



STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION

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GOVERNOR

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August 27, 2009

Memorandum To: Mr. Jay Bennett, PE  
State Roadway Design Engineer  
and  
Mr. Dave Henderson, PE  
State Hydraulics Engineer

From: Drainage Subcommittee

*JJA* FOR RON HANCOCK

Subject: Updates to drainage pipe standard details and material selection process.

**PIPE INSTALLATION STANDARDS AND SPECIFICATIONS**

As you are aware, the Drainage Subcommittee began an initiative over a year ago to improve our overall drainage pipe installation practices. A major part of this effort was to update our Standard Installation Details and associated Standard Specifications. Drainage Pipe Installation Standard Drawings have been modified and condensed to three sheets in lieu of four. The new drawings are attached and a summary of the major changes is as follows:

- No longer using reference to Method A and Method B installation types.
- Method B is replaced by a special RCP design when fill heights are greater than 40 feet. See the attached Special Provision to be used for this case.
- There are separate details for flexible and rigid pipes. Standard 300D01 sheet 1 of 3 is for flexible pipe and 300D01 sheet 2 of 3 is for rigid pipe
- Fill height tables have been updated and are included on 300D01 sheet 3 of 3. This is a condensed version of the fill height tables that should also be updated in the Roadway Design Manual.
- Arch pipe and structural plate pipe are no longer shown in the pipe Standard Drawings. Drawings for these applications will be provided on project specific basis.

The updated Standard Drawing details (3 sheets) should be included in all projects beginning with the October 20, 2009 letting. These new details will require one new pay item. This pay item will be the Foundation Conditioning Fabric. It is labeled Type IV Engineering Fabric in the revised Standard Drawings. These details sheets can be picked up from the Standards Section or by email request to Joel Howerton, PE, Standards Engineer.

## PIPE ALTERNATES/ DRAINAGE SUMMARY

In addition to improving drainage pipe installation details, the Drainage Subcommittee has developed a new Project Special Provision to expand the use of alternate drainage pipe materials. This provision titled "Drainage Pipe" is attached. In addition, Article 310-4 of the Specifications has been revised to expand the definition of "Side Drain Pipe" to include more than driveway pipe. The revised specification states "Side drain pipe is defined as storm drain pipe running parallel to the roadway to include pipes in medians, outside ditches, driveways, and under shoulder berm gutter along outside shoulders greater than four feet wide.

These changes require a modification to the Drainage Summary and Estimate Plan Sheets. The revised Drainage Summary will have columns for \_\_\_" Drainage Pipe as well as \_\_\_" Side Drain Pipe. Having these pay items will allow the Contractor to select the specific type of material used and eliminates the need for multiple alternate bid items. However, if there are specific restrictions of certain materials a note will be needed in the remarks column. The associated pay items will also be designated \_\_\_" Drainage Pipe and \_\_\_" Side Drain Pipe. The use of the "Drainage Pipe" item will be limited to pipes located on Sub Regional and Regional Tier facilities. Statewide Tier facilities will not use the "Drainage Pipe" item but will continue to use the "Side Drain Pipe" pay item with the above referenced expanded definition.

The revised Drainage Summary sheets and pay items should be implemented with all projects beginning with the January 19, 2010 letting. If there are extenuating circumstances that make this impractical, please contact Randy Garris to discuss.

Joel Howerton, of the Contract Standards and Development Unit will provide training on using the revised Drainage Summary and the new pay items. He will coordinate with you to make sure each of your units is well represented. In addition division design staff will be invited to attend and regional sessions held as needed. Your assistance with this effort is appreciated.

The Drainage Subcommittee encourages your unit to update the "Roadway Design Manual" and "Guidelines for Drainage Studies and Hydraulic Design" to reflect these changes. To aid with this, two documents have been developed and are attached for your use. The first is a table titled "NCDOT Material Selection Guidelines for Drainage Pipe" and the second is a narrative titled "Drainage Pipe Restrictions".

