DARDENNE PRAIRIE

City of Dardenne Prairie, Missouri

Storm Sewers and Other Drainage Appurtenances

Technical Requirements Manual

for the

Uptown Zoning District

(December 19, 2007)

Chapter 1

1.0 Definitions

Detention system *means a facility designed to control the discharge rate of stormwater runoff from a site by detaining flows.*
Flow control facility *means a method for controlling the discharge rate of stormwater runoff from a site.*
Flow control *means controlling the discharge rate of stormwater runoff from the site through means such as infiltration or detention.*
Impervious surface *means any surface exposed to rainwater from which most water runs off including, but not limited to, paving, packed earth material, oiled macadam, or other treated surfaces, and roof surfaces, patios, and formal planters.*
Infiltration *system means a drainage facility that temporarily stores, and then percolates stormwater runoff into the underlying soil. Examples include but are not limited to infiltration trenches, ponds, vaults, and tanks.*
Public storm drain *means the part of a public drainage control system which is wholly or partially piped, is owned or operated by a public entity, and is designed to carry only drainage water.*
Receiving waters *means the natural drainageways that receive drainage discharges.*
Small project *means a development site where the peak developed runoff rate for a 15-year 20-minute design storm is equal to 1.0 cubic foot per second or less.*
Stormwater Code *means the stormwater management regulations as required by the current City of Dardenne Prairie Municipal Code .*

1.1 Context

Stormwater control plays an important role in the quality of life for the people who live, work and play in the Dardenne Prairie area. Many swim, boat, and fish in these waters, and many others enjoy the plants and wildlife these aquatic habitats support. Before Dardenne Prairie was developed to its current point, wetlands, meadows and forests supported these aquatic habitats by retaining much of the rainfall and releasing the runoff slowly throughout the year to natural drainageways. As Dardenne Prairie has developed, urban stormwater runoff from decreased vegetation and increased impervious surface has compromised the health of Dardenne Prairie's aquatic resources. In addition, downstream properties may be subject to flooding from increased imperious surface upland. Now, Dardenne Prairie residents, businesses and agencies are faced with the challenge of protecting the natural drainageways of Dardenne Prairie and St. Charles County, while continuing to build and enhance the civic amenities of a thriving community. Under the Federal Clean Water Act, the Missouri Department of Natural Resources regulates the impacts of non-point pollution on water quality through the National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit. As a condition of the City of Dardenne Prairie's NPDES permit, the City regulates development and land use activities that impact the quality and quantity of stormwater runoff through the Dardenne Prairie Municipal Code, (Stormwater Code). To protect and enhance the health of Dardenne Prairie's natural drainageways, flow control standards for development are designed to lower the peak flow in urban creeks, decrease downstream flooding, and reduce combined sewer overflow events.

1.2 Purpose of this Document

This document provides the technical guidance necessary to comply with the flow control requirements prescribed in the Stormwater Code for projects in the Uptown Zoning District. Projects meeting the thresholds described in the Stormwater Code must install flow control facilities to meet the discharge rate requirements required by the Stormwater Code. The flow control options and associated technical requirements are intended for private development. Public facilities and facilities in the public right of way must comply with the City of Dardenne Prairie adopted standard plans adopted for highway construction (St. Charles County Highway Department) and other regulations governing work in the public right of way.

1.3 Discharge Points

The discharge of drainage water from a project site shall be limited to one or more of the discharge points listed below, unless otherwise approved by the City Engineer:

- A public piped storm drain; or
- A natural or constructed drainage location, such as an existing stream, lake, drainageway, or storm sewer system.

When more than one discharge point is available, the City Engineer may specify the discharge point and may require that drainage water be discharged at a combination of the above locations to preserve existing water courses and riparian rights or to prevent damage from drainage water. When specifying the discharge point(s), the City Engineer shall consider the need to protect streambanks from erosion, to protect the water table, and to prevent downstream flooding and erosion, sewer overflows, and groundwater problems. Drainage water shall not be discharged to a public sanitary sewer.

1.4 Stormwater Code Flow Control Requirements

The Stormwater Code for developments projects shall be according stormwater management regulations as required by the current City of Dardenne Prairie Subdivision Regulations Section 410.290. Notwithstanding any other provision of the Stormwater Code, due to the higher development densities planned in the Uptown Zoning District, stormwater detention shall be provided for all development sites,

1.5 Principles of Flow Control

When rain falls, it may soak into soil as infiltration, it may be absorbed by vegetation and return to the atmosphere as evapotranspiration, or it may collect and flow off roofs, pavement or saturated soil as stormwater runoff. Long before Dardenne Prairie was developed, wetlands, meadows and forests retained much of the rainfall and released runoff slowly throughout the year to natural drainageways.
When Dardenne Prairie developed, vegetation decreased and impervious surface increased, causing higher volumes and much faster stormwater runoff. Increased runoff has compromised the health of Dardenne Prairie's aquatic resources. **Figure 1** illustrates these impacts by comparing the rate of runoff over time (the hydrograph) from a pre-developed condition with the hydrograph from a developed condition. A developed site has much more runoff, flowing at a much faster rate.

Each contribution to slow down runoff and keep water on site helps keep Dardenne Prairie's creeks and water bodies healthy. To protect and enhance the health of Dardenne Prairie's natural drainageways, flow control standards for development are designed to lower the peak flow in urban creeks, decrease downstream flooding, and reduce combined sewer overflow events. Flow control attempts to mitigate the impacts of urban development by replenishing vegetated cover and pervious surfaces to slow stormwater release rates and increase stormwater infiltration into local soils. When clay soils or landslide prone areas discourage infiltration or site conditions restrict vegetative techniques, underground detention systems can slow the rate of runoff.

Figure 1. Pre-developed and Developed Hydrographs

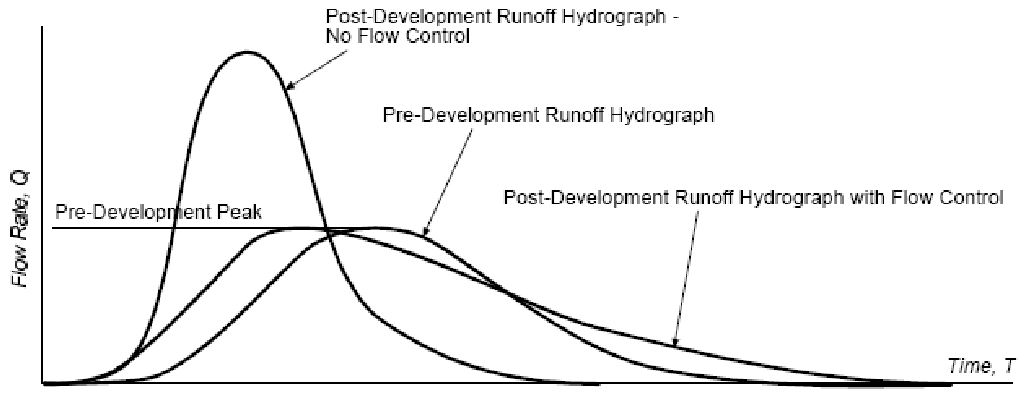


Diagram showing the relationship between pre-development hydrographs, post-development hydrographs, and post-development hydrographs with flow control

1.6 Stormwater Management Design Options

Several methods may be used to manage stormwater flow rates. Acceptable methods include:

- Impervious Surface Reduction (reducing the total impervious surface on site),
- Detention Facilities (wet/dry ponds, tightlined stormwater planters, detention vaults or tanks),
- Bioengineered Facilities (vegetated stormwater management systems),
- Infiltration Facilities (infiltration facilities where conditions permit).

These stormwater management design options and design methods are explained below.

Impervious Surface Reduction

Impervious surface reduction is recommended as a first step in managing stormwater on site. Flow control and stormwater treatment requirements are based on the amount of new and replaced impervious surface. The amount of impervious surface may be reduced with any of the best management practices listed below in **Table 1**. If the total impervious surface for the project is reduced to the point of cause a net decrease in the amount of stormwater runoff from a developed site during the design storm (per the Stormwater Code), then additional flow control is not required. If application of impervious surface reduction credit does not lower the total impervious surface of the project below the requirement threshold, then the modified total impervious surface for the project may be used to design additional stormwater management facilities.

Table 1. Impervious Surface Reduction Designs

Impervious Surface Reduction Design	Modification	Description
Porous pavement	Paving replacement	Reduces and cleanses runoff from pavement
Eco-roof	Roof replacement	Reduces and cleanses roof runoff
Roof garden	Partial Roof replacement	Reduces and cleanses roof runoff
Landscape planter	Paving replacement	Planter slows runoff and drains to pavement

Bioengineered and Infiltration Facilities

Bioengineered and infiltration systems are stormwater management facilities that use soil, gravel or vegetation to detain and cleanse stormwater runoff. Vegetated and infiltrating systems have additional benefits over standard detention systems such as increased infiltration, pollution reduction, and in some cases, reduced cost. However suitability varies according to soil conditions and other site constraints. For more information on requirements see Chapter 3.

Table 2. Bioengineered and Infiltration Facilities

Facilities	Function
Bioengineered Planting Strip	Collects, filters and conveys stormwater; appropriate discharge required
Infiltration Planter	Collects, filters and infiltrates stormwater
Infiltration Trench	Collects and infiltrates stormwater
Drywell	Collects and infiltrates stormwater

Conventional Detention Systems

Detention systems detain stormwater flow before discharging to the public drainage control system or other approved discharge point. Detention systems may be the only option if space is limited on site or if soils do not provide infiltration rates adequate to cause a net decrease in the amount of stormwater runoff from a developed site during the design storms (per the Stormwater Code) when impervious surface reduction and/or bioengineered and infiltration systems are employed to reduce stormwater runoff. Chapter 3 includes specifications for two standard detention systems: detention tanks and detention vaults. Specifications are also included for a Stormwater Planter, which has the added benefit of filtering stormwater before discharging to an approved discharge point. For more information on standard detention systems, refer to Chapter 2: Design Specifications for Detention Facilities.

Table 3. Detention Facilities

Facility	Function
Stormwater planter	Detains and cleanses stormwater through soil, vegetation and reservoir storage
Detention tank or vault	Detains stormwater through storage and controlled release orifice

1.7 Facility Design Methods

Stormwater management designs will be based on the routing the post-developed design storms per the Stormwater Code.

1.8 Hydrologic Analysis Method

Flow control facilities should be sized based on the hydrologic analysis methods per the Stormwater Code.

1.9 Planter Sizing Method

Infiltration facilities shall be sized by a Missouri-licensed engineer to drain a 24-hour design storm within 48 hours. Additional flow control facilities may be required to detain the 100-year storm. The following method or equivalent should be used to size the Infiltration Planter, the Stormwater Planter and the Bioengineered Planting Strip.

Infiltration in the planter is calculated using a water balance approach where inflow volume into the planter equals the storage volume in the planter plus the outflow volume from the planter. The storage volume in the planter is estimated as:

$$S_e = A_p D_p \theta_e \quad (1)$$

Where,
S_e = Effective storage volume, Area of planter, ft^3
A_p = Area of planter, ft^2
D_p = Depth of planter, ft
θ_e = effective porosity, ft^3/ft^3

The effective porosity is defined as

$$\theta_e = \eta - \theta_r \quad (2)$$

Where,
θ_r = residual moisture content after soil has thoroughly drained, ft^3/ft^3
η = porosity, ft^3/ft^3

The effective porosity for the topsoil of loamy sand is estimated as 0.34 based on a porosity of 0.43 and residual moisture content of 0.09 (Chow et al., 1988). The value for the pea gravel layer is estimated as 0.31 based on porosity of 0.38 and residual moisture content of 0.07 (Chow et al., 1988).

The outflow from the planter is estimated using the Darcy's law for saturated flow conditions (Gaymon, 1994).

$$Q_{outflow} = A_p K_{avg}(\Delta h/L_t) \quad (3)$$

Where,
$Q_{outflow}$ = Outflow rate from planter, cfs
A_p = Area of the planter
K_{avg} = Average infiltration rate* for the loamy sand and sand/gravel layer in the planter, in
Δh = total head of water ponding in the planter**, in
L_t = Total length of soil in planter, $L_1 + L_2$, where L_1 and L_2 are the lengths of the sandy loam, and sand/gravel layers, respectively, inches.

The average infiltration rate K_{avg} through the planter is estimated as the average infiltration rate of the two layers, the loamy sand and the pea gravel layers (Gaymon, 1994; Luthin, 1965):

$$K_{avg} = (L_1 + L_2) / [\ (L_1 / K_1) + (L_2 / K_2)\ ] \qquad (4)$$

Where,
L_1 =the depth of layer 1, in
L_2 =the depth of layer 2, in
K_{avg} =the average infiltration rate, in/hr
K_1 and K_2 = infiltration rates of the sandy loam and sand/gravel layers, in/hr

The outflow of the Infiltration Planter should be estimated in part with a composite average infiltration rate from the loamy sand layer and the sand/gravel layer accounting for two-thirds of the outflow. This assumption reflects the fact that the composite section covers two-thirds of the planter volume. The rest of the outflow is assumed to come through the non-composite (loamy sand) section of the planter.

* A correction factor of 2 should be applied to the hydrologic infiltration rate to obtain the design infiltration rate. Loamy sand should have a hydrologic infiltration rate of 2.41 inches per hour, and the gravel layer should have a hydrologic infiltration rate of 20 inches per hour.
** A conservative, constant head total should be used based on the depth of medium and no surface storage.

