and the surrounding topography, including cover, existing development and other prominent features.

   D. Detailed description of the proposed development.

2. Previous Drainage Reports

   A. Note the development name, date and engineer for the previous drainage report.

   B. Compare the proposed development to the development anticipated for the same area in the original report. Compare runoff factors and future discharges.

   Note: ***If the report covers an area that is basically the same as that covered in the original report, then reference may be made to the applicable portions of the original drainage report. If substantial changes are made (different channel locations, more intense development, etc.), then each item shall be discussed in detail.***

   C. Hydraulic Discussion – Discuss in detail the following:

      (1) What is the increase in discharges from the site?

      (2) For each location where runoff is discharged, will the downstream system handle the increase?

         a. If analysis determines that the downstream system is inadequate, give preliminary detention details.

         b. Is detention required based on an existing stormwater management study or an area wide drainage plan?

      (3) Will runoff discharge into unplatted private property or an area not covered by drainage easements? If so, indicate how drainage agreements will be handled.

(4) Discuss methods of conveying stormwater across the proposed development:

a. Channels – If channels are involved, the information shall be presented in accordance with the criteria outlined in section 400 *Channel Report Requirements*.

b. Storm Sewers – Show preliminary sewer layouts. At appropriate points, calculate flows and show preliminary pipe sizes and size overflow swales. Determine necessary easement widths.

c. Minimum Openings – If channels or overflow swales are involved, calculate the 100-year water surface profile and indicate which lots should be covered by minimum opening elevations and calculate those elevations.

3. Conclusions

Briefly summarize the impact of development, whether any problems exist or will exist after development and whether detention, retention, or any other structural control will be necessary, and demonstrate how 10-year discharge will not exceed historic peak flows.

4. Category "B" Exhibits

A. Preliminary plat, development plan or site plan with contours and suggested drainage easements.

B. Copy of previous drainage report(s).

C. Figure showing future drainage areas due to development of the tract if different from previous report.

D. Preliminary street plans or other exhibit showing proposed storm sewer system alignment, sizes, channels, etc., if different from previous report.

E. Existing and proposed topography. Existing topography shall extend not less than 50 feet beyond the property that is the subject of the report.

330 Category "C" Drainage Report – Minimum Information Required

1. Development Data

    A. Location of tract using street names, adjacent subdivisions, landmarks and other features.

    B. Size of the proposed development, in acres.

    C. General description of the existing tract and the surrounding topography, including cover, existing development and other prominent features.

    D. Detailed description of the proposed development.

2. Drainage Discussion / Conclusions

    A. Compare proposed future development to that anticipated by original report.

    B. Discuss any changes in easements, storm sewers, channels, etc. due to the development.

    C. Discuss any drainage restrictions mentioned in the original report that cover the tract (detention, etc.).

3. Category "C" Exhibits

    A. Preliminary plat, development plan or site plan.

    B. Copy of original drainage report.

340 Category "D" Drainage Report – Minimum Information Required

1. Required Data

   A. Location and address of the proposed structure.

   B. Sketch of lot showing property lines, location of structures, location of driveways, public streets and all existing easements.

   C. Proposed minimum opening elevation for proposed structure (finished floor, window well or entrance to walkout basement.

   D. Elevations of top of curb on adjacent public streets at midpoint of lot or flowlines of existing ditch at entrance and exit points on the lot.

   E. Flowline elevations of any drainage structures on or adjacent to the lot.

2. Category "D" Exhibits

   A. Copy of the plat showing the location of the lot.

   B. Drawing showing information noted in 1. above.

350 Drainage Report Waiver – Minimum Information Required

A waiver from the drainage report requirements will only be given if all of the following conditions are met:

1. The only purpose of the request is to change setback lines or non-drainage easements.
2. Only one lot is involved.
3. The outside dimensions of the tract do not change.
4. No further development is proposed for the tract.

Required Exhibits:

1. Preliminary plat or site plan.
2. Signed statement from the engineer or surveyor verifying that conditions A through D apply.

SECTION 400
CHANNEL REPORT REQUIREMENTS

410 Overview

A channel report shall be included as part of a drainage report, where a natural channel exists or a new channel is proposed as part of the development. If platting is involved, the final plat shall reflect the necessary channel easements.

Open channels may be used to convey the large volumes of water across the proposed development. The channel may be either an existing natural channel, a newly constructed (artificial) channel or a combination of the two (modified natural channel). The use of existing, natural channels is preferred over newly constructed channels. A natural channel will require analysis to determine the ability of the channel to convey the increased runoff due to development and the water surface elevations of the 100 year design storm and corresponding easements. An artificial channel will require complete design, based on the developed 100 year design storm. A combination channel may require both analysis and design. Channel requirements are as follows:

420 Natural Channels

The report on the analysis of a natural channel shall contain the following minimum data:

Field Input Data

1. Horizonal location of channel in relation to proposed development, including reach lengths.

2. Cross-sectional and profile information at key locations, including points of restriction, changes in channel width and at critical structure locations.

3. Estimates of roughness coefficients, including floodway and overbank.

4. Starting water surface elevation assumptions.

Flood Analysis Details: (Based on the 100 year design storm)

1. Hydraulic data for both pre and post development conditions.

2. Flows, velocities, water surface elevations and limits of inundations for both pre and post development conditions.

Erosion Analysis Details: (Based on the 5 year design storm)

1. Hydrologic data for the post-development conditions.

2. Flows and velocities for the post-development conditions.

Recommendations

The report shall contain recommendations including the following:

1. Drainage easements based on the areas inundated by the 100 year post-development design storm plus one foot.

2. Minimum structure opening elevations for the proposed lots containing or adjacent to the channel and drainage easement, based on the water surface elevation plus one foot.

3. Recommendations for the treatment of areas prone to erosion.

430 Artificial Channels

The report on the analysis of an artificial channel shall contain the following minimum data:

Analysis Details

1. Horizontal location of channel in relation to proposed development, including reach lengths.

2. Typical cross-sections and profile of channel, information at key locations, including points of restriction, changes in channel width and at critical structure locations, channel lining and location of easements and maintenance access details.

3. Roughness coefficients, flows, velocities and channel depths for the 100 year post development design storm.

4. Flows, velocities and channel depths for the 5 year and 10 year post development design storm.

Additional Requirements

If crossings of the proposed channel are required, the design engineer shall perform a preliminary hydraulic design of the structure. The upstream drainage width determination shall account for any expected backwater effects.

Proposed easements shall be adequate to contain the design storm flow, plus the required freeboard. At crossing locations, easements shall be provided to cover the entire area which is expected to be inundated by backwater due to the design storm flow plus one foot.

Recommendations

The report shall contain recommendations including the following:

1. Drainage easements based on the channel geometry, maintenance access, and 100-year water surface plus one foot.

2. Minimum structure opening elevations for the proposed lots adjacent to the channel and drainage easement, based on the water surface elevation plus one foot.

440 Modified Natural Channels

Natural channels modified to contain the post-development flows, must be analyzed under that same criteria as a natural channel and may also require additional design information. The report shall be presented in the same format as 420 Natural Channels.

450 DWR Requirements

The design engineer shall comply with all applicable Corp of Engineers and Division of Water Resources design criteria and requirements.

SECTION 500
EASEMENT
REQUIREMENTS

510 General

Final plats shall dedicate the proper type and size of drainage easement as necessary to meet the requirements defined by the preliminary plat drainage report. An easement (whether dedicated by plat or granted subsequent to platting) will be required whenever any of the following situations exist:

- Concentrated off-site drainage is conveyed through the development.
- Onsite drainage generates a 100 year storm flow which equals or exceeds 100 cfs, or
- Any public storm drainage system discharges into the plat area.

