DESIGN CRITERIA
AND
CONSTRUCTION SPECIFICATIONS

STORM DRAINAGE

SEPTEMBER 2013

DEPARTMENT OF PUBLIC WORKS

TOWN OF PLATTEVILLE

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SECTION 1.0 GENERAL

1.1 PURPOSE

The purpose of the "Town of Platteville Storm Drainage Design Criteria" (hereafter referred to as "Criteria") is to present the minimum design and technical criteria for the analysis and design of storm drainage facilities. These facilities shall be designed to reduce flooding and improve the quality of water released into the river system. These Criteria may be amended as new technology is developed or a need for revision is demonstrated and proven through experience and use.

All subdivisions, residential, commercial, industrial development or any other proposed construction submitted for approval under the Town of Platteville regulations shall include adequate storm drainage system analysis and drainage system design. Such analysis and design shall conform to these criteria set forth herein. Options or alternatives to the provisions of these Criteria may be suggested by the applicant, and used only on the written approval of the Town. The applicant must demonstrate through adequate information and technical documentation that such options are equal to or better than the requirements of these Criteria.

Policies and technical criteria not specifically addressed in this document shall follow the provisions of the most recent edition and revisions of the Urban Drainage and Flood Control District (hereafter called ”Urban Drainage") "Urban Storm Drainage Criteria Manual" (hereafter abbreviated to USDCM), which is incorporated in these Criteria by reference. Copies of the USDCM can be obtained from the Urban Drainage, 2480 West 26th Avenue, Suite 156B, Denver, Colorado 80211-5500.

The applicant is also referred to the Colorado Department of Transportation's Standard Plans ("M-Standards") for additional design details not covered in these Criteria or the USDCM.

These Criteria shall apply to all land within the incorporated area of the Town of Platteville, and those areas outside the Town of Platteville covered by intergovernmental agreements with the appropriate jurisdiction, including any public lands. These Criteria shall apply to all facilities constructed on Town Right-of-Way; easements dedicated for public use, private roads, and to all privately and quasi-publicly owned and maintained stormwater detention facilities.

1.2 PRINCIPLES FOR STORM DRAINAGE PLANNING & DESIGN

Planning and design of all stormwater drainage systems should adhere to the Town of Platteville design criteria, specifications and standards.

The provision for adequate drainage in urban areas is necessary to preserve and promote the general health, welfare, and economic well-being of the region. The Town of Platteville recognizes drainage as a sub-system of all development; and as such, the planning and design of drainage facilities shall be included in the development process.

Planning and design of stormwater drainage systems should not be based on the premise that problems can be transferred from one location to another. Colorado drainage law recognizes the inequity of transferring the burden of managing storm drainage from one location or property to another. Liability questions also arise when historic drainage patterns are altered. The diversion of stormwater drainage from one basin to another should be avoided unless specific and prudent reasons justify and dictate such a transfer.

The subdivision process can significantly alter the historic or natural drainage paths. When these alterations result in a subdivision outfall system that discharges back into the natural drainage way at or near the historic location, then the alterations (inter-basin transfer) are generally acceptable. However, when the subdivision outfall system does not return to the historic drainage way, then inter-basin transfer may result. This inter-basin transfer should be prevented since it violates a basic drainage law principle by discharging water into a subservient property in a manner or quantity to do more harm than formerly. If the development significantly increases the drainage area tributary to the subdivision outfall, then inter-basin transfer into the property has occurred and must be prevented.

In addition to planning for the control of stormwater runoff flows, consideration for maintaining the quality of the urban stormwater runoff resource should be included in the evaluation and design of drainage facilities. Drainage facilities can fulfill other purposes in conjunction with primary stormwater considerations. Recreational, water quality and open space values should be integrated where possible.

Likewise, facilities not designed primarily for drainage, such as parks, open space areas and other natural resource areas, can frequently be designed to utilize or enhance some aspects of the stormwater runoff resource or provide some drainage control benefits.

The Town requires on-site detention for all new development, expansion, and redevelopment.

Developments are responsible for runoff to the centerlines of all adjacent streets surrounding their site. This runoff must be routed to on-site detention facilities and released at a 5-year historic rate as required for other on-site runoff. In in-fill lots within the Town the release rate may be increased to the undeveloped rate of the lot. This will be a decision made by the Town Engineer.

On-site detention requirements may be waived where regional detention facilities are sized with the capacity to accommodate flows from a fully developed basin and are publicly owned and maintained. Detention facilities may also be waived where storm runoff discharges directly to the South Platte River. In these situations however, as in all new development, a stormwater management plan (SWMP) must be developed and implemented (see Section 12.0 Stormwater Quality Enhancement). Therefore, the SWMP may dictate the need for an on-site detention facility for the purposes of providing water quality capture volume (see USDCM for more detail).

On-site detention facilities are not required for attenuation of off-site flows. However, the urbanization process must safely pass all off-site flows (including all irrigation and stormwater flows) through the development without creating any adverse impact to other upstream or downstream properties.

Detention facilities shall not be constructed within public rights-of-way. The design high water level of detention ponds shall not encroach upon public rights-of-way.

Adequate drainage easements must be provided for all detention and stormwater conveyance facilities including proper access for operation and maintenance (see various applicable sections of this criteria manual for more details).

The Town requires that maintenance access be provided to all storm drainage facilities to assure continuous operational capability of the system. The property owner shall be responsible for the maintenance of all privately owned drainage facilities including inlets, pipes, culverts, channels,

ditches, hydraulic structures, and detention basins located on their land unless modified by the Development Agreement. Should the property owner fail to adequately maintain said facilities, the Town shall have the right to enter said land for the purposes of operations and maintenance. All such maintenance costs shall be assessed to the property owner.

Drainage easements shall be shown on the preliminary and final plats and any development plans. The plans shall state that the Town has the right of access on the easements, which shall be kept clear of flow obstructions and/or obstructions to maintenance access.

On-site erosion/sedimentation control programs are required for all development and redevelopment (see Section 13.0 Construction Site Erosion and Sediment Control).

The urbanization process may adversely affect downstream properties due to changes in the historic frequency and quantity of stormwater discharge. Even though on-site detention facilities are provided which reduce the historic peak runoff from development, the increase in impervious area will result in a more frequent release of stormwater. With the installation of perimeter drains around buildings, the historic release of surface water to downstream properties may be increased due to the diversion of groundwater. This may also affect existing water rights because of the diversion of groundwater to a surface flow.

In all cases, the Developer is responsible for mitigation of any and all impacts to other property or water rights owners. The Developer must negotiate and obtain drainage easements as needed from all downstream properties to accept the changes in the historic frequency and quantity of stormwater discharge. The Developer must augment as necessary any and all losses of water rights.

Due to the natural terrain on which urbanization occurs, some lots within subdivisions are located at higher elevations than others. It is common law in Colorado that properties at lower elevations must accept runoff from higher elevations. Lots within subdivision type developments can be designated as either Type “A” lots (those at lower elevations) or Type “B” lots (those at higher elevations). A more thorough description of these two types of lots is as follows:

> “A” lots shall provide surface drainage for on-site and pass-through runoff from the back of the lot to the frontage top of walk elevation. Pass-through runoff, if present, will originate from any adjacent type “B” lot. Type “A” lots typically do not drain onto other type “A” lots. Type “A” lots pass their drainage onto street right-of-way and shall have a minimum slope of two percent (2%) from the rear of the lot to the street.
>
> “B” lots, if feasible, shall provide surface drainage for the front one-half or more of the lot and house to the frontage top of walk elevation. A type “B” lot may discharge surface runoff to an adjacent type “A” lot. A Type “B” lot shall have a minimum slope of two percent (2%) from the high point of the lot to the street and rear of the lot.

Site grading plans shall designate lot corner elevations and a mid-point elevation on all side lot lines for lot grading. These plans shall also include the top of foundation elevations for houses or structures. An as-constructed Site Certification Survey is required for each lot for assurance that drainage will actually function as per the approved design grading plans.

For a Type “A” lot, a drainage way shall be required to allow surface runoff to drain from the low point of the backyard to the frontage top of walk elevation. This drain way may consist of a “V” type ditch or swale or drainage along a retaining wall. A typical swale may be from six (6) inches to over twelve (12) inches in depth in order to provide a continuous slope from the

backyard to the street top of walk. In most cases, there is between twelve (12) inches and eighteen (18) inches of fall from the low point of the backyard to the frontage top of walk for a Type "A" lot.

For the purposes of flood protection, window wells on all houses shall be extended at least six (6) inches above the ground level or to the top of foundation elevation. An eight (8) inch to twelve (12) inch deep space shall be provided inside the window well below the bottom of the window elevation. This space will store some water should it get into the window well before it reaches the bottom of the window. Window wells shall be sealed all around with outdoor type silicon caulking.

Drainage easements are sometimes provided within subdivisions along back property lines intended to drain runoff to street right-of-way. These easements, however, are often ineffective due to improper grading of lots or restrictions created by wood privacy fences or other types of obstructions. As a result, these easements shall not be relied upon for drainage of backyard areas.

It shall be a subdivision designer's primary goal to design Type "A" lots back to back with other Type "A" lots. The secondary objective shall be to design Type "A" lots back to back with Type "B" lots. Only as a last alternative will Type "B" lots be allowed to back up to other Type "B" lots. This will help minimize the problem of accumulative drainage being diverted down rear lot lines and causing flooding problems at the end of the drainage. If Type "B" lots do back up to other Type "B" lots, a two (2) foot wide by three (3) inch deep concrete trickle pan shall be installed offset, on one side or the other from the property line.

Drainage easements through the back or sides of lots within subdivisions shall not be designated to convey off-site flows through the development. Right-of-ways dedicated to the Town must be provided when necessary to convey these off-site flows. Plats shall show a five (5) foot drainage easement either side of a side lot property line between structures.

Sometimes drainage easements for on-site surface water flows must be designated within subdivision lots when no other viable alternatives exist. When drainage easements of this type are necessary, Developers, Home Builders/Owner's must accept the responsibility to provide site grading in a manner consistent with development plans regarding site drainage. Drainage easements shall not be restricted. On-site and pass-through runoff shall be routed to streets, along property lines, and through easements in a manner, which controls surface runoff. To accommodate runoff, "V" shaped swales may need to be constructed at least one (1) foot deep and six (6) feet wide.

It is usually better to line swales with a woven weed barrier fabric geo-textile and crushed rock as opposed to a grass swale. Grass swales sometimes fill in and become non-existent over time.

Drainage easements and drainage swales should not be blocked with wood privacy fences. A space shall be left under the fence for water to pass. Steel rebar may be pounded into the ground at three (3) inch to four (4) inch spacing to keep dogs and small children from crawling under the fence.

1.3 RESERVED

1.4 IRRIGATION FACILITIES

There are many irrigation ditches within and around Platteville. The ditches have historically intercepted the storm runoff from the rural and agricultural type basins, generally without major problems. However, with urbanization of the basins, the storm runoff has increased in rate, quantity and frequency, and even the water quality has changed.

In evaluating the interaction of irrigation ditches with a major drainage way for the purpose of basin delineation, the ditch should not be used as a basin boundary. Irrigation ditches are designed with flat slopes and limited carrying capacity decreasing in the downstream direction. As a general rule, irrigation ditches cannot be used as an outfall point for the storm drainage system because of these physical limitations. In addition, certain ditches are abandoned after urbanization and, therefore, could not be considered a permanent part of the storm drainage system. Due to these changes in the urban stormwater response, irrigation facilities shall not be considered as part of the available drainage system for new development.

Irrigation facilities must be preserved through new development areas in order to maintain service to any upstream or downstream users of the irrigation ditch. Adequate easements must be provided for the ditch including access for operations and maintenance. Irrigation lines passing under roadways must be approved RCP pipe materials.

1.5 RELATIONSHIP TO OTHER STANDARDS

Whenever a provision of these Criteria, and any other provision in any law, ordinance, resolution, rule, or regulation of any kind, contains any restrictions covering any of the same subject matter, the most restrictive standard shall apply.

These Criteria are consistent with the Urban Drainage and Flood Control District's criteria. If the state or federal government imposes stricter criteria, standards, or requirements, these shall be incorporated into the Town's requirements after the appropriate due process needed to modify the Town's regulations and standards.

Adherence to these Criteria does not remove the applicant's responsibility to investigate and obtain any other regulatory permits or approvals, from local, regional, state or federal agencies, that may be required for a particular project.

1.6 VARIANCES

It is the responsibility of the Owner, or Owner's selected Design Engineer, to request any variances from Town Standards during the early stages of planning or design development. Variances from these Criteria shall be considered on a case-by-case basis.

1.7 REVIEW AND ACCEPTANCE

The Town shall review all drainage submittals for general compliance with these specific Criteria. An acceptance by the Town does not relieve the Owner, Engineer, or Designer from the

responsibility of ensuring that the calculations, plans, specifications, construction, and as-built drawings comply with these Criteria.

Approval of the submittal information shall remain valid for one year after the acceptance date. If construction of the project has not been initiated within that period, the acceptance by the Town shall become invalid.

SECTION 2.0 SUBMITTAL REQUIREMENTS
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SECTION 2.0 SUBMITTAL REQUIREMENTS

2.1 REVIEW PROCESS

Drainage reports and plans, construction drawings, specifications and as-built information shall be submitted as required by the Town of Platteville Subdivision Regulations and these Storm Drainage Design Criteria. A pre-application consultation is suggested of all applicants for all processing steps of the Subdivision Regulations. The applicant should consult with the Town for general information regarding subdivision regulations, the development process, possible drainage problems, stormwater requirements.

All topographic mapping is to be based on NAVD 88 survey datum. The Town of Platteville will not accept any other datum nor will an adjustment from some other datum to NAVD 88 be acceptable. All contour mapping and construction details must be on NAVD 88 datum. All reports shall be typewritten on 8-1/2" x 11" paper and bound. A cover letter shall be included, identifying the project and the type of information submitted (preliminary or final).

The report shall be prepared (or supervised), signed and stamped by a Professional Engineer licensed to practice in the State of Colorado, and possessing adequate experience in the fields of hydrology and hydraulics. The report shall contain a certification sheet with the following statement, and appropriate signatures.

"I hereby attest that this report for the (Preliminary or Final) drainage design of (Name of Development) was prepared by me, or under my direct supervision, in accordance with the provisions of the Town of Platteville Storm Drainage Design Criteria for the responsible parties thereof. I understand that the Town of Platteville does not and shall not assume liability for drainage facilities designed by others."

_____

Registered Professional Engineer

State of Colorado No._____ (Affix Seal)

The drawings , figures, plats and tables shall be bound within the report or included in a pocket attached to the report. Photo copies of charts, tables, nomographs, calculations, or any other referenced material shall be legible and contain the origin of reference. Washed out, blurred, or unreadable portions of the report are unacceptable, as is incomplete or absent information. The information presented in technical appendicies shall contain sufficient detail to allow replication of the results presented in the report. Any unacceptable conditions could warrant a requirement for re-submittal of the report, and subsequent delay of the project review.

2.2 RESERVED

2.3 PRELIMINARY DRAINAGE REPORT

The purpose of the Preliminary Drainage Report is to identify and define problems and solutions occurring on-site or off-site because of the developments. Any problems that existed on the site prior to development must also be addressed during the preliminary phase. The Preliminary Drainage Report shall be submitted with the Preliminary Subdivision Plat submittal. Two (2) copies of the Preliminary Drainage Report shall be submitted to the Town. Number all pages consecutively in the Preliminary Drainage Report for easy reference.

In addition to the information listed below, the requirements for submitting a Preliminary Stormwater Management Plan and a Preliminary Erosion Control Plan are detailed in Sections 12 and 13 respectively.

2.3.1 PRELIMINARY REPORT CONTENTS

The report shall be in accordance with the following outline and contain the applicable information listed:

2.3.1.A GENERAL LOCATION AND DESCRIPTION

1. Location
    a. Township, range, section, ¼ section
    b. Local streets within and adjacent to the subdivision with ROW width shown
    c. Major drainage ways, facilities, and easements within and adjacent to the site
    d. Locations of other utilities
    e. Names of surrounding developments
2. Description of Property
    a. Area in acres
    b. Ground cover (types of trees, shrubs, vegetation, general soil conditions, topography and slope)
    c. Major drainage ways
    d. General project description
    e. Irrigation facilities
    f. Proposed Land Use

2.3.1.B DRAINAGE BASINS AND SUBBASINS

1. Major Basin Description
    a. Reference to major drainage way planning studies, flood hazard delineation reports or flood insurance rate maps
    b. Identify irrigation facilities will influence or be influenced by the local drainage
2. Sub-basin Description
    a. Discussion of historic drainage patterns of the property
    b. Discussion of off-site flow patterns and impact on the development under existing and fully developed conditions

2.3.1.C DRAINAGE DESIGN CRITERIA

Regulations: Discussion of the optional provisions selected or the deviation from these criteria, if any, and its justification.

1. Development Criteria Reference and Constraints

a. Discussion of previous drainage studies and/or pertinent master plans for the site in question that influence or are influenced by the drainage design and how the plan will affect drainage design for the site
b. Discussion of the effects of adjacent drainage studies
c. Discussion of the drainage impact of site constraints such streets, utilities, existing structures and the development or site plan

2. Hydrological Criteria
   a. Identify design rainfall
   b. Identify runoff calculation method
   c. Identify detention discharge and storage calculation method
   d. Identify design storm recurrence interval
   e. Discussion and justification of other criteria or calculation methods used that are not presented in or referenced by these Criteria
3. Hydraulic Criteria
   a. Discussion of other drainage facility design criteria used that are not presented in this criteria
4. Waiver/Variance from Critera
   a. Identify provisions by section number for which a waiver or variance is requested
   b. Provide justification for each waiver or variance requested
5. Stormwater Quality Considerations
   a. See Section 12 for submittal requirements associated with the Stormwater Management Plan

2.3.1.D WETLAND MITIGATION (IF APPLICABLE)

2.2.1.E DRAINAGE FACILITY DESIGN

1. General Concept
   a. Facility design concept and typical drainage patterns
   b. Compliance with off-site runoff considerations
   c. Discussion of the content of tables, charts, figures, plats, or drawings presented in the report
   d. Anticipated and proposed drainage patterns
   e. Water quality considerations
   f. Opportunities for multi-functional use of drainage facilitiesss
2. Specific Details
   a. Detail drainage problems encountered and solutions at specific design points
   b. Detention storage and outlet design
   c. Provisions of stormwater quality facilities
   d. Maintenance access and aspects of facility design
   e. Provision of easements and tracts for drainage purposes, including conditions and limitation for use

2.3.1.F CONCLUSIONS

1. Compliance with Standards
    a. Town Criteria
    b. USDCM
2. Drainage Concept
    a. Effectiveness of drainage design to control damage from storm runoff flooding

2.3.1.G REFERENCES

Reference all criteria and technical information used

2.3.1.H APPENDICES

1. Hydrologic Computations
    a. Land use assumptions regarding adjacent properties
    b. Initial and major storm runoff at specific design points
    c. Historic and fully developed runoff computations at specific design points
    d. Hydrographs at critical design points
    e. Time of concentration and runoff coefficients for each basin
    f. A computer disk or CD of all hydrologic modeling (CUHP, EPA SWMM, UD SWMM, etc.) necessary to support analyses and conclusions in the report; documentation of modeling efforts will be in sufficient detail t allow replication of results
2. Hydraulic Computations
    a. Open channel design. Check structure and/or channel drop design
    b. Detention area/volume capacity and outlet capacity calculations; depths of detention basins
    c. Downstream /outfall capacity to the Major Drainage way system
3. Hydraulic computations (optional for preliminary)
    a. Culvert capacities
    b. Storm drain capacity, including energy grade line (EGL) and hydraulic grade line (HGL) elevations for 18” or larger pipes
    c. Gutter and street capacity as compared to allowable
    d. Storm inlet capacity including inlet control rating at connection to the storm drain

2.3.2 PRELIMINARY DRAINAGE REPORT CHECKLIST

Project:_____ Date:_____

Refer to Town of Platteville Storm Drainage Criteria (SDC) Manual for requirements.
Note: Include Checklist as part of Preliminary Report

	YES	NO
Is general location and description in accordance with SDC Manual?	____	____
Are existing contours based on DAVD 88 datum?	____	____
Do contours extend a minimum of 100 feet outside Property and are they labeled as to elevation?	____	____
Are basin boundaries to centerline of adjacent streets surrounding the development?	_____	____
Is offsite water safely passed through the site?	____	____
Are drainage design criteria in accordance with SDC manual?	____	____
If over five acres, have CUHP and SWMM hydraulic analysis been used to size the detention pond?	____	____
Are runoff coefficients reasonable? I.E., 5-year historic Average = 0.08, 100-year historic = 0.35	____	____
Has Water Quality Capture Volume (WQCV) been determined and added to total detention pond volume?	____	____
Is detention pond release rate equal to 5-year historic flow?	____	____
Are pond side slopes no greater than 4H:1V?	____	____
Does volume calculated from pond contours approximately equal designer's volume?	____	____
Is wetland preservation and mitigation required and if so have provisions been made to address these issues?	____	____

2.3.3 PRELIMINARY SUBMITTAL: PLAN CONTENT

2.3.3.A GENERAL LOCATION MAP

All drawings shall be 24" x 36". A map shall be provided with sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns. The map should be at a scale adequate to show the path of all drainage from the upper end of any off-site basins to a major drainage way. The map shall identify any major facilities from the property (i.e., development, irrigation ditches, existing detention facilities, culverts, storm drains) along the entire path of drainage. Basins and divides are to be identified and topographic contours are to be included.

2.3.3.B FLOODPLAIN INFORMATION

The location of any defined floodplains on the property shall be shown.

2.3.3.C DRAINAGE PLAN

Map(s) of the proposed development at a scale of 1"=20' to 1"=200' on a 24"x36" drawing shall be included. The plan shall show the following:

1. Existing and (if available) proposed topographic contours at a 1-foot maximum interval. The contours shall extend a minimum of 100 feet beyond the property lines and be labeled as to elevation.
2. Property lines and easements with purposes noted.
3. Streets, indicating ROW width, flow line width, curb type, sidewalk and approximate street slopes.
4. Existing drainage facilities and structures, including irrigation ditches, roadside ditches, cross-pans, drainage ways, gutter flow directions and culverts. All pertinent information such as material, size, shape, slope and location shall also be noted.
5. Location of other utilities.
6. Overall drainage area boundary and drainage sub-area boundaries.
7. Proposed type of street flow (i.e., vertical or combination curb and gutter), roadside ditch, gutter, slope and flow directions, and cross-pans.
8. Proposed storm drains and open drainage ways, including inlets, manholes, culverts and other appurtenances, including riprap protection.
9. Proposed outfall point for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties.
10. Routing and accumulation of flows at various critical points for the initial storm runoff listed on the drawing using the format shown in Table 2-1.
11. Routing and accumulation of flows at various critical points for the major storm runoff listed on the drawing using the format shown in Table 2-1.
12. Volumes and release rates for detention storage facilities and information on outlet works.
13. Location and elevations of all existing floodplains affecting the property.
14. Location and elevations of all existing and proposed utilities affected by or affecting the drainage design.
15. Routing of off-site drainage flow through the development.

16. Definition of flow path leaving the development through the downstream properties ending at a major drainage way.
17. Legend to define map symbols.
18. Title block in lower right corner.

2.4 FINAL DRAINAGE REPORT

The purpose of the Final Drainage Report is to update the concepts and present the design details for the drainage facilities discussed in the Preliminary Drainage Report. Also, any changes to the Preliminary Drainage concept must be presented and supported with the same level of information as originally required in the Preliminary Drainage Report. Number all pages of the Final Drainage Report for easy reference.

The Final Drainage Report, which shall accompany the Final Subdivision Plat submittal or the final Planned Unit Development (P.U.D.) submittal, must address comments made during the review of the Preliminary submittal. The Final Drainage Report shall be prepared in accordance with the outline for the Preliminary Drainage Report (Section 2.3.1); the Final Drainage Report drawings shall fulfill the requirements for the contents of the Preliminary Drainage Report Checklist (Section 2.3.2). See Section 12 of these Criteria for the Final Stormwater Management Plan submittal requirements, and Section 13 for the Final Erosion Control Plan submittal requirements. Two (2) copies of the Final Drainage Report shall be submitted to the Town.

In addition to the report format and submittal requirements presented in Section 2.1, the Final Drainage Report shall include a page with the following certification language, and the appropriate signature:

(Name of Developer/Owner) hereby certifies that the drainage facilities for (Name of Project) shall be constructed according to the design presented in this report. I understand that the Town of Platteville does no and will not assume liability for drainage facilities designed and/or certified by my Engineer. I also understand that the Town of Platteville relies on the representations of others to establish that drainage facilities are designed and constructed in compliance with Town guidelines, standard, or specifications. Review by the Town of Platteville can therefore in no way limit or diminish any liability, which I or any other party may have with respect to the design or construction of such facilities

_____
(Name of Developer/Owner)

Attest:

_____ _____
Notary Public (Developer/Owner Signature)

A reproducible of the approved Final Drainage Plan shall be submitted to the Town for signature and retention in their files. A copy of the approved plan shall be returned to the applicant.

2.4.1 FINAL DRAINAGE REPORT CHECKLIST

Project:_____ Date:_____

	YES	NO
Is report signed and sealed by a licensed PE?	____	____
Is report certified by owner and authorized	____	____
Are pages of the report numbered for easy referencing?	____	____
Are there any infringements on drainage easements?	____	____
Are sub-basin areas and total area of site close to those of Designer?	____	____
Time of concentration, Check if (L/180) + 10 verified?	____	____
Are runoff coefficients reasonable, 5-year historic average = 0.08, 100 year historic = 0.35?	____	____
Do offsite flows pass through pond or route around site?	____	____
Has Water Quality Capture Volume (WQCV) been determined and added to total detention pond volume requirements?	____	____
Is detention pond release rate equal to 5-year historic flow?	____	____
Are drainage channel and pond side slopes no greater than 4H:1V?	____	____
Have detention pond top of dike elevations (freeboard) been set one foot above the elevation of water passing over the spillway during a plugged orifice condition?	____	____
Does volume calculated from pond contours approximately equal designer's volume?	____	____
Is the spillway rip rapped or concreted and does it have sufficient grading to pass the overflow downstream to a suitable and safe conveyance?	____	____
Orifice calculations – is head on orifice to center of opening? Is backwater from outlet possible and if so has it been considered?	____	____

	YES	NO
On the WQCV drawing details – are the holes per row and the spacing of holes correctly determined?	____	____
Has a trash rack and orifice plate been properly designed and detailed?	____	____
Are outlet metal components minimum 3/8” thick metal hot dipped galvanized?	____	____
Are bolts a minimum 3/8” diameter, by 1-1/2” minimum length plus 3” for concrete embedment and stainless steel material?	____	____
Has the street capacity at critical locations for both minor and major storm events been determined?	____	____
Have inlet capacities using interception ratios been determined, if applicable?	____	____
Is “A” and “B” lot designation with diagram shown on grading plan?	____	____
Do grading contours around perimeter of site match existing terrain? Are they labeled for elevation?	____	____
Do spot elevations match grading contours?	____	____
Do all areas drain to the detention/retention pond?	____	____
Are details for detention pond retaining wall construction shown?	____	____
Are there any “B” lots adjoining other “B” lots along back lot lines? If so, has an Outlot separating them for drainage, or a concrete pan offset to one side of property line been provided?	____	____
Are finished top of foundation, lot corners and each side lot mid point elevations shown on the grading plan?	____	____
Have hydraulic calculations with energy grade lines (EGL) and hydraulic grade line (HGL) been shown for the 100 year storm event on the storm drain profiles in the Drainage Report?	____	____
Have backwater effects been considered? Do pipe sizes and slopes agree between drawings and calculations?	____	____

	YES	NO
Have adequate sump depths been provided at sump inlets to accommodate sump design capacity before allowing water to overflow curb?	____	____
Are storm drains sized so that there is no surcharge during a 2 year storm event?	____	____
Do the drawings contain standard Town of Platteville details for storm pipe bedding, inlets manholes, inlet protection, vehicle tracking control, etc? Town standards can be found at www.plattevillegov.org.	____	____
Is there at least 1 foot of cover between the top of all RCP storm pipes and top of pavement?	____	____
Are storm manholes placed no more than 400 feet apart and are they accessible from the street?	____	____
On culverts has both the inlet and outlet control been taken into account?	____	____
Do all culverts pass the 10-year storm event?	____	____
Is there erosion protection at the discharge of storm pipes?	____	____
Have toe walls been provided at storm drain outlets?	____	____
Has an irrigation system been provided?	____	____
Is riprap placed on geotextile fabric and bedding?	____	____
In channel designs is there adequate freeboard (1'), velocity (<5 fps, Foude Number < 0.8)?	____	____
On sidewalk chases – 2 year storm should pass under and 100 year storm should pass over sidewalk?	____	____
Is a minimum opening elevation (M.O.) shown on all buildings next to ponds and major drainage swales: The M.O. shall be 1' above the top of the stormwater elevation as it overtops the spillway. This elevation would be the minimum allowed elevation for all window sill elevations, doorway threshold elevations, top of window well elevations, garage door threshold elevations and any other building opening water could penetrate. Include an explanation in the key of the drawing for the M.O. elevation designation.	____	____

2.5 CONSTRUCTION PLANS

Where drainage improvements are to be constructed, the final construction plans (24"x36") shall be submitted with the Final Drainage Report. Approval of the construction plans by the town is a condition of the Town prior to issuing all construction permits.

Should circumstance warrant changes from the approved plans or specifications, a written approval must be obtained from the Town. Copies shall be given to the Contractor and the Developer. Project as-built record drawings that record changes in construction are the Developer/Owners responsibility. These record drawings shall consist of detailed drawings that have been prepared by the Developer/Owner's Design Engineer, upon completion and at the time of the Certificate of Completion. They shall show actual construction and contain field dimensions, elevations, details, changes made the construction drawings, details which were not included on the construction drawings, and horizontal and vertical location of underground utilities which have been affected by the utility installation.

The plans for the drainage improvements shall include:

2.5.1 GENERAL DETAILS

1. Title Block (lower right hand corner preferred)
2. Scale
3. Date and Revisions Block
4. Name of Professional Engineer and Firm
5. Statement: All work must be in accordance with applicable Town of Platteville construction standards. The Town's acceptance allows for plan distribution and permit application. The Town's acceptance shall not relieve the design engineer's responsibility for errors, omissions, or design deficiencies for which the Town is held harmless.

Accepted By: _____ Date: _____
Town Engineer

2.5.2 PLAN PORTION

1. North Arrow
2. Property lines
3. Easement limits with dimensions and identification
4. Ownership of subdivision information
5. Street names
6. All existing utilities
7. All topographic features (houses, curbs, water courses, etc.)

2.5.3 PROPOSED FACILITIES

1. Storm drains, inlets, outlets, and manholes with pertinent elevations, dimensions, type and horizontal control indicated.
2. Culverts, end sections, cutoff walls, and inlet/outlet protection with dimensions, type, elevations and horizontal control indicated.
3. Channels, ditches and swales (including side and/or back yard swales) with lengths, widths, cross-sections and erosion control (i.e. riprap, concrete grouted riprap) indicated.
4. Check structures, channel drops, erosion control facilities.

5. Detention pond grading (elevations and horizontal control), trickle channel and outlets.
6. Other drainage related structures and facilities (including under drains and sump pump lines).
7. Maintenance access considerations.
8. Overlot Grading.
9. A & B lot designation for all residential lots and either a written definition or a schematic of A & B lot drainage as per Section 1.2 Principles for Storm Drainage Planning and Design.
10. Lot corner and mid point side lot elevations for all residential lots.
11. Top of foundation (TOF) elevations (which are set two feet higher than the highest curb elevation fronted by the property).

2.5.4 PROFILE INFORMATION

1. Stationing
2. Elevations shall be North American Vertical Datum (NAVD) 88.
3. Length between structures and connections
4. Slope of pipe
5. Existing ground profile
6. Proposed ground profile
7. Utility crossings

The information required for the plans shall be in accordance with sound engineering principles, these Criteria and the Town requirements for constructing storm drainage facilities. The approved Final Plan shall be included as part of the construction documents for all facilities affected by the drainage plan. Construction plans shall be signed by a Registered Professional Engineer as being in accordance with the Town approved drainage reports/drawings. Construction plans along with the Town's Design Criteria and Construction Specification Manuals shall be provided at the construction site by the Contractor at all times.

2.6 CONSTRUCTION CERTIFICATION & DRAWINGS OF RECORD

Record drawings for all improvements are to be submitted to the Town Clerk with the request for Substantial Completion Certificate. Certification of the record drawings is required as follows:

The project responsible Design Engineer and Surveyor shall observe construction as required to be able to certify that the conditions and information recorded on the As-Built Record drawings is true and correct. The owner or responsible party of the General Contractor for the project shall sign each drawing sheet in the As-Built plan set with the following statement:

I, _____, hereby state that this project was constructed to the Town of Platteville approved construction drawings and standards, as designed by the Project Engineer, and as field staked by the Project Surveyor. All deviations to the approved constructions drawings, standards, design, and/or survey were so noted on Field Drawings and these were provided to the Project Engineer for acceptance and inclusion in the As-Built Drawings.

Construction Company _____

Address _____

Authorized Representative _____

Title _____

Date _____

A Professional Engineer, licensed in the State of Colorado, shall review the As-Built information for compliance with the original design and standards and shall stamp and seal each drawing sheet in the As-Built Record plan set with the following statement:

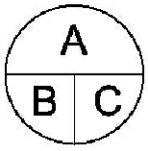
I _____, hereby state that I have reviewed the as-built information provided by the project contractor. I certify that according to the information provided and periodic field inspections, the As-Built drawings are in compliance with the Town of Platteville approved construction drawings and standards and will function as designed.

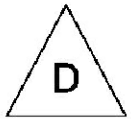
The Town shall compare the certified record drawing information with the construction drawings. A Certificate of Substantial Completion shall be issued only if:

1. The record drawing information demonstrates that the construction complies with the design intent.
2. The record drawings are certified by a Professional Engineer and the responsible party of the General Contractor.

A summary of the required certifications and approvals is presented below:

Item	**Certification Required**	**Town Approval Required**
Preliminary Report	Professional Engineer	Yes
Final Report	Professional Engineer & Responsible Party	Yes
Construction Drawings	Professional Engineer	Yes
Record Drawing	Professional Engineer General Contractor	Yes (Certificate of Substantial Completion)





A = BASIN DESIGNATION

B = AREA IN ACRES

C = COMPOSITE RUNOFF COEFFICIENTS

D = DESIGN POINT DESIGNATION

SUMMARY RUNOFF TABLE
(TO BE PLACED ON DRAINAGE PLAN)

DESIGN POINT	CONTRIBUTING AREA (ACRES)	RUNOFF 5-YR (CFS)	PEAK 100-YR (CFS)
XX	XX.XX	XX.X	XX.X

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

DRAWING SYMBOL CRITERIA & HYDROLOGY REVIEW TABLE

TABLE 2-1

March, 2010

NOT TO SCALE

SECTION 3.0 – RAINFALL
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SECTION 3.0 RAINFALL

3.1 INTRODUCTION

Presented in this section is the design rainfall data to be used with the Colorado Urban Hydrograph Procedure (CUHP) and the Rational Method. All hydrological analysis within the jurisdiction of these Criteria shall use the rainfall data presented herein for calculating storm runoff.

The design storms and intensity-duration-frequency curves for the Town were developed using the rainfall data as presented in the NOAA Atlas for Colorado and the procedures presented in the Urban Storm Drainage Criteria Manual (USDCM).

3.2 SELECTION OF DESIGN STORM FREQUENCIES

All drainage systems for new development have to take into consideration two separate and distinct drainage situations. The first is the initial storm, which occurs at regular intervals and is based on the two, five and ten year storm events, depending on land use. The runoff from the initial storm is usually not the cause of extensive damage, but can represent higher costs in maintenance, repair and replacement of public facilities if not handled correctly.

The second drainage situation that shall be considered is the planning and design of facilities to convey the major storm, which occurs at less frequent intervals, and is based on the 100-year storm event. The runoff from this type of storm event can cause catastrophic property damage and personal injury or loss of life.

The initial and major storm frequencies used for runoff analysis and the subsequent design of stormwater control facilities in the Town of Platteville are presented below:

TABLE 3.2 - DESIGN STORM FREQUENCIES

Land Use	Initial Storm Frequency	Major Storm Frequency
Residential	2-year	100-year
Commercial, Business & Industrial	5-year	100-year
Downtown Business Area and Industrial	10-year	100-year

3.3 COLORADO URBAN HYDROGRAPH PROCEDURE (CUHP) DESIGN STORMS

For drainage basins less than five square miles, a two-hour storm distribution without area adjustments of the point rainfall values shall be used for CUHP. For drainage basins between five and ten square miles, a two-hour storm distribution is used but the incremental rainfall values are adjusted for the large basin area in accordance with suggested procedures in the NOAA Atlas for Colorado. The adjustment is an attempt to relate the average of all point values

for a given duration and frequency within a basin to the average depth over the basin for the same duration and frequency.

For drainage basins between ten and twenty square miles, a three-hour storm distribution with adjustment for area shall be used. The distribution for the last hour was obtained by uniformly distributing the difference between the two- and three-hour point rainfall values. The adjustment for area was obtained from the NOAA Atlas for Colorado. The incremental rainfall distribution for all basin areas up to 20 square miles is presented in Table 3-1.

3.4 INTENSITY-DURATION-FREQUENCY (IDF) CURVES

Intensity-Duration-Frequency (IDF) curves are necessary to utilize the Rational Method for runoff analysis. The one-hour design point rainfall values obtained from the NOAA Atlas for Colorado are required for the development of the IDF curves. The one-hour point rainfall values applicable for the Town of Platteville are presented below.

TABLE 3.4 - ONE-HOUR POINT RAINFALL (INCHES)

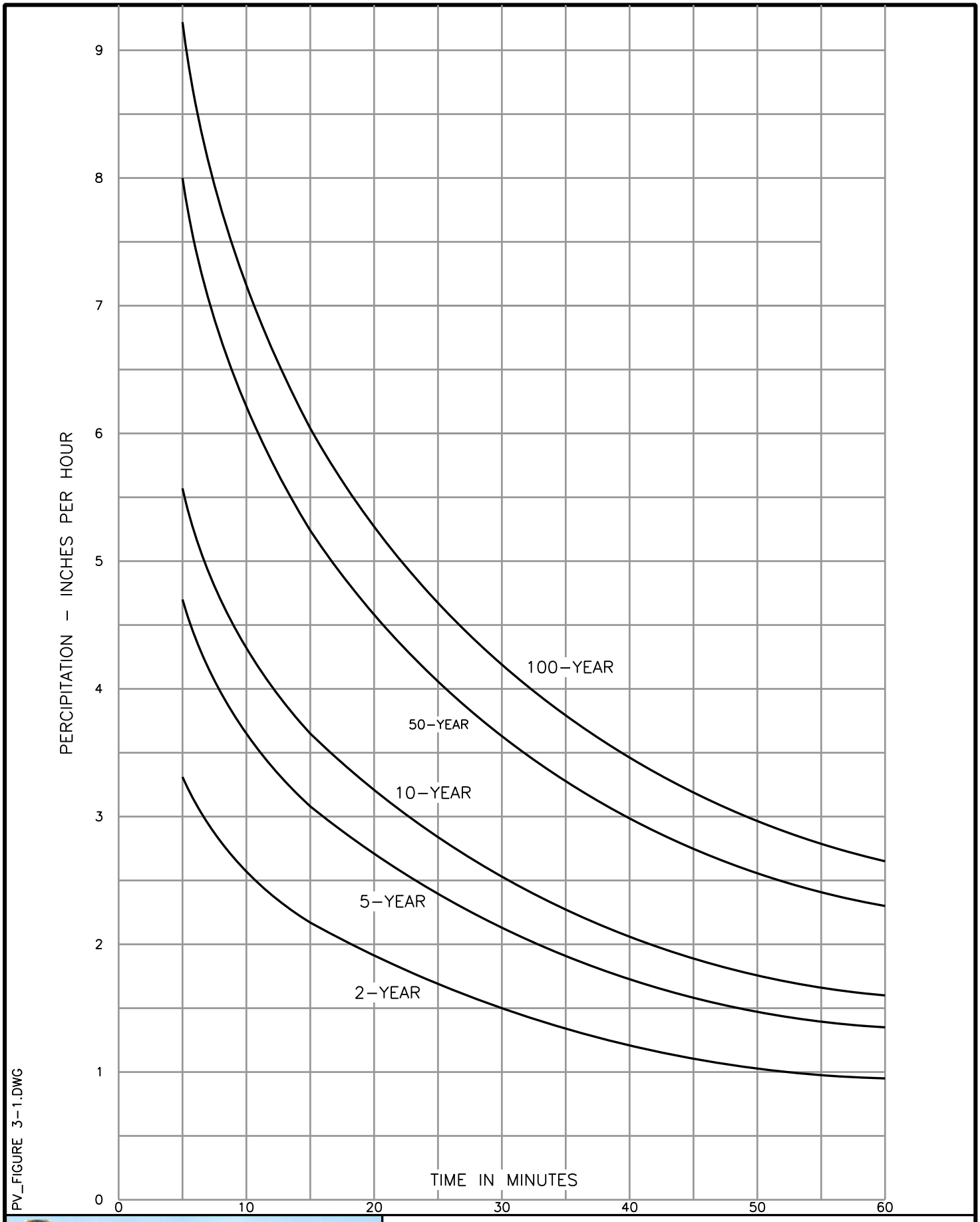
2-year	5-year	10-year	50-year	100-year
0.95	1.35	1.60	2.30	2.65

The IDF curves were developed by distributing the one-hour point rainfall values using the factors obtained from the NOAA Atlas as presented below.

TABLE 3.4(1) - FACTORS FOR DURATIONS OF LESS THAN ONE HOUR

Duration (minutes)	5	10	15	30
Ratio to 1-hour Depth	0.29	0.45	0.57	0.79

The point values were then converted to intensities and plotted on Figure 3-1. The data are also presented in Tables 3-1, 3-2, and 3-3.



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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

INTENSITY-DURATION-FREQUENCY CURVES

FIGURE 3-1

March, 2010

NOT TO SCALE

DESIGN STORM DISTRIBUTION FOR PLATTEVILLE
INCREMENTAL RAINFALL DEPTH/RETURN PERIOD

TIME (MIN.)	2-YEAR (INCHES)	5-YEAR (INCHES)	10-YEAR (INCHES)	50-YEAR (INCHES)	100-YEAR (INCHES)
5	0.02	0.03	0.03	0.03	0.03
10	0.04	0.05	0.06	0.08	0.08
15	0.08	0.12	0.13	0.12	0.12
20	0.15	0.20	0.24	0.18	0.21
25	0.24	0.34	0.40	0.35	0.37
30	0.13	0.18	0.19	0.58	0.66
35	0.06	0.09	0.09	0.28	0.37
40	0.05	0.07	0.07	0.18	0.21
45	0.03	0.04	0.06	0.12	0.16
50	0.03	0.04	0.05	0.12	0.13
55	0.03	0.04	0.05	0.07	0.11
60	0.03	0.04	0.05	0.07	0.11
65	0.03	0.04	0.05	0.07	0.11
70	0.02	0.04	0.05	0.06	0.05
75	0.02	0.03	0.05	0.06	0.05
80	0.02	0.03	0.04	0.04	0.03
85	0.02	0.03	0.03	0.04	0.03
90	0.02	0.03	0.03	0.03	0.03
95	0.02	0.03	0.03	0.03	0.03
100	0.02	0.02	0.03	0.03	0.03
105	0.02	0.02	0.03	0.03	0.03
110	0.02	0.02	0.03	0.03	0.03
115	0.01	0.02	0.03	0.03	0.03
120	0.01	0.02	0.02	0.03	0.03
TOTAL	1.12	1.57	1.84	2.66	3.04

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INTENSITY – DURATION – FREQUENCY TABULATION

DURATION	5 MIN 0.29	10 MIN 0.45	15 MIN 0.57	30 MIN 0.79	60 MIN 1.00	120 MIN	180 MIN
2-YEAR							
1-HR DEPTH (IN)	0.95	0.95	0.95	0.95	0.95		
DEPTH AT DURATION (IN)	0.28	0.43	0.54	0.75	0.95	1.10	1.22
INTENSITY (IN/HR)	3.31	2.57	2.17	1.50	0.95	0.55	0.41
5-YEAR							
1-HR DEPTH (IN)	1.35	1.35	1.35	1.35	1.35		
DEPTH AT DURATION (IN)	0.39	0.61	0.77	1.07	1.35	1.56	1.71
INTENSITY (IN/HR)	4.70	3.65	3.08	2.13	1.35	0.78	0.57
10-YEAR							
1-HR DEPTH (IN)	1.60	1.60	1.60	1.60	1.60		
DEPTH AT DURATION (IN)	0.46	0.72	0.91	1.26	1.60	1.82	1.99
INTENSITY (IN/HR)	5.57	4.32	3.65	2.53	1.60	0.91	0.66
50-YEAR							
1-HR DEPTH (IN)	2.30	2.30	2.30	2.30	2.30		
DEPTH AT DURATION (IN)	0.67	1.04	1.31	1.82	2.30	2.59	2.80
INTENSITY (IN/HR)	8.00	6.21	5.24	3.63	2.30	1.30	0.93
100-YEAR							
1-HR DEPTH (IN)	2.65	2.65	2.65	2.65	2.65		
DEPTH AT DURATION (IN)	0.77	1.19	1.51	2.09	2.65	2.94	3.15
INTENSITY (IN/HR)	9.22	7.16	6.04	4.19	2.65	1.47	1.05

NOTE: DEPTH AT EACH DURATION = 1 HOUR OF RAINFALL X RESPECTIVE DURATION FACTOR

EXAMPLE FOR 5 MINUTE DURATION:

DEPTH (IN) = 2-YEAR, 1-HR DEPTH (IN) X FACTOR
= 0.95 X 0.29 = 0.28 INCHES

REFERENCE : URBAN STORM DRAINAGE CRITERIA MANUAL
URBAN DRAINAGE & FLOOD CONTROL DISTRICT

EXTENDED DURATION – INTENSITY – FREQUENCY TABULATION

STORM DURATION (MIN)	STORM FREQUENCY				
	2-YEAR (IN/HR)	5-YEAR (IN/HR)	10-YEAR (IN/HR)	50-YEAR (IN/HR)	100-YEAR (IN/HR)
5	3.31	4.70	5.57	8.00	9.22
10	2.57	3.65	4.32	6.21	7.16
15	2.17	3.08	3.65	5.24	6.04
20	1.92	2.71	3.21	4.58	5.27
25	1.70	2.40	2.84	4.06	4.67
30	1.50	2.13	2.53	3.63	4.19
40	1.21	1.73	2.06	2.99	3.46
50	1.02	1.47	1.76	2.56	2.97
60 (1 HR)	0.95	1.35	1.60	2.30	2.65
80	0.79	1.12	1.32	1.90	2.17
100	0.65	0.93	1.10	1.56	1.78
120 (2 HR)	0.55	0.78	0.91	1.30	1.47
150	0.45	0.63	0.73	1.04	1.17
180 (3 HR)	0.41	0.57	0.66	0.93	1.05

SECTION 4.0 – RUNOFF ANALYSIS
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TABLES & FIGURES LOCATED IN THE BACK OF SECTION 4.0

SECTION 4.0 RUNOFF ANALYSIS

4.1 INTRODUCTION

This section presents the criteria and methodology for determining the storm runoff design peaks and volumes to be used in the Town of Platteville in the preparation of storm drainage studies, plans, and facility design. Further details and discussion of each of these rainfall/runoff models are presented in the Urban Storm Drainage Criteria Manual (USDCM).

4.2 RATIONAL METHOD

The Rational Method may be utilized for the sizing of storm drains and for determining the amount of runoff from undeveloped areas. The limit of application of the Rational Method is approximately 160 acres. It has been concluded that, for tributary basins in excess of 160 acres, the cost of the drainage works justifies significantly more study, thought, and judgment on the part of the Design Engineer, than is permitted by the Rational Method. When the urban drainage basin exceeds 160 acres, the CUHP Method represents better practice and should be used.

The procedures for the Rational Method, as explained in the USDCM, Volume 1, Chapter, "Runoff" shall be followed in the preparation of drainage reports and storm drainage facility designs in the Town.

Standard forms for the calculation of Time of Concentration and Storm Drainage System Design are provided in Tables 4-1 and 4-2.

4.3 COLORADO URBAN HYDROGRAPH PROCEDURE (CUHP)

The application of the CUHP is required for drainage basins and projects larger than 5 acres. The procedures for the CUHP, as explained in the USDCM, Volume 1, Chapter "Runoff", shall be followed in the preparation of drainage reports and storm drainage facility designs in the Town. The design storm events to be used with the CUHP method are presented in Section 3 of these Criteria. Applicable infiltration depths are outlined in Section 3.2 of the USDCM, Volume 1, Chapter "Runoff".

A computer program has been developed to calculate hydrographs using the CUHP Method. In addition, the computer version has an added capability of using CUHP to compute runoff hydrographs for basins as small as 5 acres. For the Town, only the computer version with the capability to model basins as small as 5 acres shall be allowed. Specific details of the required input for this version are available in the CUHPE/PC Version Users Manual. The computer program can be obtained by contacting the Urban Storm Drainage and Flood Control District – www.udfcd.org.

The CUHPE/PC computer program was modified to provide the capability of estimating hydrographs for small drainage basins greater than 5 acres. The resulting flood peaks in many cases are generally comparable, but not identical to those estimated by the Rational Formula as specified in the USDCM. To estimate a hydrograph for small basins requires the input of the time of concentration as computed by the Rational Method described in the USDCM. It is often advantageous to generate a storm hydrograph to facilitate the routing of flows through detention facilities or channels.

4.4 STORM FLOW ANALYSIS

When determining the design storm flows, the Design Engineer shall follow particular criteria and guidelines to assure that minimum design standards and uniformity of drainage solutions are maintained throughout the Town. The information presented herein shall be used by the Design Engineer in the development of design storm runoff. Runoff coefficients used for analysis shall be as given in Tables RO-3 and RO-5 of Volume 1, Chapter "Runoff", of the Urban Storm Drainage Design Criteria Manual (USDCM) latest edition. "C" factors shall be determined per Table RO-5. An acceptable percentage of imperviousness for soils found in the Platteville area typically should be 2 percent as given in Table RO-3.

4.4.1 ON-SITE FLOW ANALYSIS

When analyzing the flood peaks and volumes, the Design Engineer shall use the proposed fully developed land use plan to determine runoff coefficients. In addition, the Design Engineer shall take into consideration the changes in flow patterns (from the undeveloped site conditions) caused by the proposed street alignments. When evaluating surface flow times, the proposed site grading shall be used to calculate the time of concentration or the CUHP parameters.

4.4.2 OFF-SITE FLOW ANALYSIS

The analysis of off-site runoff is dependent on the development status of the off-site area. For developed off-site areas with approved detention facilities, no off-site analysis is necessary. For undeveloped off-site areas, the proposed development must design drainage facilities to pass a 100-year undeveloped from the off-site area. If the off-site area is developed without detention facilities, the development must pass the 100-year developed storm.

4.5 Whenever a larger or non-homogeneous watershed is being investigated, it is necessary to segment the watershed into smaller and somewhat homogeneous sub-basins. The storm hydrograph for each sub-basin can then be calculated by the CUHP methodology as explained in the USDCM, Volume 1, Chapter, "Runoff". It is up to the Engineer to route and combine the individual sub-basin hydrographs to calculate a storm hydrograph for the entire watershed. There are several methods commonly used in channel routing that include:

- Direct Translation
- Convex
- Muskingum
- Storage-Discharge (Modified Puls)
- Kinematic Wave
- Diffusion Wave
- Dynamic Wave

The Direct Translation and Convex methods are presented in the USDCM, Volume 1, Chapter, "Runoff". The last three methods are more accurate. Computer programs, such as the EPA Stormwater Management Model (SWMM) which incorporates the Kinematic wave method, are available to route flows through channels, pipes and detention ponds and are recommended for utilization within the City. Of the remaining methods, the Muskingum method is similar to the

Convex method and the Storage-Discharge method is less convenient for hand calculations than the Direct Translation or Convex methods. Other computer programs capable of routing flows through stormwater conveyance channels and detention ponds will be reviewed by the Town and written approval must be obtained prior to utilization.

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

CALCULATED BY ______________ JOB NO. ______________

DATE ______________ PROJECT ______________

CHECKED BY ______________ DESIGN STORM ______________

	STREET	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
			AREA DESIGN	AREA (AC)	RUNOFF COEFF	tc (MIN.)	CA (AC)	I IN\HR	Q (CFS)	tc (MIN.)	ΣCA (AC)	I IN\HR	Q (CFS)	SLOPE %	STREET FLOW CFS	DESIGN FLOW CFS	SLOPE %	PIPE SIZE	LENGTH (FT)	VELOCITY (FPS)	tt (MIN.)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						

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TIME OF CONCENTRATION

SUB-BASIN DATA			INITIAL/OVERLAND TIME (t_i)			TRAVEL TIME (t_t)				t_c CHECK (URBANIZED BASINS)			FINAL t_c	REMARKS
DESIGN (1)	AREA AC (2)	C_5 (3)	LENGTH FT (4)	SLOPE % (5)	t_i MIN (6)	LENGTH FT (7)	SLOPE % (8)	VEL FPS (9)	t_t MIN (10)	COMP t_c (11)	TOTAL LENGTH FT (12)	$t_c = (L/180) + 10$ MIN (13)	MIN (14)	

SUBDIVISION _____

CALCULATED BY _____ DATE _____

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

TIME OF CONCENTRATION
TABLE 4-2

March, 2010

NOT TO SCALE

SECTION 5 – OPEN CHANNELS
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SECTION 5.0 OPEN CHANNELS

5.1 INTRODUCTION AND DEFINITIONS

This section addresses the technical criteria for the hydraulic evaluation and hydraulic design of open channels in the Town. This information shall be considered a minimum standard. Except as modified herein, all open channel criteria shall be in accordance with the most current edition and/or revisions of the Urban Storm Drainage Criteria Manual (USDCM).

Channels in the Town are defined as natural or artificial, and either major drainage ways or small drainage ways. Natural channels include all watercourses that have occurred naturally, such as the South Platte River. Artificial channels are those constructed or developed by human effort: large designated floodways, irrigation canals and flumes, roadside ditches, and grassed or lined channels.

Major drainage ways, as defined by these criteria, are identified and classified in conjunction with the Town of Platteville, Public Works Department. All remaining drainage ways shall be classified as small drainage ways. Channels conveying 20 cfs or greater flow shall be considered a major drainage way channel.

5.1.1 DEFINITIONS

cfs - cubic feet per second

fps - feet per second

Thalweg - a line drawn to join the lowest points along the entire length of a channel or streambed.

5.2 CHANNEL TYPES, MAJOR AND SMALL DRAINAGEWAYS

These standards cover the design of major and small drainage ways. The design standards for open channels cannot be presented in a step-by-step fashion because of the wide range of design options available to the Design Engineer. Certain planning and conceptual design criteria are particularly useful in the preliminary design of a channel. These criteria, which have the greatest effect on the performance and cost of the channel, are discussed below.

For these criteria Major drainage ways are defined as channels with flow rates of more than 20 cfs whereas small drainage ways are channels with flow rates less than 20 cfs. Additional flexibility and less stringent standards are allowed for small drainage ways.

5.2.1 NATURAL CHANNELS

The hydraulic properties of natural channels vary along the channel reach and can be either controlled to the extent desired or altered to meet given requirements. The initial decision made regarding natural channels is whether or not the channel is protected from erosion due to high velocity flows, or protected from excessive silt deposition due to low velocity flows.

Many natural channels in urbanized and developing areas have mild slopes, are reasonably stable, and are not in a state of serious degradation or aggradation. However, if a natural channel is used for carrying storm runoff from an urbanized area, the altered nature of the runoff peaks and volumes from urban development will cause erosion. Detailed hydraulic and channel stability analyses are required for natural channels in order to identify the

erosion tendencies and the affect of the storm runoff on channel stability. Some on-site modifications of the natural channel may be required to assure a stabilized condition.

The investigations necessary to assure that the natural channels will be adequate are different for every waterway. The Design Engineer shall prepare cross sections of the channel, define the water surface profiles for the initial and major design storm events, investigate the bed and bank material to determine erosion tendencies, and study the stability of the channel bed and bank under future conditions of flow. Super critical flow does not normally occur in natural channels, but calculations shall be made to assure that the results do not reflect super critical flow. If super critical flow is present, drop structures or other appropriate energy dissipater structures shall be provided.

5.2.1.A NATURAL CHANNELS – MAJOR DRAINAGE WAYS

The design criteria and evaluation techniques for natural channels are:

1. The channel and over-bank areas shall have adequate capacity for the 100-year storm runoff.
2. Natural channel segments which have a calculated Froude Number greater than 0.8 for the 100-year flood peak shall be protected from erosion.
3. The water surface profile shall be defined so that the floodplain can be zoned and protected.
4. Roughness factors (Manning's n), which are representative of un-maintained channel conditions, shall be used for the analysis of water surface profiles.
5. Roughness factors (Manning's n), which are representative of maintained channel conditions, shall be used to determine velocity limitations.
6. Erosion control structures, such as drop structures or check dams, may be required to control flow velocities, including the initial storm runoff.
7. If a natural channel is utilized as a major drainage way for a developed area, then the applicant shall meet with the Town to discuss the concept and to obtain the requirements for planning and design documentation, including the completion of a detailed channel stability analysis.
8. Plan and profile drawings of the floodplain shall be prepared. Appropriate allowances for known future bridges or culverts, which can raise the water surface profile and cause the floodplain to be extended, shall be included in the analysis. The applicant shall contact the Town for information on future bridges, culverts or other planned improvements.

Many specifications governing artificial channels do not apply to natural ones. Extensive modifications should not be undertaken unless they are necessary to avoid excessive erosion with subsequent deposition downstream. However, with most natural waterways, erosion control structures should be constructed at regular intervals to decrease the thalweg (flow line) slope and to control erosion. All structures constructed along the natural channel shall be elevated a minimum of two feet above the 100-year water surface level. Also, some advantages may become evident during peak runoff events, if overtopping and localized flooding areas are laid out during design.

5.2.1.B NATURAL CHANNELS – SMALL DRAINAGE WAYS

The design criteria and evaluation techniques for natural channels are:

1. The channel and over bank areas shall have adequate capacity for the 100-year storm runoff.
2. Natural channel segments, which have a calculated Froude Number greater than 0.8 for the 100-year flood peak shall be protected from erosion.
3. Roughness factors (Manning's n), which are representative of un-maintained channel conditions, shall be used for the analysis of water surface profiles.
4. Roughness factors (Manning's n), which are representative of maintained channel conditions, shall be used to determine velocity limitations.
5. Erosion control structures, such as check drops or check dams, may be required to control flow velocities, including the initial storm runoff.
6. A channel stability analysis will be completed to determine the impact of urbanization on the stability of the channel bed and banks.
7. Plan and profile drawings shall be prepared showing the 100-year water surface profile, floodplain, and details of erosion protection, if required.

5.2.2 GRASS LINED CHANNELS

Grass lined channels are the most desirable of the artificial channels. The grass will stabilize the body of the channel, consolidate the soil mass of the bed, check the erosion on the channel surface, and control the movement of soil particles along the channel bottom. Channel storage, lower velocities, and greenbelt multiple-use benefits create significant advantages over other artificial channels.

The presence of grass in channels creates turbulence, which results in loss of energy and increased flow retardance. Therefore, the designer must give full consideration to sediment deposition and to scour, as well as hydraulics. Unless existing development within the Town restricts the availability of right-of-way, only channels lined with grass will be considered acceptable for major drainage ways. Grass lined channels may require an acceptable trickle channel, as defined below.

5.2.2.A GRASS LINED CHANNELS – MAJOR DRAINAGE WAYS

Key parameters in grass lined channel design include velocity, slope, roughness coefficients, depth, freeboard, curvature, cross-section shape, and lining materials. Other factors such as water surface profile computation, erosion control, drop structures, and transitions also play an important role. A discussion of these parameters is presented below.

1. Flow Velocity (Major Drainage Way)
   The maximum normal depth velocity for the 100-year flood peak shall not exceed 5.0 fps. The Froude Number shall be less than 0.8 for grass-lined channels. The minimum velocity, wherever possible, shall be greater than 2.0 fps for the initial storm runoff.
2. Longitudinal Channel Slope (Major Drainage Way)
   Grass-lined channel slopes are dictated by velocity and Froude Number requirements. Where the natural topography is steeper than desirable, drop structures shall be utilized to maintain design velocities and Froude Numbers.

3. Freeboard (Major Drainage Way)
   Except where localized overflow in certain areas is desirable for additional ponding benefits or other reasons, the freeboard for the 100-year flow shall be as follows. The minimum freeboard shall be 1.0 foot.

rd shall be 1.0 foot.

$$H_{FB} = 2.0 + 0.025V(yo)^{1/3} + \Delta y \quad \text{Equation 5.2.2.A}$$

Where: H_{FB} = freeboard height (feet)

4. Horizontal Curvature (Major Drainage Way)
   The centerline curvature shall have a radius twice the top width of the design flow but not less than 100 feet.

5. Roughness Coefficient (Major Drainage Way)
   The variation of Manning's "n" with the retardance and the product of mean velocity and hydraulic radius, as presented in Figure 5-1, shall be used in the capacity computation.
   Retardance curve C shall be used to determine the channel capacity, since a mature channel (substantial vegetation with minimal maintenance) will have a higher Manning's "n" value. However, a recently constructed channel will have minimal vegetation and the retardance will be less than the mature channel. Therefore, retardance curve D shall be used to determine the limiting velocity in a channel.
   For the purpose of floodplain definition, only the higher Manning's "n" values need to be considered in the hydraulic analysis.

6. Cross-Sections (Major Drainage Way)
   The channel shape may be almost any type suitable to the location and to the environmental conditions. Often the shape can be chosen to suit open space and recreational functions. Representative cross-sections are presented in Figures 5-2, 5-3, and 5-4. The limitations within which the design must fall for the major storm design flow include:

   a. Trickle Channel - The base flow shall be carried in a trickle channel except for sandy soils. The minimum capacity shall be 2.0 percent to 4.0 percent of the 100-year flow but not less than 1 cfs. Trickle channels shall be grass-lined with a perforated under drain for water quality enhancement wherever practical. Where the water quality trickle channel is impractical, construct the channel with concrete or other approved materials to minimize erosion, to facilitate maintenance, and to aesthetically blend with the adjacent vegetation and soils. Recommended trickle channel sections are presented in Figure 5-5. The minimum trickle channel width shall be three feet.
      An alternative configuration for a trickle channel may consist of a subsurface storm drain pipe. If used, this alternative would consist of a minimum 24" diameter pipe,

provided with access manholes, and sloped to maintain a minimum pipe flow velocity of 3 feet per second at one-half of full pipe depth.

b. Main Channel - Representative main channels, and limitations for these channels, are shown in Figures 5-2, 5-3, and 5-4. Figure 5-4 indicates channel configurations for sandy soils.

c. Bottom Width - The minimum bottom width shall be consistent with the maximum depth and velocity criteria. The minimum width shall be four (4) feet or the trickle channel width, where required.

d. Right-Of-Way Width - The minimum ROW width shall include freeboard and a twelve (12) foot wide maintenance access. In some situations, the Town may require a twelve (12) maintenance access on both sides of the channel.

e. Flow Depth - The maximum design depth of flow (outside the trickle channel area and main channel area) for the 100-year flood shall be limited to five (5) feet in grass-lined channels.

f. Maintenance/Access Road - Continuous maintenance access shall be provided for all major drainage ways at a minimum width of twelve (12) feet. The Town may require six (6) inches of Class 2 road base or a concrete slab.

g. Side Slopes - Side slopes shall be 4H (horizontal) to 1V (vertical) or flatter.