1.10 Submittal Requirements

Site improvement construction plans, including but not limited to downspouts, conveyance pipes, catch basins, and discharge from the site must meet the requirements of the Stormwater Code and all applicable rules. For projects requiring detention, the standard drainage control plan must include the location of the flow control facility, the proposed discharge point and elevation, the lowest elevation of drainage water collection on the site.

The owner(s) of the site shall sign a "memorandum of stormwater control" that has been prepared by the City of Dardenne Prairie. Completion of the memorandum shall be a condition precedent to issuance of any permit or approval for which stormwater detention is required. The applicant shall file the memorandum of stormwater control with the St. Charles County Recorder of Deeds so as to become part of the St. Charles County Recorder of Deeds' records. The property owner shall give the City Engineer proof of filing of the memorandum. The memorandum shall not be required when the drainage control facility will be owned and operated by the City. A memorandum of stormwater control shall include:

- "As-built" plans that show the location of each storm-sewer outfall of the project with horizontal location of the end point of all stormwater facilities clearly labeled and referenced to the project's boundary. In addition, the vertical elevation of each outfall shall be labeled on the "as-built" plans and shall be referenced to the project's vertical datum;
- The legal description of the site;
- A summary of the terms of the drainage control plan, including any known limitations of the drainage control facilities, and an agreement by the owners to implement those terms;
- An agreement that the owner(s) shall inform future purchasers and other successors and assignees of the existence of the drainage control facilities and other elements of the drainage control plan, the limitations of the drainage control facilities, and of the requirements for continued inspection and maintenance of the drainage control facilities;
- The site improvement construction plans title, date and preparer's name from which a construction permit has been issued;
- Permission for the City to enter the property for inspection, monitoring, correction, and abatement purposes;
- An acknowledgment by the owner(s) that the City is not responsible for the adequacy or performance of the drainage control plan, and a waiver of any and all claims against the City for any harm, loss, or damage related to the plan, or to drainage or erosion on the property, except for claims arising from the City's sole negligence; and
- The owner(s)' signatures acknowledged by a notary public.

Chapter 2

2.1 Detention Systems

Layout of the Detention System

There must be at least 10 (ten) feet of clearance between the underground detention pipe and buildings or property lines. If this clearance is not possible, the City Engineer must approve the location, and may require a concrete pipe. The main components of a standard detention system are a detention pipe that temporarily stores stormwater runoff, a flow control structure (a maintenance manhole), and a flow control device. The underground detention pipe stores stormwater, which is released at the approved discharge rate through the flow control structure.

Detention Pipe Design

The size of the detention pipe and outfall must be determined by a Missouri-licensed engineer and should be designed to provide enough stormwater storage to meet the design requirements for stormwater drainage facilities per the Stormwater Code. The slope of the detention pipe must be a minimum of 0.5 %. Impervious surface, for the purpose of these calculations, includes all areas to be covered with buildings or other structures, porches, eaves, or other overhangs, and any paved or graveled areas that are part of the project whether they are located on the site or in adjacent public street areas. Detention pipes larger than 36 inches in diameter may be connected to a flow control structure by a transition pipe, at least 2 feet long and at least one-half the diameter of the detention pipe. The diameter of the transition pipe must be at least 30 inches and not more than 48 inches. Larger diameter pipes (48 inches and greater) must be vented. Detention pipe design configuration options are shown in Figure 2.

Detention pipes more than 50 feet long must provide a cleanout. Detention pipes more than 100 feet long must have a maintenance manhole at each end to allow for maintenance and repair. Detention pipes over 200 feet long must have a maintenance manhole at the upstream end and a cleanout at least every 100 feet.

Detention Pipe Material and Diameter

The detention pipe must be made of approved materials and must meet the specifications of the Stormwater Code. The material, diameter, and specification of pipe selected must be indicated on the site improvement construction plans, required before installing the drainage system. If the detention pipe is located under a building, a load analysis must be evaluated by a Missouri-licensed engineer to determine the pipe specifications. The pipe must not be located under the foundation or have pressure exerted on it by the foundation. Flow control structures located under buildings should be accessible to vehicles. Plastic or corrugated metal pipe for detention pipes shall not be constructed in public rights-of-way.

Figure 2. Detention Pipe Design Configuration Options

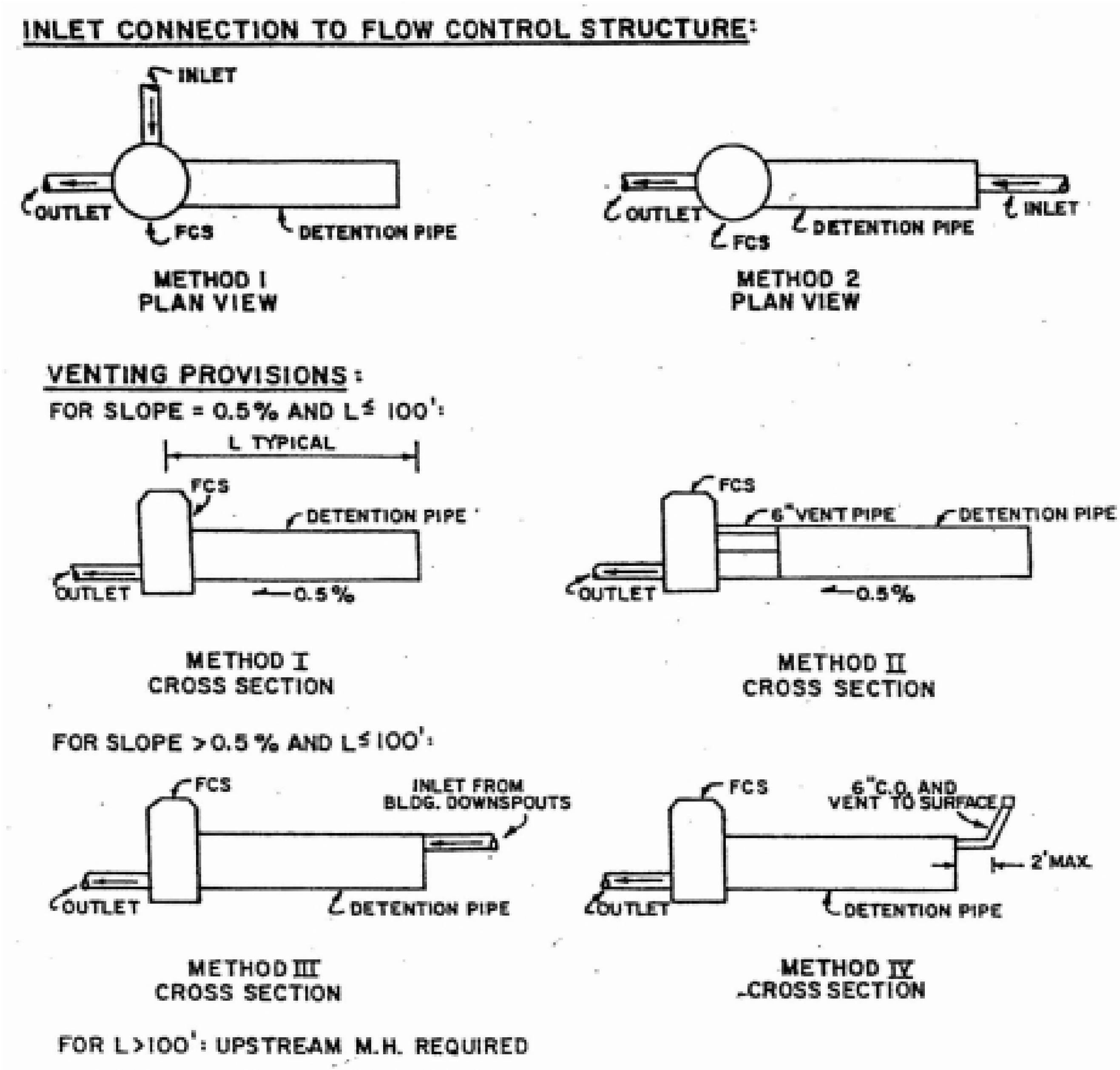


Table 4. Recommended Detention Pipe Material and Diameter

Pipe Material	Pipe Diameter	Recommended Specification
Concrete	24" or larger	ASTM C76 CL IV
Corrugated Metal	24" in diameter	14 gauge
	30" to 72" in diameter	12 gauge
	84" or larger in diameter	10 gauge
Galvanized or aluminized corrugated steel		AASHTO* M36. Galvanized steel pipe must have Asphalt Treatment #1.
Corrugated aluminum alloy		AASHTO M196, with no Perforations.
"ADS" or equal	All	AASHTO M294 Type S
Ductile Iron	12" or larger	ANSI** A21.51 Class 50, with push-on joints
PVC	12'" or larger	12" to 15" diameter: ASTM D3034 SDR35 18" in diameter: ASTM F679

* American Association of State Highway and Transportation Officials.
** American Society for Testing and Materials.

Detention Pipe End Plates and Connections

The upstream end of the detention pipe must have a watertight end plate or plug of standard manufacture (not constructed in the field) and must be made from the same material as the detention pipe. The inlet pipes may connect to the flow control structure or the detention pipe. Connections to the detention pipe are most easily made through the end plate.

Cover, Bedding, and Slope

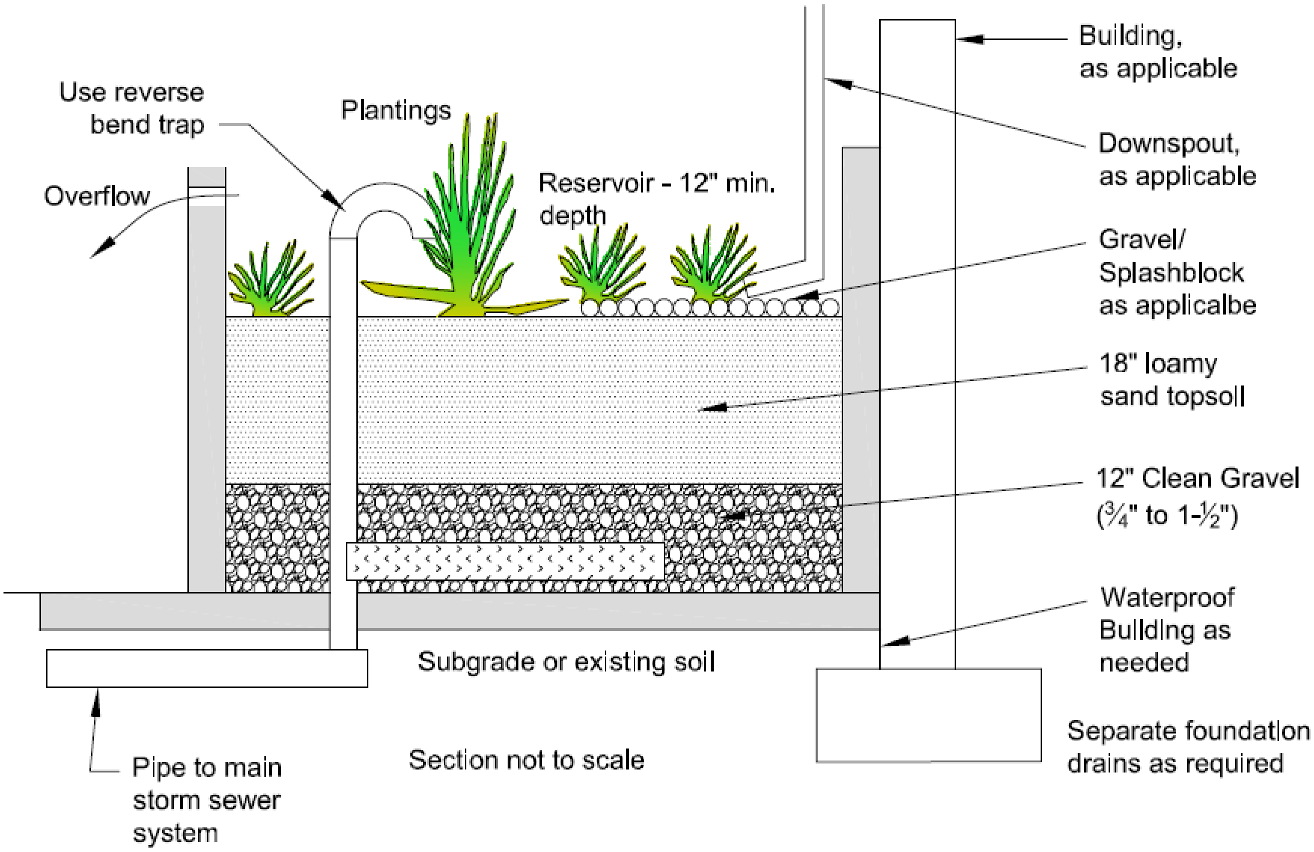
The bedding required for non-perforated detention pipes is the same as for other pipes in the drainage system per Stormwater Code. Provide at least 2 feet of cover over a detention pipe. For single-family and duplex residences, 18 inches of cover is allowable. Before an occupancy permit is issued by the City, the City Engineer or his/her inspector must approve the installed system, including the detention pipe and the flow control structure, after it is bedded but before it is covered with soil. The minimum slope for detention pipes is 0.5 %. The inlet pipe to the detention pipe and the outlet pipe from the flow control structure must have at least a 1 % slope.