Easements must be defined on the plat as follows:

- Channel Easement
- Drainage Easement
- Detention Easement

The following standard notes shall be included in the grant of easement or placed on the final plat when the referenced easements are contained on the plat:

CHANNEL DRAINAGE EASEMENT

> "Channel drainage easements shall not be obstructed by any permanent or semi-permanent obstruction. This includes, but is not limited to, trees or shrubs, fences, retaining walls, buildings or other miscellaneous obstructions that interfere with access and egress of maintenance vehicles and equipment or obstruct the flow of water in the channel such that the design conditions are not present. Any permanent or semi-permanent obstruction located in the easement may be removed by personnel representing the City of McPherson to provide for the proper operation and maintenance of the channel without cost or obligation for replacement. Cost of removal and replacement shall be the responsibility of the property owner."

GENERAL DRAINAGE EASEMENT

> "Drainage easements are hereby established as shown to provide for the unobstructed overland flow of surface water and/or the construction and maintenance of pipes, flumes, ditches, or any or all improvements for the drainage of storm runoff. Property owners shall not place any permanent or semi-permanent obstruction in the drainage easement. All maintenance within the general drainage easement (GDE) shall be the right, duty, and responsibility of the property owner(s) of the property in which the easement is so located; however, if maintenance is neglected or subject to other unusual circumstances and is determined to be a hazard or threat to public safety by the Director of Public Works, corrective maintenance may be performed by the governing jurisdiction with costs assessed to and borne upon said property owner(s). Officials representing the Department of Public Works shall have the right to enter upon the easement for purposes of periodic inspection and/or corrective maintenance."

DRAINAGE DETENTION FACILITY EASEMENT

> "Drainage detention facility easements are hereby established as shown to provide for the detention of storm surface water and constructed as approved by the City Engineer. All maintenance within the drainage detention facility easement (DDFE) shall be the right, duty, and responsibility of the property owner(s) of the property in which the easement is so located; however, if maintenance is neglected or subject to other unusual circumstances and is determined to be a hazard or threat to public safety by the Director of Public Works, corrective maintenance may be performed by the governing jurisdiction with costs assessed to and born upon said property owner(s). Officials representing the Department of Public Works shall have the right to enter upon the easement for purpose of periodic inspection and/or corrective maintenance of the facility. Upon receiving written approval from the Department of Public Works, property owner(s) may construct improvements within the easement, provided the improvements do not interfere with the function of the detention facility."

In the event that unusual or unknown circumstances prevent the dedication of drainage related easements and notes, those requirements may be waived by the governing body, the following note needs to be added to the final plat:

> "Prior to issuance of building permits, drainage easements shall be granted to the City of McPherson as may be required by the City Engineer for safe conveyance of stormwater runoff as outlined in the preliminary plat drainage report."

SECTION 600
DESIGN CRITERIA FOR STORMWATER CALCULATIONS

610 Runoff Calculations

The Rational Formula may be used to determine the amount of runoff for any area of 320 acres or less. For areas larger than 320 acres, an approved method, such as TR-55, TR-20 or HEC-1, shall be used to determine the amount of runoff.

The Rational Formula is defined as:

$$Q = kCiA$$

where:
- Q = Peak runoff (cfs)
- C = Runoff coefficient
- i = Rainfall intensity, (inches per hour)
- A = Area, (acres)
- k = Dimensionless coefficient used to account for antecedent moisture conditions as follows:

Table 600
Rational Formula "k" Factor

Return Period	k
10 years or less	1.0
25 years	1.1
50 years	1.2
100 years	1.25

Note: *In no case shall the product (C * k) be greater than 1.0.*

Runoff coefficients listed in the following Design Charts & Tables are subject to the interpretation and judgment of the design engineer and the approval of the City Engineer.

Rainfall intensity shall be taken from the Rainfall Intensity Tables, McPherson County, Kansas. These tables are included and can be found in the section Design Charts & Tables, for runoff calculations. The storm duration shall be considered equal to the time of concentration and shall be estimated by the design engineer using applicable elements of overland flow, gutter flow, channel flow and pipe flow to the point under consideration. Historic flow shall be considered as pre-development conditions assuming "unimproved greenbelt conditions", with determination of "C" being guided by slope and SCS (NRCS) soil type.

Table 601
Runoff Coefficient "C" for Rational Formula

Description of Area	Area Type	Coefficient
Business	CBD Commercial	.70 - .95 .50 - .70
Residential	Single Family Multi – Units ½ Acre lots or larger	.35 - .45 .40 - .75 .25 - .40
Industrial	Light Heavy Railroad Yards	.50 - .80 .60 - .90 .20 - .40
Green Belts	Parks/Cemeteries Playgrounds Unimproved	.10 - .25 .20 - .35 .10 - .30

For Impervious Surfaces

Description of Surface	Coefficient
Asphalt	.70 - .95
Concrete	.80 - .95
Roofs	.75 - .95

For Pervious Surfaces

Slope	SCS Soils			
	A	B	C	D
Flat (<2%)	.04	.07	.11	.15
Average (2-6%)	.09	.12	.16	.20
Steep (>6%)	.13	.18	.23	.28

Table 602
Rainfall Intensity Table
McPherson County
Kansas

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION	RETURN PERIOD						
HR:MIN	1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0:05	4.77	5.52	6.56	7.32	8.44	9.32	10.20
0:06	4.50	5.23	6.26	7.00	8.10	8.96	9.81
0:07	4.28	5.00	6.00	6.73	7.81	8.64	9.48
0:08	4.09	4.79	5.78	6.49	7.54	8.35	9.17
0:09	3.93	4.61	5.57	6.27	7.28	8.08	8.87
0:10	3.78	4.44	5.38	6.05	7.04	7.81	8.58
0:11	3.64	4.28	5.20	5.85	6.81	7.56	8.30
0:12	3.52	4.14	5.02	5.66	6.59	7.32	8.04
0:13	3.40	4.00	4.87	5.48	6.39	7.09	7.79
0:14	3.29	3.88	4.72	5.32	6.20	6.88	7.57
0:15	3.18	3.76	4.58	5.17	6.03	6.69	7.36
0:16	3.08	3.65	4.45	5.03	5.87	6.52	7.17
0:17	2.99	3.54	4.33	4.90	5.72	6.36	7.00
0:18	2.90	3.44	4.22	4.78	5.59	6.21	6.84
0:19	2.82	3.35	4.12	4.67	5.46	6.08	6.69
0:20	2.74	3.26	4.02	4.56	5.34	5.95	6.55
0:21	2.66	3.18	3.93	4.46	5.23	5.82	6.42
0:22	2.59	3.10	3.84	4.36	5.12	5.71	6.29
0:23	2.52	3.03	3.76	4.27	5.02	5.60	6.17
0:24	2.46	2.96	3.68	4.19	4.92	5.49	6.06
0:25	2.40	2.89	3.60	4.11	4.83	5.39	5.95
0:26	2.34	2.83	3.53	4.03	4.74	5.29	5.85
0:27	2.29	2.76	3.46	3.95	4.65	5.20	5.74
0:28	2.24	2.71	3.39	3.88	4.57	5.11	5.65
0:29	2.19	2.65	3.33	3.81	4.49	5.02	5.55
0:30	2.14	2.60	3.27	3.74	4.41	4.94	5.46
0:31	2.10	2.55	3.21	3.68	4.34	4.86	5.37
0:32	2.06	2.50	3.16	3.61	4.27	4.78	5.28
0:33	2.02	2.46	3.10	3.55	4.20	4.70	5.20
0:34	1.98	2.41	3.05	3.50	4.13	4.63	5.12
0:35	1.94	2.37	3.00	3.44	4.07	4.56	5.04
0:36	1.91	2.33	2.95	3.38	4.00	4.49	4.96
0:37	1.87	2.29	2.90	3.33	3.94	4.42	4.89
0:38	1.84	2.25	2.86	3.28	3.88	4.35	4.82