7. Grass lining (Major Drainage Way)
   The grass lining for channels shall be in accordance with the USDCM, "Major Drainage", Section 4.1, "Grass-lined Channels,".
8. Erosion Control (Major Drainage Way)
   The requirements for erosion control for grass-lined channels shall be as defined in the USDCM, "Major Drainage", Section 4.1, "Grass-lined Channels." The design of riprap and erosion control devices shall be in accordance with Sections 10.1 and 10.2 of these Criteria.
9. Water Surface Profiles (Major Drainage Way)
   Computation of the water surface profile shall be presented for all open channels utilizing standard backwater methods, taking into consideration losses due to changes in velocity or channel cross section, drops, waterway openings, or obstructions. The energy gradient shall be included in the Final Drainage Report.

5.2.2.B GRASS LINED CHANNELS – SMALL DRAINAGE WAYS

Key parameters in grass lined channel design include velocity, slope, roughness coefficients, depth, freeboard, curvature, cross section shape, and lining materials. Other factors such as water surface profile computation, erosion control, drop structures, and transitions also play an important role. A discussion of these parameters is presented below.

1. Flow Velocity (Small Drainage Way)
   The maximum normal depth velocity for the 100-year flood peak shall not exceed 5.0 fps. The Froude Number shall be less than 0.8 for grass-lined channels. The minimum velocity, wherever possible, shall be greater than 2.0 fps for the initial storm runoff.

2. Longitudinal Channel Slope (Small Drainage Way)
   Grass-lined channel slopes are dictated by velocity and Froude Number requirements. Where the natural topography is steeper than desirable, drop structures shall be utilized to maintain design velocities and Froude Numbers.

3. Freeboard (Small Drainage Way)
   A minimum freeboard of 1 foot shall be included in the design of the 100-year flow. For swales (i.e. small drainage ways with a 100-year flow less than 20 cfs), the minimum freeboard requirement is 6 inches.

4. Horizontal Curvature (Small Drainage Way)
   The minimum radius for channels with a 100-year runoff of 20 cfs or less shall be 25 feet.

5. Roughness Coefficient (Small Drainage Way)
   The variation of Manning's "n" with the retardance and the product of mean velocity and hydraulic radius, as presented in Figure 5-1, shall be used in the computation of capacity and velocity.

6. Cross-Sections (Small Drainage Way)
   The channel shape may be almost any type suitable to the location and to the environmental conditions. Often the shape can be chosen to suit open space and recreational functions. Representative cross sections are presented in Figures 5-2, 5-3, and 5-4. The limitations on the cross-sections are as follows:

   a. Trickle Channel - The base flow (except for swales) shall be carried in a trickle channel. The minimum capacity shall be 1.0 percent to 3.0 percent of the 100-year flow. Trickle channels shall be constructed of concrete or other approved materials to minimize erosion, to facilitate maintenance, and to aesthetically blend with the adjacent vegetation and soils. For sandy soils, a main channel is required in accordance with Figure 5-4. Trickle channel requirements will be evaluated for each case. Trickle channels help preserve swales crossing residential property.

   b. Right-Of-Way, Easement, or Outlot Width - The minimum width shall include freeboard and a 12-foot wide maintenance access road.

   c. Flow Depth - The maximum design depth of flow outside the trickle channel area and main channel area for the 100-year flood shall be limited to 5.0 feet in grass-lined channels.

   d. Side Slopes - Side slopes shall be 4H (horizontal) to 1V (vertical) or flatter.

7. Grass Lining (Small Drainage Way)
   The grass lining for channels shall be in accordance with the USDCM, Volume 1, Chapter, "Major Drainage", Section 4.1, “Grass lined Channels."

8. Erosion Control (Small Drainage Way)
   The requirements for erosion control for grass-lined channels shall be as defined in the USDCM, Volume 1, Chapter, "Major Drainage", Section 4.1, “Grass lined Channels." The design of riprap and erosion control devices shall be in accordance with Section 10.1 and 10.2 of these Criteria.

9. Hydraulic Information (Small Drainage Way)
   Calculations of the capacity, velocity, and Froude Numbers shall be submitted with the Final Drainage Report.

5.2.3 CONCRETE LINED CHANNELS

Concrete lined channels for major drainage ways will be permitted only where right-of-way restrictions within existing development prohibit grass lined channels. The lining must be designed to withstand the various forces and actions, which tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining, and erode unlined areas, especially for super critical flow conditions.

If the project constraints suggest the use of a concrete channel for a major drainage way, the Town shall allow such use only upon approval. The applicant shall present the justification and design to the Town for consideration of a variance from these Criteria.
A Design Report is required for approval of a concrete lined channel. The Town shall determine the contents of such report.

$$H_{FB} = 2.0 + 0.025\ V\ (d)^{1/3} \qquad \text{Equation 5.2.3.A}$$

Where: H_{FB} = freeboard height (feet)

5.2.3.A CONCRETE LINED CHANNELS – MAJOR DRAINAGE WAYS

1. Hydraulics (Major Drainage Way)
   a. Freeboard - Adequate channel freeboard above the designed water surface shall be provided and shall not be less than determined by the following:
      Freeboard shall be in addition to super-elevation, standing waves, and/or other water surface disturbances. These special situations shall be addressed in the Final Drainage Report.
      Concrete side slopes shall be extended to include the freeboard height.
   b. Super-elevation - Super-elevation of the water surface shall be determined at all horizontal curves, and design of the channel section adjusted accordingly.
   c. Velocities - Flow velocities shall be such that critical or super critical flow conditions are not created. In no case shall the velocity exceed 18 fps.
   d. Critical or super critical flow conditions are not allowed. Drop structures or other appropriate energy dissipation facilities may be required to maintain a sub critical flow regime.
2. Concrete Materials (Major Drainage Way)
   All concrete materials shall meet or exceed Metropolitan Government Engineer's Council (MGPEC) specifications Item 11, Portland Cement Concrete Pavement; Section 11.2, Materials.
3. Concrete Lining Section (Major Drainage Way)
   a. All concrete lining shall have a minimum thickness of seven (7) inches.

b. The side slopes shall be a maximum of 2V (vertical) to 1H (horizontal), or shall be designed as a structurally reinforced retaining wall, if steeper.

4. Concrete Joints (Major Drainage Way)

   a. Concrete channels shall be continuously reinforced and contain transverse joints. Expansion joints shall be installed where new concrete lining is connected to a rigid structure or to an existing concrete lining which is not continuously reinforced.

   b. Longitudinal joints, where required, shall be constructed on the sidewalls at least one foot vertically above the channel invert.

   c. All joints shall be designed to prevent differential movement.

   d. Construction joints are required for all cold joints and where the lining thickness changes. Reinforcement shall be continuous through the joint.

5. Concrete Finish (Major Drainage Way)
   The concrete lining shall be finished per the most current Town of Platteville Design Criteria and Construction Specifications (DCCS), Volume I, Streets, Section 03310, paragraph 3.8.

6. Concrete Curing (Major Drainage Way)
   Concrete shall be cured per the most current DCCS, Volume 1, Streets, Section 03310, paragraph 3.10.

7. Reinforcement Steel (Major Drainage Way)

   a. Steel reinforcement shall be minimum grade 60 deformed bars. Fabric mesh may also be approved. Wire mesh shall not be used.

   b. Reinforcing steel shall be placed at the center of the section with a minimum clear cover of three inches adjacent to the earth.

   c. All other reinforcement steel requirements shall follow the latest revision of American Concrete Institute ACI 318-89, (latest edition).

8. Earthwork (Major Drainage Way)
   All earthwork shall be performed per the most current DCCS, Volume I, Streets, Sections 02220 – Excavation, Removals, and Embankment; 02223 – Structural Backfill; 02225 – Grading, Compaction Subgrade, and Unimproved area Preparation; and 02227 – Sub-base. Maintenance Roads and any area within 10 feet of the channel lip shall be considered “improved areas”.

9. Bedding (Major Drainage Way)
   Provide six inches of granular bedding equivalent in gradation to ¾" concrete aggregate, No. 67 (Standard Specifications for Road & Bridge Construction, CDOT, latest revision) under channel bottom and side slopes.

10. Under Drain (Major Drainage Way)
    Longitudinal under drains shall be provided on 10-foot centers and shall daylight at the check drops. Weep holes shall be provided in vertical wall sections of the channel.

11. Safety Requirements (Major Drainage Way)

a. A six-foot high vinyl coated chain link or comparable fence shall be installed to prevent access wherever the 100-year channel flow depths exceed three (3) feet. Gates, with top latch, shall be placed at 250-foot intervals and staggered where fence is required on both sides of the channel.

b. Ladder-type steps shall be installed not more than 400 feet apart on alternating sides of the channel. Bottom rung shall be placed approximately 12 inches vertically above the channel invert.

12. Maintenance Access Road
A maintenance access road may be required along the entire length of all major drainage ways with a minimum passage width of 12 feet. The Town will require the road to be surfaced with six inches of Class 2 road base.

5.2.3.B CONCRETE LINED CHANNELS – SMALL DRAINAGE WAYS

1. Hydraulics (Small Drainage Way)

a. Freeboard - Adequate channel freeboard above the designed water surface shall be provided and shall not be less than determined by Equation 5.2.2.A. Freeboard shall be in addition to super elevation, standing waves, and/or other water surface disturbances. These special situations shall be addressed in the Final Drainage Report.
Concrete side slopes shall be extended to include the freeboard height.

b. Super-elevation - Super-elevation of the water surface shall be determined at all horizontal curves, and design of the channel section adjusted accordingly.

c. Velocities - Flow velocities shall be such that critical or super critical flow conditions are not created. In no case shall the velocity exceed 18 fps.

2. Concrete Materials (Small Drainage Way)
All concrete materials shall meet or exceed Metropolitan Government Engineer's Council (MGPEC) specifications Item 11, Portland Cement Concrete Pavement; Section 11.2, Materials.

3. Concrete Lining Section (Small Drainage Way)

a. All concrete lining shall have a sufficient thickness to withstand the structural and hydraulic loads. In all cases concrete lining shall be a minimum of 5" thick.

b. The side slopes shall be a maximum of 2V (vertical) to 1H (horizontal), or be designed as a structurally reinforced retaining wall, if steeper.

4. Concrete Joints (Small Drainage Way)

a. Expansion joints shall be installed where new concrete lining is connected to a rigid structure or to existing concrete lining which is not continuously reinforced.

b. Longitudinal joints, where required, shall be constructed on the sidewalls at least one foot vertically above the channel invert.

c. All joints shall be designed to prevent differential movement.

d. Construction joints are required for all cold joints and where the lining thickness changes.

5. Concrete Finish (Small Drainage Way)
   The concrete lining shall be finished per the most current Town of Platteville Design Criteria and Construction Specifications (DCCS), Volume I, Streets, Section 03310, paragraph 3.8.
6. Concrete Curing (Small Drainage Way)
   Concrete shall be cured per the most current DCCS, Volume 1, Streets, Section 03310, paragraph 3.10.
7. Reinforcement Steel (Small Drainage Way, where appropriate)
   a. Steel reinforcement shall be minimum grade 60 deformed bars. Fabric mesh may also be approved. Wire mesh shall not be used.
   b. Reinforcing steel shall be placed at the center of the section with a minimum clear cover of three inches adjacent to the earth.
   c. All other reinforcement steel requirements shall follow the latest revision of American Concrete Institute ACI 318-89.
8. Earthwork (Small Drainage Way)
   All earthwork shall be performed per the most current DCCS, Volume I, Streets, Sections 02220 – Excavation, Removals, and Embankment; 02223 – Structural Backfill; 02225 – Grading, Compaction Subgrade, and Unimproved area Preparation; and 02227 – Sub-base. Maintenance Roads and any area within 10 feet of the channel lip shall be considered "improved areas".
9. Bedding (Small Drainage Way)
   Provide six inches of granular bedding equivalent in gradation to ¾-inch concrete aggregate (Standard Specifications for Road & Bridge Construction, CDOT, latest revision) under channel bottom and side slopes.
10. Under Drain (Small Drainage Way)
    Longitudinal under drains shall be provided and shall daylight at the check drops. Weep holes shall be provided in vertical wall sections of the channel.
11. Safety Requirements (Small Drainage Way)
    a. A six-foot high vinyl coated chain link or comparable fence shall be installed to prevent access wherever the 100-year channel flow depths exceed three (3) feet. Gates, with top latch, shall be placed at 250-foot intervals and staggered where fence is required on both sides of the channel.
    b. Ladder-type steps shall be installed not more than 400 feet apart on alternating sides of the channel. Bottom rung shall be placed approximately 12 inches vertically above the channel invert.

5.2.4 ROCK LINED CHANNELS

Riprap lined channels are generally discouraged and shall be permitted only in areas of existing development where right-of-way for major drainage ways is limited and such limitation prohibits the use of grass lined channels. The advantage of rock lining a channel is that a steeper channel grade can be used due to the higher 'n' factor associated with the rock

and a higher allowable shear stress. 4H:1V is the steepest side slope permitted. Rock linings, or revetments, are permitted as a means of controlling erosion for natural channels.

If the project constraints dictate the use of riprap lining for a major drainage way, then the Design Engineer shall present the concept, with justification, to the Town for consideration of a variance from these Criteria. The design of rock-lined channels shall be in accordance with the most current revision of the USDCM, Volume 1, Chapter, "Major Drainage", Section 4.4, "Riprap – Lined Channels."

5.2.4.A ROCK LINED CHANNELS – MAJOR DRAINAGE WAYS

The criteria for the design and construction of riprap channel linings shall be in accordance with the USDCM, Volume 1, Chapter, "Major Drainage", Section 4.4, "Riprap – Lined Channels." Riprap lined channels shall be designed for a turbulence factor (Froude Number) less than 0.8 for the 100-year flood peaks.

The riprap shall be designed and constructed in accordance with Section 10.2 of these Criteria. Freeboard and maintenance access road requirements shall be in accordance with the standards for grass-lined channels as defined in Section 5.2.2.A of these Criteria.

5.2.4.B ROCK LINED CHANNELS – SMALL DRAINAGE WAYS

The criteria for the design and construction of riprap channel linings shall be in accordance with the USDCM, Volume 1, Chapter, "Major Drainage", Section 4.4, "Riprap – Lined Channels." Riprap lined channel shall be designed for a turbulence factor (Froude Number) less than 0.8 for the 100-year flood peaks. The riprap shall be designed and constructed in accordance with Section 10.2 of these Criteria. Freeboard requirements shall be in accordance with the standards for grass-lined channels (see Section 5.2.2.B). Riprap channels are not encouraged.

5.2.5 OTHER LINING TYPES

The use of synthetic fabrics and slope revetment mats for major drainage ways in the Town is restricted to areas of existing development where the ROW constraints prohibit the use of a grass lined section. A synthetic lining, such as a soil stabilization fabric, in combination with grass lining may be acceptable in some situations. If a soil stabilization fabric also referred to as turf reinforcement mat (TRM) is used in combination with grass, a permanent irrigation system must be included. Grass shall always be planted prior to installing the fabric. Provide details on construction drawings for proper installation of the fabric, according to manufacturer's recommendations. Such use shall be allowed only upon written approval from the Town. The linings shall be restricted to channels with a Froude Number of 0.8 or less.

Note: The use of TRM that uses fish line netting to hold the filler material together has caused birds and reptiles to become trapped resulting in death. This type of TRM shall not be used.

Below are soil stabilization materials that may be used for Froude Numbers greater than 0.8.

Terra Cell, a Geo Cell, is another type of soil stabilization product. It is a cellular confinement mat, manufactured in different depths. These mats are anchored with 'J' hooks and the cells filled with rock or amended soil.

Articulating Block (AB) Mat is an articulating block mat with cable reinforced concrete block mattresses that resist erosive forces.

5.2.5.A OTHER LINING TYPES – MAJOR DRAINAGE WAYS

The criteria for the design of major drainage way channels with linings other than grass, rock, or concrete will be dependent on the manufacturer's recommendations for the specific product. The applicant will be required to submit the technical data in support of the proposed material. Additional information or calculations may be requested by the Town to verify assumptions or design criteria. The following minimum criteria will also apply.

1. Flow Velocity (Major Drainage Way)
   The maximum normal depth velocity will be dependent on the construction material used; however, the Froude Number shall be less than 0.8.
2. Freeboard (Major Drainage Way)
   Same as for grass lined channels (see Section 5.2.2.A).
3. Curvature (Major Drainage Way)
   The centerline curvature shall have a minimum radius twice the top width of the design flow but not less than 100 feet.
4. Roughness Coefficient (Major Drainage Way)
   A Manning's "n" value range shall be established by the manufacturer's data, with the high value used to determine depth/capacity requirements and the low value used to determine the Froude Number and velocity restrictions.
5. Cross Sections (Major Drainage Way)
   Same as for grass lined channels (see Section 5.2.2.A).

5.2.5.B OTHER LINING TYPES (SMALL DRAINAGE WAY)

The criteria for the design of small drainage way channels with linings other than grass, rock, or concrete will be dependent on the manufacturer's recommendations for the specific product. The applicant will be required to submit the technical data in support of the proposed material. Additional information or calculations may be requested by the Town to verify assumptions or design criteria. The following minimum criteria will also apply.

1. Flow Velocity (Small Drainage Way)
   The maximum normal depth velocity will be dependent on the construction material used; however, the Froude Number shall be less than 0.8.
2. Freeboard (Small Drainage Way)
   Same as for grass lined channels (see Section 5.2.2.B).
3. Curvature (Small Drainage Way)
   The minimum radius of curvature for channels with a 100-year runoff of 20 cfs or less shall be 25 feet.
4. Roughness Coefficient (Small Drainage Way)
   A Manning's "n" value range shall be established by the manufacturer's data, with the high value used to determine depth/capacity requirements and the low value used to determine the Froude Number and velocity restrictions.

5. Cross Sections (Small Drainage Way)
   Same as for grass lined channels (see Section 5.2.2.B).

5.2.6 WETLANDS VEGETATION BOTTOM CHANNELS

The selection of a particular channel can be based on many factors, including hydraulic practice, environmental design, sociological considerations, and basic project requirements. However, prior to choosing the channel type, the need or desire for channelization should be established.

Once a decision is made to channelize, investigations into the status of the present drainage way are necessary to define the constraints on the channel design. For instance, if the channel presently has wetland characteristics, then the Section 404 requirements of the Clean Water Act may require that the design maintain a wetland area. The Design Engineer should contact the Corps of Engineers for additional information.

The process of choosing a channel configuration and the design criteria for a wetlands bottom channel (if this type is selected) shall follow the latest revision of the USDCM. The Design Engineer is referred to these interim criteria (USDCM, Chapter, "Major Drainage", Sections 2 and 3) for the procedures and criteria for all channel design.

5.3 FLOW COMPUTATION

Uniform flow and critical flow computations shall be in accordance with the USDCM, "Major Drainage", Section 3, and shall use the Manning's equation as follows:

$$Q = \frac{1.49}{n}(AR^{2/3}S^{1/2})$$

Equation 5.3

Where: Q = flow rate (cfs)
n = Manning's roughness coefficient
A = Area of channel cross-section (ft^2)

R = A/P = hydraulic radius (ft)
P = wetted perimeter (ft)
S = channel bottom slope (ft/ft)

5.4 ROADSIDE DITCHES

1. The criteria for the design of roadside ditches are similar to the criteria for grass-lined channels with modification for the special purpose of initial storm drainage. The criteria is as follows (refer to Figure 5-6):
2. Capacity - Roadside ditches shall have adequate capacity for the initial storm runoff peaks. During the initial storm runoff event, encroachment shall not extend beyond the street right-of-way. Where the storm runoff exceeds the capacity of the ditch, a storm drain system shall be required.

3. Flow Velocity - The maximum velocity for the initial storm flood peak shall not exceed 5 feet per second.
4. Longitudinal Slope - The slope shall be limited by the average velocity of the initial storm flood peaks. Check drops may be required where street slopes are in excess of 2%. Maximum permissible slope is 5%.
5. Freeboard - Freeboard shall be equal to the velocity head, or a minimum of six inches.
6. Curvature - The minimum radius of curvature shall be 25 feet.
7. Roughness Coefficient - Manning's "n" values presented in Figure 5-1 shall be used in the capacity computation for roadside ditches.
8. Grass Lining - The grass lining shall be in accordance with USDCM, "Major Drainage", Section 3, "Grass Lined Channels -Grass."
9. Driveway Culverts - Driveway culverts shall be sized to pass the initial storm ditch flow capacity without overtopping the driveway. The minimum size culvert shall be a 12-inch diameter pipe (or equivalent) with flared end sections. More than one culvert may be required.
10. Major Drainage Capacity - The capacity of roadside ditches for major drainage flow is restricted by the maximum flow depth allowed at the street crown (see Section 8). However, the flow spread should not inundate the ground line of residential dwellings, or public, commercial, or industrial buildings.

5.5 CHANNEL RUNDOWNS

A channel rundown is used to convey storm runoff from the bank or side-slope of a channel or detention pond to the channel invert or to the bottom of a detention pond. The purpose of the structure is to minimize channel bank erosion from concentrated overland flow. The design criteria for channel rundowns is as follows:

1. Cross Sections - Typical cross sections for channel rundowns are presented in Figure 5-7.
2. Design Flow - The channel rundown shall be designed to carry a minimum flow of a one hundred year frequency storm.
3. Flow Depth - The maximum depth at the design flow shall be 12 inches. Due to the typical profile of a channel rundown beginning with a flat slope and then dropping steeply into the channel, the design depth of flow shall be the computed critical depth for the design flow.
4. Outlet Configurations Into Channels - The channel rundown outlet shall enter the drainage-way at the trickle channel flow line. Erosion protection of the opposite channel bank shall be provided by a 24-inch layer of grouted Type M riprap. The width of this riprap erosion protection shall be at least three times the channel rundown width or pipe diameter. Riprap protection shall extend up the opposite bank to the initial storm flow depth in the drainage way or 2 feet, whichever is greater. Riprap shall only be used with bedding or fabric on slopes less than or equal to 4H (horizontal): 1V (vertical).
5. Outlet Configurations Into Detention Ponds - the channel rundown outlet shall be constructed with a flared end section, a concrete cutoff wall and an adequately reinforced splash pad at the bottom of the rundown.

Cut off walls shall be concrete, eight inches (8") thick, four-feet (4') deep, and four-feet (4') wider than the flared end section, two-feet (2') either side. Rebar centered within the cutoff wall shall be #4-12" o.c. each way (horizontal and vertical).
The splash pad may be constructed with eight-inch (8") thick concrete; a twenty-four (24") layer of grouted Type M riprap or may be bluegrass with a Geo fabric designed to withstand the splash pad forces.
All components must be sized for a 100-year frequency storm. Consult the latest edition of the USDCM, Volume 2, for guidance in designing various components of the rundown.

6. Turf Reinforcement Mat (TRM) on soil with native grass is not allowed for channel rundowns. Only a Geo fabric designed to withstand the splash pad forces with irrigated bluegrass is allowed in conjunction with a cut off wall and Geo fabric at the base of the slope, which will allow the flow to dissipate in different directions.
7. If concrete V-pan rundowns sized for 5-year frequency storms are used they must be constructed with an eighteen-inch (18") layer of grouted Type M riprap on both sides to accommodate for a 100-year frequency storm. This type of rundown must have a FES, an adequate concrete cutoff wall at the FES and an adequately reinforced splash pad at the bottom of the rundown.
8. Rundowns may be constructed with a 24-inch layer of Type M riprap, on bedding, on Geo fabric that is completely grouted and sized for a 100-year frequency storm. A concrete cutoff wall must be provided with an adequate splash pad at the bottom.

5.6 MAINTENANCE AND ACCESS EASEMENTS

An important aspect of storm drainage facilities is continued maintenance. Maintenance of storm drainage channels and structures may include periodic removal of sediment and debris; repair of channel erosion; and repair of inlet, outlet, and drop structures. The Town requires the following minimum right-of-way or easement widths, which must be shown on the Final Plat or separate document when a plat is not proposed:

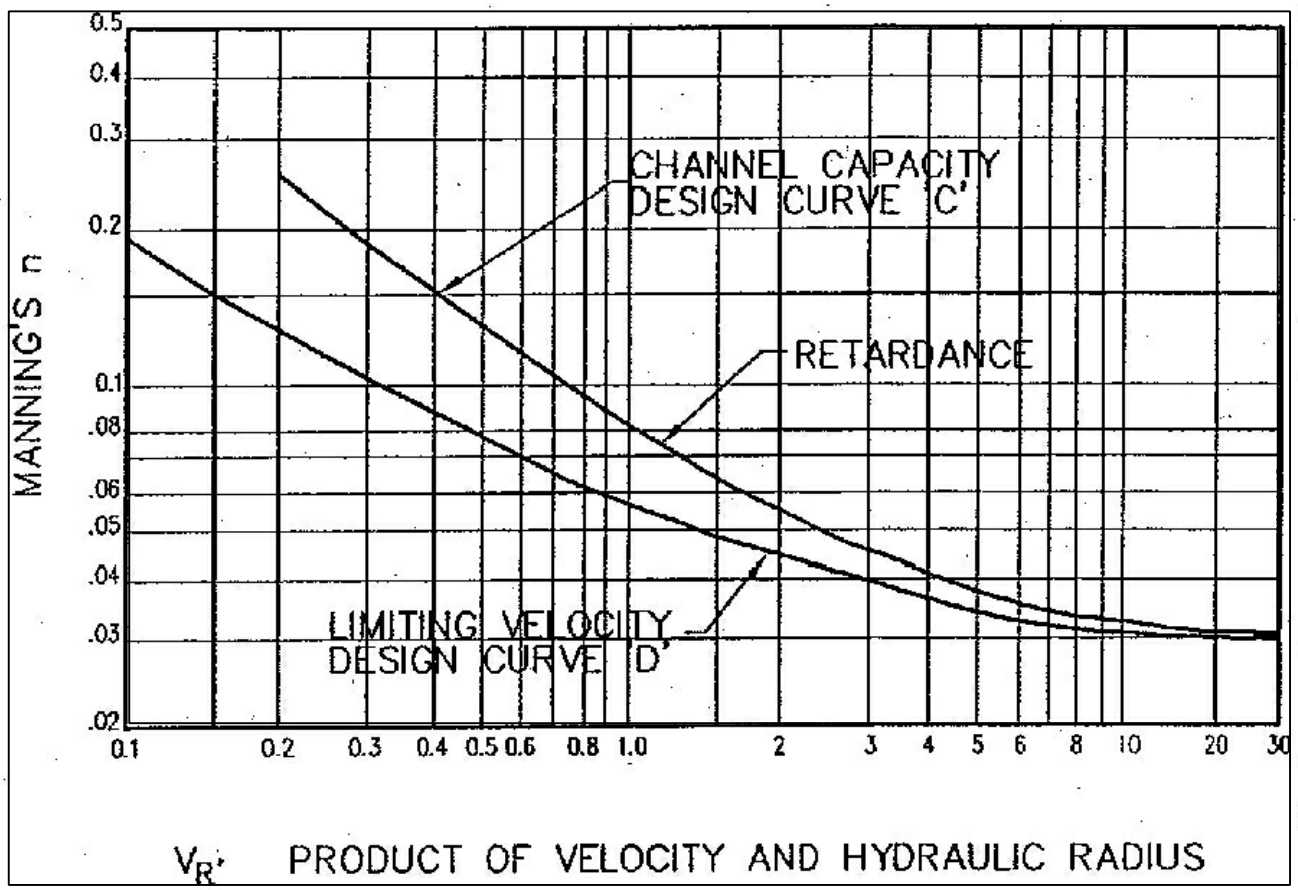
TABLE 5.6 - MINIMUM CHANNEL EASEMENTS WIDTHS

Channel Size	Total R.O.W. or Easement Width
Q_{100} less than 20 cfs	15 feet
Q_{100} less than 100 cfs	25 feet
Q_{100} greater than 100 cfs	Minimum width calculated to include freeboard plus 12-foot wide access road. The Town shall determine if access is required on both sides of channel.

5.7 CHECKLIST

To aid the designer and reviewer, the following checklist has been prepared.

1. Check flow velocity with the low retardance factor and capacity with the high retardance factor.
2. Check the Froude Number and critical flow conditions.
3. Grass channel side slopes must be 4H:1V or flatter.
4. Show the energy grade line and the hydraulic grade line in the Drainage Report.
5. Consider all backwater conditions at culverts when determining channel capacity.
6. Check the flow velocity for flood conditions without backwater effects.
7. Provide adequate freeboard.
8. Provide adequate right-of-way for the channel and continuous maintenance access.



NOTE: FROM "HANDBOOK OF CHANNEL DESIGN FOR SOIL AND WATER CONSERVATION," U.S. DEPARTMENT OF AGRICULTURE. SOILS CONSERVATION SERVICE, No. SCS-TP-61 MARCH, 1947 REVISED JUNE, 1954

PV_DRAIN_P68.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

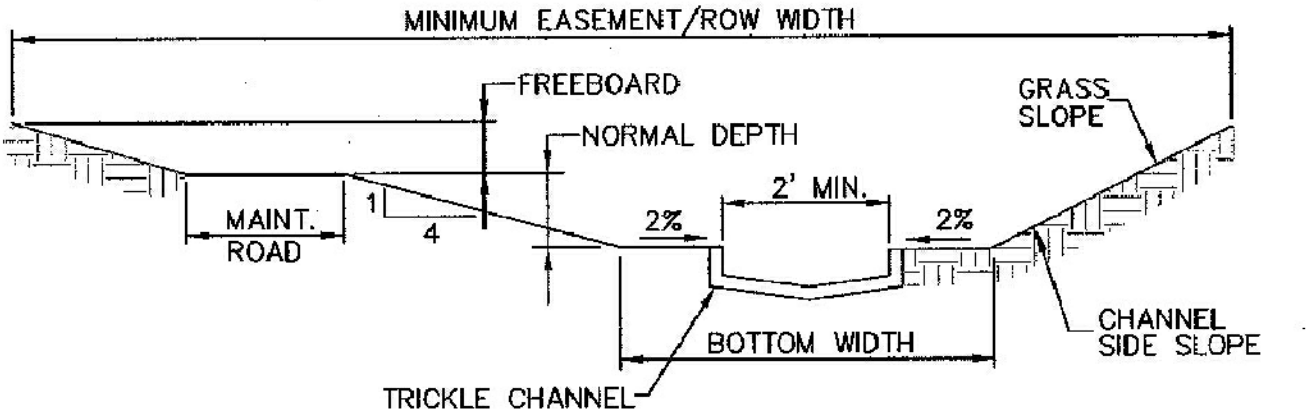
ROUGHNESS COEFFICIENT FOR GRASS CHANNELS

FIGURE 5-1

March, 2010

NOT TO SCALE

TYPE A



NOTES:

1. BOTTOM WIDTH: CONSISTENT WITH MAXIMUM ALLOWABLE DEPTH AND VELOCITY REQUIREMENTS, SHALL NOT BE LESS THAN TRICKLE CHANNEL WIDTH.
2. TRICKLE CHANNEL: MINIMUM CAPACITY TO BE 2% TO 4% OF 100-YEAR FLOW BUT NOT LESS THAN 1 CFS. CHANNEL TO BE CONSTRUCTED OF CONCRETE, GROUTED RIPRAP, OR OTHER APPROVED MATERIALS.
3. NORMAL DEPTH: NORMAL DEPTH AT 100-YEAR FLOW SHALL NOT EXCEED 5 FEET. MAXIMUM 100-YEAR FLOW VELOCITY AT NORMAL DEPTH SHALL NOT EXCEED 5.0 FPS.
4. FREEBOARD: FREEBOARD TO BE A MINIMUM OF 1 FOOT.
5. MAINTENANCE ACCESS ROAD: MINIMUM WIDTH TO BE 12 FEET. CITY MAY REQUIRE ALL OR PART OF THE ROAD TO BE SURFACED.
6. EASEMENT/ROW WIDTH: MINIMUM WIDTH TO INCLUDE FREEBOARD AND MAINTENANCE ACCESS ROAD.
7. CHANNEL SIDE SLOPE: MAXIMUM SIDE SLOPE FOR GRASSED CHANNELS TO BE 4:1.
8. FROUDE NUMBER: MAXIMUM VALUE SHALL NOT EXCEED 0.8 FOR MINOR AND MAJOR STORM EVENTS.
9. LOW FLOW PIPE MAY BE USED IN LIEU OF TRICKLE CHANNEL.

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

TYPICAL GRASS LINED CHANNEL SECTION

FIGURE 5-2

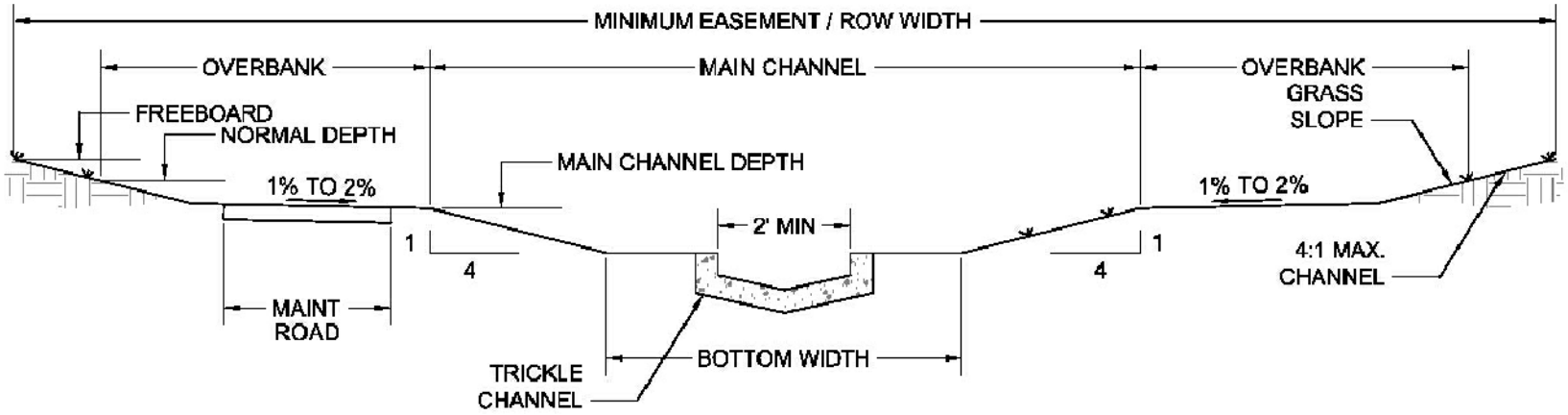
March, 2010

NOT TO SCALE

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

PV_DRAIN_P70.DWG

TYPE B



NOTES:

1. MAIN CHANNEL: CAPACITY TO BE NO LESS THAN 20% OF 100-YEAR AT MAIN CHANNEL DEPTH. MAXIMUM 100-YEAR FLOW VELOCITY IS 5.0 FPS.
2. TRICKLE CHANNEL: MINIMUM CAPACITY TO BE 2% TO 4% OF 100-YEAR FLOW BUT NOT LESS THAN 1 CFS. CHANNEL TO BE CONSTRUCTED OF CONCRETE, GROUTED RIPRAP OR OTHER APPROVED MATERIAL. SEE FIGURE 5-4 FOR REQUIREMENTS IN SANDY SOILS.
3. NORMAL DEPTH: SHALL INCLUDE MAIN CHANNEL DEPTH. FLOW DEPTH FOR 100-YEAR SHALL NOT EXCEED 5 FEET.
4. FREEBOARD: FREEBOARD TO BE A MINIMUM OF 1 FOOT.
5. MAINTENANCE ACCESS ROAD: MINIMUM WIDTH TO BE 12 FEET. CITY MAY REQUIRE ALL OR PART OF THE ROAD TO BE SURFACED.
6. EASEMENT / ROW WIDTH: MINIMUM WIDTH TO INCLUDE FREEBOARD AND MAINTENANCE ACCESS ROAD.
7. OVERBANK: FLOW IN EXCESS OF MAIN CHANNEL TO BE CARRIED IN THIS AREA. AREA MAY BE USED FOR RECREATION PURPOSES.

March, 2010

TYPICAL GRASS LINED
CHANNEL SECTION

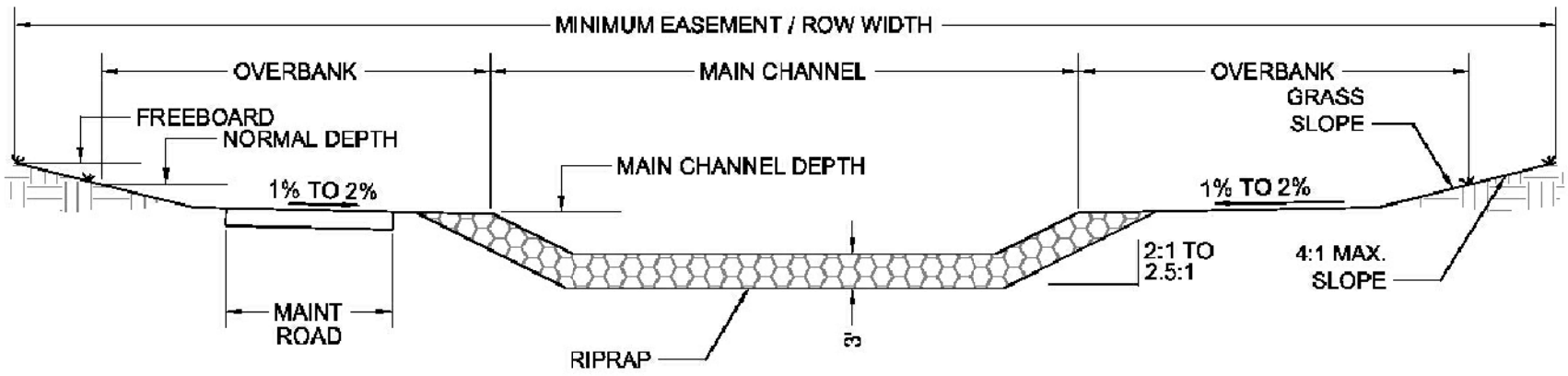
FIGURE 5-3

NOT TO SCALE

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

PV_DRAIN_P71.DWG

TYPE C



NOTES:

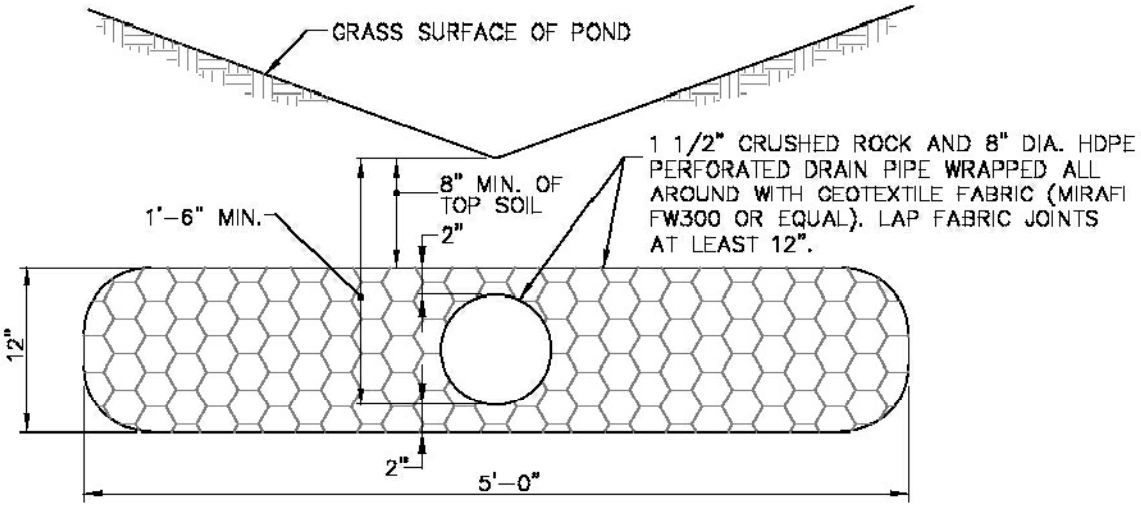
1. THIS SECTION IS REQUIRED FOR CHANNELS IN SANDY SOILS.
2. MAIN CHANNEL: CAPACITY TO BE THE EQUIVALENT OF THE INITIAL STORM RUNOFF. MAXIMUM 100-YEAR FLOW VELOCITY IS 5 FPS. PROTECT SLOPES WITH RIPRAP. USE A MANNINGS N-VALUE OF 0.03 FOR HYDRAULIC CALCULATIONS.
3. NORMAL DEPTH: FLOW DEPTH FOR 100-YEAR FLOW SHALL NOT EXCEED 5 FEET, NOT INCLUDING THE MAIN CHANNEL DEPTH.
4. FREEBOARD: FREEBOARD TO BE A MINIMUM OF 1 FOOT.
5. MAINTENANCE ACCESS ROAD: MINIMUM WIDTH TO BE 12 FEET. CITY MAY REQUIRE ALL OR PART OF THE ROAD TO BE SURFACED.
6. EASEMENT / ROW WIDTH: MINIMUM WIDTH TO INCLUDE FREEBOARD AND MAINTENANCE ACCESS ROAD.
7. OVERBANK: FLOW IN EXCESS OF MAIN CHANNEL TO BE CARRIED IN THIS AREA. AREA MAY BE USED FOR RECREATION PURPOSES.

TYPICAL GRASS LINED CHANNEL SECTION FOR SANDY SOILS

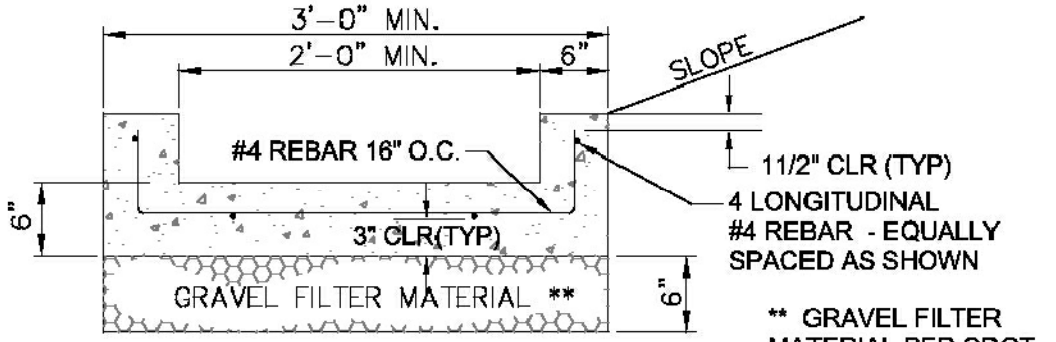
March, 2010

FIGURE 5-4

NOT TO SCALE

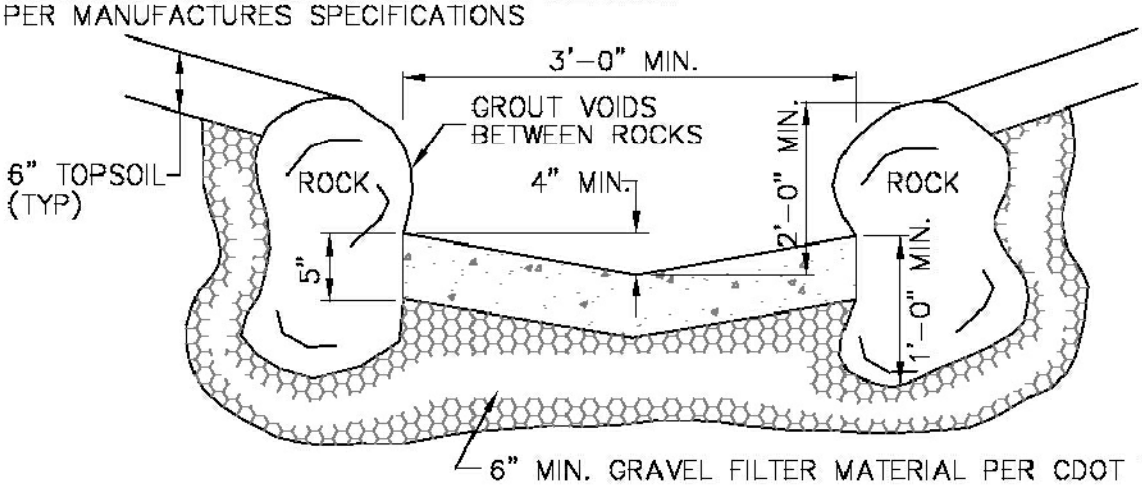


WATER QUALITY CHANNEL SECTION



RECTANGULAR CHANNEL SECTION

NOTES:
CONCRETE TO BE REINFORCED WITH FIBERMESH PER MANUFACTURES SPECIFICATIONS



COMBINATION CHANNEL SECTION

PV_DRAIN_P72.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

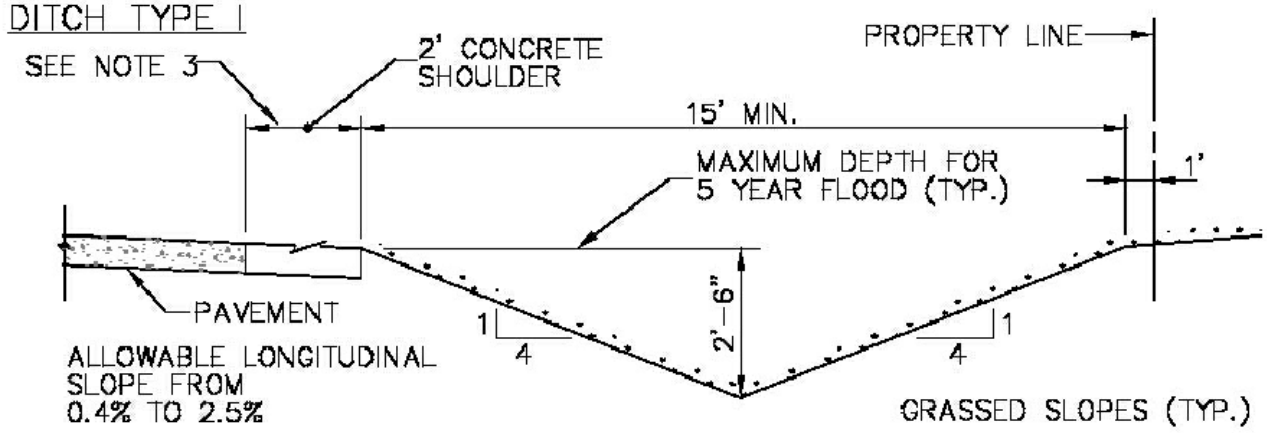
TRICKLE CHANNEL DETAILS

FIGURE 5-5

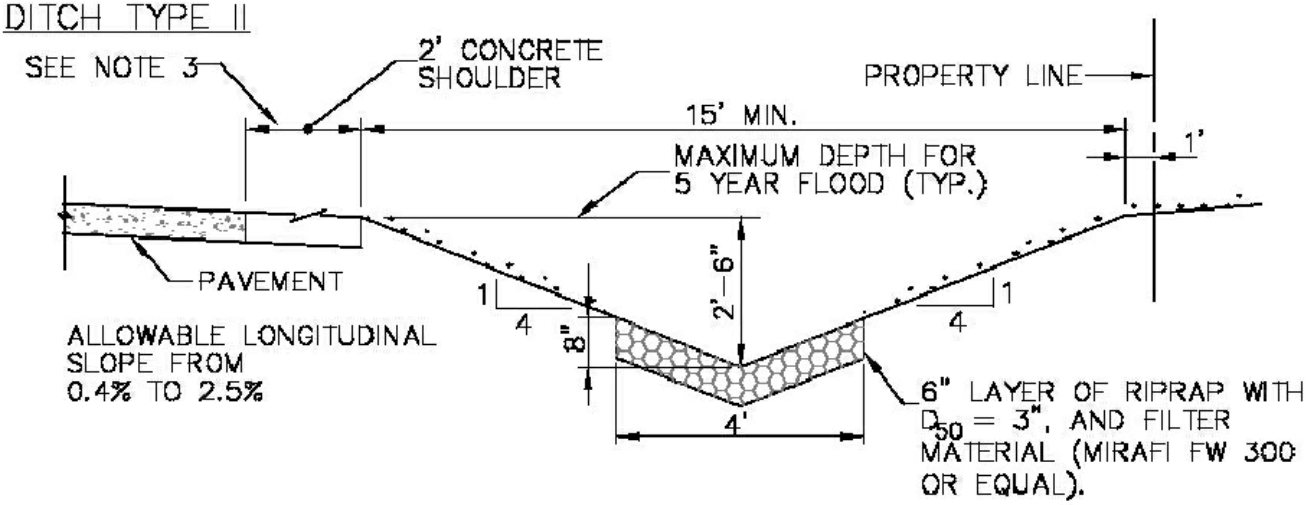
March, 2010

NOT TO SCALE

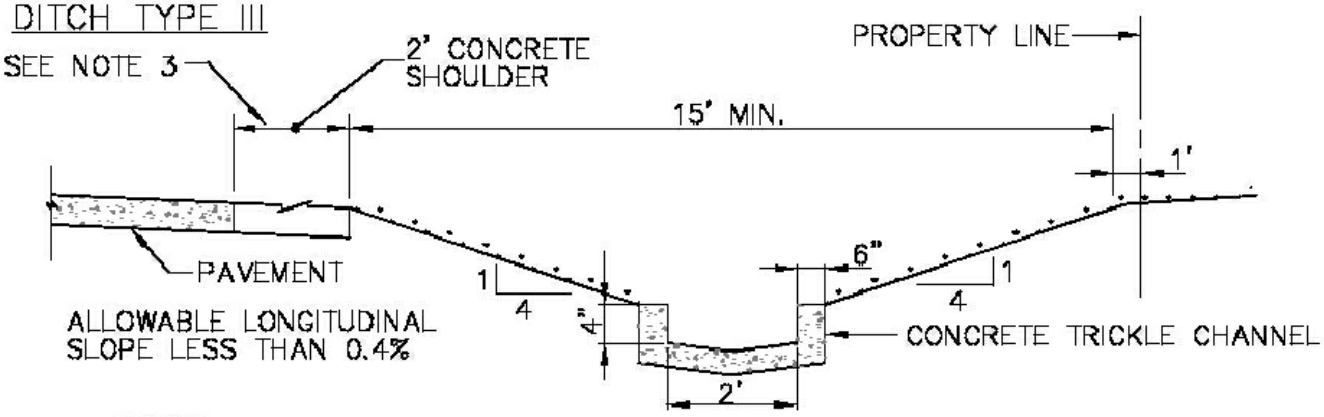
DITCH TYPE I



DITCH TYPE II



DITCH TYPE III



NOTE:

1. FOR STREET SLOPES GREATER THAN MAXIMUM ALLOWABLE, CHECK DROPS (2' MAXIMUM HEIGHT) WILL BE REQUIRED.
2. STREET CROSS SECTION MAY INCLUDE CONCRETE CURB AND GUTTER.
3. PROVIDE 2' WIDE 8" THICK CONCRETE CURB, SEE STREET STANARDS DETAIL NO. S-1.

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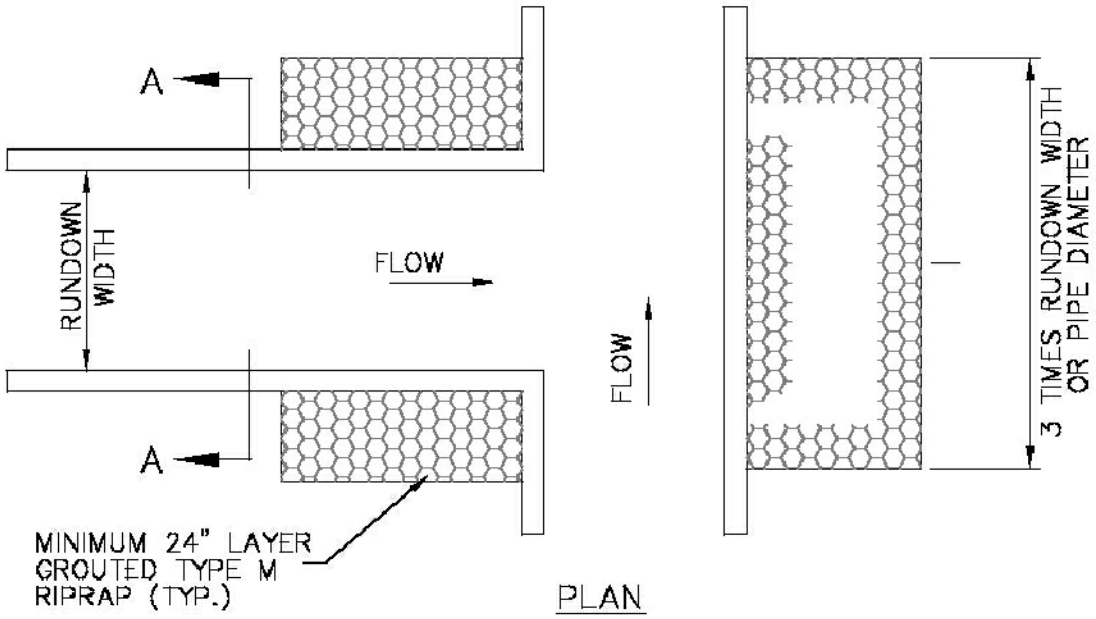
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

STORM DRAINAGE CRITERIA
ROADSIDE DITCH SECTIONS

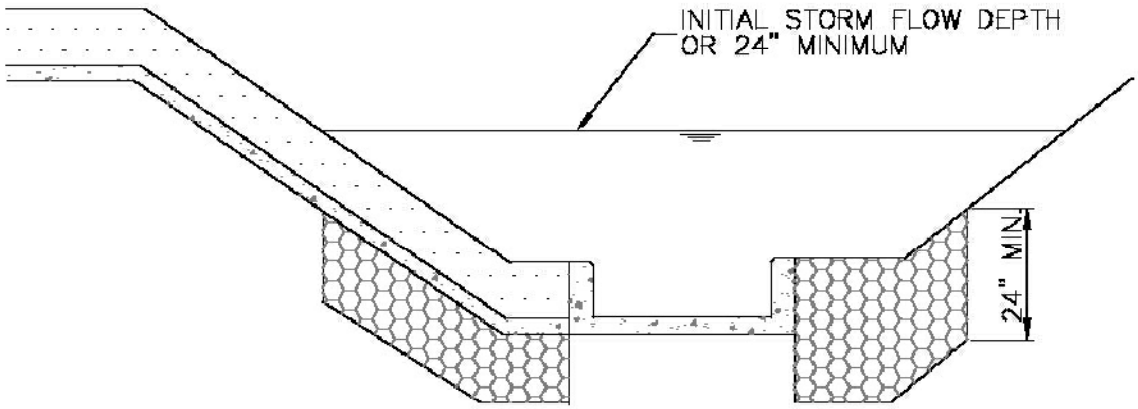
FIGURE 5-6

March, 2010

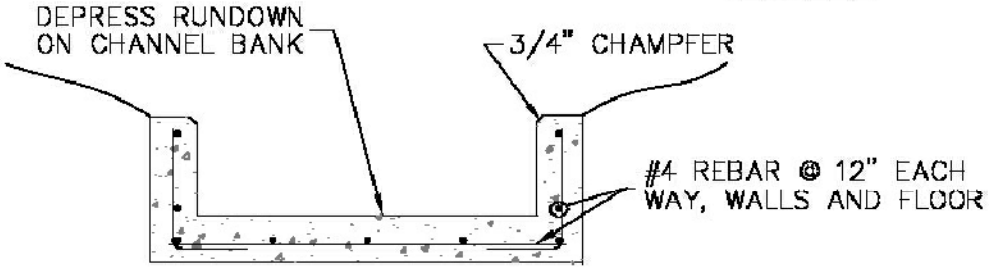
NOT TO SCALE



PLAN



PROFILE



SECTION A–A

PV_DRAIN_P74.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

CHANNEL RUNDOWN

FIGURE 5–7

March, 2010

NOT TO SCALE

SECTION 6.0 – STORM DRAINS
TABLE OF CONTENTS

FIGURES & TABLES LOCATED IN THE BACK OF SECTION 6.0

SECTION 6.0 STORM DRAINS

6.1 INTRODUCTION

Storm drains are required when other parts of the drainage system, primarily curb, gutter, and roadside ditches no longer have capacity for the additional stormwater runoff.

Except as modified herein, the design of storm drains shall be in accordance with the USDCM, Volume 1, Chapter, "Street/Inlets/Storm Sewers". Reference is made to follow specific sections in the USDCM for clarity. The user is referred to the USDCM and any other references cited for additional information and basic design concepts.

6.2 CONSTRUCTION MATERIALS/INSTALLATION OF STORM DRAINS

6.2.1 CONSTRUCTION MATERIALS

6.2.1.A STORM DRAIN PIPING MATERIALS

All storm drains within the Town shall be constructed using one of the following materials and meet applicable standards as presented below:

TABLE 6.2.1.A - STORM DRAIN STANDARDS

Pipe Material	Standard
Reinforced Concrete Pipe (RCP)	ASTM C-33, 76, 150, 260, 361, 443, 494 (Type A or D), 497, & 655, ASTM E 329 and AASHTO M 170, and 242 and FED Specifications (FS): SS-S-00210
Plastic Pipe (PVC)	AASHTO M304M-911, ASTM D-1784, 2122, 2321, 2412, & 3212, and ASTM D3034 DR35 or better, and with elastomeric gaskets per ASTM F477, and ASTM F679, 794, 949, & 1803
Aluminized Steel Pipe (ASP)	AASHTO M-36, 198 & 274 and ASTM A-760, 796, 798 & 891
Corrugated Steel for Culverts Only	AASHTO M-36, 167, 190, 218, 243, 245, 246, 264, 289 and ASTM A-444, 742, 760, 761, 762, 806, 819, 849, 885 and D-1056
High Density Polyethylene Pipe (HDPE)	AASHTO M-252, 294 (Type S), and Section 18 with rubber water-tight joints and ASTM D-1056 (Grade 2A2), 1248, 2321, 3212 & 3350 (cell class 324420C or higher) and F477 & 667

Notes:

Elliptical and arched pipe should be used only when conditions prevent the use of circular pipe

At the option of the Contractor, and with the Town's written approval, non-reinforced concrete pipe conforming to ASTM-C14 and AASHTO M 86 may be used in lieu of reinforced concrete pipe for all sizes 36 inches in diameter and smaller. It shall meet the same D-load to produce the

ultimate load under the three-edge bearing method as specified for reinforced concrete pipe in accordance with AASHTO M170, and the Contractor provide written certification that it does so. Wall thickness of pipe may be increased as required to meet D-load requirement. All requirements for reinforced concrete pipe, except those referring to reinforcement shall apply to non-reinforced concrete pipe.

The minimum class for RCP pipe shall be Class-III with flexible gasket material (water tight rubber gaskets) meeting ASTM C443 and gasket bell and spigot joints. The required pipe strength shall be determined from the actual depth of cover, true load, and proposed field conditions. A typical design strength calculation shall be submitted to the Town for approval.

ASP and HDPE pipe may be used for storm drain in parks, green belts, and other open space areas only upon approval of the Town. Where corrugated metal pipe (CMP) is intended to be used as culvert material, the minimum gauge for the pipe shall be determined from Colorado Department of Transportation (CDOT) Standard Plan M-603-1, latest edition, for actual depth of cover. Site-specific calculations may be submitted utilizing the following structural design specifications: AASHTO – M167M / M167-04; ASTM - Standard Practice for Structural Design of Corrugated Steel Pipe, Pipe Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications, ASTM A796. The following, ASP, HDPE or CMP pipe shall not be used under railroad tracks within the Town. PVC may be used provided a schedule 80 steel pipe acts as a sleeve as required by the American Railroad Engineers Association Specifications, AREA.

Also, when CMP is intended to be used as culvert material, site soil pH and Rmin, minimum resistivity, tests shall be performed. pH shall be measured for soil and water. Minimum resistivity shall be for soil and water and shall be determined in the laboratory and not in the field. Corrugated aluminum pipe may be used when the pH is between 7.2 and 9.0 and Rmin is 1,000 ohm-cm or greater. Galvanized steel corrugated pipe shall be used when the pH is between 6.0 and 10.0 and Rmin is 2000 ohm-cm or greater. Supplemental corrosion protection coatings approved by the Town shall be applied to corrugated steel pipe when the pH is outside the above-stated range and/or Rmin is less than 2000 ohm-cm.

When ASP pipe is intended to be used as the storm drain pipe material, site soil pH and Rmin, minimum resistivity, tests shall be performed. PH shall be measured for soil and water. Minimum resistivity shall be for soil and water and shall be determined in the laboratory and not in the field. ASP pipe may be used when the pH is between 7.2 and 9.0 and Rmin is 1,000 ohm-cm or greater.

6.2.1.B BEDDING MATERIALS

RCP pipe and other rigid pipe systems are susceptible to failure due to improper bedding and backfill procedures. Bedding for RCP pipe shall be 3/8-inch squeegee, per the following gradation:

SIZE	PERCENT PASSING
3/8”	80-100
#4	0-80
#200	0-4

Backfill of ASP, HDPE, CMP or PVC pipe or any flexible pipe is very critical. Non-structural (flexible) pipe materials shall include bedding requirements as specified in USDCM latest edition. Backfill is a major component to the structural integrity of the pipe system. Bedding materials and compaction must have good quality control for a successful pipe installation.

See Standard Stormwater Bedding Details 6-6 and 6-7 for all types of pipe.

6.2.1.C CONCRETE MATERIALS

Concrete materials for manholes, junction boxes, vaults, headwalls, cutoff walls, and other miscellaneous concrete structures within the storm drain system shall conform to or exceed Metropolitan Government Engineer's Council (MGPEC) specifications Item 11, Portland Cement Concrete Pavement; Section 11.2, Materials.

Rebar shall conform to the latest edition of American Concrete Institute 318-89 (ACI 318-89) or 602-Reinforcing Steel CDOT Standard Specifications for Road and Bridge Construction.

