The information contained in Appendix C: Pipe Material Policy, dated August 2006, has been updated to reflect the August 2018 Errata. The errata addresses errors, changes in procedure, changes in NDOT department titles, changes in other Roadway Design and Drainage Design Manual chapters and other reference material citations occurring since the latest publication of this chapter.

## Nebraska Department of Roads

Roadway Design Division – Policy Letter

Policy Number: **DES 14–02**

Approval Date: 4/17/14 By: _____ Roadway Design Engineer

Approval Date: 4/17/14 By: _____ Materials & Research Engineer

Approval Date: 4/18/14 By: _____ for FHWA Division Administrator

This policy letter affects the Drainage Design & Erosion Control Manual
Appendix C, "Pipe Material Policy"

## PIPE MATERIAL POLICY

Policy: This policy will replace all previous policies regarding the selection of pipe material for cross drains, drive pipe, drop pipe, storm sewers, and railroad pipe. Under this policy, designers will select the allowable pipe material options for each installation. The contractor will choose the final pipe material from the list of options provided.

The following topics are discussed in more depth:

- Types of pipe specified in this policy
- Maximum permissible diameter of standard pipe
- Design values for Manning Coefficient, (n)
- Flared end sections
- Minimum and maximum fill heights
- Excavation, bedding, and backfill requirements
- Functional use of different pipes
- Connections

## TYPES OF PIPE SPECIFIED IN THIS POLICY

**RCSP** Reinforced Concrete Sewer Pipe

**RCP** Reinforced Concrete Pipe

**MCCMP** Metallic Coated Corrugated Metal Pipe, which includes:
**GCCMP** Galvanized (Zinc) Coated Corrugated Metal Pipe and
**ACCMP** Aluminum Coated Corrugated Metal Pipe

**PCCMP** Polymer Coated Corrugated Metal Pipe

**HDPE** High Density Polyethylene Pipe, which includes:
HDPE-CI (Corrugated Interior) and
HDPE-SI (Smooth Interior), including Steel Reinforced Ribbed Pipe

**PVC** Polyvinyl Chloride Pipe

The numerical designations shown below will be used by designers for specifying the various types of pipe:

| Type | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| | RCSP | RCP | GCCMP | ACCMP | PCCMP | HDPE | | PVC |
| | | | | | | CI | SI | |

Designers shall identify all pipes by their corresponding Type number. For example, if RCSP, PCCMP and PVC are appropriate options, the designation would be 1-5-8. The Type “1” in this example is a RCSP.

Note: Normally, the contractor has the option of selecting the class of pipe, and type of installation in accordance with the fill height tables shown on the plans. However, for fill heights less than one foot, the designer must specify the class of pipe required. Refer to the Drainage Design and Erosion Control Manual for live load information. Use Attachment 2 for maximum fill height data.

## MAXIMUM PERMISSIBLE DIAMETER OF STANDARD PIPE

The maximum allowable inside diameter for the various pipes are shown in Attachment 2. These pipes are standard manufactured sizes. Sizes other than those shown are considered special designs that must be submitted to NDOT for approval.

## DESIGN VALUES FOR MANNING COEFFICIENT, (n)

The selected (n) value for design purposes when using corrugated pipe (MCCMP, PCCMP, and HDPE-CI) is 0.024. The design (n) value for smooth interior pipes (RCSP, RCP, PVC, and HDPE-SI) is 0.012. When it is necessary to determine the true magnitude of the pipe outlet flow velocity, designers should use the actual (n) value recommended by the manufacturer to perform computations. When designing for outlet control and *both* corrugated and smooth pipe are selected, the designer will use an (n) value of 0.024. A Manning (n) value of 0.012 shall be used when *only* smooth interior pipe are specified.

## FLARED END SECTIONS

Use concrete flared end sections (CFES) for all concrete pipes. Specify metal flared end sections (MFES) for metal and plastic pipes when flared end sections are required. Flared end sections are not required for drive pipes unless they are to be installed within the clear zone. Safety flared end sections manufactured with a 10:1 slope and equipped with protective cross bars must be provided for the approach end of all drive pipes placed within the lateral obstacle clearance area.