RH RAG/JSB

Attachments

Cc: Division Engineers

Jon Nance, PE

Cecil Jones, PE

Greg Perfetti, PE

Njoroge Wainaina, PE

Dan Holderman, PE

Jennifer Brandenburg, PE

John Sullivan, PE - FHWA

Drainage Subcommittee Members

Ron Hancock, PE

Randy Garris, PE

# NCDOT PIPE MATERIAL SELECTION GUIDE (rev. 11/30/09 Hydraulics Unit)

**\*SWT: ALTERNATE PIPE APPLICABLE ONLY FOR SIDE AND SLOPE DRAINS FOR SIZES 12" TO 48"**

**\*RT AND SRT: ALTERNATE PIPE APPLICABLE ONLY FOR FILL HEIGHTS >2.0' & <20.0' FOR SIZES 12" TO 48"**

	RCP (REINFORCED CONCRETE) AASHTO M170								CSP (CORRUGATED STEEL) AASHTO M36 2 2/3 x 1/2 CORRUGATION **						CAAP (CORRUGATED ALUMINUM) AASHTO M196 2 2/3 x 1/2 CORRUGATION **						HDPE AASHTO M294			PVC-ASTM F949 AASHTO M304									
	CLASS II		CLASS III		CLASS IV		CLASS V		SIZE	*MIN.	MAXIMUM					SIZE	*MIN.	MAXIMUM					SIZE	*MIN.	MAX.	SIZE		*MIN.	MAX.				
	*MIN.	MAX.	*MIN.	MAX.	*MIN.	MAX.	*MIN.	MAX.			(Ga)	16	14	12	10			8	(Ga)	16	14	12								10	8		
<b>FILL TABLES</b>		2.0'	10.0'	2.0'	20.0'	1.0'	30.0'	1.0'	40.0'	12"	12"		204'	256'				12"	12"		123'	155'	218'	281'	344'	12"	2.0'	20'	12"	2.0'	30'	<p>*MINIMUM FILL HEIGHT IS MEASURED FROM TOP OF PIPE TO BOTTOM OF PAVEMENT STRUCTURE</p> <p>** FOR DIFFERENT CORRUGATIONS AND ARCH PIPES REFER TO ROADWAY DESIGN MANUAL AND MANUFACTURERS SPECIFICATION.</p> <p>NOTES: FILL HEIGHTS SHOWN WERE CALCULATED USING AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS</p> <p>1' MINIMUM TO 10' MAXIMUM COVER FOR ALL SIDE DRAIN PIPE IN ACCORDANCE WITH STANDARD SPECIFICATIONS</p> <p>ALL PIPE TYPES ARE SUBJECT TO THE MAXIMUM AND MINIMUM FILL HEIGHT REQUIREMENTS AS FOUND IN CHAPTER 5 OF THE ROADWAY DESIGN MANUAL. THE APPROPRIATE CLASS OF PIPE FOR RCP AND GAGE THICKNESS FOR CSP/CAAP SHOULD BE SELECTED BASED ON FILL HEIGHT. RCP IS NOT ALLOWED FOR GRADES &gt;10%.</p> <p>FOR COUNTIES LISTED IN ARTICLE 310-2 OF THE STANDARD SPECIFICATIONS CSP IS NOT ALLOWED. IN OTHER COUNTIES CSP REQUIRES AN ACCEPTABLE COATING IN ACCORDANCE WITH 1032-4.</p> <p>SITE SPECIFIC CONDITIONS MAY LIMIT A PARTICULAR MATERIAL BEYOND WHAT IS IDENTIFIED IN THE TABLE. THESE CONDITIONS INCLUDE, BUT ARE NOT LIMITED TO, ABRASION, ENVIRONMENTAL, SOIL RESISTIVITY AND PH, HIGH GROUND WATER, AND SPECIAL LOADING CONDITIONS. THE HYDRAULIC DESIGN ENGINEER WILL DETERMINE IF ADDITIONAL RESTRICTIONS ARE NECESSARY.</p> <p>ONLY PIPE WITH SMOOTH WALL INSIDE WALLS WILL BE ALLOWED FOR STORM DRAIN SYSTEMS.</p> <p>DEFINITIONS: STATEWIDE TIER (SWT)-THE STRATEGIC HIGHWAY CORRIDOR NETWORK AS APPROVED BY THE BOARD OF TRANSPORTATION. REGIONAL TIER (RT)- US AND NC ROUTES NOT ON THE STATEWIDE TIER. SUBREGIONAL TIER (SRT)- SR ROUTES SIDE DRAINS- STORM DRAIN PIPES RUNNING PARALLEL TO THE ROADWAY TO INCLUDE PIPES IN THE MEDIANS, OUTSIDE DITCHES, DRIVEWAYS, AND UNDER SHOULDER BERM GUTTER ALONG OUTSIDE SHOULDERS GREATER THAN 4 FEET WIDE. MAY OR MAY NOT BE OPEN ENDED. STORM DRAIN SYSTEMS- LATERAL DRAIN PIPE UNDER CURB AND GUTTER, EXPRESSWAY GUTTER, AND SHOULDER BERM GUTTER (WITH SHOULDERS 4 FEET WIDE OR LESS) THAT CONNECT DRAINAGE STRUCTURES AND IS NOT OPEN ENDED. ALSO INCLUDES CROSS DRAIN CONNECTING TWO OR MORE SYSTEMS OR SYSTEM OUTLETS. TRANSVERSE MEDIAN DRAINS- SHALLOW CROSS DRAIN PIPE THAT COLLECTS DRAINAGE IN A MEDIAN DITCH OR CURB SECTION AND DEPOSITS IT TO OUTSIDE DITCHES OR NATURAL DRAINAGE CHANNELS. MAY OR MAY NOT BE OPEN ENDED.</p>	