2.2 Detention Vaults

Detention vaults are allowed for stormwater flow control. Calculations prepared by a Missouri-licensed engineering that demonstrate that the vault provides the same volume as a detention pipe system must be provided. The flow control device in a detention vault should be the same as that used in a detention pipe system.

2.3 Stormwater Planter

Figure 3. Stormwater Planter



Description

The Stormwater Planter is designed with an impervious bottom or is placed on an impervious surface. Flow control is obtained by storing the water in a reservoir above the soil. The additional benefit of pollutant reduction is achieved as the water filters through the vegetation and soil. Planters may be inground or above grade. For soils with a minimum infiltration rate of 4 inches/hour, see the Infiltrating Planter in Chapter 3.

Technical Requirements

Minimum planter width is 24 inches. Planters shall include a 12-inch layer of uniformly graded clean gravel with nominal size from 3/4" to 1-½," covered by a minimum of 18 inches of loamy sand topsoil with an infiltration rate of 2"/hr. The planter must include an overflow and be designed to drain to an approved discharge point. Plantings shall be appropriate for moist and seasonally dry conditions, and can include rushes reeds, sedges, iris, dogwood, currants, and numerous other shrubs, trees, and herbs/grasses.

Sizing

Stormwater planters shall be sized by a Missouri-licensed engineer to drain a 24-hour design storm within 48 hours. Additional flow control facilities may be required to detain the 100-year storm.

2.4 Surface Detention

Site improvement construction plans prepared by a Missouri-licensed engineer is required for surface detention. Allowable storage areas for surface detention include parking lots and wet/dry ponds. The design engineer shall calculate the detention volume using the same release rate and design storm required by the Stormwater Code.

Additional Specifications

- Provide at least two (2) feet of clearance between the lowest sill elevation and the limits of maximum ponding of the detention basin per the Stormwater Code.
- Depth of storage in parking lots must be per the Stormwater Code and varies depending upon whether the parking lot is for automobiles or for trucks.
- The embankment of surface ponds must be compacted and stabilized for erosion control.
- The rim of the flow control structure will be higher than the surface detention area and, in the case of parking lot surface detention, is usually placed in a nearby landscaped berm.
- Place a catch basin at the lowest point in the surface storage facility and connect it to the flow control structure.

Chapter 3

3.1 Description

Bioengineered and Infiltration flow control facilities use soil, gravel or vegetation to store, filter and infiltrate stormwater. Stormwater management facilities that use soil and vegetation have additional benefits over standard detention systems such as increased infiltration, pollution reduction, and in some cases, reduced cost. However, due to the geologic and topographic conditions in Dardenne Prairie, not all sites are suitable for discharging stormwater into the ground. In addition, Bioengineered and Infiltration facilities are not permitted in the public right-of-way unless approved by the City Engineer. Refer to the applicability section below to determine whether your site is suitable for these options.

Infiltration facility means a system designed to reduce or eliminate surface water runoff through onsite percolation. Infiltration facilities may be used in areas with relatively high infiltration rates, and, if designed to accommodate the required design-storm, may not need to discharge to the public drainage control system. Benefits of infiltration include the preservation of baseflow in streams, recharge of groundwater, and reduction of runoff peak flows. Infiltration facilities may include trenches, ponds, vaults, drywells, or tanks. This section outlines the minimum requirements for infiltration facilities in general and provides specific design criteria for ***infiltration trenches, infiltration planters*** and ***dry wells.***

Bioengineered systems use soil and vegetation to detain and cleanse stormwater, and then discharge to the public drainage control system. Bioengineered systems are appropriate for soils with a moderate infiltration rate. In addition to providing flow control, bioengineered systems improve water quality and may be integrated with landscape design on site. This chapter includes specifications for ***bioengineered planting strips.*** The ***Stormwater Planter*** in Chapter 2, also designed with soil and vegetation, can be used for sites where discharging to the ground is prohibited. The City Engineer may propose or approve alternative infiltration or bioengineered facilities that are determined to provide equal or greater flow control protection. However alternative infiltration facilities must meet the minimum general requirements and setbacks described in this section.

3.2 Applicability and Setbacks

- ***Geologic Hazard Areas.*** Infiltrating stormwater into the ground is not permitted within know sinkhole areas.
- ***Structures.*** Geotechnical analysis is required for facilities within 20 feet from any structure or property line, or within 50 feet up-slope of a building when the slope is greater than 5%.
- ***Soils.*** For a small project, no soils report is required and the Simple Soil Test Method may be used to determine the infiltration rate. For all other projects, the applicant must demonstrate through engineering analysis and the written opinion of an experienced Missouri-licensed geotechnical engineer that construction of a properly functioning infiltration facility is feasible. An experienced Missouri-licensed geotechnical engineer shall provide a report stating whether the site is suitable for the proposed infiltration facility, and shall recommend a design infiltration rate.
    - Unless geotechnical analysis demonstrates lower infiltration rates can be accommodated by the site and facility design, a minimum infiltration rate of one-half (0.5) inches per hour is required for bioengineered facilities and a minimum infiltration rate of four (4) inches per hour is required for infiltration facilities.
    - The base of all proposed facilities must be located at least three (3) feet above the seasonal high groundwater level, bedrock (or hardpan), and/or other impermeable layer. A minimum of three (3) feet of permeable soil must exist below the proposed facility.
    - The site must not contain contaminated soils. Sites which have been used in the past to dispose of materials or which may have been subjected to industrial or commercial contamination, leaks or spills must submit a geotechnical report indicating no contaminated soils exist on the site.

3.3 Siting Requirements

- Infiltration facilities shall not be located under buildings.
- Infiltration facilities may not be placed beneath pavement, or any surface that is subject to the compacting action of vehicular traffic, except for the following situations:
    - Infiltration facilities serving single family residences may be located under driveways.
- Infiltration facilities may be located under pavement (except in the public right-of-way) that is not subject to vehicular traffic, provided that an overflow is placed at an elevation of at least one (1) foot below that of any overlying pavement and in a location that can accommodate the overflow. The overflow must be five (5) feet away from property lines unless it discharges to a stream or ditch.

3.4 Overflow Conveyance System

All systems must be designed with an overflow conveyance designed to convey the 100-year, 24-hour developed peak flow rate to the downstream storm drain system or other acceptable discharge location. An overflow shall be located at an approved discharge point, a minimum of five (5) feet from any property line unless the overflow discharges into a stream or a ditch. The overflow location must not result in significant adverse impacts, such as uncontrolled, erosive, concentrated flows, or other impacts to drainage systems of the adjacent or downhill property. Systems shall be designed with emergency surface storage on site equal to at least ten (10) percent of the design storm volume.

3.5 Construction Requirements

- Infiltration facility areas must be delineated with fences prior to construction to prevent compaction by heavy equipment. Care must be taken not to compact soil during construction.
- No runoff from construction sites shall be allowed to enter the facility prior to completion of all construction activities, including re-vegetation and final site stabilization. Facilities may not be used as temporary sediment traps during the construction phase. If construction runoff enters the infiltration facility prior to site stabilization, all contaminated materials must be removed and replaced with new, clean materials before final inspection.
- Final construction of facilities shall not be done until after other site construction has finished and the site has been properly stabilized with permanent erosion control practices. If the area contributing to the facility cannot be stabilized prior to the start of construction, sediment laden runoff must be diverted away from the facility construction area.

3.6 Submittal Requirements

1. Drainage Control Plan

In addition to other specified information, the site improvement construction plans must include:

- Topography of the site and 50 feet beyond the property boundary at 2 foot intervals (or 5 foot intervals for slopes greater than 15%)
- All structures or walls, which alter the perviousness or topography of the site
- Location of proposed pipes and infiltration facilities
- Overflow discharge points
- Sizing calculations, including drainage area contributing to the infiltration facility

2. An as-built drawing submitted prior to final construction compliance inspection approval and/or occupancy permit issuance.

3. A Soils Report (see also “Simple Soil Test Method” below*)

The applicant must demonstrate through engineering analysis and the written opinion of an experienced Missouri-licensed geotechnical engineer that construction of a properly functioning infiltration facility is feasible. An experienced Missouri-licensed geotechnical engineer shall provide a report stating whether the site is suitable for the proposed infiltration facility and shall recommend a design infiltration rate. The soils report must also contain the following information:

- A site map indicating locations of subsurface explorations and proposed infiltration facility.
- Explorations must extend a minimum of three feet below the proposed base of the facility. All explorations shall be at the same depth. At least one exploration should be taken for every 50 feet of trench length. One exploration should be taken within 20 feet of proposed drywell locations (one exploration may be used for a cluster of drywells). An additional exploration shall be taken for every 5,000 square feet of infiltrating surface area. Additional explorations may be required if, in the opinion of an experienced Missouri-licensed geotechnical engineer, the soil characteristics vary greatly, the site is located in an area with a seasonal high groundwater table, or increasing the depth or number of explorations is necessary to accurately estimate the performance of the infiltration system. The exploration program may be decreased if, in the opinion of an experienced Missouri-licensed geotechnical engineer, the conditions are relatively uniform and the borings omitted will not influence the design or successful operation of the facility.
- Detailed soil logs for each exploration that include depth of hole, soil descriptions, the location of and depth to the seasonal high water table, bedrock, impermeable layer, and/or dissimilar soil layers if located during borings.
- Soils in each exploration shall be characterized by laboratory testing (grain size distribution for granular soils per ASTM Method D-422, Atterberg limits for silt and clay type soils per ASTM Method D-4318) and note any evidence of high ground water such as mottling or moisture, and variations and nature of stratification.
- Infiltration rates may be estimated on grain size distribution from the explorations. As a minimum, one soil gradation test per soil stratum in each test hole shall be performed within 2.5 times the maximum design depth of the water proposed for the infiltration facility, but with no less than 6 feet. This will result in a minimum of 2-3 soil gradation tests per soil stratum if the stratum is continuous across the facility. Below this depth, adequate soil gradation and classification testing shall be preformed to characterize the soil strata, but no less than one soil classification per test soil stratum.
- A statement that soil conditions are adequate for the proposed infiltration system, and that no adjacent downstream private or public properties will be adversely affected by the infiltration of stormwater on the site.
- Additional information as determined by the City Engineer due to the nature of the site or the proposed project.

***Simple Soil Test Method**

For Small Projects, a Simple Soil Test Method may be conducted, in place of a soils report developed by an experienced Missouri-licensed geotechnical engineer, to determine whether the site meets the minimum infiltration rate required for bioengineered or infiltration facilities. The soil test shall be conducted in accordance with the procedure described below:

1. Excavate test hole 6 inches in diameter at the site of the proposed infiltration facility. Complete excavation of test hole to 3 feet below the bottom of the proposed facility.
2. Carefully scrape the bottom and sides of the hole to provide a clean interface with the native soil. Remove all loose material from the test hole. Add two inches of coarse (1/2 to ¾ inch) washed gravel to the bottom of the hole.
3. Fill the hole with clear water to a minimum depth of 12 inches over the gravel. Care should be taken to direct water slowly to the graveled bottom to prevent erosion of the sides of the hole while filling with water. Keep water in the hole, by re-filling if necessary, for at least four hours and preferably overnight. If the soil, other than loose sand, has a dry appearance when the hole is initially dug, the soil must be allowed to swell overnight after the soaking period. If the soil was initially wet to saturation, proceed with the percolation rate measurement below after the initial four hours of soaking.
4. After saturating the soil and permitting it to swell, adjust the depth of water in the test hole to six inches over the gravel. From the surface, measure the reduction in water level over three 30-minute intervals. This average reduction in water depth over 30 minutes is used to calculate the percolation rate expressed as inches per hour.

3.7 Operation and Maintenance Requirements

Infiltration facilities and bioengineered systems can clog after extended use, thereby requiring system replacement. Proper maintenance methods will prolong the useful life of an infiltration facility. The property owner must comply with the maintenance requirements outlined in the Appendix for each facility.

3.8 Additional Conditions and Responsibilities

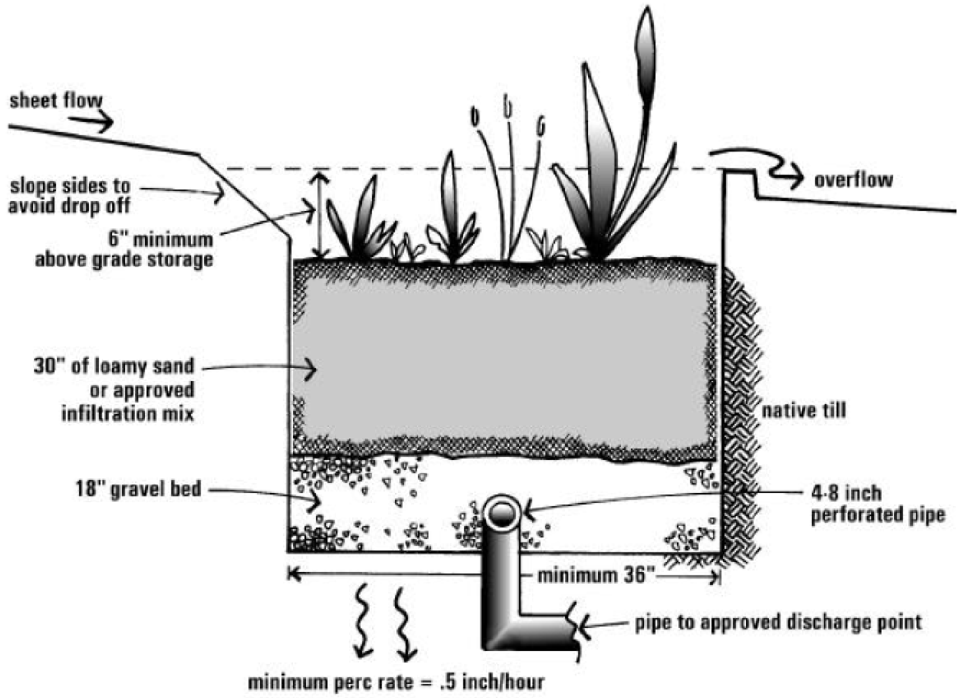
If not properly designed or maintained, or during intense storms, infiltration facilities may overflow to the surface and cause temporary flooding. When the City authorizes the use of infiltration on a site, the property owner and an experienced Missouri-licensed geotechnical engineer shall be responsible for determining the suitability of the site for infiltration and shall be responsible for any damage that may occur as a result of infiltration.