## MINIMUM AND MAXIMUM FILL HEIGHTS

Fill height determines the amount of dead load (or live load) that is imposed upon a culvert pipe. Minimum fill height is defined as the vertical distance measured from the top of the conduit to the bottom of the pavement or shoulder surfacing at its lowest point. Maximum fill height is defined as the vertical distance measured from the top of the conduit to the top of the pavement at its highest point. Minimum fill height for all culverts is one foot. The designer should review the live load computations as shown in the Drainage Design and Erosion Control Manual for special circumstances when this one foot minimum cannot be maintained. The maximum fill height that a pipe can withstand depends greatly on the type of bedding and backfill, pipe size, and pipe material. Refer to Attachment 2, along with the appropriate Standard Plans, for guidelines in specifying various types of pipe.

## EXCAVATION, BEDDING, AND BACKFILL REQUIREMENTS

Refer to Standard Plan 41100e00 (4110), “Bedding and Backfill Requirements for Concrete Pipe” (http://www.roads.nebraska.gov/business-center/design-consultant/stand-spec-manual/), for installation details. Standard Plan 4110, Sheet 4, “Bedding and Backfill Requirements for MCCMP, PCCMP, and Plastic Pipe”, shows details for installing flexible pipe. Granular material is required for all flexible MCCMP, PCCMP, and plastic pipe installed under surfaced roadways. Unless special circumstances exist, granular material is not required for drive pipe, drop pipe, or temporary pipe installed outside the surfaced roadway prism.

On trench installations, the trench width depends on the outside diameter of the pipe and the side clearance requirement on each side of the pipe as shown on the Standard Plans. Trench depth depends on the size of the pipe and the flow line location relative to the ground surface. On embankment installations, where the flowline of the pipe is above the natural ground, the culvert

contractor is required to raise the ground along the centerline of the pipe to an appropriate elevation above the flowline (See Standard Plan 4110). This embankment must be wide enough to excavate to the proper depth and install the pipe at the flowline shown on the cross sections. A contractor may choose to provide an embankment deep enough to use a trench installation. All excavations will be determined as established quantities using the method of measurement as shown in the current Nebraska Standard Specifications for Highway Construction.

## FUNCTIONAL USE OF DIFFERENT PIPES

The functional usage of the various pipes that designers specify is summarized in Attachment 3. The plus sign shown in the Functional Usage table signifies that the use of a particular pipe material is acceptable for that function. The minus sign indicates where material use is prohibited. Designers may refer to the flow chart in Attachment 1 for assistance in the pipe selection process.

## CONNECTIONS

All RCP and RCSP connections under the roadway prism (or back-to-back of curb-line on urban projects) shall be Tongue and Groove (T&G) or modified T&G type, and have watertight joints (using cement mortar, fibered roof coating, or gaskets) in accordance with the Nebraska Standard Specifications for Highway Construction. All plastic and CMP pipe under the roadway prism (or back-to-back of curb-line) must be installed with approved watertight joints. CMP and plastic pipe outside the roadway prism (or back of curb-line) may be installed with soil tight connecting bands or other approved soil tight joints. All pipe used for sewer applications must be installed with approved watertight connections.