		(FOR FILLS >40' & <80' USE LRFD DIRECT DESIGN METHOD)																															
											15"	12"		162'	204'				15"	12"		98'	123'	174'	224'	275'	15"	2.0'	20'	15"	2.0'		30'
											18"	12"		135'	169'	239'			18"	12"		81'	102'	144'	187'	228'	18"	2.0'	20'	18"	2.0'		30'
											24"	12"		100'	126'	178'			24"	12"		60'	76'	108'	139'	171'	24"	2.0'	20'	24"	2.0'		30'
											30"	12"		79'	100'	142'			30"	12"		60'	85'	111'	136'	30"	2.0'	17'	30"	2.0'	30'		
											36"	12"		65'	83'	117'	152'		36"	12"		50'	71'	92'	113'	36"	2.0'	17'	36"	2.0'	30'		
											42"	12"		55'	70'	100'	130'	160'	42"	12"				60'	78'	96'	42"	2.0'	17'				
											48"	12"		48'	61'	87'	113'	139'	48"	12"				52'	68'	84'	48"	2.0'	17'				
											54"	12"			54'	77'	100'	123'	54"	12"				46'	50'	74'	54"	2.0'	17'				
											60"	12"				69'	90'	111'	60"	12"				50'	62'	60"	2.0'	17'					
											66"	12"					81'	100'	66"	12"					51'								
											72"	12"					74'	91'	72"	12"					41'								
										78"	12"						81'																
										84"	12"						69'																
<b>OPEN END CROSS PIPES</b>	SWT	CAN BE USED								USE ONLY IF PIPE SLOPE IS GREATER THAN 10%						USE ONLY IF PIPE SLOPE IS GREATER THAN 10%						DO NOT USE			DO NOT USE								
	RT & SRT	CAN BE USED								CAN BE USED						CAN BE USED						CAN BE USED			CAN BE USED								
<b>STORM DRAIN SYSTEMS</b>	SWT	CAN BE USED								USE ONLY AT SYSTEM INLETS & SYSTEM OUTLET IF PIPE SLOPE IS GREATER THAN 10%						USE ONLY AT SYSTEM INLETS & SYSTEM OUTLET IF PIPE SLOPE IS GREATER THAN 10%						DO NOT USE			DO NOT USE								
	RT & SRT	CAN BE USED								USE ONLY AT SYSTEM INLETS & SYSTEM OUTLET IF PIPE SLOPE IS GREATER THAN 10%						USE ONLY AT SYSTEM INLETS & SYSTEM OUTLET IF PIPE SLOPE IS GREATER THAN 10%						CAN BE USED			CAN BE USED								
<b>TRANSVERSE MEDIAN PIPES</b>	SWT	CAN BE USED								USE ONLY IF PIPE SLOPE IS GREATER THAN 10%						USE ONLY IF PIPE SLOPE IS GREATER THAN 10%						DO NOT USE			DO NOT USE								
	RT & SRT	CAN BE USED								CAN BE USED						CAN BE USED						CAN BE USED			CAN BE USED								
<b>SLOPE DRAINS</b>	SWT	CAN BE USED IF PIPE SLOPE IS <10%								CAN BE USED						CAN BE USED						CAN BE USED			CAN BE USED								
	RT & SRT	CAN BE USED IF PIPE SLOPE IS <10%								CAN BE USED						CAN BE USED						CAN BE USED			CAN BE USED								
<b>SIDE DRAINS</b>	SWT	CAN BE USED								CAN BE USED						CAN BE USED						CAN BE USED			CAN BE USED								
	RT & SRT	CAN BE USED								CAN BE USED						CAN BE USED						CAN BE USED			CAN BE USED								

