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)

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 NDOR 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 Special Plans, for guidelines in specifying various types of pipe.

EXCAVATION, BEDDING, AND BACKFILL REQUIREMENTS

Refer to Special Plan 4110, "Bedding and Backfill Requirements for Concrete Pipe", for installation details. Special 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 Special 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 Special 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.

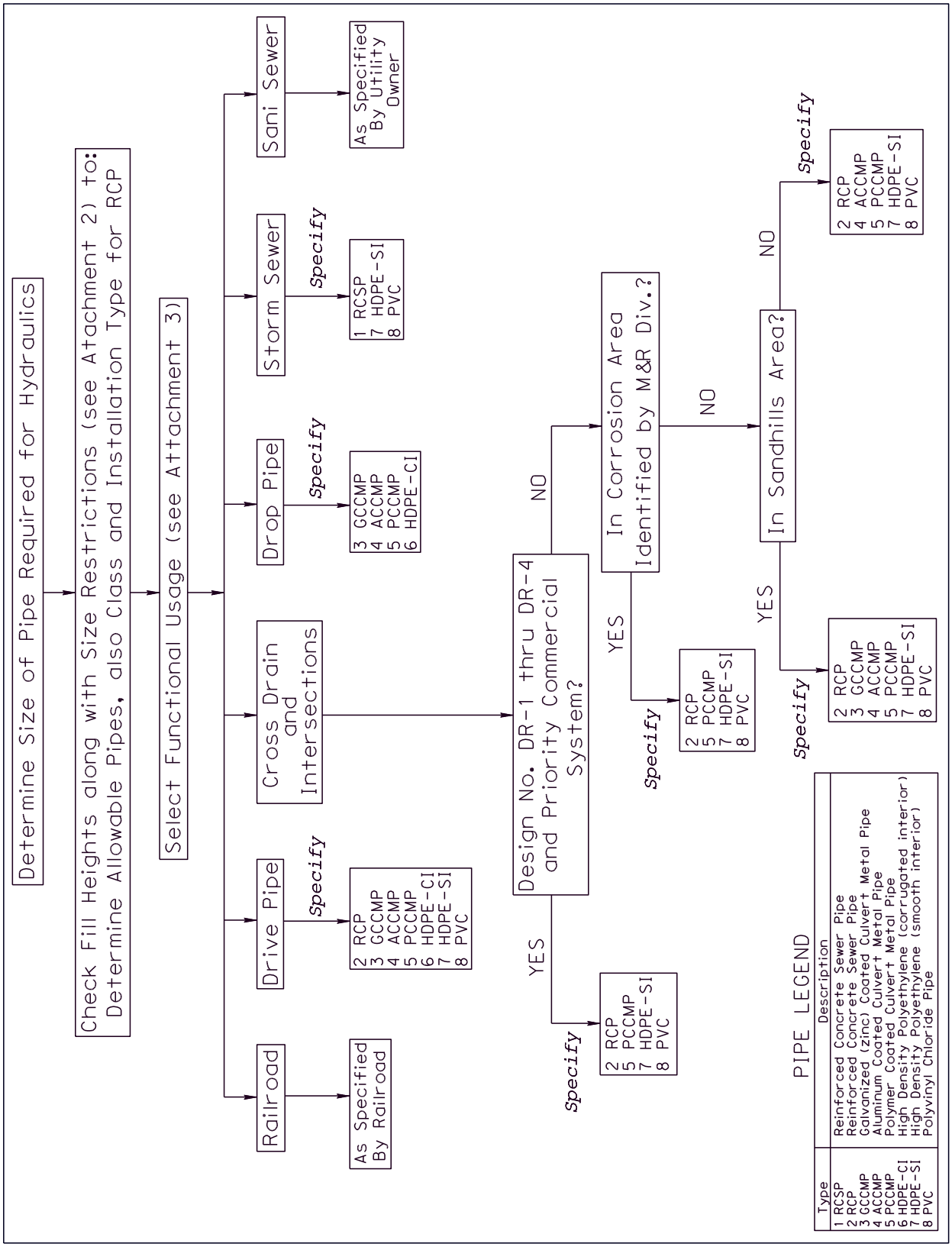
CULVERT EXTENSIONS

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.

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 NDOR.

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	36	36

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 NDOR Standard. See Special 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 Special Plan 4110. 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							
StormSewer	+	-	-	-	-	-	+	+
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 (f.)	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

Following is a summary of the major changes, additions and improvements incorporated in the 1997 Pipe Material Policy:

Plastic Pipe

Past policy and Specifications limited the use of plastic pipe primarily for driveway, underdrain and sewer applications. As a result of research and field testing, the use of plastic pipe (HDPE and PVC) has been broadened to include roadway cross drain as well as other drainage applications. The new Special 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, improved 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.