Infiltration and bioengineered facilities require regular maintenance and periodic replacement. The property owner is responsible for maintaining and replacing onsite infiltration and bioengineered facilities designed to meet the flow control requirement.

If the City Engineer determines (either before or after the site improvement construction plans are approved by the City), that the site topography and/or soils are unsuitable for infiltration, the property owner is responsible for design and installation of a suitable alternative, such as a detention pipe with controlled release, or an extension of a public storm drain.

3.9 Bioengineered Facilities: Bioengineered Planting Strip

Figure 4. Bioengineered Planting Strip



Description

A Bioengineered Planting Strip (see **Figure 4**) is an excavated trench backfilled with gravel and loamy sand and planted with groundcover and shrubs. Bioengineered Planting Strips must include an overflow system and a perforated pipe to convey excess drainage to the public drainage control system or other approved discharge point, (unless the soils report and calculations demonstrate full infiltration of the required design-storm.) Bioengineered Planting Strips may receive sheet flow from adjacent pavement or may be modified to receive concentrated flows.

Design Requirements

Bioengineered planting strips must be designed according to the following criteria:

- Trenches designed to receive concentrated flows must use a conveyance pipe of ASTM 3034 SDR 35 or equivalent, and include a catch basin with trap or sump and a central trench pipe (4" to 8" perforated pipe).
- For trenches designed to receive flow from adjacent pavement, the site must be graded so that runoff is directed in sheet flow across the length of the facility.
- Trenches should be excavated in a manner that does not disturb the native soil on the sides of the trench.
- The bottom of the trench must have a minimum longitudinal slope of 1-1/2% and a maximum slope of 2%.
- Trenches must be a minimum of three feet wide.
- The minimum depth of an infiltration trench 4–1/2 feet, including 6 inches of surface storage.

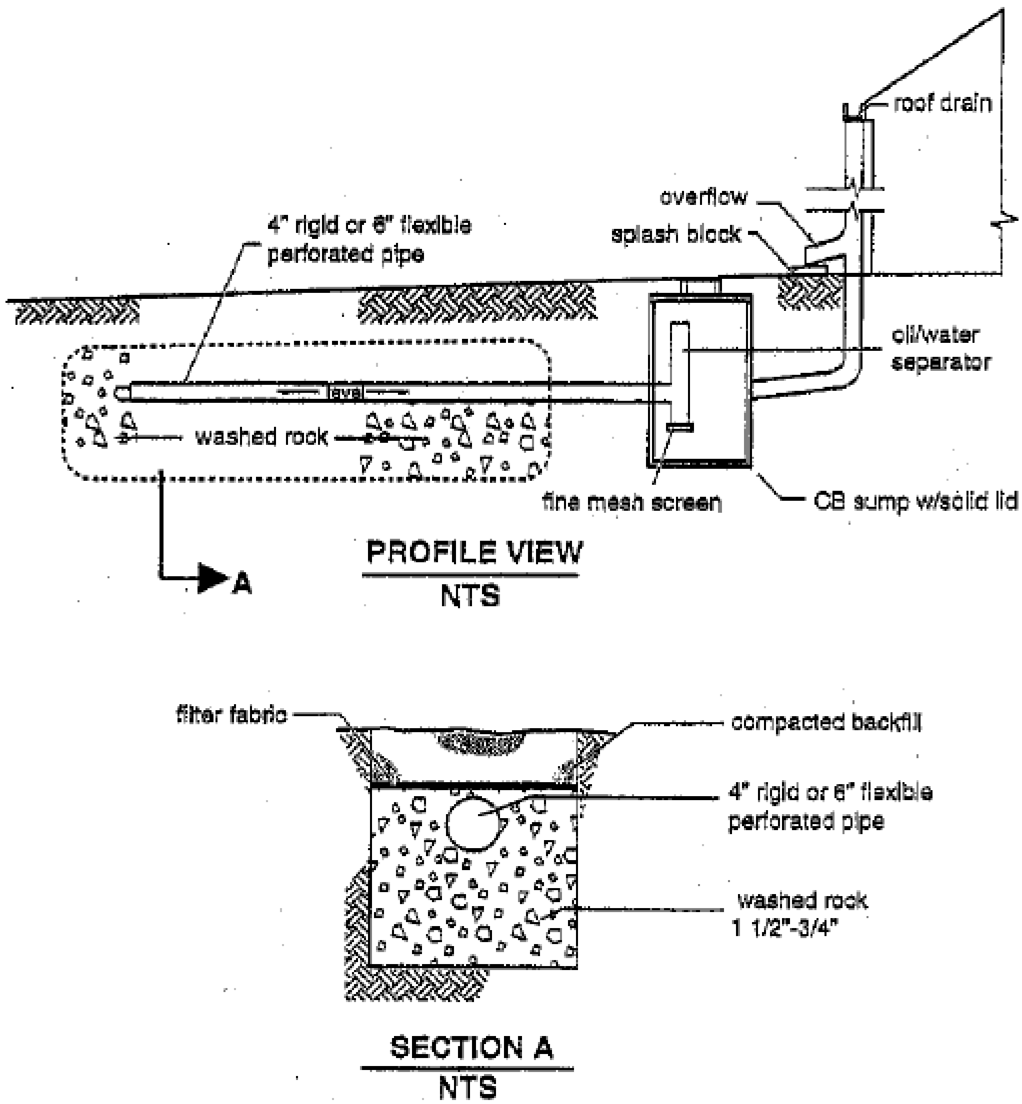
- The trench must be backfilled with:
  - a bottom layer of 18 inches of ¾" clean gravel;
  - Covered with 30 inches of loamy sand (or approved infiltration mix) with a minimum discharge rate of 2 in./hr.
- Trenches shall have perforated pipe in the center of the gravel portion. The pipe shall be between four (4) inches and eight (8) inches in diameter. The pipe shall be:
  - PVC ASTM 3034 SDR 35, meeting the requirements of AASHTO M 278, or
  - perforated corrugated polyethylene underdrain pipe, Type S, meeting the requirements of AASHTO M 294, or equivalent.
- Trenches must contain an overflow structure.
- Trenches must be equipped with an observation well, with a secure locking well cap, to measure the drawdown time following a storm and to monitor sedimentation to determine maintenance needs. The observation well may be a 4" diameter perforated pipe that extends to the bottom of the trench, located at a point approximately halfway along the trench length.
- Plantings shall be designed to provide full cover within one year.

Sizing

Bioengineered planting strips shall be sized by a Missouri-licensed engineer to drain a 24-hour design storm within 48 hours. Additional flow control facilities may be required to detain the 100-year storm.

3.10 Infiltration Facility: Infiltration Trench

Figure 5. Infiltration Trench



Description

An ***infiltration trench*** is a shallow, excavated trench that has been backfilled with coarse stone aggregate to create an underground reservoir. See **Figure 5.** Stormwater runoff diverted into the trench gradually exfiltrates from the bottom of the trench into the subsoil and eventually into the water table. Infiltration trenches are a good option with sandy soils where the depth to the maximum wet-season water table or hardpan is between 3 and 6 feet.

Sizing

Infiltration trenches shall be sized by a Missouri-licensed engineer to drain a 24-hour design storm within 48 hours. Additional flow control facilities may be required to detain the 100-year storm.

Design Requirements

Infiltration trenches must be designed according to the following criteria:

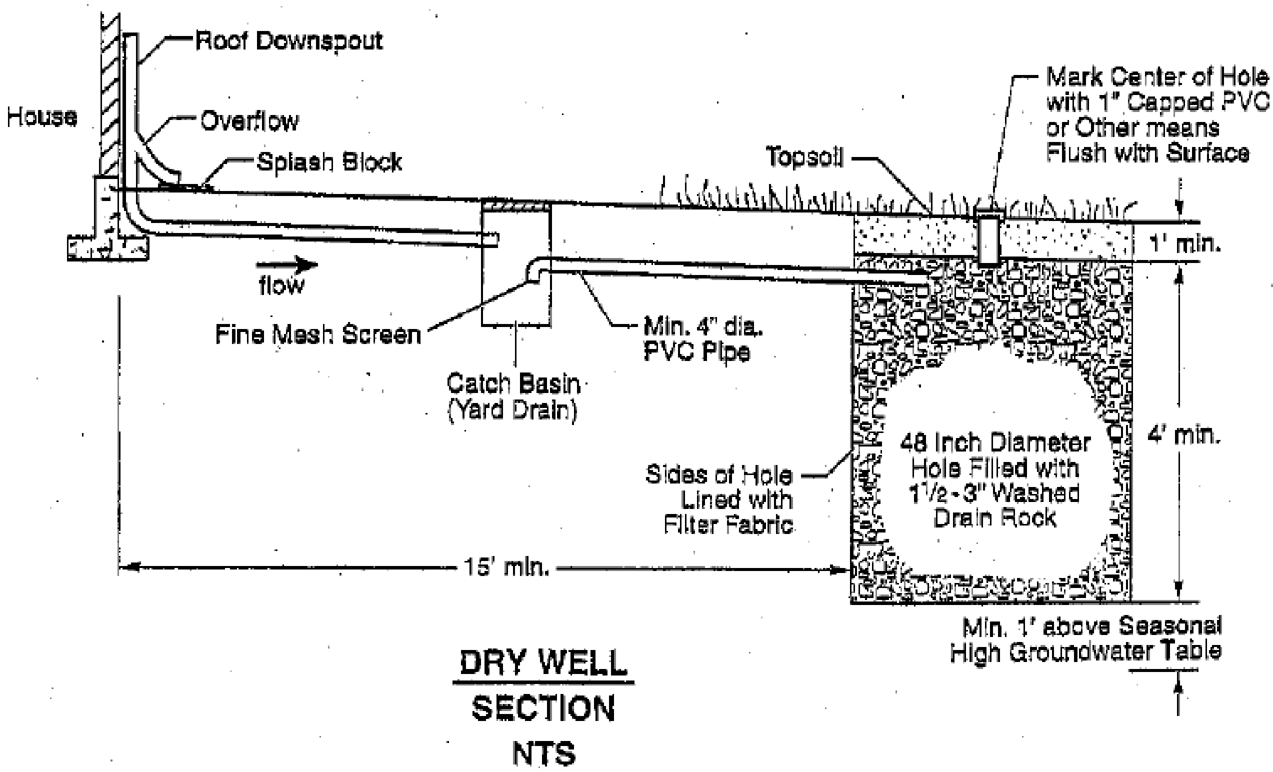
- Trenches must contain an overflow structure.
- Trenches designed to receive concentrated flows must use a conveyance pipe of ASTM 3034.
- SDR 35 or equivalent, and include a catch basin with trap or sump and a central trench pipe (4" to 8" perforated pipe).
- For trenches designed to receive sheet flow, the site must be graded so that runoff is directed in sheet flow across a minimum 10 foot grass buffer strip to remove larger sediment particles.
- Trenches shall run parallel to site contour lines.
- Sides of adjacent trenches shall be a minimum of five (5) feet apart.
- The bottom of the trench must be level.
- The trench must have a minimum of one (1) foot of cover.
- The minimum width and depth of an infiltration trench shall be two feet (2) and the maximum width and depth shall be four (4) feet.
- Geotextile fabric, according to the specifications below, shall be placed around the walls and bottom of the trench. A six (6) inch layer of sand may also be used as a filter media at the bottom of the trench.

Grab tensile strength (lbs.)	75 (min)	ASTM D4632
Burst strength (psi)	130 (min)	ASTM D3786
Puncture resistance (lbs)	80 (min)	ASTM D4833
Permeability (cm/sec) Permittivity (sec^{-1})	0.2 (min)	ASTM D4491
AOS (sieve size)	#60 - #70	ASTM D4751
Ultraviolet resistance	70% (min)	ASTM D4355

- Trenches shall be filled with uniformly graded clean gravel with nominal size from 3/4" to 1-1/2" diameter.
- Trenches shall have perforated pipe in the center of the cross section. The pipe shall be between four (4) inches and eight (8) inches in diameter. The pipe shall be:
    - PVC ASTM 3034 SDR 35, meeting the requirements of AASHTO M 278, or
    - perforated corrugated polyethylene underdrain pipe, Type S, meeting the requirements of AASHTO M 294, or equivalent.
- Trenches must be equipped with an observation well, with a secure locking well cap, to measure the drawdown time following a storm and to monitor sedimentation to determine maintenance needs. For projects with more than 5,000 square feet of impervious surface, each trench shall have one observation well (4" diameter perforated pipe with a secure locking well cap) that extends to the bottom of the trench, located at a point approximately halfway along the trench length.