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## FLEXIBLE PIPE

Round Corrugated Steel Pipe 2 2/3 x 1/2 corrugation **						
Diameter (inches)	Minimum cover (inches)	Maximum Height of Cover (feet)				
		(Ga)	16	14	12	10
12	12		204	256		
15	12		162	204		
18	12		135	169	239	
21	12		115	145	204	
24	12		100	126	178	
30	12		79	100	142	
36	12		65	83	117	152
42	12		55	70	100	130 160
48	12		48	61	87	113 139
54	12			54	77	100 123
60	12				69	90 111
66	12					81 100
72	12					74 91
78	12					81
84	12					69

Round Corrugated Aluminum Pipe 2 2/3 x 1/2 corrugation **						
Diameter (inches)	Minimum cover (inches)	Maximum Height of Cover (feet)				
		(Ga)	16	14	12	10
12	12		123	155	218	281 344
15	12		98	123	174	224 275
18	12		81	102	144	187 228
21	12		69	87	123	160 195
24	12		60	76	108	139 171
27	12			67	95	123 151
30	12			60	85	111 136
36	12			50	71	92 113
42	12				60	78 96
48	12				52	68 84
54	12				46	50 74
60	12					50 62
66	12					51
72	12					41

\*\* FOR DIFFERENT CORRUGATIONS AND ARCH PIPES REFER TO ROADWAY DESIGN MANUAL OR MANUFACTURERS SPECIFICATION.

REFER TO THE FOLLOWING FOR PIPE SPECIFICATIONS

- CSP - AASHTO M36
- CAAP - AASHTO M196
- HDPE - AASHTO M294
- PVC - ASTM F949 or AASHTO M304

NOTES: FILL HEIGHTS SHOWN WERE CALCULATED USING AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

1' MINIMUM COVER FOR ALL SIDE DRAIN PIPE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS

- HDPE - \* (Minimum fill) *To SUBGRADE* 2' for pipe diameters ≥ 12" and ≤ 60"  
 \* (Maximum fill) 20' for pipe diameters ≤ 24"  
 17' for pipe diameters ≥ 30" and ≤ 60"
- PVC - \* (Minimum fill) 2' for pipe diameters ≥ 12" and ≤ 36"  
 \* (Maximum fill) 30' for pipe diameters ≥ 12" and ≤ 36"

\* FILL HEIGHT IS MEASURED FROM THE TOP OF THE PIPE TO THE BOTTOM OF THE PAVEMENT STRUCTURE

## RIGID PIPE

- RCP - \* (Minimum fill) *To SUBGRADE* 1' for Class IV & CLASS V  
 2' for Class III & Class II  
 \* (Maximum fill) 10' - ~~Class II pipe~~ *DISREGARD*  
 20' - Class III pipe  
 30' - Class IV pipe  
 40' - Class V pipe *OVER 40' CONTRACTOR DESIGN*

(For fills > 40' & < 80' use LRFD Direct Design Method)