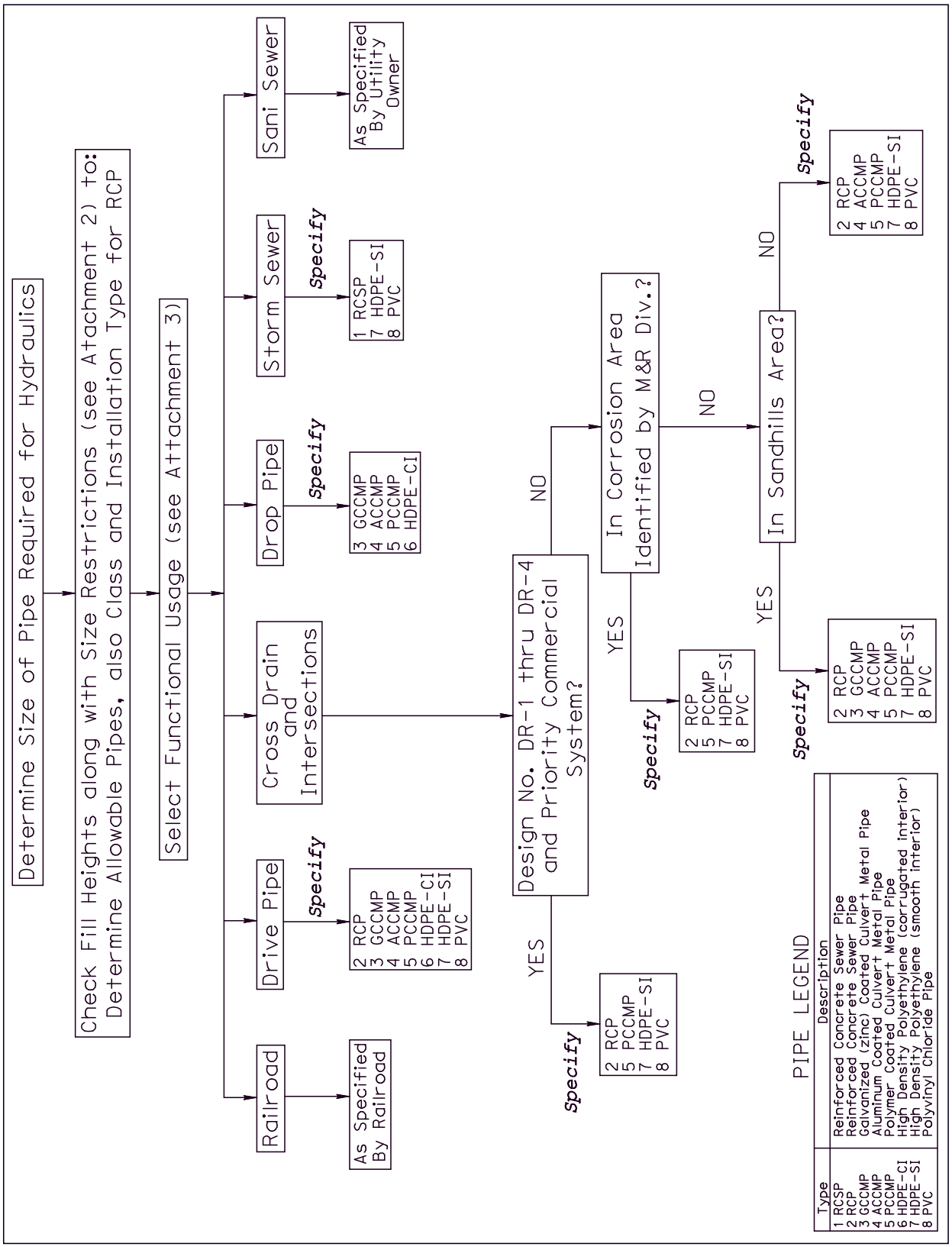
## CULVERT EXTENSIONS

Existing culverts will be extended using the same material as the existing structure. If the plans call for extension of Corrugated Metal Pipe Culvert, the pipes shall be connected by the contractor with an approved connecting band. When the plans designate the extension of a Concrete Pipe Culvert, the connection shall be made by enclosing the connecting joint with a concrete collar.

## TEMPORARY PIPE

The designer should contact the District to determine culvert type when temporary pipe is to be placed under a temporary (2 years or less) facility such as a temporary road or median crossover. If the pipe is to be furnished by the State, the construction note will call for INSTALLING the pipe. If the pipe is to be furnished by the contractor, the construction note will call for BUILDING the pipe. The District will also determine if the pipe will be salvaged to the State when the temporary roadway is removed. Corrugated metal pipe (Type 3, 4 or 5) will be allowed for temporary roadways. Granular backfill for temporary structures Type 3, 4 or 5 is not required, unless called for in the plans.