6.2.2 INSTALLATION OF STORM DRAINS

6.2.2.A EXCAVATION

(See Street Design Standards and Construction Specifications, Section 02595, Street Cut and Excavation Repair).

6.2.2.B PIPE INSTALLATION AND TESTING

All pipe shall be installed in accordance with the manufacturer's recommendations and/or standard installation specifications required by AASHTO and others. In addition, installation shall be as follows:

Installation – General

Use equipment, methods, and materials ensuring installation to lines and grades indicated.

a.1. Maintain within tolerances specified or acceptable laying schedule.

a.2. Do not lay pipe on blocks unless pipe is to receive total concrete encasement.

a.3. Accomplish horizontal and vertical curve alignments with bends, bevels, and joint deflections.

Limit interior joint opening in concrete pipe except for open side on deflected joints to:

(1) 3/8-inch in laying schedule.

(2) ½-inch in actual installation.

Install pipe of size, materials, strength class, and joint type with embedment indicated for plan location.

Begin installation at downstream end of line and install pipe with spigot or tongue ends in direction of flow. Town's approval required for any deviations from this.

Clean interior of all pipe, fittings, and joints prior to installation. Exclude entrance of foreign matter during installation and at discontinuance of installation.

d.1. Close open ends of pipe with snug-fitting closures.

d.2. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate.

d.3. Remove water, sand, mud, and other foreign materials from trench before removal of end cap.

Brace or anchor as required preventing displacement after establishing final position.

Perform only when weather and trench conditions are suitable. Do not lay pipe in water.

Adhere to confined space procedures.

Jointing

General Requirements:

a.1. To provide for differential movement at impervious trench checks, structures, and changes in type of pipe bedding:

No joints within 8-inches from structure wall.

Support pipe from wall to first joint with concrete cradle structurally continuous with base slab or footing.

As indicated by manufacturer or plans.

a.2. Place joints per manufacturer's recommendations.

a.3. Clean and lubricate all joint and gasket surfaces with lubricant recommended by pipe manufacturer.

a.4. Use methods and equipment capable of fully seating joints without damage.

a.5. Check joint opening and deflection for specification limits.

a.6. Excavate bell holes at each joint or coupling to provide full-length barrel support of the pipe and to prevent point loading at the bells or couplings.

Special Provision for Jointing Concrete Pipe:

b.1. With rubber gaskets:

Check gasket position and condition with feeler gauge prior to installation of next section.

Special Provisions for Jointing PVC Pipe and HDPE Pipe:

c.1. Conform to ASTM D2321.

c.2. Connect pipe to new or existing rigid structures or manhole tie-ins with manhole couplings and a standard boot.

Special Provisions for Jointing ASP:

d.1. Connect pipe to new or existing rigid structures or manhole tie-ins with manhole couplings and a standard boot.

Pipe Cutting

Pipe section shall not be damaged by cutting.

Temporary Plugs:

Furnish and install temporary plugs at each end of Work for removal by others when work resumes. Plug must be secured in place and must be removable.

Plugs

b.1. Temporary plugs as supplied by pipe manufacturer.

b.2. Fabricated by Contractor of substantial construction.

b.3. Watertight against heads up to 20 feet of water.

Connections to existing structures:

Connect pipe to existing structures and pipelines where indicated.

Opening in structure shall have a minimum 3 inches clearance on all sides.

Adhere to pipe manufacturer's specifications.

Grout opening on inside with non-shrink grout.

Place structural concrete collar on outside.

Field Testing

Acceptance Tests:

a.1. Alignment:

Pipe shall be inspected by lamping the line or by physical passage where space permits.

Contractor shall clean pipe of excess mortar, joint sealant, and other dirt and debris prior to inspection.

Determine:

(1) Presence of any misaligned, displaced, or broken pipe.

(2) Presence of visible infiltration or other defects.

Deflection Testing:

b.1 Maximum installed deflections of flexible pipe shall be as follows:

Type of Pipe	Deflection – Percent of Mean Internal Diameter
ASP & CMP	5
PVC	5
HDPE	5

Town shall require Contractor to test flexible pipe after backfill has been in place 30 days and again after eleven (11) months if deemed necessary.

c.1. Provide rigid ball or mandrel deflection testing equipment and labor.

c.2. Obtain approval of equipment and acceptance of method proposed for use. Test shall be performed without mechanical pulling devices.

c.3. Remove and replace pipe exceeding deflection limits

6.2.2.C Backfill and Compaction

The backfill is the area above the pipe bedding. The pipe trench shall be backfilled and compacted in accordance with Volume 1, Street Design Standards and Construction Specifications, Section 02595, Utility Cut and Backfill.

Backfill material may be local site material that is well-graded, non-cohesive granular material free of rocks, frozen lumps, foreign material or stones greater than 3" in any dimension, aggregate base course, or flowfill. Remove all debris including soda cans, rags, pipe banding material, etc. from the pipe trench before backfilling.

In areas where a portion of the trench bottom is lower than the water table, line the trench and wrap the bedding material with a woven geotextile fabric meeting AASHTO M288 Specification for Class 2, Subsurface Drainage and Permanent Erosion Control. Lap fabric joints at least 12 inches. If the plans specify, furnish and install reinforced concrete cut-off walls at one hundred (100) foot intervals along the trench line.

Haunching is the area of bedding up to the pipe spring line. Granular material as outlined for the bedding shall be placed and consolidated evenly on each side of the pipe. The bedding materials shall be consolidated under the lower haunch of the pipe with shovel slicing and tamping. Care shall be taken to see that pipe alignment and cross-sectional areas are maintained.

Compaction machinery should not be used around flexible pipes until the select bedding is placed 12-inches over the top of the pipe and the first lift of backfill is placed.

6.2.2.D Inspection and Testing

Installation of the pipe bedding, haunching, and backfill up to a point 12-inches above the top of the pipe, shall be observed by the Town. The Contractor shall take Quality Control tests in the pipe haunch area for pipe diameters 36-inches and larger. For pipes smaller than 36-inch diameter, begin tests at one foot above the pipe. Quality Control tests shall be taken as follows:

Schedules For Quality Control and Quality Assurance Sampling and Testing shall be per Streets Volume 1.

After backfill and compaction of the trench is completed, the pipe shall be inspected to detect any deformations, sags, or joint displacements. Rigid pipe shall be visually inspected for sags or displaced joints.

Upon completion of storm drain installation and prior to paving, the contractor shall notify the Town. The Contractor shall be required to perform a pipe deflection test for flexible pipes with runs greater than 100' long in the presence of the Town.

Flexible pipe, 48-inch diameter and smaller, may be tested with a "Go/No Go" deflection test gauge, which shall be pulled through the pipe. The maximum allowable deflection is 5 percent. The horizontal diameter shall not differ from the design diameter by more that 5 percent. Similarly, for pipes other than circular, the field-installed dimensions shall not vary more than 5 percent of the design dimensions. Any pipe that exceeds the maximum allowable deflection is to be removed and replaced.

The tests and inspection reports shall be submitted to the Town prior to proceeding to the next phase of construction and prior to paving. The Contractor shall provide the Town a letter of certification, prior to the issuance of building permits. The letter of certification shall state that the class, gauge, or stiffness of pipe is in accordance with the Town's design for installation conditions encountered.Inspection checklists for handling, storing, installing, and testing pipe are included at the end of this Section.

6.2.3 CONNECTIONS TO EXISTING STORM DRAIN

Connection to different pipe materials shall be made using manholes or transition sleeves. Details for connection to different materials shall be provided by the Design Engineer. If nothing is specified, a minimum of a structural concrete collar shall be installed.

6.2.4 PIPE INSPECTION CHECKLIST

Before unloading, inspect pipe and fittings for any obvious transportation damage.

Check each pipe section and fitting for proper markings on pipe.

Check for correct ASTM or AASHTO Specification.

Pipe diameter, class or strength designation.

Manufacturer or trade name.

Date of manufacture.

Number assigned to each pipe corresponding to laying diagram if required.

Check each pipe section for external and internal damage.

Check gaskets for damage and proper markings or identifications.

Check that all pre-inserted gaskets are in place.

Check lubricants, cleaners, or adhesives for conformance.

Check flexible pipe for axial or longitudinal deformation.

Mark each pipe that is rejected or needs to be repaired to prevent usage.

Compare field repair procedures with manufacturer's requirements.

Document repairs with photos, names of personnel, dates, equipment, and supplies.

Pipe stored in accordance with manufacturer's instructions.

Pipe stored on flat area, with joints supported.

Pipe shall not be stacked higher than allowed by manufacturer.

Procedures followed that will not allow the pipe to become deformed during storage.

All blocks, chocks, wedges are intact and firmly in place.

PVC/HDPE pipe is protected from long-term (greater than 30 days) exposure to sunlight.

Pipe is protected from adverse weather, harmful chemicals, dirt or debris accumulating on the interior of the pipe.

Gaskets are protected from dust and grit, solvents, and petroleum-based greases and oils, and other agents having a harmful effect on the gasket.

Stringing of pipe is in accordance with manufacturer's recommendations.

Pipes are blocked to prevent movement due to wind or accidental bumping.

Pipe joining surfaces shall be cleaned of any dust, dirt, and debris accumulation prior to installing gasket and joining.

Interior of pipe is free of dirt and debris.

Access to roads, driveways, etc., shall be maintained.

If stringing of pipe is required along roadway, is pipe orientated (angular rotation) properly, is pipe a safe distance from traffic, and is proper flasher signage present to protect traveling public.

6.2.5 PIPE INSTALLATION CHECKLIST

Pipe is correct type, diameter, strength, (class, SDR, gauge, etc).

Pipe numbers and stationing checked against lay schedule.

Pipe re-inspected for damage.

Pipe cleaned of debris in interior and on gasket sealing surfaces.

Pipe shall not be laid uphill on grades that exceed 10% (or less if specified).

Pipe with marked field top laid with top up.

Contractor continually checks alignment and grade of pipeline.

Ends of pipe sealed at close of work or for shut-down periods.

Bedding material shall meet specifications.

Compaction requirements are met.

Frequency of testing the bedding material conforms to specifications.

Bedding material checked for compatibility with other trench materials to prevent soil migration in groundwater areas.

Trench bottom is free from loose rocks, large dirt clods, and debris.

Bedding material free from organic matter, stumps or limbs, frozen earth, debris, refuse, or other unsuitable material.

Minimum bedding thickness met. Required thickness = _____.

Bedding surface is at the proper elevation so that pipe will be placed on grade.

Bedding is placed so that barrel of pipe has uniform support.

Blocking or mounding shall not be used to bring pipe to grade.

Bell holes and/or sling holes excavated.

Clearance between bell and bedding checked.

If high groundwater table present, floating may become a problem during installation of flexible pipelines. Trench must be dewatered during installation.

Special attention given to HDPE pipe during times of high temperature to ensure increased pipe flexibility does not cause excessive deflection.

PVC and HDPE may become brittle during cold weather. Avoid impact damage

6.2.6 DRAWINGS OF RECORD (AS-BUILTS)

Detailed drawings shall be prepared by the Design Engineer, upon completion of work. (For Capital Improvement Projects where the Contractor is responsible for the Drawings of Record, the Drawings of Record shall be completed prior to issuance of the Substantial Completion). Drawings shall contain field dimensions, elevations, details, changes made to the construction drawings by modification, details which were not included on the construction drawings, and horizontal and vertical locations of underground utilities which have been impacted by the utility installation.

Maintain record drawings in clean, dry, legible conditions and in good order. Do not use record documents for construction purposes.

Record as-built information concurrently with construction progress. Do not backfill work until required information is recorded.

As-built record drawings shall be submitted to the Town for approval on 24"x36" black line form.

6.3 HYDRAULIC DESIGN

Storm drains shall be designed to convey initial storm peaks without surcharging the pipe. To ensure that this objective is achieved, the hydraulic grade line shall be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses will include friction, expansion, contraction, bend, and junction losses. The final energy grade line shall be at or below the proposed ground surface. The methods for estimating the hydraulic losses are presented in the following sections.

6.3.1 PIPE FRICTION LOSSES

The Manning's "n" values to be used in the calculation of storm drain capacity are presented in Table 6-1 for concrete and plastic pipe and Table 9-1 for corrugated metal pipe.

6.3.2 PIPE FORM LOSSES

Generally, between the inlet and outlet the flow encounters a variety of configurations in the flow passageway such as changes in pipe size, branches, bends, junctions, expansions, and contractions. These shape variations impose losses in addition to those resulting from pipe friction. Form losses are the result of fully developed turbulence and can be expressed as follows:

$$H_L = K \left(V^2 / 2g \right)$$ Equation 6.3.2

Where:

H_L = head loss (feet)
K = loss coefficient
$\frac{V^2}{2g}$ = velocity head (feet)
g = gravitational acceleration (32.2 ft/sec^2)

The following is a discussion of a few of the common types of form losses encountered in stormwater system design. The user is referred to the USDCM or other professional manuals for additional discussion.

6.3.2.A EXPANSION LOSSES

Expansion in a storm drain conduit will result in a shearing action between the incoming high velocity jet and the surrounding pipe boundary. As a result, much of the kinetic energy is dissipated by eddy currents and turbulence. The loss of head can be expressed as:

$$H_L = K_e \left(V_1^2 / 2g \right) \left[1 - A_1 / A_2 \right]^2$$ Equation 6.3.2.A

In which A is the cross section area, V is the average flow velocity, and Ke is the loss coefficient. Subscripts 1 and 2 denote the upstream and downstream sections, respectively. The value of Ke is about 1.0 for a sudden expansion, and about 0.2 for a well-designed expansion transition. Table 6-2 presents the expansion loss coefficients for various flow conditions.

6.3.2.B CONTRACTION LOSSES

The form loss due to contraction is:

$$H_L = K_c \left(V_2^2 / 2g \right) \left[1 - (A_2)^2 / A_1 \right]^2$$ Equation 6.3.2.B

Where K_c is the contraction coefficient. K_c is equal to 0.5 for a sudden contraction and about 0.1 for a well-designed transition. Subscripts 1 and 2 denote the upstream and downstream sections, respectively. Table 6-2 presents the contraction loss coefficients for various flow conditions.

6.3.2.C BEND LOSSES

The head losses for bends, in excess of that caused by an equivalent length of straight pipe, may be expressed by the relation:

$$H_L = K_b (V^2/2g) \qquad \text{Equation 6.3.2.C}$$

In which K_b is the bend coefficient. The bend coefficient has been found to be a function of: (a) the ratio of the radius of curvature of the bend to the width of the conduit, (b) deflection angle of the conduit, (c) geometry of the cross section of flow, and (d) the Reynolds Number and relative roughness. A tabulation of the recommended bend loss coefficients for standard bends, radius pipe, and bend through manholes is presented in Tables 6-3 and 6-4.

6.3.2.D JUNCTION AND MANHOLE LOSSES

A junction occurs where one or more branch drains enter a main drain, usually at manholes. The hydraulic design of a junction is in effect the design of two or more transitions, one for each flow path. Allowances should be made for head loss due to the impact at junctions. The head loss for a straight through manhole or at an inlet entering the storm drain is calculated from the original equation for form losses (Equation 6.3.2). The head loss at a junction can be calculated from:

$$H_L = (V_2^2/2g) - K_j (V_1^2/2g) \qquad \text{Equation 6.3.2.D}$$

Where V_2 is the outfall flow velocity and V_1 is the inlet velocity. The loss coefficient, K_j, for various junctions is presented in Table 6-5.

6.3.3 STORMWATER OUTLETS

When the stormwater system discharges into the Major Drainage way system (usually an open channel), additional losses occur at the outlet in the form of expansion losses (refer to Section 6.3.2.A). For a headwall and no wing walls, the loss coefficient $K_e = 1.0$ (refer to Table 6-2), and for a flared-end section the loss coefficient is approximately 0.5 or less.

6.3.4 PARTIALLY FULL PIPE FLOW

When a storm drain is not flowing full, the drain acts like an open channel, and the hydraulic properties can be calculated using open channel techniques (refer to Section 5). For convenience, charts for various pipe shapes have been developed for calculating the hydraulic properties (Figures 6-1, 6-2, and 6-3). The data presented assumes that the friction coefficient, Manning's "n" value, does not vary throughout the depth.

6.3.5 HYDRAULIC RESEARCH

The American Public Works Association (APWA) has conducted research into the head losses at various junctions and manholes. The work consisted of experimentally modeling three types of pipe junctions: junctions with a 90 degree bend, junctions of a main with a perpendicular lateral, and junctions of two opposed laterals. The work was primarily directed at sanitary sewers because the sizes investigated (i.e., manhole diameter to sewer diameter ratio of 2.3 to 4.6) and the flow conditions (i.e., pressure flow) were typical for sanitary sewers. However, several trends were observed that are considered to be suitable for

storm drains, including specific energy loss coefficients that have been adopted for these Criteria. The trends observed from the test results are as follows:

1. For manhole diameter to pipe diameter ratios between two (2) and six (6), the variation in head loss was insignificant.

2. The most significant reduction in head loss occurs when the manhole is shaped by benching the bottom of the manhole up to the top of the pipe. This appears to provide a better channelization of the flow, which reduces the losses.

3. Some testing was also performed for open channel flow conditions. These tests generally showed that the energy losses were less than for pressure flow. Since most storm drains are not pressurized, the use of the coefficients should be conservative.

This information is presented to aid the Designer in selecting suitable energy loss coefficients for situations not covered by these Criteria.

6.4 VERTICAL ALIGNMENT

The storm pipe grade shall be such that a minimum cover is maintained to withstand AASHTO HS-20 loading (or as designated by the Public Works Director). The minimum cover depends upon the pipe size, type and class, and soil bedding condition, but shall not be less than 12 inches on any point along the pipe.

The minimum clearance between storm drain and water main, in open cuts, either above or below, shall be eighteen (18) inches. In addition, when a water line lies below a storm line, or within 24 inches above, the storm line joints shall be grouted for a minimum of 10 foot on each side of the crossing. Storm line shall be installed so that a joint is not directly above or below the water main. Storm pipe shall be centered over or under the water main.

The minimum clearance between storm drain and sanitary sewer, either above or below, shall also be eighteen (18) inches. In addition, when a sanitary sewer main lies above a storm drain, or within 18 inches below, the sanitary sewer shall have an approved encasement or be constructed of structural sewer pipe for a minimum of 10 feet on each side of where the storm drain crosses. Storm line shall be installed so that a joint is not directly above or below the sewer main. Storm pipe shall be centered over or under the sewer main.

6.5 HORIZONTAL ALIGNMENT

Storm drain alignment between manholes shall be straight for storm drains less than 48-inches in diameter. Storm drains may be constructed with curvilinear alignment for 48-inch diameter and larger pipe by either the pulled joint method or by radius pipe in accordance with Table 6-1. The limitations on the radius for pulled joint pipe are dependent on the pipe length and diameter, and amount of opening permitted in the joint. The maximum allowable joint pull shall be ¾ of an inch. The minimum parameters for radius type pipe are shown in Table 6-1. The radius requirement for pipe bends is dependent upon the manufacturer's specifications.

The minimum horizontal separation between storm drains or sanitary sewers and water lines shall be 10 feet.

6.6 PIPE SIZE

The minimum allowable pipe size for storm drains, except for detention outlets, shall be 18 inches in diameter and shall be round pipe. Table 6-1 presents the minimum pipe size for storm drains.

6.7 MANHOLES

6.7.1 GENERAL INFORMATION

Manholes or maintenance access ports shall be required whenever there is a change in size, direction, elevation, grade, or where there is a junction of two or more storm pipes. A manhole may be required at the beginning and/or at the end of the curved section of storm drain. The maximum spacing between manholes for various pipe sizes shall be in accordance with Table 6-1.

The required manhole size shall be as follows:

TABLE 6.7.1 - MANHOLE SIZE

Storm Pipe Diameter	Manhole Diameter
15" to 18"	4'
21" to 30"	5'
36" to 54"	6'
60" and larger	CDOT Standard M-604-20

Larger manhole diameters or a junction structure may be required when storm pipe alignments are not straight through or more than one storm pipe line goes through the manhole.

6.7.2 MANHOLE MATERIALS

6.7.2.A MANHOLE

All materials, manufacturing operations, testing and inspection of manholes shall conform to the requirements of:

ASTM C 478M(C478) Precast Reinforced Concrete Manhole Risers (AASHTO M199) and Tops.

All precast concrete materials shall conform to Section 712.05 - Precast concrete units and all poured in place concrete manholes or vaults shall conform to or exceed Metropolitan Government Engineer's Council (MGPEC) specifications Item 11, Portland Cement Concrete Pavement; Section 11.2, Materials.

Rebar shall conform to the latest edition of American Concrete Institute 318-89 (ACI 318-89) or 602 - Reinforcing Steel, CDOT Standard Specifications for Road and Bridge Construction.

Manholes shall consist of precast riser sections, top or cone section, precast adjusting rings, precast or field poured base, steps and rings and covers. Manholes shall be constructed in accordance with the DCCS Standard Details or as shown on the Plans.

Precast concrete manholes shall be of the eccentric, concentric or flat top type as described in the Standard Details. Manholes shall be of the diameter and depth shown on the Plans. Manholes in excess of 20 feet depth shall have an intermediate platform located at the approximate center of the depth (See Detail 6-11).

Riser and top sections shall be precast reinforced concrete.

Adjusting rings shall be reinforced with the same percentage of steel as the riser and top.

6.7.2.B STEPS

Steps shall be required when the manhole depth exceeds 3'-6" and shall be in accordance with AASHTO M 199. Steps shall be firmly embedded in the wall of each manhole riser and cone section. Steps shall withstand vertical loads of 400 pounds. Steps shall be placed in a straight line and be uniformly spaced. Steps shall be positioned to allow 20 to 26 inches spacing from the rim to the first step, and spacing thereafter shall be not less than 12 inches or more than 15 inches center to center.

Steps may be aluminum alloy conforming to Federal Specification QQ-A-200/8 and shall be equal to Alcoa No. 12653B, or may be a step comprised of a minimum 3/8-inch diameter grade 60 steel reinforcing rod completely encapsulated in polypropylene, as manufactured by M.A. Industries, Inc. or equal. M.A. steps shall be either type PS-2PF or PS-2-PFS. Plastic manhole steps shall conform to ASTM C-478. Steps in riser sections shall project from the wall not less than 6-5/8 inches.

Steps in cone sections shall project from the wall not less than 4-7/8 inches. All steps shall penetrate the wall not less than 3-3/8 inches.

6.7.2.C RINGS AND COVERS

Iron manhole rings and covers shall be the best quality gray iron, tough and even grain, and when cast, shall be free from faults, blowholes, or other defects, and shall posses a tensile strength of not less than 35,000 psi. Rings and covers shall be designed to withstand the traffic loads that will be imposed upon them. Rings and covers shall be manufactured for current CDOT Standards 712.06 and meet the requirements shown on Detail 6-8.

The horizontal bearing surfaces of the ring and cover shall be machined so that they will not shift under traffic. Covers, which do not rest solidly in the frames, will not be accepted.

Manhole rings and covers shall be in accordance with the Town of Platteville Standards. Covers shall be non-perforated, and shall show the lettering as indicated on Detail 6-8.

When a manhole is located in a pavement area, it shall not be brought to final grade until the pavement has been completed.

6.7.2.DMANHOLE GASKETS

Where preformed, flexible plastic gaskets shall be used to seal joints between precast manhole sections, they shall conform to Federal Specifications SS-S-00210 (6SA-FSS), Type I, Rope Form, and shall have a minimum diameter of 1-1/2 inches. Gaskets shall be applied to the tongue and shoulder lips of the precast section, providing two (2) gaskets per joint. "RUB'R NEK" or "KENT SEAL" or approved equal products shall be used.

6.7.3 MANHOLE CONSTRUCTION

The work covered by this Subsection consists of constructing precast, preassembled or field assembled manholes for storm drain construction. Construction consists of excavation; shoring; dewatering; subgrade preparation; construction of base; placement and assembly of risers, cone, or tops; installation of ring, cover and adjusting rings; backfilling; surface restoration and other related work. The following quality standards shall apply:

ASTM C 891: Installation of Underground Precast Concrete Utility Structures.

6.7.3.A MATERIALS

The Contractor shall install manholes of the dimensions shown on the Plans. All materials used shall conform to the requirements of Section 6.7.2 above.

6.7.3.B SURFACE PREPARATION, EXCAVATION, DEWATERING

Surface preparation, excavation and dewatering shall conform to the requirements cited in Volume I - Streets - Design Criteria and Construction Specifications.

6.7.3.C MANHOLE BASE

Manhole bases shall be precast or field poured as detailed on standard details but never less than 8" thick below the invert. Concrete shall conform to or exceed Metropolitan Government Engineer's Council (MGPEC) specifications Item 11, Portland Cement Concrete Pavement; Section 11.2, Materials.

Rebar shall conform to the latest edition of American Concrete Institute 318-89 (ACI 318-89) or 602-Reinforcing Steel (for larger manholes, See Detail 6-9), CDOT Standard Specifications for Road and Bridge Construction. Concrete shall be consolidated and struck-off to a horizontal surface within the forms or pouring rings.

Invert channels shall be smooth and semi-circular in shape conforming to the inside of the adjacent storm pipe section. Changes in direction of flow in manholes with only one entering storm pipe shall be made per Details 6-9 & 6-10. Changes in size and grade of the channels shall be made gradually and evenly. Channels in bases of manholes at intersections of storm pipes shall follow the alignment of the storm pipes. The invert channels may be formed directly in the concrete of the manhole base or may be half-pipe laid in concrete. Flow entering into and passing through the manhole shall be unobstructed. Liquid or solids shall not be retained by the manhole or adjoining pipe. The floor of the manhole outside the channel shall be broomed and shall slope toward the channel not less than one inch per foot, nor more than two inches per foot.

Field poured concrete bases for 4' dia. or larger manholes shall be reinforced as detailed on the Plans or as shown on Details 6-9 & 6-10.

Precast reinforced concrete bases shall be of the size and shape detailed on the Plans or as shown on Details 6-9 & 6-10.

Precast sections which appear to be porous, honeycombed, cracked, chipped, out-of-round, have exposed rebar, or are otherwise defective shall be rejected.

6.7.3.D MANHOLE BARRELS

Manhole barrels shall be assembled of precast riser sections. Riser sections shall be placed vertically with tongue and groove properly keyed. Ladder rungs shall be vertically aligned and equally spaces in the finished manhole. The top step shall be placed so that it is between 20 and 26 inches below the finished rim elevation. Barrel sections that appear to be porous, honeycombed, out-of-round, cracked, chipped, have exposed rebar, or are otherwise deformed or damaged shall be rejected.

Intermediate platforms shall be assembled for manholes that are over 20 feet in depth (see Detail 6-11).

Free drop inside the manhole shall not exceed five feet measured from the invert of the inlet pipe to the invert of the outlet pipe. Where the drop exceeds five feet, inside drop manholes shall be constructed as detailed on the Plans or as approved by the Town.

All connections between the riser or base sections and the storm pipe shall be joined in such a manner as to make the manhole watertight. Preformed rubber water stop gasket cast into the riser or base section is an acceptable joining method.

Preformed flexible plastic sealing compounds similar or equal to “Rub‘R Nek” or “Kent Seal” are acceptable, provided acceptable water tightness is achieved.

6.7.3.E TOP OR CONE SECTIONS

Flat top sections may be used on a shallow manhole. Otherwise, cone sections shall be installed for heights exceeding 8 feet (see Figure 6-9 for more detail).

Cone shaped top sections shall be assembled on top of the manhole barrel with tongues and grooves properly keyed. Ladder rungs shall be equally spaced and vertically aligned in the finished manhole. The top ladder rung shall be installed to an elevation in accordance with Figure 6-9.

Concrete grade rings may be used for adjusting the manhole lid elevation. The total height from the top of cone to top of frame shall not exceed 16 inches. Metal adjusting grade rings are not allowed. Broken concrete grade rings shall be rejected.

4500 psi (min) non-shrink grout, shall be placed under and between the metal ring and adjusting grade rings, and between adjusting grade rings and the cone section. For manholes in open areas, grass or on gravel roads, concrete grout shall surround the metal ring and adjusting grade rings; the grout shall be formed horizontally to the outside diameter of the cone section and vertically to the rim elevation, in accordance with Detail 6-9. Install manhole lid to the ground surface in an open area or grass area. In gravel roads, leave the lid 6-inches below the road surface. For manholes in paved (asphalt or concrete) streets or other paved areas, install a concrete collar in accordance with Section 02610, Manhole and Valve Box Adjustment and Detail No. S-34 (Town of Platteville DCCS, Volume I - Streets).

6.7.3.F WATERTIGHTNESS

The finished manhole is expected to be as watertight as the pipe system it is incorporated into. Observed leaks shall be cause for rejection.

All connections between riser sections, bases, tops, and rings shall be sealed with preformed flexible plastic joint sealing compound. Application of sealing compound shall be accomplished in conformance with the manufacturer's recommendations. Grade of materials, quantity of materials and application temperatures recommended by the manufacturer shall govern. Sealing compound similar or equal to "Rub 'R Nek" or "Kent Seal" shall be used.

6.7.3.G CONNECTIONS

All connections of pipe to manhole shall be made with a proper water stop. Mains tapped into manholes shall be constructed so that the flow entering the manhole is channeled through the bench into the invert of the manhole under all flow conditions.

6.7.3.H BEDDING AND BACKFILLING

Bedding, backfilling, and surface restoration around manholes shall conform to the requirements of DCCS Streets, Volume 1, Section 02223. Bedding material shall be placed up to a point equal to that required for the adjacent pipe.

6.7.3.I QUALITY CONTROL

Inspection, testing, approval and acceptance shall conform to the requirements of Volume I - Streets - Design Criteria and Construction Specifications.

Materials not inspected by the Town or damaged by an action of the Contractor shall be subsequently rejected and replaced at the Contractor's expense.

Materials inspected by the Town, installed by the Contractor and found to be damaged through no fault of the Contractor shall be repaired or rejected and replaced at the Developer's expense.

6.7.3.J CLEAN UP

All rubbish, unused materials and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness. Manholes and pipelines shall be free of dirt, scum, gravel, excess grout, and other foreign material.

6.8 STORMCEPTOR – OIL/SEDIMENT IN-LINE SEPARATOR UNIT

The oil/sediment separator unit shall be a "Stormceptor®" model or approved equal. Other types of "Stormceptor® type" products meeting the criteria below are acceptable upon special review.

The separator shall remove oil and sediment from stormwater during frequent wet weather events. The separator shall treat a minimum of 75 to 90 percent of the annual runoff volume and be capable of removing up to 80 percent of the total suspended sediment load (TSS) and greater than 90 percent of the floatable free oil. The separator must be capable of trapping silt and clay size particles in addition to large particles and local TSS load reduction requirements. The separator shall be installed underground as part of the storm drain system and be structurally designed for traffic loading (HS-20 min) at the surface. The separator shall be maintainable from the surface via one or more access points.

The separator shall be equipped with a high flow bypass that regulates the flow rate into the treatment chamber and conveys high flows directly to the outlet such that scour and/or re-suspension of material previously collected in the separator does not occur. The bypass area shall be physically separated from the separation area to prevent mixing. The concrete portion of the separator shall be designed and manufactured in accordance with ASTM C-478. The

concrete joints shall be oil resistant, water tight and meet the design criteria according to ASTM C-443. If a concrete separator is specified, it should be lined with an oil resistant material or coating for a minimum oil depth of 12 inches to provide secondary containment of any hydrocarbon materials.

The difference between the inlet pipe elevation to the separator and the outlet pipe elevation from the separator shall be minimized to allow installations into existing systems. The separator should be able to be used as a bend structure in the storm drain system. The access cover for all non-inlet type separators should clearly indicate that it is an oil/sediment separator.

The separator shall be capable of containing spills of floatable substances such as free oil and not be compromised by temporary backwater conditions (i.e., trapped pollutants should not be re-suspended and scoured from the separator during backwater conditions).

The capabilities of the selected separator must be documented with scientific studies and reports.

6.9 MAINTENANCE AND ACCESS EASEMENTS

An important aspect of stormwater operation is the continued maintenance of the infrastructure to ensure that it will continue to function as designed. Maintenance may include cleaning of trash racks, inlet and outlet structures, and the removal of sediment and debris from the storm drains.

The Town requires that maintenance access be provided to all storm drainage infrastructure. The following minimum easement widths, which must be shown on the Final Plat, (or provided by separate document) are required:

TABLE 6.9 - REQUIRED STORM DRAIN MAINTENANCE AND ACCESS EASEMENTS

Storm Pipe Diameter	Easement Width
Less than 36"	20'
Equal to or greater than 36"	25' (with pipe placed at the 1/3 point in the easement)

Long term operation and maintenance of detention ponds can be found in these Criteria in Section 12 – Stormwater Quality Enhancement.

6.10 DESIGN EXAMPLE

The following calculation example, including the calculation Table 6-6, and Figures 6-4 and 6-5, were obtained from Modern Sewer Design, AISI, Washington D.C., 1980 and edited for the calculation of manhole and junction losses in accordance with this Section.

Given:

(a) Plan and Profile of storm pipe (Figures 6-4 and 6-5), example calculation form (Table 6-6).

(b) Station 0+00 (outfall) data as follows:

Design Discharge	Q	= 145 cfs	(Column 9)
Invert of Pipe		= 94.50 feet	(Column 2)
Diameter	D	= 66 inch RCP	(Column 3)
Starting Water Surface	W.S.	= 100 feet	(Column 4)
Area of Pipe	A	= 23.76 SF	(Column 6)
Velocity = Q/A		V = 6.1 fps	(Column 8)
Pipe Roughness	n	= 0.013	

Notes:

(I) Numbers in brackets refer to the Columns on Table 6-6.

(ii) Sizes of the storm drain were determined during the preliminary design phase.

Find: Hydraulic Grade Line and Energy Grade Line for storm drain.

Discussion: The following procedure is based on full-flow pipe conditions. If the pipe is flowing substantially full (i.e., greater than 80 percent), the following procedures can be used with minimal loss of accuracy. However, the Design Engineer is responsible for checking the assumptions (i.e., check for full flow) to assure that the calculations are correct.

STEP 1: The normal depth is greater than critical depth, dn > dc; therefore, calculations to begin at outfall, working upstream. Compute the following parameters:

$$\varphi = \frac{2gn^2}{2.21} = \frac{2 \times 32.2 \times (.013)^2}{2.21}$$

This equation is derived from the Manning's equation by solving for velocity and converting to velocity head.

$\varphi = 0.00492$

This value remains constant for this design since the n-value does not change.

STEP 2: Velocity Head (Column 10):

$$H_v = \frac{V^2}{2g} = \frac{(6.1)^2}{(2)(32.2)}$$

$H_v = 0.58$

STEP 3: Energy Grade Point, E.G. (Column 11):

$E.G. = W.S. + H_v = 100 + 0.58$

$E.G. = 100.58$

For the initial calculation, the Energy Grade Line is computed as described above. For subsequent calculations, the equation is reversed, and the water surface is calculated as follows (see Step 12):

$W.S. = E.G. - H_v$

This equation is used since the losses computed in Step 8 are energy losses which are added to the downstream energy grade elevation as the new starting point from which the velocity head is subtracted as shown above.

STEP 4:

$$S_f = \frac{\varphi H_v}{R^{4/3}} = \frac{(.00492)(0.58)}{(1.375)^{4/3}}$$

$S_f = .0019$

Note: R = the hydraulic radius of the pipe

STEP 5: Avg S_f (Column 13):

Average skin friction: This is the average value between S_f of the station being calculated and the previous station. For the first station, Avg $S_f = S_f$. Beginning with Column 13, the entrees are placed in the next row since they represent the calculated losses between two stations.

STEP 6: Enter drain length, L, in Column 14.

STEP 7: Friction loss Hf (Column 15):

$H_f =$ (Avg S_f)(L)

$H_f =$ (.0019)(110)

$H_f =$ 0.21

STEP 8: Calculate the form losses for bends, junctions, manholes, and transition losses (expansion or contraction) using the appropriate equations. The calculation of these losses is presented below for the various pipe segments since all the losses do not occur for one pipe segment.

(a) Station 1 + 10 to 1 + 52.4 (bend)

$H_b = K_b H_v$, where the degree of bend is 60 degrees

$K_b = 0.20$ {Table 6-3, Case I}

$H_b = (0.20)(0.58) = 0.12$ (Enter in Column 16)

(b) Station 2 + 48 to 2 + 55.5 (transition, expansion)

$H_L = K_e\, Hv_1\, [1-A_1/A_2]$

$K_e = 1.06$ {Table 6-2} for $D_2/D_1 = 1.5$, and $\varphi = 45$

$H_L = (1.06)\, 1.29\, [1 - 15.9/23.76]^2 = 0.15$ (Enter in Column 19)

(c) Station 3 + 55.5 (manhole, straight through)

$H_m = K_m H_v$ (Note: $K_m = K_j$)

$K_m = (0.05)$ {Table 6-5, Case I}

$H_m = (0.05)(1.29) = 0.06$ (Enter in Column 18)

(d) Station 4 + 55.5 to 4 + 65.5 (junction)

$H_j = H_{v2} - K_j H_{v1}$

$K_j = 0.62$ {Table 6-5, Case III} $\varphi = 30$ degrees

$H_j = 1.29 - (.66)(0.99) = 0.64$ (Enter in Column 17)

(e) Station 5 + 65.5 to 5 + 75.5 (junction) since there are two laterals, the loss is estimated as twice the loss for one lateral

$K_j = 0.33$ {Table 6-5, Case III} $\varphi = 70$ degrees

$H_j = 0.99 - (0.33)(0.64) = 0.78$ for one lateral

STEP 9: Sum all the form losses from Columns 15 through 19 and enter in Column 20. For the reach between Station 0+00 and 1+10, the total loss is 0.21

STEP 10: Add the total loss in Column 20 to the energy grade at the downstream end (Sta 0+00) to compute the energy grade at the upstream end (Sta 1+10) for this example.

E.G. (U/S) = E.G. (D/S) + TOTAL LOSS

= 100.58 + 0.21

= 100.79 (Column 11)

Where: E.G. = energy grade

U/S = upstream

D/S = downstream

STEP 11: Enter the new invert (Column 2), pipe diameter D (Column 3), pipe shape (Column 5), pipe area A (Column 6), then compute the constant φ from Step 1 in Column 7, the computed velocity V in Column 8, the new Q (Column 9), and the computed velocity head H_v (Column 10).

STEP 12: Compute the new water surface, W.S., for the upstream station (Station 1+10 for this example).

W.S. = E.G. - H_v

= 100.79 -0.58

= 100.21 (Column 4)

STEP 13: Repeat Steps 1 through 12 until the design is complete. The hydraulic grade line and the energy grade line are plotted on the profile (see Figure 6-5).

DISCUSSION OF RESULTS:

The hydraulic grade line (HGL) is at the crown of the pipe from Station 0+00 to 2+48. Upstream of the transition (Station 2+55.5), the 54-inch RCP has a greater capacity (approximately 175 cfs) at that slope than the design flow (145 cfs). The pipe is therefore not flowing full but is substantially full (i.e., 145/175 = 0.84, greater than 0.80). The computed HGL is below the crown of the pipe. However, at the outlet, the actual HGL is higher, since the outlet of the 54-inch RCP is submerged by the headwater for the 66-inch RCP. To compute the actual profile, a backwater calculation would be required; however this accuracy is not necessary for stormwater design in most cases.

At the junction (Station 4+55.5), the HGL is below the top of the pipe. However, in this case, the full flow capacity (100 cfs) is the same as the design capacity, and the HGL remains parallel to the top of the pipe. A similar situation occurs at the junction at Station 5+65.5 except that the HGL remains above and parallel to the top of the pipe.

If the pipe entering a manhole or junction is at an elevation significantly above the manhole invert, a discontinuity in the EGL may occur. If the EGL of the incoming pipe for the design flow condition is higher then the EGL in the manhole, then a discontinuity exists, and the higher EGL is used for the incoming pipe.

6.11 CHECKLIST

To aid the Designer and Reviewer, the following checklist has been prepared:

Calculate the energy grade line (EGL) and hydraulic grade line (HGL) for all storm drains and include calculations in the drainage report.

Account for all losses in the EGL calculation including outlet, form, bend, manhole, and junction losses.

Provide adequate protection at the outlet of all storm pipes into open channels.

Check for minimum pipe cover and clearance with all utilities.

VERTICAL DIMENSION OF PIPE (INCHES)	MAXIMUM ALLOWABLE DISTANCE BETWEEN MANHOLES AND/OR CLEANOUTS
15 TO 36	400 FEET
42 AND LARGER	500 FEET

MINIMUM RADIUS FOR RADIUS PIPE

DIAMETER OF PIPE	RADIUS OF CURVATURE
48" TO 54"	28.50 FEET
57" TO 72"	32.00 FEET
78" TO 108"	38.00 FEET

SHORT RADIUS BENDS SHALL NOT BE USED ON PIPES 42 INCHES OR LESS IN DIAMETER

MINIMUM PIPE DIAMETER

TYPE	MINIMUM EQUIVALENT PIPE DIAMETER	MINIMUM CROSS-SECTIONAL AREA
MAIN TRUNK	18 INCHES	1.77 SQ. FT.
*LATERAL FROM INLET		

*MINIMUM SIZE OF LATERAL SHALL ALSO BE BASED UPON A WATER SURFACE INSIDE THE INLET WITH A MINIMUM DISTANCE OF 1 FOOT BELOW THE GRATE OR THROAT

MANNING'S N-VALUE

PIPE TYPE	CAPACITY CALCULATION	VELOCITY CALCULATION
CONCRETE (NEWER PIPE)	.013	.011
CONCRETE (OLDER PIPE)	.015	.012
CONCRETE (PRELIMNARY SIZING)	.015	.012
PLASTIC	.012	.009
ALUMINIZED STEEL (ASP)	.012	.011

PV_DRAIN_P99.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

STORM PIPE ALIGNMENT AND SIZE CRITERIA

TABLE 6-1

March, 2010

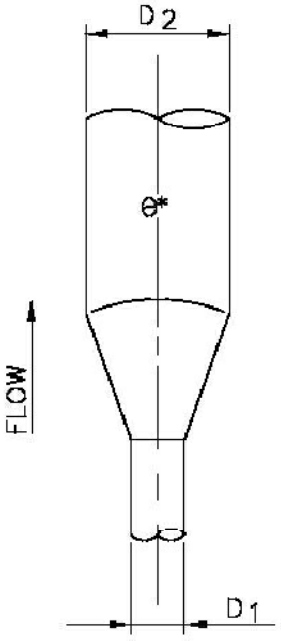
NOT TO SCALE

EXPANSION/CONTRACTION

(a) EXPANSION (Ke)

θ*	$\frac{D2}{D1} = 3$	$\frac{D2}{D1} = 1.5$
10	0.17	0.17
20	0.40	0.40
45	0.86	1.06
60	1.02	1.21
90	1.06	1.14
120	1.04	1.07
180	1.00	1.00

* THE ANGLE θ IS THE ANGLE IN DEGREES BETWEEN THE SIDES OF THE TAPERING SECTION



(b) PIPE ENTRANCE FROM RESERVOIR

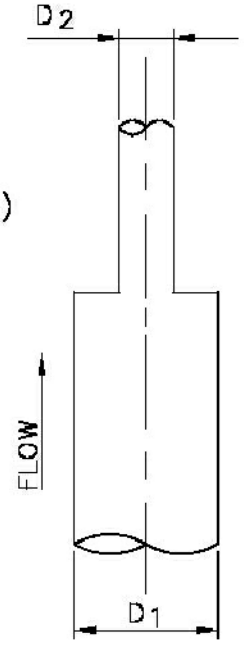
BELL-MOUTH $H_L = 0.04\frac{V2}{2g}$

SQUARE EDGE $H_L = 0.5\frac{V2}{2g}$

GROOVE END U/S FOR CONCRETE PIPE $H_L = 0.2\frac{V2}{2g}$

(c) CONTRACTION (Kc)

$\frac{D2}{D1}$	Kc
0	0.5
0.4	0.4
0.6	0.3
0.8	0.1
1.0	0



PV_DRAIN_P100.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

STORM PIPE ENERGY LOSS COEFFICIENT

TABLE 6-2

March, 2010

NOT TO SCALE

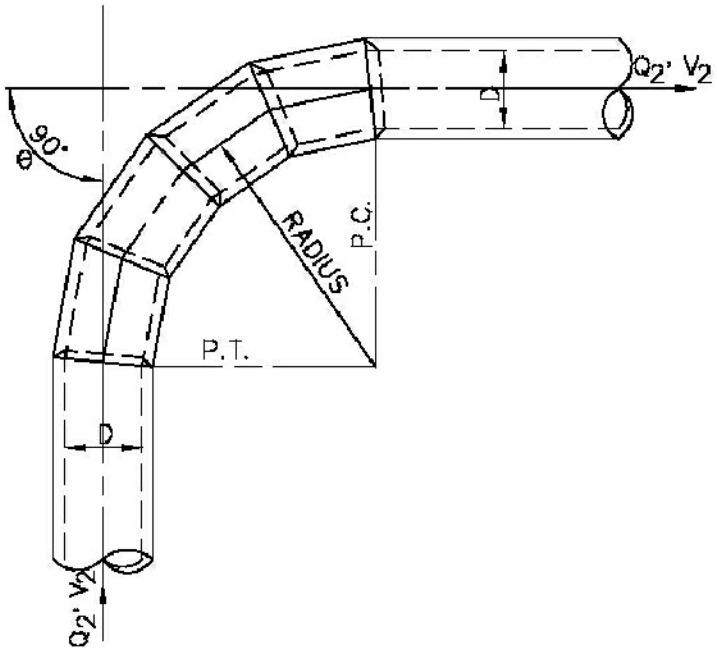
BENDS

CASE 1
CONDUIT ON 90° CURVES

$$K_b = 0.25\sqrt{\frac{\theta}{90}}$$

NOTE: HEAD LOSS APPLIED AT P.C. FOR LENGTH

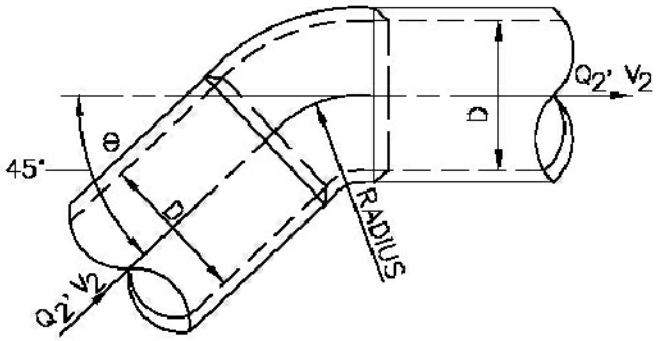
θ	K_b
90	0.25
60	0.20
45	0.18
30	0.14



CASE II
BENDS WHERE RADIUS IS EQUAL TO DIAMETER OF PIPE

NOTE: HEAD LOSS APPLIED AT BEGINNING OF BEND

θ° BEND	K_b
90	0.50
60	0.43
45	0.35
22 1/2	0.20



REFERENCE: APWA SPECIAL REPORT NO. 49, 1981

PV_DRAIN_P101.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

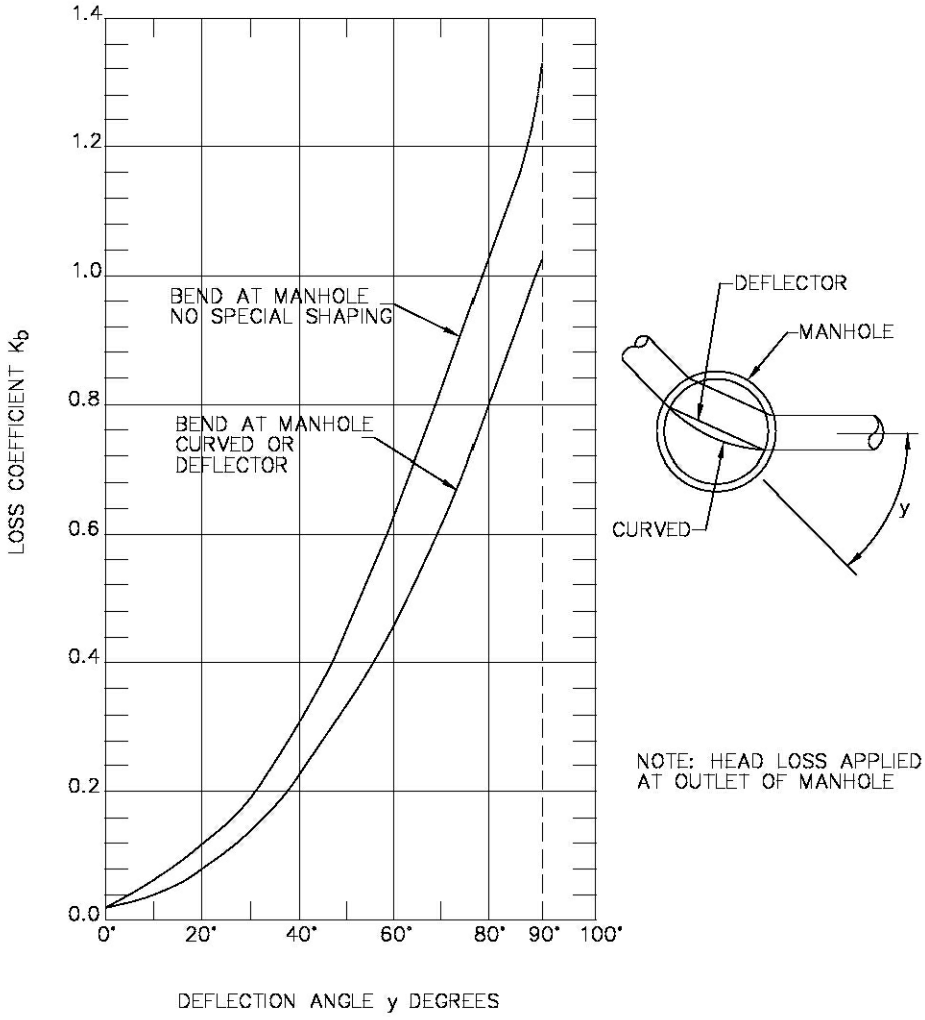
STORM PIPE ENERGY LOSS COEFFICIENT

TABLE 6-3

March, 2010

NOT TO SCALE

BENDS AT MANHOLES



PV_DRAIN_P102.DWG

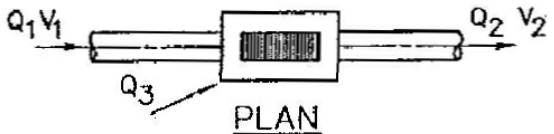
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

STORM PIPE ENERGY LOSS COEFFICIENT

TABLE 6-4

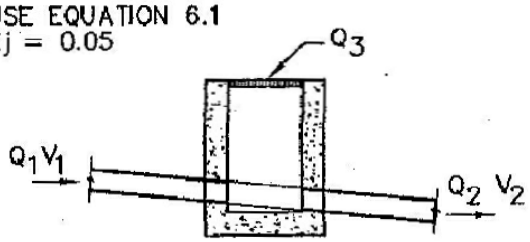
March, 2010

NOT TO SCALE



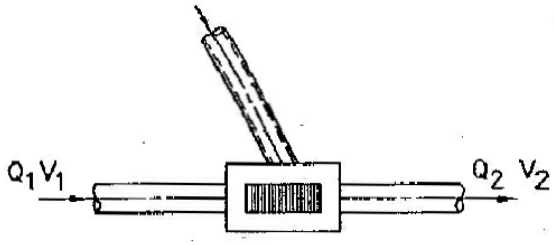
PLAN

USE EQUATION 6.1
Kj = 0.05



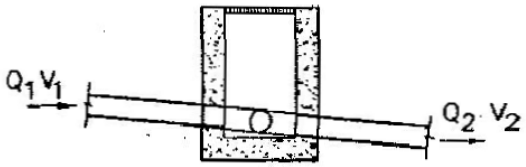
SECTION

CASE I
INLET OR STRAIGHT THROUGH
MANHOLE ON MAIN LINE



PLAN

USE EQUATION 6.5
Kj = 0.25

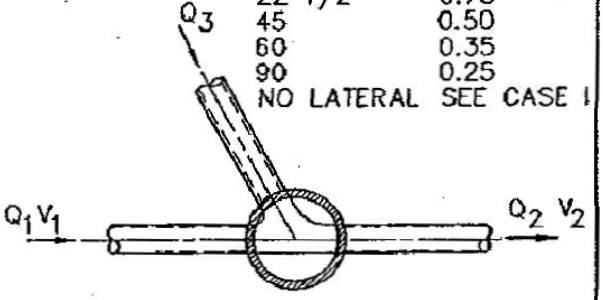


SECTION

CASE II
INLET ON MAIN LINE
WITH BRANCH LATERAL

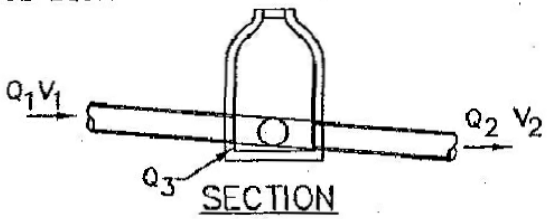
CASE III

θ	Kj
22 1/2	0.75
45	0.50
60	0.35
90	0.25
NO LATERAL	SEE CASE I



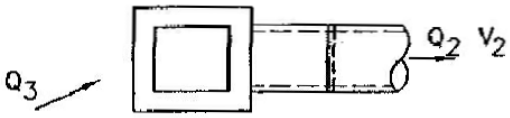
PLAN

USE EQUATION 6.5



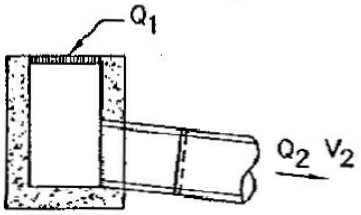
SECTION

CASE III
MANHOLE ON MAIN LINE
WITH θ BRANCH LATERAL



PLAN

USE EQUATION 6.1
Kj = 1.25



SECTION

CASE IV
INLET OR MANHOLE AT
BEGINNING OF LINE

PV_DRAIN_P103.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

MANHOLE JUNCTION LOSSES

TABLE 6-5

March, 2010

NOT TO SCALE

PV_DRAIN_P104.DWG

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
STA	INVERT	D	W.S.	PIPE SHAPE	A	¢	V	Q	Hv	E.G.	Sf	AVG Sf	L	Hf	Hb	Hj	Hm	Ht	TOTAL LOSS
0+00	94.50	66	100.00	RND	23.76	0.00492	6.1	145	0.58	100.58	0.0019	0.0019	110	0.21	–	–	–	–	0.21
1+10	94.71	66	100.21	RND	23.76	0.00492	6.1	145	0.58	100.79	0.0019	0.0019	42.4	0.08	0.12	–	–	–	0.20
1+52.4	94.91	66	100.41	RND	23.76	0.00492	6.1	145	0.58	100.99	0.0019	0.0019	95.6	0.18	–	–	–	–	0.18
2+48	95.08	66	100.59	RND	23.76	0.00492	6.1	145	0.58	101.17	0.0019	0.0019	7.5	0.01	–	–	–	0.15	0.16
2+55.5	96.08	54	100.04	RND	15.90	0.00492	9.1	145	1.29	101.33	0.0054	0.0037	100	0.37	–	–	–	–	0.37
3+55.5	96.90	54	100.41	RND	15.90	0.00492	9.1	145	1.29	101.70	0.0054	0.0054	100	0.54	–	–	0.06	–	0.61
4+55.5	97.66	54	101.01	RND	15.90	0.00492	9.1	145	1.29	102.30	0.0054	0.0054	10	0.05	–	0.64	–	–	0.69
4+65.5	98.40	48	102.01	RND	12.57	0.00492	8.0	100	0.99	103.00	0.0049	0.0052	100	0.52	–	–	–	–	0.52
5+65.5	98.89	48	102.52	RND	12.57	0.00492	8.0	100	0.99	103.51	0.0049	0.0049	10	0.05	–	1.56	–	–	1.61
5+75.5	100.89	24	104.49	RND	3.14	0.00492	6.4	20	0.64	105.12	0.0079	0.0063	100	0.63	–	–	–	–	0.63
6+75.5	101.61	24	105.13	RND	3.14	0.00492	6.4	20	0.64	105.76	0.0079	0.0078							

$$Sf = \frac{¢\ Hv}{R^{1.33}}$$

$$¢ = \frac{2g(n^2)}{2.21}$$

TOTAL FRICTION LOSS = 2.64
TOTAL FORM LOSS = 2.54

NOTE:
SEE FIGURE 6–4 AND 6–5

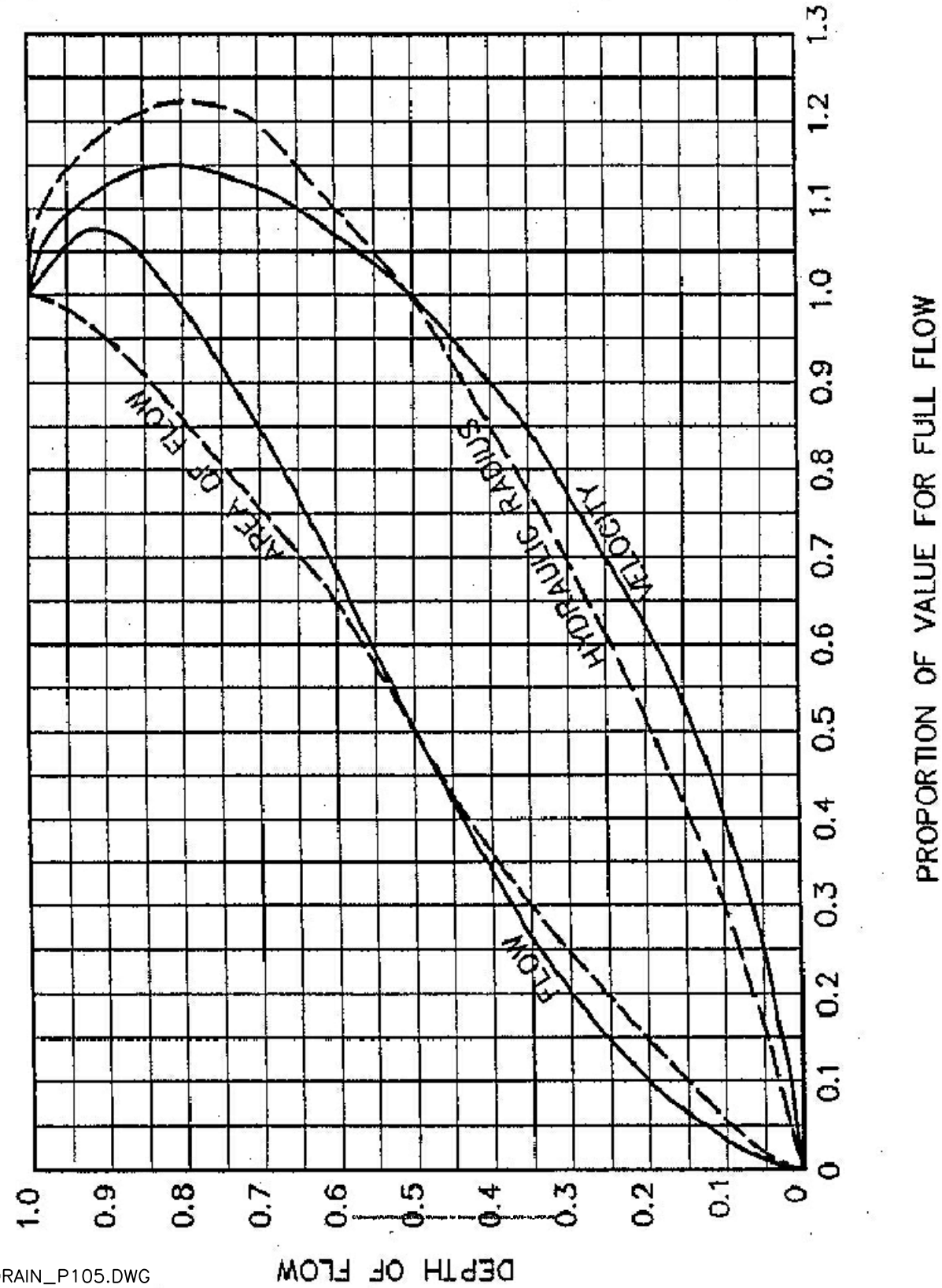
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

DESIGN EXAMPLE FOR STORM DRAINS

TABLE 6–6

March, 2010

NOT TO SCALE



PV_DRAIN_P105.DWG

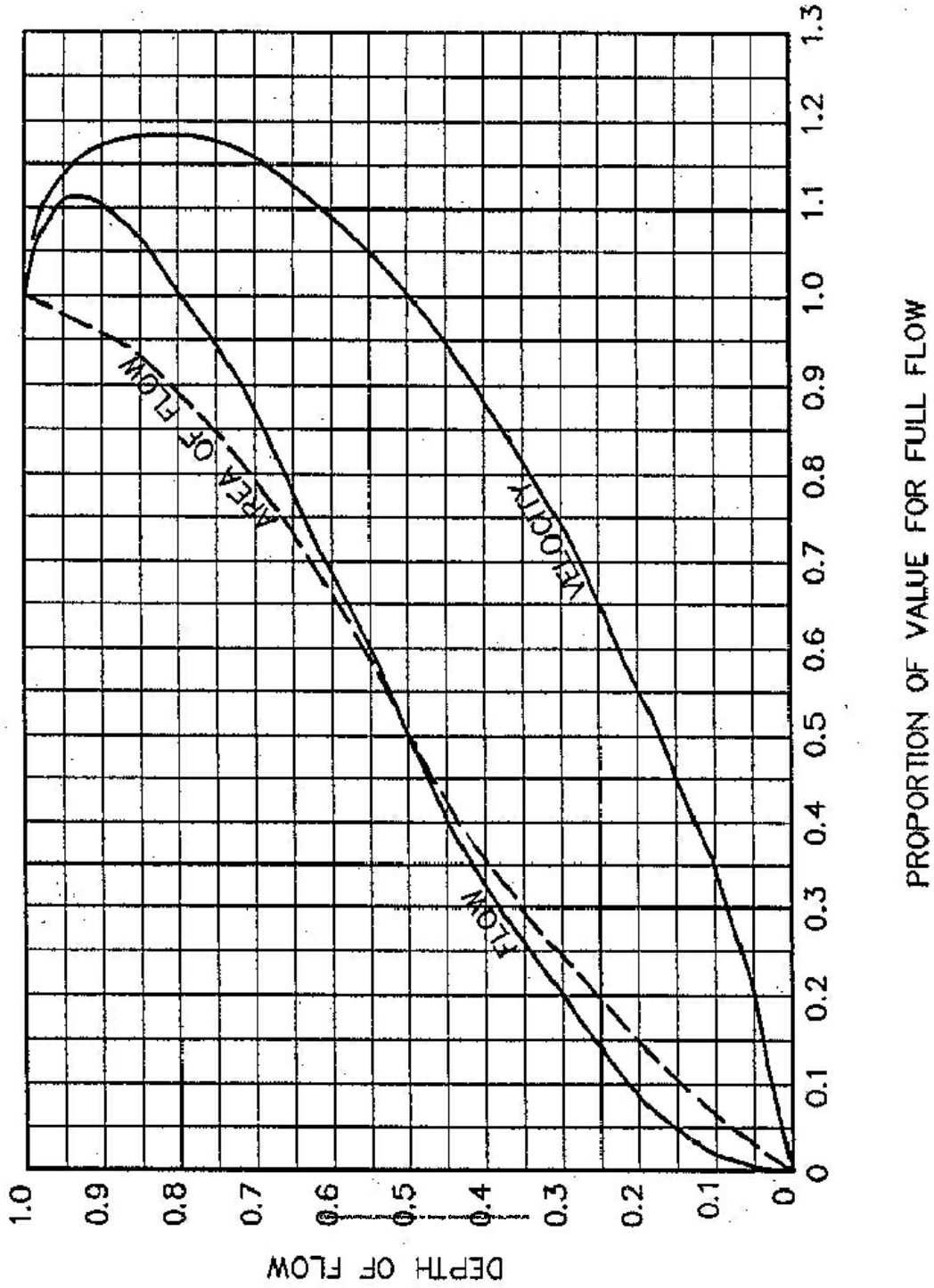
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