\* FILL HEIGHT IS MEASURED FROM THE TOP OF THE PIPE TO THE BOTTOM OF THE PAVEMENT STRUCTURE

REFER TO THE FOLLOWING FOR PIPE SPECIFICATIONS

- RCP - AASHTO M170

NOTES: FILL HEIGHTS SHOWN WERE CALCULATED USING AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

1' MINIMUM COVER FOR ALL SIDE DRAIN PIPE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS

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## Drainage Pipe Restrictions

These restrictions are intended to be used by the designer when preparing the three series (Drainage Summary) plan sheets that contain the pay item *Drainage Pipe*. There are three restrictions for use of the *Drainage Pipe* pay item. If these conditions exist, particular type of pipe should be specified on the plans and in the drainage summary:

1. Do not use *Drainage Pipe* pay item when fill height is greater than 20'
2. Do not use *Drainage Pipe* pay item when fill height is less than 2'
3. Do not use *Drainage Pipe* pay item on Statewide Tier Routes. *Drainage Pipe* pay item is restricted to Regional and Sub-Regional Tier Routes.

Below is a list of restrictions per pipe type that must be applied when the *Drainage Pipe* pay item is allowed. If a restriction applies, it should be noted in the "Remarks" section of the Drainage Summary plan sheet.

### Reinforced Concrete Pipe (RCP)

- Not allowed when pipe slope is greater than 10%
- Class II not allowed when fill height greater than 10 feet. Require Class III in this case.

### Corrugated Polyethylene Pipe (HDPE)

- Pipe diameter of 30" or greater not allowed when fill is greater than 17 feet

### Polyvinyl-Chloride (PVC)

- No restrictions

### Corrugated Steel Pipe (CSP)

- Not allowed in the following counties due to corrosion concerns: Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrell, and Washington
- Not allowed in Storm Drain Systems – defined as lateral drain pipes under curb and gutter, expressway gutter, and shoulder berm gutter (with shoulder 4 feet wide or less) that connects drainage structures and is not open ended. Also includes cross drain pipe connecting two or more systems or outlets for a system.

### Corrugated Aluminum Alloy Pipe (CAAP)

- Not allowed in Storm Drain Systems – see definition above

## Side Drain Pipe

This guide is intended to be used by the designer when preparing the three series (Drainage Summary) plan sheets that contain the pay item *Side Drain Pipe*. As defined in Article 310-4 of the Standard Specifications, *Side Drain Pipe* is storm drain pipe running parallel to the roadway to include pipe in medians, outside ditches, driveways, and under shoulder berm gutter along outside shoulders greater than 4 feet wide. Several pipe material options are allowed for *Side Drain Pipe*. The following exceptions should be considered when preparing the plans.

1. Do not use the pay item of *Side Drain Pipe* for fill heights greater than 10'. Call out a particular pipe type or use the *Drainage Pipe* pay item in this case.
2. Do not use the pay item of *Side Drain Pipe* for Commercial Driveways. Call out a particular pipe type for this application.
3. If there is known future widening that will lead to the *Side Drain Pipe* being under future pavement, call out a particular pipe type or use the *Drainage Pipe* pay item in this case.

## **REINFORCED CONCRETE PIPE DESIGN:**

(10-20-09)

SPI 3-06

### **Description**

This work consists of the design and manufacture of reinforced concrete pipes which require fills greater than 40' and less than or equal to 80 feet.

### **Materials**

#### **(A) Design**

When the design of a reinforced concrete pipe is required in the contract plans, design the reinforced concrete pipe in accordance with the current edition of the AASHTO LRFD Bridge Design Specifications. Provide the diameter of pipe as indicated on the plans and manufacture the pipe in accordance with ASTM C 1417. Provide a reinforced concrete pipe that meets the requirements of Section 1032-9, Section 1077 and any other applicable parts of the Standard Specifications.

The design of the reinforced concrete pipe is the responsibility of the Contractor and is subject to review, comments and approval. Submit two sets of detailed plans for review. Include all details in the plans, including the size and spacing of the required reinforcement necessary to fabricate the reinforced concrete pipe. Include checked design calculations for the reinforced concrete pipe. Have a North Carolina Registered Professional Engineer seal the plans and design calculations. After the plans are reviewed and, if necessary, the corrections made, submit one set of reproducible tracings on 22" x 34" sheets to become part of the contract plans.