3.11 Infiltration Facility: Dry Well

Figure 6. Dry Well



Description

Dry wells are designed to be deep and therefore are generally more compact than infiltration trenches, but are appropriate only where the depth to maximum wet-season water table is 6 feet or greater. **Figure 6** illustrates the requirements for infiltration dry wells as outlined below:

Sizing

Dry wells shall be sized by a Missouri-licensed engineer to drain a 24-hour design storm within 48 hours. Additional flow control facilities may be required to detain the 100-year storm.

Design Requirements

- Dry wells designed to receive concentrated flows must use a conveyance pipe of ASTM 3034 SDR 35 or equivalent, and include a catch basin with trap or sump and a central trench pipe (4" to 8" perforated pipe).

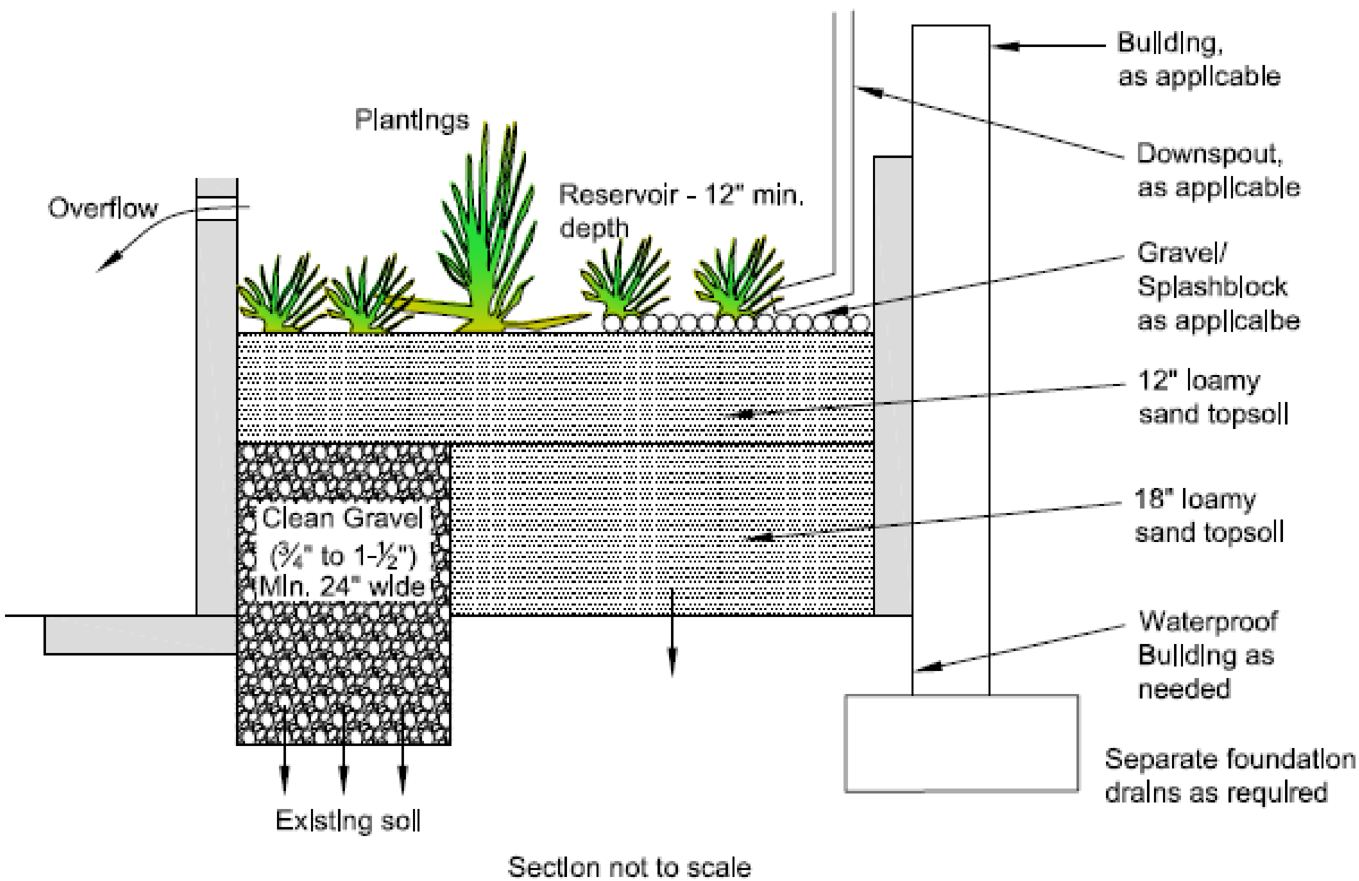
- Dry well bottoms must be a minimum of 1 foot above seasonal high groundwater level or impermeable soil layers.

- Filter fabric (geotextile) shall be placed on top of the drain rock and on dry well sides prior to backfilling.

- Spacing between dry wells should be a minimum of 4 feet.
- Dry wells must be equipped with an observation well, with a secure locking oil cap, to measure the drawdown time following a storm and to monitor sedimentation to determine maintenance needs.
- A minimum 5-foot setback shall be maintained between any part of a dry well and any structure or property line.

3.12 Infiltration Facility: Infiltration Planter

Figure 7. Infiltration Planter



Description

The Infiltration Planter is designed to temporarily store runoff in a reservoir, filter stormwater through the planter soils and vegetation, and then infiltrate into the native soil. Planters may be in-ground or above grade.

Technical Requirements

Minimum planter width is 36 inches. The planter shall include a 24-inch wide, 48-inch deep trench filled with uniformly graded clean gravel with nominal size from 3/4" to 1-½", covered with 12" of loamy sand topsoil. The remainder of the planter should be backfilled with loamy sand with a minimum infiltration rate of 2 inches per hour, leaving a 12" reservoir or surface storage. (See **Figure 7**). Plantings shall be appropriate for moist and seasonally dry conditions, and can include rushes, reeds, sedges, iris, dogwood, currants, and numerous other shrubs, trees, and herbs/grasses.

Sizing

Infiltration planters shall be sized by a Missouri-licensed engineer to drain a 24-hour design storm within 48 hours. Additional flow control facilities may be required to detain the 100-year storm.

Chapter 4

4.1 General Requirements

All storm sewers and other drainage appurtenances shall meet the requirements of the Stormwater Code and pursuant to the details in Appendix B of this Manual.

Tree grates, when required, shall be pursuant to Appendix C of this Manual.

Appendix A: Maintenance Requirements

Introduction

This appendix outlines inspection, maintenance, and recordkeeping requirements. Each section includes a description and lists the inspection and maintenance requirements of each type of drainage system. The inspection and maintenance requirements include information about what features to inspect at each facility, when and how often these systems should be inspected, and how to identify specific defects that warrant corrective action. Corrective actions are described that should be taken to maintain system performance. The description includes basic information about the common types of drainage systems used to detain urban runoff, how they function, and how well they perform in removing stormwater pollutants. The types of drainage systems covered in this appendix include:

- Catch basins, maintenance holes, and storm drain inlets
- Vaults, tanks, and pipes
- Bioengineered Planting Strips (swales and filter strips)
- Infiltration trenches
- Ponds and constructed wetlands

Catch Basins, Maintenance Manholes, and Storm Drain Inlets

Grated and curb-inlet type catch basins are designed to collect and direct runoff into the storm drainage system, as well as to trap debris and litter present in roadway runoff. Unlike maintenance holes and inlets, catch basins contain a sump at the bottom of the structure to collect sediment and other debris. The purpose of the sump is to prevent the downstream pipes from becoming clogged and to prevent sediment and debris from being discharged into receiving waters. In addition, the outlet pipe on catch basins in Dardenne Prairie is typically installed with a downturned elbow or tee to trap floatable material. Storm drain inlets and maintenance holes which do not contain sumps are not effective in removing pollutants from stormwater.

Table 5. Maintenance Requirements for Catch Basins, Maintenance Holes, and Inlets

CATCH BASIN	INSPECTION FREQUENCY[1]			
Components	**W**	**A**	**Condition when maintenance required**	**Action Required**
CLEANING				
Trash, debris, sediment, vegetation	√	√	Accumulated material within 18 inches of the bottom of the lowest pipe entering or exiting the structure.	Remove/dispose
	√	√	Sediment visible in inlet/outlet pipes.	Rod lines
	√	√	Root intrusion greater than 6 inches in length or less than 6 inches apart	Root saw pipes
	√	√	Vegetation/debris on inlet grate.	Clean and dispose material
Chemical Pollution	√	√	Chemicals (solvents, gas, diesel, paint, natural gas) present	Identify and control source and remediate site
Frame and/or top slab		√	Corner extends more than 0.75 inch past curb face or street surface (where applicable)	Repair so frame even with curb
		√	Holes greater than 2" or cracks greater than 0.5" in top slab	Repair to water tight condition
		√	Frame not flush with top slab (separation >0.75")	Repair
CB structure		√	Cracks wider than 0.5" and longer than 3 feet, missing bricks, or any evidence of water leakage, bricks missing	Repair
		√	Cracks wider than 0.5" and longer than 1 foot at pipe inlet/outlet	Repair
Cover/grate		√	Cover/grate missing, damaged, or only partially in place	Repair/replace
		√	Cannot be opened by one person. Locking bolts missing or damaged.	Repair/replace
	√	√	Buried	Excavate
Ladder		√	Ladder rungs damaged, missing, or misaligned	Repair/replace

[1] **Inspection frequency:**
W = Wet season inspections. Inspect the items that are checked once in the early part of the wet season (April) and again near the end of the wet season (July).
A = Annual inspection. Inspect the items that are checked once each year. To avoid interference caused by rainfall, the annual inspection should be conducted during the dry season (January-February).

Vaults, tanks, and pipes

Vaults, tanks, and pipes are underground storage facilities that can be designed as dry systems (i.e., detention for flow control), wet systems for water quality treatment, or as combined systems that provide both flow and water quality control. Underground facilities are generally used to manage storm water from smaller sites (e.g., less than 5 acres). Vaults are typically constructed of reinforced concrete, while tanks and pipes are usually made of corrugated metal or plastic pipe.

Dry vaults/tanks. Detention systems are designed primarily to control the rate of runoff from developed sites. Runoff enters the vault or tank and is temporarily stored as water is slowly released through a small orifice to the downstream drainage system. Detention storage, sometimes referred to as "live" storage, is used to control peak discharge rates from developed sites, reduce stream bank erosion and minimizes flooding in downstream areas. Detention vaults/tanks should be designed to drain completely dry following storm events.
Although not specifically designed to provide water quality treatment, these systems can also remove some pollutants if the storage volume is large enough to adequately detain incoming runoff. Typically a storage time of 24 hours or more is needed for a detention vault/tank to provide any significant amount of pollutant removal. Removal occurs primarily via sedimentation as suspended solids and particulate-bound pollutants settle out in the vault/tank.

Wet vaults/tanks. Wet vaults/tanks contain a permanent pool (i.e., wet pool) that functions as an energy dissipater, slowing the velocity of incoming storm water and allowing suspended sediment to settle. The permanent pool volume is generally referred to as "dead" storage. Wet vaults/tanks typically provide no live storage for flow control purposes and function only as water treatment devices.

Combined systems simply incorporate the live storage of a dry vault/tank with the dead storage (i.e., wet pool) of a wet vault/tank into a single facility. Consequently, these facilities provide both flow control and water quality treatment. Pollutant removal mechanisms in a combined system are similar to those described above under water quality ponds.