HYDRAULIC PROPERTIES CIRCULAR PIPE

FIGURE 6-1

March, 2010

NOT TO SCALE



PV_DRAIN_P106.DWG

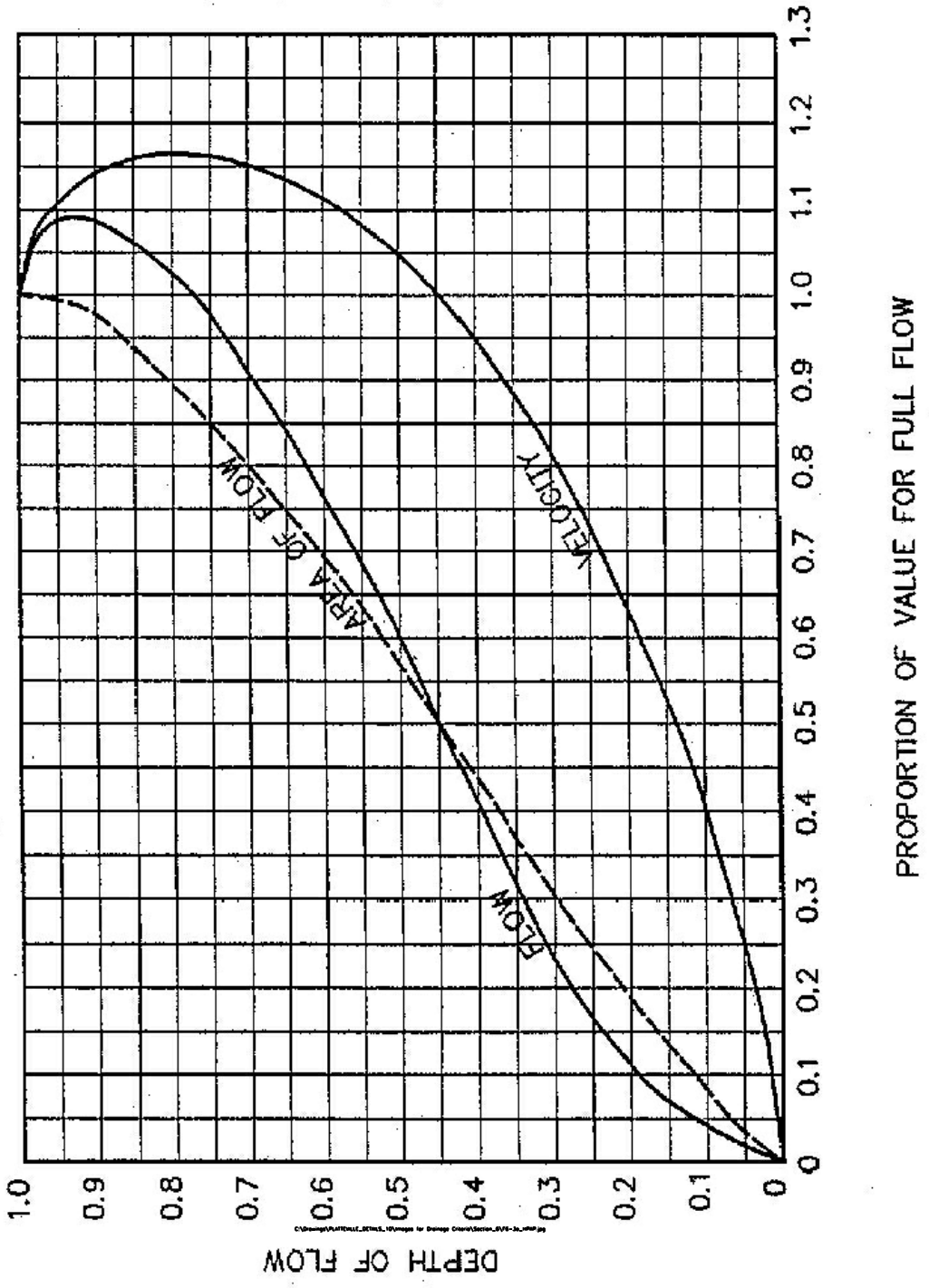
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

HYDRAULIC PROPERTIES
HORIZONTAL ELLIPTICAL PIPE

FIGURE 6-2

March, 2010

NOT TO SCALE



PV_DRAIN_P107.DWG

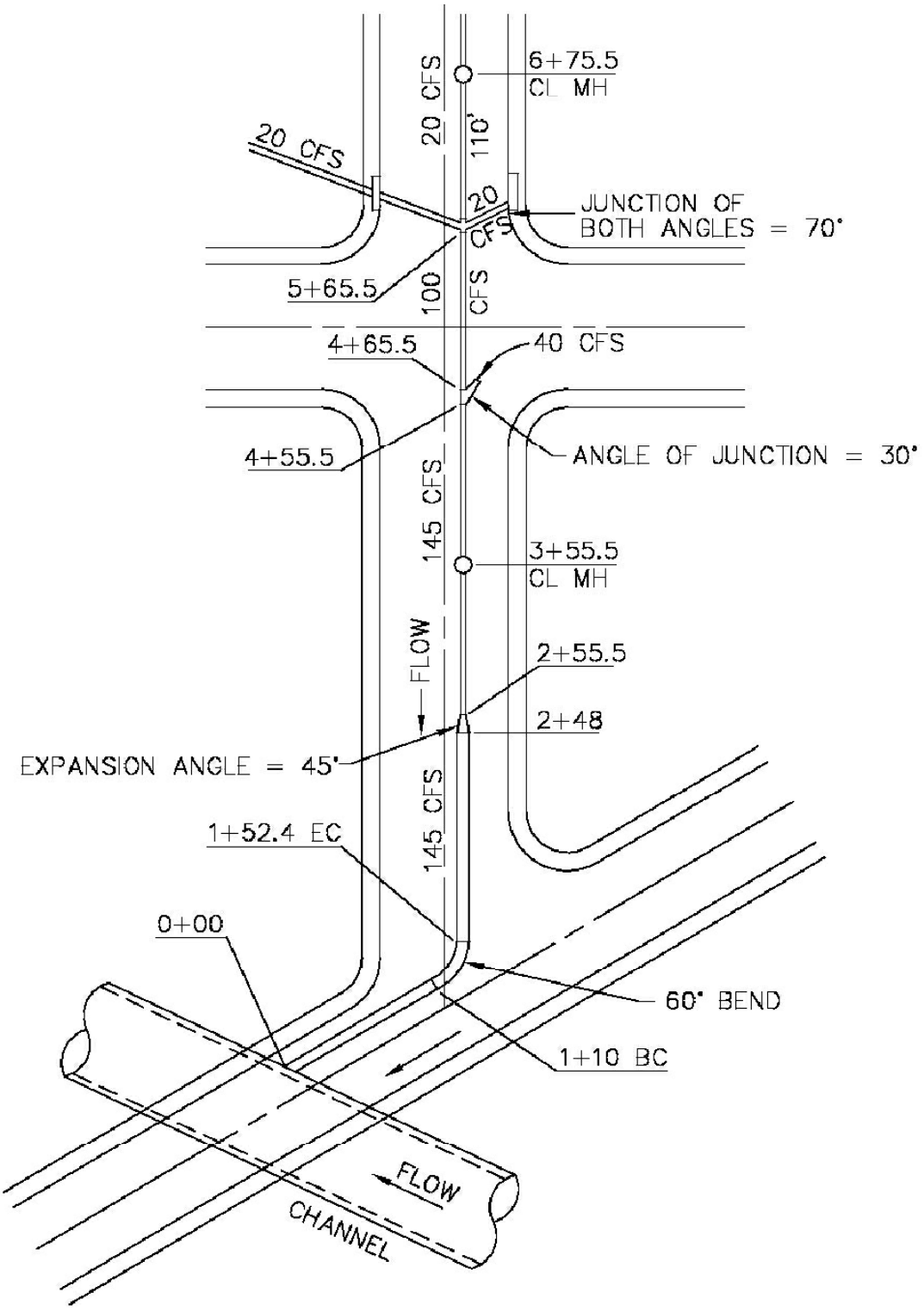
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

HYDRAULIC PROPERTIES
ARCH PIPE

FIGURE 6-3

March, 2010

NOT TO SCALE



PV_DRAIN_P108.DWG

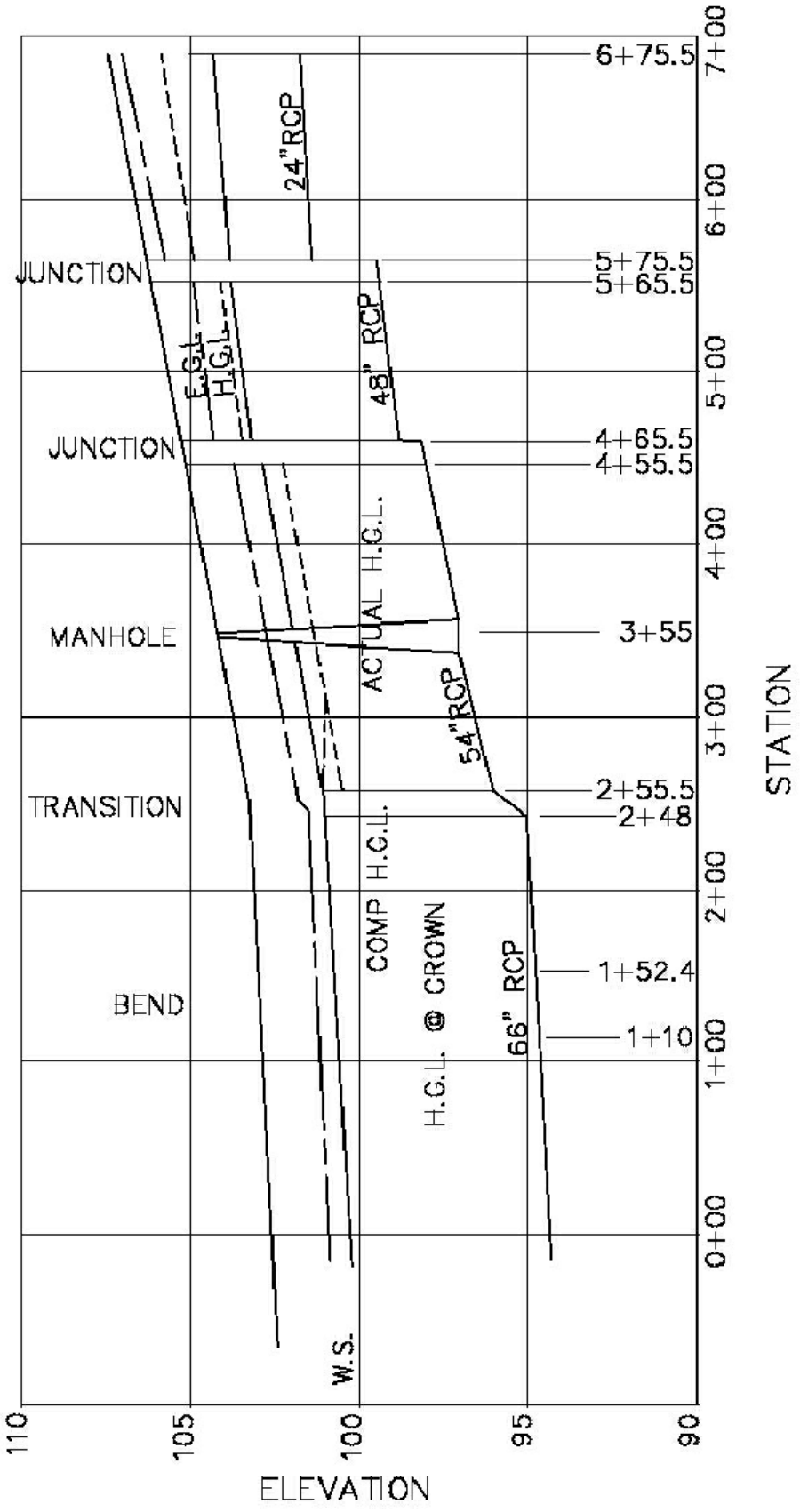
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

DESIGN EXAMPLE FOR STORM DRAINS – PLAN

FIGURE 6–4

March, 2010

NOT TO SCALE



PV_DRAIN_P109.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

DESIGN EXAMPLE FOR STORM DRAINS – PROFILE

FIGURE 6–5

March, 2010

NOT TO SCALE

SECTION 7 – INLETS
TABLE OF CONTENTS

TABLES & FIGURES LOCATED IN THE BACK OF SECTION 7.0

SECTION 7 INLETS

7.1 INTRODUCTION

There are three types of inlets: curb opening, grated, and combination inlets. Inlets are further classified as being on a "continuous grade" or in a sump condition. The term continuous grade refers to an inlet located so that the grade of the street has a continuous slope past the inlet and, therefore, ponding does not occur at the inlet. The sump condition exists whenever water ponds because the inlet is located at a low point. A sump condition can occur at a change in grade of the street from negative to positive, or at an intersection due to the crown slope of a cross street.

Presented in this section is the criteria and methodology for design and evaluation of stormwater inlets in the Town. Except as modified herein, all stormwater inlet criteria shall be in accordance with the USDCM.

7.2 STANDARD INLETS

The standard inlets permitted for use in the Town are in the following table:

TABLE 7.2 – STANDARD INLETS

Inlet Type	Detail	Permitted Use
Curb Opening Inlet, Type R	Detail 7-1	Arterial and Collector Streets; Commercial and Industrial Areas; Discouraged on rollover curb and Residential Streets (See note below)
Grated Inlet, Type C	Detail 7-2	Streets with road-side ditches or median ditches
Grated Inlet, Type 13	Detail 7-3	All Street types w/o curbs; Alleys; parking lots; or private drives with a valley pan
Combination Inlet, Type 3	Detail 7-4	All street types w/ curbs; Recommended for Residential Areas
Note: In areas where vertical curbs are installed, particularly where there is no on-street parking, Type R inlets may be acceptable. In areas where large storm flows need to be captured by inlets, particularly with flat street grades; it may be desirable to install Type R inlets. These situations shall be reviewed on a case by case basis. Other types of combination inlets may be requested as a variance and used only with Town Approval.		

Inlets and inlet transitions are prohibited in curb transitions.

7.3 INLET HYDRAULICS

The procedures and basic data used to define the capacities of the standard inlets under various flow conditions were obtained from the USDCM, Volume 1, Chapter on "Street/Inlets/Storm Sewers", for curb opening inlets. The procedure consists of defining the amount and depth of flow in the gutter and determining the theoretical flow interception by the inlet. To account for effects which decrease the capacity of the various types of inlets, such as debris plugging, pavement overlaying, and variations in design assumptions, the theoretical capacity calculated for the inlets is reduced to the allowed capacity by the factors presented below for the standard inlets.

TABLE 7.3 - ALLOWABLE INLET CAPACITY

Condition	Inlet Type	Percentage of Theoretical Capacity Allowed
Sump or Continuous Grade	Type R 5' Length 10' Length 15' Length	 88 92 95
Sump or Continuous Grade	Grated Type 13	50
Continuous Grade	Combination Type 3	66
Sump	Grated Type C	50
Sump	Combination Type 3	65

Allowable standard inlet capacities for the initial storm have been developed and are presented in Figures 7-5, 7-6, and 7-7 for continuous grade and Figure 7-8 for sump conditions. **These figures include the reduction factors in the above table.** (Depths greater than initial storm shall be calculated.) The allowable inlet capacity is compatible with the allowable street capacity (see Section 8). The values shown were calculated on the basis of the maximum flow allowed in the street gutter (or roadside ditch for Type C). For the gutter flow amounts less than the maximum, the allowable inlet capacity must be proportionately reduced.

7.3.1 CONTINUOUS GRADE CONDITION

For the continuous grade condition, the capacity of the inlet is dependent upon many factors including gutter slope, depth of flow in the gutter, height and length of curb opening, street cross slope, and the amount of depression at the inlet. In addition, not all of the gutter flow will be intercepted and some flow will continue past the inlet area (called "carryover"). The amount of carryover must be included in the drainage facility evaluation as well as in the design of the inlet.

DESIGN EXAMPLE – Design of Type R Curb Opening Inlets (Initial Storm)

GIVEN:

Street type = Arterial, 6 lane; S = 1.0 percent
Maximum flow depth = 0.5 feet (refer to Section 8)
Maximum allowable gutter capacity = 11.0 cfs
Starting gutter flow (Q_t) = 8.0 cfs

FIND: Interception and carryover amounts for the inlets and flow conditions illustrated on Figure 7-9.

SOLUTION: From Figure 7-9 we can see that inlets 1 and 2 are in a continuous grade condition and inlet 3 is in a sump condition. The first step is to calculate the interception ratio R, for the continuous grade inlets. This ratio is then applied to the actual gutter flow (local runoff plus carryover flow) to determine amount intercepted by the inlet and the carryover flow. The final step is to calculate the size of the inlet required for the sump condition, as discussed in the following section.

STEP 1: From Figure 7-6 for an allowable depth of 0.50 feet and a 15-foot inlet, read the value 8.6 cfs. Note that even though the gutter flow is less than maximum allowable, the maximum depth is used for Figure 7-6. The effect of the lower depth on the inlet capacity shall be accounted for in the following steps.

STEP 2: Compute the interception ratio R

R = Allowable inlet capacity = 8.6
Allowable street capacity 11.0
R = 0.78

STEP 3: Compute the interception amount Q_1

Q_1 = R x Q street
= 0.78 x 8.0
= 6.2 cfs intercepted by inlet

STEP 4: Compute the carryover amount Q_{co}

Q_{co} = Q street - Q_1
= 8.0 - 6.2
= 1.8 cfs

STEP 5: Compute the total flow at the next inlet, which is the sum of the carryover (Q_{co}) from inlet #1 plus the local to inlet #2

Q_T (inlet #2) = Q_{co} (inlet #1) + Q_L (inlet #2)
= 1.8 cfs + 4 cfs
= 5.8 cfs

STEP 6: Compute the interception ratio, intercepted amount, and carryover flow for inlet #2 using the procedure described in Steps 1 through 4.

Allowable inlet capacity = 7.2 cfs {Figure 7-**6**}
R = (7.2 cfs)/(11.0 cfs) = 0.65
Q_1 (inlet #2) = (0.65)(5.8 cfs) = 3.8 cfs
Q_{co} (inlet #2) = 5.8 cfs - 3.8 cfs = 2.0 cfs

STEP 7: Compute the total flow at inlet #3 using the procedures described in Step 5

Q_T (inlet #3) = 8 cfs + 2.0 cfs = 10.0 cfs

STEP 8: Size the inlet in the sump condition using the procedures described in the following section for a sump condition. For this example, with an allowable maximum depth

of flow of 0.5 ft, a 10-foot Type R inlet shall intercept more than the total gutter flow and is therefore acceptable.

7.3.2 SUMP CONDITION

The capacity of the inlet in a sump condition is dependent on the depth of ponding above the inlet. Typically, the problem consists of estimating the amount of inlets or depth of flow required to intercept a given flow amount.

DESIGN EXAMPLE: Allowable capacity for Type 3 Inlet in a Sump (Initial Storm)

GIVEN:

Flow = 8.0 cfs
Maximum allowable street depth = 0.50
Type 3 combination double inlet

FIND: Depth of ponding

SOLUTION:

STEP 1: From Figure 7-8 read the depth of ponding for a double Type 3 combination inlet as D = 0.28' at the gutter flow of 8.0 cfs (inlet capacity).

STEP 2: Compare computed to allowable depth. Since the computed depth is less than the allowable depth, the inlet is acceptable, otherwise the amount of inlets or the type of inlet would be changed and the procedure repeated.

7.4 INLET SPACING

The optimum spacing of storm inlets is dependent upon several factors including traffic requirements, contributing land use, street slope, and distance to the nearest outfall system. The suggested sizing and spacing of the inlets is based upon the interception rate of 70 to 80 percent. This spacing has been found to be more efficient than a spacing using 100 percent interception rate. Using the suggested spacing only, the most downstream inlet in a development would be designed to intercept 100 percent of the flow. Also, considerable improvements in overall inlet system efficiency can be achieved if the inlets are located in the sumps created by street intersections. The following example illustrates how inlet sizing and interception capacity may be analyzed:

DESIGN EXAMPLE: Inlet Spacing

GIVEN:

Maximum allowable street flow depth = 0.50 ft.
Street slope = 1.0 percent
Maximum allowable gutter flow = 11.0 cfs
Gutter flow = 11.0 cfs

FIND: Size and type of inlet for 75 percent interception

SOLUTION:

STEP 1: Compute desired capacity

Q = 0.75 (11.0 cfs) = 8.3 cfs

STEP 2: Read the allowable inlet capacities from Figures 7-5 and 7-6 for various inlets. The following values were obtained:

Inlet Type	Capacity	% Interception
Triple Type 3	5.5 cfs	50
Triple Type R	8.6 cfs	78

Therefore, a curb opening inlet Type R, L = 15 feet is required and shall intercept 8.6 cfs. The remaining 2.4 cfs shall continue downstream and contribute to the next inlet. Spacing between such inlets shall depend on the local runoff, and the amount of flow bypassed at the upstream inlet. In situations where local runoff is not the governing factor, inlets placed on a continuous grade must be spaced at least 50 feet apart in order to pick up carry over flow as indicated by allowable inlet capacity as shown by Figures 7-5, 7-6, and 7-7.

A comparison of the inlet capacity with the allowable street capacity (refer to Section 8) shall show that the percent of street flow interception by the inlets varies from less than 50 percent to as much as 95 percent of the allowable street capacity. Therefore, the optimum inlet spacing cannot be achieved in all instances, and the Design Engineer should analyze the spacing requirements.

7.5 CHECKLIST

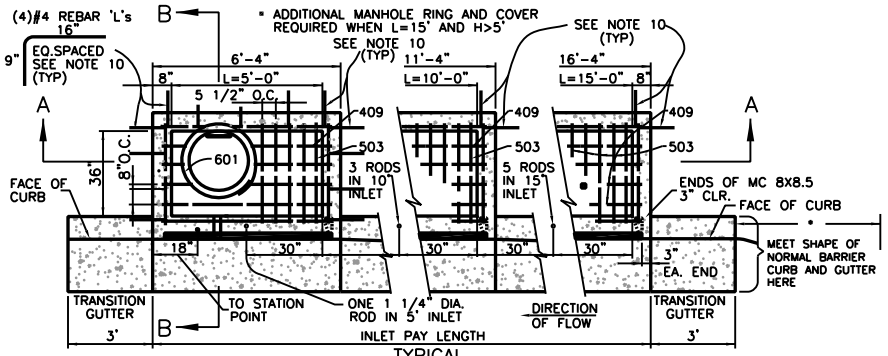
To aid the Designer and Reviewer, the following checklist has been prepared:

Check the inlet capacity to determine the carryover flow, and account for this flow plus the local runoff in the sizing of the downstream inlet.

Place inlets at the flattest grade or in sump conditions where possible to increase capacity.

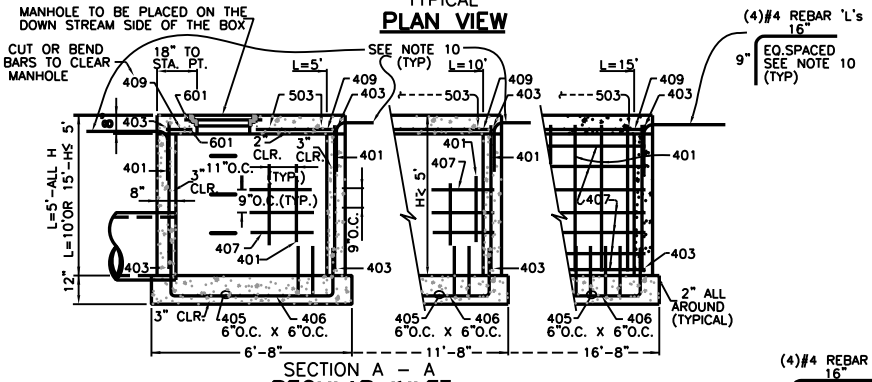
Space inlets based upon the interception rate of 70 to 80% of the gutter flow to optimize inlet capacity.

Inlet structures shall not be constructed until the curb and gutter has been installed. The Town may allow the inlet structures to be constructed if the curb and gutter has been staked and the stakes can be used to set the inlet structures for line and grade 100 feet in each direction.



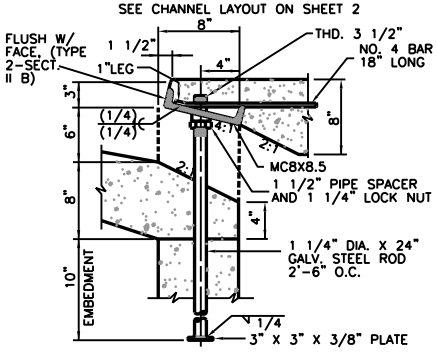
TYPICAL

PLAN VIEW



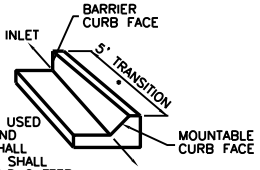
SECTION A – A

REGULAR INLET



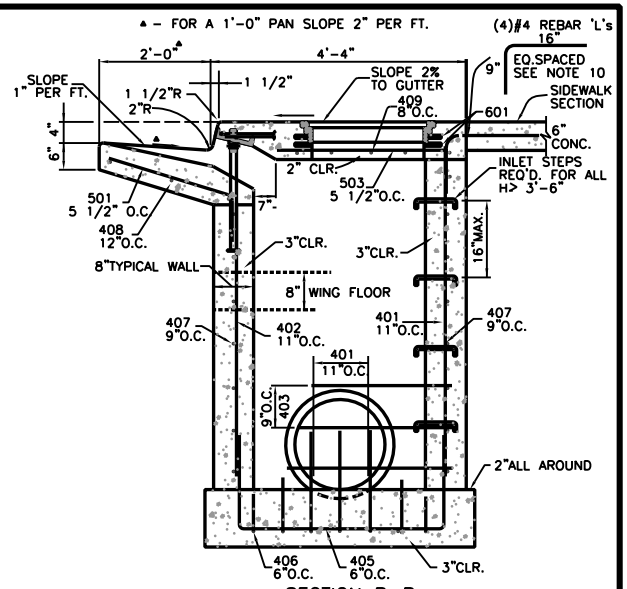
CURB FACE ASSEMBLY

PLACE ENTIRE ASSEMBLY BEFORE POURING CONCRETE



* WHEN A TYPE R INLET IS USED WITH MOUNTABLE CURB AND GUTTER, 5' TRANSITION SHALL BE REQUIRED. TRANSITION SHALL BE PAID FOR AS CURB AND GUTTER

TRANSITION CURB



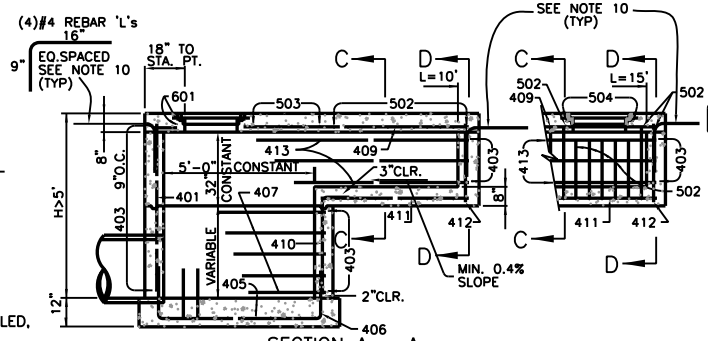
SECTION B–B

TYPICAL END VIEW

NOTE: 1. MANHOLE RING & COVER, STATION POINT AND OUTFLOW PIPE SHALL BE LOCATED AT THE SAME END OF THE INLET.
2. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.

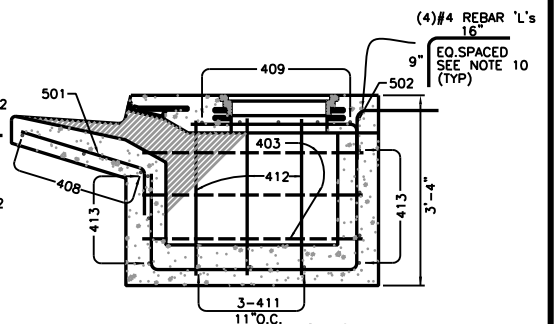
GENERAL NOTES

1. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL (MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2 MATERIALS.
2. INLET MAY BE CAST-IN-PLACE OR PRECAST. CAST-IN-PLACE CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4".
3. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, EPOXY COATED, AND SHALL HAVE A 2" MINIMUM CLEARANCE.
4. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" EXCEEDS 3'–6" AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.
5. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO CDOT–712.06. GRATES AND FRAMES SHALL BE DESIGNED TO WITHSTAND HS–20 LOADING.
6. SEE PLAN DETAILS FOR LOCATION AND SIZE OF PIPE.
7. SEE DETAIL 7–3 FOR BAR LIST AND INLET QUANTITIES.
8. TYPE R DISCOURAGED ON ROLLOVER CURB.
9. INLET STRUCTURES SHALL NOT BE CONSTRUCTED UNTIL THE CURB AND GUTTER HAS BEEN INSTALLED, OR CONTRACTOR STAKES THE CURB & GUTTER FOR 100' ON EACH SIDE OF INLET. CONTRACTOR MUST ALSO STAKE INLET BOX CORNERS.
10. ADD (4) #4 REBARS–"L" SHAPED, EQUALLY SPACED MID–DEPTH INTO THE CONCRETE LID & WALL & MID–DEPTH INTO EACH SIDEWALK SECTION POURED NEXT TO THE INLET (TYP L=5'). 4 ADDITIONAL BARS ARE REQUIRED FOR EACH 5' OF LENGTH ADDED FOR DOUBLE OR TRIPLE INLET.
11. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".



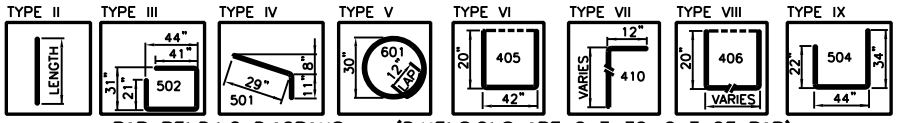
SECTION A – A

INLET WITH DROP BOX – H>5'



SECTIONS C–C & D–D

REFERENCE:
COLORADO DEPARTMENT OF TRANSPORTATION STANDARD M–604–12 (SHEET 1 OF 2)
REFER TO THE LATEST M & S STANDARDS.



BAR BENDING DIAGRAMS — (DIMENSIONS ARE OUT–TO–OUT OF BAR)

PV_SD_7–1.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

CURB INLET TYPE R

DETAIL No. 7–1

March, 2010

NOT TO SCALE

(FOR ESTIMATING ONLY)

TABLE ONE — BAR LIST FOR CURB INLETS, TYPE "R"

MARK	DIA. IN.	O.C. SPACING	TYPE	ALL INLETS L = 5' NO. REQ'D.	ALL INLETS L = 5' LENGTH	INLETS, H ≤ 5' L = 10' NO. REQ'D.	INLETS, H ≤ 5' L = 10' LENGTH	INLETS, H ≤ 5' L = 15' NO. REQ'D.	INLETS, H ≤ 5' L = 15' LENGTH	INLETS, H > 5' L = 10' NO. REQ'D.	INLETS, H > 5' L = 10' LENGTH	INLETS, H > 5' L = 15' NO. REQ'D.	INLETS, H > 5' L = 15' LENGTH
401		11"	II	15	•	21	•	26	•	11	•	11	•
402		11"	II	7	•	13	•	18	•	7	•	7	•
403		9"	II	•	4'-0"	•	4'-0"	•	4'-0"	•	4'-0"	•	4'-0"
405		6"	VI	11	6'10"	21	6'10"	31	6'10"	11	6'10"	11	6'10"
406		6"	VIII	7	8'-10"	7	13'-10"	7	18'-10"	7	8'-10"	7	8'-10"
407	1/2"	9"	II	•	5'-10"	•	10'-10"	•	15'-10"	•	5'-10"	•	5'-10"
408		12"	II	3	6'-0"	3	11'-0"	3	16'-0"	3	11'-0"	3	16'-0"
409		8"	II	6	5'-10"	6	10'-10"	6	15'-10"	6	10'-10"	6	15'-10"
410		11"	VII							3	•	3	•
411		11"	II							3	5'-2"	3	10'-2"
412		11"	II							3	2'-9"	3	2'-9"
413		9"	II							7	10'-10"	7	15'-10"
501	5/8"	5 1/2"	IV	11	3'-4"	22	3'-4"	33	3'-4"	22	3'-4"	33	3'-4"
502	5/8"	5 1/2"	III							11	11'-5"	17	11'-5"
503	5/8"	5 1/2"	II	5	3'-6"	16	3'-6"	27	3'-6"	6	3'-6"	6	3'-6"
504	5/8"	5 1/2"	IX									5	8'-4"
601	3/4"	2 1/2"	V	2	8'-10"	2	8'-10"	2	8'-10"	2	8'-10"	4	8'-10"
ØMC8X8.5				1	5'-10"	1	10'-10"	1	15'-10"	1	10'-10"	1	15'-10"
				2 BARS, 1 ROD	——	4 BARS 3 RODS	——	8 BARS 5 RODS	——	4 BARS 3 RODS	——	8 BARS 5 RODS	——
						REGULAR INLETS				DROP BOX INLETS			

• VARIABLE, REFER TO TABLE TWO
Ø INCLUDE 18" NO. 4 BARS (SEE CHANNEL LAYOUT DETAIL)
▼ SEE CURB FACE ASSEMBLY ON SHEET 1 AND CHANNEL LAYOUT DETAILS ON THIS SHEET

(FOR ESTIMATING ONLY)

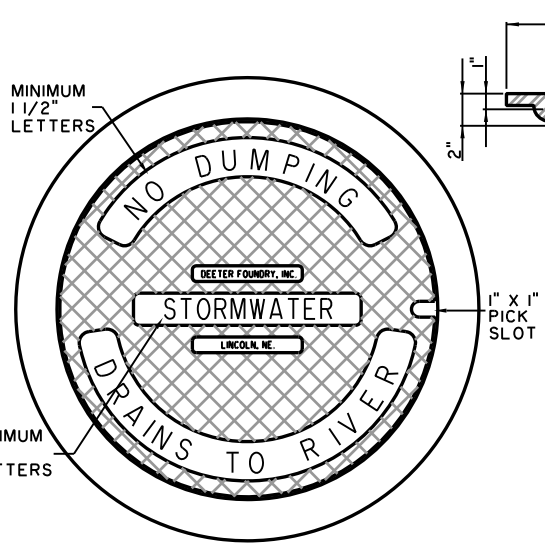
TABLE TWO — BARS AND QUANTITIES VARIABLE WITH "H"

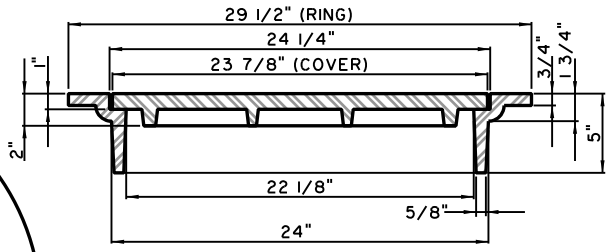
'H'	LENGTH 401	LENGTH 402	LENGTH 410	NO. REQ'D. REGULAR 403	NO. REQ'D. REGULAR 407	NO. REQ'D. DROP BOX 403	NO. REQ'D. DROP BOX 407	L = 5' CU. YD. CONC.	L = 5' LB. STEEL	L = 10' CU. YD. CONC.	L = 10' LB. STEEL	L = 15' CU. YD. CONC.	L = 15' LB. STEEL
3'-0"	2'-8"	1'-8"		10	7			3.2	285	5.3	497	7.4	706
3'-6"	3'-2"	2'-2"		10	7			3.4	305	5.7	528	7.9	747
4'-0"	3'-8"	2'-8"		12	9			3.7	326	6.0	559	8.4	786
4'-6"	4'-2"	3'-2"		12	9			3.9	334	6.4	571	8.8	803
5'-0"	4'-8"	3'-8"		14	11			4.1	354	6.7	602	9.3	844
5'-6"	5'-2"	4'-2"	3'-5"	16	13	15	6	4.4	375	6.0	607	7.4	850
6'-0"	5'-8"	4'-8"	3'-11"	16	13	16	6	4.6	382	6.2	616	7.6	860
6'-6"	6'-2"	5'-2"	4'-5"	18	15	18	8	4.8	402	6.4	637	7.8	880
7'-0"	6'-8"	5'-8"	4'-11"	20	17	19	10	5.0	423	6.6	654	8.0	897
7'-6"	7'-2"	6'-2"	5'-5"	20	17	20	10	5.3	430	6.9	664	8.3	907
8'-0"	7'-8"	6'-8"	5'-11"	22	19	22	12	5.5	451	7.1	684	8.5	927
8'-6"	8'-2"	7'-2"	6'-5"	24	21	23	14	5.7	471	7.3	702	8.7	944
9'-0"	8'-8"	7'-8"	6'-11"	24	21	24	14	6.0	479	7.6	711	9.0	954
9'-6"	9'-2"	8'-2"	7'-5"	26	23	26	16	6.2	499	7.8	732	9.2	974
10'-0"	9'-8"	8'-8"	7'-11"	28	25	27	18	6.4	520	8.0	749	9.4	992
10'-6"	10'-2"	9'-2"	8'-5"	28	25	28	18	6.7	527	8.3	759	9.7	1001
11'-0"	10'-8"	9'-8"	8'-11"	30	27	30	20	6.9	547	8.5	779	9.9	1022

NOTE: FOR L=5', L=10' AND L=15' REGULAR INLETS: TOTAL QUANTITIES NEEDED ARE OUTSIDE OF THE HEAVY BLACK LINE.

DROP BOX INLETS: TOTAL QUANTITIES NEEDED ARE INSIDE OF THE HEAVY BLACK LINE.

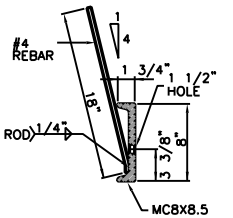
STEEL WEIGHTS DO NOT INCLUDE STRUCTURAL STEEL.



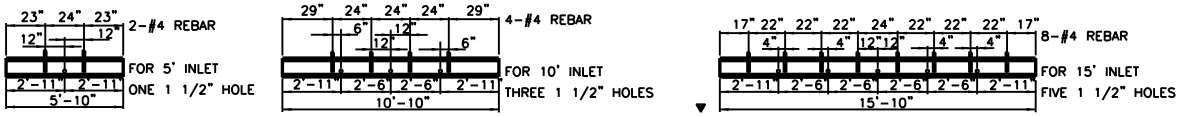


SECTION

WEIGHTS
COVER = 145 LBS.
FRAME = 140 LBS.
TOTAL = 285 LBS.



TYPICAL SECTION AT HOLE



CHANNEL LAYOUT DETAILS

MANHOLE RING AND COVER

GENERAL NOTES

1. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL(MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2 MATERIALS.
2. CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES AND SHALL BE 8" THICK.
3. INLET STEPS SHALL BE IN ACCORDANCE WITH AASHTO M 199.
4. CURB FACE ASSEMBLY SHALL BE GALVANIZED AFTER WELDING.
5. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4", CURB AND GUTTER CORNERS SHALL BE FINISHED TO MATCH THE EXISTING CURB AND GUTTER BEYOND THE TRANSITION GUTTER.
6. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, EPOXY COATED, AND SHALL HAVE A 2" MINIMUM CLEARANCE.
7. DIMENSIONS AND WEIGHTS OF TYPICAL MANHOLE RING AND COVER ARE NOMINAL.
8. MATERIAL FOR MANHOLE RINGS AND COVERS SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO CDOT-712.06.
9. SINCE PIPE ENTRIES INTO THE INLET ARE VARIABLE, THE DIMENSIONS SHOWN ARE TYPICAL. ACTUAL DIMENSIONS AND QUANTITIES FOR CONCRETE AND REINFORCEMENT SHALL BE REQUIRED IN THE WORK. QUANTITIES INCLUDE VOLUMES OCCUPIED BY PIPES.
10. STRUCTURAL STEEL SHALL BE GALVANIZED AND SHALL CONFORM TO THE REQUIREMENTS OF CDOT – 712.06.
11. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".

PV_SD_7-1C.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

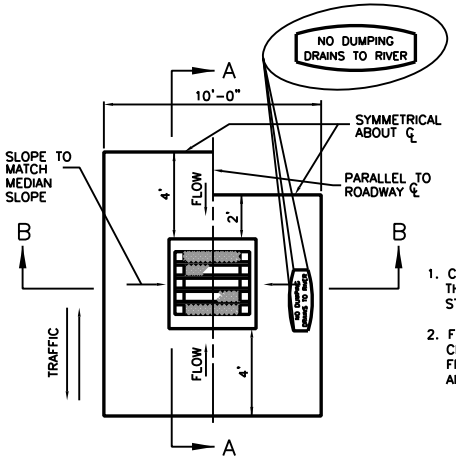
CURB INLET TYPE R

DETAIL No. 7-1 (CONTINUED)

March, 2010

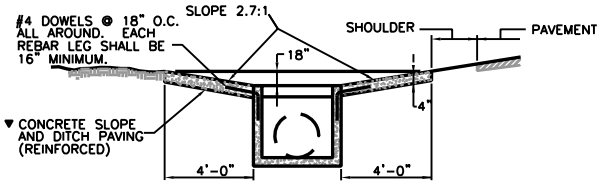
NOT TO SCALE

REFERENCE:
COLORADO DEPARTMENT OF TRANSPORTATION STANDARD M-604-12 (SHEET 2 OF 2)
REFER TO LATEST M & S STANDARDS.



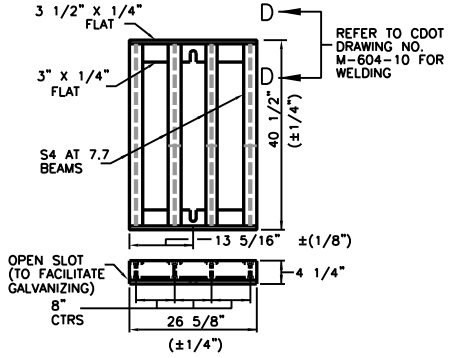
INLET WITH DITCH PAVING

1. CONTRACTOR SHALL IMPRINT THE CONCRETE WITH STAMP STAMP AS SHOWN.
2. FINAL IMPRESSION SHALL BE CLEAR AND LEGIBLE AND FREE OF ANY AGGREGATE AND DEBRIS.

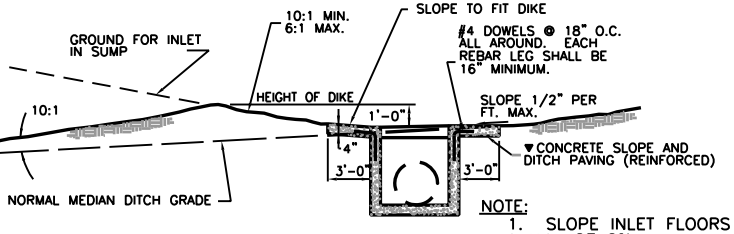


SECTION A–A

NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.



STANDARD INLET GRATE

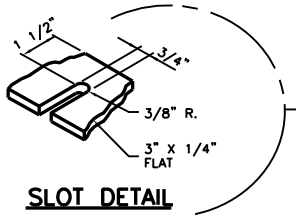


NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2%.

SECTION B–B

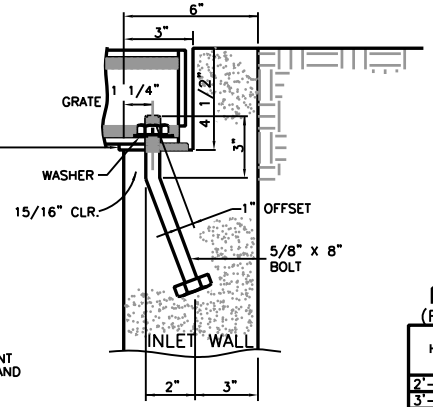
INLET FOR USE IN DITCH ON GRADE

(FLOW FROM ONE DIRECTION)



SLOT DETAIL

NOTE: REFER TO CDOT DRAWING NO. M-604-10 FOR ALTERNATE SLOT AND HOLD DOWN PLATE DETAIL.

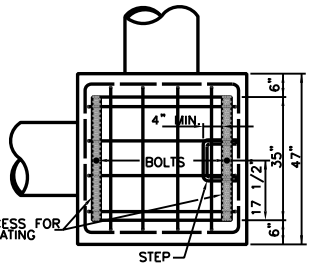


GRATE INSTALLATION DETAIL

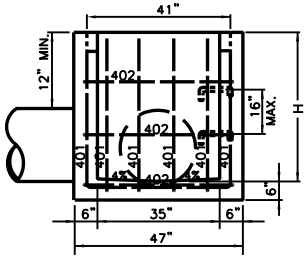
GENERAL NOTES

1. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL (MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2, MATERIALS.
2. INLET MAY BE CAST-IN-PLACE OR PRECAST.
3. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, EPOXY COATED, AND SHALL HAVE A 2" MINIMUM CLEARANCE.
4. CONCRETE SLOPE AND DITCH PAVING SHALL CONFORM TO CDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION SECTION 507. REINFORCEMENT FOR CONCRETE SLOPE PAVING SHALL BE 6 X 6 – W1.4 X W1.4 OR 6 X 6 – W2.1 X W2.1.
5. STRUCTURAL STEEL FOR GRATES AND GRATE INSTALLATION HARDWARE SHALL BE GALVANIZED AND SHALL BE IN ACCORDANCE WITH CDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION 712.06.
6. THE STANDARD INLET GRATES SHALL BE USED ON ALL TYPE C INLETS UNLESS CLOSE MESH GRATES ARE SPECIFIED ON THE PLANS.
7. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" EXCEEDS 3'-6" AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.
8. CLOSE MESH GRATE SHALL BE USED FOR PEDESTRIAN AND BICYCLE AREAS. FOLLOW CDOT DRAWING M-604-10 TO MANUFACTURE GRATE.
9. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".

▼ – CONCRETE SLOPE AND DITCH PAVING WILL BE REQUIRED WHEN SHOWN ON PLANS.



PLAN



ELEVATION CONCRETE INLET

QUANTITIES FOR ONE INLET

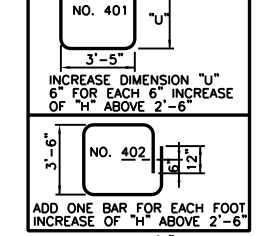
(FOR ESTIMATING ONLY)

H	CONCRETE *(CU. YDS)	REINF. STEEL (LBS)	NO. STEPS REQ'D
2'-6"	0.9	75	0
3'-0"	1.0	80	0
3'-6"	1.2	96	0
4'-0"	1.3	101	1
4'-6"	1.4	116	2
5'-0"	1.5	122	2
5'-6"	1.7	137	2
6'-0"	1.8	142	3
6'-6"	1.9	158	3
7'-0"	2.0	163	3
7'-6"	2.2	179	4
8'-0"	2.3	184	4
8'-6"	2.4	199	4
9'-0"	2.5	205	5
9'-6"	2.7	220	5
10'-0"	3.0	235	6
11'-6	3.4	251	6

*INCLUDES VOLUME OCCUPIED BY PIPES

BAR LIST FOR H=2'-6" AND BENDING DIAGRAM

MARK	NO. REQ'D.	HGT.	LENGTH
401	2	2'-3"	7'-11"
401	6	2'-7"	8'-7"
402	3	"U"	15'-0"



ALL BARS TO BE 1/2" DIA. CUT OR BEND AROUND PIPES AS REQUIRED

PV_SD_7-2.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

GRATED INLET TYPE C

DETAIL No. 7-2

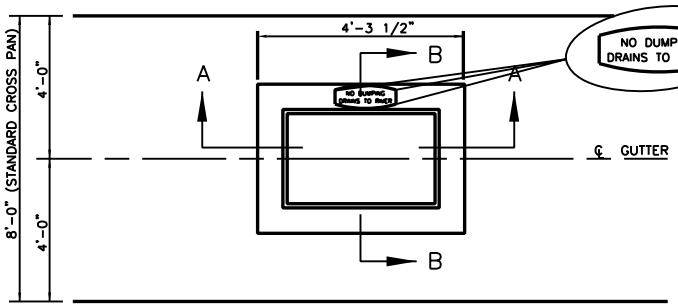
March, 2010

NOT TO SCALE

REFERENCE:
COLORADO DEPARTMENT OF TRANSPORTATION STANDARD M-604-10
REFER TO LATEST M & S STANDARDS.

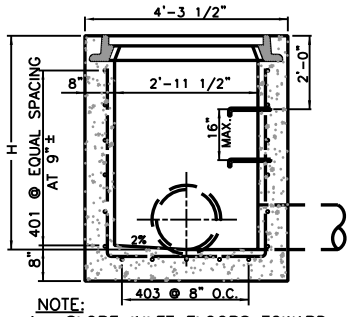
1. CONTRACTOR SHALL IMPRINT THE CONCRETE WITH STAMP STAMP AS SHOWN.

2. FINAL IMPRESSION SHALL BE CLEAR AND LEGIBLE AND FREE OF ANY AGGREGATE AND DEBRIS.



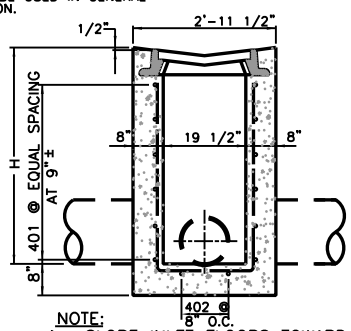
PLAN OF TYPE 13 INLET

NOTE: INLET MAY BE USED IN GENERAL TYPE CONSTRUCTION.



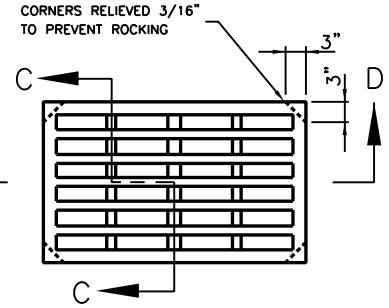
NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.

SECTION A-A

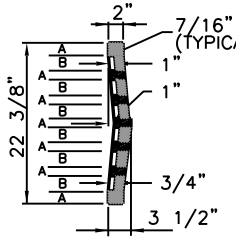


NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.

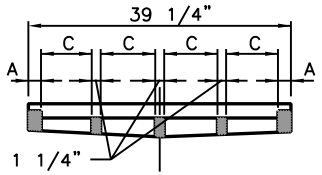
SECTION B-B



PLAN



SECTION C-C

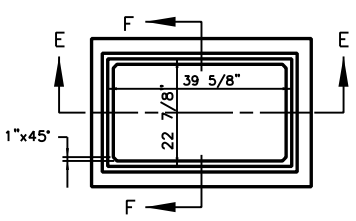


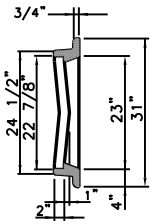
SECTION D-D

A = 1 3/4" MIN.
B = 1 3/4" MAX
C = 8" MAX

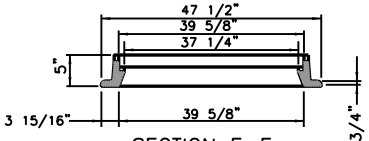
PLAN - GRATE

APPROXIMATE WEIGHT 235 LBS.





SECTION F-F



SECTION E-E

QUANTITIES

(FOR ESTIMATING ONLY)

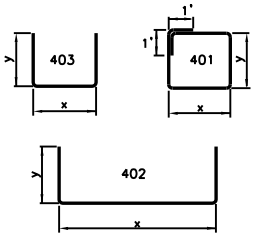
H	CONCRETE (CU. YDS)	REINFORCING STEEL Θ (LBS)	NO. OF 401 BARS REQ'D.
3'-0"	1.3	72	4
3'-6"	1.5	76	4
4'-0"	1.6	90	5
4'-6"	1.8	104	6
5'-0"	1.9	109	6
5'-6"	2.1	122	7
6'-0"	2.2	136	8
6'-6"	2.4	141	8
7'-0"	2.5	154	9
7'-6"	2.7	168	10
8'-0"	2.8	173	10
8'-6"	3.0	187	11
9'-0"	3.1	200	12
9'-6"	3.3	205	12
10'-0"	3.4	219	13

Θ INCLUDES 1% FOR OVERRUN
NOTE: CONCRETE QUANTITIES INCLUDE VOLUME OCCUPIED BY PIPE

BAR LIST FOR H=3'-0"

MARK	NO. REQ'D.	DIMENSIONS X	DIMENSIONS Y	LENGTH
401	4	3'-6"	2'-2"	13'-4"
402	2	3'-4 1/2"	*2'-6 1/2"	8'-5 1/2"
402	5	2'-0 1/2"	*2'-7"	7'-2 1/2"

*ADD 6" TO THIS DIMENSION FOR EACH 6" INCREASE OF "H" OVER 3'-0"



ALL DIMENSIONS ARE OUT-TO-OUT BAR

BENDING DIAGRAM

GENERAL NOTES

1. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL (MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2, MATERIALS.
2. CAST-IN-PLACE CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES.
3. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4".
4. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, AND SHALL HAVE A 2" MINIMUM CLEARANCE.
5. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" EXCEEDS 3'-6" AND SHALL BE IN ACCORDANCE W/ AASHTO M199.
6. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO CDOT STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTRUCTION-712.06. GRATES AND FRAMES SHALL BE DESIGNED TO WITHSTAND HS-20 LOADING.
7. SEE PLAN DETAILS FOR LOCATION AND SIZE OF PIPE.
8. INLET STRUCTURES SHALL NOT BE CONSTRUCTED UNTIL THE CURB AND GUTTER HAS BEEN INSTALLED, OR CONTRACTOR STAKES THE CURB & GUTTER FOR 100' ON EACH SIDE OF INLET. CONTRACTOR MUST ALSO STAKE INLET BOX CORNERS.
9. A MULTIPLE TYPE 13 INLET SHALL BE CONSTRUCTED THE SAME AS A MULTIPLE TYPE 3 INLET MINUS THE CURB OPENING DETAILS.
10. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".

DEETER #2501-A CATCH BASIN INLET FRAME

APPROXIMATE WEIGHT 295 LBS.

PV_SD_7-3.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

GRATED INLET TYPE 13 (GENERAL)

DETAIL No. S-7-3

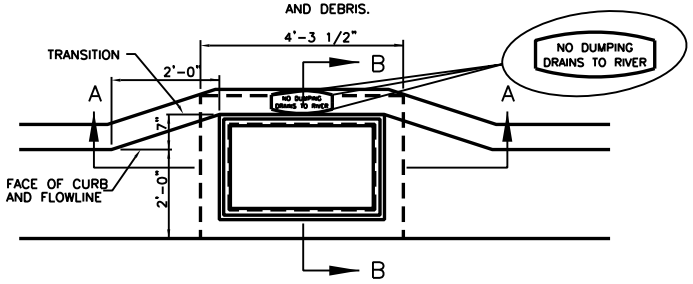
March, 2010

NOT TO SCALE

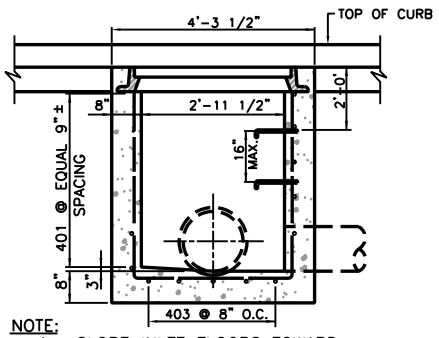
TYPE 13 GRATE
FRAME - #2501-A DEETER FOUNDRY, INC., OR EQUAL

1. CONTRACTOR SHALL IMPRINT THE CONCRETE WITH STAMP STAMP AS SHOWN.

2. FINAL IMPRESSION SHALL BE CLEAR AND LEGIBLE AND FREE OF ANY AGGREGATE AND DEBRIS.

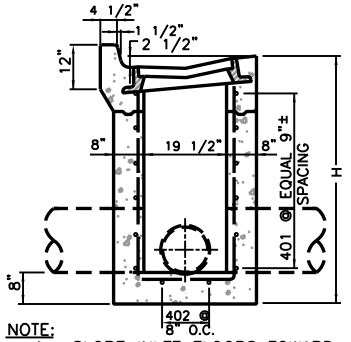


PLAN OF TYPE 13 INLET
STANDARD TYPE 2 SECTION II-B
VERTICAL FACE CURB, GUTTER & SIDEWALK



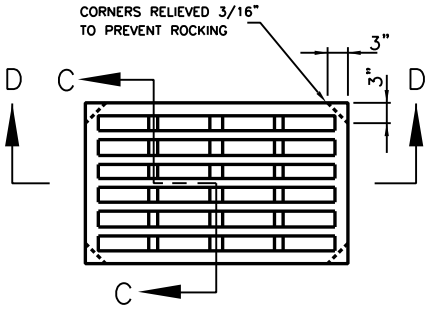
NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.

SECTION A-A

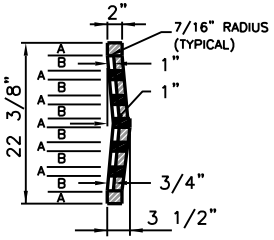


NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.

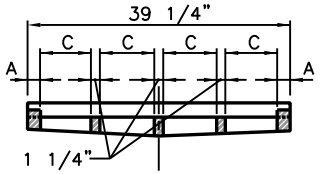
SECTION B-B



PLAN



SECTION C-C



SECTION D-D

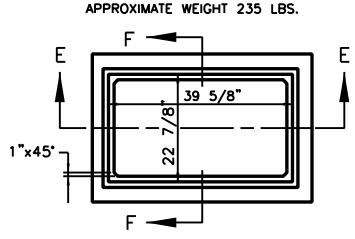
A = 1 3/4" MIN.
B = 1 3/4" MAX
C = 8" MAX

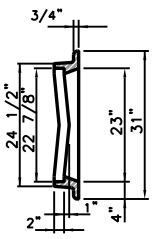
QUANTITIES
(FOR ESTIMATING ONLY)

H	CONCRETE (CU. YDS)	REINFORCING STEEL θ (LBS)	NO. OF 401 BARS REQ'D.
3'-0"	1.3	72	4
3'-6"	1.5	76	4
4'-0"	1.6	90	5
4'-6"	1.8	104	6
5'-0"	1.9	109	6
5'-6"	2.1	122	7
6'-0"	2.2	136	8
6'-6"	2.4	141	8
7'-0"	2.5	154	9
7'-6"	2.7	168	10
8'-0"	2.8	173	10
8'-6"	3.0	187	11
9'-0"	3.1	200	12
9'-6"	3.3	205	12
10'-0"	3.4	219	13

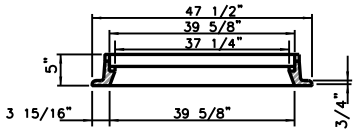
θ INCLUDES 1% FOR OVERRUN
NOTE: CONCRETE QUANTITIES INCLUDE VOLUME OCCUPIED BY PIPE

PLAN - GRATE
APPROXIMATE WEIGHT 235 LBS.





SECTION F-F

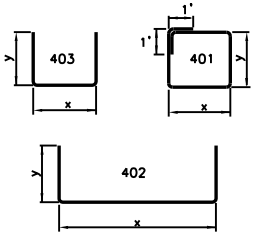


SECTION E-E

BAR LIST FOR H=3'-0"

MARK	NO. REQ'D.	DIMENSIONS X	DIMENSIONS Y	LENGTH
401	4	3'-6"	2'-2"	13'-4"
402	2	3'-4 1/2"	*2'-6 1/2"	8'-5 1/2"
402	5	2'-0 1/2"	*2'-7"	7'-2 1/2"

*ADD 6" TO THIS DIMENSION FOR EACH 6" INCREASE OF "H" OVER 3'-0"



ALL DIMENSIONS ARE OUT-TO-OUT BAR

BENDING DIAGRAM

GENERAL NOTES

1. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL (MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2, MATERIALS.
2. INLET MAY BE CAST-IN-PLACE OR PRECAST. CAST-IN-PLACE CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES.
3. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4".
4. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, AND SHALL HAVE A 2" MINIMUM CLEARANCE.
5. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" EXCEEDS 3'-6" AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.
6. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO CDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION-712.06. GRATES AND FRAMES SHALL BE DESIGNED TO WITHSTAND HS-20 LOADING.
7. SEE PLAN DETAILS FOR LOCATION AND SIZE OF PIPE.
8. INLET STRUCTURES SHALL NOT BE CONSTRUCTED UNTIL THE CURB AND GUTTER HAS BEEN INSTALLED, OR CONTRACTOR STAKES THE CURB & GUTTER FOR 100' ON EACH SIDE OF INLET. CONTRACTOR MUST ALSO STAKE INLET BOX CORNERS.
9. A MULTIPLE TYPE 13 INLET SHALL BE CONSTRUCTED THE SAME AS A MULTIPLE TYPE 3 INLET MINUS THE CURB OPENING DETAILS.
10. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".

DEETER #2501 CATCH BASIN
FRAME AND GRATE
APPROXIMATE WEIGHT 295 LBS.