Table 602 (Continued)
Rainfall Intensity Table
McPherson County
Kansas

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION	RETURN PERIOD						
HR:MIN	1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0:39	1.81	2.22	2.81	3.23	3.83	4.29	4.75
0:40	1.78	2.18	2.77	3.18	3.77	4.23	4.68
0:41	1.75	2.15	2.73	3.14	3.72	4.17	4.61
0:42	1.73	2.12	2.69	3.09	3.66	4.11	4.55
0:43	1.70	2.08	2.65	3.05	3.61	4.05	4.49
0:44	1.67	2.05	2.61	3.01	3.56	4.00	4.43
0:45	1.65	2.02	2.58	2.97	3.52	3.94	4.37
0:46	1.62	2.00	2.54	2.93	3.47	3.89	4.31
0:47	1.60	1.97	2.51	2.89	3.42	3.84	4.26
0:48	1.58	1.94	2.48	2.85	3.38	3.79	4.20
0:49	1.56	1.91	2.44	2.81	3.34	3.74	4.15
0:50	1.54	1.89	2.41	2.78	3.29	3.70	4.10
0:51	1.52	1.86	2.38	2.74	3.25	3.65	4.05
0:52	1.50	1.84	2.35	2.71	3.21	3.61	4.00
0:53	1.48	1.82	2.32	2.68	3.18	3.56	3.95
0:54	1.46	1.79	2.29	2.64	3.14	3.52	3.90
0:55	1.44	1.77	2.27	2.61	3.10	3.48	3.86
0:56	1.42	1.75	2.24	2.58	3.07	3.44	3.82
0:57	1.40	1.73	2.21	2.55	3.03	3.40	3.77
0:58	1.39	1.71	2.19	2.52	3.00	3.36	3.73
0:59	1.37	1.69	2.16	2.49	2.96	3.33	3.69
1:00	1.35	1.67	2.14	2.47	2.93	3.29	3.65
1:05	1.28	1.58	2.03	2.34	2.78	3.12	3.46
1:10	1.21	1.50	1.93	2.22	2.64	2.97	3.30
1:15	1.15	1.43	1.84	2.12	2.52	2.83	3.15
1:20	1.10	1.36	1.75	2.03	2.41	2.71	3.01
1:25	1.05	1.30	1.68	1.94	2.31	2.60	2.88
1:30	1.00	1.25	1.61	1.86	2.22	2.49	2.77
1:35	0.96	1.20	1.55	1.79	2.13	2.40	2.66
1:40	0.93	1.15	1.49	1.72	2.05	2.31	2.56
1:45	0.89	1.11	1.43	1.66	1.98	2.23	2.47
1:50	0.86	1.07	1.38	1.60	1.91	2.15	2.39
1:55	0.83	1.03	1.34	1.55	1.85	2.08	2.31
2:00	0.80	1.00	1.29	1.50	1.78	2.01	2.23
2:05	0.78	0.97	1.25	1.45	1.73	1.94	2.16

Table 602 (Continued)
Rainfall Intensity Table
McPherson County
Kansas

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION	RETURN PERIOD						
HR:MIN	1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
2:15	0.73	0.91	1.18	1.36	1.63	1.83	2.03
2:20	0.71	0.89	1.14	1.32	1.58	1.78	1.97
2:25	0.69	0.86	1.11	1.29	1.53	1.73	1.92
2.30	0.67	0.84	1.08	1.25	1.49	1.68	1.86
2:35	0.66	0.82	1.05	1.22	1.45	1.63	1.81
2:40	0.64	0.80	1.03	1.19	1.42	1.59	1.77
2:45	0.62	0.78	1.00	1.16	1.38	1.55	1.72
2:50	0.61	0.76	0.98	1.13	1.35	1.52	1.68
2.55	0.59	0.74	0.96	1.10	1.32	1.48	1.64
3:00	0.58	0.72	0.93	1.08	1.29	1.45	1.61
3:15	0.54	0.68	0.87	1.01	1.21	1.36	1.51
3:30	0.51	0.64	0.82	0.95	1.14	1.28	1.42
3:45	0.48	0.60	0.78	0.90	1.08	1.21	1.34
4:00	0.46	0.57	0.74	0.86	1.02	1.15	1.28
4:15	0.43	0.54	0.70	0.82	0.97	1.10	1.22
4:30	0.41	0.52	0.67	0.78	0.93	1.05	1.17
4:45	0.40	0.50	0.64	0.75	0.89	1.01	1.12
5:00	0.38	0.47	0.62	0.72	0.86	0.97	1.07
5:15	0.36	0.46	0.59	0.69	0.83	0.93	1.03
5:30	0.35	0.44	0.57	0.67	0.80	0.90	1.00
5:45	0.34	0.42	0.55	0.64	0.77	0.87	0.96
6:00	0.32	0.41	0.53	0.62	0.74	0.84	0.93
6:30	0.30	0.38	0.50	0.58	0.70	0.79	0.88
7:00	0.29	0.36	0.47	0.55	0.66	0.74	0.83
7:30	0.27	0.34	0.45	0.52	0.62	0.70	0.78
8:00	0.26	0.32	0.43	0.50	0.59	0.67	0.75
8:30	0.24	0.31	0.41	0.47	0.57	0.64	0.71
9:00	0.23	0.29	0.39	0.45	0.54	0.61	0.68
9:30	0.22	0.28	0.37	0.43	0.52	0.59	0.65
10:00	0.21	0.27	0.36	0.42	0.50	0.56	0.63
10:30	0.20	0.26	0.34	0.40	0.48	0.54	0.60
11:00	0.20	0.25	0.33	0.38	0.46	0.52	0.58
11:30	0.19	0.24	0.32	0.37	0.45	0.50	0.56
12:00	0.18	0.23	0.31	0.36	0.43	0.49	0.54
13:00	0.17	0.22	0.29	0.34	0.40	0.46	0.51

Table 602 (Continued)
Rainfall Intensity Table
McPherson County
Kansas

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION	RETURN PERIOD						
HR:MIN	1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
15:00	0.15	0.20	0.26	0.30	0.36	0.41	0.45
16:00	0.15	0.19	0.24	0.29	0.34	0.39	0.43
17:00	0.14	0.18	0.23	0.27	0.33	0.37	0.41
18:00	0.13	0.17	0.22	0.26	0.31	0.35	0.39
19:00	0.13	0.16	0.21	0.25	0.30	0.34	0.37
20:00	0.12	0.16	0.20	0.24	0.29	0.32	0.36
21:00	0.12	0.15	0.20	0.23	0.27	0.31	0.34
22:00	0.12	0.14	0.19	0.22	0.26	0.30	0.33
23:00	0.11	0.14	0.18	0.21	0.25	0.29	0.32
24:00	0.11	0.14	0.18	0.21	0.25	0.28	0.31

620 Time of Concentration

Design Requirements

The following criteria shall be utilized to determine the *Time of Concentration* (T_c) for urban storm sewer design.

$$T_c = T_i + T_t$$

Where: T_c = Time of Concentration (minutes)
T_i = Initial or overland flow component (minutes)
T_t = Travel time from point of concentrated flow or beginning of conveyance system to point under consideration (minutes)

The initial or overload flow time shall be calculated as follows:

$$T_i = \frac{1.8(1.1 - C)L^{1/2}}{S^{1/3}}$$

Where: T_i = Initial time, (minutes)
C = Runoff coefficient
L = Length of overland flow, (Ft)
S = Slope, (%)

Minimum Design Values

- The maximum length for initial or overload flow shall be 500 feet.
- The minimum time of concentration T_c shall be 5 minutes.
- The minimum T_i shall be 5 minutes and the maximum shall be 15 minutes.
- Travel times T_t shall be derived from calculated velocities.

Time of concentration for undeveloped areas may also be calculated by other generally accepted methods.

$$T_c \text{ min.} = 0.0078\left(\frac{L^3}{H}\right)^{0.385}$$

Where: L=Length of flow path, ft.
H=Elevation change in ft.

630 Inlet Design

General

Inlets shall be designed to limit gutter flows, for non-sump inlets, for a 10 year design storm as follows:

Street Width	Maximum Allowable Spread
29 feet or less	10.5 feet from back of curb
Greater than 29 feet	11.5 feet from back of curb

Inlets in a sump condition may pond water to a level no more than 6 inches deep measured at the crown of the street for the 100 year event.