New Special Plans for concrete pipe installations have been developed in order to provide more 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. Previous specifications required the culvert contractor to place concrete pipe upon a carefully shaped trench bottom. The new plans provide more options for bedding and backfill in order to utilize different classes of pipe, or to reduce labor during installation.

NDOR concrete pipe design procedures are currently being upgraded in order to take advantage of concrete pipe computer programs such as SIDD and PIPECAR. These programs are already being used by the concrete pipe industry, and are acceptable programs developed through the efforts of ANSI, FHWA, and the Concrete Pipe Association. The new Special Plans for concrete pipe incorporate detailing to support and complement these industry accepted programs.

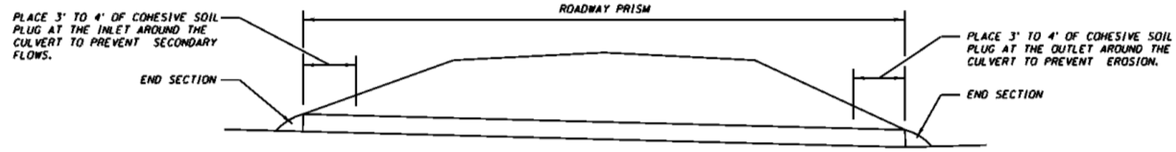
TABLE 1
STANDARD INSTALLATIONS, SOILS AND MINIMUM COMPACTION REQUIREMENTS

INSTALLATION TYPE	BEDDING THICKNESS	HAUNCH AND OUTER BEDDING	LOWER SIDE
TYPE 1		95% SW	90% SW, 95% ML, 100% CL, OR NATURAL SOILS OF EQUAL FIRMNESS
TYPE 2	DO/24 MINIMUM, NOT LESS THAN 3 IN. IF ROCK FOUNDATION, USE DO/12 MINIMUM, NOT LESS THAN 6 IN.	90% SW OR 95% ML	85% SW, 90% ML, 95% CL, OR NATURAL SOILS OF EQUAL FIRMNESS
• TYPE 3		85% SW, 90% ML, OR 95% CL	85% SW, 90% ML, 95% CL, OR NATURAL SOILS OF EQUAL FIRMNESS

TABLE 1 NOTES:

• THE TYPE 3 INSTALLATION SHOWN IS THE NDOR MINIMUM STANDARD, USING EITHER A SHAPED TRENCH ACCORDING TO THE STANDARD SPECIFICATIONS, OR AT THE OPTION OF THE CONTRACTOR, THE BEDDING WITH COMPACTIONS AS SHOWN.

ALLOWABLE FILL HEIGHTS FOR THE TYPE 1, 2, AND 3 INSTALLATIONS ARE SHOWN IN TABLE 4.



LIMITS OF BEDDING AND BACKFILL

EXCAVATION, BEDDING AND EMBANKMENT SEQUENCE:

TRENCH INSTALLATION:

(A) DETERMINE THE FLOW LINE AND TRENCH BOTTOM ELEVATIONS.

(B) DETERMINE THE SHAPE OF TRENCH. DECIDE IF SHORING IS NEEDED. CONTRACTOR IS ULTIMATELY RESPONSIBLE FOR THE SAFETY OF ALL WORKERS, EQUIPMENT AND MATERIALS IN THE TRENCH.

(C) PLACE THE BEDDING MATERIAL (SEE TABLE 1) LOOSELY.

(D) PLACE PIPE ON THE BEDDING AND COMPACT OUTER BEDDING. (SEE TABLE 1).

(E) PLACE AND COMPACT THE LOWER SIDE, HAUNCH AND OVERFILL MATERIAL AT 6 IN. INTERVALS.

EMBANKMENT INSTALLATION:

(A) DETERMINE THE FLOW LINE AND SPRING LINE ELEVATION.

(B) IF FLOW LINE IS ABOVE THE NATURAL GROUND, PLACE AN EMBANKMENT AT LEAST 3DO WIDE WITH 3:1 FORESLOPES OR FLATTER AT SPRING LINE ELEVATION, COMPACTED AT ROADBED REQUIRED COMPACTION.