## ATTACHMENT 1 PIPE SELECTION FLOW CHART



## ATTACHMENT 2 PIPE SIZE AND FILL HEIGHT REQUIREMENTS

### Maximum Permissible Diameters Of Standard Pipe

**The following interior pipe diameters (in inches) are considered maximum standard sizes. Larger sizes may be allowed by special design approved by NDOT.**

| Type | 1 | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| RCSP | | | RCP | GCCMP | ACCMP | PCCMP | HDPE | | PVC |
| III | IV | | V | | | | CI | SI | |
| 108 | 72 | | 48 | 84 | 84 | 84 | 36 | 60 | 48 |

### Maximum Fill Heights (feet) For Round Concrete Pipe

| | Installation Type 3 | | | Installation Type 2 | | | Installation Type 1 | | |
|---|---|---|---|---|---|---|---|---|---|
| Pipe Size (in) | Class III | Class IV | Class V | Class III | Class IV | Class V | Class III | Class IV | Class V |
| 15 | 12 | 15 | 21 | 15 | 19 | 26 | 23 | 28 | 40 |
| 18 | 12 | 17 | 24 | 16 | 22 | 30 | 24 | 32 | 45 |
| 21 | 13 | 19 | 26 | 16 | 24 | 32 | 25 | 37 | 48 |
| 24 | 13 | 19 | 26 | 17 | 24 | 33 | 25 | 32 | 45 |
| 27 | 13 | 17 | 26 | 17 | 21 | 34 | 23 | 26 | 51 |
| 30 | 12 | 14 | 25 | 15 | 17 | 32 | 20 | 21 | 49 |
| 36 | 10 | 16 | 24 | 13 | 21 | 31 | 20 | 31 | 47 |
| 42 | 10 | 15 | 23 | 13 | 19 | 29 | 20 | 29 | 44 |
| 48 | 10 | 14 | 22 | 13 | 18 | 29 | 20 | 28 | 43 |
| 54 | 10 | 14 | | 13 | 17 | | 20 | 27 | |
| 60 | 9 | 14 | | 12 | 18 | | 19 | 28 | |
| 66 | 9 | 14 | | 12 | 18 | | 19 | 28 | |
| 72 | 9 | 14 | | 12 | 18 | | 19 | 28 | |
| 78 | 9 | | | 12 | | | 19 | | |
| 84 | 9 | | | 12 | | | 19 | | |
| 90 | 9 | | | 12 | | | 20 | | |
| 96 | 9 | | | 12 | | | 19 | | |
| 102 | 10 | | | 13 | | | 20 | | |
| 108 | 10 | | | 14 | | | 22 | | |

**The Type 3 Installation (shaded) is the NDOT Standard. See Standard Plan 4110 (Bedding and Backfill for Concrete Pipe) for additional information about table development and usage.**

### Maximum Fill Heights For Flexible Pipe

The maximum dead load fill height for HDPE, PVC, and CMP is set at 40 feet, using the bedding and backfill requirements as shown in Standard Plan 4110 (http://www.roads.nebraska.gov/business-center/design-consultant/stand-spec-manual/). Consult with the pipe manufacturer when designing for fills greater than 40 feet, or when special situations are encountered that are beyond the scope of this policy. When installing flexible pipe outside the roadway prism (or back of curb-line on urban projects), and when granular materials are not used as shown in this policy, the maximum fill height is set at 20 feet (standard proctor test density for non-granular material must be greater than 95%).

## ATTACHMENT 3 PIPE DESIGN APPLICATIONS AND EXAMPLES

### Functional Usage

| Type | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **Functional Usage** | **RCSP (All Classes)** | **RCP (All Classes)** | **GCCMP Galvanized (Zinc) Coated CMP** | **ACCMP Aluminum Coated CMP** | **PCCMP Polymer Coated CMP** | **HDPE-CI Corrugated Interior** | **HDPE-SI Smooth Interior** | **PVC** |
| **Cross Drain & Intersections** | + | + | See Footnotes | | + | - | + | + |
| **Drive Pipes** | - | + | + | + | + | + | + | + |
| **Drop Pipe** | - | - | + | + | + | + | - | - |
| **Railroad** | As Specified by the Railroad | | | | | | | |
| **Storm Sewer** | + | - | - | - | - | - | + | + |
| **Sani. Sewer** | As Specified by the Utility Owner | | | | | | | |