#### **(B) Reinforced Concrete Pipe Sections**

##### **(1) Class**

Reinforced concrete pipe sections manufactured in accordance with this Special Provision are designated by inside pipe diameter and design earth cover.

##### **(2) Design Criteria**

The design of the reinforced concrete pipe shall be in accordance with Article 12.10.4.2 "Direct Design Method" of the current edition of the AASHTO LRFD Bridge Design Specifications. The following assumptions shall be used in the design calculations:

NCDOT Criteria for Direct Design Method
Process and Material Factors, Radial Tension, $F_{rp}=1.0$ Shear Strength, $F_{vp}=1.0$
Design Concrete Strength - $f'_c$ $5,000 \text{ psi} < f'_c < 7,000 \text{ psi}$
Heger Pressure Distribution - Type 2 Installation Vertical Arching Factor = 1.40 Horizontal Arching Factor = 0.40
Soil Unit Weight = 120 lb/ft <sup>3</sup>
Depth of Fluid = Inside Pipe Diameter
Minimum Concrete Cover = 1.00"
Crack Control = 0.90 (maximum)

**(C) Joints**

Produce the reinforced concrete pipe sections with spigot and bell ends. Design and form the ends of the pipe section so, when the sections are laid together, they make a continuous line of pipe with a smooth interior free of appreciable irregularities in the flow line, and compatible with the permissible variations given in Standard Specifications and ASTM C 1417.

**(D) Manufacture**

In addition to the requirements of the *Standard Specifications* and ASTM C 1417, devices or holes are permitted in each pipe section for the purpose of handling and placement. Submit details of handling devices or holes for approval and do not cast any concrete until approval is granted. Remove all handling devices flush with concrete surfaces as directed. Fill holes in a neat and workmanlike manner with an approved non-metallic non-shrink grout, concrete or plug.

**Measurement and Payment**

\_\_\_\_\_ " *R.C. Pipe Culvert* will be measured and paid for in linear feet. Such price and payment will be full compensation for all work and will include, but not be limited to, furnishing all labor, materials, equipment and other incidentals necessary to complete this work.

Payment will be made under:

**Pay Item**

\_\_\_\_\_ " R.C. Pipe Culvert (Contractor Design)

**Pay Unit**

Linear Feet

**CULVERT PIPE:**

(1-19-09)

Revise the *Standard Specifications* as follows:

**Page 10-67, Article 1032-1, replace (A), (B), (C), (E) and (F) with the following:**

- (A) Coated corrugated metal culvert pipe and pipe arches.
- (B) Coated corrugated metal end sections, coupling band, and other accessories
- (C) Corrugated aluminum alloy structural plate pipe and pipe arches
- (D) Corrugated aluminum alloy end sections, coupling band, and other accessories
- (E) Welded steel pipe

**Page 10-69, Subarticle 1032-3(A)(5) Coating Repair, replace with the following:**

Repair shall be in accordance with Section 1076-6 of the *Standard Specifications*.

**Subarticle 1032-3(A)(7) Aluminized Pipe, replace with the following:**

Aluminized pipe shall meet all requirements herein, except that the pipe and coupling bands shall be fabricated from aluminum coated steel sheet meeting the requirements of AASHTO M274.

**Page 10-71, Article 1032-4 Coated Culvert Pipe, replace (A), (1), (2), (3), (4), (B), (C), (D), (E), (F) and (G) with the following:**

- (A) Coatings for Steel Culvert Pipe or Pipe Arch

The below coating requirements apply for steel culvert pipe, pipe arch, end sections, tees, elbows, and eccentric reducers.

- (1) Steel Culvert pipe shall have an aluminized coating, meeting the requirement of AASHTO M274
- (2) When shown on the plans or as approved by the Engineer, a polymeric coating meeting the requirements of AASHTO M246 for Type B coating may be substituted for aluminized coating.