Inlet design data shall be presented in a tabular format and shall contain the following information for each inlet:

- The area, runoff coefficient, and time of concentration for the area tributary to each inlet
- Intensity associated with the time of concentration
- Total flow at the inlet; flow entering the inlet; and flow bypassing the inlet

Inlet Layout

The crowns of pipes entering a structure shall be at or above the crown of the outlet pipe and a minimum fall of 0.2 feet shall be provided across the invert. For structures with multiple pipes, odd entrance angles or transitions, a minimum fall of 0.5 feet shall be provided across the invert.

The maximum inlet spacing shall be 400 feet.

640 Pipe Design, Layout & Erosion Control

General

Pipes and other structures shall be designed using the Manning Equation.

The roughness coefficient for precast concrete pipe shall be 0.012. The roughness coefficient for corrugated steel pipe shall be 0.24:

Pipe capacity shall be determined using the combination of basins on the system upstream from the pipe under consideration, which produces the greatest peak flow.

Design Requirements

- The minimum pipe size shall be 15 inches.
- The minimum cover above the top of the pipe shall be 12 inches plus pavement thickness.
- The minimum velocity shall be 3 fps for a pipe flowing full or half full.
- The maximum velocity within the system shall be 15 ft/sec.
- Maximum exit velocities shall be as follows:

Table 603
Maximum Exit Velocities

Outlet Channel Type	Maximum Exiting Velocity
Natural, grass lined or unimproved channel	5 ft/sec
Improved channel with rip-rap lining	10 ft/sec
Improved channel with concrete or grouted rip-rap lining	15 ft/sec

Pipe Layout

The layout of pipes shall minimize the length of pipe under the roadway. Pipes which cross the roadway shall cross reasonably close to perpendicular of the centerline of the roadway, unless approved by the City Engineer. Pipes which run parallel to the roadway shall have a minimum clear distance of 1 foot behind the back of curb.

Pipe design data shall be presented in a tabular format and shall contain the following information for the system:

- Contributing area or combination of areas producing greatest peak flow
- Runoff coefficient for the areas
- Time of concentration (including pipe travel time)
- Intensity
- Flow
- Pipe size
- Roughness coefficient
- Slope Capacity
- Velocity

Erosion Control

Erosion control measures shall be provided when a storm sewer, culvert or any concentration of surface runoff discharges into any type of channel.

All pipe culverts and storm sewers shall include end sections. Rip-rap or broken concrete scour protection, 2 feet in depth and extending 2 feet back under the end of the end section, shall be provided for all culverts and storm sewers. The stone size and horizontal extent of the rip-rap will be determined based on exit velocity from the pipe. Where unusually high velocities or scour potential exists, concrete head walls with energy dissipaters should be substituted for the standard end section. Box culverts shall include concrete aprons on the downstream end. Rip-rap or broken concrete scour protection should also be provided depending on outlet velocities and wingwall configuration.

Entrance velocities shall be determined at all pipe and box culvert inlets to assess the need for erosion control measures. Concrete drop inlets should also be considered to increase culvert hydraulic efficiency and provide for erosion control.

Concentrated drainage from paved or grassed swales, curb openings or other sources must be conveyed from the natural or artificial channel bank to the channel bottom in a manner which protects the channel bank from erosion. Concrete flumes shall be specified for this purpose. The flume cross-section shall be determined by a hydraulic analysis. It shall be designed to convey the 5 year storm flow, with the assumption that the bottom slope of the flume is equal to the slope of the swale which discharges into the flume. If the flume discharges into a natural or grass lined artificial channel, rip-rap or broken concrete scour protection shall be provided.

650 Channel Design

Typical Channel Cross-Sections

The typical section illustrated in Figure No. 601 shows the minimum and maximum criteria to be adhered to in the cross sectional design of City maintained channels. The City Engineer shall determine the channel lining requirements.

Fully grass lined channels will be allowed for 100 year storm flows up to 150 cfs. Channels carrying flows greater than 150 cfs are required to have at least a partial rip-rap or concrete lining.

Trickle channels may be required in all grass lined channels.

Trickle channel linings shall be provided to convey a minimum of the 5 years storm flow.

General Channel Design

Open channels shall be analyzed and designed for uniform flow using the Manning Equation.

Roughness coefficients listed in the Tables 605 and 606 are subject to the interpretation and judgment of the design engineer and the approval of the City Engineer.

All open channels, shall provide adequate capacity to convey the 100 year storm flow, plus the required 1 foot of freeboard. In areas where overbank flow occurs, a minimum of 1 foot of freeboard shall be provided from the 100 year stormwater surface to the minimum opening of any habitable structure.

Wash checks, flumes, outfall erosion protection, energy dissipaters, and stone rip-rap or concrete channel linings shall be designed to provide adequate protection from erosion. The top elevations for all linings and structures shall be placed at or above the anticipated water surface elevation for the 5 year storm flow. The remainder of the channel cross section shall be grass lined.

Artificial Channel Design Criteria

The following criteria shall apply for the design of artificial open channels.

When possible, the angle between the centerline of two connecting channels shall not exceed 45 degrees.

In all situations, and particularly where the angle exceeds 45 degrees, rip-rap or concrete linings shall be provided to control erosion.

Grass Lined Channels

Grass lined channels shall be designed for subcritical flow.

For a given channel cross-section, roughness, and bottom slope, both the 10 year storm flow and the 100 year storm flow shall be analyzed.

The maximum allowable velocities for grass lined channels shall be as follows:

Table 604
Maximum Velocities – Grass Lined Channels

	Easily Eroded Soils (A&B)	**Erosion Resistant Soils(C&D)**
5 year storm (erosion control)	5 fps	6 fps
100 year storm (capacity)	6 fps	7 fps

The channel bottom slope shall not exceed 5 percent in grass lined channels.

The normal depth for the 100 year storm flow shall not exceed 4 feet in grass lined channels (4.5' with trickle channel).

Temporary erosion control measures must be provided to ensure the development of a good stand of grass following channel construction.

Rip-Rap Lined Channels

Each individual situation shall be carefully examined to determine whether there is a need for protection for greater storm flows. In compound channels, the lower section of the channel shall be completely lined as a minimum.

The rock or broken concrete rubble specified for use as rip-rap shall be based on the d50 particle size, of which 50 percent of the mixture is finer by weight. The rip-rap lining shall have a minimum thickness of 1.5 times the largest expected stone diameter.

Concrete Lined Channels

Due to the expected high velocities, concrete linings shall be provided to convey the 10 year storm flow. With compound channels, the entire lower section of the channel shall be lined. Specific situations may require concrete lining protection for flows greater than the 10 year storm flow.

Table 605
Roughness Coefficients For Pipe and Flume Design

Material	Roughness Coefficient (n)
Concrete, pre-cast pipe	.012
Concrete, trowel finish	.013
Concrete, float finish	.015
PVC / HDPE Pipe (smooth wall)	.011
Vitrified Clay Pipe	.015
Brick w/ Cement Mortar	.014
Cast Iron Pipe	.015
Corrugated Metal Pipe	.024

Table 606
Roughness Coefficients For Channel Design
(from Urban Drainage and Flood Control District, 06/2001)

Channel Type	Roughness Coefficient (n)		
	Minimum	Typical	Maximum
I. Excavated or Dredged			
1. Earth, straight and uniform			
a. Gravel, Uniform section, clean	0.022	0.025	0.030
b. With short grass, few weeds	0.022	0.027	0.033
2. Earth, winding and sluggish			
a. Grass, some weeds	0.025	0.030	0.033
b. Dense weeds or aquatic plants	0.030	0.035	0.040
c. Earthy bottom and rubble/riprap sides	0.028	0.030	0.035
3. Channels not maintained, weeds and brush uncut			
a. Dense weeds, high as flow depth	0.050	0.080	0.120
b. Clean bottom, brush on sides	0.040	0.050	0.080
II. Natural Streams (top width at flood stage 100 ft)			
1. Streams on plain			
a. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. Clean, winding, some pools and shoals, some weeds and stones	0.035	0.045	0.050
c. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
III. Lined or Built-up Channels			
1. Concrete			
a. Trowel/float finish	0.011	0.015	0.016
b. Shotcrete	0.016	0.020	0.025
2. Gravel bottom with sides of:			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
3. Grassed	Flow Depth		Flow Depth
a. Bermuda grass, buffalo grass, Kentucky bluegrass	= 0.1-1.5 ft		> 3.0 ft
i. Mowed to 2 in	0.035		0.030
ii. Length = 4-6 in	0.040		0.030
b. Good stand, any grass			
i. Length = 12 in	0.070		0.035
ii. Length = 24 in	0.100		0.035
c. Fair stand, any grass			
i. Length = 12 in	0.060		0.035
ii. Length = 24 in	0.070		0.035