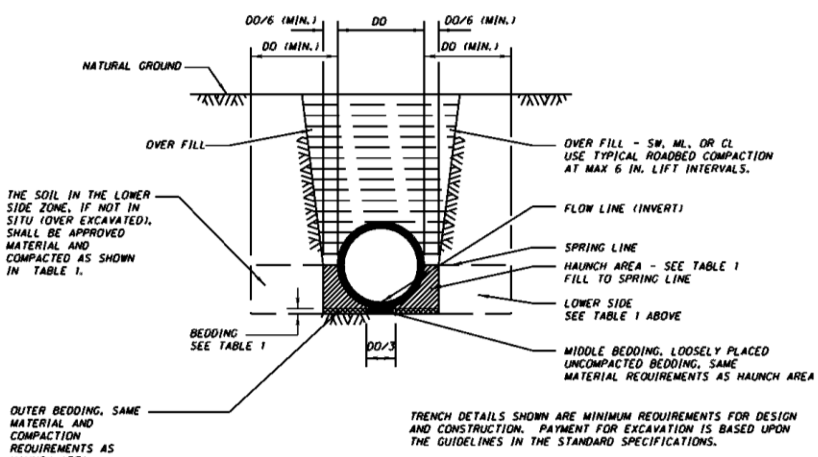
(C) IF THE FLOW LINE IS BELOW THE NATURAL GROUND BUT THE SPRING LINE IS ABOVE THE NATURAL GROUND, PLACE THE EMBANKMENT SIMILAR TO THE ONE IN STEP B.

(D) EXCAVATE TO PROPER ELEVATION.

(E) PLACE BEDDING MATERIAL (SEE TABLE 1) LOOSELY.

(F) PLACE THE PIPE ON THE BEDDING MATERIAL AND COMPACT OUTER BEDDING MATERIAL (SEE TABLE 1).

(G) PLACE AND COMPACT THE HAUNCH, LOWER SIDE AND OVERFILL MATERIAL AT 6 IN. INTERVALS.



TRENCH DETAILS SHOWN ARE MINIMUM REQUIREMENTS FOR DESIGN AND CONSTRUCTION. PAYMENT FOR EXCAVATION IS BASED UPON THE GUIDELINES IN THE STANDARD SPECIFICATIONS.

TRENCHES SHALL BE EXCAVATED IN ACCORDANCE WITH APPROVED SAFETY PRACTICE.

TYPICAL TRENCH INSTALLATION

NOTES FOR TRENCH INSTALLATIONS:

1. COMPACTION AND SOIL SYMBOLS, I.E. 95% SW, REFER TO SW SOIL MATERIAL WITH MINIMUM STANDARD PROCTOR COMPACTION OF 95%.
2. THE TRENCH TOP ELEVATION SHALL BE NO LOWER THAN 1 FT. BELOW THE BOTTOM OF THE PAVEMENT BASE MATERIAL.
3. SOIL IN BEDDING AND HAUNCH ZONES SHALL BE COMPACTED TO AT LEAST THE SAME COMPACTION AS SPECIFIED FOR THE MAJORITY OF SOIL IN THE BACKFILL ZONES.
4. THE TRENCH WIDTH SHALL BE WIDER THAN SHOWN IF REQUIRED FOR ADEQUATE SPACE TO ATTAIN THE SPECIFIED COMPACTION IN THE HAUNCH AND BEDDING ZONES.
5. FOR TRENCH WALLS THAT ARE WITHIN 10 DEGREES OF VERTICAL, THE COMPACTION OR FIRMNESS OF THE SOIL IN THE TRENCH WALLS AND LOWER SIDE ZONE NEED NOT TO BE CONSIDERED.
6. FOR TRENCH WALLS WITH GREATER THAN 10 DEGREE SLOPES THAT CONSIST OF EMBANKMENT, THE LOWER SIDE SHALL BE COMPACTED TO AT LEAST THE SAME COMPACTION AS SPECIFIED FOR THE SOIL IN THE BACKFILL ZONE.

REV. NO.	DATE	DESCRIPTION OF REVISION
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NEBRASKA DEPARTMENT OF ROADS
STANDARD PLAN NO. 411
BEDDING AND BACKFILL REQUIREMENTS FOR CONCRETE PIPE

PROFESSIONAL CIVIL ENGINEER MOSTAFA JAMSHIDI E-6574 STATE OF NEBRASKA

FHWA APPROVED:
DATE
ORIGINAL: JUNE 6, 2008
DATE

1/4

Roadway Design Division

DATE:sssssssssssss

TABLE 1
STANDARD INSTALLATIONS, SOILS AND MINIMUM COMPACTION REQUIREMENTS

INSTALLATION TYPE	BEDDING THICKNESS	HAUNCH AND OUTER BEDDING	LOWER SIDE
TYPE 1	DO/24 MINIMUM, NOT LESS THAN 3 IN. IF ROCK FOUNDATION, USE DO/12 MINIMUM, NOT LESS THAN 6 IN.	95% SW	90% SW, 95% ML, OR 100% CL.
TYPE 2		90% SW OR 95% ML	85% SW, 90% ML, OR 95% CL.
• TYPE 3		85% SW, 90% ML, OR 95% CL	85% SW, 90% ML, OR 95% CL.