- (B) Acceptance

Acceptance of coated steel culvert pipe, and its accessories will be based on, but not limited to, visual inspections, classification requirements, check samples taken from material delivered to the project, and conformance to the annual Brand Registration.

**Page 10-73, Article 1032-5, sixth paragraph, third sentence, remove the work "spelter"**

**Page 10-74, 1032-7 Vitrified Clay Culvert Pipe, delete section in its entirety.**

Page 10-75, Article 1032-8 Welded Steel Pipe, change title to **WELDED STEEL PIPE FOR DRAINAGE**

Subarticle 1032-9(B) Plain Concrete Culvert Pipe, delete section in its entirety.

Page 10-77, Article 1032-10 Corrugated Polyethylene Culvert Pipe, change title to **CORRUGATED POLYETHYLENE (HDPE) CULVERT PIPE**

Add the following: **Article 1032-11 Polyvinyl Chloride (PVC) Pipe**

Polyvinyl Chloride pipe shall conform to AASHT M 304 or ASTM 949. When rubber gaskets are to be installed in the pipe joint, the gasket shall be the sole element relied on to maintain a tight joint. Test pipe joints at the plant hydrostatically using test methods in ASTM D 3212. Soil tight joints shall be watertight to 2 psi. Watertight joints shall be watertight to 5 psi unless a higher pressure rating is specified in the plans.

**PIPE INSTALLATION AND PIPE CULVERTS:**

(1-19-10)

SP3R40

Revise the *Standard Specifications* as follows:

Replace Section 300 and Section 310 with the following:

**SECTION 300  
PIPE INSTALLATION**

**300-1 DESCRIPTION**

Excavate, undercut, provide material, condition foundation, lay pipe, joint and couple pipe sections, and furnish and place all backfill material as necessary to install the various types of pipe culverts and fittings required to complete the project.

Do not waste excavation unless permitted. Use suitable excavated material as backfill; or in the formation of embankments, subgrades, and shoulders; or as otherwise directed. Furnish disposal areas for the unsuitable material. The Engineer will identify excavated materials that are unsuitable.

Where traffic is to be maintained, install pipe in sections so that half the width of the roadway is available to traffic.

**300-2 MATERIALS**

Refer to Division 10:

<b>Item</b>	<b>Section</b>
Flowable Fill	1000
Select Materials	1016
Joint Materials	1032-9(G)
Engineering Fabric	1056-1

Provide foundation conditioning material meeting the requirements of Article 1016-3 for Class V or VI as shown in the contract documents.

Provide bedding material meeting the requirements of Article 1016-3 for Class II (Type 1 only) or Class III as shown in contract documents.

Provide backfill material meeting the requirements of Article 1016-3 for Class II (Type 1 only) or Class III material as shown in the contract documents.

Do not use corrugated steel pipe in the following counties:

Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell, and Washington.

### **300-3 UNLOADING AND HANDLING**

Unload and handle pipe with reasonable care. Do not roll or drag metal pipe or plates over gravel or rock during handling. Take necessary precautions to ensure the method used in lifting or placing the pipe does not induce stress fatigue in the pipe. Use a lifting device that uniformly distributes the weight of the pipe along its axis or circumference. Repair minor damage to pipe when permitted. Remove pipe from the project that is severely damaged or is rejected as being unfit for use. Undamaged portions of a joint or section may be used where partial lengths are required.

### **300-4 PREPARATION OF PIPE FOUNDATION**

Prepare the pipe foundation in accordance with the applicable as shown in the contract documents, true to line and grade, and uniformly firm.

Camber invert grade an amount sufficient to prevent the development of sag or back slope in the flow line. The Contractor shall determine the amount of camber required and submit to the Engineer for approval.

Where material is found to be of poor supporting value or of rock and when the Engineer cannot make adjustment in the location of the pipe, undercut existing foundation material within the limits established on the plans. Backfill the undercut with foundation conditioning material, Class V or VI select material. Encapsulate the foundation conditioning material with Type 4 engineering fabric prior to placing bedding material. Overlap all transverse and longitudinal joints in the fabric at least 18 inches.

Maintain the pipe foundation in a dry condition.