PV_SD_7-3A.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

GRATED INLET TYPE 13
(FOR VERTICAL FACE CURB)

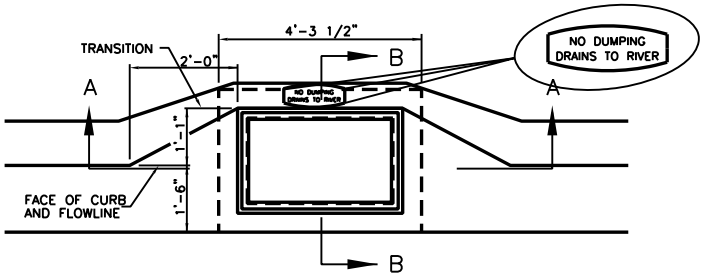
DETAIL No. S-7-3A

March, 2010

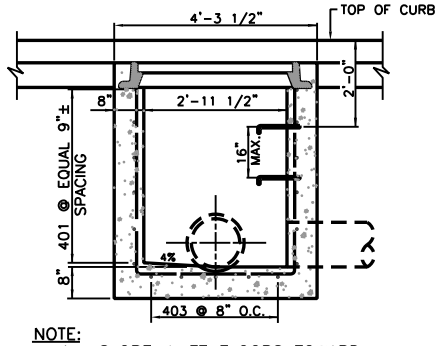
NOT TO SCALE

TYPE "13" GRATE
FRAME - #2501-A NEENAH / DEETER FOUNDRY, INC., OR EQUAL

1. CONTRACTOR SHALL IMPRINT THE CONCRETE WITH STAMP STAMP AS SHOWN.
2. FINAL IMPRESSION SHALL BE CLEAR AND LEGIBLE AND FREE OF ANY AGGREGATE AND DEBRIS.

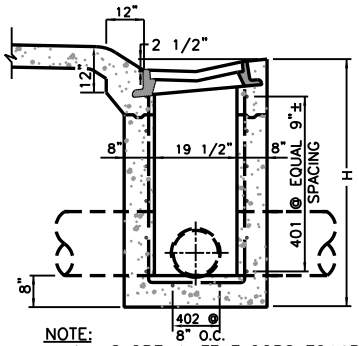


PLAN OF TYPE 13 INLET
STANDARD MOUNTABLE TYPE 2 SECTION
MS MODIFIED CURB, GUTTER & SIDEWALK



NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.

SECTION A-A

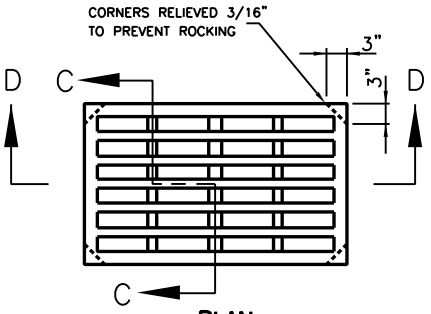


NOTE:
1. SLOPE INLET FLOORS TOWARD PIPES A MIN. OF 2% SO THEY WILL DRAIN COMPLETELY.

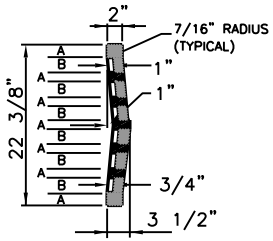
SECTION B-B

GENERAL NOTES

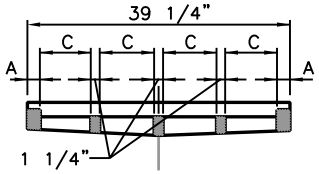
1. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL (MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2, MATERIALS.
2. INLET MAY BE CAST-IN-PLACE OR PRECAST. CAST-IN-PLACE CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES.
3. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4".
4. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, AND SHALL HAVE A 2" MINIMUM CLEARANCE.
5. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" EXCEEDS 3'-6" AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.
6. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO CDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION-712.06. GRATES AND FRAMES SHALL BE DESIGNED TO WITHSTAND HS-20 LOADING.
7. SEE PLAN DETAILS FOR LOCATION AND SIZE OF PIPE.
8. INLET STRUCTURES SHALL NOT BE CONSTRUCTED UNTIL THE CURB AND GUTTER HAS BEEN INSTALLED, OR CONTRACTOR STAKES THE CURB & GUTTER FOR 100' ON EACH SIDE OF INLET. CONTRACTOR MUST ALSO STAKE INLET BOX CORNERS.
9. A MULTIPLE TYPE 13 INLET SHALL BE CONSTRUCTED THE SAME AS A MULTIPLE TYPE 3 INLET MINUS THE CURB OPENING DETAILS.
10. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".



PLAN



SECTION C-C

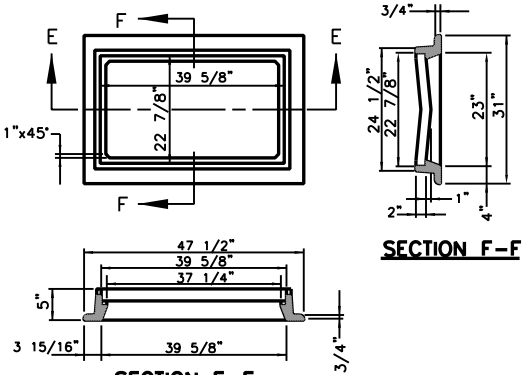


SECTION D-D

A = 1 3/4" MIN.
B = 1 3/4" MAX
C = 8" MAX

PLAN - GRATE

APPROXIMATE WEIGHT 235 LBS.



SECTION E-E

SECTION F-F

DEETER #2501-A CATCH BASIN FRAME AND GRATE

APPROXIMATE WEIGHT 295 LBS.

QUANTITIES
(FOR ESTIMATING ONLY)

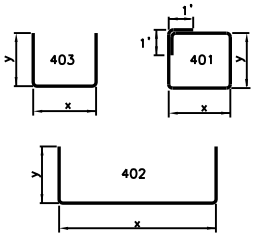
H	CONCRETE (CU. YDS)	REINFORCING STEEL Θ (LBS)	NO. OF 401 BARS REQ'D.
3'-0"	1.3	72	4
3'-6"	1.5	76	4
4'-0"	1.6	90	5
4'-6"	1.8	104	6
5'-0"	1.9	109	6
5'-6"	2.1	122	7
6'-0"	2.2	136	8
6'-6"	2.4	141	8
7'-0"	2.5	154	9
7'-6"	2.7	168	10
8'-0"	2.8	173	10
8'-6"	3.0	187	11
9'-0"	3.1	200	12
9'-6"	3.3	205	12
10'-0"	3.4	219	13

Θ INCLUDES 1% FOR OVERRUN
NOTE: CONCRETE QUANTITIES INCLUDE VOLUME OCCUPIED BY PIPE

BAR LIST FOR H=3'-0"

MARK	NO. REQ'D	DIMENSIONS X	DIMENSIONS Y	LENGTH
401	4	3'-6"	2'-2"	13'-4"
402	2	3'-4 1/2"	*2'-6 1/2"	8'-5 1/2"
402	5	2'-0 1/2"	*2'-7"	7'-2 1/2"

*ADD 6" TO THIS DIMENSION FOR EACH 6" INCREASE OF "H" OVER 3'-0"



ALL DIMENSIONS ARE OUT-TO-OUT BAR

BENDING DIAGRAM

PV_SD_7-3B.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

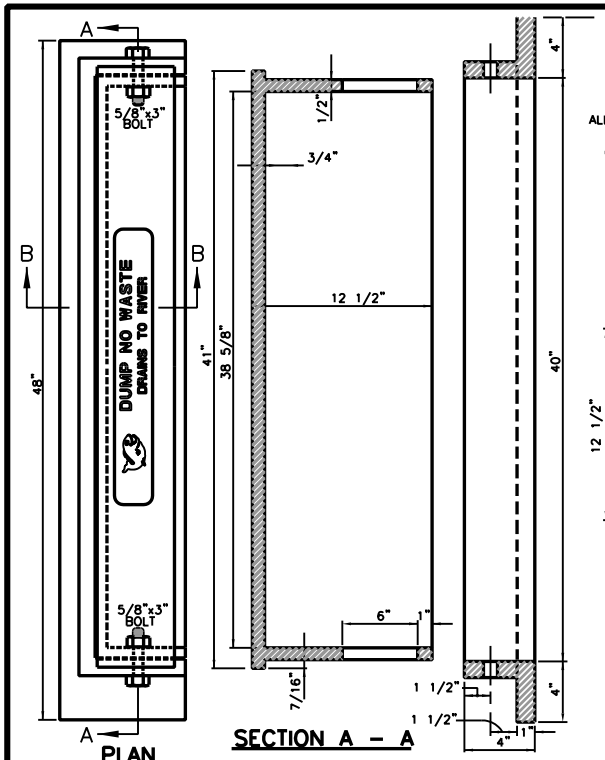
GRATED INLET TYPE 13 (FOR ROLLOVER CURB)

DETAIL No. S-7-3B

March, 2010

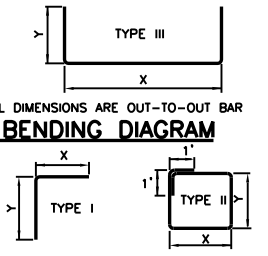
NOT TO SCALE

TYPE "13" GRATE
FRAME - #2501-A NEENAH / DEETER FOUNDRY, INC., OR EQUAL



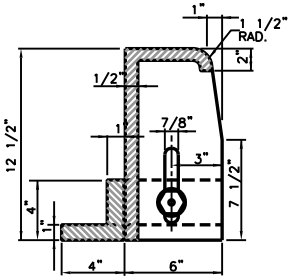
PLAN

SECTION A – A

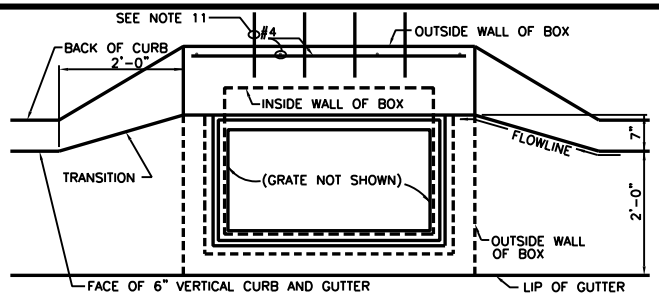


ALL DIMENSIONS ARE OUT-TO-OUT BAR

BENDING DIAGRAM



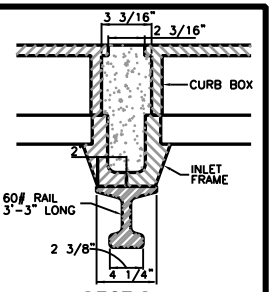
SECTION B – B



DEETER NO. 2502-A SINGLE, CURB INLET FRAME, GRATE, CURB & PARTIAL FRAME

PLAN OF TYPE 3 INLET/STANDARD TYPE 2 SECTION II-B VERTICAL FACE CURB, GUTTER & SIDEWALK

BAR QUANTITIES H	NO. OF 402 BARS REQ'D.
3'-0"	3
3'-6"	4
4'-0"	4
4'-6"	5
5'-0"	6
5'-6"	6
6'-0"	7
6'-6"	8
7'-0"	8
7'-6"	9
8'-0"	10
8'-6"	10
9'-0"	11
9'-6"	12
10'-0"	12



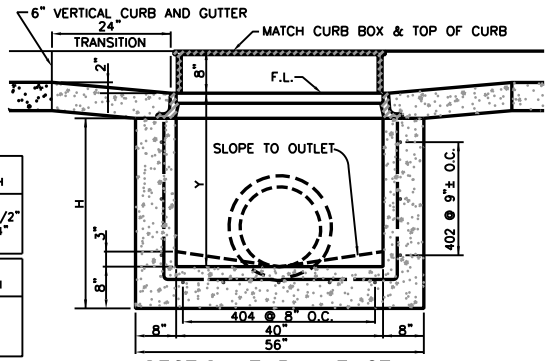
SECTION
CENTER OF MULTIPLE INLETS

BAR LIST FOR H=3'-0"

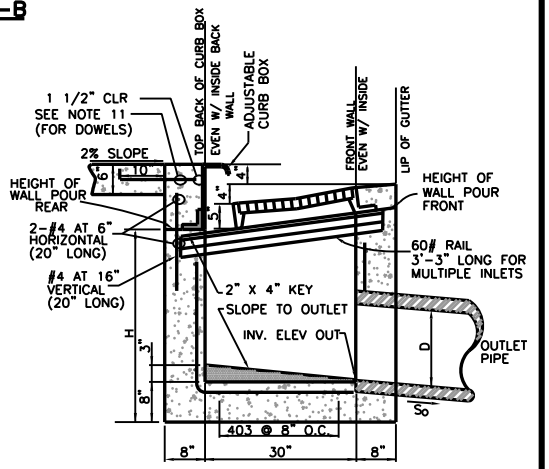
MARK	TYPE	NO. REQ'D	TYPE 3 INLET DIMENSIONS X	Y	LENGTH
401	I	4	1'-0"	1'-0"	2'-0"
402	II	3	3'-7 1/4"	2'-10 1/2"	14'-11 1/2"
403	III	2	3'-5 3/4"	*2'-0 1/2"	7'-6 3/4"
404	III	4	2'-9"	*2'-1"	6'-11"

MARK	TYPE	NO. REQ'D	TYPE 3 DOUBLE INLET DIMENSIONS X	Y	LENGTH
401	I	7	1'-0"	1'-0"	2'-0"
402	II	3	7'-2 1/2"	2'-10 1/2"	22'-2"
403	III	2	7'-1"	*2'-0 1/2"	11'-2"
404	III	8	2'-9"	*2'-1"	6'-11"

*ADD 6" TO THIS DIMENSION FOR EACH 6" INCREASE OF "H" OVER 3'-0"



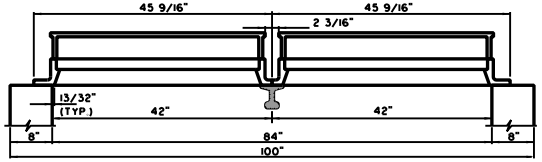
SECTION THRU LENGTH



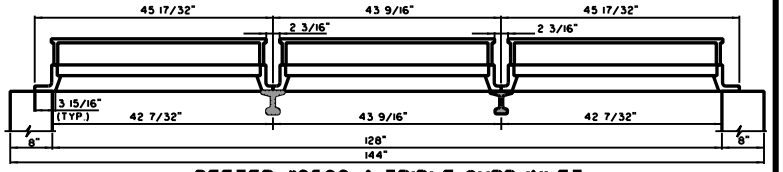
SECTION THRU WIDTH

GENERAL NOTES:

1. ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE TOWN OF PLATTEVILLE DESIGN CRITERIA AND CONSTRUCTION SPECIFICATIONS.
2. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL (MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2, MATERIALS.
3. ALL CONCRETE SHALL BE FORMED ON BOTH SIDES.
4. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4".
5. ALL GRATINGS, FRAMES, RINGS AND COVERS SHALL BE CAST IRON.
6. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, & SHALL HAVE A 2" MINIMUM CLEARANCE.
7. BARS MAY BE BENT OR CUT AT CULVERT ENTRANCES.
8. ALL CULVERTS SHALL BE SMOOTHLY GROUTED INTO THE WALLS OF THE BOX.
9. FOR INLETS WHERE H IS LESS THAN 3'-0", REINFORCING IS STILL REQUIRED AS DIRECTED BY THE ENGINEER. INLET FRAMES SHOWN ARE FOR SINGLE INLETS. ONLY DOUBLE INLETS REQUIRE FRAMES WITH CLIPPED FLANGES WHERE THE TWO FRAMES ABUT.
10. INLET STRUCTURES SHALL NOT BE CONSTRUCTED UNTIL THE CURB AND GUTTER HAS BEEN INSTALLED, OR CONTRACTOR STAKES THE CURB & GUTTER FOR 100' ON EACH SIDE OF INLET. CONTRACTOR MUST ALSO STAKE INLET BOX CORNERS.
11. ADD (4) #4 REBARS-16 INCHES LONG (MIN) EQUALLY SPACED AND 6" AT MID-DEPTH INTO THE TYPE 3 INLET CONCRETE & 10" AT MID-DEPTH INTO EACH SIDEWALK SECTION ADJACENT TO THE INLET (TYP L=5'). 4 ADDITIONAL BARS ARE REQUIRED FOR EACH 5' OF LENGTH ADDED FOR DOUBLE OR TRIPLE INLET.
12. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO CDOT STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTRUCTION-712.06. GRATES & FRAMES SHALL BE DESIGNED TO WITHSTAND HS-20 LOADING.
13. MINIMUM CURB OPENING AREA = 150 SQ. IN.
14. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".



DEETER #2502-A DOUBLE CURB INLET



DEETER #2502-A TRIPLE CURB INLET

PV_SD_7-4A.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

COMBINATION INLET TYPE 3 (FOR VERTICAL FACE CURB)

DETAIL No. S-7-4A

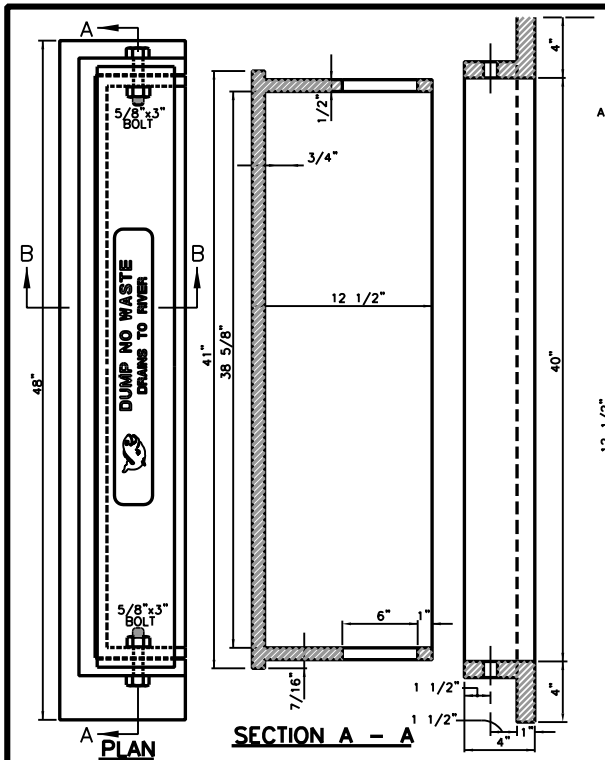
March, 2010

NOT TO SCALE

# OF INLETS	STD. DEPTH (Y)	MIN ø (D)	MIN. SLOPE S_o
SINGLE	3'-6"	18"	1.00%
DOUBLE	4'-0"	18"	1.80%
TRIPLE	4'-6"	21"	1.80%

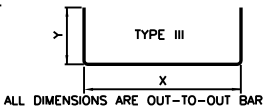
FRAME AND GRATE

FRAME AND GRATE SHALL BE A DEETER 2502-A OR EQUAL



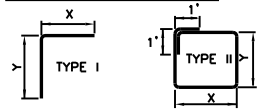
PLAN

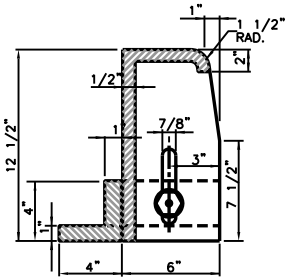
SECTION A – A



ALL DIMENSIONS ARE OUT-TO-OUT BAR

BENDING DIAGRAM





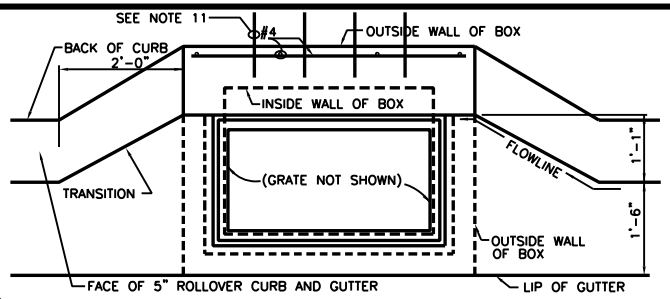
SECTION B – B

BAR LIST FOR H=3'-0"

MARK	TYPE	NO. REQ'D	TYPE 3 INLET DIMENSIONS X	Y	LENGTH
401	I	4	1'-0"	1'-0"	2'-0"
402	II	3	3'-7 1/4"	2'-10 1/2"	14'-11 1/2"
403	III	2	3'-5 3/4"	*2'-0 1/2"	7'-6 3/4"
404	III	4	2'-9"	*2'-1"	6'-11"

MARK	TYPE	NO. REQ'D	TYPE 3 DOUBLE INLET DIMENSIONS X	Y	LENGTH
401	I	7	1'-0"	1'-0"	2'-0"
402	II	3	7'-2 1/2"	2'-10 1/2"	22'-2"
403	III	2	7'-1"	*2'-0 1/2"	11'-2"
404	III	8	2'-9"	*2'-1"	6'-11"

*ADD 6" TO THIS DIMENSION FOR EACH 6" INCREASE OF "H" OVER 3'-0"

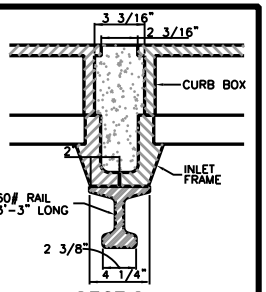


DEETER NO. 2502-A SINGLE, CURB INLET FRAME, GRATE, CURB & PARTIAL FRAME

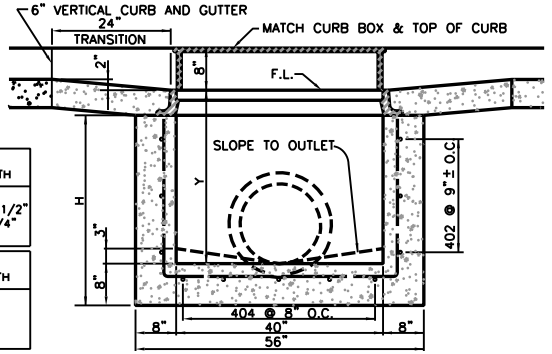
PLAN OF TYPE 3 INLET/STANDARD MOUNTABLE TYPE 2 SECTION MS MODIFIED CURB, GUTTER & SIDEWALK

H	NO. OF 402 BARS REQ'D.
3'-0"	3
3'-6"	4
4'-0"	4
4'-6"	5
5'-0"	6
5'-6"	6
6'-0"	7
6'-6"	8
7'-0"	8
7'-6"	9
8'-0"	10
8'-6"	10
9'-0"	11
9'-6"	12
10'-0"	12

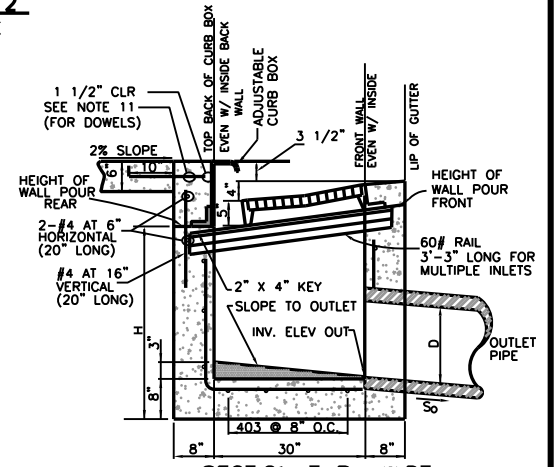
BAR QUANTITIES



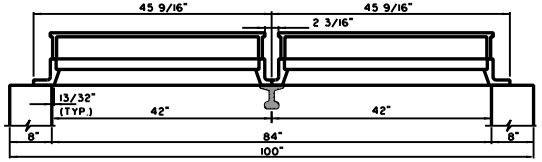
SECTION
CENTER OF MULTIPLE INLETS



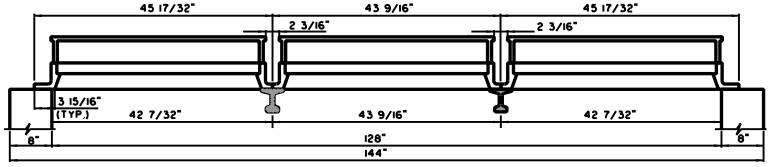
SECTION THRU LENGTH



SECTION THRU WIDTH



DEETER #2502-A DOUBLE CURB INLET



DEETER #2502-A TRIPLE CURB INLET

GENERAL NOTES:

1. ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE TOWN OF PLATTEVILLE DESIGN CRITERIA AND CONSTRUCTION SPECIFICATIONS.
2. CONCRETE SHALL MEET OR EXCEED METROPOLITAN GOVERNMENT ENGINEERING COUNCIL (MGPEC) SPECIFICATIONS, ITEM 11, PORTLAND CEMENT CONCRETE PAVEMENT; SECTION 11.2, MATERIALS.
3. ALL CONCRETE SHALL BE FORMED ON BOTH SIDES.
4. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4".
5. ALL GRATINGS, FRAMES, RINGS AND COVERS SHALL BE CAST IRON.
6. REINFORCING BARS SHALL BE DEFORMED, GRADE 60, PER ASTM A615, & SHALL HAVE A 2" MINIMUM CLEARANCE.
7. BARS MAY BE BENT OR CUT AT CULVERT ENTRANCES.
8. ALL CULVERTS SHALL BE SMOOTHLY GROUTED INTO THE WALLS OF THE BOX.
9. FOR INLETS WHERE H IS LESS THAN 3'-0", REINFORCING IS STILL REQUIRED AS DIRECTED BY THE ENGINEER. INLET FRAMES SHOWN ARE FOR SINGLE INLETS. ONLY DOUBLE INLETS REQUIRE FRAMES WITH CLIPPED FLANGES WHERE THE TWO FRAMES ABUT.
10. INLET STRUCTURES SHALL NOT BE CONSTRUCTED UNTIL THE CURB AND GUTTER HAS BEEN INSTALLED, OR CONTRACTOR STAKES THE CURB & GUTTER FOR 100' ON EACH SIDE OF INLET. CONTRACTOR MUST ALSO STAKE INLET BOX CORNERS.
11. ADD (4) #4 REBARS-16 INCHES LONG (MIN) EQUALLY SPACED AND 6" AT MID-DEPTH INTO THE TYPE 3 INLET CONCRETE & 10" AT MID-DEPTH INTO EACH SIDEWALK SECTION ADJACENT TO THE INLET (TYP L=5'). 4 ADDITIONAL BARS ARE REQUIRED FOR EACH 5' OF LENGTH ADDED FOR DOUBLE OR TRIPLE INLET.
12. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO CDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION-712.06. GRATES AND FRAMES SHALL BE DESIGNED TO WITHSTAND HS-20 LOADING.
13. MINIMUM CURB OPENING AREA = 150 SQ. IN.
14. MINIMUM REBAR SPLICE LENGTH SHALL BE 10".

PV_SD_7-4B.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

COMBINATION INLET TYPE 3 (FOR ROLLOVER CURB)

DETAIL No. S-7-4B

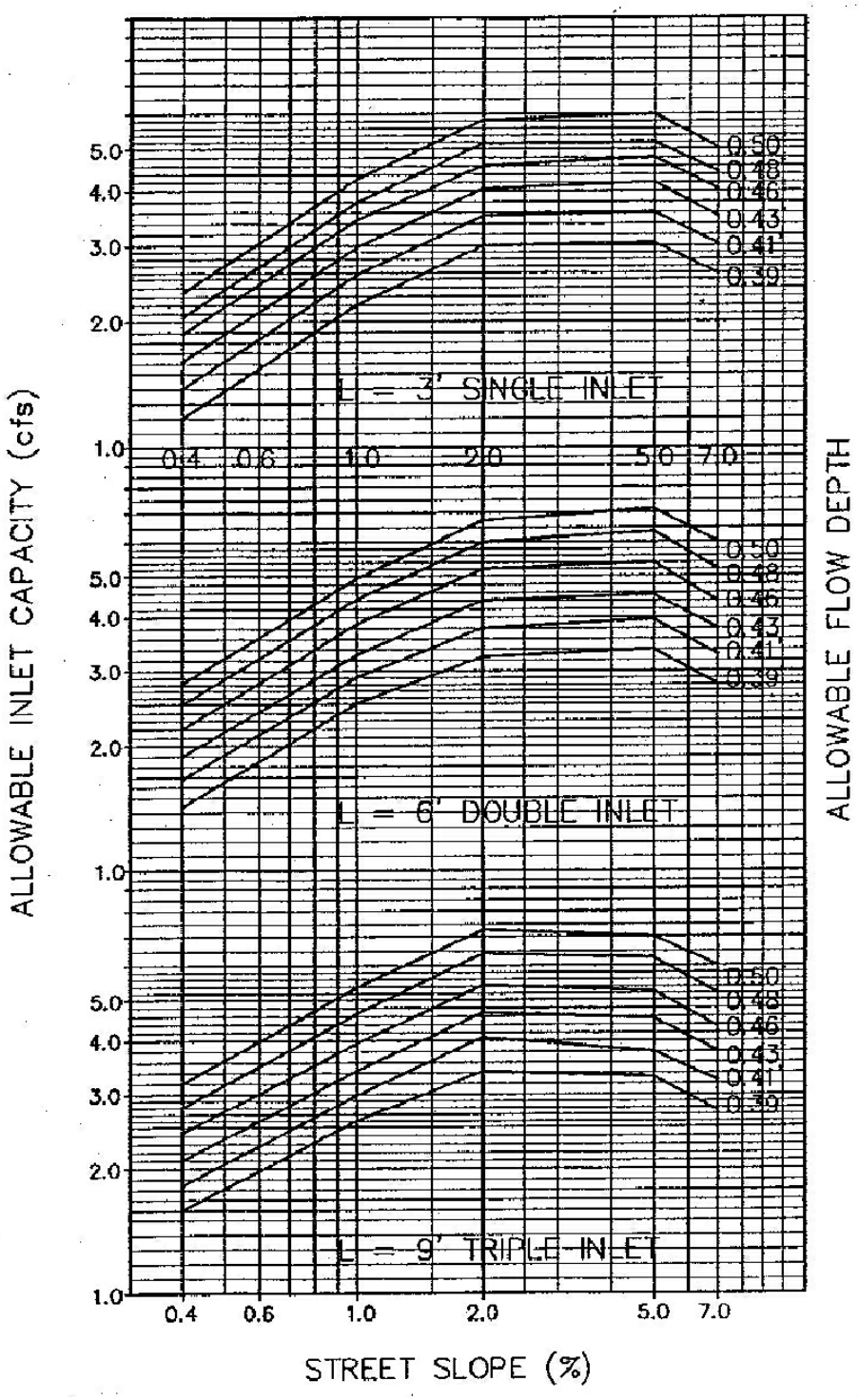
March, 2010

NOT TO SCALE

# OF INLETS	STD. DEPTH (Y)	MIN ø (D)	MIN. SLOPE S_o
SINGLE	3'-6"	18"	1.00%
DOUBLE	4'-0"	18"	1.80%
TRIPLE	4'-6"	21"	1.80%

FRAME AND GRATE

FRAME AND GRATE SHALL BE A DEETER 2502-A OR EQUAL



NOTES:
1. ALLOWABLE CAPACITY = 66% THEORETICAL CAPACITY
2. MAXIMUM INLET CAPACITY AT MAXIMUM ALLOWABLE FLOW DEPTH. PROPORTIONALLY REDUCE FOR OTHER DEPTHS.

PV_DRAIN_P116.DWG

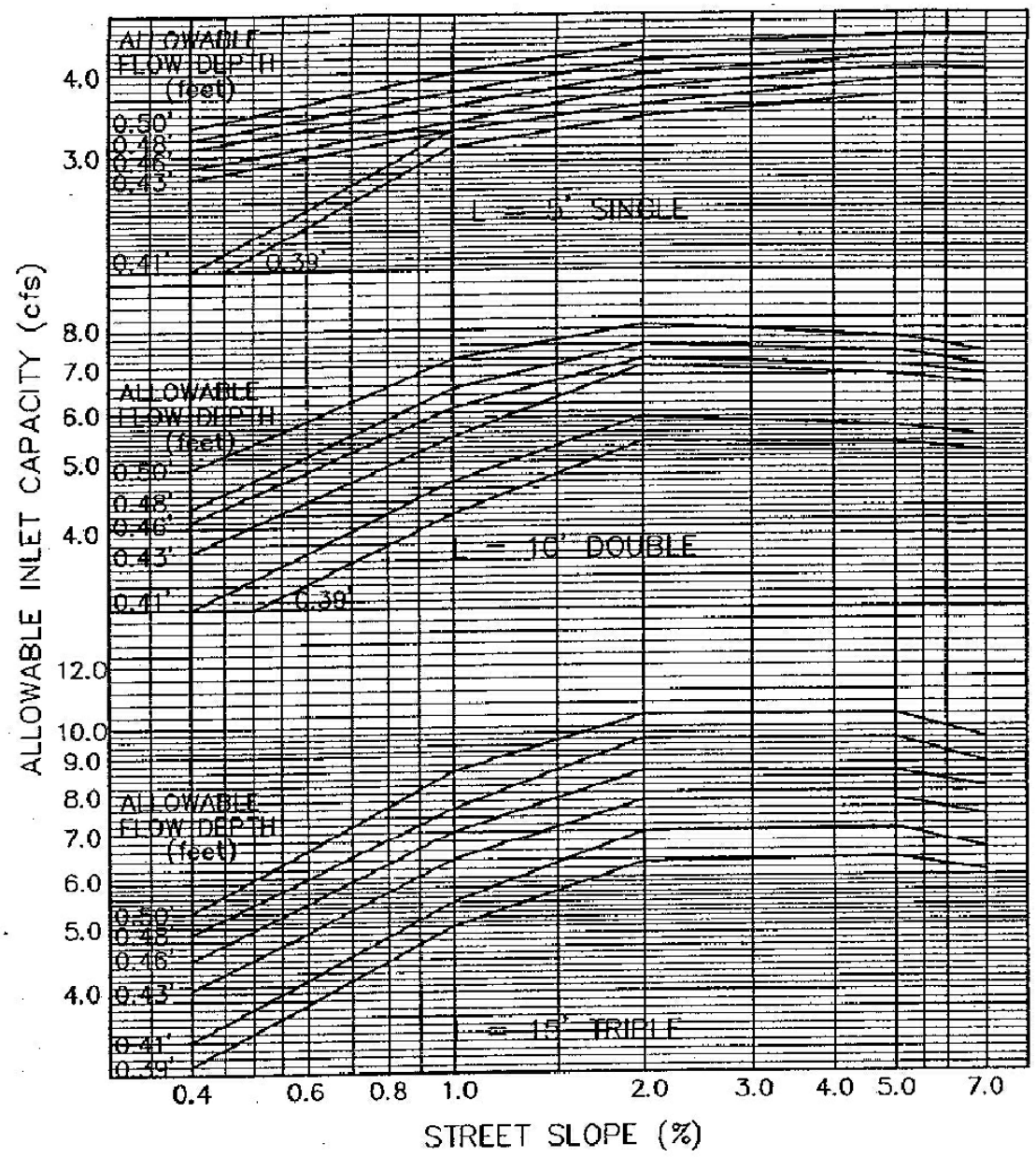
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

ALLOWABLE INLET CAPACITY TYPE 3 COMBINATION ON A CONTINUOUS GRADE

March, 2010

FIGURE 7-5

NOT TO SCALE



NOTES:

1. MAXIMUM INLET CAPACITY AT MAXIMUM ALLOWABLE FLOW DEPTH. PROPORTIONALLY REDUCE FOR OTHER DEPTHS.
2. ALLOWABLE CAPACITY =
   88% (L = 5')
   92% (L = 10')
   95% (L = 15')
   OF THEORETICAL CAPACITY
3. INTERPOLATE FOR OTHER INLET LENGTHS.

PV_DRAIN_P117.DWG

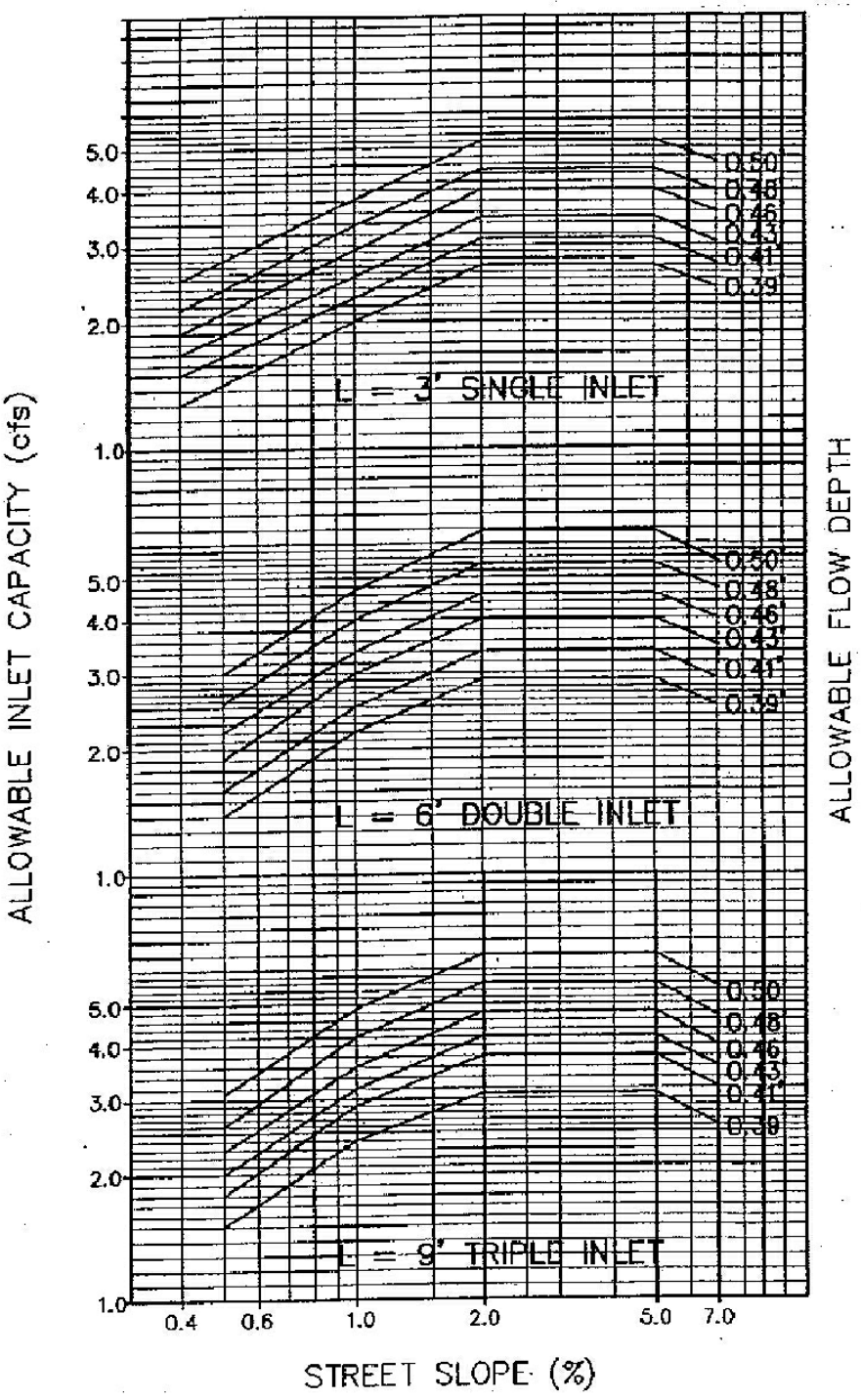
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

ALLOWABLE INLET CAPACITY TYPE R CURB OPENING ON A CONTINUOUS GRADE

March, 2010

FIGURE 7-6

NOT TO SCALE



NOTES:
1. ALLOWABLE CAPACITY = 60% THEORETICAL CAPACITY
2. MAXIMUM INLET CAPACITY AT MAXIMUM ALLOWABLE FLOW DEPTH. PROPORTIONALLY REDUCE FOR OTHER DEPTHS.

PV_DRAIN_P118.DWG

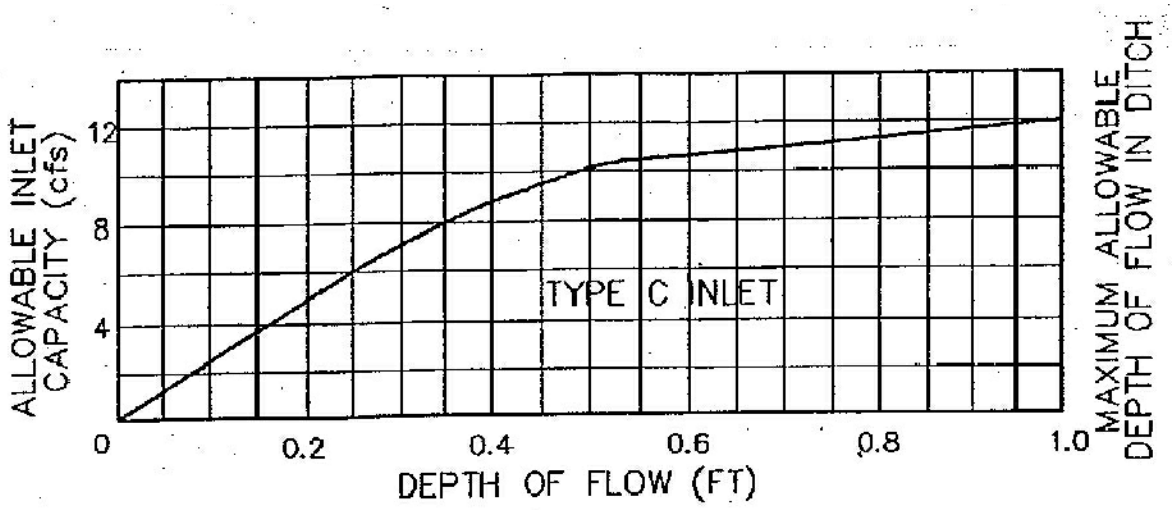
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

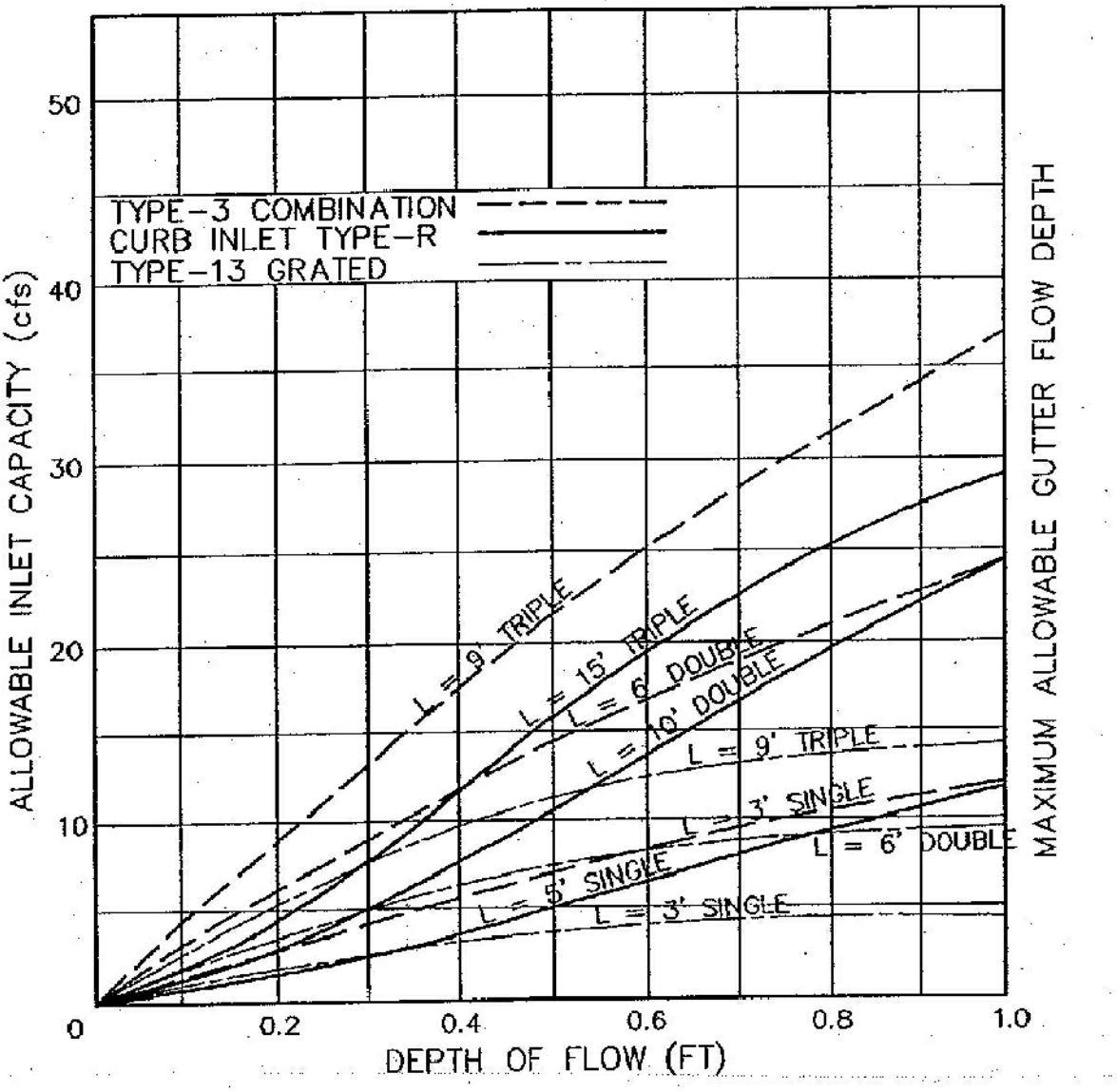
ALLOWABLE INLET CAPACITY TYPE 13 GRATED INLET ON A CONTINUOUS GRADE

March, 2010

FIGURE 7-7

NOT TO SCALE





PV_DRAIN_P119.DWG

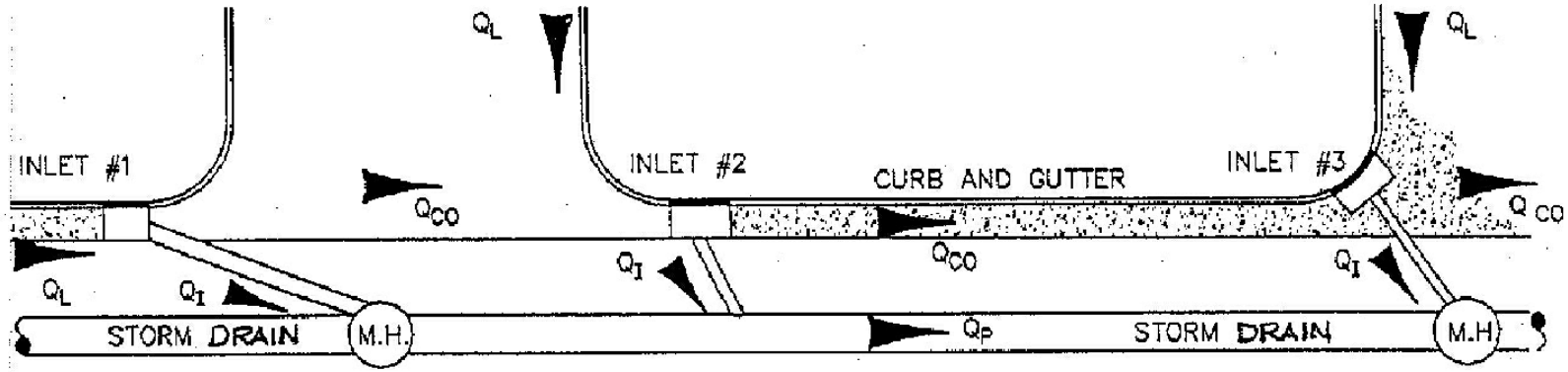
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

ALLOWABLE INLET CAPACITY SUMP CONDITIONS – ALL INLETS

FIGURE 7-8

March, 2010

NOT TO SCALE



LEGEND
- Q_L = LOCAL RUNOFF FOR DESIGN STORM TRIBUTARY TO DESIGNATED INLET (cfs)
- Q_I = RUNOFF INTERCEPTED BY INLET (cfs)
- Q_{CO} = CARRY OVER RUNOFF PAST INLET (cfs)
- Q_T = TOTAL RUNOFF AT INLET = $Q_L + Q_{CO}$
- Q_P = RUNOFF IN PIPE

SUMMARY OF FLOWS
FOR DESIGN EXAMPLE 3

INLET	Q^* ALLOW	Q_L	Q_{CO}	Q_T	Q_I	Q_{CO}	Q_P DRAIN	COMMENTS
NO. 1, 15' TYPE R	8.6	8	0	8	6.2	1.8	6.2	INLET ON GRADE
NO. 2, 10' TYPE R	7.2	4	1.8	5.8	3.8	2.0	10.0	INLET ON GRADE
NO. 3, 10' TYPE R	10.4	8	2.0	10.0	10.0	0	20.0	INLET IN SUMP CONDITION

* MAXIMUM ALLOWABLE INLET CAPACITY AT MAXIMUM ALLOWABLE GUTTER CAPACITY, FROM FIGURES – 7-6 AND 7-8

INLET DESIGN EXAMPLES
INITIAL STORM

FIGURE 7-9

March, 2010

NOT TO SCALE

PV_DRAIN_P120.DWG

SECTION 8.0 – STREETS
TABLE OF CONTENTS

TABLES & FIGURES LOCATED IN THE BACK OF SECTION 8.0

SECTION 8.0 STREETS

8.1 INTRODUCTION

The criteria presented in this section shall be used in the evaluation of the allowable drainage encroachment within public streets. The review of all submittals shall be based on the criteria herein.

8.2 FUNCTION OF STREETS IN THE DRAINAGE SYSTEM

Urban and rural streets, specifically the curb and gutter or the roadside ditches, are part of the storm drainage system. When the drainage in the street exceeds allowable limits, a storm drain system or an open channel is required to convey the excess flows. However, the primary function of the urban street system is for traffic movement, and, therefore, the drainage function is secondary and must not interfere with the traffic function of the street.

Design criteria for collecting and moving runoff water on public streets are based on a reasonable frequency and magnitude of traffic interference. Depending on the character of the street, certain traffic lanes can be inundated during specific design storm runoff events. The primary function of the streets during the initial storm runoff event is to convey the nuisance flows quickly and efficiently to the storm drain or open channel drainage without interference with traffic movement. During the major storm runoff event the function of the streets is to provide a passageway for the flood flows with minimal damage to the urban environment, and passage of emergency vehicles.

8.3 STREET CLASSIFICATIONS AND CAPACITY LIMITATIONS

8.3.1 STREET CLASSIFICATIONS

The streets in the Town are classified for drainage use according to the average daily traffic (ADT) for which the street is designed and the adopted Town classifications. The larger the ADT, the more restrictive the allowable drainage encroachment into the driving lanes is. Refer to the Town of Platteville Standard Details and "Street Design Criteria" for specific dimensions and cross sections of each street classification. The adopted Town of Platteville classifications are summarized in the following table:

TABLE 8.3.1 - TOWN OF PLATTEVILLE STREET CLASSIFICATIONS

Classification	Width (Flow line to Flow line)	Town of Platteville Standard Detail No.*
Local – Residential	30'	S-1
Minor Collector	38'	S-3
Major Collector	44'	S-4

* Reference: See Town of Platteville Street Design Criteria Manual for Standard Detail Nos. S-1 to S-4.

8.3.2 STREET CAPACITY- INITIAL STORM

The street capacity for initial storm runoff events is determined by the limitations set forth below:

TABLE 8.3.2 - STREET CAPACITYFOR INITIAL STORM or MINOR STORM RUNOFF

Street Classification	Curb Overtopping Allowed	Maximum Pavement Encroachment
Local Residential w/drive over curb	No	Flow may spread to crown of street
Local Residential W/ vertical face curb	No	Flow may spread to crown of street
Minor Collector	No	Flow must leave a minimum 10' wide center lane open
Major Collector	No	Flow must leave a minimum 10' wide center lane open

8.3.3 STREET CAPACITY- MAJOR STORM

The street capacity during major storm events is determined by the limitations set forth below:

TABLE 8.3.3 - STREET CAPACITYFOR MAJOR STORM RUNOFF[1]

Street Classification	Maximum Depth At Gutter Flow line	Maximum Depth at Crown	Allowable Inundation
Local Residential w/ drive over curb	18"	N/A	No inundation at groundline[2]
Local Residential W/ vertical face curb	18"	N/A	No inundation at groundline[2]

Minor Collector	18"	N/A	No inundation at groundline[2]
Major Collector	18"	N/A	No inundation at groundline[2]

Notes:

[1]Most restrictive condition shall control design

[2]Includes inundation of residential dwellings, public, commercial and industrial buildings

8.4 HYDRAULIC EVALUATION FOR STREET CAPACITY

8.4.1 ALLOWABLE STREET CAPACITY- INITIAL STORMS

The determination of the Allowable Street Capacity shall be based on the following procedure: determine the Theoretical Capacity based on the street cross section; compute the street flow; then, apply the appropriate reduction factor to calculate the Allowable Street Capacity.

Based on the Maximum Pavement Encroachment for the various street classifications presented in Section 8.3, the Theoretical Capacity of each street section is calculated using the Modified Manning's formula shown below:

$$Q = (0.56)\,(Z/n)S^{1/2}d^{8/3} \qquad \textbf{Equation 8.4.1}$$

Where: Q = discharge in cfs
Z = $1/S_x$, where S_x is the cross slope of the pavement (ft/ft)
d = depth of water at face of curb (feet)
S = longitudinal grade of street (ft/ft)
n = Manning's roughness coefficient

Note: This equation does not pertain to streets with borrow ditches. Also, the solution to the above equation can be obtained through the use of the nomograph (Figure 8-1 and included for information only).

The Allowable Capacity of a Street Section is then calculated by multiplying the Theoretical Capacity by the appropriate reduction factor found in Figure 8-2. The purpose of the reduction factor is to account for various street conditions, which decrease the street capacity. These conditions may include street overlays, parked vehicles, debris and hail accumulation, and deteriorated pavement.

The Designer will find the Allowable Street Capacity already calculated in Table 8-1 for several of the standard, symmetrical street sections. The calculations were performed for

various allowable flow depths and street slopes. A Manning's n-value of 0.016 was used for the calculations at all street slopes.

The Designer shall calculate the Theoretical Capacity using equation 8.4.1, then calculate the Allowable Street Capacity by multiplying the Theoretical Capacity obtained, by the appropriate reduction factor found in Figure 8-2. These street options shall meet the requirements specified in the Street Capacity for Initial Storm Runoff depending on ADT and Street Classification (Contact Traffic Division for this information). These calculations shall be included in the Drainage Report.

The Allowable Street Capacity will also need to be reduced if non-symmetrical street sections are encountered. Street capacity calculations at critical locations of non-symmetrical street sections shall be submitted in the Drainage Report.

8.4.2 ALLOWABLE STREET CAPACITY- MAJOR STORMS

The street capacity for the major storm is determined by the depth and inundation limits set forth in Section 8.3.3. The Allowable Street Capacity is found by using the same procedure outlined in Section 8.4.1 with one exception due to the addition of grass areas. A weighted Manning's n for the entire roadway cross-section will be used in Equation 8.4.1 to find the maximum theoretical flowrate – Q.

Again, the Designer will find the Allowable Street Capacity already calculated in Table 8-1 for several of the Town's standard, symmetrical street sections. A Manning's value of 0.016 for the pavement and sidewalk areas and 0.033 for the grass area was used to determine capacity. The maximum allowable depth at the gutter flowline is 18 inches.

For non-symmetrical streets, such as shown in Figure 8-13, street capacity calculations shall be performed at all critical locations and shall be submitted to the Town for review. The computed street capacity must never exceed the allowable street capacity presented in these criteria.

8.4.3 RURAL STREETS (LOCAL, LOW-VOLUME STREETS WITHOUT CURB AND GUTTER)

Rural streets are characterized by the use of roadside ditches instead of curb and gutters. The capacity is limited by the depth in the ditch and the maximum flow velocity. Refer to Section 5.4 for the design and capacity of roadside ditches.

8.5 ALLOWABLE STREET CROSS-FLOW CONDITIONS

8.5.1 CROSS STREET FLOW AT INTERSECTIONS

Cross street flow normally occurs at converging street intersections where the flow must cross from one side to the other in either a cross pan (where allowed) or across the street crown. The restrictions for flow depth at intersections are set forth below:

TABLE 8.5.1 - ALLOWABLE CROSS STREET FLOW AT INTERSECTIONS		
Street Classification	**Initial Storm or Minor Storm Runoff**	**Major Storm Runoff**
Local w/ drive over curb	Maximum 5" Depth at Street Crown or in Cross Pan	Maximum 18" Depth Above Gutter Flow line
Local w/ vertical curb	Maximum 6" Depth at Street Crown or in Cross Pan	Maximum 18" Depth Above Gutter Flow line
Minor Collector	Maximum 6" Depth Above Cross Pan Flow line (Where Cross Pan is Allowed)	Maximum 18" Depth Above Gutter Flow line
Major Collector	Maximum 6" Depth Above Cross Pan Flow line (Where Cross Pan is Allowed)	Maximum 18" Depth Above Gutter Flow line

8.5.2 STREET OVERTOPPING

In locations of culvert crossings, the opportunity for the flow in the drainage way to exceed the road culvert capacity

and subsequently overtop the crown of the street must be investigated. The restrictions for street overtopping are set forth below:

TABLE 8.5.2 - ALLOWABLE CULVERT OVERTOPPING		
Street Classification	**10-Year Storm Maximum Depth**	**Major Storm Maximum Depth[1.]**
Local	None	18" At The Gutter Flow line
Minor Collector	None	6" At The Street Crown
Major Collector	None	6" At The Street Crown

1. The maximum headwater for the 100-year design flows shall be 1.5 times the culvert diameter or 1.5 times the rise dimension for pipe shapes other than round.

8.6 DESIGN EXAMPLE – DETERMINATION OF STREET CAPACITY

GIVEN:

Street with a traffic classification of "Minor Collector" and a slope of 1.0 percent.

FIND:

Maximum allowable capacity for initial and major storm.

SOLUTION:

STEP 1: Determine the allowable depth:
From Section 8.3, for a Minor Collector, the maximum depth at the curb (without overtopping) would be 6" for the initial storm.

STEP 2: Determine the allowable initial storm gutter capacity:
From Table 8-1, for a "Minor Collector" with an allowable depth of 0.406 feet and a slope of 1.0 percent, read the allowable gutter capacity of 5.5 cfs.

STEP 3: Determine the allowable major storm street capacity:
From Table 8-1, for a "Minor Collector" with a slope of 1.0 percent, read the allowable capacity of 664 cfs for the full street section, assuming the street is symmetrical.

8.7 CHECKLIST

To aid the Designer and Reviewer, the following checklist has been prepared:

1. Determine the street classification first and then the allowable flow depth and gutter capacity.
2. Use the flattest street slope to determine the gutter capacity.
3. To calculate the allowable street flow, use the appropriate reduction factor (F) to calculate the allowable gutter capacity.
4. Check for non-symmetrical street evaluation.
5. Check for cross-flow conditions at intersections and allowable culvert overtopping depths.
6. Storm drains required when gutter capacity is exceeded.
7. Check adequacy of downstream facilities.