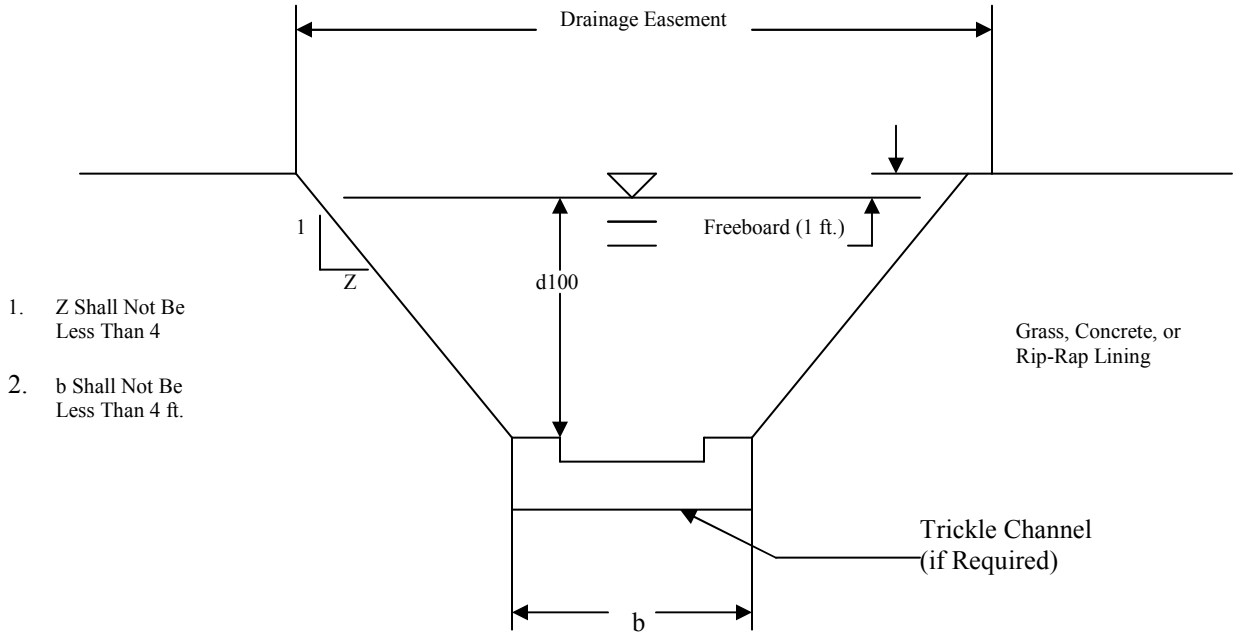


Figure 601
Typical Channel Details

660 Detention Design

Purpose and Benefits

The main purpose of detention storage is to reduce storm runoff from an area to a rate which is lower than the rate which would have occurred from the area after the proposed development without using detention. A major benefit with the use of detention storage in a storm sewer system is a reduction of downstream sewer requirements and costs. In some cases detention storage can be used to relieve an inadequate storm sewer system downstream.

In addition to these criteria, the requirements of the Kansas State Board of Agriculture, Division of Water Resources shall apply to all detention dams greater than 25 feet in height (K.S.A. 82 a-301(b)) or impounding more than 30 acre-feet (Kansas Department of Agriculture, Division of Water Resources, "Kansas Handbook of Water Rights", Form DWR 1-672 (Revised 03/12/01)). Such facilities shall be classified as Hazard Class C – High Hazard.

Design Requirements

Design of the detention facility shall be accomplished using any recognized engineering method to establish the inflow hydrograph. The Rational Formula may be used for any watershed up to 320 acres. Any type of combination of detention facilities may be used including parking lots, underground pipes, underground structures and ponds. The storm frequency and release rate from the detention structure shall be determined by the predevelopment (historic) 10 year design storm or a previous basin wide drainage report, whichever results in the smaller release rate.

The detention structure should detain the 10 year design storm and safely handle the 100 year design storm, or in conformance with a basin-wide drainage management plan.

The following information shall be included for review:

- Inflow hydrograph (tabular & graphical)
- Stage-Storage-outflow chart (tabular & graphical)
- Routing information including peak stage and outflow and the routing time interval shall be 5 minutes.

Criteria for Detention Facilities

Public Facilities

Public detention facilities, if recommended by the Stormwater Management Master Plan, shall be designed, constructed, operated and maintained by the City.

Private Facilities

Private detention facilities shall be constructed by the property owner after plan approval and issuance of a permit by the City. Design of the detention facilities shall follow Section *660 Detention Design.* Dedication of easements to the City will be required.

Operation and maintenance of private detention facilities shall be the responsibility of the property owner and successors.

Maintenance Activities

The design of the detention facility will require the facility to be designed such that the following maintenance can occur:

- Debris removal and cleaning
- Cutting of vegetation
- Repair of erosion and removal of silt
- Maintenance of structural facilities, including outlet works

Easements

Easements dedicated to the City are to provide access for inspection, construction, and maintenance. Easements must be provided for all stormwater detention facilities.

Easements must cover the land occupied by the facility to the high water elevation plus an access easement of 20 feet adjacent to the structure for maintenance access, plus an entry access easement (if necessary) between the structure and the nearest public street. Formulation of the maintenance and access easements may be deferred to the site plan design.

Other Requirements

Wet Basin

The design of wet detention facilities shall include provisions for complete drainage to permit sediment removal and other periodic maintenance activities.

Dry Basin

Dry detention facilities with storage on other than paved surfaces shall have the bottom graded at a minimum of 0.5 percent to drain to an interior gutter. The concrete drainage gutter shall be 4.0 feet or greater in width.

Erosion Control

Principal spillways and outlet works, as well as conveyance systems entrances to detention basins, shall be equipped with energy dissipating devices as necessary to limit the peak discharge velocity.

Parking Lot Detention

Paved parking lots may be designed to provide temporary detention storage of stormwater on a portion of their surfaces. Generally, such detention areas shall be limited to a maximum depth of seven inches, and such areas shall be located so that access to and from parking areas is not impaired.

Other Detention Facilities

All or a portion of the detention storage may also be provided in underground or surface detention areas, including, but not limited to, oversized storm sewers, vaults, tanks, swales, etc.

SECTION 700
BACKYARD AND SIDEYARD LOT DRAINAGE POLICIES

710 Basic Criteria Land Developer Backyard Lot Drainage Responsibility

All land development or subdivision plans presented to the City of McPherson will contain overall storm drainage design, flow direction, and/or evaluations for backyard lots. This engineering solution to backyard drainage of new or old developed lots must be evaluated because of the accumulative effects upon the adjacent existing subdivision and downstream backyard lot drainageways. Elements of the backyard lot line storm drainage shall be designed with peak discharge of a 10 year design storm.