Table 6. Maintenance Requirements for Dry/Wet Vaults, Tanks, Pipes

Vault Components	INSPECTION FREQUENCY[1]			
Components	**W**	**A**	**Condition when maintenance required**	**Action**
GENERAL				
Trash/debris Remove/dispose	√	√	More than 1 ft^3	Remove/dispose
Sediment		√	Accumulated sediment in vault/tank exceeds 6 inches.	Remove/dispose
Pollution *(check for noticeable sheen or unusual odor)*		√	Any visible accumulation of oil, gas, or other contaminant.	Remove/dispose
VAULT/TANK				
Ladder		√	Ladder rungs damaged, missing, or misaligned	Repair/replace
Concrete		√	Riser, concrete walls, or joints cracked or leaking. Bricks missing. Cracks greater than 0.5 inches wide.	Repair
Maintenance holes		√	Cannot be opened by one person. Locking bolts missing or damaged	Repair/replace
		√	Buried	Excavate
Inlet grates		√	Cracked or broken grate	Replace
Baffle(s)		√	Corroded, cracked, or warped.	Repair/replace
Air vents			Plugged or blocked with debris	Clean
CONTROL STRUCTURE				
Shear gate (exercise full open/close and inspect)		√	Gate cannot be operated by 1 person	Lubricate, repair, or replace
		√	Gate rusted, not watertight, or missing	Repair/replace
		√	Chain or pull rod missing	Replace
		√	Not plumb within 10%	Repair
		√	Connection to outlet pipe rusted or leaking	Repair/replace
Orifice plates (inspect when vault cleaned)		√	Bent, rusted, or missing	Replace
Sediment/debris		√	More than 12 inches of accumulated material.	Clean/remove
Outlet pipe		√	Submerged or partially submerged	Check for downstream obstruction
Oil absorbent pads (if applicable)		√	Pads missing or stained over more than 75% of pad area	Remove and replace
SHUTOFF VALVE AND/OR MAINT. DRAIN				
Valve exercised		√	Valve cannot be operated by 1 person. Valve rusted or not watertight.	Repair/replace
Sediment		√	Vertical distance between sediment and drain pipe is less than 6 inches.	Remove and dispose
INLET/OUTLET				
Trash rack	√	√	Trash or other debris present on trash rack.	Clean and dispose trash
		√	Bar screen damaged or missing	Replace
Pipes		√	Root intrusion greater than 6 inches in length or less than 6 inches apart	Root saw pipes
Receiving water	√	√	Erosion damage along banks outlet	Regrade/armour

[1] **Inspection frequency:**
W = Wet season inspections. Inspect the items that are checked once in the early part of the wet season (April) and again near the end of the wet season (July).
A = Annual inspection. Inspect the items that are checked once each year. To avoid interference caused by rainfall, the annual inspection should be conducted during the dry season (January-February).

Bioengineered Planting Strips

A Bioengineered Planting Strip is an excavated trench backfilled with gravel and sandy loam and planted with groundcover and shrubs. Although the planting strip is designed to provide flow control, these facilities have the added benefit of removing pollutants by filtering stormwater through vegetation. They are usually planted with grass, however other vegetation such as emergent wetland species can be used depending on site conditions.

The bioengineered planting strips included in this manual are designed for flow control. However, bioengineered planting strips are likely effective in removing suspended sediment and particulate-bound pollutants via filtration an sedimentation. Dense vegetation aids in the filtration process as particulates and associated pollutants adhere to the grass blades as runoff passes through the filter. Sedimentation occurs when runoff is spread across the large filtration area, thus reducing the flow velocity and allowing particles to settle in the filter. To a lesser extent, bioengineered planting strips can remove dissolved pollutants through biological and chemical mechanisms. Biological removal occurs primarily through plant uptake and microbial degradation. Removal efficiencies for bioengineered planting strips are still being determined.

Table 7. Maintenance Requirements for Bioengineered Planting Strips

Swale/Filter Strip	INSPECTION FREQUENCY[1]			
Components	**W**	**A**	**Condition when maintenance required**	**Action**
SWALE/FILTER				
Trash/yard waste	√	√	More than 1 ft^3	Remove/dispose
Sediment	√	√	Sediment exceeds 4 inches or covers grass, especially within the upper section, near inlet.	Remove/dispose sediment. Restore grass, protect from erosion until vegetation established.
Pollution *(check for noticeable sheen or unusual odor)*		√	Any visible accumulation of oil, gas, or other contaminant.	Remove/dispose
Noxious weeds		√	Any nuisance or noxious veg. (morning glory, English ivy, reed canary grass, Japanese knotweed, purple loosestrife, blackberry, Scotch broom, tansy, poison oak, stinging nettles, devils club).	Remove and dispose cuttings
Grass/vegetation		√	Poor vegetation growth (<75 percent coverage)	Aerate soil, fertilize with 21-3-21 low P fertilizer, and reseed
Flow characteristics		√	Standing/stagnant water, no visible water movement.	Check for downstream obstruction.
Erosion/scouring			Flow channelized, forming rills/gullies more than 2 inches deep.	Regrade swale bottom, reinstall flow spreader, revegetate, protect from erosion until vegetation established.
Flow Spreader				
Sediment	√	√	Ports/notches clogged or sediment trap filled.	Remove and dispose
Grade board/baffle	√	√	Damaged or not level	Remove and reinstall to level position.

[1] **Inspection frequency:**
W = Wet season inspections. Inspect the items that are checked once in the early part of the wet season (April) and again near the end of the wet season (July).
A = Annual inspection. Inspect the items that are checked once each year. To avoid interference caused by rainfall, the annual inspection should be conducted during the dry season (January-February).

Infiltration Trenches

Infiltration trenches and other stormwater infiltration systems such as rock pockets and dry wells temporarily store stormwater so that it can gradually seep into the underlying soil and groundwater. Infiltration systems treat stormwater runoff by physically filtering particulates and particulate-bound pollutants as the water moves through the soil. In addition, pollutants can attach to the soil particles which aids in removing dissolved pollutants. Microbial degradation of some contaminants can also occur as water infiltrates through the soil. Infiltration systems can also be used to reduce the rate of runoff from a site by removing the volume of runoff that would otherwise be discharged to the surface drainage system and allowing it to infiltrate into the ground. However, due to the relatively low permeability of soil in many areas of the City of Dardenne Prairie, infiltration systems have fairly limited applicability in the Dardenne Prairie area. Infiltration systems in Dardenne Prairie are typically only useful for fairly small sites where the volume of runoff is low.

Table 8. Maintenance Requirements for Infiltration Trenches

Trench Components	INSPECTION FREQUENCY[1]			
Components	**W**	**A**	**Condition when maintenance required**	**Action**
GENERAL				
Trash/debris	√	√	More than 1 ft^3	Remove/dispose
Pollution *(check for noticeable sheen or unusual odor)*	√	√	Any visible accumulation of oil, gas, or other contaminant	Remove/dispose
Noxious weeds	√	√	Any nuisance or noxious veg. (morning glory, English ivy, reed canary grass, Japanese knotweed, purple loosestrife, blackberry, Scotch broom, tansy, poison oak, stinging nettles, devils club).	Remove and dispose cuttings
Drain rock	√	√	Water ponds at surface during storm events. Little or no water flows through system	Replace rock material
Roof downspout	√	√	Splash pad missing or damaged	Repair/replace
STORAGE SUMP (IF PRESENT)				
Sediment	√	√	Accumulated material within 18 inches of the bottom of the outlet pipe.	Remove/dispose
Maintenance holes	√	√	Cannot be opened by one person. Lock missing or damaged	Repair/replace
		√	Buried	Excavate
Pollution (check for noticeable sheen or unusual odor)	√	√	Any visible accumulation of oil, gas, or other contaminant	Remove/dispose

[1] **Inspection frequency:**
W = Wet season inspections. Inspect the items that are checked once in the early part of the wet season (April) and again near the end of the wet season (July).
A = Annual inspection. Inspect the items that are checked once each year. To avoid interference caused by rainfall, the annual inspection should be conducted during the dry season (January-February).

Ponds and Constructed Wetlands

Like vaults, ponds are storage facilities that can be designed as detention, water quality, or combined systems, except that ponds are above ground rather than underground facilities. Above ground pond systems require more land to construct in urban setting. In addition to physical removal via sedimentation, ponds, particularly wet ponds also provide a suitable environment and adequate hydraulic residence time to promote biological and chemical reactions, which improves their ability to remove pollutants from urban runoff. In addition, aquatic plants that establish in the wet pool can also enhance sedimentation and promote pollutant uptake.

Table 9. Maintenance Requirements for Ponds and Constructed Wetlands

	INSPECTION FREQUENCY[1]			
Pond Components	**W**	**A**	**Condition when maintenance required**	**Action**
DRY POND AREAS				
Trash/yard waste	√	√	More than 1 ft^3	Remove/dispose
Sediment		√	Accumulated sediment exceeds 1 foot	Remove/Restore
Pollution	√	√	Any visible accumulation of oil, gas, or other contaminant.	Remove/dispose
Noxious weeds		√	3 Any nuisance or noxious veg. (morning glory, English ivy, reed canary grass, Japanese knotweed, purple loosestrife, blackberry, Scotch broom, tansy, poison oak, stinging nettles, devils club).	Remove and dispose cuttings
Grass/ground cover		√	Residential area: mow when grass height reaches 8". In other areas, match adjacent ground cover/terrain as long as there is no interference with facility function.	Mow to 2-inch height. Remove cuttings and dispose
Insects		√	Wasps, hornets interfere with operations	Remove
Tree/brush growth		√	Growth does not allow maintenance access, interferes with future maintenance activity (e.g., alder), or reduces storage capacity. Otherwise leave alone.	Remove and restore pond bottom
Fence		√	Damage to gate/fence, posts out of plumb, or rails bent more than 6 inches.	Repair/replace
		√	Brush/weeds along fenceline	Remove brush to within 3 feet of fence
		√	Erosion/settlement causing opening under the fence greater than 4 inches and 12-18 inches wide or openings along fenceline greater than 8-inch diameter.	Repair
EMBANKMENT AND EMERGENCY SPILLWAY				
Spillway		√	Rock lining down to 1 layer of rock	Add rock to design conditions.
		√	Brush, tree (alder) growth on spillway.	Remove and dispose
Embankment		√	Downstream face wet, seeps or leaks evident Plug holes.	Contact a Missouri-licensed geotechnical engineer ASAP
		√	Any evidence of rodent holes or water piping around holes if facility acts as dam or berm	Eradicate rodents/repair holes (fill and compact)
		√	Erosion (gullies/rills) greater than 2 inches around inlets, outlet, and along side slopes. Note evidence of leakage through embankment.	Eliminate source of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control blanket)
		√	Settlement greater than 4 inches (relative to undisturbed sections of berm)	Restore to design height

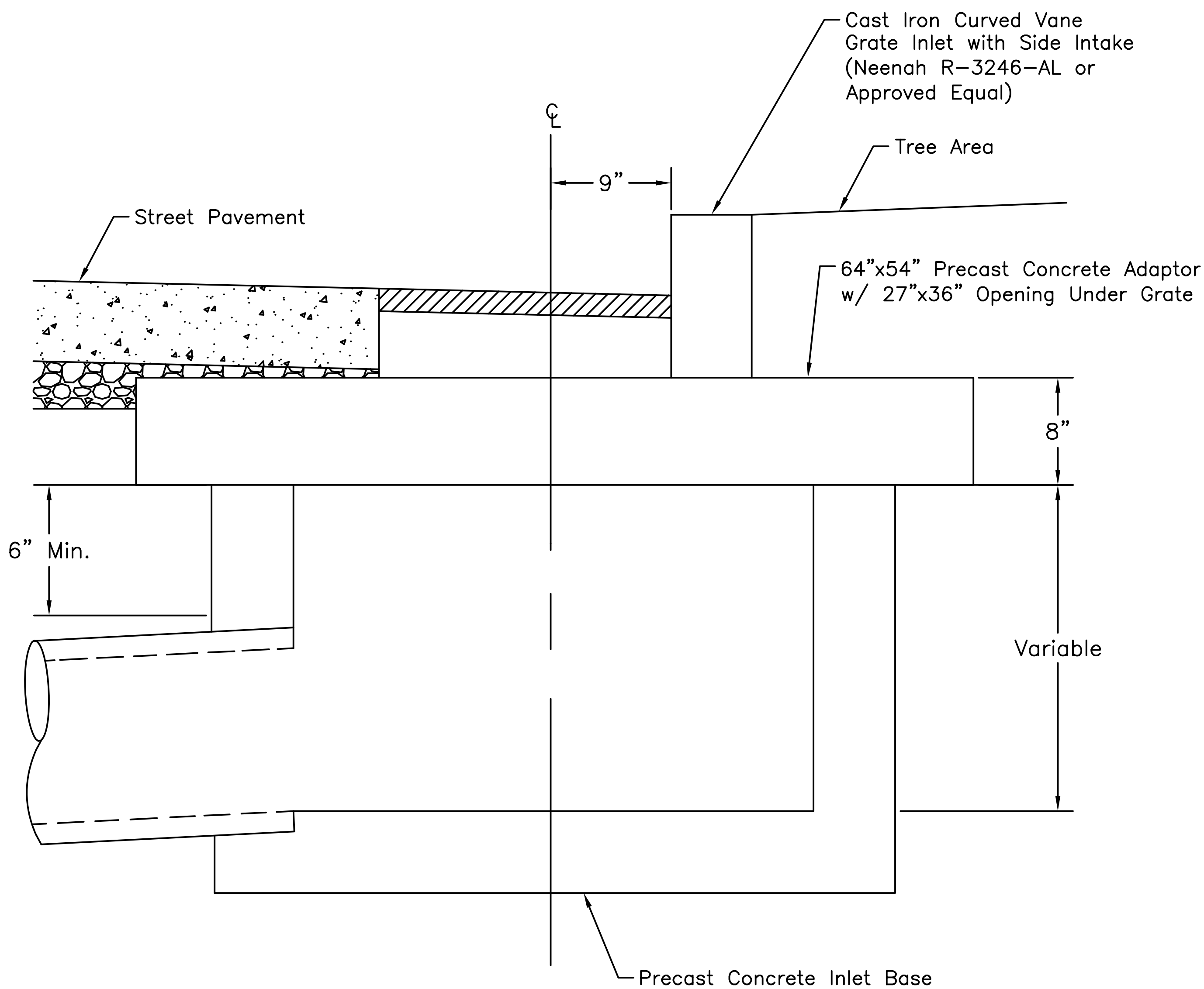
[1] **Inspection frequency:**
W = Wet season inspections. Inspect the items that are checked once in the early part of the wet season (April) and again near the end of the wet season (July).
A = Annual inspection. Inspect the items that are checked once each year. To avoid interference caused by rainfall, the annual inspection should be conducted during the dry season (January-February).