Local-Residential w/ 5" tall rollover curb						
Gutter Slope (ft/ft)	Reduction Factor (from Figure 8-2) Initial Storm	Mayor Storm	Initial Storm (half street) Theoretical Capacity w/ 4-3/4" of water above flow line (cfs)	Allowable Capacity w/ 4-3/4" of water above flow line (cfs)	Major Storm (full street) Theoretical capacity (cfs)	Allowable capacity (cfs)
(ft/ft)						
0.004	0.500	0.500	5.1	**2.6**	549	**275**
0.005	0.650	0.650	5.8	**3.7**	614	**399**
0.006	0.800	0.800	6.3	**5.0**	673	**538**
0.008	0.800	0.800	7.3	**5.8**	777	**622**
0.009	0.800	0.800	7.7	**6.2**	824	**659**
0.010	0.800	0.800	8.1	**6.5**	869	**695**
0.020	0.800	0.700	11.5	**9.2**	1229	**860**
0.040	0.610	0.500	16.3	**9.9**	1738	**869**
0.060	0.410	0.375	19.9	**8.2**	2128	**798**
0.080	0.280	0.270	23.0	**6.4**	2457	**663**

Local-Residential w/6" tall vertical curb						
Gutter Slope (ft/ft)	Reduction Factor (from Figure 8-2) Initial Storm	Mayor Storm	Initial Storm (half street) Theoretical Capacity w/ 5-1/8" of water above flow line (cfs)	Allowable Capacity w/ 5-1/8" of water above flow line (cfs)	Major Storm (full street) Theoretical capacity (cfs)	Allowable capacity (cfs)
(ft/ft)						
0.004	0.500	0.500	5.1	**2.6**	475	**238**
0.005	0.650	0.650	5.7	**3.7**	531	**345**
0.006	0.800	0.800	6.3	**5.0**	582	**466**
0.008	0.800	0.800	7.2	**5.8**	672	**538**
0.009	0.800	0.800	7.7	**6.1**	713	**570**
0.010	0.800	0.800	8.1	**6.5**	751	**601**
0.020	0.800	0.700	11.4	**9.1**	1062	**744**
0.040	0.610	0.500	16.2	**9.9**	1502	**751**
0.060	0.410	0.375	19.8	**8.1**	1840	**690**
0.080	0.280	0.270	22.9	**6.4**	2125	**574**

Minor Collector w/6" tall vertical curb						
Gutter Slope (ft/ft)	Reduction Factor (from Figure 8-2) Initial Storm	Mayor Storm	Initial Storm (half street) Theoretical Capacity w/ 4-7/8" of water above flow line (cfs)	Allowable Capacity w/ 4-7/8" of water above flow line (cfs)	Major Storm (full street) Theoretical capacity (cfs)	Allowable capacity (cfs)
(ft/ft)						
0.004	0.500	0.500	4.3	**2.2**	525	**263**
0.005	0.650	0.650	4.8	**3.1**	587	**382**
0.006	0.800	0.800	5.3	**4.2**	643	**514**
0.008	0.800	0.800	6.1	**4.9**	742	**594**
0.009	0.800	0.800	6.5	**5.2**	788	**630**
0.010	0.800	0.800	6.9	**5.5**	830	**664**
0.020	0.800	0.700	9.7	**7.8**	1174	**822**
0.040	0.610	0.500	13.7	**8.4**	1660	**830**
0.060	0.410	0.375	16.8	**6.9**	2033	**763**
0.080	0.280	0.270	19.4	**5.4**	2348	**634**

PV_DRAIN_P129.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

ALLOWABLE STREET FLOWS
TABLE 8-1

March, 2010

NOT TO SCALE

Major Collector w/6" tall vertical curb						
Gutter Slope (ft/ft)	Reduction Factor (from Figure 8-2)		Initial Storm (half street)		Major Storm (full street)	
	Initial Storm	Mayor Storm	Theoretical Capacity w/ 5-19/32" of water above flow line	Allowable Capacity w/ 5-19/32" of water above flow line	Theoretical capacity	Allowable capacity
(ft/ft)			(cfs)	(cfs)	(cfs)	(cfs)
0.004	0.500	0.500	6.9	**3.5**	558	**279**
0.005	0.650	0.650	7.8	**5.0**	624	**406**
0.006	0.800	0.800	8.5	**6.8**	684	**547**
0.008	0.800	0.800	9.8	**7.9**	790	**632**
0.009	0.800	0.800	10.4	**8.3**	837	**670**
0.010	0.800	0.800	11.0	**8.8**	883	**706**
0.020	0.800	0.700	15.5	**12.4**	1248	**874**
0.040	0.610	0.500	22.0	**13.4**	1766	**883**
0.060	0.410	0.375	26.9	**11.0**	2162	**811**
0.080	0.280	0.270	31.1	**8.7**	2497	**674**

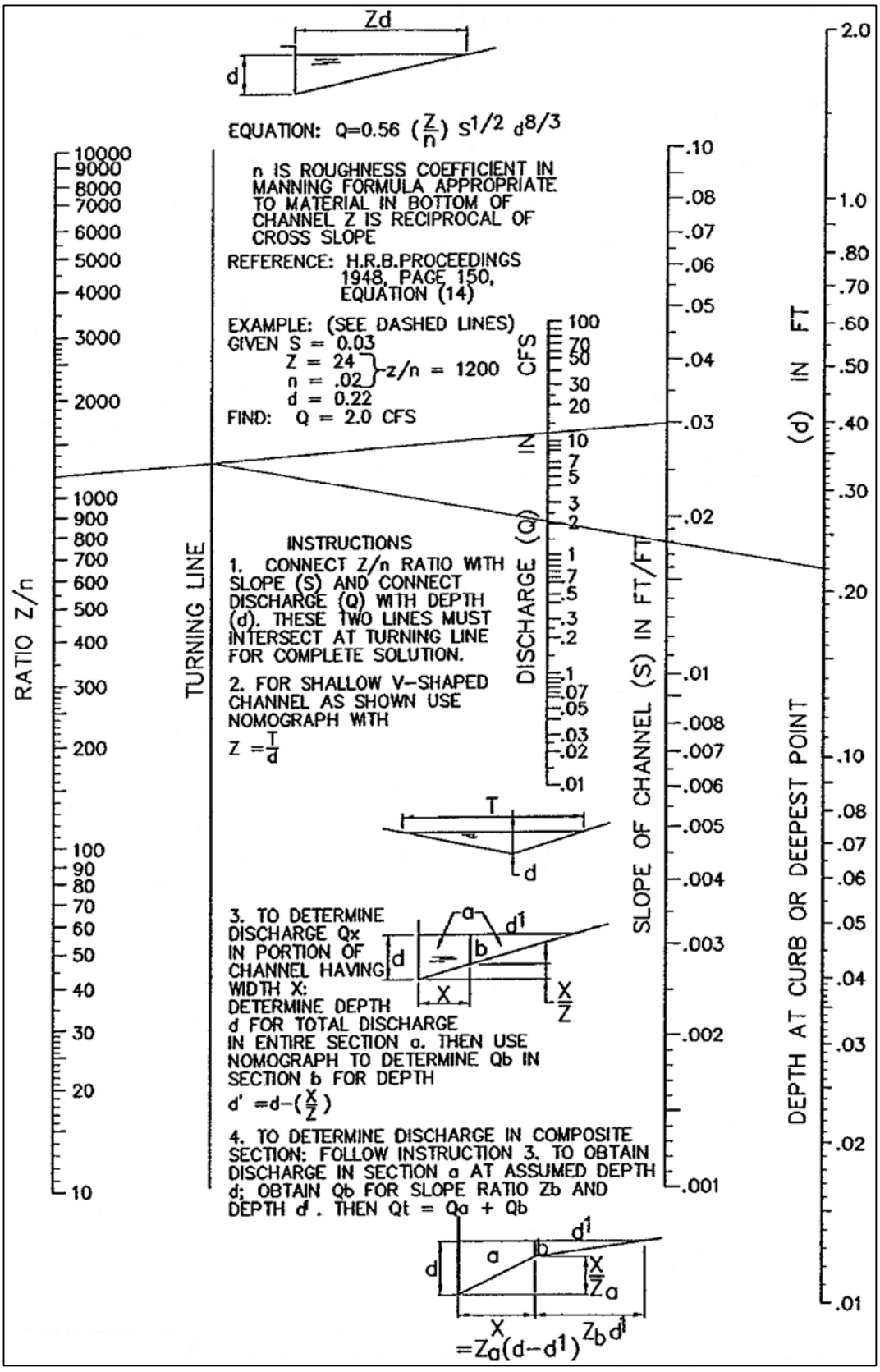
PV_DRAIN_P130.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

ALLOWABLE STREET FLOWS
TABLE 8-1A

March, 2010

NOT TO SCALE



PV_DRAIN_P132.DWG

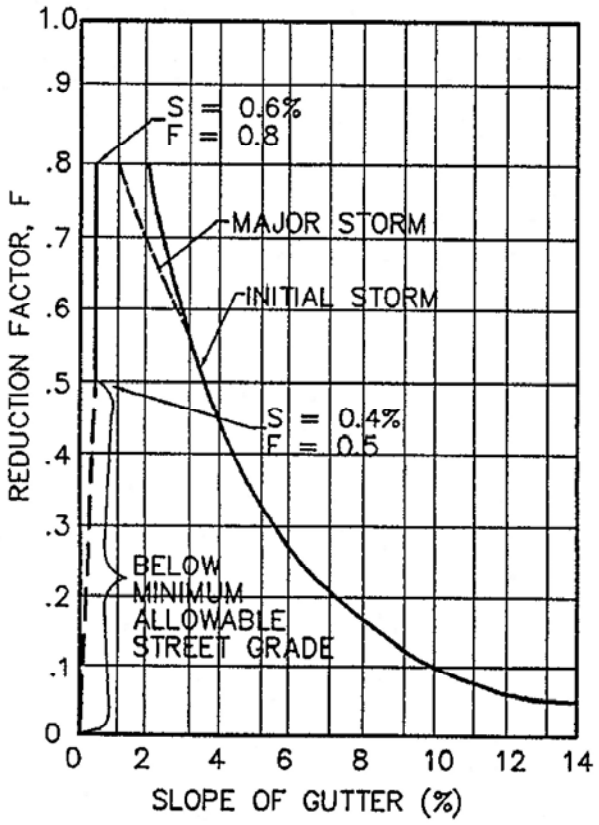
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS

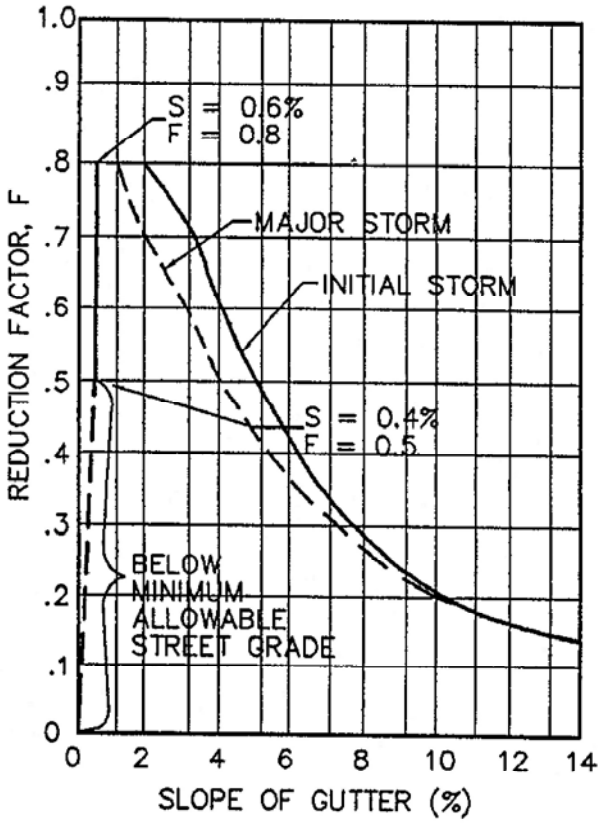
FIGURE 8-2

March, 2010

NOT TO SCALE



REDUCTION FACTOR FOR ALLOWABLE GUTTER CAPACITY WHEN APPROACHING AN ARTERIAL STREET



REDUCTION FACTOR FOR ALLOWABLE GUTTER CAPACITY LOCAL AND COLLECTOR STREETS

PV_DRAIN_P133.DWG

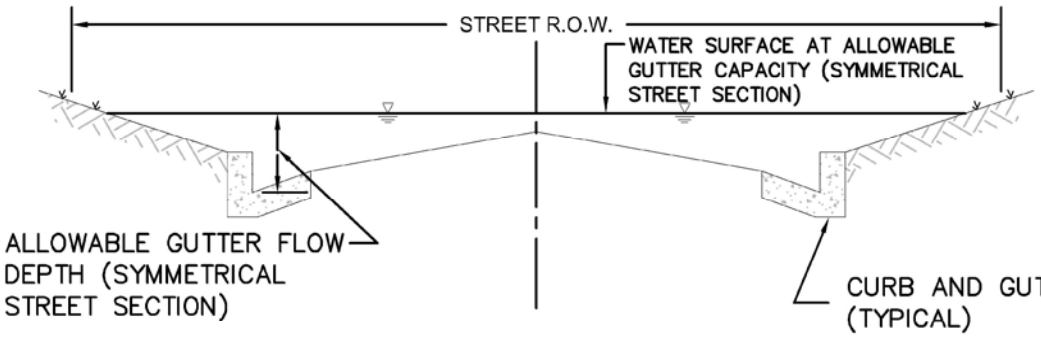
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

GUTTER CAPACITY REDUCTION CURVES

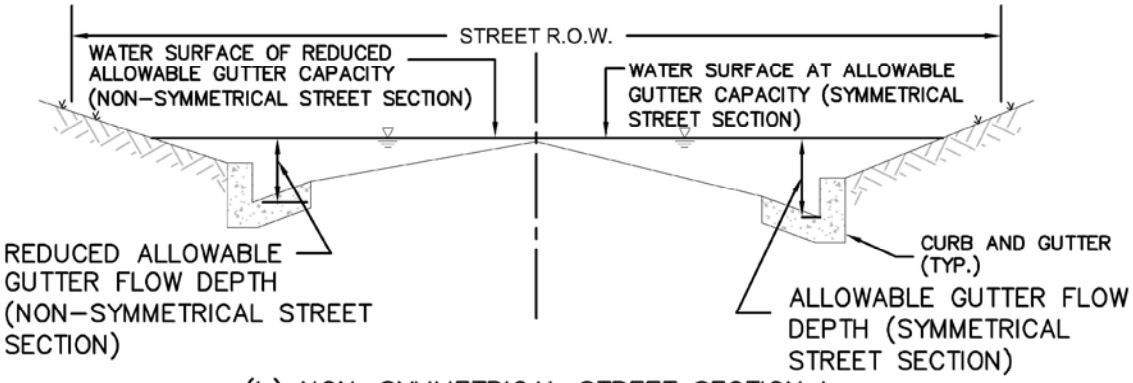
FIGURE 8-3

March, 2010

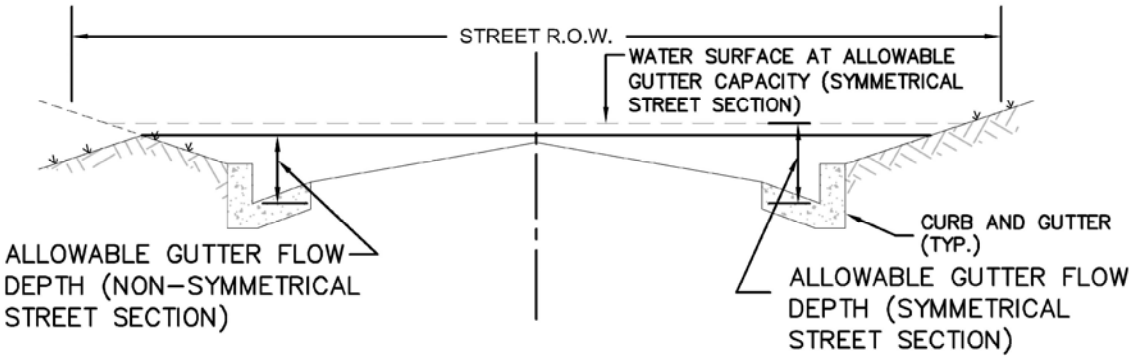
NOT TO SCALE



(a) SYMMETRICAL STREET SECTION



(b) NON-SYMMETRICAL STREET SECTION I



(c) NON-SYMMETRICAL STREET SECTION II

NOTE: FOR NON-SYMMETRICAL STREET SECTION, ADJUST THE TOTAL GUTTER CAPACITY BY REDUCING THE ALLOWABLE GUTTER CAPACITY FOR THE GUTTER WITH THE HIGHER FLOWLINE OR FOR THE ENTIRE SECTION WHEN PROPERTY LINE SLOPES ARE DIFFERENT.

PV_DRAIN_P144.DWG

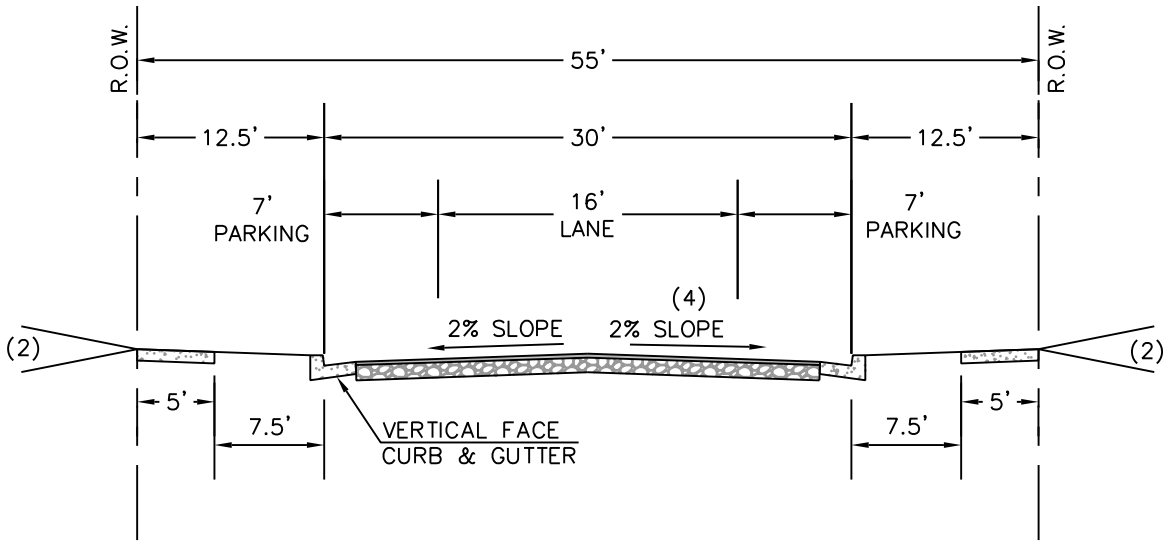
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

ADJUSTMENT FOR GUTTER CAPACITY WITH NON-SYMMETRICAL STREET SECTION MAJOR STORM

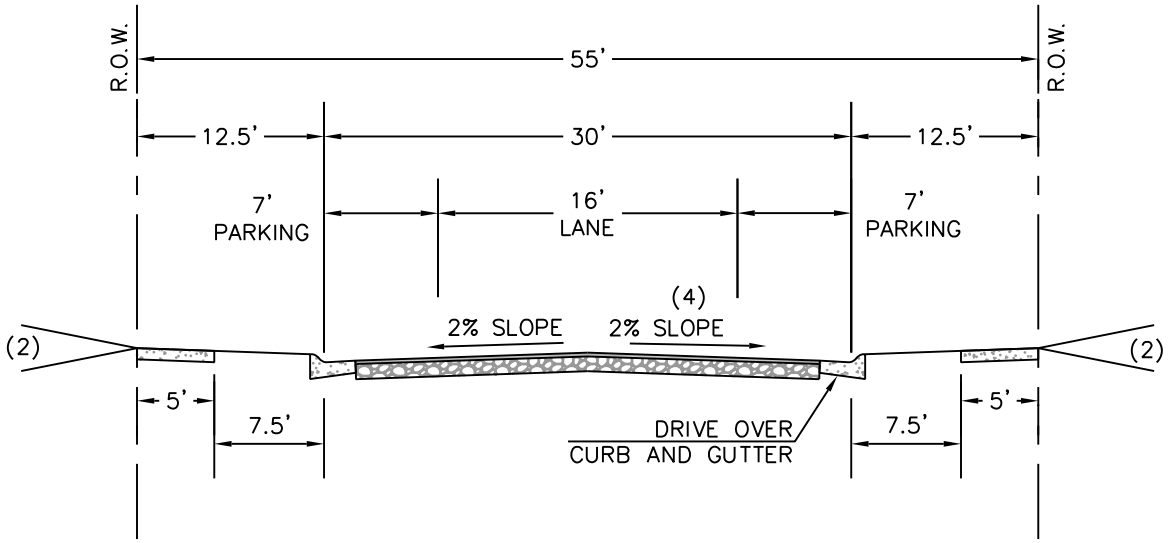
March, 2010

FIGURE 8-4

NOT TO SCALE



LOCAL - COMMERCIAL/INDUSTRIAL



LOCAL-RESIDENTIAL

NOTES:

1. PARKING ALLOWED ON BOTH SIDES OF STREET.
2. CUT AND FILL SLOPES SHALL BE A MAXIMUM OF 4:1.
3. RIGHT-OF-WAY AND EASEMENT AREAS SHALL BE GRADED (CUT AND FILL) TO SUBGRADE (+/-0.5') PRIOR TO AND AFTER UTILITY INSTALLATION.
4. NORMAL CROWN SLOPE IS 2%. WITH SPECIAL DESIGN REVIEW, 1% TO 5% IS ALLOWABLE AT TRANSITION AND OTHER NON-NORMAL SECTIONS.

LOCAL_RESIDENTIAL_S-1

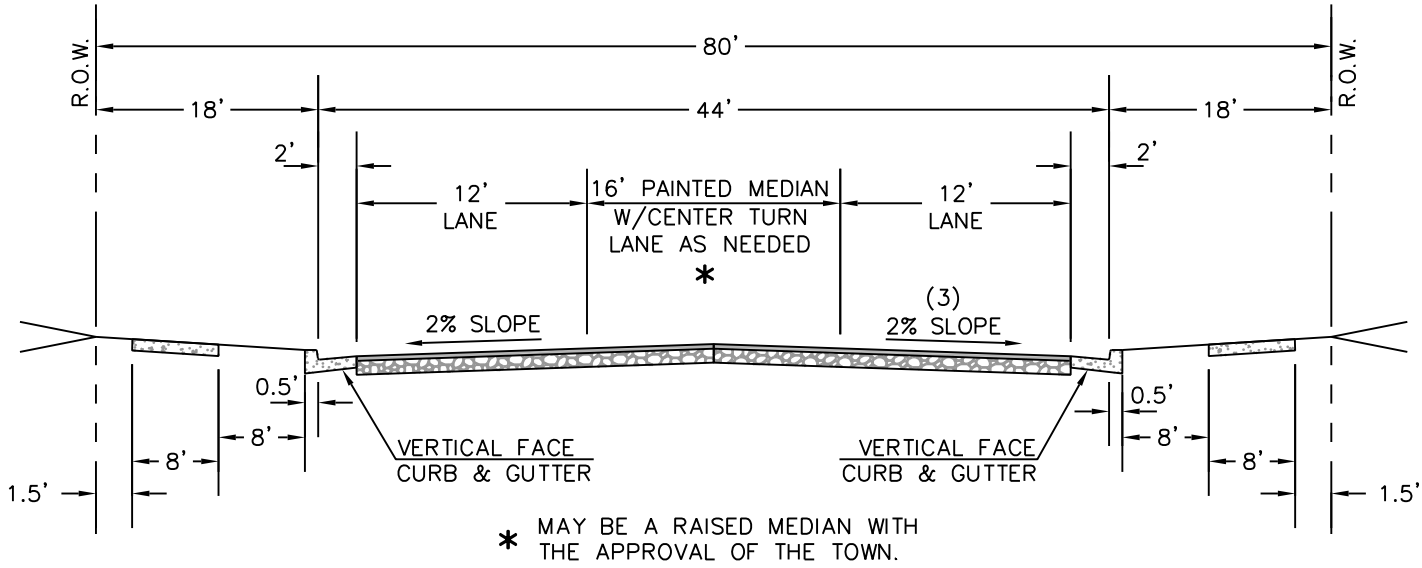
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

STANDARD ROADWAY SECTION
LOCAL STREET

FIGURE 8-5

March, 2010

NOT TO SCALE



TYPICAL SECTION

NOTES:

1. CUT AND FILL SLOPES SHALL BE A MAXIMUM OF 4:1.
2. RIGHT-OF-WAY AND EASEMENT AREAS SHALL BE GRADED (CUT AND FILL) TO SUBGRADE (+/-0.5') PRIOR TO AND AFTER UTILITY INSTALLATION.
3. NORMAL CROWN SLOPE IS 2%. WITH SPECIAL DESIGN REVIEW, 1% TO 5% IS ALLOWABLE AT TRANSITION AND OTHER NON-NORMAL SECTIONS.
4. ADDITIONAL RIGHT-OF-WAY WILL BE NEEDED FOR RIGHT TURN LANES WHERE WARRANTED.

MAJOR_COLLECTOR_S-4

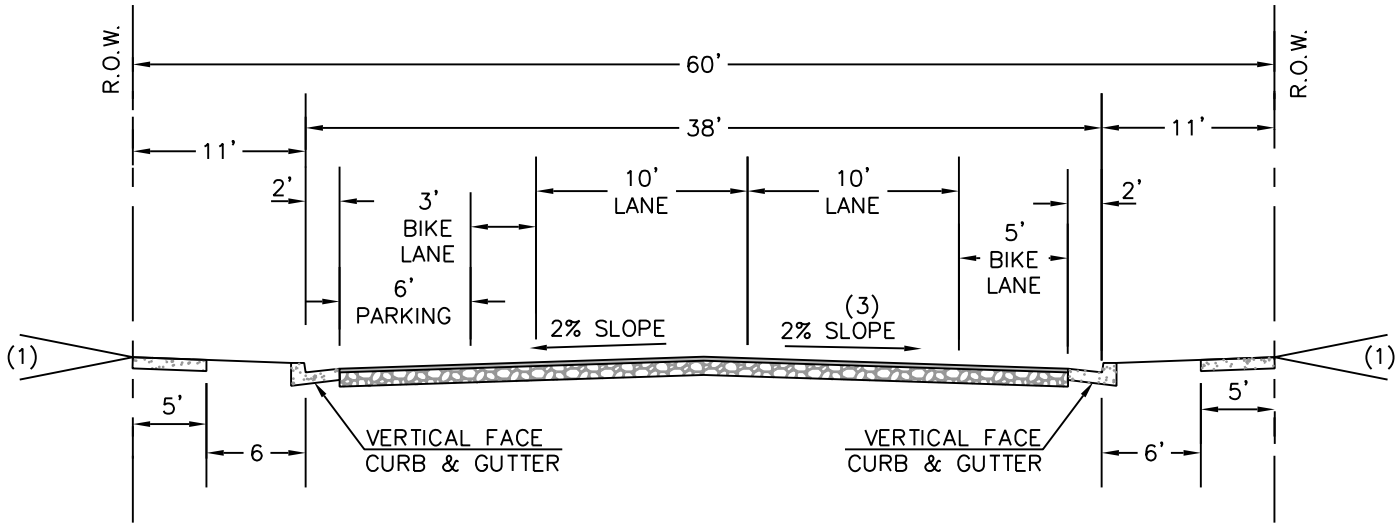
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

STANDARD ROADWAY SECTION
MAJOR COLLECTOR

FIGURE 8-6

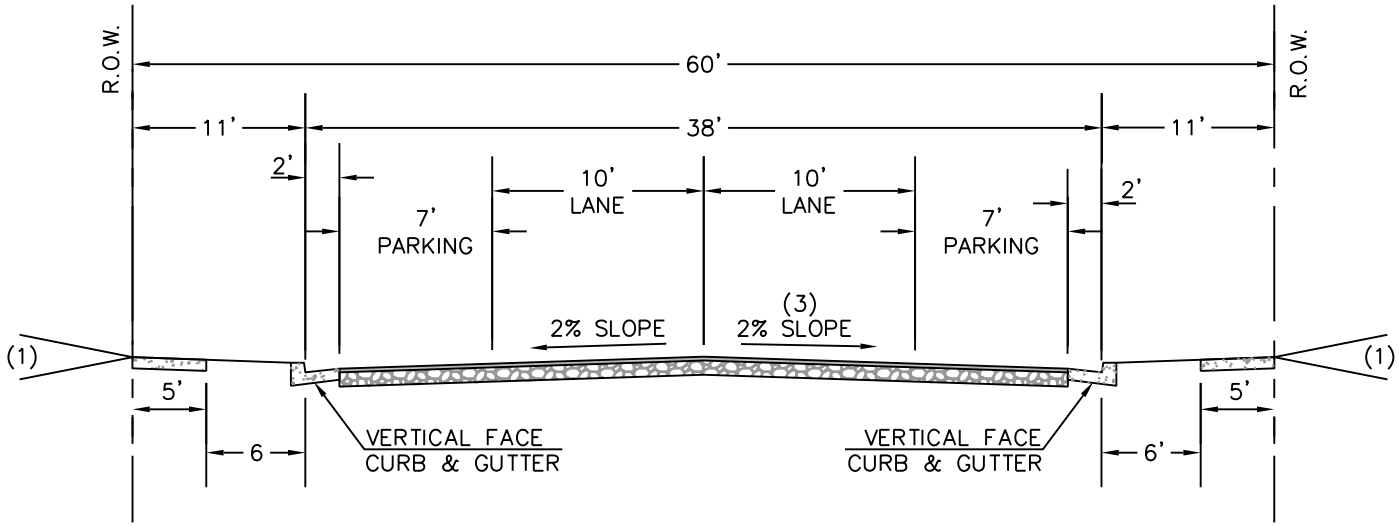
March, 2010

NOT TO SCALE



SIDEWALK AND BIKE LANES

ONE PARKING LANE



SIDEWALK AND NO BIKE LANES

TWO PARKING LANES

NOTES:

1. CUT AND FILL SLOPES SHALL BE A MAXIMUM OF 4:1.
2. RIGHT-OF-WAY AND EASEMENT AREAS SHALL BE GRADED (CUT AND FILL) TO SUBGRADE (+/-0.5') PRIOR TO AND AFTER UTILITY INSTALLATION.
3. NORMAL CROWN SLOPE IS 2%. WITH SPECIAL DESIGN REVIEW, 1% TO 5% IS ALLOWABLE AT TRANSITION AND OTHER NON-NORMAL SECTIONS.
4. WHERE THIS MINOR COLLECTOR IS ADJACENT TO SIDE LOTS OF SINGLE FAMILY RESIDENTIAL LOTS, THE PARKING LANE MAY BE REMOVED WITH TOWN APPROVAL. RIGHT-OF-WAY CAN BE REDUCED IN THIS INSTANCE WITH TOWN APPROVAL.

MINOR_COLLECTOR_S-3

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

STANDARD ROADWAY SECTION
MINOR COLLECTOR

FIGURE 8-7

March, 2010

NOT TO SCALE

SECTION 9.0 – CULVERTS
TABLE OF CONTENTS

SECTION 9.0 CULVERTS

9.1 INTRODUCTION

A culvert is defined as a conduit for the passage of surface drainage water under a street, highway, railroad, canal, or other embankment (except detention outlets). Culverts may be constructed with many shapes and materials. Reinforced concrete pipe (RCP) is available in round, elliptical, or arch cross sections, in sizes typically ranging from 12 inches to 108 inches in diameter.

Corrugated metal pipe (CMP), Aluminized Steel (ASP) and aluminum pipe culverts are available in round or arch cross sections. Sections of corrugated metal can also be bolted together to form several other cross sectional shapes, such as elliptical and pear shapes, forming structural plate pipe (SPP). Corrugations also come in various dimensions, which affect the hydraulics of the pipe flow.

Reinforced concrete box culverts (RCBC) can be constructed with generally any rectangular cross section, the only limitations being the physical site constraints and the structural requirements. Precast box culverts are also available in several standard dimensions.

9.2 CULVERT HYDRAULICS

The procedures and basic data to be used for the hydraulic evaluation of culverts in the Town shall be in accordance with the USDCM, Volume 2, Chapter, "Culverts", Section 2, Hydraulics, except as modified herein. The reader is also referred to the many texts and publications covering the subject for additional information.

9.3 CULVERT DESIGN STANDARDS

9.3.1 CONSTRUCTION MATERIAL AND PIPE SIZE

Within the Town, culverts shall be constructed from corrugated steel, Aluminized Steel (ASP), Plastic Pipe (PVC) or aluminum, reinforced concrete pipe or box culvert, or corrugated metal. Standards for the use of these materials are presented in Section 6 of these Criteria. Other materials for construction shall be subject to the approval of the Town Engineer. The minimum pipe size for culverts within a public ROW shall be a 24-inch diameter round culvert, or shall have a minimum cross sectional area of 2.8 ft^2 for arch shapes, and 3.3 ft^2 for elliptical shapes. Roadside ditch culverts for driveways shall be a minimum of 12-inch diameter round, or have a minimum cross sectional area of 0.79 ft^2.

9.3.2 INLET AND OUTLET CONFIGURATION

Within the Town, all culverts are to be designed with headwalls and wing walls or with flared-end sections at the inlet and outlet. Downstream flared-end sections shall require cut-off walls per Section 5.5. Flared-end sections are only allowed on pipes with diameters of 42 inches (or equivalent) or less.

Additional protection in the form of riprap or concrete will also be required at the inlet and outlet due to the potential scouring velocities. Refer to Sections 10.2 and 10.3.

Headwalls, wing walls, and flared-end sections should be designed and constructed to complement the existing landforms of the site and blend with the natural surrounding environment, to the greatest extent possible.

9.3.3 HYDRAULIC DATA

When evaluating the capacity of a culvert, the following data shall be used:

1. Roughness Coefficient: see Table 6-1 or 9-1.
2. Entrance Loss Coefficients: see Table 9-1.
3. Capacity Curves: There are many charts, tables, and curves in the literature for the computation of culvert hydraulic capacity. To assist in the review of the culvert design computations and to obtain uniformity of analysis, the following data shall be used:
   a. All culverts: USDCM, Vol.2, Chapter, "Culverts".
   b. Concrete Pipe: Concrete Pipe Design Manual, ACPA, Arlington, Virginia, latest edition.
   c. Corrugated Metal Pipe: "Handbook of Steel Drainage and Highway Construction Products", AISI, Washington, DC, latest editions.
   (Copies of product manuals may frequently be obtained through local pipe suppliers.)
4. Table 9-2 is to be used for determining culvert capacities. A design example is presented in Section 9-5 and shown on Table 9-3.

9.3.4 VELOCITY CONSIDERATIONS

In the design of culverts, both the minimum and maximum velocities must be considered. A minimum velocity of three feet per second at the outlet is required.

The maximum velocity is dictated by the channel conditions at the outlet. If the outlet velocities are less than 5 feet per second for grassed channels, then the minimum amount of protection is required due to the eddy currents generated by the flow transition. Higher outlet velocities will require substantially more protection. A maximum outlet velocity of 12 feet per second is recommended with erosion protection. Refer to Sections 10.2 and 10.3 for protection requirements at culvert outlets.

9.3.5 HEADWATER CONSIDERATIONS

The maximum headwater for the 100-year design flow will normally be 1.5 times the culvert diameter, or 1.5 times the culvert rise dimension for non-round shapes. Also, the headwater depth may be limited by the street overtopping requirements in Section 8. For headwater depths greater than 1.5, the applicant shall submit detailed calculations determining the outlet velocity. If the outlet velocity is greater than 12 fps, an energy dissipater will be required.

9.3.6 STRUCTURAL DESIGN

As a minimum loading, all culverts shall be designed to withstand an HS-20 loading (unless designated otherwise by the Town) in accordance with the design procedures of AASHTO, "Standard Specifications for Highway Bridges," and with the pipe manufacturers' recommendations.

9.3.7 TRASH RACKS

Due to differing site conditions, trash racks may be required at the entrance of culverts for some installations as designated by the Town. Trash racks are required for all pond outlets. Routine cleaning of the trash racks is required to remove the collection of debris. Trash racks are not typically required at entrances to culverts crossing local streets or at culverts within the right-of-way which cross driveways, unless a safety hazard is identified. Trash

racks are typically required at entrances to culverts in all other situations, for purposes of safety, water quality, and/or maintenance.

The following criteria shall be used for design of trash racks for storm drainage applications:

1. Materials: All trash racks shall be constructed with smooth steel pipe with a minimum 1.25 inches outside diameter. The trash rack ends and bracing should be constructed with steel angle sections. All trash rack components shall have a corrosion protective finish.

2. Trash Rack Design: All trash racks shall be constructed without cross braces (if possible) in order to minimize debris clogging. All trash racks shall be designed to carry a minimum load (live load) equal to 250 lbs/ft^2 or twice the hydraulic loading placed on the trash rack during a clogged condition at the 100 year storm event water elevation, whichever is greater. All trash racks shall also be hinged and removable for maintenance purposes.

3. Bar Spacing: Steel pipe bars shall be spaced with a maximum clear opening of six inches. In addition, the entire trash rack area shall have a minimum clear opening area (normal to the rack) at the design flow depth of two times or greater the culvert opening area, i.e. if the culvert open area is 12 ft^2 then the trash rack open area shall be two times (or greater) larger or 24 ft^2.

4. Trash Rack Slope: All trash racks shall have a longitudinal slope of no steeper than 2 horizontal to 1 vertical (2:1) for maintenance purposes.

5. Hydraulics: Hydraulic losses through trash racks shall be computed using the following equation:

$$H_T = 0.11 (TV/D^2) (\sin A)$$

Where: H_T = head loss through trash rack (feet)

T = thickness of trash rack bar (inches)
V = velocity normal to trash rack (fps)
D = center to center spacing of bars (inches)
A = angle of inclination of rack from horizontal

This equation shall apply to all racks constructed normal to the approach flow direction. The velocity normal to the trash rack shall be computed considering the rack to be 50 percent plugged.

9.4 CULVERT SIZING CRITERIA

The sizing of a culvert is dependent upon two factors, the drainage classification of the street (arterial, collector, local, etc.) and the allowable street overtopping. The allowable street overtopping is set forth in Section 8. No street overtopping shall occur for any street classification at a 10-year frequency design storm event.

Therefore, as the minimum design standard for street crossings, the following procedure shall be used.

1. Using the future developed conditions 100-year runoff, the allowable street overtopping shall be determined from overflow rating curves developed from the street profile crossing the waterway.

2. The culvert is then sized for the difference between the 100-year runoff and the allowable overtopping or for the minimum size to pass the 10 year storm event flow, whichever is greater.

The criteria are considered a minimum design standard and must be modified where other factors are considered more important. For instance, if the procedure still results in certain structures remaining in the 100-year floodplain, the design frequency may be increased to lower the floodplain elevation.

9.5 DESIGN EXAMPLE

The procedure recommended to evaluate existing and proposed culverts is based on the procedures presented in the Hydraulic Design Series, No. 5 (See Hydraulic Design of Highway Culverts, Hydraulic Design Series No. 5, Report No. FHWA IP-85-15, USDOT, FHWA, September 1985). The methodology consists of evaluating the culvert headwater requirements, assuming both inlet control and outlet control. The rating that results in the larger headwater requirements is the governing flow condition.

CULVERT RATING

A sample calculation for rating an existing culvert is presented in Table 9-3. The required data are as follows:

Culvert size, length, and type: 48" CMP, L = 150', n = 0.024
Inlet, outlet elevation, and slope: 5540.00, 5535.5, S_o = 0.03 ft/ft
Inlet treatment: flared-end section
Low point elevation of embankment: El = 5551.9
Tail water-rating curve: see Table 9-3, Column 5

From the data above, the entrance loss coefficient, Ke, and the "n" value are determined. The full flow Q and the velocity are calculated for comparison. The rating then proceeds in the following sequence:

STEP 1: Headwater values are selected and entered in Column 3. The headwater to pipe diameter ratio (H_w/D) is calculated and entered in Column 2. If the culvert is other than circular, the height of the culvert is used.
STEP 2: For the H_w/D ratios, the culvert capacities are read from the rating curves (refer to Section 9.3.3) and entered into Column 1. This completes the inlet condition rating.
STEP 3: For outlet conditions, the Q values in Column 1 are used to determine the head values (H) in Column 4 from the appropriate outlet control rating curves (refer to Section 9.3.3).
STEP 4: The tail water depths (T_w) are entered into Column 5 for the corresponding Q values in Column 1 according to the tail water-rating curve (i.e., downstream channel rating computations). If a tail water-rating curve is not available, then the tail water can be approximated by calculating the normal depth for each flow value using the trapezoidal section (noted on Table 9-3). If the tail water depth (T_w) is less than the diameter of the culvert (D), Columns 6 and 7 are to be calculated (go to Step 5). If T_w is more than D, the tail water values in Column 5 are entered into Column 8 for the h_o values, and proceed to Step 6.
STEP 5: The critical depth (d_c) for the corresponding Q values in Column 1 is entered into Column 6. The average of the critical depth and the culvert diameter is calculated and entered into Column 7 as the h_o value.

STEP 6:The headwater values (H_w) are calculated according to the equation:

$$H_w = H + h_o - LS_o \qquad \text{Equation 9.5}$$

Where H is from Column 4, and h_o is from Column 8 (for $T_w > D$) or the larger value between Column 5 and Column 7 (for $T_w < D$). The values are entered into Column 9.

STEP 7: The final step is to compare the headwater requirements (Columns 9 and 3) and to record the higher of the two values in Column 10. The type of control is recorded in Column 11, depending upon which case gives the higher headwater requirements. The headwater elevation is calculated by adding the controlling H_w (Column 10) to the upstream invert elevation. A culvert-rating curve can then be platted from the values in Columns 12 and 1.

To size a culvert crossing, the same form can be used with some variations in the basic procedures. First, a design capacity is selected and the maximum allowable headwater is determined. An inlet type (i.e., headwall) is selected, and the invert elevations and culvert slope are estimated based upon site constraints. A culvert type is then selected and first rated for inlet control and then for outlet control.

If the controlling headwater exceeds the maximum allowable headwater, a different culvert configuration is selected and the procedure is repeated until the desired results are achieved.

9.6 CHECKLIST

To aid the Designer and Reviewer the following checklist has been prepared:

1. Minimum culvert size within the public ROW is 24-inch diameter round, or equivalent for other shapes.
2. Minimum culvert size for roadside ditches at driveways is 12-inch diameter round, or equivalent for other shapes.
3. Headwalls, wing walls, or flared-end sections are required for all culverts.
4. Check outlet velocity and provide adequate erosion protection.
5. Check maximum headwater for design condition.
6. Verify structural requirements.

HYDRAULIC DATA FOR CULVERTS

(A) VALUES OF COEFFICIENT OF ROUGHNESS (n) FOR STANDARD CORRUGATED STEEL PIPE (MANNING'S FORMULA

CORRUGATIONS	ANNULAR 2 ⅔" X ½"	HELICAL															
		1½" X ¼"		2 ⅔" X ½"													
FLOWING:	DIAMETERS	8"	10"	12"	15"	18"	24"	30"	36"	42"	48"	54" AND LARGER					
FULL-UNPAVED	0.024	0.012	0.014	0.011	0.012	0.013	0.015	0.017	0.018	0.019	0.020	0.021					
FULL-25% PAVED	0.021						0.014	0.016	0.017	0.018	0.020	0.019					
PART FULL-UNPAVED	0.027			0.012	0.013	0.015	0.017	0.019	0.020	0.021	0.022	0.023					
FLOWING:	PIPE ARCH				17 X 13	21 X 15	28 X 20	35 X 24	42 X 29	49 X 33	57 X 38	64" X 43" AND LARGER					
FULL-UNPAVED	0.026				0.013	0.014	0.016	0.018	0.019	0.020	0.021	0.022					
PART FULL	0.029				0.018	0.019	0.021	0.023	0.024	0.025	0.025	0.026					
FLOWING:	ANNUALAR 3"X1"	HELICAL 3" X 1"															
									36"	42"	48"	54"	60"	66"	72"	78" AND LARGER	
FULL-UNPAVED	0.027								0.022	0.022	0.023	0.023	0.024	0.025	0.026	0.027	
25% PAVED	0.023								0.019	0.019	0.020	0.020	0.021	0.022	0.022	0.023	
FLOWING:	ANNULAR 5"X1"	HELICAL 5" X 1"															
											48"	54"	60"	66"	72"	78" AND LARGER	
FULL-UNPAVED	0.025										0.022	0.022	0.023	0.024	0.024	0.025	
25% PAVED	0.022										0.019	0.019	0.020	0.021	0.021	0.022	
ALL PIPE WITH SMOOTH INTERIOR *		ALL DIAMETERS 0.012															

* INCLUDES FULL PAVED, CONCRETE LINED, SPIRAL RIB AND DOUBLE WALLL PIPE. REFERENCE 13 MODIFIED FOR LOWER VALUES OF n FOR HELICAL PIPE. SEE HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS BY THE AMERICAN IRON AND STEEL INSTITUTUE, 1994 OR LATEST EDITION.

NOTE: COEFFICIENT VALUES SHALL CONFORM TO THE HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS 1994 OR LATEST EDITION BY THE PUBLISHED BY THE AMERICAN IRON AND STEEL INSTITUTE.

HYDRAULIC DATA FOR CULVERTS

(B) MANNING'S n-VALUES FOR STRUCTURAL PLATE METAL PIPE

CORRUGATIONS 6"X2"	DIAMETER			
	5 FT	7 FT	10 FT	15 FT
PLAIN-UNPAVED	0.033	0.032	0.030	0.028
25% PAVED	0.028	0.027	0.026	0.024

(C) MANNING'S n-VALUES FOR CONCRETE PIPE / CULVERT

PRE-CAST	0.012
CAST-IN-PLACE	------
WITH STEEL FORMS	0.013
WITH WOOD FORMS	0.015

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

HYDRAULIC DATA FOR CULVERTS (CONTINUED)

TABLE 9-1

March, 2010

NOT TO SCALE

HYDRAULIC DATA FOR CULVERTS

(D) CULVERT ENTRANCE LOSSES

TYPE OF ENTRANCE	ENTRANCE COEFFICIENT, Ke
PIPE	
HEADWALL	
GROOVED EDGE	0.20
ROUNDED EDGE (0.15D RADIUS)	0.15
ROUNDED EDGE (0.25D RADIUS)	0.10
SQUARE EDGE (CUT CONCRETE AND CMP)	0.40
HEADWALL AND 45° WINGWALL	
GROOVED EDGE	0.20
SQUARE EDGE	0.35
HEADWALL WITH PARALLEL WINGWALLS SPACED 1.25 D APART	
GROOVED EDGE	0.30
SQUARE EDGE	0.40
BEVELED EDGE	0.25
PROJECTING ENTRANCE	
GROOVED EDGE (RCP)	0.25
SQUARE EDGE (RCP)	0.50
SHARP EDGE, THIN WALL (CMP)	0.90
SLOPING ENTRANCE	
MITERED TO CONFORM TO SLOPE	0.70
FLARED-END SECTION	0.50
BOX, REINFORCED CONCRETE	
HEADWALL PARALLEL TO EMBANKMENT (NO WINGWALLS)	
SQUARE EDGE ON 3 EDGES	0.50
ROUNDED ON 3 EDGES TO RADIUS OF 1/12 BARREL DIMENSION	0.20
WINGWALLS AT 30° TO 75° TO BARREL	
SQUARE EDGE AT CROWN	0.40
CROWN EDGE ROUNDED TO RADIUS OF 1/12 BARREL DIMENSION	0.20
WINGWALLS AT 10° TO 30° TO BARREL	
SQUARE EDGE AT CROWN	0.50
WINGWALLS PARALLEL (EXTENSION OF SIDES)	
SQUARE EDGE AT CROWN	0.70

NOTE: THE ENTRANCE LOSS COEFFICIENTS ARE USED TO EVALUATE THE CULVERT OR PIPE CAPACITY OPERATING UNDER OUTLET CONTROL.

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

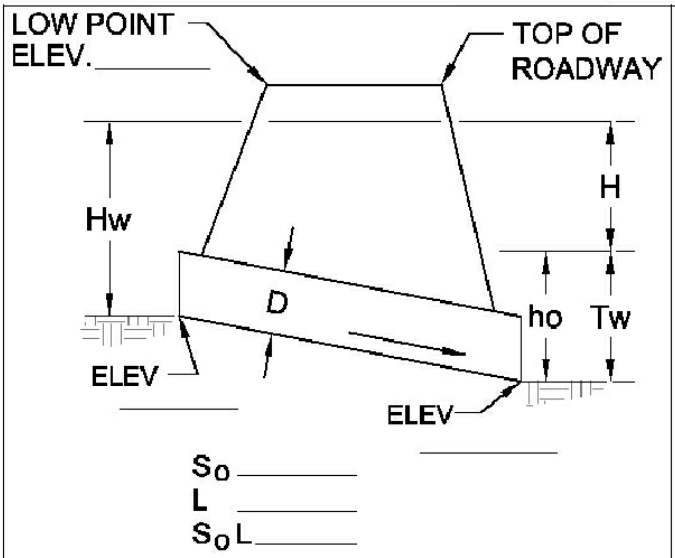
HYDRAULIC DATA FOR CULVERTS (CONTINUED)

TABLE 9-1

March, 2010

NOT TO SCALE

PROJECT _____ LOCATION _____ STATION _____



S_o _____
L _____
$S_o L$ _____

CULVERT DATA

TYPE _____ n _____
INLET _____ Q_{FULL} _____
Ke _____ V_{FULL} _____

OUTLET CONTROL EQUATIONS

(1) $Hw = H + h_o - LS_o$

(2) FOR $Tw < D$; $h_o = \frac{d_c + D}{2}$ OR Tw (WHICHEVER IS GREATER)

$Tw > D$; $h_o = Tw$

(3) FOR BOX CULVERT: $d_c = 0.315(Q/B)^{2/3} \leq D$

Q	INLET CONTROL		OUTLET CONTROL						CONT Hw	CONTROL	ELEV
	$\frac{Hw}{D}$	Hw	H	Tw	Tw < D		Tw > D	Hw			
					d_c	$\frac{d_c + D}{2} = h_o$	h_o				
1	2	3	4	5	6	7	8	9	10	11	12

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

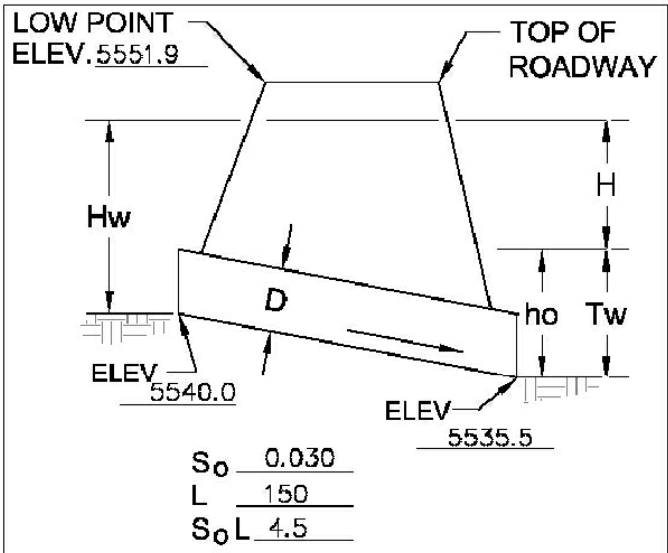
CULVERT RATING
TABLE 9-2

March, 2010

NOT TO SCALE

CULVERT RATING

PROJECT EXAMPLE LOCATION STATION GREELEY, CO



S_o 0.030
L 150
$S_o L$ 4.5

CULVERT DATA

TYPE 48" CMP n 0.024
INLET FLARED END SECTION Q_{FULL} 135
Ke 0.5 V_{FULL} 10.7

OUTLET CONTROL EQUATIONS

(1) $Hw = H + h_o - LS_o$

(2) FOR $Tw < D$; $h_o = \frac{d_c + D}{2}$ OR Tw (WHICHEVER IS GREATER)

$Tw > D$; $h_o = Tw$

(3) FOR BOX CULVERT: $d_c = 0.315(Q/B)^{2/3} \leq D$

Q	INLET CONTROL		OUTLET CONTROL						CONT Hw	CONTROL	ELEV
	Hw/D	Hw	H	Tw	Tw < D		Tw > D	Hw			
					d_c	$\frac{d_c + D}{2} = ho$	ho				
1	2	3	4	5	6	7	8	9	10	11	12
70	1.0	4	1.9	1.5	2.5	3.3		0.7	4	INLET	5544.0
115	1.5	6	5.5	2.0	3.0	3.5		4.5	6	INLET	5546.0
145	2.0	8	8.9	2.5	3.4	3.7		8.1	8.1	OUTLET	5548.8
170(1)	2.5	10	12.5	3.0	3.7	3.9		11.9	11.9	OUTLET	5551.9
195(2)	3.0	12	16.0	3.5	4.0	4.0		15.5	15.5	OUTLET	5555.5

OUTLET VELOCITY, V=Q/A =170 cfs^2 / 12.6 ft = 13.5 fps

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

EXAMPLE OF STANDARD FORM 400-SF4

TABLE 9-3

March, 2010 NOT TO SCALE

SECTION 10.0 – HYDRAULIC STRUCTURES
TABLE OF CONTENTS

SECTION 10.0 - HYDRAULIC STRUCTURES

10.1 EROSION CONTROL

Hydraulic structures are used in storm drainage design to control the flow of the runoff. The energy associated with flowing water has the potential to create damage to the drainage infrastructure, especially in the form of erosion. Hydraulic structures, which include rock riprap revetment, energy dissipators, check structures, bridges, and irrigation ditch crossings, all control the energy and minimize the damage potential of storm runoff.

The criteria to be used in the design of hydraulic structures shall be in accordance with the USDCM, Volume 1, "Major Drainage" and Volume 2, "Hydraulic Structures". The specific criteria to be used within the Town of Platteville are summarized in the following information.

10.2 ROCK RIPRAP REVETMENT

The design of the riprap protection for culverts, channel bottom and banks, check drops, bridges, gabions, or other areas subject to erosion, shall be in accordance with the latest revisions of the USDCM, Volume 1, "Major Drainage."

10.3 ENERGY DISSIPATORS

Where riprap structures are insufficient to control the storm runoff, concrete energy dissipator structures (stilling basins) shall be provided in accordance with the USDCM, Volume 2 "Hydraulic Structures."

For culverts or storm drains where the Froude Number at the outlet is in excess of 2.5, the USBR Type VI impact-stilling basin shall be used.

10.4 CHECK STRUCTURES AND DROP STRUCTURES

As discussed in Section 5-Open Channels, there is a maximum permissible velocity for major design storm runoff in grass-lined channels. One of the more common methods of controlling the flow velocity is to reduce the channel invert slope. This requires a drop structure to make up for the elevation difference when the channel slope is reduced.

Design criteria for drop structures shall be in accordance with the USDCM, Volume 2, "Hydraulic Structures."

10.5 BRIDGES

Design of bridges within the Town shall be in accordance with the USDCM, Volume 2, "Hydraulic Structures." The design capacity of the bridge shall be determined by the method presented in Section 9.4 of these Criteria. Overtopping of a bridge during the Major Storm Event is not allowed.

Breakaway type bridges are required for pedestrian bridges within floodplains with maximum loading of 10,000 pounds or less. They shall have a tether six times the strength of the total bridge weight plus its maximum loading to keep the bridge from floating away. Reference the Town of Platteville Comprehensive Plan for Pedestrian Trail Specifications and Guidelines.

10.6 IRRIGATION DITCH CROSSINGS

Any proposed developments in the vicinity of irrigation ditches and canals, crossing or utilizing the ditches or canals for surface drainage, shall have the plans approved by the controlling ditch company prior to acceptance by the Town.

SECTION 11.0 DETENTION
TABLE OF CONTENTS

TABLES & FIGURES LOCATED IN THE BACK OF SECTION 11.0

SECTION 11.0 - DETENTION

11.1 INTRODUCTION

The criteria presented in this section shall be used in the design and evaluation of all detention facilities for the Town. The review of all planning submittals (refer to Section 2) shall be based on the criteria presented in this section.

Detention facilities store excess runoff associated with an increase in basin imperviousness and discharge this excess at a rate similar to the rate experienced from the basin without development. It is intended that the detention facility protect downstream property and improvements, and avoid the overloading of storm drainage facilities located further downstream. If special design conditions exist that cannot be defined by this criteria, the designer shall bring these up with the Town during the review process.

The various detention methods are defined on the basis of where the facility is constructed: open space, parking lot, underground. The Town permits all methods of detention except for rooftop detention.

Detention facilities shall not be constructed within public right-of-way. The design high water level of detention ponds shall not encroach upon public right-of-way. For additional information see Section 1.2.

11.2 WATER QUALITY ENHANCEMENT

Refer to Section 12 – Stormwater Quality Enhancement - for guidelines to incorporate water quality considerations within the design and construction of detention ponds.

11.2.1 DRAINAGE MAINTENANCE

The property owner shall be responsible for maintenance of all drainage facilities installed pursuant to the development agreement and/or drainage easement agreement. Requirements include, but are not limited to maintaining the specified storm water detention/retention volumes, maintaining outlet structures, flow restriction devices and facilities needed to convey flow to said basin.

Long term operation and maintenance of detention ponds can be found in these Criteria in Section 12 – Stormwater Quality Enhancement.

11.3 STORAGE REQUIREMENTS

11.3.1 AREAS WITHOUT MASTER DRAINAGE PLANS

In basins where a master drainage plan has not been approved, the Town may require detention storage in accordance with this section to protect irrigation structures or downstream development. Stormwater runoff shall not be released from developments at a rate greater than the 5-year historical runoff. The amount of runoff detained on-site shall be the difference between the 100-year developed runoff and the 5-year historical runoff. In all cases, detention is required unless proven otherwise. For infill development the Town may allow the release from detention ponds to not exceed historic rates.

11.3.2 AREAS WITH MASTER DRAINAGE PLANS

Stormwater runoff shall be released from developments in accordance with the master drainage plan for the area. The release rates may vary from the 5-year historic to the 100-

year developed rate. Historic runoff is runoff which occurred under the physiographic conditions prior to any proposed development.

In cases where master drainage plans are approved but the improvements have not been constructed (i.e., an adequate outfall to protect downstream property) detention may be required until such time that the outfall is constructed.

11.3.3 VARIANCES

For any release rate greater than specified in either Sections 11.3 or 11.4, the Design Engineer requesting the variance shall analyze the downstream conditions in detail and show that no adverse effects will occur. This analysis shall include any and all information required by the Town. All calculations pertaining to the analysis shall be submitted for review (such as the volume and peak discharge calculations). This analysis shall be submitted to the Town in the preliminary and final drainage reports.

Examples of when detention requirements may be varied are: (a) if development occurring on the site decreases the percentage of impervious area already present, (b) if the latter phase of a subdivision is submitted and the previous phases have already met the detention requirements for the entire site, (c) if a Regional Pond capable of accepting the minimum required detention and water quality capture volume exists or (d) if development occurs adjacent to the South Platte River then detention may not be required. Any variances shall be approved by the Town and these areas must be thoroughly analyzed to show that no hazards will be created downstream.

Retention ponds are not acceptable unless there is no feasible method for draining the pond by gravity. If a retention pond is found to be the only alternative, the minimum volume of the facility must be adequate to retain the storm runoff from twice the 100-year developed storm event. Percolation/evaporation alone may be an accepted method for draining the pond, but percolation will not be acceptable in situations where an increase in groundwater flow as a result of pond percolation could cause an adverse impact upon structures with basements down gradient of the pond site. For any storm event, if the pond cannot be drained within 3 days permanent pumping facilities shall be required to drain the pond.

11.4 DESIGN CRITERIA

11.4.1 VOLUME AND RELEASE RATE

The minimum required volume shall be determined using either: (a) the Rational Formula Method; or (b) the CUHP method as documented in the USDCM Volume 2 "Storage" or the UD SWMM computer program. Utilization of the Rational Formula Method is restricted to basins less than or equal to 5 acres. For basins larger than 5 acres, detention volumes should be determined using the CUHP method or the UD SWMM computer program. Alternative computer programs for routing flows through detention facilities must be reviewed and approved by the Town prior to utilization.

For all detention facilities within the Town, the minimum volume of the facility must be adequate to detain the storm runoff from the 100-year developed storm event. Off-site flows may pass through the detention facility but not by over-sizing the orifice. Adequate spillway/outlet capacity shall be provided to safely pass these flows to downstream conveyance elements. Additional information related to minimum storage volumes and

maximum release rates from detention ponds can be obtained from the master drainage plans for each major drainage basin.

Procedures for the determination of the required detention volume using the Rational Formula Method are presented below.

Rational Formula Method

The cumulative runoff volume entering a detention pond is estimated by:

$V_{in} = CiAT$ Equation 11.4.1(1)

Where V_{in} = cumulative runoff volume, ft^3
C = runoff coefficient (per Urban Drainage)
i = storm's intensity taken from IDF curve at time T, inches per hour
A = tributary area, acres
T = storm duration, seconds

The cumulative volume leaving the basin is estimated

$V_{out} = kQ_{out}T$ Equation 11.4.1(2)

in which T is defined above and
V_{out} = cumulative volume of outflow, ft^3
Q_{out} = maximum outflow rate, cfs
k = outflow adjustment coefficient from Figure 11-1

In Figure 11-1, Qpin (peak inflow rate) is determined from the Rational Method Formula (Q=CiA).

The required detention volume is the maximum difference between the cumulative inflow and the cumulative outflow volumes or

$V = \max (V_{in} - V_{out})$ Equation 11.4.1(3)

As per Urban Drainage Design Guidelines, if the procedure results in an increasing storage volume at the end of two hours, use the 2-hour storage volume.

This procedure assumes a constant outflow rate which is the rate of discharge when the detention pond is full. Discharge varies, however, with the depth of water. This fact is partially compensated for by the outflow adjustment factor k.

11.4.2 DESIGN FREQUENCY

All detention facilities are to be designed to release not greater than the 5-year historical (prior to any development) peak runoff during the 100-year storm event.

11.4.3 HYDRAULIC DESIGN

Hydraulic design procedures for sizing a detention facility's outlet works are described below.

11.4.3.A WEIR FLOW

The general form of the equation for horizontal crested weirs is:

$$Q = CL(H)^{3/2} \qquad \text{Equation 11.4.3.A(1)}$$

Where Q = discharge (cfs)
C = weir coefficient (see Table 11-1)
L = horizontal length (feet)
H = total energy head (feet)

Another common weir is the v-notch, whose equation is as follows:

$$Q = 2.5 \tan(\Theta/2)H^{5/2} \qquad \text{Equation 11.4.3.A(2)}$$

Where Θ = angle of the notch at the apex (degrees)

When designing or evaluating weir flow, the effects of submergence must be considered. A single check on submergence can be made by comparing the tail water to the headwater depth. The example calculation for a weir design on Figure 11-2 illustrates the submergence check.

11.4.3.B ORIFICE FLOW

The equation governing the orifice opening and plate is the orifice flow equation:

$$Q = C_dA\,(2gh)^{1/2} \qquad \text{Equation 11.4.3.B}$$

Where Q = flow (cfs)
C_d= orifice coefficient
A = area (ft^2)
g = gravitational constant = 32.2 ft/sec^2
h = head on orifice measured from centerline (ft)

An orifice coefficient (Cd) value of 0.65 shall be used for sizing of all square edged orifice openings and plates (see Figure 11-4).

11.5 DESIGN STANDARDS FOR OPEN SPACE DETENTION

11.5.1 STATE ENGINEER'S OFFICE

Any dam constructed for the purpose of storing water, with a surface area, volume, or dam height as specified in Colorado Revised Statues 37-87-105 as amended, shall require the approval of the plans by the State Engineer's Office. Those detention storage facilities

subject to state statutes shall be designed and constructed in accordance with the criteria of the State.

11.5.2 GRADING REQUIREMENTS

Slopes on earthen embankments shall not be steeper than 4H:1V.

For grassed detention facilities, the minimum bottom slope shall be 1.0 percent, measured perpendicular to the trickle channel.

11.5.3 FREEBOARD REQUIREMENTS

The minimum required freeboard for detention facilities is one foot above the computed 100-year water surface hydraulic grade line elevation. The invert of the emergency spillway shall be placed at or above the computed on-site 100-year water surface elevation. The computed 100-year water surface hydraulic grade line elevation is defined as follows:

A flow situation for which the emergency spillway is passing the 100-year developed on-site flow plus the 100-year off-site flows (if they exist) based on an assumed plugged orifice condition.

All state dam safety criteria must be carefully considered when determining the freeboard capacity of ponds which incorporate high embankments or large areas and storage volumes.

11.5.4 TRICKLE FLOW CHANNELS

All grassed bottom detention ponds shall include a concrete lined trickle channel. A perforated under drain shall be required if the soils report indicates close proximity to groundwater or groundwater is encountered during construction. Minimum longitudinal slope of trickle channel shall be 0.4%. Trickle flow channel criteria are presented in Section 5.2.2.

11.5.5 OUTLET CONFIGURATION

There are two examples of a detention pond outlet configuration (see Section 12 for outlet requirements for stormwater quality enhancement). A Type 1 outlet consists of a grated drop inlet, outlet pipe, and an overflow weir in the pond embankment. The outlet will be designed to release the peak discharge associated with the 5-year historical runoff during the 100-year developed runoff. The control for the 100-year peak discharge shall be at the throat of the outlet pipe under the head of water as defined on Figure 11-3. The trash rack must be designed to pass the 5-year historical storm flow with a minimum of 50 percent blockage. Since the minimum size of the outlet pipe is 12 inches, then a control orifice plate at the entrance of the pipe shall be required to control the discharge of the design flow. An example orifice plate is shown in Figure 11-4.

A Type 2 outlet consists of a depressed inlet with an outlet pipe and an overflow weir in the pond embankment. Again, an orifice plate at the entrance shall be required to control the release rate to the 5-year historical peak flow. The control for the 100-year developed condition discharge occurs at the throat of the outlet pipe as shown on Figure 11-3. The outlet pipe must have an adequate slope to ensure throat control in the pipe.

For both outlet types, flows in excess of the developed condition 100-year discharge are released through the overflow weir or spillway. The control orifice plate shall not be oversized to pass release flows from off-site (upstream) detention facilities. The overflow weir or spillway shall be oversized to pass other off-site flows through the pond. Size the

spillway to pass the 100-year developed on-site flow plus the 100-year off-site flows based on an assumed plugged orifice condition. The maximum trash rack-opening dimension shall be equal to 6".

Other outlet configurations will be allowed provided they meet the requirements of the permitted release rates at the required volume and include proper provisions for maintenance and reliability. The outlet shall be designed to minimize unauthorized modifications which affect proper function.