Table 700
Backyard Lot Line
Drainage Element Standards

SLOPE	DRAINAGE ELEMENT REQUIRED	DRAINAGE EASEMENT RESTRICTIONS	MARKER
0 – 1%	SIZED SMOOTH CONCRETE TRAPEZOIDAL CHANNEL OR UNDER-GROUND PIPE WITH INLETS	NO OBSTRUCITONS* (MOWED GRASS)	←
1 – 2%	STANDARD CITY TRIANGULAR CONCRETE CHANNEL	NO OBSTURCITONS* (MOWED GRASS)	← V
2 – 3%	GRADED/SEEDED/MOWED GRASS SWALE 2" – 4" DEPTH WITH 3' – 5' WIDTH SLOPING TO NATURAL LOT GRADING	NO OBSTRUCTIONS* (MOWED GRASS)	
2 – 5%	GRADED/SEEDED/MOWED GRASS SWALE 1" – 2" DEPTH WITH 3' – 5' WIDTH SLOPING TO NATURAL LOT GRADING	NO OBSTRUCITONS* (MOWED GRASS)	

*NOTE: BACKYARD DRAINAGE EASEMENTS SHALL NOT BE OBSTRUCTED BY ANY PERMANENT OR SEMI-PERMANENT OBSTRUCTIONS WHICH INCLUDE BUT ARE NOT LIMITED TO TREES, SHRUBS, FENCES, RETAINING WALLS, COMPOST PILES, GARDENS, BUILDING MATERIALS, BUILDINGS OR OTHER OBSTRUCTIONS THAT INTERFERE WITH THE FLOW OF STORM DRAINAGE ELEMENTS.

The land development plans will include the following developer, builder, and lot owner information:

A. Final Subdivision Plot Plan

1. Backyard drainage element type identification (marker), flow direction, and its easement location.

B. Engineering/Grading Elevation Survey Drawing

1. Contour elevation lines and values for backyard drainage elements.

2. Proposed minimum garage floor elevations for builder to identify lot basement type:

   a. Buried (B)

   b. View Out (VO)

   c. Walk Out (WO)

720 Basic Criteria Builders Sideyard Lot Drainage Responsibility

The builder/owner shall be required to final rough grade the developed individual lot, such that the side lot contains half of a seeded grass common property line swale** to accommodate the storm drainage as best fits the overall drainage addition plan as follows:

A. Sideyard storm drainage directed towards front and rear of the building.

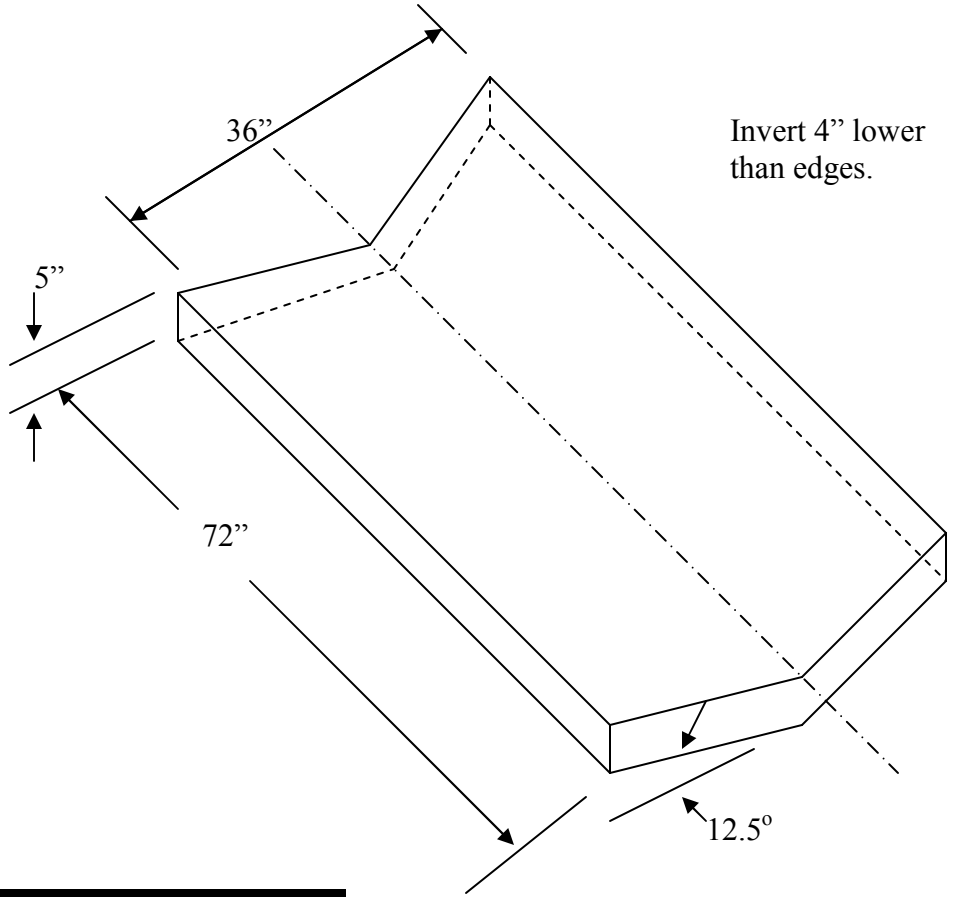
B. Sideyard storm drainage directed towards front of the building to the street.

C. Sideyard storm drainage directed towards the backyard drainage element.

**Note: Swale is a ground level depression 4" to 6" depth with sides 3 – 6 feet wide that gradually slopes back to natural lot building ground drainage grade.

Backyard Drainage Channel Design Specifications

1. City mix concrete (3500 psi min.)
2. Expansion joints every 100’ and at street curb flume.
3. Sawed control joints every 6’ laterally.
4. No longitudinal control joints.
5. Concrete air entrainment 4 – 6%.
6. Channel base undisturbed or compacted clay soil.



Channel Design Performance

1%	Slope	2%
2.95	fps	4.17
1.47	cfs	2.09

Figure 701
Backyard Channel Details

SECTION 800
WATER QUALITY

810 General

Stormwater related facilities shall be designed and constructed to eliminate to the greatest degree practicable the introduction of pollutants into the stormwater collection and conveyance system and the discharge of pollutants into waters of the United States. This shall include, without limitation, utilizing Best Management Practices to achieve compliance with applicable laws, policies, rules, regulations, ordinances, and resolutions presently in effect or as may be adopted by Federal, State and City governments to achieve the goal of complying with the EPA Phase II Stormwater Quality Regulations.

820 Construction Activities

Construction activities within the City of McPherson shall comply with the requirements of the "Kansas Water Pollution General Permit and Authorization to Discharge Stormwater Runoff From Construction Activities Under the National Pollutant Discharge Elimination System" as fully described in the Kansas Department of Health and Environment (KDHE), Bureau of Water "National Pollution Discharge Elimination System, Stormwater Runoff From Construction Activities, General Permit, Jan 2, 2007".

The following construction activities will not be allowed until and unless a valid KDHE permit, and all supporting documentation submitted to KDHE for obtaining the permit, are on file with the Director of Public Works.

Large Construction Activity

Large construction activity consists of any activity (e.g. clearing, grubbing, excavating, grading, etc.) which disturbs a cumulative total of five (5.0) or more acres or that is part of a larger common plan of development or sale which will disturb a cumulative total of five or more acres.

Small Construction Activity

On or before January 9, 2003, owners or operators who may discharge stormwater runoff from small construction activity on or after March 10, 2003 shall apply for authorization to discharge stormwater runoff from their construction site. Small construction activity consists of any activity (e.g. clearing, grubbing, excavating, grading, etc.) which disturbs a cumulative total area equal to one (1.0) acre; or greater than one (1.0) acre and less than five (5.0) acres. Activity which disturbs less than one (1.0) acre is considered to be small construction activity when the site is part of a larger common plan of development or sale which will disturb a cumulative total area equal to one (1.0) acre; or greater than one (1.0) acre and less than five (5.0) acres.

Less than one (1.0) acre

Owners or operators of construction activities which disturb less than one acre (<1.0 acres), and which are not part of larger common plan of development or sale, must have authorization to discharge stormwater runoff from construction activities under the general NPDES permit when KDHE believes the water quality impact warrants consideration.

Owners or operators of construction activities which disturb less than one acre (<1.0 acre) and are not otherwise required to obtain an NPDES Permit, shall follow the guidelines set forth in "Erosion Control for Home Builders and Their Contractors, Fact Sheet No. 3" (copy attached). An erosion and runoff control plan shall be submitted to and approved by the Director of Public Works or his/her designee prior to beginning construction activities.

Failure to comply with stormwater quality control requirements will result in revocation of any City approvals or permits for the project, and work on the project shall cease until compliance is achieved.