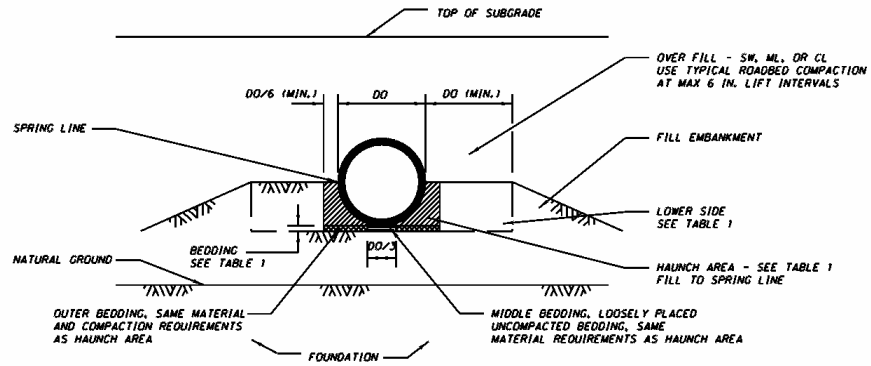
TABLE 1 NOTES:

- *THE TYPE 3 INSTALLATION SHOWN IS THE NDOR MINIMUM STANDARD, USING EITHER A SHAPED TRENCH ACCORDING TO THE STANDARD SPECIFICATIONS, OR AT THE OPTION OF THE CONTRACTOR, THE BEDDING WITH COMPACTIONS AS SHOWN.*

ALLOWABLE FILL HEIGHTS FOR THE TYPE 1, 2, AND 3 INSTALLATIONS ARE SHOWN IN TABLE 4.

TABLE 2
PIPE DIMENSIONS

NOMINAL PIPE DIAMETER (INCHES)	STANDARD OUTSIDE PIPE DIAMETER, DO (SPAN)			
	ROUND PIPE	ARCH PIPE	H. ELLIP. PIPE	V. ELLIP. PIPE
15	19.5	22.5		
18	23	27	28.5	
21	26.5	31.5		
24	30	34.5	36.5	
27	33.5		41	
30	37	43.25	45.5	
36	44	51.75	54	38
42	51	60.13	63	44
48	58	68.5	71	49
54	65	76	80	55
60	72	85	89	61
66	79		97	67
72	86	102	106	73
78	93		114	79
84	100	118	123	85
90	107			
96	114			
102	121			
108	128			



TYPICAL EMBANKMENT INSTALLATION

TABLE 3
SOIL CLASSIFICATION FOR BEDDING & BACKFILL

ASTM SOIL GROUP SYMBOL D 2487	DESCRIPTION	PERCENTAGE PASSING SIEVE SIZES		
		1½ IN. (40 mm)	NO. 4 (4.75 mm)	NO. 200 (0.075 mm)
SW	WELL GRADED SANDS AND GRAVELLY-SANDS; LITTLE OR NO FINES, NON PLASTIC	100%	> 50% OF "COURSE FRACTION"	< 5%
ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY-FINE-SANDS, SILTS WITH SLIGHT PLASTICITY		100%	> 50%
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELY-CLAYS, SANDY-CLAYS, SILTY-CLAYS, LEAN CLAYS			

NOTES FOR EMBANKMENT INSTALLATIONS:

1. *COMPACTION AND SOIL SYMBOLS, I.E. 95% SW, REFER TO SW SOIL MATERIAL WITH A MINIMUM STANDARD PROCTOR COMPACTION OF 95%.*
2. *SOIL IN THE OUTER BEDDING, HAUNCH, AND LOWER SIDE ZONES, EXCEPT WITHIN THE DO/3 MIDDLE BEDDING, SHALL BE COMPACTED TO AT LEAST THE SAME COMPACTION AS THE MAJORITY OF THE SOIL IN THE OVERFILL ZONES.*
3. *SUBTRENCHES*
   - *3.1 A SUBTRENCH IS DEFINED AS A TRENCH WITH ITS TOP AT AN ELEVATION LOWER THAN 1 FT. BELOW THE BOTTOM OF THE PAVEMENT BASE MATERIAL.*
   - *3.2 THE MINIMUM WIDTH OF A SUBTRENCH SHALL BE 1.33DO, OR WIDER IF REQUIRED FOR ADEQUATE SPACE TO ATTAIN THE SPECIFIED COMPACTION IN THE HAUNCH AND BEDDING ZONES.*
   - *3.3 FOR SUBTRENCHES WITH WALLS OF NATURAL SOIL, ANY PORTION OF THE LOWER SIDE ZONE IN THE SUBTRENCH WALL SHALL BE AT LEAST AS FIRM AS AN EQUIVALENT SOIL PLACED TO THE COMPACTION REQUIREMENTS SPECIFIED FOR THE LOWER SIDE ZONE, AND AS FIRM AS THE MAJORITY OF SOIL IN THE OVERFILL ZONE, OR SHALL BE REMOVED AND REPLACED WITH SOIL COMPACTED TO THE SPECIFIED LEVEL.*

GENERAL NOTES:

WHEN IN-SITU LATERAL SOIL RESISTANCE IS NEGLIGIBLE, E.G. PEAT, MUCK, OR HIGHLY EXPANSIVE SOIL, EMBEDMENT SHALL BE PLACED AND COMPACTED AT THE DIRECTION OF THE ENGINEER.

TO PROTECT THE PIPE AND BACKFILL DURING CONSTRUCTION, PROVIDE A MINIMUM OF 36 IN. OF COMPACTED FILL MATERIAL OVER THE TOP OF THE PIPE BEFORE ALLOWING ANY HEAVY EQUIPMENT TO TRAVERSE OVER THE PIPE. EXTREMELY HEAVY EQUIPMENT MAY REQUIRE LARGER COVER AS DETERMINED BY THE CONTRACTOR.

THE PIPE VOLUME SHOULD NOT BE SUBTRACTED FROM THE VOLUME OF EXCAVATION.

THESE DESIGN STANDARDS ARE MINIMUM. IF A MORE RESTRICTIVE DESIGN IS REQUIRED BY THE ENGINEER OR CULVERT MANUFACTURER, THEN THESE STANDARDS SHALL BE MODIFIED. CHANGES TO PAY ITEM QUANTITIES DUE TO UNFORESEEN SITE CONDITIONS SHALL BE CALCULATED AND INCORPORATED INTO THE CONTRACT THRU A CHANGE ORDER.

BOTH ENDS OF THE PIPE SHALL BE SEALED WITH COHESIVE SOIL (AROUND THE PIPE EXTENDING 3 FT. TO 4 FT. FROM EACH END) TO PROTECT AGAINST INFILTRATION AND EROSION.

BEDDING AND BACKFILL MATERIAL IS NOT PAID FOR DIRECTLY, BUT IS SUBSIDIARY TO THE LINEAR FEET OF CULVERT.

BEDDING AND BACKFILL MATERIAL SHALL MEET ASTM D 2487 (SOIL GROUPS AS SHOWN IN TABLE 3).

PERCENT COMPACTION SHALL BE DETERMINED IN ACCORDANCE WITH NDOR STANDARD TEST METHOD T 99.

REV. NO.	DATE	DESCRIPTION OF REVISION

NEBRASKA DEPARTMENT OF ROADS

STANDARD PLAN NO. 411

BEDDING AND BACKFILL REQUIREMENTS FOR CONCRETE PIPE

PROFESSIONAL CIVIL ENGINEER — MOSTAFA JAMSHIDI E-6574 — STATE OF NEBRASKA

FHWA APPROVED:

DATE

ORIGINAL: JUNE 6, 2008

DATE

2/4

STANDARD INSTALLATIONS, SOILS AND MINIMUM COMPACTION REQUIREMENTS

INSTALLATION TYPE	BEDDING THICKNESS	HAUNCH AND OUTER BEDDING	LOWER SIDE
TYPE 1	DO/24 MINIMUM, NOT LESS THAN 3 IN. IF ROCK FOUNDATION,USE DO/12 MINIMUM, NOT LESS THAN 6 IN.	95% SW	90% SW, 95% ML, OR 100% CL.
TYPE 2		90% SW OR 95% ML	85% SW, 90% ML, OR 95% CL.
• TYPE 3		85% SW, 90% ML, OR 95% CL	85% SW, 90% ML, OR 95% CL.