Additional storage shall be required to incorporate water quality considerations into the design and construction of a detention pond. Minimum requirements for the implementation and use of detention ponds for stormwater quality control are provided in Section 12.0-Stormwater Quality Enhancement. For information and design guidelines related to the construction of detention ponds that promote stormwater quality control, the reader is referred to the Urban Storm Drainage Criteria Manual (USDCM), Volume 3, "Best Management Practices".

11.5.6 EMBANKMENT PROTECTION

Whenever a detention pond uses an embankment to contain water, the embankment shall be protected from catastrophic failure due to overtopping. Overtopping can occur when the pond outlets become obstructed or when a larger than 100-year storm occurs.

Failure protection for the embankment may be provided in the form of a 24" deep, Type M, buried riprap layer on the entire downstream face of the embankment or a separate emergency spillway having a minimum capacity equal to the 100-year developed storm event for the basin.

Detention facilities in major drainage channels shall have a spillway capacity equal to the 100-year peak discharge associated with fully developed conditions in the basin. Structures shall not be permitted in the path of the emergency spillway or overflow. The invert of the emergency spillway should be set equal to or above the 100-year water surface elevation.

11.5.7 VEGETATION REQUIREMENTS

All detention ponds shall be vegetated by either irrigated sod or irrigated native dry land grasses. Refer to Section 14 – Vegetation and Irrigation for these specifications.

No more than one or two deciduous trees, small leaf, maintainable to a single stem, and not inherent to suckering, shall be allowed per 4500 square foot of pond. These trees shall be planted as far away from the outlet structure as possible to prevent plugging the outlet and WCCV holes.

No evergreens shall be allowed in a pond.

11.5.8 MAINTENANCE ACCESS

To assure that the detention facility performs as designed, maintenance access shall be provided, and shown on the Final Plat. Regional detention ponds are usually dedicated to the Town for operation and maintenance. For privately maintained facilities such as commercial, residential, or industrial sites, an easement shall be granted to the Town to allow access and to assure that the facility continues to function as intended. The Town has standard easement agreement forms for this purpose.

11.6 DESIGN STANDARDS FOR PARKING LOT DETENTION

11.6.1 DEPTH LIMITATION

The maximum allowable design depth of ponding is 18 inches for the 100-year flood and 6 inches for the initial storm runoff event. Calculations shall be provided to the Town indicating the depth of ponding for the 10-year storm event. Signs shall be posted within parking lots warning users of high water during significant storm events.

11.6.2 OUTLET CONFIGURATION

Where a drop inlet is used to discharge to a storm drain or drainage way, the minimum pipe size for the outlet pipe is 12 inches in diameter. Where a weir and a small diameter outlet pipe through a curb are used, the size and shape are dependent on the discharge and storage requirements. In this case, a minimum pipe diameter of 4 inches is required.

11.6.3 MAINTENANCE ACCESS

To assure that the detention facility performs as designed, maintenance access, especially to outlet structures, shall be provided. The outlet shall be designed to minimize unauthorized modifications, which affect function. Any repaving of the parking lot shall be evaluated for impact on volume and release rates and is subject to approval by the Town prior to proceeding with the repaving. A sign shall be attached or posted in accordance with Section 11.6.4.

11.6.4 FLOOD HAZARD WARNING

All parking lot detention areas shall post a minimum of two signs identifying the detention pond area. The sign shall have a minimum area of 1.5 square feet and contain the following message:

"WARNING"

This area is a detention pond and is subject to periodic flooding depths ranging from a depth of __ (provide the design depth) for the initial storm runoff event to __ (provide the design depth) for the 100-year storm."

Any suitable materials and geometry of the sign are permissible, subject to approval of the Town.

11.7 DESIGN STANDARDS FOR UNDERGROUND DETENTION

11.7.1 MATERIALS

Underground detention shall be constructed using corrugated aluminum pipe (CAP) or reinforced concrete pipe (RCP) or other system approved by the Town. The pipe thickness, cover, bedding, and backfill shall be designed to withstand HS-20 loading. The minimum diameter of pipe allowed shall be 48”.

A Stormceptor shall be required for the water quality capture volume requirement for all underground detention facilities. See Section 6.8.

11.7.2 CONFIGURATION

Pipe segments shall be sufficient in number, diameter, and length to provide the required minimum storage volume for the 100-year design. As an option, the initial design storm

runoff volume can be stored in the pipe segments and the difference for the 100-year runoff volume stored above the pipe in an open space detention pond, or in parking lot detention.

The pipe segments shall be placed side by side and connected at both ends by elbow tee fittings and across the fitting at the outlet (see Figure 11-5). The pipe segments shall be continuously sloped at a minimum of 0.4 percent to the outlet. Manholes for maintenance access (see Section 11.7.4) shall be placed in the tee fittings and in the straight segments of the pipe, when required.

Permanent buildings or structures shall not be placed above the underground detention.

11.7.3 INLET AND OUTLET DESIGN

The outlet from the underground detention shall consist of a short (maximum 25 feet) length of CAP or RCP with a 12-inch minimum diameter. The outlet pipe(s) shall discharge into a standard manhole or into a drainage way with erosion protection provided per Sections 9.3.2, 10.2, and 10.3. If an orifice plate is required to control the release rates, the plate shall be hinged to open into the detention pipes to facilitate back flushing of the outlet pipe.

Stormwater access to the detention pipes can be by way of surface inlets and/or by a local private storm drain system. The system shall be designed to accommodate 100 year storm flow rates in order to ensure the 100 year storm will be retained in the underground detention.

Channel rundowns down the slope of detention ponds shall be designed as per Section 5.0, Open Channels, Part 5.5 Channel Rundowns.

11.7.4 MAINTENANCE ACCESS

Access easements to the detention site shall be provided. To facilitate cleaning of the pipe segments, 3-foot diameter maintenance access ports shall be placed according to the following schedule:

MAINTENANCE ACCESS REQUIREMENTS

Detention Pipe Size	Maximum Spacing	Minimum Frequency
48" to 54"	150'	Every pipe segment
60" to 66"	200'	Every other pipe segment
Greater than 66"	200'	One at each end of the battery of pipes

Manholes shall be constructed in accordance with Figure 11-5.

11.8 RESERVED

11.9 DESIGN EXAMPLE - DETENTION VOLUME

GIVEN:

Basin area = 5 acres
Single family residential site, Percent Impervious = 40%
Historical 5-year release rate = 2 cfs
Developed 100-year peak inflow rate = 16.5 cfs
100-year Runoff Coefficient = 0.6

FIND: Determine size of detention pond to limit developed 100-year peak inflow rate to historical 5-year release rate of 2 cfs.

SOLUTION:

STEP 1: Determine Q_{out}/Q_{pin} to be 0.12

STEP 2: From Figure 11-1, k = 0.96

STEP 3: At intervals of 5 minutes, determine the rainfall intensity (from IDF curves)

Runoff volume (Vin from Equation 11.4.1(1))

Outflow volume (Vout from Equation 11.4.1(2))

Storage volume (V_{in} - V_{out})

The calculating procedure is illustrated in Table 11-2. The required detention volume from Table 11-2 is determined to be 0.53 acre-feet.

DETENTION OUTLET STRUCTURE

GIVEN:
Detention pond with the following characteristics.

Maximum 100-year release rate = 23.0 cfs
Maximum 5-year release rate = 6.9 cfs
Type 2 outlet (refer to Detail 11-3)
100-year water surface elevation = 105.0
5-year outlet pipe invert elevation = 100.0
18-inch diameter outlet pipe

FIND: 5-year outlet sizing

SOLUTION: (see Figure 11-6)

STEP 1: Determine maximum discharge from the outlet pipe. Depth to centerline of the outlet pipe = 4.25 ft.

$Q = C_d A(2gh)^{1/2}$ (Equation 11.4.3.B)
$= 0.65\ (1.76)\ [2(32.2)(4.25)]^{1/2}$
$= 18.9$ cfs
$Q > Q_5$; requires orifice plate

STEP 2: Determine 5-year orifice opening size; estimate depth to centerline of orifice (try 4.5 ft)

$A = Q / [C_d\ (2gh)^{1/2}]$ (Rearranged Equation 11.4.3.B)
$= 6.9 / \{0.65\ [2(32.2)(4.5)]^{1/2}\}$
$= 0.62\ ft^2$

STEP 3: Determine 5-year orifice diameter

$\text{Diameter} = [4A/\pi]^{½}$
$= [4(0.62)/\pi]^{½}$
$= 0.9$ feet (10.7 inches)

Therefore, use an orifice opening with a 10.5-inch diameter hole at the entrance to the outlet box.

STEP 4: Check discharge through 5-year outlet for 100-year headwater and 10.5-inch orifice opening (h= 4.56 feet).

$Q = C_d A(2gh)^{½}$ (Equation 11.4.3.B)
$= 0.65(0.60)[2(32.2)(4.56)]^{½}$
$= 6.7$ cfs
$Q = 6.7$ cfs $< Q_5 = 6.9$ cfs

STEP 5: Check trash rack design area given orifice diameter of 10.5 inches.

Orifice area $= A_o = 0.6\ ft^2$
$A/A_o = 10$ (from Figure 11-4 for 10.5-inch orifice diameter)
$A = 10(A_o) = 10(0.6) = 6\ ft^2$
Maximum opening $= 0.5(10.5) = 5.25$ inches

Note: If maximum opening for trash rack is greater than 6" per this equation, use Maximum opening = 6".

11.10 CHECKLIST

To aid the Designer and Reviewer, the following checklist has been prepared:

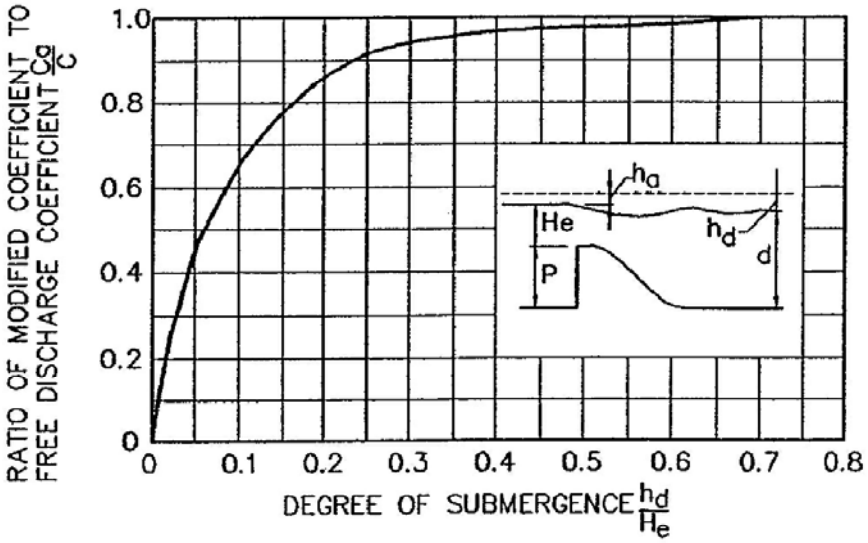
1. Earth slopes are to be 4:1 or flatter.
2. Minimum freeboard of 1 foot for the 100-year detention is required.
3. Open space detention areas shall include trickle channels. For the purpose of enhancing storm water quality, where practical, the trickle channel shall be grass lined with a buried perforated under drainpipe, surrounded by filter fabric and rock filter material. See Section 5.0 Open Channels, Figure 5-5, Trickle Channel Details.

4. Channel rundowns have been designed as per Sections 5.0, Open Channels, and 5.5 Channel Rundowns and Figure 5-7 Channel Rundown.
5. Protect embankment for overtopping condition by adding riprap or other acceptable erosion protection.
6. Provide trash racks where required.
7. Provide signs as required.
8. Provide maintenance access.

11.11 TOWN ACCEPTANCE OF STORMWATER DETENTION/RETENTION FACILITIES

The Town may accept maintenance of detention facilities if the facility is vegetated with native grass requiring occasional mowing for weed control and outlet structure cleaning. Refer to Section 11.5.7 for further requirements. Maintenance of more exotic landscape and irrigation shall be provided by someone other than the Town. Acceptance by the Town can occur after 75% of the lots in the subdivision have been landscaped, eroded areas have been repaired, vegetation has been established (no noxious weeds), the structure is complete with outlet works, spillway, etc. Town shall also require a survey by a Colorado licensed surveyor or professional engineer that confirms the Town approved detention volume.

SHAPE	COEFFICIENT	COMMENTS	SCHEMATIC
SHARP CRESTED	–		
PROJECTION RATIO (H/P = 0.4)	3.4	H<1.0	
PROJECTION RATIO (H/P = 2.0)	4.0	H>1.0	
BROAD CRESTED	–		
W/SHARP U/S CORNER	2.6	MINIMUM VALUE	
W/ROUNDED U/S CORNER	3.1	CRITICAL DEPTH	
TRIANGULAR SECTION	–		
A) VERTICAL U/S SLOPE	–		
1:1 D/S SLOPE	3.8	H>0.7	
4:1 D/S SLOPE	3.2	H>0.7	
10:1 D/S SLOPE	2.9	H>0.7	
B) 1:1 U/S SLOPE	–		
1:1 D/S SLOPE	3.8	H>0.5	
3:1 D/S SLOPE	3.5	H>0.5	
TRAPEZOIDAL SECTION			
1:1 U/S SLOPE, 2:1 D/S SLOPE	3.4	H>1.0	
2:1 U/S SLOPE, 2:1 D/S SLOPE	3.4	H>1.0	
ROAD CROSSINGS			
GRAVEL	3.0	H>1.0	
PAVED	3.1	H>1.0	



ADJUSTMENT FOR TAILWATER

REFERENCE: KING & BRATER, HANDBOOK OF HYDRAULICS, McGRAW HILL BOOK COMPANY, 1963 – DESIGN OF SMALL DAMS, BUREAU OF RECLAMATION, 1977

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

WEIR FLOW COEFFICIENTS

TABLE 11–1

March, 2010

NOT TO SCALE

STORM DURATION T (min) [1]	RAINFALL INTENSITY *i* (IN/HR) [2]	RUNOFF VOLUME C*i*AT (FT) [3]	OUTFLOW VOLUME kQT (FT) [4]	STORAGE VOLUME* (FT) [5]	STORAGE VOLUME (AF) [6]
5	9.67	8,703	576	8,127	0.19
10	7.51	13,518	1,152	12,366	0.28
15	6.34	17,118	1,728	15,390	0.35
20	5.34	19,224	2,304	16,920	0.39
25	4.74	21,330	2,880	18,450	0.42
30	4.40	23,706	3,456	20,304	0.47
35	4.00	25,200	4,032	21,168	0.49
40	3.59	25,848	4,608	21,240	0.49
45	3.35	27,135	5,184	21,951	0.50
50	3.10	27,900	5,960	21,940	0.50
55	2.94	29,106	6,336	22,770	0.52
60	2.78	30,024	6,912	23,112	0.53**
70	2.47	31,122	8,064	23,058	0.53
80	2.16	31,104	9,216	21,888	0.50
90	2.00	32,400	10,008	22,392	0.51

* COLUMN [3] - COLUMN [4]

** REQUIRED DETENTION VOLUME

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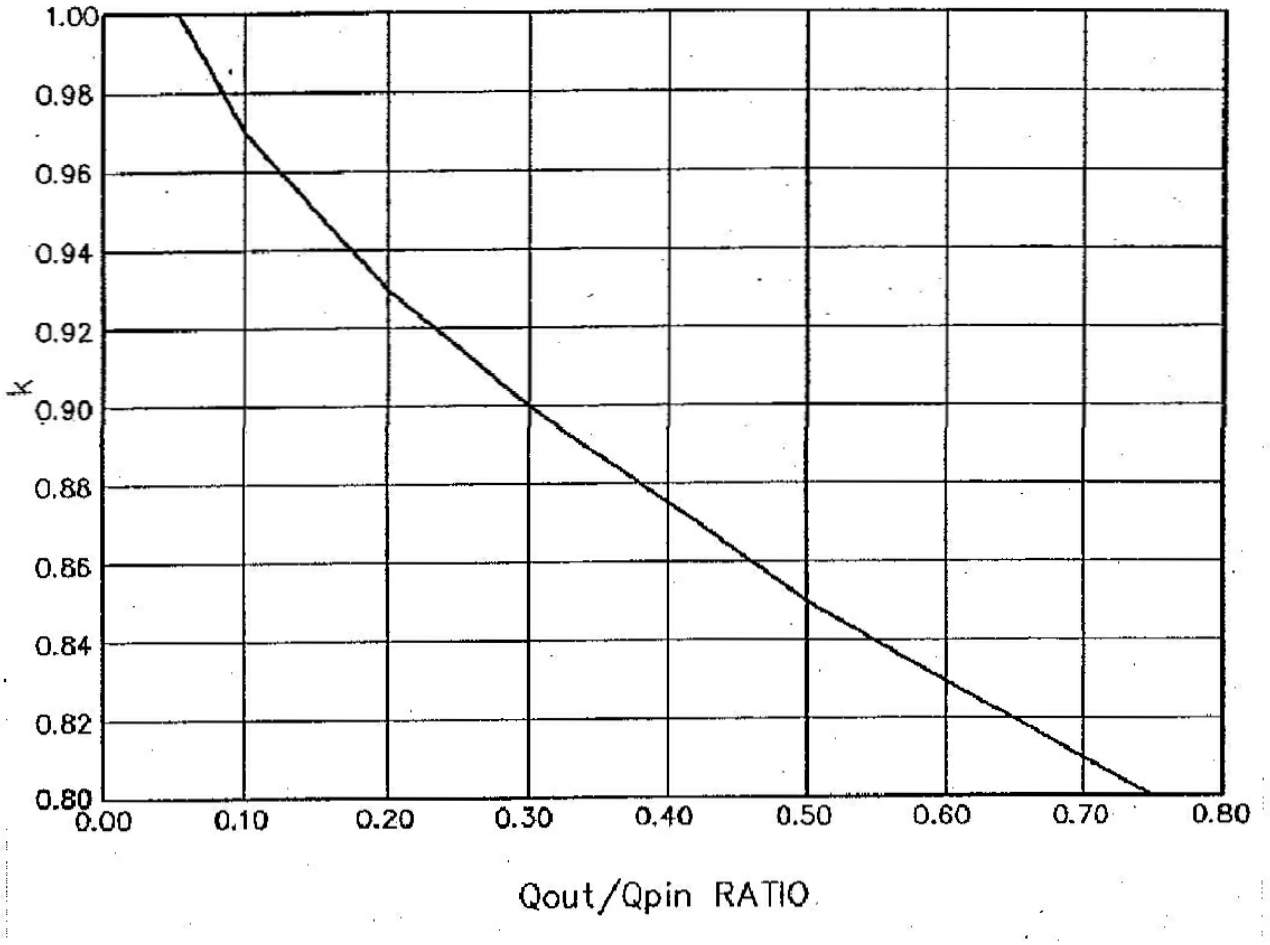
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

RATIONAL FORMULA METHOD FOR DETENTION POND SIZING

TABLE 11-2

March, 2010

NOT TO SCALE



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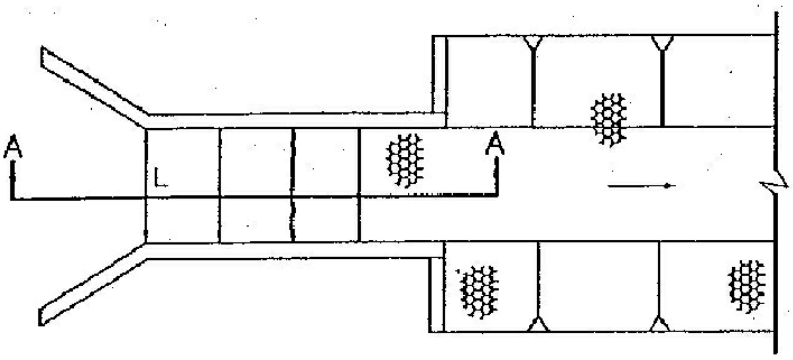
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

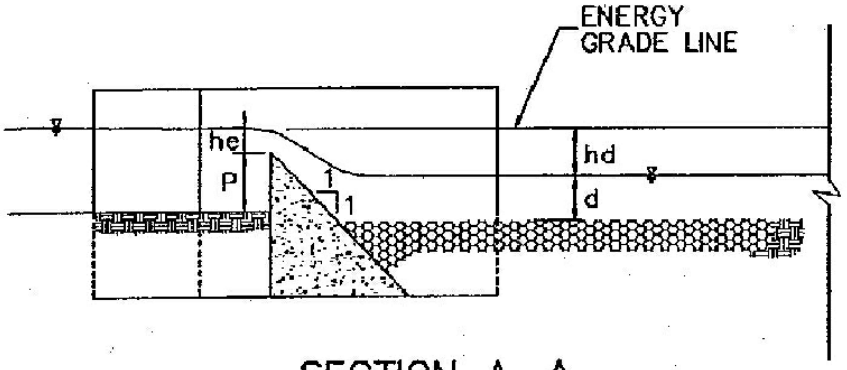
OUTFLOW ADJUSTMENT FACTOR VERSUS OUTFLOW RATE / INFLOW PEAK RATIO

(UNIVERSITY OF COLORADO – DENVER, 1991)

March, 2010 FIGURE 11–1 NOT TO SCALE



PLAN



SECTION A–A

GIVEN: Q=100 CFS, TRIANGULAR WEIR WITH VERTICAL FACE, AND 1:1 DOWNSTREAM SLOPE, P=2', he =z', TAILWATER DEPTH = 4.5, hd = 1.5

FIND: L, AND CHECK SUBMERGENCE

SOLUTION: Cw = 3.8 (TABLE 11–1)

$L = Q/CH^{3/2} = (100)/[(3.8)(2)^{3/2}] = 9.3$ FT

SUBMERGENCE CHECK

$\frac{hd}{he} = \frac{1.5}{2.0} = 0.75$, THEN Ca/C = 1.0, (TABLE 11–1)
THEREFORE NO SUBMERGENCE ADJUSTMENT IS REQUIRED

PV_DRAIN_P174.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

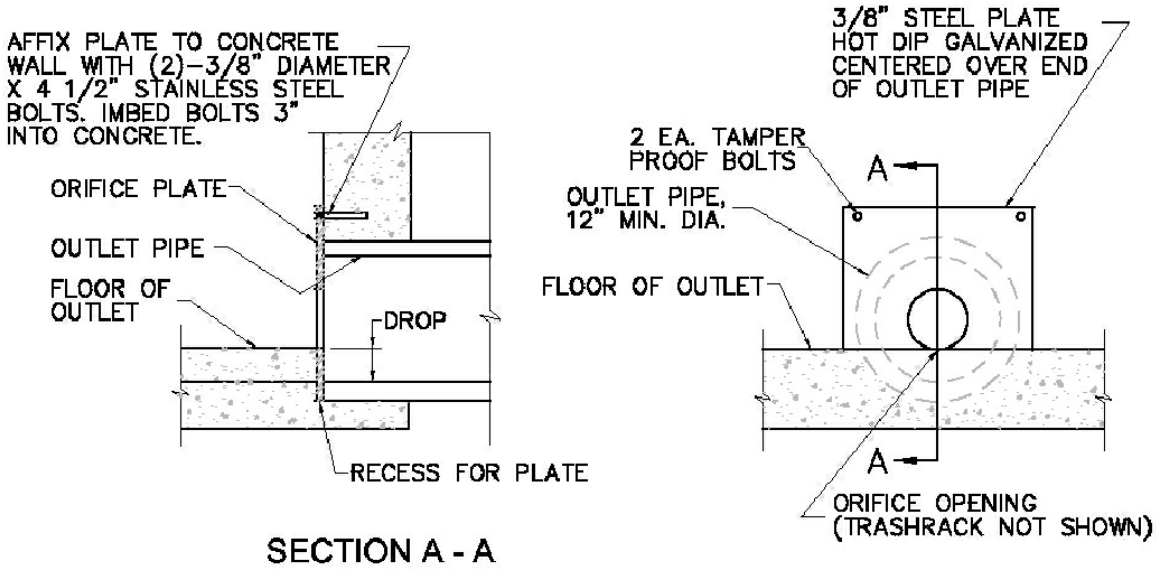
WEIR DESIGN EXAMPLE

FIGURE 11–2

March, 2010

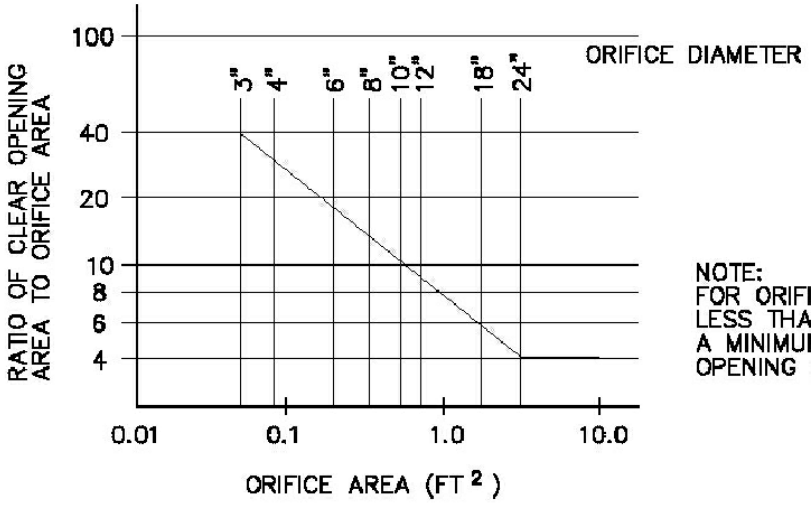
NOT TO SCALE

ORIFICE PLATE DETAIL



SECTION A - A

(B) TRASHRACK AREA REQUIREMENTS



NOTE:
FOR ORIFICE DIAMETER LESS THAN 3", USE A MINIMUM CLEAR OPENING OF 2 FT^2

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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

DETENTION POND DETAILS

FIGURE 11–4

March, 2010

NOT TO SCALE

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

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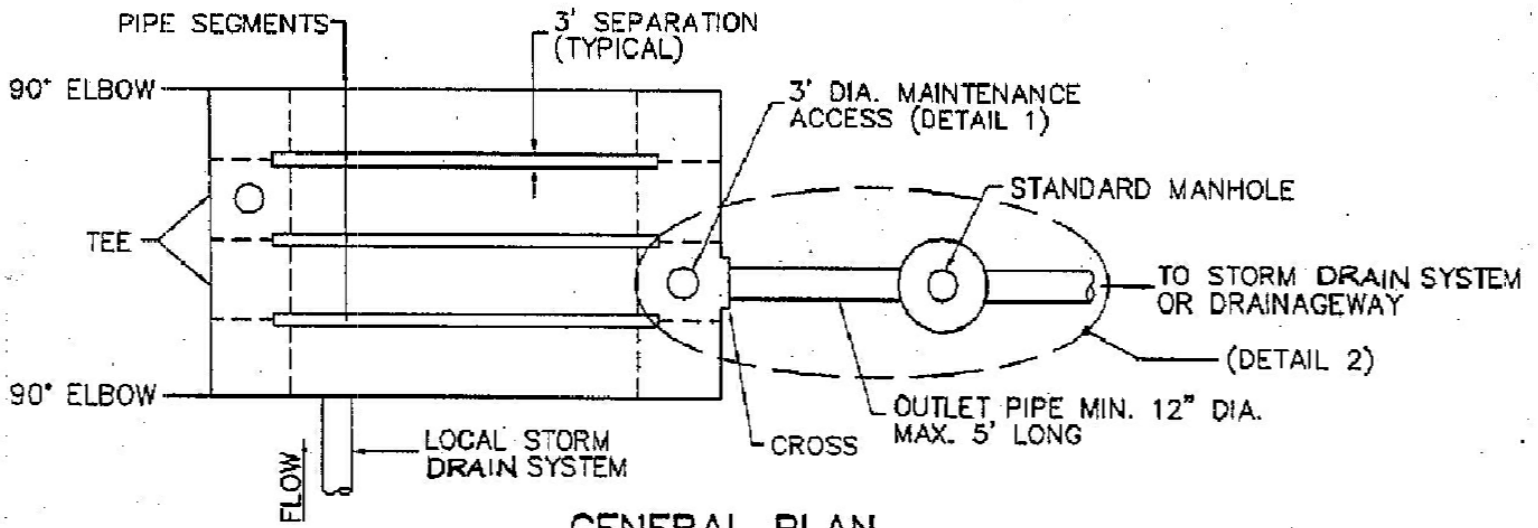
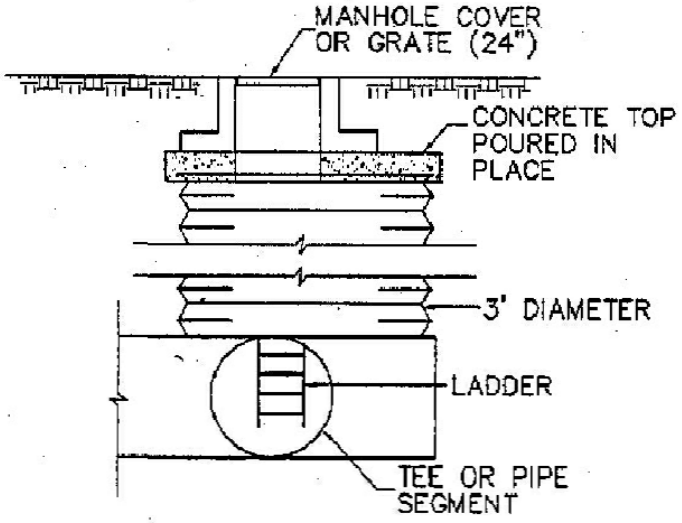
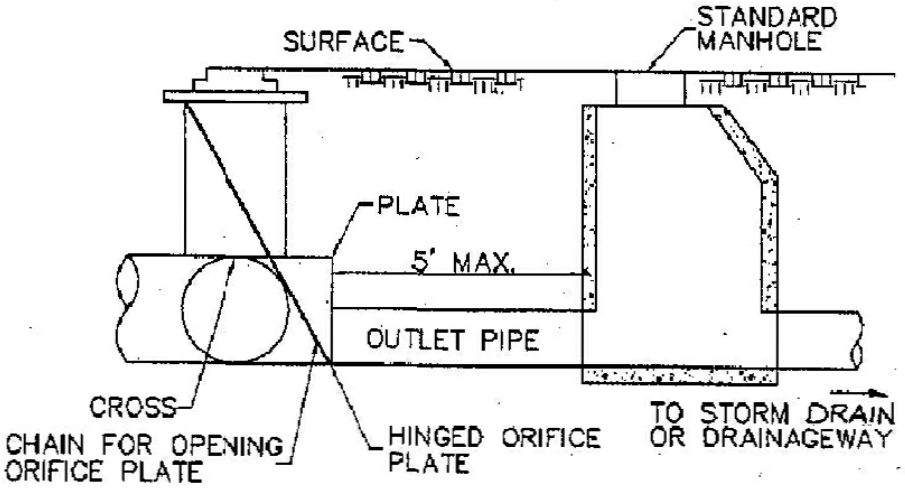


GENERAL PLAN



MAINTENANCE ACCESS DETAIL 1



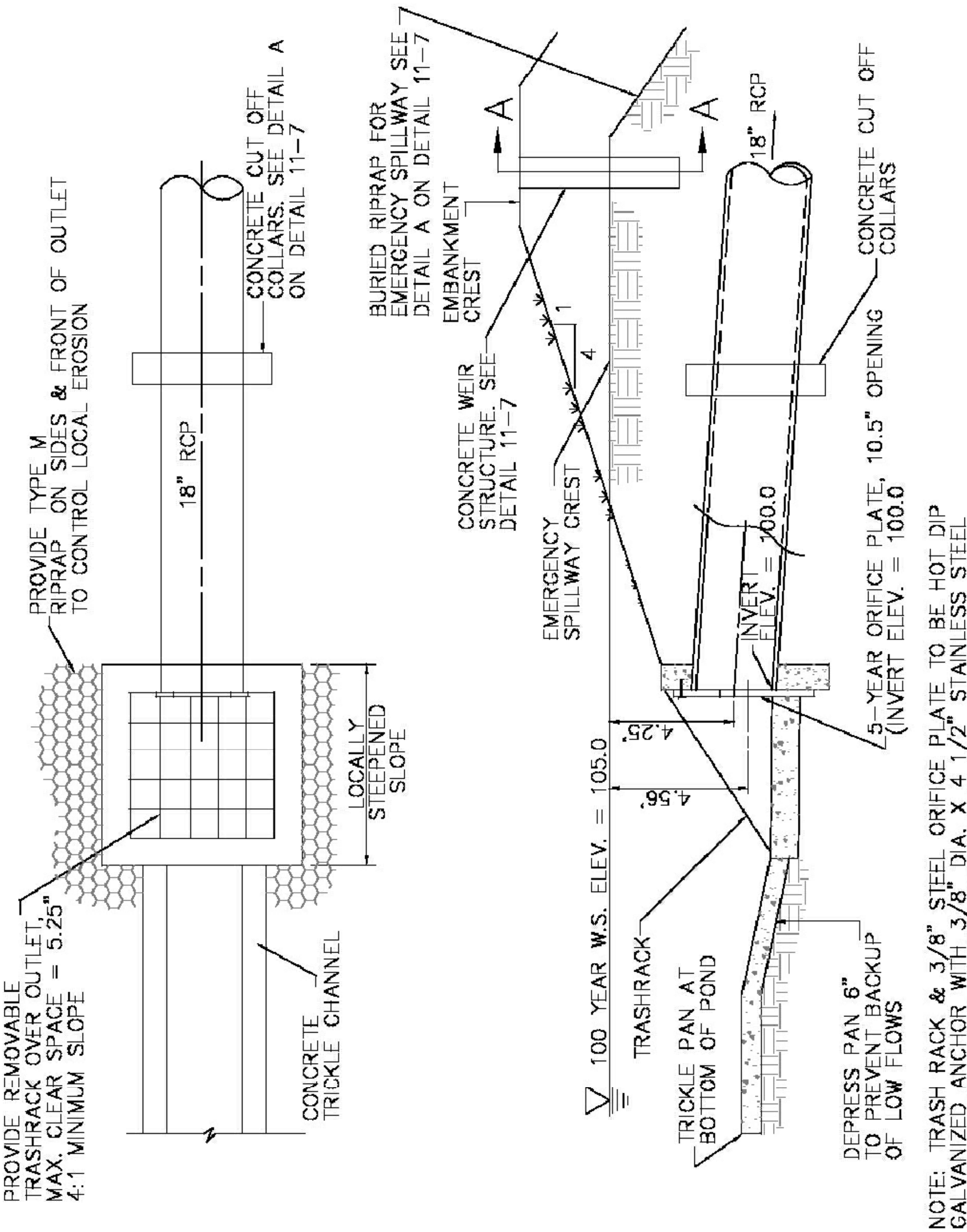
OUTLET DETAIL 2

UNDERGROUND DETENTION

FIGURE 11-5

March, 2010

NOT TO SCALE



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CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

OUTLET DESIGN EXAMPLE

FIGURE 11-6

March, 2010

NOT TO SCALE

SECTION 12.0 STORMWATER QUALITY ENHANCEMENT
TABLE OF CONTENTS

SECTION 12.0 STORMWATER QUALITY ENHANCEMENT

12.1 REGULATORY BACKGROUND

Since the National Environmental Policy Act of 1969 (NEPA), much attention has been given to the control of erosion and sedimentation by Federal, State and local governments. Numerous laws and regulations governing land-disturbing activities have been developed and published. Some important legislation that affect construction activities in regard to erosion and sediment control are:

1. The Clean Water Act (sections 401,402 and 404)
2. Senate Bill 40 (SB40) Wildlife Certification (Title33, article 5, CRS)
3. The Colorado Water Quality Control Act (Title 25, article 8, CRS)

Of particular importance are the National Pollutant Discharge Elimination System (NPDES) Phase II stormwater regulations issued by the Environmental Protection Agency (EPA). In 1999, the regulation was extended to include smaller municipalities as well. The Phase II Stormwater Permit Regulation required small municipalities (<100,000 population) to obtain NPDES MS4 Permit coverage. **The phase II regulation also reduced the minimum size of construction projects requiring NDPES permits from 5 acres of disturbed area to just 1 acre.**

Colorado is an NPDES state, which means the EPA's authority to issue NPDES permits is delegated to the state regulatory agency, the Colorado Department of Public Health & Environment (CDPHE). CDPHE implements and enforces the NPDES Programs through the Colorado Discharge Permit System (CDPS) program.

12.2 INTRODUCTION

The character of the urban landscape affects both the quantity and the quality of stormwater discharged to receiving waters during and after each runoff event. The quality of stormwater runoff from developed lands and urbanized areas can be impacted by some or all of the sources and contaminants shown below. The increase in impermeable areas such as rooftops, parking lots and paved surfaces acts directly to impact stormwater quality by decreasing the opportunity for stormwater to infiltrate and percolate into the ground, and the absence of natural surfaces and vegetation allows for increased runoff velocity and pollutant carrying forces.

TABLE 12.2 - POSSIBLE SOURCES OF POLLUTANTS IN STORMWATER	
Source	Contaminant
Vehicles, Machinery and Industry	Metals, Lubricants, Solvents, Paints
Lawn Care, Gardening	Pesticides, Herbicides, Fertilizers
Household Chemicals Cleaners, Chlorine	Paints, Solvents, Detergents, Disinfectants,
Pets and Animals	Fecal Material, Organic Wastes
Parking Lots	Oil, Grease, Automotive Fluids, Sediments

The intent of this section of these Criteria is to present minimum requirements for the implementation and use of Best Management Practices (BMP's) for stormwater quality control within the Town of Platteville. Compliance with this section does not require water quality monitoring, or quantitative descriptions of pollutant load removal. Instead, a performance-based approach is described, whereby the existing principles and objectives of pollutant transport control are addressed in a general manner. Individual methods must be selected and implemented to best fit the conditions and requirements of each site.

These Criteria are developed from information and design guidelines presented in the Urban Storm Drainage Criteria Manual (USDCM), Volume 3, "Best Management Practices." The reader is referred to the USDCM for an extensive discussion of the development of stormwater quality controls and regionally acceptable BMP's.

Section 13 of these Criteria discusses the Town 's requirements for stormwater quality control due to erosion and sedimentation during the construction period.

12.3 REGULATION CONTROLLING DISCHARGES TO STORM DRAINS

The following regulations shall apply to discharges to storm drains:

No person shall discharge non-stormwater wastewater, which contains pollutants from industrial, commercial or sanitary point sources to a storm drain unless a Colorado Discharge Permit System (CDPS) permit has been obtained for the discharge.

No person shall connect a system for drainage of industrial, commercial or sanitary wastewater, which contains pollutants, other than to convey stormwater runoff to a storm drain unless a CDPS permit has been obtained.

All connections between industrial, commercial, or sanitary non-stormwater wastewater sewers or other drainage conveyances and storm drains which are not the subject of a CDPS permit shall be disconnected even though the connection is unused.

12.4 OBJECTIVES FOR STORMWATER QUALITY CONTROL

The following principles and objectives for stormwater quality control shall be used by the Town to determine if adequate Best Management Practices have been proposed for a site during the design and development process:

1. Minimize, to the maximum extent practicable, impacts of stormwater on receiving waters. An effective level of urban pollutant removal should be accomplished by the selected BMP's.

2. Consider the sites physical constraints. The Town realizes that each site presents different topography, area limitations, and land use requirements. Select and design BMP's to work within the conditions on the site.

3. Evaluate the economic impacts of the selected BMP's. Controls must be evaluated for Installation (construction) costs and for future operation and/or maintenance costs.

4. Recognize and incorporate multi-use benefits within stormwater quality features whenever possible. Land intensive BMP's such as detention/retention ponds and vegetative strips should be designed to incorporate recreational and aesthetic features such as open space and landscape values whenever possible.

12.5 PERFORMANCE AND DESIGN CRITERIA

The Town of Platteville shall require that all land undergoing development incorporate BMP's to achieve, to the maximum extent practicable, the objectives of stormwater quality control. Due to the variability of factors such as land use, extent of development, existing improvements, and the physical characteristics of the site (including soils, slope, and runoff) it is expected that the BMP's designed for each site may vary considerably.

The Town of Platteville requires the use of the following BMP's or equivalent, as presented in the USDCM, Volume 3, "Best Management Practices":

- Minimization of Directly Connected Impervious Areas (DCIA)
- Irrigated grass buffer strips
- Grass lined swales
- Extended detention basins (dry basins)
- Retention ponds (w/permanent pool)
- Constructed wetlands
- Modular block porous pavement (as defined in the USDCM, Volume 3)

The design of these structural BMP's shall be incorporated within the provision for flood control facilities.

The Town shall evaluate the adequacy and appropriateness of the proposed BMP's based on their fulfillment of the previously stated objectives, as well as the satisfaction of the following minimum design criteria:

A site specific Stormwater Quality Control Plan describing the type of BMP's selected, a construction and implementation schedule, and a description of long-term maintenance requirements is approved by the Town .

The site is designed to minimize the extent of Directly Connected Impervious Areas (DCIA's) to at least 50% of Level 1 as described in the USDCM, Volume 3, "Structural Best Management Practices".

The maximum allowable slope for developed land surfaces utilizing Level 1 minimization of DCIA is 4%. Terracing and retaining wall construction may be required to maintain allowable slopes.

The design of developing sites shall incorporate one or more BMP's designed to capture and treat the calculated runoff equal to the 80th percentile rainfall event (see USDCM, Volume 3, "Best Management Practices, Section 5 - Stormwater Quality Hydrology). A variance may be allowed for development of small sites, such as the construction of small parking lot type detention ponds. Alternatives for stormwater quality treatment include extended detention basins (dry), retention ponds, or constructed wetlands.

The evaluation and design for permanent erosion protection and stabilization measures shall be provided for all detention pond outlets, conveyance, outfall and channel facilities constructed on the site.

Detailed information on the development, application, design, and construction details for the BMP's required by the Town of Platteville can be found in the USDCM, Volume 3, "Best Management Practices". All updates and revisions to the USDCM shall be included in these Criteria.

The Town of Platteville encourages the innovative use and application of measures to insure stormwater quality control. The methods and applications of BMP's designed to meet the objectives of stormwater quality control are expected to increase and improve as the industry's experience and technology evolve. Applicants are encouraged to utilize the newest technology available, and incorporate the design data for these new methods in the Stormwater Management Plan.

12.5.1 STORMWATER CONSTRUCTION SITE QUALITY BMPS

Operation of a construction site may produce pollutants that are transported by runoff and cause adverse impacts to receiving waters. Other potential pollutants, not associated with erosion, are chemicals that are used and stored at construction sites. Table 12.5.1 lists pollutants that may be present during construction activities.

TABLE 12.5.1 – CONSTRUCTION SITE POLLUTANTS

Source	Pollutants
Adhesives	Phenols, Formaldehydes, Asbestos, Benzene, Naphthalene
Cleaners	Metals, Acidity, Alkalinity, Chromium
Plumbing	Lead, Copper, Zinc, Tin
Painting	VOCs, Metals, Phenolics, Mineral Spirits
Woods	BOD, Formaldehyde, Copper, Creosote, Arsenic
Masonry/Concrete	Acidity, Sediments, Metals, Asbestos
Demolition	Asbestos, Aluminum, Zinc, Dust

Yard O&M	Oils, greases, coolants, Metals, etc
Landscaping & Earthmoving	Pesticides, Herbicides, Fertilizers, Nutrients, Acidity, Alkalinity, Metals, Sulfur, Aluminum Sulfate
Materials Storage	Spills, Leaks, Dust, Sediments, Litter and Trash

The water quality BMPs for a site are usually comprised of five major elements:

Erosion Control – see Section 13

Sediment Control – see Section 13

Materials Handling and Spill Prevention – see Section 12.

Waste Management –see Section 12.

General Pollution Prevention Measures –see Section 12.

Materials Handling and Spill Prevention are measures implemented to minimize or prevent contamination of the natural resources present from materials stored on construction sites.

General Pollution Prevention BMPs are implemented to minimize or prevent general contamination of the construction site and natural resources present.

12.5.2 MATERIALS HANDLING AND SPILL PREVENTION

Material management is important because the optimal approach to reduce pollution potential is to prevent it at the source. Material storage areas are a major source of risk due to possible mishandling of materials and accidental spills. Developing protocols for materials storage and handling, and response procedures for handling spills, are necessary measures to minimize the contamination impact to stormwater runoff. Developing and incorporating these measures will increase awareness and minimize the opportunities for mishandling and spills.

Material Handling and Spill Prevention BMP's need to address the following:

A. Stockpile Management
B. Material Management
C. Material Use
D. Spill Prevention and Control

12.5.2.A STOCKPILE MANAGEMENT

These practices are implemented to reduce associated stormwater pollutants from entering storm drains and watercourses from typical soil, concrete, asphalt, or aggregate stockpiles found at construction sites.

This shall include both areas where active and non-active stockpiles of construction materials are stored.

Standards and Specifications

Stockpiles must be protected continuously and located away from areas where concentrated stormwater flow is anticipated, major drainage ways, and stormwater inlets. Stockpiles shall be covered and/or protected with a temporary perimeter sediment barrier. Stockpiles of "cold

mix" asphalt shall be placed on and covered with durable plastic or comparable material at all times when not in use.

Temporary perimeter sediment barrier such as berms, dikes, silt fences, or sandbags must be constructed to protect stockpiles from runoff.

Implement wind erosion control practices as appropriate on all stockpiles

Waste stockpiles of concrete, solid, sanitary/septic materials, liquids, hazardous materials, and contaminated soils, shall be in accordance to Waste Management BMPs.

Stock piles shall not exceed ten (10) feet in height.

12.5.2.B MATERIAL MANAGEMENT

These practices are to be implemented for proper handling and storage of materials in order to prevent spills or leaks into the storm drains or watercourses.

These practices are implemented at all construction sites where delivery and storage of materials may be detrimental to the environment. Materials of concern include but are not limited to soil, pesticides, herbicides, fertilizers, petroleum products, asphalt and concrete components, and hazardous chemicals such as acids, paints, solvents, adhesives, and curing compounds.

Standards and Specifications

Storage and Material Handling Areas

a.1. Designated storage sheds must meet Town and State building and fire code regulations.

a.2. Material safety data sheets (MSDS) shall be made available for all materials.

a.3. Training for proper material handling and storage techniques shall be required.

a.4. Provide sufficient separation between storage containers to allow cleanup and emergency response.

a.5. Provide storage for materials indoor away from rainfall and offsite flows.

a.6. Chemically incompatible materials should not be stored together or in the same storage facility.

a.7. Label all materials properly and maintain current legible labels; also maintain a current inventory of all material delivered and stored.

a.8. Hazardous materials must comply with federal, state, and local HazMat requirements.

a.9. Provide above ground secondary containment for all hazardous chemical materials.

a.10. Immediately contain and cleanup any spills.

Loading and Unloading Areas

b.1. Cover loading and unloading areas to reduce exposure of materials to rainfall.

b.2. Routinely check vehicles and equipment such as valves, pumps, flanges, and connections for leaks.

b.3. Direct offsite stormwater flows away by grading, berming, or curbing the area around the loading/unloading area.

12.5.2.C MATERIAL USE

These practices are implemented to ensure minimal water quality impacts from the use of construction materials.

These practices shall be implemented at all construction sites. The contractor is responsible for identifying proper material use measures for all materials used at construction site projects. The following represent some of the materials of concern where this BMP will be implemented:

Pesticides, herbicides, and fertilizers
Detergents and cleaners
Petroleum products such as fuel, oil, and grease
Asphalt and concrete compounds
Hazardous chemicals
Other materials that may have negative impacts if released into the environment

Design Guidelines

MSDS shall be made available for all materials.

Do not remove original labels; re-label all materials properly and maintain current legible labels with proper safety and disposal information.

Use less hazardous, recycled, or non-toxic materials when possible.

Leftover materials should be recycled and properly disposed of.

Use materials only where and when necessary to complete the construction activity; avoid excess application of materials.

Never clean paintbrushes or paint containers into a street, gutter, storm drain, or watercourse. Dispose of used materials properly.

Herbicides shall be applied by a licensed applicator; fertilizers and herbicides shall not be over-applied. Only the amounts needed should be prepared.

12.5.2.D SPILL PREVENTION AND CONTROL

These practices are implemented to prevent and control spills to ensure that spills and leaks do not result in water quality impacts.

This BMP applies to all construction activities. Spill prevention and control measures shall be implemented any time chemicals or hazardous substances are used, stored, or handled.

Design Guidelines
The following general design guidelines can be implemented for spill prevention and control measures for various activities and areas:

Identify materials delivered, handled, stored, and used at a project site.

Identify project areas and activities potentially susceptible to spills. Areas and activities that are most vulnerable to spills include: transportation facilities, loading and unloading areas, fuel and chemical storage areas, process activities, dust or particulate generating processes, and waste disposal activities.

Develop spill response procedures.

Limitations
This BMP only applies to spills caused by the contractor. The measures described in the BMP are general. The contractor is responsible for identifying practices for specific materials used, stored, or handled on a project site.

Standards and Specifications

Spills shall be contained and cleaned up as soon as possible.

If complete cleanup is not immediately possible, then spills shall be fully covered and not exposed to rainfall.

Spills shall not be washed down into the storm drain or buried.

Residuals left over from the cleanup activity such as absorbent pads or containers of spill material shall be disposed of properly.

Proper spill and illicit discharge reporting procedures shall be followed for both hazardous and non-hazardous materials.

An area where a spill has occurred shall be inspected to verify that spill residuals are not present after the initial cleaning and that the area does not need to be re-cleaned.

12.5.3 WASTE MANAGEMENT

Stormwater runoff from areas where construction wastes are stored or disposed of can be polluted. Wastes leached or spilled from management areas may build up in soils or on other surfaces and be carried by stormwater runoff. There is also the potential for liquid wastes from lagoons or surface impoundments to overflow, soak the surrounding area, or be washed to receiving waters. Solid wastes improperly stored can contaminate stormwater runoff and contribute pollutants. Possible contaminants include toxic compounds, oil and grease, oxygen-demanding organics, paints and solvents, heavy metals, and high levels of suspended solids.

The optimal approach to reduce the potential for stormwater contamination from wastes is to reduce the amount generated and, consequently, the amount stored onsite. Waste Management BMPs are considered for: concrete wash out, solid wastes, Sanitary and septic wastes, liquid waste, hazardous waste and contaminated waste.

12.5.3.A CONCRETE WASTE MANAGEMENT

Practices to be used in order to minimize and prevent concrete waste associated with construction activities from entering storm drains and watercourses.

Facilities or designated construction work areas where Concrete waste is generated from demolition activities; where concrete is used as a construction material; where concrete trucks or concrete-coated equipment are washed on site as permitted by the Town ; where

slurries containing Portland cement concrete (PCC) or asphalt concrete are generated; and where mortar-mixing areas exist.

1. Standards and Specifications

Collection, Storage, and Disposal Guidelines

Waste generated from concrete activities shall not be allowed to flow into drainage ways, inlets, receiving waters, or in the Town of Platteville right-of way. Concrete waste shall be placed in a temporary concrete washout facility.

Concrete washout facilities will be comprised of an excavation with erosion bales and construction fences along the perimeter. The bottom of the excavation must be proven to be at least 5 vertical feet above groundwater or, alternatively, the excavation must be lined with either a clay or synthetic liner that is designed to control seepage to a maximum rate defined in CDOT Standard Specifications for Road and Bridge, Section 208. The facilities shall be maintained in good condition to contain all liquid and concrete waste generated by operations at a project site.

Proper signage such as “Concrete Washout” or “Concrete Sawcutting Water Disposal” shall be placed near concrete washout facilities to inform construction personnel of the location of designated concrete washout facilities.

Temporary concrete washout facilities shall be located 100 horizontal feet from drainage ways, inlets, and receiving waters unless otherwise approved by the Town .

Adding solvents, flocculents, or acid to wash water is prohibited.

Hardened concrete waste shall be properly disposed of following solid waste management procedures.

Removal of temporary facilities, including the solid concrete waste and the material used to construct the facilities, shall be the responsibility of the contractor, who shall remove the waste from the project site and dispose of it properly following guidelines outlined in solid, liquid waste management and any applicable regulations.

12.5.3.B SOLID WASTE MANAGEMENT

Practices to be used in order to minimize and prevent solid waste associated with construction activities from entering storm drains and watercourses.

Facilities or designated construction work areas where solid waste is generated. Solid waste can be classified as non-hazardous solid material including: concrete, rock, debris, soil, wood, plastic, fabrics, mortar, metal scraps, Styrofoam, and general litter created by the public, such as but not limited to beverage containers and plastic wrappers.

Limitations
During the non-rainy season or in arid portions of the state, temporary stockpiling of non-hazardous solid waste may not require stringent drainage control measures. The Town shall determine if drainage control measures are warranted for a specific construction site where nonhazardous solid waste is being stockpiled.

Standards and Specifications

Collection, Storage, and Disposal Guidelines

Litter shall be minimized at all construction sites and collected on a weekly basis into water-tight dumpsters. Trash receptacles shall be provided in various locations within the construction site boundaries. Collected trash shall not be placed near drainage inlets or watercourses. A trash hauling contractor shall be used to properly dispose of the collected waste in a timely manner.

a.1. Dumpster washout at the construction site is not permissible.

a.2. Priority shall be given to remove waste and debris from drainage inlets, trash racks, and ditches in order to prevent clogging of the stormwater system.

a.3. Waste storage areas shall be pre-approved by the Town .

a.4. Storage areas for solid waste shall be located at least 100 feet from drainage ways and watercourses, and shall not be located in areas susceptible to frequent flooding. Sediment barriers such as berms, dikes, or other temporary diversion structures shall be used to prevent stormwater runoff from contacting stored solid waste at the project site.

a.5. Solid waste shall be segregated properly into various categories for recycling or disposal. Proper disposal is required for each waste category. The contractor shall make every attempt to recycle useful vegetation, packaging material, and surplus construction materials when practical. Most construction materials can be recycled at recycling facilities.

a.6. Additional disposal guidelines for hazardous materials and liquid waste.

12.5.3.C SANITARY AND SEPTIC WASTE MANAGEMENT

Practices to be used in order to minimize and prevent sanitary and septic waste associated with construction activities from entering storm drains and watercourses.

Facilities or designated construction work areas that use temporary or portable sanitary and septic waste systems.

Standards and Specifications

Temporary sanitary facilities shall be located away from drainage ways, inlets, receiving waters, areas of high traffic, and areas susceptible to flooding or damage by construction equipment.

Temporary sanitary facilities shall be properly connected into a sanitary sewer system where permissible to prevent illicit discharges. Authorized sanitary sewer system connections shall comply with local health agency, county, and sanitary sewer district requirements.

Wastewater generated from sanitary facilities shall not be allowed to flow into drainage ways, inlets, receiving waters, or into the Town of Platteville right-of-way.

Only licensed sanitary/septic waste haulers shall be used to properly dispose of waste from temporary sanitary facilities.

Temporary sanitary facilities shall be secured to prevent overturning.

12.5.3.D LIQUID WASTE MANAGEMENT

Practices to be used in order to minimize and prevent liquid waste associated with construction activities from entering storm drains and watercourses.

Facilities or designated construction work areas where liquid waste is generated.

Limitations

Does not apply to solid waste management, hazardous wastes, concrete slurries/wastes, dewatering operations, and sanitary/septic wastes.

Does not apply to non-stormwater discharges permitted by the CDPS permit held by Town of Platteville.

The following group of non-stormwater discharges are not considered to be illicit or illegal unless the discharges are identified by Town of Platteville as sources of pollutants to State waters:

landscape irrigation

diverted stream flows,

rising groundwater,

uncontaminated groundwater infiltration to separate storm systems,

uncontaminated pumped groundwater,

discharges from potable water sources,

foundation drains,

air conditioning condensation,

irrigation water,

springs,

water from crawl space pumps,

footing drains,

lawn watering,

individual residential car washing,

and flows from riparian habitats and wetlands.

Disposal of some liquid wastes may be subject to regulations or requirements of other CDPS permits secured for the construction site.

Standards and Specifications

The contractor shall oversee and enforce all liquid waste measures and will instruct all employees and subcontractors on the identification of hazardous and non-hazardous liquid waste, and non-hazardous handling, storage, and proper disposal.

The contractor shall hold regular safety meetings to ensure proper liquid waste measures are adhered to and efforts are made to minimize the amount of liquid waste produced.

The contractor shall ensure compliance with all liquid waste management procedures and practices.

12.5.3.E HAZARDOUS WASTE MANAGEMENT

Practices to be used in order to prevent hazardous waste associated with construction activities from entering storm drains and watercourses.

Facilities or designated construction work areas where hazardous waste is discovered or generated by lead paint removal operations, and other operations encountering waste that are designated as hazardous by the Code of Federal Regulations or Colorado state laws.

Contact Platteville/Gilcrest Fire Department for additional information.

12.5.3.F CONTAMINATED WASTE MANAGEMENT

Practices used to minimize and prevent pollutants from contaminated soils from leaching into watercourses or drainage systems.

Facilities or designated construction work areas where contaminated soils have been identified to be present.

Contact Platteville/Gilcrest Fire Department for additional information.

12.5.4 GENERAL POLLUTION PREVENTION

This section describes specific common BMPs that minimize stormwater runoff pollution. The objective of General Pollution Prevention BMPs is to reduce the discharge of materials other than stormwater to drainage systems or receiving waters.

The BMPs to consider are included in the following sections.

A Dewatering Operations
B Wind erosion control
C Paving Operations
D Street Sweeping & Vacuuming
E Vehicle & Equipment Management

12.5.4.A DEWATERING OPERATIONS

This involves practices to remove and discharge excess water from construction sites. These practices manage the discharge of groundwater and accumulated precipitation in order to prevent potential pollutants from entering storm drains and watercourses.

These dewatering practices are implemented to remove accumulated water and sediments from sediment traps, basins, and excavated areas. Sediment control from dewatering operations is required on all projects where excess water containing sediment-laden water is planned to be discharged.

Limitations

These practices are limited to providing sediment control only, allowing for minimal settling time for sediment particles. Other sediment control methods shall be used for better sediment removal when site conditions allow.

Standards and Specifications

The contractor shall notify the Town of all planned discharges. All dewatering operations must comply with applicable CDPS permits as well as regional and watershed-specific discharge requirements.

The following are guidelines for water quality control:

Water from dewatering operations shall not be directly discharged into any State waters including wetlands, irrigation ditches, canals, or storm drains, unless allowed by the permit.

Discharge into sanitary drains will not be allowed unless written permission is obtained from the owner or controlling authority and a copy of this approval submitted to the Town.

Unless prohibited by law or otherwise specified in the contract, water from dewatering operations shall be contained in basins for dissipation by infiltration or evaporation; hauled away from the project for disposal in accordance with applicable laws and regulations; or shall be land applied to approved non-wetland vegetation areas and allowed to soak into the soil. Depending upon the quality of the water, land application of water to vegetated areas may require a written concurrence of permit from the CDPHE. The contractor shall determine the quality of water based on the CDPHE guidelines, obtain applicable concurrences or permits, and furnish copies of the concurrences or permits to the Town.

12.5.4.B NON-STORMWATER DISCHARGE MANAGEMENT

This involves practices implemented to prevent discharges of potential pollutants from irrigation systems, discharges from potable water sources, water line, hydrant flushing and other similar activities from entering storm drains and watercourses.

These practices are implemented where irrigation and water flushing practices exist at a construction site.

Standards and Specifications

Offsite flows shall be routed around construction sites to prevent runoff from scouring the construction site and carrying sediment loads downstream.

Broken irrigation and waterlines shall be shut off at the source to prevent excess water flow and repaired immediately.

Irrigation systems shall be scheduled to water construction areas without over-watering and causing runoff. Considerations should be made for site-specific conditions such as soil type, slopes, season, and vegetation type when developing watering schedules.

Inlets and watercourses shall be protected with bales or other suitable BMPs from potentially polluted discharges at construction sites. In addition, when possible, non-polluted water resulting from waterline or hydrant flushing shall be reused for irrigation purposes.

12.5.4.C WIND EROSION CONTROL

This involves practices implemented during construction operations, such as applying water or dust palliatives, to prevent wind erosion from exposed soil surfaces.

These practices are limited to exposed soil where wind erosion is expected.

Limitations

The effectiveness of this application can be limited by soil, temperature, and wind velocity.

Standards and Specifications

Irrigation practices can be applied to a project site until the soil is moist and can be repeated as necessary. However, the soil shall not be over saturated causing runoff to flow from the project site. The distribution system shall be equipped with a proper spray system to ensure even water distribution. When a distribution system is unavailable, at least one mobile unit shall be available at all times to apply water or a dust palliative to the project site. All non-potable tanks, pipes, and other conveyances shall be marked "non-potable water-do not drink."

Other temporary methods to prevent wind erosion include seeding, mulching, soil binder, and grading techniques.

12.5.4.D PAVING OPERATIONS

Practices implemented during paving and grinding operations to prevent associated stormwater pollutants from entering storm drains and watercourses.

These practices are implemented where paving and grinding operations such as surfacing, resurfacing, or saw cutting may cause pollutants to enter stormwater runoff.

Limitations
These practices are limited to dry weather conditions.

Standards and Specifications

Protect drainage inlet structures and manholes with filter fabric during paving applications.

Do not conduct paving operations when rainfall is predicted.

Use drip pans or absorbent materials under equipment not in use to catch and contain leaks.

Use only non-foaming and non-toxic coating materials for asphalt trucks and spreading equipment. Follow vehicle cleaning and maintenance guidelines to properly clean asphalt-coated equipment offsite. Dispose of hardened asphalt debris and aggregate debris by following guidelines for concrete waste management.

Apply temporary perimeter controls when asphalt material is used in embankments or shoulder backing to prevent materials from entering the storm drains or watercourses. Examples of perimeter controls are silt fences, berms, and drainage swales.

Do not wash waste sweepings from exposed aggregate concrete into storm drain inlets. Sweepings shall be placed back into the aggregate base stockpile.

Residuals from grinding operations shall not be allowed to remain on the pavement surface or flow across the pavement surface into a watercourse. Residuals shall be cleaned up or contained.

Recycle excavated material and excess asphalt when possible during pavement grinding and removal. If material cannot be reused, store or dispose of properly.

When using thermoplastic striping techniques or performing pavement application/removal inspect equipment for leaks, do not overfill tanks, and do not transfer material near stormwater inlets, storm drain systems, or watercourses.

During raised or recessed pavement marker application, make sure to transfer or load bituminous material away from storm drains and watercourses. Do not overfill melting tanks so as to prevent splashing. Release all pressure from melting tanks before removing lids while filling or servicing. Follow proper disposal methods for collecting excess bituminous material from the roadway after removal of pavement markers.

12.5.4.E STREET SWEEPING AND VACUUMING

Practices to remove sediment transported onto streets to prevent the sediment from entering a storm drain or watercourse.

These practices are implemented anywhere sediment is tracked from the project site onto public or private roads, typically at points of egress.

Limitations
Sweeping and vacuuming may not be effective when soil is wet or muddy.