Erosion Control Best Management Practices (BMP's)

The following is a list of BMP's for use in preventing sediment runoff from construction activities. Any one or more of the BMP's shall be used for both large and small construction activities. Although the BMP's listed below do not represent every possible scenario, they do cover the most common types used for erosion control. Additional BMP's can be used, but will require approval by the Director of Public Works or his/her designee prior to their installation. Included in this section is a copy of a fact sheet from the Kansas Department of Health and Environment (KDHE) discussing the BMP's listed below, in addition to others, along with contact information..

Silt Fence

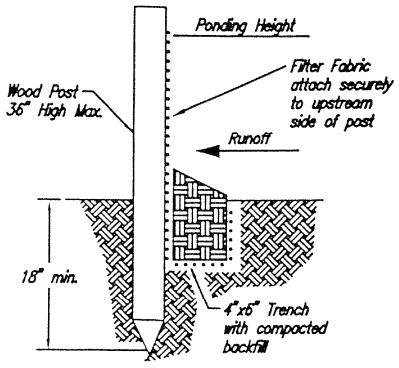
Silt fence fabric should conform to the AASHTO M288 96 silt fence specification. The posts used to support the silt fence fabric should be a hardwood material with the following minimum dimensions:

Two inch (2") square (nominal) by four feet (4') long

Silt fence fabric should be attached to the wooden posts with staples, wire, zip ties, or nails.

A slope barrier should be used at the toe of a slope when a ditch does not exist. The slope barrier should be placed on a nearly level ground five to ten feet away from the toe of the slope. The barrier is placed away from the toe of the slope to provide adequate storage for settling out sediment.

When practicable, silt fence slope barriers should be placed along contours to avoid a concentration of flow. Silt fence slope barriers can also be placed along right-of-way fence lines to keep sediment from crossing into adjacent property. When placed in this manner, however, the slope barrier will not likely follow contours.



SILT FENCE BARRIERS

Installation

Excavate a trench the length of the planned slope barrier that is six inches deep by four inches wide. Make sure that the trench is excavated along a single contour. Place the excavated soil on the upslope side of the trench for later use. Roll out a continuous length of silt fence on the downslope side of the trench. Place the edge of the fabric in the trench starting at the top upslope edge. Line all three side of the trench with the fabric as shown above. Backfill over the fabric in the trench with the excavated soil and compact. There should now be approximately 24 to 36 inches of silt fence fabric exposed.

Lay the exposed silt fence fabric on the upslope side of the trench to clear an area for driving in the posts. Just downslope of the trench, drive posts into the ground to a depth of at least 18 inches. Space posts no more than four feet apart. Attach the silt fence fabric to the posts with staples, wire, zip ties, or nails.

Inspection

Silt fences should be inspected every seven (7) days. They should also be inspected within 24 hours of a rainfall event of ½" or more. The following questions should be addressed during each inspection:

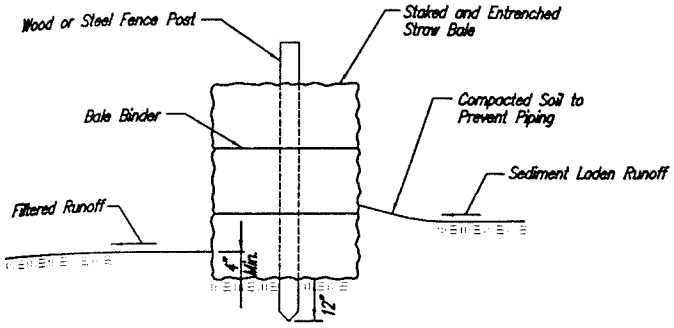
- Are there any points along the silt fence where water is concentrating?
- Does water flow under the silt fence?
- Do the silt fences sag excessively?
- Has the silt fence torn or become detached from the posts?
- Does sediment need to be removed from behind the silt fence?

Straw Bales

Straw bale barriers may be of wheat straw, oat straw, prairie hay, or bromegrass hay that is free of weeds declared noxious by the State of Kansas. The stakes used to anchor the bales should be a hardwood material with the following minimum dimensions:

Two inch (2") square (nominal) by four feet (4') long

As with a silt fence, a slope barrier should be used at the toe of a slope when a ditch does not exist. The slope barrier should be placed on a nearly level ground five to ten feet away from the toe of the slope. The barrier is placed away from the toe of the slope to provide adequate storage for settling out sediment.



STRAW BALE BARRIERS

Installation

Excavate a trench the length of the planned slope barrier that is four inches deep and a bale's width wide. The trench needs to be excavated along a single contour to avoid a concentration of flow. Place the soil on the upslope side of the trench for later use.

Place the bales in the trench, making sure they are butted tightly. Two stakes should be driven through each bale along the centerline of the ditch, approximately 6 to 8 inches in from the bale ends. Stakes should be driven at least 12 inches into the ground. Once all the bales have been installed and anchored, place the excavated soil against the upslope side of the bales and compact the soil. The compacted soil should be no more than 3 to 4 inches deep.

Common placement and installation mistakes

1. Bales placed across contours. Bales placed across contours create a concentration of flow which can create a scour hole on the downslope side of the bales. This will ultimately undermine the bales and cause them to fail.

2. Bales placed at ground level. Bales placed on the ground and not in a trench will allow water to flow under the bale and not effectively filter sediment.

3. Insufficient anchors. Bales not properly staked will allow for movement and will ultimately wash out.

Inspection

As with silt fences, bales should be inspected every seven (7) days. They should also be inspected within 24 hours of a rainfall event of ½" or more. The following questions should be addressed during each inspection:

- Are there any points along the bale barrier where water is concentrating?
- Does water flow under the bales?
- Does water flow through spaces where bales are abutted?
- Have any bales become dislodged?
- Are bales decomposing due to age and/or water damage?
- Does sediment need to be removed from the downslope side of the bales?

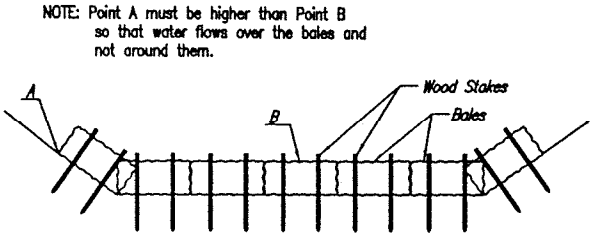
Bale barriers are intended as temporary structures and must be removed when they have served their purpose. Removal is dependant upon stabilization of the soil above the bales.

Straw Bale Ditch Checks

Straw bale ditch checks may be of wheat straw, oat straw, prairie hay, or brome grass hay that is free of weeds declared noxious by the State of Kansas. The stakes used to anchor the bales should be a hardwood material with the following minimum dimensions:

Two inch (2") square (nominal) by four feet (4') long

Optional - A downstream scour apron should be constructed of a double-netted straw erosion control blanket at least six feet wide. If using this additional option, metal landscape staples should be used to anchor the blanket. Staple length should be at least eight (8) inches long.



Bale ditch checks should be placed perpendicular to the flowline of the ditch (Point B above). The ditch check should extend far enough so that the ground level at the ends of the check is higher than the top of the lowest center bale (Point A above). This prevents water from flowing around the check.

Bale checks should not be placed in ditches where high flows are expected. In this case, rock checks should be used. Bales should be placed in ditches with slopes of six percent (6%) or less. For slopes steeper than 6%, rock checks should be used. The following table provides check spacing for a given ditch grade:

Ditch grade (%)	Check Spacing (feet)
0.5	200
1.0	200
2.0	100
3.0	65
4.0	50
5.0	40
6.0	30

Installation

Excavate a trench perpendicular to the ditch flowline that is four (4) inches deep and a bale's width wide. Extend the trench in a straight line along the entire length of the proposed ditch check. Place the excavated soil on the upstream side of the trench for use later.