NOTES:

- *THE TYPE 3 INSTALLATION (SHADED) IN TABLE 4 IS THE NDOR STANDARD, USING EITHER A SHAPED TRENCH ACCORDING TO THE STANDARD SPECIFICATIONS, OR AT THE OPTION OF THE CONTRACTOR, THE BEDDING WITH COMPACTIONS AS SHOWN.*

INSTALLATION TYPE 2 AND TYPE 1 ARE IMPROVED METHODS IN ORDER TO SUPPORT HIGHER FILL HEIGHTS USING CLASS III, IV, AND V CIRCULAR CONCRETE PIPE. INSTALLATION TYPE 1 WILL PROVIDE THE BEST IN-SITU PERFORMANCE USING GREATER COMPACTION WITH GRANULAR BEDDING AND BACKFILL. THE CONTRACTOR WILL CHOOSE THE INSTALLATION TYPE AND CLASS OF PIPE. ACTUAL PROJECT FILL HEIGHTS MUST BE KNOWN IN ORDER TO USE TABLE 4.

ROUND EQUIVALENT, NON-CIRCULAR PIPE SUCH AS ARCH OR ELLIPTICAL PIPE, MAY BE SELECTED, PROVIDED SUCH PIPE ARE DESIGNED AND MANUFACTURED TO THE SAME D-LOADS AND ULTIMATE STRENGTHS (SEE TABLE 5) AS THE SELECTED CIRCULAR PIPE FROM THE FILL HEIGHT TABLE.

TABLE 4
MAXIMUM FILL HEIGHTS (FEET) FOR STANDARD DESIGN (AASHTO M 170) ROUND CONCRETE PIPE

	INSTALLATION TYPE 3* (NDOR STANDARD)			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	18	26	16	24	32	25	37	48
24	13	19	26	17	24	33	25	32	45
27	13	17	28	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		

GENERAL NOTES:

FILL HEIGHTS SHOWN IN TABLE 4 WERE DEVELOPED USING ASCE STANDARDS FOR DIRECT DESIGN OF BURIED PRECAST CONCRETE PIPE, MANUFACTURED IN ACCORDANCE WITH AASHTO M 170 SPECIFICATION REQUIREMENTS (SEE TABLE 4 FOOTNOTE FOR EXCEPTIONS). FILL HEIGHTS SHOWN APPLY ONLY TO ROUND PIPE (UNDER FULL FLOW CONDITIONS), USED UNDER RIGID AND FLEXIBLE PAVEMENT, WITH SOIL OVERFILL WEIGHING 120 POUNDS PER CUBIC FOOT. UNDER SPECIAL CIRCUMSTANCES (WHERE PAVEMENT IS NOT USED AND LIVE LOAD BECOMES CRITICAL, OR DIFFERENT SOIL DENSITY IS ENCOUNTERED, OR THE ONE FOOT MINIMUM CLEARANCE FROM THE BOTTOM OF THE PAVEMENT TO THE TOP OF THE PIPE CANNOT BE MAINTAINED) THESE FILL HEIGHTS MAY NEED TO BE MODIFIED. DEEPER FILL HEIGHTS MAY BE USED BY SUBMITTING A SPECIAL STANDARD INSTALLATION DIRECT DESIGN (SIDD) FOR NDOR APPROVAL.

CONCRETE PIPE DESIGNS THAT ARE NOT SHOWN IN APPLICABLE AASHTO SPECIFICATIONS WILL BE CONSIDERED SPECIAL DESIGNS THAT MUST BE SUBMITTED TO NDOR FOR APPROVAL.

TABLE 4 NOTES:

AASHTO M 170 SPECIFICATIONS ARE MODIFIED AS FOLLOWS:

ONLY SINGLE INNER CAGE, CIRCULAR REINFORCING IS ALLOWED FOR CLASS III, 15, 18, 21, AND 24 IN. ROUND RCP AS SHOWN:

PIPE SIZE (IN.)	CLASS	MINIMUM CIRCUMFERENTIAL REINFORCING (IN.²/FT. OF PIPE WALL)
15	III	0.08
18	III	0.10
21	III	0.12
24	III	0.14

APPLICABLE SPECIFICATIONS:

AASHTO M 170---ROUND RCP
AASHTO M 206---ARCH RCP
AASHTO M 207---ELLIPTICAL RCP

TABLE 5
D-LOADS FOR CONCRETE PIPE

PIPE CLASS	III	IV	V
D-LOAD TO PRODUCE A 0.01-IN. CRACK	1350	2000	3000
D-LOAD TO PRODUCE THE ULTIMATE LOAD	2000	3000	3750

NOTES:

LOAD ON PIPE IN POUNDS PER LINEAR FOOT = D-LOAD X INSIDE SPAN IN FEET D-LOAD = TEST LOAD EXPRESSED IN POUNDS-FORCE PER LINEAR FOOT PER FOOT OF DIAMETER

REV. NO.	DATE	DESCRIPTION OF REVISION

NEBRASKA DEPARTMENT OF ROADS
STANDARD PLAN NO. 411
BEDDING AND BACKFILL REQUIREMENTS FOR CONCRETE PIPE

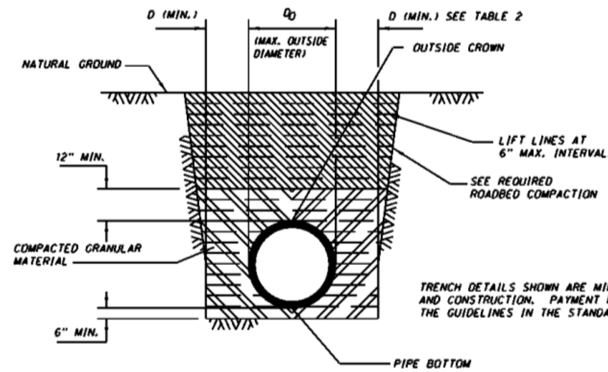
PROFESSIONAL CIVIL ENGINEER — JOHN M. JANSSEN E-6574 — STATE OF NEBRASKA

FHWA APPROVED:

DATE

ORIGINAL: JUNE 6, 2008
DATE

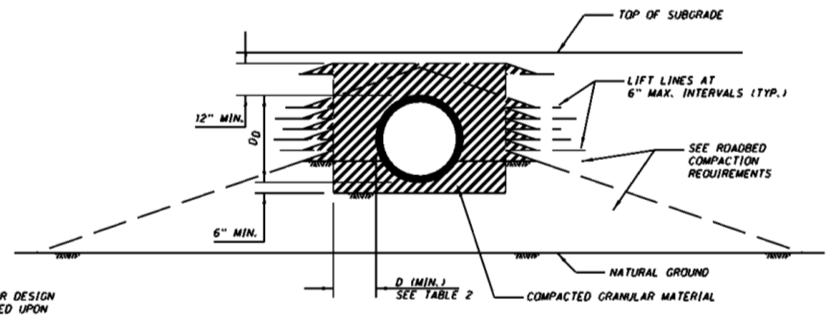
3/4



TRENCH DETAILS SHOWN ARE MINIMUM REQUIREMENTS FOR DESIGN AND CONSTRUCTION. PAYMENT FOR EXCAVATION IS BASED UPON THE GUIDELINES IN THE STANDARD SPECIFICATIONS.

TRENCHES SHALL BE EXCAVATED IN ACCORDANCE WITH APPROVED SAFETY PRACTICE.

TYPICAL TRENCH INSTALLATION



TYPICAL EMBANKMENT INSTALLATION

TABLE 1
SOIL CLASSIFICATION FOR GRANULAR FILL MATERIAL

		SOIL GROUP SYMBOL D 2487	DESCRIPTION	% PASSING SIEVE SIZES		
				1½ IN.	NO. 4	NO. 200
PLASTIC PIPE	MCCMP & PCCMP	GW	WELL GRADED GRAVEL AND GRAVEL-SAND MIXTURES; LITTLE OR NO FINES.	100%	< 50% OF COARSE FRACTION	< 5%
PLASTIC PIPE	MCCMP & PCCMP	GP	POORLY GRADED GRAVEL AND GRAVEL-SAND MIXTURES; LITTLE OR NO FINES.	100%	< 50% OF COARSE FRACTION	< 5%
PLASTIC PIPE	MCCMP & PCCMP	SW	WELL GRADED SAND AND GRAVEL-SANDS; LITTLE OR NO FINES.	100%	> 50% OF COARSE FRACTION	< 5%
PLASTIC PIPE	MCCMP & PCCMP	SP	POORLY GRADED SAND AND GRAVEL-SANDS; LITTLE OR NO FINES.	100%	> 50% OF COARSE FRACTION	< 5%
	MCCMP & PCCMP	E.G. GW-GC SP-SM	SAND AND GRAVELS WHICH ARE BORDER LINE BETWEEN CLEAN AND WITH FINES.	100%	VARIES	5% TO 12%
	MCCMP & PCCMP	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES.	100%	< 50% OF COARSE FRACTION	12% TO 50%
	MCCMP & PCCMP	GC	CLAYEY-GRAVEL, GRAVEL-SAND-CLAY MIXTURES.	100%	< 50% OF COARSE FRACTION	12% TO 50%
	MCCMP & PCCMP	SM	SILTY SANDS, SAND-SILT MIXTURES.	100%	> 50% OF COARSE FRACTION	12% TO 50%