Design Guidelines

Visible sediment tracking shall be swept and vacuumed on a daily basis.

If not mixed with debris or trash, consider incorporating the removed sediment back into the project.

12.5.4.F VEHICLE AND EQUIPMENT MANAGEMENT

Practices used during vehicle and equipment fueling, cleaning, and maintenance to prevent associated stormwater pollutants from entering storm drains and watercourses.

Facilities or designated construction work areas where vehicles and equipment are fueled, cleaned, or maintained.

Standards and Specifications

Perform cleaning, washing, and maintenance in a centralized station offsite. Onsite activities are highly discouraged.

Designated onsite stations should preferably be located indoors on impervious surfaces 50 feet away from watercourses, configured with a sump, and bermed to collect the wastewater.

Wastewater shall not be discharged into the Town of Platteville right-of-way. Wastewater shall be contained for percolation and evaporation.

Constructed berms shall be durable and leak proof.

Eliminate or reduce the amount of toxic or hazardous solvent used.

Use proper waste or recycling drums for used or spilled fluids. Separate and recycle materials when possible.

Use drip pans or absorbent materials under equipment to catch and contain leaks.

Do not pour liquid waste into floor drains, sinks, or storm drain inlets.

Avoid hosing down work stations.

Routinely check vehicles and equipment for leaking oil or fluids.

Proper spill and illicit discharge reporting and cleanup procedures shall be followed for both hazardous and non-hazardous materials.

12.6 THE EROSION CONTROL PLAN

A site specific Erosion Control Plan shall be submitted to the Town for review and approval. The Erosion Control Plan should be consistent with the site's drainage report and shall be included within the required drainage report for the project.

NOTE: The Construction Permit from the Colorado Department of Public Health, Water Quality Control Divisions requires a Stormwater Management Plan (SWMP) be prepared. The Erosion Control Plan may or may not meet this requirement. It is up to the design engineer to determine if they have developed an adequate SWMP to meet the state requirements.

12.6.1 PRELIMINARY EROSION CONTROL PLAN

The following information shall be included within the Preliminary Erosion Control Plan which shall be submitted along with the Preliminary Drainage Report (refer to Section 2.3 of these Criteria) for the site:

Name, address and telephone number of the applicant and the Professional Engineer preparing the report.

Project description; briefly describing the nature and purpose of the development, the total area of the site, the area of disturbance involved, and the project location, including township, section and range.

Existing site conditions should be described, including existing topography, vegetation, and drainage. If wetlands are present on the site they must be described: location, aerial extent, and type. It is the applicant’s responsibility to determine and comply with all other federal or state regulations regarding the impact of development on wetlands.

A vicinity map indicating the general area and property lines for the site should be included. Acceptable scales range from 1" = 1000' to 1" = 2000'.

An exhibit or map of existing and proposed drainage features or facilities, and basin boundaries (existing and proposed) for the site. Complete basin boundaries shall be shown for all basins extending off of the site.

Neighboring areas must be described as to land use and existing features, such as adjacent streams, lakes, structures, roads, etc.

A description of the stormwater quality management-planning concept for the site.

Preliminary sizing and location of the selected BMP's.

A discussion of the maintenance requirements for all proposed BMP's, including suggested schedules, costs and designation of responsible party.

12.6.2 EROSION CONTROL PLAN

In addition to items numbered 1 through 9 as required in the Preliminary Erosion Control Plan, the following information must be included within the Final Erosion Control Plan, which shall be submitted along with the Final Drainage Report (refer to Section 2.4 of these Criteria):

A discussion of the final design, sizing and location of the selected BMP's.

Hydrologic, hydraulic and all other calculations used to size and design the selected BMP's.

A final site and grading plan indicating the path of all stormwater flow and the location of stormwater control and stormwater quality facilities.

Final construction drawings of the proposed stormwater quality improvements, if appropriate.

12.7 EXTERIOR TRASH COMPACTORS

This new requirement applies to all commercial stores as detailed below.

The area of the exterior trash compactor shall be provided with curb all around except the entry to prevent surface water from entering the trash compactor area drain. The entry side must be ramped in a manner to channel surface water away from the entry edge. The trash compactor curbed area shall slope to a low point where an area drain, like a catch basin, shall be provided.

For exterior trash compactors the area drain shall be connected to the storm water drainage system via a double compartment grease/sand interceptor to intercept sediment and any oil and grease fluid leakage from the compactor.

For interior trash compactors the area drain shall be connected to the sanitary sewage system.

The interceptor shall be a minimum of 750 gallon capacity per UPC definition for Grocery stores, Hardware stores, and Lumber yards.

The interceptor for all other type stores shall be a minimum of 350 gallon grease and sand trap.

A 4 inch drain connection will be adequate for the area involved.

The area drain need not be trapped and vented. The grease/sand interceptor shall serve as the trap and shall be properly vented per the Town of Platteville’s current Plumbing Code.

The access manhole covers over the interceptor compartments shall be accessible while the trash compactor is attached to the building and functioning, to allow cleaning and inspections to occur without moving the trash compactor.

12.8 SWIMMING POOLS, SPAS, JACUZZIS, FISHPONDS AND FOUNTAINS

This is a new section discussing the regulatory issues regarding the discharge of water from swimming pools, spas, Jacuzzis, fishponds and fountains. These facilities often contain chemicals used for sanitizing or cleaning purposes. These chemicals (such as chlorine or copper-based algaecides) may be damaging to the environment if the wastewater is allowed to flow to the South Platte River by way of storm drains. It is illegal to discharge filter backwash and chlorinated water into the storm drains.

Filter backwash shall be discharged into the sanitary sewer system and not into the street. Backwash water has a heavy concentration of chlorine and other chemicals that are good for treating sewage water, but are damaging to natural aquatic environments. Additionally, backwash leaves a residue of contaminated diatomaceous earth (DE) along the gutter and street. If filter backwash cannot be discharged to the sanitary sewer, a catch basin should be installed to remove the DE prior to draining it into a landscaped area.

Federal law allows **dechlorinated pool water** to be released to the environment, if the following criteria are met:

The residual chlorine does not exceed 0.1 mg/l (parts per million)

The pH is between 6.5 and 8.5

The water is free of any unusual coloration

There is no discharge of contaminated filter media.

There is no discharge of acid cleaning wastes.

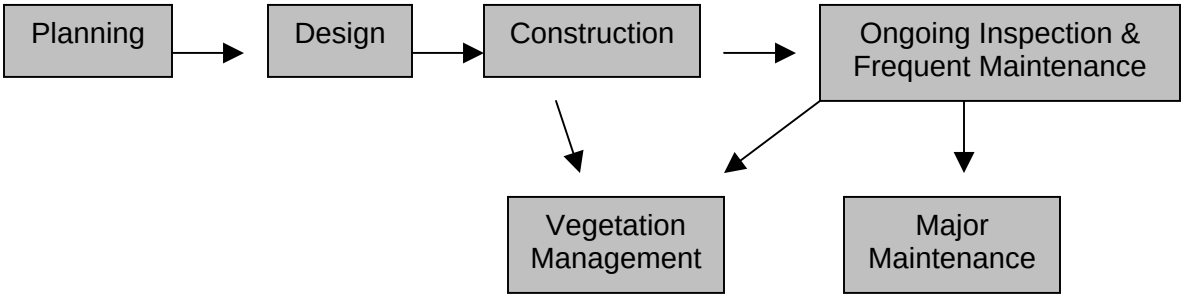
12.9 POST CONSTRUCTION: LONG TERM OPERATION & MAINTENANCE OF STRUCTURAL CONTROL BMP'S

In accordance with the National Pollution Detection and Elimination System (NPDES) Phase II, structural BMP's like detention and retention ponds are to be actively maintained to ensure the long-term operation and maintenance.

Stormwater ponds and wetlands are popular stormwater structural BMP's for a number of reasons including aesthetics, pollutant removal capability, habitat value and relatively low maintenance burden. Stormwater wetlands can provide diverse habitat for aquatic and terrestrial species. The large permanent pool volume of ponds and wetlands enhances pollutant removal because of relatively long residence times, reduced flow velocities and their ability to retain settled sediments and pollutants. Stormwater wetlands also provide biological uptake of pollutants through contact between wetland plants and stormwater runoff.

Stormwater pond maintenance is related to the entire pond lifecycle, depicted below and needs to be considered in the design phase.

Figure 12.9 - The Pond / Wetland Lifecycle



Maintenance is necessary for a stormwater pond or wetland to operate as designed on a long-term basis. The pollutant removal, channel protection, and flood control capabilities of ponds and wetlands will decrease if:

Sediment accumulates in the pond, reducing the storage volume

Debris blocks the outlet structure

Pipes or the riser are damaged

Invasive plants out compete the wetland plants

Slope stabilizing vegetation is lost

The structural integrity of the embankment, weir, or riser is compromised.

Pond and wetland maintenance activities range in terms of the level of effort and expertise required to perform them. Routine pond and wetland maintenance, such as mowing and removing debris or trash, is needed multiple times each year, but can be performed by property owners. This could include Home Owner's Associations and Business Owners. More significant maintenance such as removing accumulated sediment is needed less frequently, but requires more skilled labor and special equipment. Inspection and repair of critical structural features such as embankments and concrete structures, needs to be performed by a qualified professional (e.g., professional engineer) that has experience in the construction, inspection and repair of these features.

Property owners and responsible parties need to recognize and understand that neglecting routine maintenance and inspection can lead to more serious problems that threaten public safety, impact water quality, and require more expensive corrective actions.

A typical inspection/maintenance frequency for Ponds and Wetlands is presented below.

TABLE 12.9(1) - TYPICAL INSPECTION / MAINTENANCE FOR PONDS AND WETLANDS

Frequency	Inspection Item	Skill Level	Maintenance Items
Monthly to Quarterly or After A Storm Event (>1 ")	Inspect low flow orifices and other pipes for clogging Check the permanent pool or dry pond area for floating debris and undesirable vegetation Check banks for erosion	0	Mowing – minimum Spring & Fall Remove debris in and around trash racks, water quality boxes and trickle pans.
One time – After First Year	Ensure that at least 85% of vegetation survive Check for invasive plants and noxious weeds	1-2	Replace vegetation as needed
Every 1 to 3 years	All routine inspection items listed above Inspect riser, barrel and	3	Repair pipe and riser as needed

	embankment for damage Inspect all pipes Monitor sediment deposition in facility and forebay		Forebay maintenance and sediment removal when needed.
2-7 years	Monitor sediment deposition in facility and forebay	3	Forebay maintenance and sediment removal when needed
10 -25 years	Remote television inspection of reverse slope pipes, under drains, and other non-accessible piping.	3-4	Sediment removal from main pond/wetland Pipe replacement if needed

The skills level needed to diagnose a problem during inspection is listed below and referenced in the above table.

Skill Level	Description
0	No special skills or prior experience required.
1	Maintenance crew member or citizen with prior experience with ponds and wet lands
2	Agronomist with experience with plants within ponds and wetlands
3	Contractor or Inspector with extensive pond and wetland maintenance issues.
4	Professional Engineer

SECTION 13.0 CONSTRUCTION SITE SEDIMENT AND EROSION CONTROL
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SECTION 13.0 CONSTRUCTION SITE EROSION AND SEDIMENT CONTROL

13.1 INTRODUCTION

Construction activities that disturb the natural soil and vegetation have the potential to increase soil erosion and sediment movement. The forces of rainfall, concentrated runoff, and even strong winds easily erode the disturbed, loose soil. Erosion and sediment control practices, also known as Best Management Practices (BMPs), shall be required to the maximum extent practicable, on all developing or redeveloping lands within the Town of Platteville. BMPs are "schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States (40 CFR 122.2). Implementation of BMPs for erosion and sediment control and stormwater management are required by the CPDS stormwater regulations, and other regulatory guidance (see section 12.0). BMPs are to be included in the SWMP drawings prepared for construction projects. They shall be designed to prevent disturbed soils from entering stormwater runoff and maintain stormwater quality at a level comparable to the historic runoff conditions, which existed prior to the construction activities.

Part of the NPDES program consists of reducing the amount of silt and erosion from construction sites, as well as the proper handling and storage of fuels, lubricants, chemicals and other waste, debris and slurry commonly found in construction areas.

These Criteria are developed from information and design guidelines presented in the Urban Storm Drainage Criteria Manual (USDCM), Volume 3, "Best Management Practices." The reader is referred to the USDCM for an extensive discussion of the development of erosion and sediment control BMPs.

The Town of Platteville requires that a grading permit be obtained for construction activities on sites equal to or greater than 1 (one) acre, or a site that is a part of a larger common plan of development (which would include phased development of sites less than 1 (one) acre).

Other sites smaller than one acre but, due to the nature of their topography or location, provide a potential for significant negative impact on the Town's stormwater facilities, streets, or receiving waters, also must use BMPs during construction activity. The Town shall identify such sites and provide written notice to the property owner with instructions to obtain a grading permit and prepare a SWMP plan prior to beginning or continuing grading activities.

In accordance with the requirements of the Federal Clean Water Act, the State of Colorado requires that a stormwater discharge permit be obtained for construction activities on sites equal to or greater than 1 (one) acre, or a site that is part of a larger common plan of development (which would include phased development of sites less than 1 (one) acre). Information on the requirements and forms necessary for obtaining a stormwater discharge permit from the State of Colorado may be obtained from the Stormwater Unit, Water Quality Control Division, of the Colorado Department of Public Health and Environment.

Common Construction site violations:

1. Failure to maintain silt fence, inlet protection or tracking pads
2. Un-contained Concrete slurry or masonry wash-out

3. Wanton disregard for erosion control devices by contractors/subcontractors, i.e. driving over, moving or removing BMPs
4. Dirt and/or mud tracked onto streets
5. Stockpiling of dirt, manure, rocks or other products on street or parking lots
6. Use of Detention ponds as stock-pile areas.

13.2 OBJECTIVES FOR EROSION AND SEDIMENT CONTROL PRACTICES

The following objectives and principles of erosion and sediment control shall be used by the Town to determine if a site undergoing land disturbing activities has proposed and implemented adequate BMPs.

1. Fit development to the existing terrain and retain existing vegetation. The goal of this objective is to minimize the overall land disturbance, and maintain stormwater quality in a condition more similar to natural historic levels.
2. Schedule construction, grading, and land disturbing activities to minimize soil exposure, and avoid heavy runoff seasons. The best protection is prevention; therefore, effective scheduling should be used to minimize soil exposure between initial grading and completion of final grading or installation of improvements.
3. Manage stormwater flows to minimize erosion and sediment movement. This objective would include diverting concentrated flows from disturbed slopes, minimizing the length and steepness of disturbed slopes, keeping runoff velocities low, and preparing or reinforcing drainage ways and outlets to receive runoff flows.
4. Do not allow increased sediment movement off of the site. All sediment disturbed on site should be contained and either redeposited in a more stable location, or removed from the site.
5. Inspect, maintain, and remove all measures when appropriate. Scheduling will be highly dependent on the selection of BMPs, the rainfall/runoff events occurring during the land disturbance period, and the establishment of permanent stabilization.

The objective of erosion control is to limit the amount of erosion occurring on disturbed areas until the site is stabilized. The objective of sediment control is to capture the eroded soil before it leaves the construction site.

13.3 PERFORMANCE AND DESIGN CRITERIA

The Town shall require that BMPs for construction site or land disturbing activities be designed and implemented for each site in a manner that addresses the objectives and principles of erosion and sediment control (see Section 13.2). Given that the land use, topography, soils, and runoff flows will vary from site to site, it is expected that the proposed BMPs for each site will also vary.

The BMPs for a construction site are usually comprised of five major elements:

Erosion Control

Sediment Control

Materials Handling and Spill Prevention –See Section 12.0

Waste Management – See Section 12.0

General Pollution Prevention Measures – See section 12.0

The Town of Platteville recommends the use of the following stormwater quality management BMPs, as presented in the USDCM, Volume 3, "Best Management Practices" and listed below:

1. Erosion Control:

   Erosion controls are surface treatments that stabilize soil exposed by excavation or grading. Erosion control measures are referred to as source controls.

   Erosion and sedimentation processes during and after construction or maintenance activities can result in adverse impacts to the environment. These adverse impacts can be minimized through the proper application of BMPs. Some of the most common erosion control BMPs are presented in following table.

TABLE 13.3(1) - EROSION CONTROL BMPS	
Soil Stabilization	Re-vegetation & Waddles
Surface Roughening	Erosion Control Blankets
Mulch Tackifier	Turf Reinforcement Mats (can be harmful to wildlife, see Section 5), & Terra Cell
Outlet Protection	Grading Techniques & Rip Rap
Drainage Way Protection	Design Techniques, Rip Rap, & Concrete

2. Sediment Control:

   Sediment controls capture soil that has eroded. Soil particles suspended in runoff can be filtered through a porous media or deposited by slowing the flow and allowing the natural process of sedimentation to occur.

   Sites exposed to wind, rain and snow can be susceptible to soil erosion and subsequent sedimentation. Sedimentation results when soil particles are suspended in surface runoff or wind and are deposited in streams and other water bodies.

   Erosion can be accelerated by vegetation removal, earthwork activities, changing natural drainage patterns, and by covering the ground with impermeable surfaces. It is important to recognize that the optimal BMP is to prevent or minimize erosion by proper planning and the use of the erosion control practices identified above. However, erosion is inevitable to some extent on construction sites. Therefore, anticipating sedimentation and providing for a secondary line of defense by implementing sediment control is good planning. Sediment control BMPs are intended to intercept, slow, or detain the flow of stormwater to allow sediment to settle and be trapped. Some of the most common sediment control BMPs are listed in table below:

TABLE 13.3(2) - SEDIMENT CONTROL BMPS	
Sediment Basins & Traps	Vehicle Tracking Pads
Slope Drains & Dikes	Silt Fence Mirafi 100x or equivalent
Storm Drain Inlet Protection	Inlet Filters
Brush Barrier	Erosion Bale or Logs

NOTE: If Silt Fencing is used to delineate the site, it will be inspected for operation and maintenance. It is suggested that silt fence be used only where it is needed to keep stormwater runoff from running off the site in a rain event.

If wind erosion is a suspected problem the use of orange safety fence 15 – 20' upwind of the silt fence is recommended. There shall be a 'Tee' post every 15' minimum. Periodic maintenance of the safety fence will be required. Occasional removal of sediment will be required between the orange safety fence and the silt fence. This procedure shall be followed until the threat of erosion has elapsed.

3. Materials Handling & Spill Prevention

Materials Handling and Spill Prevention are measures implemented to minimize or prevent contamination of the natural resources present from materials stored on construction sites.

Material management is important, because the optimal approach to reduce pollution potential is to prevent it at the source. Material storage areas are a major source of risk due to possible mishandling of materials and accidental spills. Developing protocols for materials storage and handling, and response procedures for handling spills, are necessary measures to minimize the contamination impact to stormwater runoff. Developing and incorporating these measures will increase awareness and minimize the opportunities for mishandling and spills.

The following BMPs provide guidance on material management and spill prevention and control.

TABLE 13.3(3) - MATERIALS HANDLING & SPILL PREVENTION BMPS
Stockpile Management
Material Management
Material Use
Spill Prevention & Control

4. Waste Management

Waste Management BMPs are measures implemented to minimize or prevent contamination of the natural resources present from waste materials.

Stormwater runoff from areas where construction wastes are stored or disposed of can be polluted. Wastes leached or spilled from management areas may build up in soils or on other surfaces and can be carried by stormwater runoff. There is also the potential for liquid wastes from lagoons or surface impoundments to overflow, soak the surrounding area, or be washed to receiving waters. Solid wastes improperly stored can contribute stormwater runoff and

contribute pollutants. Possible contaminants include toxic compounds, oil and grease, oxygen-demanding organics, paints and solvents, heavy metals and high levels of suspended solids.

The optimal approach to reduce the potential for stormwater contamination from wastes is to reduce the amount generated and, consequently, the amount stored on site. The BMPs listed below can provide guidance on dealing with the management of wastes.

TABLE 13.3(4) - WASTE MANAGEMENT BMPS
Concrete Wastes
Solid Waste
Sanitary & Septic Waste (Port-A-Potty's)
Liquid Waste
Hazardous Waste
Contaminated Waste

5. General Pollution Prevention:

General Pollution Prevention BMPs are implemented to minimize or prevent general contamination of the construction site and natural resources present.

The objective of General Pollution Prevention BMPs is to reduce the discharge of materials other than stormwater to drainage systems or receiving waters. Some BMPs to consider for this application are listed below:

TABLE 13.3(5)- GENERAL POLLUTION PREVENTION BMPS
Non-stormwater Discharge Management
Wind Erosion Control
Paving Operations
Street Sweeping & Vacuuming
Vehicle & Equipment Management

Design criteria and construction details for the selected BMPs are presented in the USDCM, Volume 3, "Best Management Practices". The Town encourages the innovative use and application of measures to adequately and efficiently control erosion and sediment movement due to land disturbing activities. Methods and applications of BMPs designed to meet the objectives for erosion and sediment control are expected to grow, improve, and expand. Owners of land undergoing land-disturbing activities are encouraged to utilize the newest technology available and incorporate the design data for these new methods in the Stormwater Management Plan (SWMP).

13.3.1 MINIMUM PERFORMANCE AND DESIGN CRITERIA

The Town shall evaluate the adequacy and appropriateness of the proposed BMPs based on their fulfillment of the previously stated objectives, as well as the satisfaction of the following minimum performance and design criteria:

1. Erosion Control Plan approved by the Town.

2. Adjacent properties are protected from increased erosion and/or sediment deposition.
3. Construction access routes protect adjacent properties from sediment and mud tracking through either immediate placement of street base or construction of mud pads.
4. Timing and stabilization of sediment trapping practices is scheduled before site grading and construction.
5. Sediment traps/basins must be constructed if one (1) acre, or greater, of disturbed land drains to a common outfall.
6. All disturbed areas shall be adequately stabilized as defined in the USDCM, Volume 3, "Best Management Practices". Permanent or temporary soil stabilization shall be required within 7 days after final grade is reached. If disturbed areas or stockpiles are not brought to final grade within 30 days following the initial disturbance, or re-disturbance, temporary stabilization measures shall be required.
7. All storm drain inlets shall be protected from the entry of sediment-laden water.
8. The landowner shall be held responsible for the long-term stability of cut and fill slopes and the successful establishment of permanent vegetative cover on exposed soil as defined in the USDCM, Volume 3.
9. Inspection of all erosion and sediment control BMPs shall be required at the end of each day's work, with necessary maintenance and repairs provided immediately.
10. All temporary erosion and sediment control measures shall be removed as soon as their function has been fulfilled. Sediment traps/basins shall be cleaned and removed, or stabilized, when all upstream areas are permanently stabilized.
11. Construction work in or directly adjacent to a watercourse shall require adequate bed and bank stabilization as defined in the USDCM, Volume 3. Construction work within a defined channel shall require a stream crossing structure for bed and bank protection.
12. Construction work in flowing channels is prohibited in the months of May and June.
13. The construction of underground utilities shall be included as a land disturbing activity. All excavated material shall be placed where sediment will erode back into the trench. All trenches shall be backfilled by the end of the days work; backfill shall be permanently stabilized before construction is considered complete.

13.4 EROSION CONTROL PLAN

A site specific Erosion Control Plan shall be submitted to the Town for review and approval.

NOTE: The Construction Permit from the Colorado Department of Public Health, Water Quality Control Divisions requires a Stormwater Management Plan (SWMP) be prepared. The Erosion Control Plan may or may not meet this requirement. It is up to the design engineer to determine if they have developed an adequate SWMP to meet the state requirements.

The link to the permit and the rational are provided below:

http://www.cdphe.state.co.us/wq/PermitsUnit/stormwater/SWConstructionApplication.pdf

The Erosion Control Plan shall consist of two components: the first component shall be a narrative report describing the site, the proposed land disturbing activities, and the recommended BMPs for erosion and sediment control, materials handling and spill prevention, waste management and general pollution prevention BMPs; the second component of the Erosion Control Plan shall be a site plan.

The Erosion Control Plan should be consistent with the site's drainage report, and shall be included within the required drainage report for the project.

13.4.1 PRELIMINARY EROSION CONTROL PLAN

The submittal for the Preliminary Erosion Control Report (which shall be submitted with the Preliminary Drainage Report as described in Section 2.3 of these Criteria) shall consist of the following information:

13.4.1.A NARRATIVE REPORT (PRELIMINARY)

1. Name, address, and telephone number of the applicant and the Professional Engineer preparing the report.
2. A project description briefly describing the nature and purpose of the land disturbing activity, the total area of the site, and the project location including township, range, and section.
3. The existing site conditions should be described, including existing topography, vegetation, and drainage. If wetlands are present on the site they must be described: location, aerial extent, and type. It is the applicant's responsibility to determine and comply with all other federal or state regulations regarding the disturbance of wetlands.
4. A vicinity map indicating the general area and property lines for the site should be included. Acceptable scales range from 1" = 1000' to 1" = 2000'.
5. Neighboring areas must be described as to land use and existing features such as streams, lakes, structures, roads, etc.
6. Soils information for the site should include soil type and names, mapping unit, erodibility, permeability, hydrologic soil group, depth, texture, and soil structure. This information may be obtained from the soil report for the site, from soil reports available for adjacent sites, or from Soil Conservation Service information. The source of information must be indicated.
7. Area and volume (in cubic yards) of the estimated quantity of excavation and fill on the site, and the surface area (acres) of the proposed disturbance.
8. A discussion of the approach to stormwater management on the site, including the erosion and sediment control measures to be used during construction. Briefly indicate the post-construction stormwater quality control measures to be included in the site development, or refer to the site's Stormwater Management Plan, if applicable.

13.4.1.B EROSION CONTROL DETAILS (PRELIMINARY)

1. The site plan shall be presented on a 24" x 36" drawing, at scales ranging from 1" = 20' to 1" = 200'. The information required on this site plan may be placed on the site drainage plan, if it can be clearly presented.
2. Existing and if available proposed topography shall be shown at one or two-foot contour intervals. Topography information shall extend at least 100 feet beyond the property line.
3. Show the location of all on-site existing structures and hydrologic features on the site. All off-site existing structures or hydrologic features within 100 feet of the property boundaries shall also be shown. The path of both existing and proposed developed stormwater runoff flows leaving the site shall be identified.
4. Indicate the preliminary location of the proposed structures and development of the site.
5. Indicate the proposed limits of clearing and grading.
6. If required for the proposed construction or development activity, indicate preliminary locations of the following: temporary roads, soil stockpiles, and construction storage areas.

13.4.2 FINAL EROSION CONTROL PLAN

The Final Erosion Control Plan (which shall be submitted with the Final Drainage Report, as described in Section 2.4 of these Criteria) shall be based on the comments and review of the preliminary submittal, and the final construction plans for the project site. In addition to presenting all of the information included in the Preliminary SWMP, the submittal for the Final SWMP Report shall also include the following:

13.4.2.A NARRATIVE REPORT (FINAL)

1. Final summaries of the areas (acres) and volumes (cubic yards) of the excavation and fill on the site, and the total surface area of the proposed disturbance.
2. A description of erosion and sediment control measures which will be used on the site.
3. A construction schedule for all proposed site grading or other construction activities must indicate:
    a. Start and completion dates for all construction.
    b. Construction sequence, including the installation and removal time periods of erosion and sediment control measures.
    c. Period and length of exposure of each area prior to the completion of temporary erosion and sediment control measures, as well as permanent stabilization.
    4. Maintenance and inspection schedules for all erosion and sediment control measures during construction should be described.
    5. A technical appendix should include all design calculations for determining rainfall and runoff, and sizing any basins, diversions or other conveyance or retention/detention facilities.

13.4.2.B EROSION CONTROL DETAILS (FINAL)

1. The final grading for the site, shown at one- or two-foot contour intervals, including elevations, dimensions, location, extent, and slope of all grading, including building site and driveway grades.
2. Final location of any soil stockpiles, storage areas (including equipment, fuel, lubricants and waste storage) and temporary roads designated for use during the construction period.
3. Plans of all drainage features, paved areas, retaining walls, cribbing, planting, temporary or permanent soil erosion control measures, or other features to be constructed in connection with, or as a part of, the proposed work. The drainage area of land tributary to the site in general, and isolated areas of disturbance, if applicable, should be shown. Tributary areas to all existing or proposed drain inlets should also be shown. All erosion measures should be depicted using the standard map symbols shown in Figure 13-1.
4. Design/detail drawings for any practices or measures not referenced in these Criteria should be included.
5. The following note shall be included on the Erosion Control Details:
6. "These Erosion & Control Details have been submitted to the Town of Platteville in fulfillment of the Town Criteria. Additional erosion and sediment control measures may be needed if unforeseen problems occur or if the submitted plan does not function as intended. The requirements of this plan shall run with the land and be the obligation of the land owner until such time as the plan is properly completed, modified, or voided. Note: These Erosion & Sediment Control Details in and of themselves do not fulfill the requirements of the Colorado Department of Public Health: Stormwater Construction Permit for a Stormwater Management Plan(SWMP)"
7. A signature block shall be placed below the note. The landowner and/or their legal agent shall affix their signature beneath the above note to acknowledge their review and acceptance of responsibility. The Professional Engineer responsible for the preparation of the Erosion Control Plan shall also affix their signature and seal.

13.5 REVIEW AND APPROVAL

The Town must issue a written approval or signed plans of the Erosion Control Plan prior to the issuance of a grading permit, subdivision plat approval, or site plan approval. The Erosion Control Plan must be consistent with the Drainage Report submitted in accordance with the Town of Platteville Criteria. The Drainage Report and Erosion Control Plan can be combined in one submittal package. Approval of the Erosion Control Plan does not imply acceptance or approval of Drainage Plans, Utility Plans, Street Plans or any other aspect of site development.

13.6 RESERVED

13.7 EXEMPTIONS AND VARIANCES

A variance request should be included with, or submitted prior to, the initial Stormwater Management Plan submittal. Variances may be granted at the time of plan submission or request

for plan revision. Variances must be requested in accordance with the subdivision regulations and must define:

1. The criteria from which the applicant seeks a variance.
2. The justification for not complying with the criteria.
3. Alternate criteria or measures to be used in lieu of these Criteria. The practices specified within these Criteria relate to the application of specific erosion and sediment control practices. Other practices or modifications to specified practices may be used if approved by the Town of Platteville prior to installation. Such practices must be thoroughly described and detailed to the satisfaction of the Town.

RECOMMENDED PLAN SYMBOLS:

EXISTING CONTOUR

FINISHED CONTOUR

DRAINAGE DIVIDE

LIMIT OF GRADING

STORMWATER

BOUNDARY OF A CONTROL MEASURE

TITLE	KEY	SYMBOL
VEHICLE TRACKING CONTROL WITH WASH RACK	WR	WR
MULCHING	MU	MU
TACKIFIER	T	T
SURFACE ROUGHENING	SR	SR
TEMPORARY SEEDING	TS	TS
PERMANENT SEEDING	PS	PS
CONSTRUCTION ROAD STABILIZATION	CRS	CRS
WADDLE	W	
SILT FENCE	SF	

PV_DRAIN_P207.DWG

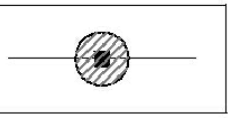
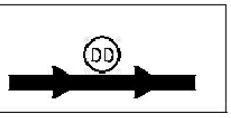
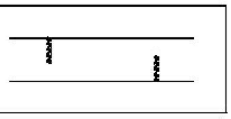
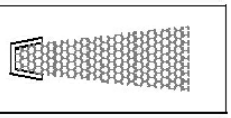
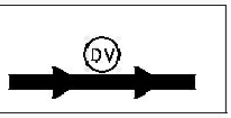
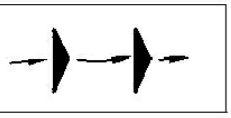
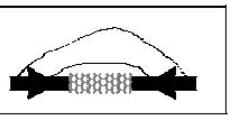
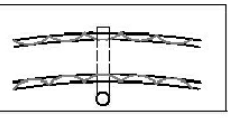
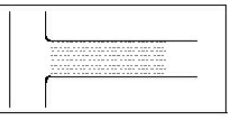
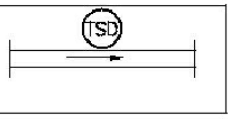
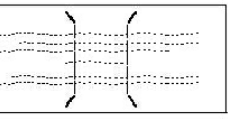
CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

MAP SYMBOLS

FIGURE 13-1

March, 2010

NOT TO SCALE

TITLE	KEY	SYMBOL
STORMWATER INLET PROTECTION	IP	
TEMPORARY DIVERSION DIKE	DD	
ROUGH CUT STREET CONTROL	RCS	
OUTLET PROTECTION	OP	
TEMPORARY CHANNEL DIVERSION	DV	
CHECK DAM	CD	
TEMPORARY SEDIMENT TRAP	ST	
TEMPORARY SEDIMENT BASIN	SB	
VEHICLE TRACKING CONTROL	VTC	
TEMPORARY SLOPE DRAIN	TSD	
TEMPORARY STREAM CROSSING	SC	

PV_DRAIN_P208.DWG

CONSTRUCTION STANDARD
TOWN OF PLATTEVILLE, COLORADO

MAP SYMBOLS
(CONTINUED)

FIGURE 13–1

March, 2010

NOT TO SCALE

SECTION 14.0 VEGETATION AND IRRIGATION
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SECTION 14 - VEGETATION AND IRRIGATION

14.1 VEGETATION REQUIREMENTS

All vegetated detention facilities shall have permanent underground irrigation systems and shall be seeded or sodded. In addition, native grass mix and soil amendments shall be approved by one of the following: a Certified Professional Agronomist (CPAg), a Certified Horticulturist, a Colorado State University Certified Master Gardner, a Local Seed Company, or a combination of the above. This approval shall be submitted to the Town in report or letter form. Before the two year warranty on seeding or sodding has elapsed one of the above listed professionals shall certify that at least 85% of the surface area throughout the detention facility is covered by approved grasses. No noxious weeds shall be allowed. Until these requirements are met, the detention facility will remain the developer's responsibility and maintenance shall not be transferred to the Town or any HOA, POA or other entity.

The requirements for soil amendments, seeding and sodding are as follows:

14.1.1 GENERAL

14.1.1.A DELIVERY, STORAGE AND HANDLING

1. General
   Handle and transport in a safe manner in compliance with local state, and federal regulations. Comply with Material Safety Data Sheets requirements.
2. Fertilizer
   Deliver inorganic or chemical fertilizer to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance to state law, bearing name and warranty of producer.
3. Soil Amendments
   Do not stockpile for more than seven (7) days. Distribute and till immediately upon arrival at site (same day, if possible, but within 7 days maximum).
4. Seed
   Deliver seed in original sealed, labeled, and undamaged containers. All material shall be furnished in original manufacturer's shipping bags or containers, and remain in these bags or containers until used. All materials shall be stored in a manner which will prevent them from coming into contact with precipitation, surface water, or other contaminating substances. All materials which have become wet, moldy or otherwise damaged in transit, or stored improperly shall not be used.
5. Sod
   Time delivery so that sod will be placed within 24 hours after shipping.
6. Sod Delivery
   Deliver sod properly loaded on vehicles and protected from exposure to sun, wind, and heat in accordance with standard practice and labeled in accordance with the Federal Seed Act. Do not drop sod from loading carts, trucks, or pallets.

14.1.1.B PROJECT/SITE CONDITIONS

1. General
   Do not perform work when climate and existing site conditions will not provide satisfactory results.
   a. Install seed between spring and fall; March 15 - September 30.
   b. Install sod only when air temperature is above freezing and below 85°F.
   c. Do not install seed or sod on saturated or frozen soil.
   d. Do not install seed or sod until soil preparations have been approved by the seed supplier.
   e. Do not install seed or sod until irrigation system is installed and tested.
   f. Proceed with planting only when existing and forecast weather conditions are suitable for work.
2. Site Information
   The Contractor shall be required to have examined the site, to ascertain the state thereof and the conditions under which the work is to be done. Note: Drawings typically indicate the physical dimensions of the site, but do not show the extent of all obstructions and subsurface conditions.
3. Existing Site Features
   Protect from damage as noted herein or on drawings.

14.1.2 MATERIALS

14.1.2.A TOP SOIL FOR SEEDING

(Note that all percentages are by weight and **not** by volume.)

1. Topsoil for Seeding
   ASTM D 5268, PH range of 6.3 to 8.2, three percent (3%) organic material minimum, free of extraneous materials harmful to plant growth.
   a. Topsoil Source (Seeding)

      a.1. Topsoil shall be fertile, friable, sandy loam or loam. Topsoil shall be of any admixture of subsoil or slag and shall be free of stones, lumps, refuse, plants or their roots, sticks, noxious weeds, salts, soil sterilant or other material detrimental to plant growth. Topsoil shall not be delivered or used onsite in any manner while in a frozen or muddy condition.

      a.2. All imported topsoil shall be from an approved point of origin satisfactory to the Town prior to delivery or placement in planting areas. Should noxious weeds be present at the topsoil source, the Town will make recommendations to the Contractor as to appropriate treatment of the topsoil prior to delivery to the project site.
2. Soil Amendments (Seeding and Sod)
   a. Compost: One hundred percent (100%) humus rich organic matter. The compost shall be a well decomposed, stable, weed free organic matter derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or

b. Provide analysis for the following:
Organic Matter Content: 30 - 70% (dry basis)
Soluble Salt Concentration (EC paste test): 5 dS (mmhols/cm) or less (as received)
PH range: 5.5 to 8.0 (as received)
Final carbon to nitrogen ratio: 20:1 or less.
Nutrient Content (dry weight basis): N 1% or above, P 1% or above, K 0.5% or above.
Bulk Density: 800 - 1,000 Ibs/yd3
Moisture Content: 35% - 55%

c. Certification of Compost Testing
The Contractor shall furnish to the Town a signed statement certifying that the compost furnished is from the lot that has been tested.

3. Amended Topsoil (Seeding)
Offsite, mechanically combined product.

a. Amended Topsoil: Components of the amended topsoil product (compost and topsoil) shall meet all previously outlined criteria for the individual components.

4. Fertilizer

a. Before seeding or sodding, apply an inorganic mixture tilled thoroughly into the top six inches (6") of soil, unless otherwise stated.

1 lb. of Nitrogen (N) per one thousand (1,000) square feet.
2 lbs. Phosphorus (P205) per one-thousand (1,000) square feet.
1 lb. Sulfur (SO4-S) per one-thousand (1,000) square feet.

14.1.2.B SEED

1. Grass Seed
Fresh, clean, dry, new-crop seed conforming to all State and Federal regulations and complying with the Association of Official Seed Analysts', "Rules for Testing Seeds" for purity and germination tolerances.

a. Seed Mixture
Provide seed of grass species and varieties, proportions by weight, and minimum percentages of purity, germination. All materials furnished shall be free of prohibited noxious weeds and meet State and Town standards for restricted noxious weeds.

b. Proportions and Mixing
All seed shall be mixed by a wholesale seed supplier in the proportions necessary to obtain the application rate specified.

c. Labels
All seed and seed mixes shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the common, scientific and variety name(s) of the seed(s), the lot number, net weight, percent of weed seed content and the guaranteed percent of purity and germination.

d. Certification of Seed Testing
The Contractor shall furnish to the Town a signed statement certifying that the seed furnished is from the lot that has been tested and comply with the Colorado Seed Law.

14.1.2.C SOD

1. Sod Materials

   a. Sod shall be a true-to-name variety, blend or mixture as specified herein and be free of all noxious weeds. Sod shall have a moist, viable root system and of a density that it will not easily tear, break or crumble. Sod in rolls or palates shall not be stored, after cutting from the sod farm, more than 48 hours and shall be protected from dehydration until installed.

   b. Provide strongly rooted sod, free of weeds and undesirable grasses, and machine cut to pad thickness of 0.75", excluding top growth and thatch. Provide only sod capable of vigorous growth and development when planted.

   c. Provide sod of uniform pad sizes with maximum 5% deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically with a firm grasp on upper 10% of pad will be rejected.

   d. Cut sod using an approved method, in accordance with local governing American Sod Producers Association.

14.1.2.D HERBICIDES

1. Herbicide: EPA registered and approved, of type utilized by Town of Platteville Public Works Department.
2. Applicators must possess a Colorado Department of Agriculture license.
3. The contractor making chemical applications must have a Qualified Supervisor on staff.

14.1.2.E EROSION CONTROL BLANKETS, MATS, FABRICS

Erosion control blankets, mats, of other commercial products for stabilizing disturbed areas may be required on certain projects. If so, the type, manufacturer, and installation method for these products will be approved by the Town. (See Section 5 for more information.)

14.1.3 EXECUTION

14.1.3.A EXAMINATION

1. General
   Verify that existing site conditions are as specified and indicated before beginning work under this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

   All work is to be performed by personnel thoroughly familiar with proper and accepted methods for soil preparation, herbicide applications, fertilizing, seeding, mulching, etc. All work is to be performed under the direct supervision of the Contractor's superintendent, who shall be thoroughly familiar with the provisions of these specifications.

2. Damaged Earth
   Inspect to verify that earth rendered unfit to receive planting due to concrete water, mortar, lime water or any other contaminant dumped on it has been removed and replaced with clean earth from a source approved by the Town. All access roadways or compacted soil shall be ripped to loosen.

3. Acceptance
   Beginning installation indicates acceptance of existing conditions by Contractor.

14.1.3.B PREPARATION

1. Protection

   a. Locate structures, playground equipment, sewer, water, irrigation, gas, electric, phone, cable TV, other pipelines or conduits and equipment prior to commencing work.

   b. Be responsible for proper repair to landscape, utilities, walls, soft surface paths, pavements and other site improvements damaged by operations under this section.

2. Existing Vegetation

   a. Contractor shall keep a log of all pesticide applications preformed throughout the duration of the project, detailing applications. Notes shall be submitted to Owner at the completion of project.

   b. Herbicides shall be applied using well maintained spraying equipment by individuals working for the Contractor who are appropriately licensed by the State or Federal agency having jurisdiction over such applications. It shall be the responsibility of the Contractor to be knowledgeable of any and all current laws and regulations pertaining to pesticide applications, and to advise the Town immediately if any requests for applications made by the Town are inappropriate as they pertain to these laws and regulations.

   c. Herbicides and other chemicals shall not be applied during periods when wind or other physical conditions cause the herbicides to be transported off site, or a distance of more than five (5') feet from the immediate area where they are being applied. It shall be the responsibility of the Contractor to notify the Town immediately if any

weather or other physical conditions exist which would make application inappropriate.

d. All herbicides and other chemicals shall be applied at rates as determined by the manufacturer's label.

d.1. Bluegrass areas
Existing vegetation, excluding trees and shrubs, in all areas designated to receive new bluegrass seed or sod, are to be sprayed with a contact non-selective post emergent herbicide (Roundup), a minimum of one (1) week and a maximum of (3) weeks prior to the ripping/tilling process.

d.2. Native areas
New seeding areas: Existing vegetation, excluding trees and shrubs, in all areas designated to receive new native seed mixes, shall be sprayed with a contact non-selective post emergent herbicide (Roundup), a minimum of one (1) week and a maximum of (3) weeks prior to the ripping/tilling process.

d.3. Over seeded areas
Spot treatment with selective post emergent herbicides may be required to eliminate undesirable vegetation in some areas. Coordinate herbicide application with the Town a minimum of two (2) weeks prior to the seeding operation.

Reapply herbicide if necessary to insure complete kill of existing vegetation.

3. Surface Grade
Remove existing grass, weeds, debris and rocks larger than one and one half-inches (1½") in all areas designated to receive seed or sod. Verify that all rough grades have been established.

4. Erosion Control
(See Sections 12 and 13 for more information.)

14.1.3.C INSTALLATION

1. Soil / Seed or Soil / Turf Bed Preparation

a. General: All ripping and tilling operations shall be done in a direction which follows the natural contours of the land on slopes of 4:1 or flatter. Any irregularities in the ground surface resulting from soil preparation operations shall be corrected and sloped to drain as intended by the grading plans.

b. Ripping/Tilling

b.1. Soil shall be ripped or tilled to a minimum of eight inches (8"), with agricultural sub-soiler in all areas to receive seed or sod. This includes any areas compacted by construction traffic during the construction process, with four (4) passes in at least two (2) directions.

b.2. In areas where extremely stiff materials, or if debris is encountered during ripping, re-adjust equipment to avoid bringing up chunks of un-tillable material.

b.3. The soils shall be worked until it has become loose and friable and no clods greater than two inches (2") in diameter remain, unless directed otherwise by the Town, prior to the addition of any soil amendments, seed, or mulch.

b.4. Remove stones larger than one and one-half inches (1½") in any dimension and sticks, roots, rubbish, and other extraneous matter.

b.5. Any required soil amendments (e.g. organic soil conditioners, fertilizer, etc.) shall be uniformly spread on the surface of soil which has been prepared as stated above and at the rates specified in sections 14.1.3.D, below.

2. Soil Amendments

   a. Blue Grass Areas: Evenly distribute composted material in the bluegrass seed or sod areas at the following rates:

      a.1. Apply the compost at four (4) cubic yards per one thousand (1,000) square feet.

      a.2. Spreading the compost shall be accomplished with either a truck or trailer mounted spreader, capable of being adjusted to apply varying rates of material at a given speed.

   b. Native Seed Areas: Evenly distribute composted material in the native seed areas at the following rates:

      b.1. Apply the compost at two (2) cubic yards per one thousand (1,000) square feet.

      b.2. Spreading the compost shall be accomplished with either a truck or trailer mounted spreader, capable of being adjusted to apply varying rates of material at a given speed.

      b.3. In areas inaccessible with a truck or trailer mounted spreader, the compost can be delivered and spread with a tractor and/or by hand.

   c. Over Seeding Native Seed into existing vegetation

      c.1. No compost will be required in these areas.

3. Fertilizer

   a. For Sod and Seeded areas receiving organic soil amendments:

      a.1. After applying soil amendments and fertilizer, thoroughly till area to a depth of six inches (6") minimum by roto-tilling, plowing, harrowing, or disking until soil is well pulverized.

   b. Fill, compact and grade the site to within +/- 0.15' of grades indicated and specified.

4. Grading in all areas to receive seed or sod

   a. For Seeding only: Do fine grading for areas prior to seeding. Perform as required to maintain positive drainage, prevent ponding and direct run-off into catch basins, drainage structures, etc. and as required to provide smooth well-contoured surface prior to proceeding.

   b. For Sodding only: Do rough grading and eliminate low spots. Perform as required to maintain positive drainage, prevent ponding and direct run-off into catch basins,

c. Prior to Acceptance of Grades: Hand-rake to a smooth even surface with a loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions. Remove debris, clods, rocks, vegetable matter, and any other objects that may interfere with planting or maintenance operations. Limit fine grading to areas that can be planted in the immediate future.

d. For Seeding: Establish finish grades to within +/- 0.15' of grades indicated.

   For Sod: Grade areas along sidewalks and driveways approximately one and one half (1 1/2) inches below top of concrete.

e. Noxious weeds or parts thereof shall not be present in the surface grade prior to seeding or sodding.

f. Moisten prepared lawn areas before planting when soil is dry. Water thoroughly and allow the surface to dry before planting. Do not create muddy soil.

g. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Leave graded surface clean and free of trash and debris. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

14.1.3.D SEEDING

1. The Contractor shall notify the Town prior to any seeding work.
2. All prepared areas, need to be firm, but not compacted, prior to seed application.
3. Bluegrass Areas
   a. Sow Bluegrass mix at a rate of 5 lbs. per 1,000 sq. ft.
   b. Sow turf grass seed using mechanical Type 3 drill, (Brillion) seeding machine for slopes 4:1 and flatter.

      b.1. Distribute seed evenly over entire area by sowing equal quantities in two directions at right angles of each other.

      b.2. For areas inaccessible to seeding machines use broadcast method. See 14.1.3.D below.

TABLE 14.1.3.D - BLUEGRASS SPECIES/VARIETY

Use as specified per Town approved drawings.

SPECIES	POUNDS PER ACRE – PURE LIVE SEED
Kentucky Bluegrass, Moonlight	**65.1**
Kentucky Bluegrass, Northstar	**65.1**

Kentucky Bluegrass, Quantum Leap	**65.1**
Perennial Ryegrass	**21.7**

4. Native Areas

   a. Seed the listed varieties in the areas designated on the drawings.

   b. All seed is to be drilled 0.25 inch to 0.50 inch into the soil at the specified PLS/acre rate listed in the Seed Mix tables below, with a mechanical, power drawn drill seeder. Rows shall be spaced not more than eight inches (8") apart.

   c. The contractor shall drill equal quantities in two directions at right angles of each other.

   d. Seeding rates need to be increased 50% on slopes 6:1 or steeper.

   e. Seeding rates need to be increased 100% for areas that are seeded by hand broadcasting.

   f. Seeding native grasses into existing vegetation, or areas that have not been ripped and tilled to a minimum of 6 inches require the use of a seeder with:

      f.1. Double Disc openers with depth bands.

      f.2. Native Grass Seed Box with agitator and picker wheels.

      f.3. Press wheels.

      f.4. In hard ground areas, the Town may require the use of a no-till Coulter unit.

   g. A cultipacker seeder (Brillion, Trillion type) is acceptable to use in well prepared (fine and firm) seed bed applications.

      g.1. The seeder should be equipped with seed boxes to handle the type of seed being planted.

      g.2. Native grass seed will need a seed box with an agitator and picker wheels.

      g.3. Seeding rates would need to be increased 50% with a cultipacker seeder since it is a broadcasting application.

TABLE 14.1.3.D(1) - LOW GROW MIX

Use a minimum 8’ wide on sides of pathways. Use at property lines abutting residential properties. Used in open areas where short grasses are desired.

SPECIES	POUNDS PER ACRE – PURE LIVE SEED
Buffalo grass	8.0
Blue gramma	6.5

TABLE 14.1.3.D(2) - SLOPE MIX **Used on all slopes and berms.**	
SPECIES	POUNDS PER ACRE – PURE LIVE SEED
Side oats gramma	4.0
Blue gramma	4.0
Little Bluestem	4.0
Sand dropseed	.12
Stream Bank Grass	8.0

TABLE 14.1.3.D(3) - POND MIX **Used in and around detention/retention ponds, and in areas that are designed to hold water, but are not necessarily wet the majority of the time.**	
SPECIES	POUNDS PER ACRE – PURE LIVE SEED
Little Bluestem	2.0
Yellow Indian Grass	2.0
Switchgrass	1.0
Blue gramma	0.6
Side oats gramma	3.0
Prairie Sandreed	1.5
Western Wheatgrass	4.0
Stream Bank Grass	5.0

TABLE 14.1.3.D(4) - RIPARIAN MIX **Used along irrigation ditches and in naturally wet areas**.	
SPECIES	POUNDS PER ACRE – PURE LIVE SEED
Switchgrass	6.0
Reeds Canary grass	6.0
Stream Bank Grass	8.0

Companion Crops

Add the prescribed companion crop with the native seed mixes to be planted at the rate listed.

TABLE 14.1.3.D(5) - COMPANION CROP or COVER CROP **Add the appropriate companion crop or cover crop to the native seed mixes to be planted.**	
SPECIES	POUNDS PER ACRE – PURE LIVE SEED
Spring Planting: Triticale	15.0
Fall Planting: Triticale	15.0

Broadcast Seeding
Some areas may be inaccessible to a drill. In these mutually agreeable areas, seed shall be uniformly broadcast at 2 times the specified rate. Seed is to be evenly distributed and sown in equal quantities, in two directions at right angles to each other. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Hand broadcasted seeded areas need to be raked in to provide a minimum of ¼" cover and a maximum of ½" cover.
Watering Newly Seeded Areas
Bluegrass areas: Coordinate with Town the irrigation controller settings to provide adequate moisture for seed germination, and to avoid erosion.
Native areas

b.1. Some native areas may have irrigation available, in which case, follow the guidelines for Bluegrass areas above.

b.2. Native areas without irrigation

Spring Planting: Plan the planting operation to start as soon as the soil can be worked and prior to the spring rainy season.
Fall Planting: Place seed prior to the first hard frost in the fall, but after dormancy begins for the varieties being planted.
Erosion Protection
Slopes of 6:1 or flatter require no erosion protection.
Protect seeded slopes steeper than 6:1 against erosion with jute or coir-fiber erosion-control mesh installed and stapled according to manufacturer's recommendations.

14.1.3.E SODDING

1. The Contractor shall notify the Town prior to any sod work.
2. The Town will be on site during sod operations.
3. Sodded areas shall be smooth and firm before lying. Sod shall be laid by staggering the joints. On slopes, sod shall run parallel to a 90̣ degree angle to the slope.
4. When in position, sod shall be watered and lightly rolled to ensure contact with the soil surface.
5. Lay sod within 48 hours from time of stripping. Do not plant if ground is frozen.
6. Lay sod parallel to contours to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to sub grade or sod. Water and tamp or roll lightly to ensure contact with sub grade. Work sifted soil into minor cracks between pieces of sod. Remove excess soil.
7. Water sod thoroughly with a fine spray immediately after planting or after completion of every 500 sq. ft.

14.1.3.F MAINTENANCE OF SOD

1. General
    a. Begin maintenance of lawns immediately after each area is planted and continue for a period of not less than 30 days for sodded areas and until satisfactory growth is achieved.
    b. Maintain lawns by watering, fertilizing, weeding, mowing and trimming and other operations such as replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas up to and until final acceptance has been issued from the Town, in writing.
    c. Resod bare areas using same materials specified for lawns.
2. Watering
    a. Water new lawn area sufficiently to thoroughly moisten soil and in such a manner as to avoid erosion. Commence watering on the day of installation and continue as needed.
    b. A new sod watering permit will be required.
    c. Provide and maintain temporary piping, hoses and lawn watering equipment to convey water from sources and to keep lawn areas uniformly moist as required for proper growth up to and until final acceptance has been issued from the Town, in writing.
3. Mowing: Mowing during maintenance period is the responsibility of the Contractor. Do not begin mowing until the sod has had at least 7 consecutive days from installation to root into the soil. Mowing height shall be no less than 2". Mow newly seeded areas when 75% of grass reaches 3" height.

14.1.3.G CLEANING

Remove and haul from the site all excess materials and debris generated during the construction process. Perform daily cleaning during installation of the work, and upon completion of the work. Clean paved and finished surfaces soiled as a result of work under this section. Clean out drainage inlet structures as required. Repair any and all damage.

14.1.3.H PROTECTION

Provide and install barriers as required and as directed by the Town to protect the seeded and sodded areas against damage from pedestrian and vehicular traffic until well established and accepted by the Town. Provide any additional erosion control measures which are necessary for the successful establishment of grass areas.

14.2 IRRIGATION

(Note: **14.2.1 and 14.2.2** regarding Sprinkler Systems are **guidelines only**.)

14.2.1 MATERIALS

Sleeving

Install a separate sleeve beneath paved areas to route each run of irrigation pipe or wiring bundle.
Sleeving material beneath pedestrian pavements shall be PVC Class 200 pipe with solvent welded joints.
Sleeving beneath drives and streets shall be PVC Class 200 pipe with solvent welded joints.
Sleeving diameter: equal to twice that of the pipe or wiring bundle.
Pipe and Fittings
Mainline Pipe and Fittings

Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end suitable for solvent welding.

Use Class 200, SDR-21, rated at 200 PSI, conforming to the dimensions and tolerances established by ASTM Standard D2241. Use PVC pipe rated at higher pressures than Class 200 in the case of small nominal diameters that are not manufactured in Class 200.

Use solvent weld pipe for mainline pipe with a nominal diameter less than 3-inches or where a pipe connection occurs in a sleeve. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564.

Lateral Pipe and Fittings

Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end suitable for solvent welding.

Use Class 160, SDR-26, rated at 160 PSI, conforming to the dimensions and tolerances established by ASTM Standard D2241.

Use solvent weld pipe for lateral pipe. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of a type approved by the pipe manufacturer.

Specialized Pipe and Fittings

c.1. Low Density Polyethylene Hose

Use pipe specifically intended for use as a flexible swing joint.
Inside diameter: 0.490 +/- 0.010 inch.
Wall thickness: 0.100 + 0.010 inch.
Color: Black.
Use spiral barbed fittings supplied by the same manufacturer as the hose.

c.2. Assemblies calling for flanged connections shall utilize stainless steel studs and nuts and rubber gaskets.

c.3. Assemblies calling for threaded pipe connections shall utilize PVC Schedule 80 nipples and PVC Schedule 40 threaded fittings.

a. Joint sealant: Use non-hardening, nontoxic pipe thread sealant formulated for use on threaded connections and approved by the pipefitting and valve manufacturers. Where directed by valve manufacturers, use thread tape for threaded connections at valves instead of thread paste.

Joint Restraint Harness

Use a joint restraint harness wherever joints are not positively restrained by flanged fittings, threaded fittings, and/or thrust blocks.

Use a joint restraint harness with transition fittings between metal and PVC pipe, where weak trench banks do not allow the use of thrust blocks, or where extra support is required to retain a fitting or joint.

Use bolts, nuts, retaining clamps, all-thread, or other joint restraint harness materials that are zinc plated or galvanized.

Use on pipe greater than or equal to 3-inch diameter or any diameter rubber gasketed pipe.

Mainline Components

Master Valve Assembly: As presented in the installation details.

Flow Sensor Assembly: As presented in the installation details.

Isolation Gate Valve Assembly: As presented in the Manufacturer's instructions. Acceptable manufacturer's are American AVK, Clow, Kennedy, Mueller, Matco, Nibco, or Waterous.

Quick Coupling Valve Assembly: As presented in the installation details.

Sprinkler Irrigation Components

Remote Control Valve (RCV) Assembly for Sprinkler Laterals: as presented in the installation details. (Contact the Parks Department for details.) Use wire connectors and waterproofing sealant to join control wires to solenoid valves. Use standard Christy I.D. tags with hot-stamped black letters on a yellow background. Install a separate valve box over a 3-inch depth of ¾-inch gravel for each assembly. Provide PRS-Dial pressure regulators at all spray and rotor sprinkler remote control valves.

Sprinkler Assembly: As presented in the drawings and installation details.

Sprinkler Pressure Test Kit: Provide Rain Bird PHG assembly, and Rain Bird Pitot Tube (part no. 41017), for use in pressure adjustment for spray and rotors sprinklers.

Component connection, hook-up of electrical, sprinkler heads, and testing shall be per manufacturer's recommendations.

Control System Components

Irrigation Controller Unit: As presented in the installation details.

Lightning protection: Provide one 12" x 36" x 0.0625" ground plate, one 5/8"x10 foot copper clad UL listed grounding rod, 30 feet of #6 AWG bare copper grounding wire, and one CADWELD connector, and two 6-inch round valve boxes at each irrigation controller.

Wire markers: Prenumbered or labeled with indelible nonfading ink, made of permanent, nonfading material.

Power Wire

Electric wire from the power source to satellite control unit shall be solid or stranded copper, Type UF single conductor cable or multi-conductor with ground cable, UL approved for direct underground burial. Power wires shall be black, white, and green

in color. The Contractor is responsible for verifying that the power wire sizes are compatible and adequate for the control system being used.

Splices: Use 3M 82-A series connectors.

Conduit: PVC Schedule 40.

Warning tape: Inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored yellow, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW?"

Control Wire

Use American Wire Gauge (AWG) No. 14 solid copper, Type UF or PE cable, UL approved for direct underground burial from the controller unit to each remote control valve.

Common Wire: Use American Wire Gauge (AWG) No. 12 solid copper, Type UF or PE cable, UL approved for direct underground burial from the controller unit to each remote control valve.

Color: Wire color shall be continuous over its entire length.

Control wire: Red.

Common wire: White.

Spare control wire: Any color except Red or White.

Spare common wire: Any color except those above.

Splices: Use 3M DBY-6 or 3M DBR-6.

Warning tape: Inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored yellow, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW."

14.2.2 SPRINKLER SYSTEM INSPECTIONS

Verify construction site conditions and note irregularities affecting work of this section. Report irregularities to the Town prior to beginning work.

Irrigation System Layout Review: Irrigation system layout review will occur after the staking has been completed. Notify the Town one week in advance of review. Modifications will be identified by the Town at this review.

14.2.3 EXCAVATION, TRENCHING, AND BACKFILLING

1. Excavate to permit the pipes to be laid at the intended elevations and to permit workspace for installing connections and fittings.

2. Minimum cover (distance from top of pipe or control wire to finish grade):

   a. 24-inches over mainline pipe and over electrical conduit.

   b. 28-inches over control wire.

   c. 18-inches over lateral pipe to sprinklers.

3. PVC lateral pipes may be pulled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling. Minimum burial depths equal minimum cover listed above.

4. Backfill only after lines have been reviewed and tested.

5. Excavated material is generally satisfactory for backfill. Backfill shall be free from rubbish, vegetable matter, and stones larger than 2-inches in maximum dimension. Remove material not suitable for backfill. Backfill placed next to pipe shall be free of sharp objects that may damage the pipe.

6. Backfill unsleeved pipe in either of the following manners:

   a. Backfill and puddle the lower half of the trench. Allow to dry 24 hours. Backfill the remainder of the trench in 6-inch lifts. Compact to 85% Standard Proctor Density at optimum moisture.

   b. Backfill the trench by depositing the backfill material equally on both sides of the pipe in 6-inch lifts and compacting to 85% Standard Proctor density at optimum moisture.

   c. Enclose pipe and wiring beneath roadways, walks, curbs, etc., in sleeves. Minimum compaction of backfill for sleeves shall be 95% Standard Proctor Density, ASTM D698. Use of water for compaction around sleeves, "puddling", will not be permitted.

7. Dress backfilled areas to original grade. Incorporate excess backfill into existing site grades.

8. Trenches may be curved to change direction or avoid obstructions within the limits of the curvature of the pipe. Minimum radius of curvature and offset per 20-foot length of pipe-by-pipe size are shown in the following table. All curvature results from the bending of the pipe lengths. No deflection will be allowed at a pipe joint.

SIZE	RADIUS	OFFSET PER 20' LENGTH
1½"	25'	7'-8"
2"	25'	7'-8"
2 ½"	100'	1'-11"
3"	100'	1'-11"
4"	100'	1'-11"

14.2.4 GUARANTEE / WARRANTY AND REPLACEMENT

The purpose of this guarantee/warranty is to insure that the Town receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner. Guarantee/warranty irrigation materials, equipment, and workmanship against defects for a period of **two years** from commencement of the formal maintenance period. Fill and repair depressions. Restore landscape or structural features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by a defective item. Make repairs within seven days of notification from the Owner's Representative. Make replacements at no additional cost to the Town. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

14.2.5 MAINTENANCE ACCESS

To assure that the detention facility performs as designed, maintenance access shall be provided, and shown on the Final Plat. Regional detention ponds are usually dedicated to the Town for operation and maintenance. For privately maintained facilities such as commercial or industrial sites, an easement shall be granted to the Town to allow access and to assure that the facility continues to function as intended. The Town has standard easement agreement forms for this purpose.