Cross Drain and Intersection Footnotes:

- Corrugated metal pipe will not be permitted in the southeast counties of Gage, Nemaha, Richardson, Pawnee, Johnson, Otoe or any other locations that are designated by M&R as unsuitable for corrugated metal pipe.
- Galvanized CMP---Allowed for Design No. DR-5, DR-6 and DR-7 in the Sandhills, unless identified corrosion areas exist.
- Aluminum Coated CMP---Allowed for Design No. DR-5, DR-6 and DR-7, unless identified corrosion areas exist.

### Examples of Culvert Types Specified

| Pipe Dia. (in.) | Max. Fill Height (ft.) | Pipe Function | Location | Type Specified |
|---|---|---|---|---|
| 48 | 20 | Cross drain pipe | S. Hills/DR-5/no corrosive areas | 1 |
| 54 | 20 | Cross drain | DR-6/corrosive area | 2-5 |
| 36 | 24 | Cross drain | Statewide/DR-3 | 2-5-7-8 |
| 30 | 5 | Cross drain | Statewide/Priority Commercial System | 2-5-7-8 |
| 42 | 25 | Cross drain | Not Sandhills/DR-7/no corrosion | 2-4-5 |
| 54 | 5 | Storm sewer | Statewide | 1 |
| 36 | 5 | Storm sewer | Statewide | 1-7-8 |
| 48 | 15 | Drive pipe | Statewide | 2-3-4-5 |
| 24 | 15 | Drive pipe | Statewide | 2-3-4-5-6-7-8 |
| 24 | 5 | Drop pipe | Statewide | 3-4-5-6 |

### Pipe Legend

| Type | Description |
|---|---|
| **1 RCSP** | Reinforced Concrete Sewer Pipe |
| **2 RCP** | Reinforced Concrete Pipe |
| **3 GCCMP** | Galvanized (zinc) Coated Culvert Metal Pipe |
| **4 ACCMP** | Aluminum Coated Culvert Metal Pipe |
| **5 PCCMP** | Polymer Coated Culvert Metal Pipe |
| **6 HDPE-CI** | High Density Polyethylene (corrugated interior) |
| **7 HDPE-SI** | High Density Polyethylene (smooth interior) |
| **8 PVC** | Polyvinyl Chloride Pipe |

**COMMENTARY**

## Plastic Pipe

Plastic pipe (HDPE and PVC) may be used for driveway, underdrain, sewer and roadway cross drain as well as other drainage applications. The Standard Plans for flexible pipe show: installation, material, and backfill requirements. Also, due to the non-corrosive nature of these materials, plastic pipe is included for use in areas where corrosion of metallic coated culverts is a concern.

## Pipe Installations under Pavement

In order to extend the design life (by improving structural performance, reducing settlement and joint movement etc.) of surfaced roadways, cross section details for all pipes (concrete, metal and plastic) have been developed. Flexible pipes require a granular material envelope to improve in-place structural performance, while reducing compaction effort and pipe movement during installation. Use of granular bedding and backfill with metallic coated pipes also has the benefit of reducing soil-side corrosion. Use of polymer coated CMP effectively reduces interior corrosion as well as exterior soil-side corrosion, and therefore, is allowed for use under all roadways.

Standard Plans for concrete pipe installations have been developed using computer programs such as SIDD and PIPECAR (*such programs have been created through the efforts of organizations such as ANSI, FHWA and the Concrete Pipe Association*). These plans provide options for the designer, contractor, and pipe manufacturer in regard to pipe class selection and installation. Under this policy the contractor will be allowed to select the type of installation and class of pipe based upon available fill height information shown on the plans. In addition, the requirements shown for bedding and backfill eliminate previous requirements for shaping the trench bottom to fit the contour of the pipe.