Table 9. Maintenance Requirements for Ponds and Constructed Wetlands (cont.)

	INSPECTION FREQUENCY[1]			
Pond Components	**W**	**A**	**Condition when maintenance required**	**Action**
CONTROL STRUCTURE				
Shear gate (exercise full open/close and inspect)		√	Gate rusted, not watertight, or missing	Lubricate, repair, or replace
		√	Chain or pull rod missing	Replace
Riser		√	Loose, not firmly attached to manhole wall	Repair
		√	Not plumb within 10%	Repair
		√	Connection to outlet pipe rusted or leaking	Repair/replace
Maintenance hole		√	Cannot be opened by one person. Lock missing or damaged	Repair/replace
		√	Buried	Excavate
Orifice plate(s)		√	Bent, rusted, or missing	Replace
Structural integrity		√	Ladder rungs damaged, missing, or misaligned	Repair/replace
		√	Cracks wider than 0.5" and longer than 3 feet, missing bricks, or any evidence of water leakage	Repair
		√	Lock bolts on maintenance hole cover missing	Replace
		√	Cracked or broken grate	Replace
Sediment, trash.		√	Accumulated material within 18 inches of the bottom of the outlet pipe.	Remove/dispose
Outlet pipe		√	Submerged or partially submerged	Check for downstream obstruction
		√	Root intrusion greater than 6 inches in length or less than 6 inches apart	Root saw pipes
PERMANENT POOL (WET PONDS)				
Undesirable or excessive vegetation		√	Undesirable plants Remove	Remove and replant with sedges, rushes, other
Sediment		√	Accumulated sediment greater than 18 inches.	Remove, regrade, and replant pond bottom.
SHUTOFF VALVE AND/OR MAINTENANCE DRAIN				
Valve exercised		√	Valve cannot be operated by 1 person. Valve rusted or not watertight.	Repair/replace
Sediment		√	Vertical distance between sediment and drain pipe is less than 6 inches.	Remove and dispose
POND OUTLET				
Trash rack		√	Trash or other debris present on trash rack.	Clean and dispose trash
		√	Bar screen damaged or missing	Replace
Inlet/outlet pipes		√	Root intrusion greater than 6 inches in length or less than 6 inches apart	Root saw pipes
Receiving water		√	3 Erosion damage along banks	Regrade armor

[1] **Inspection frequency:**
W = Wet season inspections. Inspect the items that are checked once in the early part of the wet season (April) and again near the end of the wet season (July).
A = Annual inspection. Inspect the items that are checked once each year. To avoid interference caused by rainfall, the annual inspection should be conducted during the dry season (January-February).

Appendix B: Storm Sewer Details



CURVED VAIN GRATE INLET W/ SIDE INTAKE DETAIL

(NTS)

DARDENNE PRAIRIE

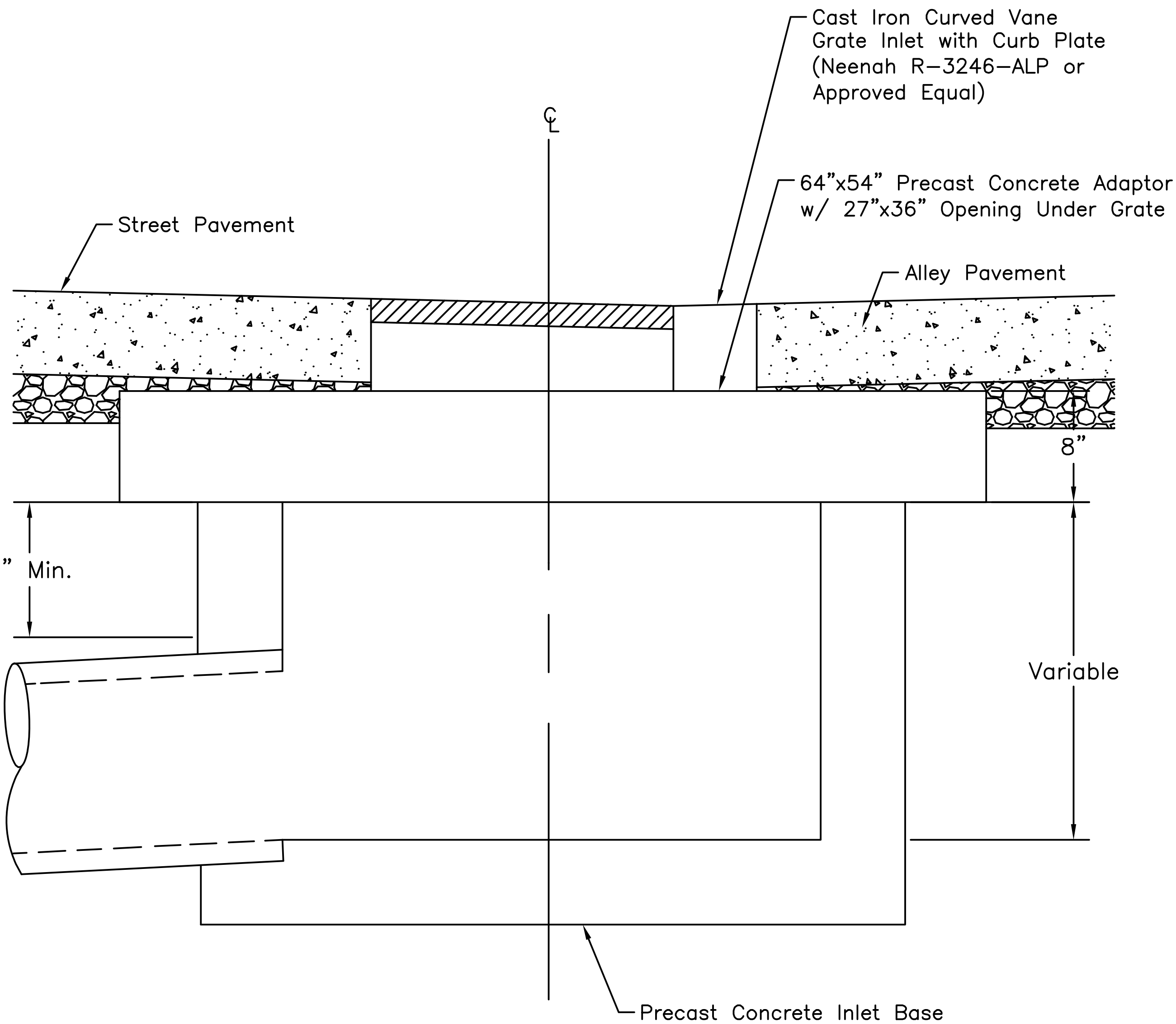
STORM SEWERS AND OTHER DRAINAGE APPURTENANCES
TECHNICAL REQUIREMENTS MANUAL

CAST IRON STREET INLET - WITH CURB

DARDENNE PRAIRIE, MISSOURI

DATE: 12/2007

FIGURE: **S1**



CURVED VAIN GRATE INLET W/ CURB PLATE

(NTS)

DARDENNE PRAIRIE

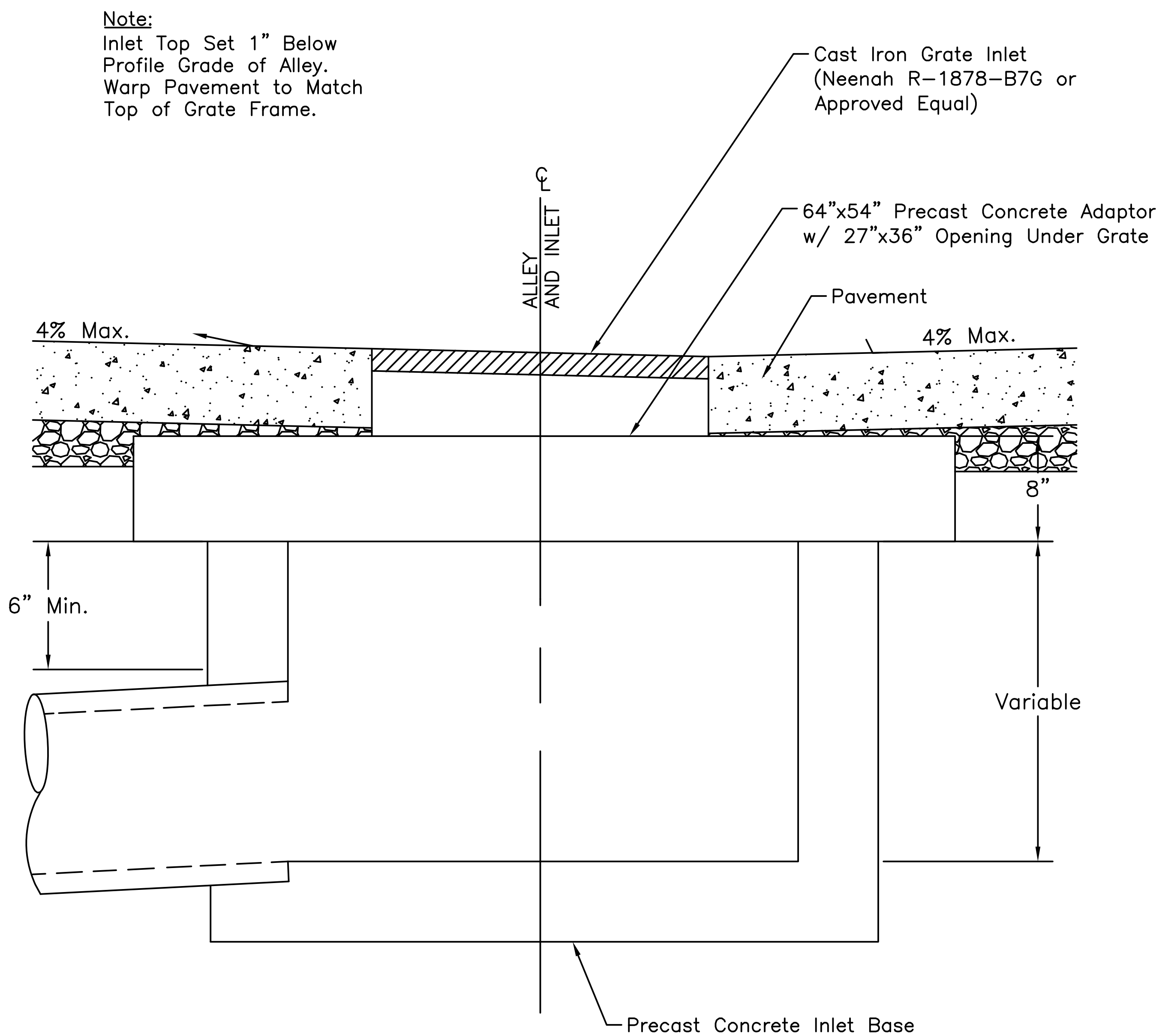
STORM SEWERS AND OTHER DRAINAGE APPURTENANCES
TECHNICAL REQUIREMENTS MANUAL

CAST IRON STREET INLET - NO CURB

DARDENNE PRAIRIE, MISSOURI

DATE: 12/2007

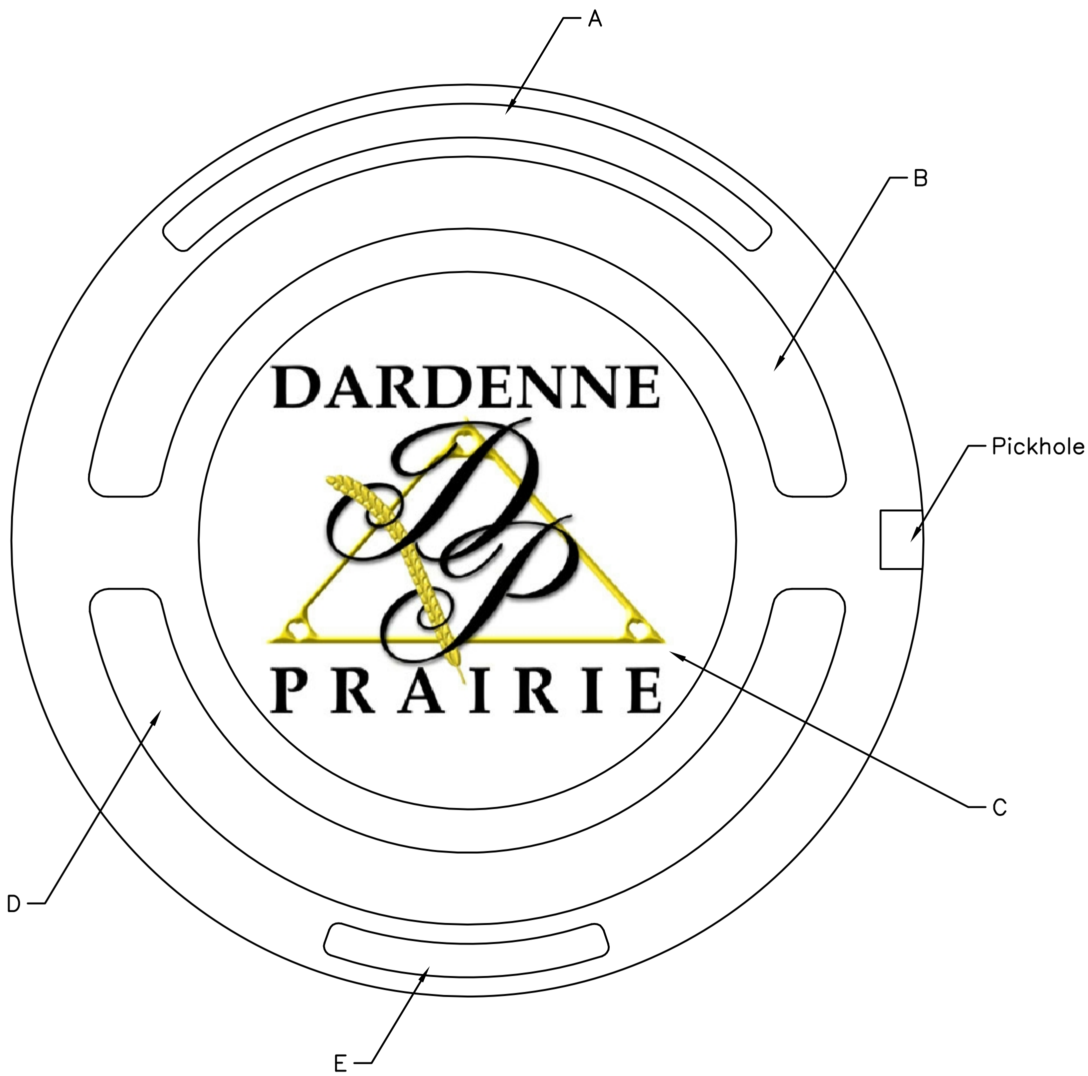
FIGURE: **S2**



GRATE INLET

(NTS)