TABLE 2
MINIMUM D (INCHES)

NOMINAL PIPE DIAMETER (INCHES)	TRENCH INSTALLATION		EMBANKMENT INSTALLATION	
	METAL PIPE	PLASTIC PIPE	METAL PIPE	PLASTIC PIPE
15	8	8	15	15
18	9	9	18	18
24	9	9	24	24
30	10	10	24	24
36	11	11	24	24
42	24		24	
48	24		24	
54	24		24	
60	24		24	
66	24		24	
72	24		24	
78	24		24	
84	24		24	

NOTES:

INSTALLATIONS AS SHOWN ARE REQUIRED UNDER ALL SURFACED ROADWAYS. BEDDING AND BACKFILL FOR DRIVE PIPE OR OTHER PIPE OUTSIDE THE ROADWAY PRISM (OR BACK OF CURB-LINE FOR URBAN PROJECTS) MAY BE INSTALLED USING SUITABLE EXISTING SOIL, PLACED AND COMPACTED IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS.

WHERE IN-SITU LATERAL SOIL RESISTANCE IS NEGLIGIBLE E.G. PEAT, MUCK, OR HIGHLY EXPANSIVE SOIL, EMBEDMENT SHALL BE PLACED AND COMPACTED AT THE DIRECTION OF THE ENGINEER.

TO PROTECT THE PIPE AND BACKFILL DURING CONSTRUCTION, PROVIDE A MINIMUM OF 36" OF COMPACTED FILL MATERIAL OVER THE TOP OF THE PIPE BEFORE ALLOWING ANY HEAVY EQUIPMENT TO TRAVERSE OVER THE PIPE. EXTREMELY HEAVY EQUIPMENT MAY REQUIRE LARGER COVER AS DETERMINED BY THE CONTRACTOR.

PIPE VOLUME SHOULD NOT BE SUBTRACTED FROM THE VOLUME OF EXCAVATION.

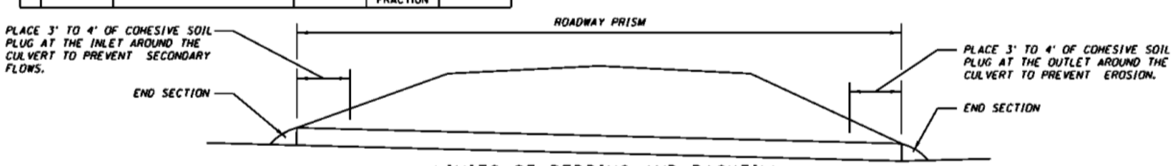
THESE DESIGN STANDARDS ARE MINIMUM. IF A MORE RESTRICTIVE DESIGN IS REQUIRED BY THE ENGINEER OR THE CULVERT MANUFACTURER, THEN THESE STANDARDS SHALL BE MODIFIED. CHANGES TO PAY ITEM QUANTITIES DUE TO UNFORESEEN SITE CONDITIONS SHALL BE CALCULATED AND INCORPORATED INTO THE CONTRACT BY A CHANGE ORDER.

EXPOSED ENDS OF THE PIPE SHALL BE SEALED WITH COHESIVE SOIL (AROUND THE PIPE EXTENDING 3' TO 4' FROM EACH END) TO PROTECT AGAINST INFILTRATION AND EROSION.

GRANULAR FILL MATERIAL IS NOT PAID FOR DIRECTLY, BUT IS SUBSIDIARY TO THE LINEAR FEET OF CULVERT.

GRANULAR MATERIAL SHALL MEET ASTM D 2487 (SOIL GROUP AS SHOWN IN TABLE 1). MATERIAL SHALL BE COMPACTED TO AT LEAST 90% PROCTOR TEST DENSITY.

PERCENT COMPACTION SHALL BE DETERMINED IN ACCORDANCE WITH NDOR STANDARD TEST METHOD T 99.



LIMITS OF BEDDING AND BACKFILL

REV. NO.	DATE	DESCRIPTION OF REVISION
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NEBRASKA DEPARTMENT OF ROADS
STANDARD PLAN NO. 411
BEDDING AND BACKFILL REQUIREMENTS FOR MCCMP, PCCMP, & PLASTIC PIPE

FHWA APPROVED:
DATE
ORIGINAL: JUNE 6, 2008
DATE