Optional – On the downstream side of the trench, roll out a length of erosion control blanket (as a scour apron) equal to the length of the trench. Place the upstream edge of the erosion control blanket along the bottom upstream edge of the trench. The erosion control blanket should be anchored in the trench with one row of eight (8) inch landscape staples place on 18 inch centers. The remainder of the erosion control blanket, not lying in the trench, will serve as the downstream scour apron. This section of the blanket should be anchored to the ground with eight (8) inch landscape staples placed around the perimeter of the blanket on 18 inch centers. The remainder of the blanket should be anchored to the ground using two evenly spaced rows of eight (8) inch landscape staples on 18 inch centers placed perpendicular to the flowline of the ditch.

Place the bales in the trench, making sure they are butted tightly. Two stakes should be driven through each bale along the centerline of the ditch check, approximately six to eight inches in from the bale ends. Stakes should be driven at least 12 inches into the ground. Once all the bales have been installed and anchored, place the excavated soil (removed earlier) against the upstream side of the check and compact it. The compacted soil should not be more than three to four inches deep and extend upstream no more than 24 inches.

Common placement and installation mistakes

1. Bale ditch checks that are placed in ditches that will likely experience high flows. They will not stand up to concentrated flows.

2. Exceeding spacing guidelines. If spacing guidelines are exceeded, erosion will occur between the ditch checks.

3. Do not allow water to flow around a ditch check. Make sure the ditch check is long enough so that the ground level at the ends of the check is higher than the top of the lowest center bale.

4. Bale ditch checks placed at ground level. Ditch checks placed on the ground and not in a trench will allow water to flow under the check and not effectively filter sediment.

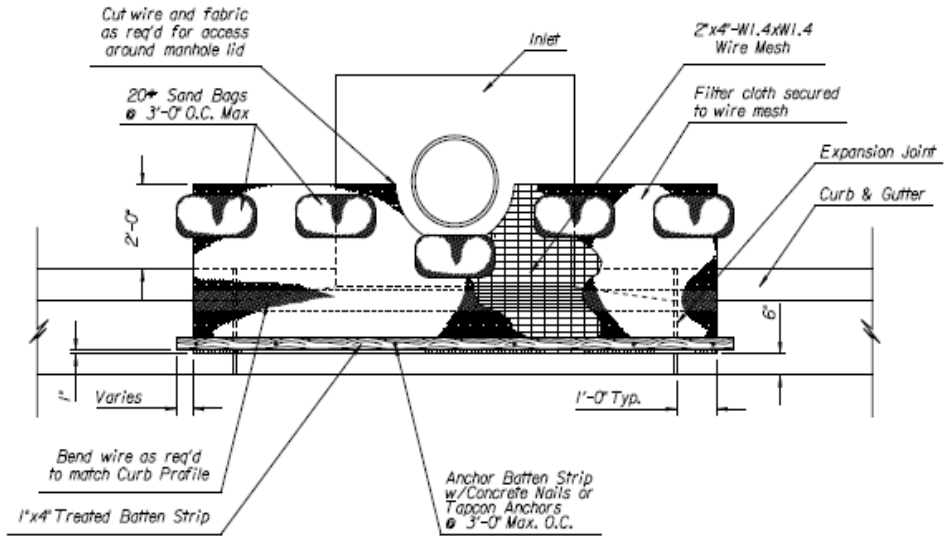
Inspection

As previously mentioned, bale ditch checks should be inspected every seven (7) days. They should also be inspected within 24 hours of a rainfall event of ½" or more. The following questions should be addressed during each inspection:

- Does water flow around or under the ditch check?
- Does water flow through spaces where bales are abutted?
- Are any bales dislodged?
- Are bales decomposing due to age and/or water damage?
- Does sediment need to be removed from behind the ditch check?

Storm Inlet Protection

Though there are numerous ways to provide proper inlet protection, the illustration on the next page is an approved method. Other inlet protection methods will require approval of the Public Works Director or his/her designee prior to their installation.



Installation

For curb inlets:

Cut a piece(s) of wire mesh (2" x 4" openings) so as to extend six (6) inches in front and two (2) feet behind the inlet, taking into account bending of the mesh to conform to the curb profile. Width should extend two feet on either side of the inlet opening. Place filter fabric over the top of the wire mesh. Filter fabric sieve size should be 40 to 85. Fasten the filter fabric to the wire mesh using hog rings, plastic zip ties, or other approved means. Anchor the screen and mesh combination to the gutter or street with a 1"x 4" treated batten strip using concrete nails or anchors on three foot on center. Anchor the screen and mesh combination behind the inlet with 20-pound sand bags at three foot on center.

When used on radius inlets, wire, filter cloth, and batten strip shall be installed in segments as required to conform to the contour of the radius of the curb and gutter.

Common placement and installation mistakes

1. Wire does not conform to the curb profile. This allows for runoff to pass under, rather than through, the filter fabric.

2. Improper anchoring allows for the inlet protection to move.

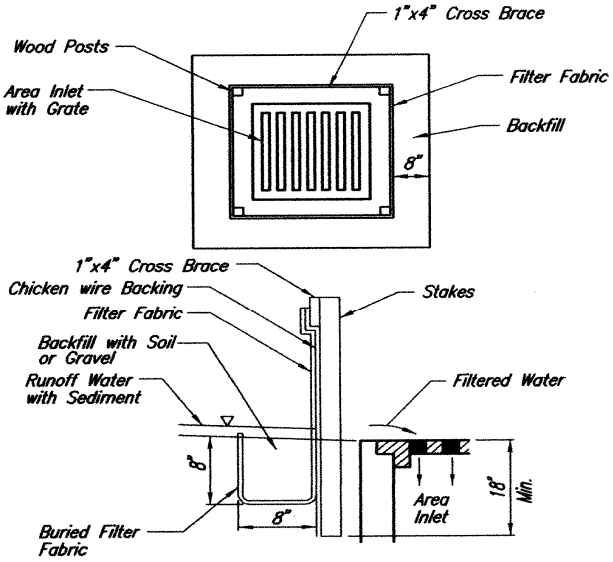
Inspection

Inspection shall be conducted within 24 hours of a rainfall event of ½" or more. Filter fabric shall be replaced when silt accumulation reaches two inches in depth. The following questions should be addressed during each inspection:

- Does water flow around or under the inlet protection?
- Does water flow through spaces other than the fabric?

- Is the batten strip secure?
- How much sediment has accumulated on the screen?

Silt fence area inlet barrier



Installation

Excavate a trench around the perimeter of the area inlet that is at least eight (8) inches deep by eight (8) inches wide. Drive posts to a depth of at least 18 inches around the perimeter of the area inlet. The distance between posts should be four (4) feet or less. If the distance between two adjacent corner posts is more than four feet, add another post(s) between them.

Connect the tops of all the posts with a wooden frame made of 1" x 4" boards. Use nails or screws to fasten. Attach wire of polymeric-mesh backing to the outside of the post/frame structure with nails, zip ties, staples, or wire.

Roll out a continuous length of silt fence fabric long enough to wrap around the perimeter of the area inlet, allowing for a little extra to overlap the joint. Place the edge of the fabric in the trench, starting at the outside edge, and work the fabric through the trench toward the wood frame. Backfill over the fabric in the trench using the excavated soil and compact. After filling the trench, approximately 24 to 36 inches of the fabric should be exposed.

Attach the silt fence fabric to the outside of the post/frame structure with nails, zip ties, staples, or wire. The joint should be overlapped to the next post.

Common placement and installation mistakes

1. Posts placed on the outside of the barrier rather than inside. In this configuration, the posts are not holding the filter fabric, and the fasteners themselves are not strong enough, so ultimately the fence will fail.

2. Inlet barriers constructed without the top frame will cause the corner posts to be stressed and lead to ultimate barrier failure.

3. Place a silt fence barrier for inlet protection in a location where it is unlikely to be overtopped.

Inspection

Silt fence barriers for are inlet protection should be inspected every seven (7) days and within 24 hours of a rainfall event of ½ inch or more. The following questions should be addressed during each inspection:

- Does water flow under the inlet protection?
- Does the silt fence sag excessively?
- Has the silt fence become torn or detached from the posts?
- Does sediment need to be removed from behind the inlet barrier?