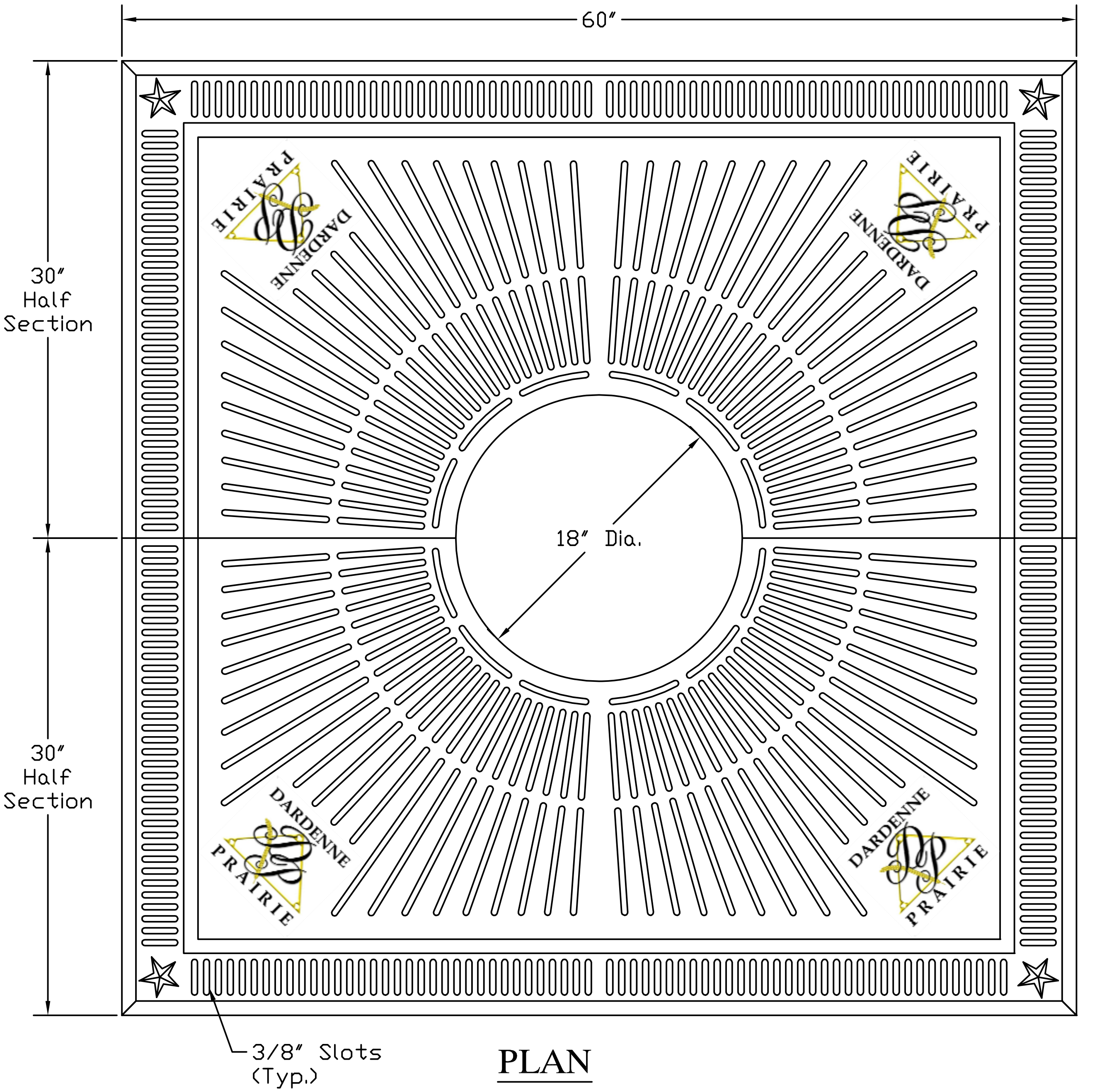
DARDENNE PRAIRIE	STORM SEWERS AND OTHER DRAINAGE APPURTENANCES TECHNICAL REQUIREMENTS MANUAL CAST IRON OFF-STREET INLET DARDENNE PRAIRIE, MISSOURI	DATE: 12/2007 FIGURE: **S3**



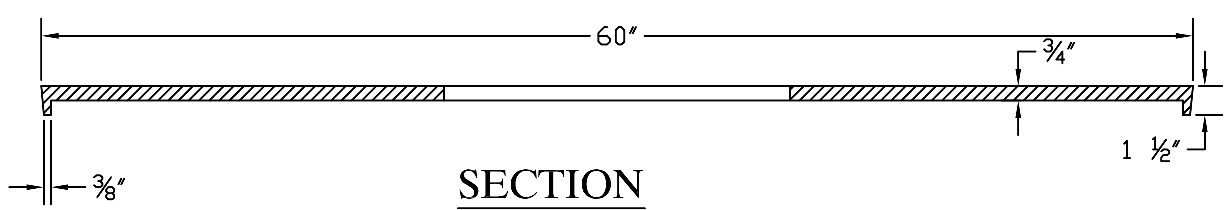
Notes:
1. Manhole and Inlet Covers Manufacture Shall be Pursuant to the Current Metropolitan St. Louis Sewer District Specifications for Cast Iron Manhole and Inlet Covers with Custom Markings and Design Shown Above.
2. Manufacturer's Shop Drawings Must be Submitted to the City Engineer for Approval Prior to the Manufacture of the Manhole and/or Inlet Covers.
3 Custom Markings and Text:
   A: Manufacturer Name
   B: 1 ¼" Recessed Lettering: "DUMP NO WASTE!"
   C: Dardenne Prairie Logo (electronic copy available from City)
   D: 1 ¼" Recessed Lettering: "DRAINS TO WATERWAYS"
   E: "MADE IN USA" or "USA"

DARDENNE PRAIRIE	STORM SEWERS AND OTHER DRAINAGE APPURTENANCES TECHNICAL REQUIREMENTS MANUAL MANHOLE COVER DARDENNE PRAIRIE, MISSOURI	DATE: 12/2007 FIGURE: S4

Appendix C: Tree Grate Details



PLAN
(NTS)



SECTION
(NTS)

DARDENNE PRAIRIE

STORM SEWERS AND OTHER DRAINAGE APPURTENANCES
TECHNICAL REQUIREMENTS MANUAL

TREE GRATE

DARDENNE PRAIRIE, MISSOURI

DATE: 12/2007

FIGURE: **T1**

SPECIFICATIONS

Load Rating:
Non—Traffic

Coating:
Undipped

Estimated Weight:
290 lbs. (½ Grate)

Approx. Open Area:
950 sq. in.

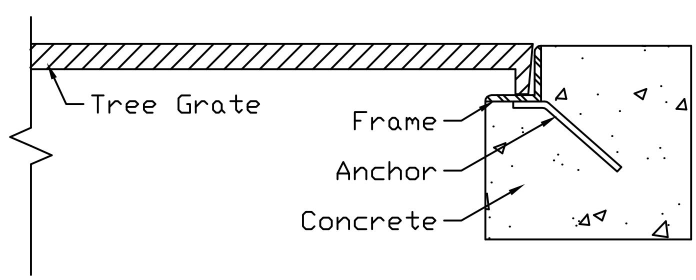
Material:
Gray Iron (ASTM A—48 Class 35 or better)

Finish:
All castings shall be manufactured true to pattern; component parts shall fit together in a satisfactory manner. They shall be of uniform quaility; free from sand, gas and blow holes, porosity, hard spots, shrinkage distortion or other defects. They shall be well cleaned by blasting.

Paint:
Tree grates and frames shall be installed without paint or primer.

Submittals:
Manufacturer's shop drawings shall be submitted to the project architect/engineer for approval prior to the manufacture. The project architect/engineer shall retain the right to reject castings not conforming to this specification and/or approved submittal drawings.

Installation:
Tree grate frames (supplied by manufacturer with tree grate) shall be used.
Grate halves shall be bolted together on the underside using the bolt slots provided by the manufacturer.



FRAME DETAIL

(NTS)

DARDENNE PRAIRIE

STORM SEWERS AND OTHER DRAINAGE APPURTENANCES
TECHNICAL REQUIREMENTS MANUAL

TREE GRATE INSTALLATION

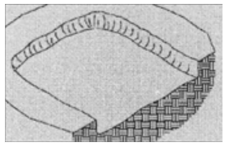
DARDENNE PRAIRIE, MISSOURI

DATE: 12/2007

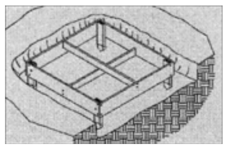
FIGURE: T2

FOR PLACED CONCRETE INSTALLATIONS

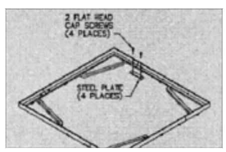
STEP 1
Excavate tree pit.



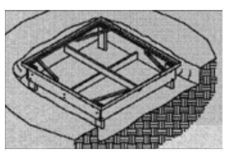
STEP 2
Place wood frame within excavation. Set at proper grade. Make form outside dimension 57–¾"x57–¾" for 60"x60" grate.



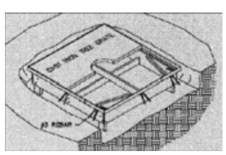
STEP 3
Assemble the tree grate frame using the hardware provided by the tree grate manufacturer. Make sure to tighten the countersunk flathead screws so they are flush or below the bearing surface of the frame.



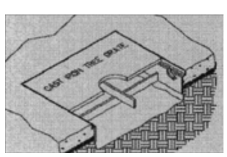
STEP 4
Place frame on wood form. Place both tree grate halves within the frame.



STEP 5
Wire grates, frames, and form together. Check and adjust frame alignment and elevation If needed. Install #3 rebar through lugs on frame and support as required. Ensure there is a $\frac{3}{16}$" spacing between vertical faces of the frame and grate.

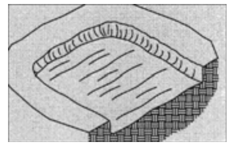


STEP 6
Place and finish concrete. Do not remove tree grate or trim alignment wires until concrete has set up.

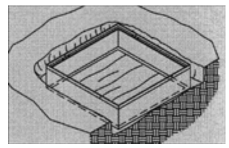


FOR PAVING BLOCK INSTALLATIONS

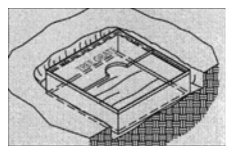
STEP 1
Excavate tree pit.



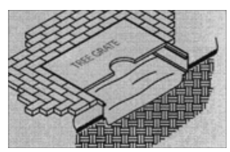
STEP 2
Place assembly within excavation. Set at proper grade.

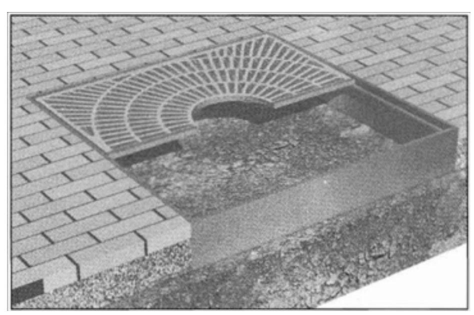


STEP 3
Place both tree grates halves within the frame.



STEP 4
Place setting bed and pavers, plant tree.





Example of Paving Block Installation.

DARDENNE PRAIRIE	STORM SEWERS AND OTHER DRAINAGE APPURTENANCES TECHNICAL REQUIREMENTS MANUAL TREE GRATE FRAME INSTALLATION DARDENNE PRAIRIE, MISSOURI	DATE: 12/2007 FIGURE: **T3**