### **300-5 INVERT ELEVATIONS**

The proposed pipe culvert invert elevations shown on the Drainage Summary Sheets are based upon information available when the plans were prepared. If proposed invert elevations are adjusted during construction based upon actual conditions encountered, no claim for an extension of time for any reason resulting from this information will be allowed.

When a pipe culvert is to be installed in a trench and the average actual elevation of the pipe between drainage structures deviates from the average proposed elevation shown on the Drainage Summary Sheets by more than one foot a pay adjustment will be made as follows:

$$\text{Pay Adjustment (per linear foot)} = [(APE - AAE) \pm 1 \text{ foot}] (0.15 \times \text{CUP})$$

Where: CUP = Contract Unit Price of Pipe Culvert

$$AAE = \text{Average Actual Elevation} \quad \frac{(\text{Actual Inlet elev.} + \text{Actual Outlet elev.})}{2}$$

$$APE = \text{Average Plan Elevation} \quad \frac{(\text{Plan Inlet elev.} + \text{Plan Outlet elev.})}{2}$$

When the actual location of a pipe culvert is changed from the location shown on the plans, the Engineer will make a pay adjustment deemed warranted based upon the relation of the pipe culvert as shown on the plans to the finished roadway and the relation of the pipe culvert as constructed to the finished roadway.

The top elevation column on the drainage summary sheet indicates the flow elevation at the top of structures intended to collect surface water.

The top elevation column on drainage structures not intended to collect surface water indicates the elevation at the top of the cover.

### 300 -6            LAYING PIPE

The Department reserves the right to perform forensic testing on any installed pipe.

#### (A)    Rigid Pipe

Concrete and welded steel pipe will be considered rigid pipe. Lay pipe on prepared foundation, bell or groove end upgrade with the spigot or tongue fully inserted. Check each joint for alignment and grade as the work proceeds.

Use flexible plastic joint material except when material of another type is specified in the contract documents. Joint material of another type may be used when permitted.

Repair lift holes in concrete pipe, if present. Thoroughly clean and soak the lift hole and completely fill the void with an approved non-shrink gout. Submit alternate details for repairing lift holes to the engineer for review and approval.

For all pipes 42 inches in diameter and larger, wrap filter fabric around all pipe joints. Use Type 2 Class B fabric. Extend fabric at least 12 inches beyond each side of the joint. Secure the filter fabric against the outside of the pipe by methods approved by the Engineer.

#### (B)    Flexible Pipe (Except Structural Plate Pipe)

Corrugated steel, corrugated aluminum, corrugated polyethylene (HDPE), and polyvinylchloride (PVC) pipe will be considered flexible pipe. Place flexible pipe carefully on the prepared foundation starting at the downstream end with the inside

circumferential laps pointing downstream and with the longitudinal laps at the side or quarter points.

Handle coated corrugated steel pipe with special care to avoid damage to coatings.

Join pipe sections with coupling band, fully bolted and properly sealed. Provide coupling bands for annular and helical corrugated metal pipe with circumferential and longitudinal strength sufficient to preserve the alignment, prevent separation of the sections, and prevent backfill infiltration. Match-mark all pipe 60 inches or larger in diameter at the plant for proper installation on the project.

At locations indicated in the plans, corrugated steel pipe sections shall be jointed together with rod and lug coupling bands, fully bolted. Sleeve gaskets shall be used in conjunction with rod and lug couplings and the joints properly sealed. Coupling bands shall provide circumferential and longitudinal strength sufficient to preserve the alignment, prevent separation of the sections and prevent infiltration of backfill material.

### **300-7 BEDDING AND BACKFILLING**

Loosely place bedding material, in a uniform layer, a depth equal to the inside diameter of the pipe divided by 6 or 6 inches, whichever is greater. Leave bedding material directly beneath the pipe uncompacted and allow pipe seating and backfill to accomplish compaction. Excavate recesses to receive the bells where bells and spigot type pipe is used.

Place fill around the pipe in accordance with the applicable method shown on the plans in layers not to exceed 6 inches loose unless otherwise permitted. Compact to the density required by Subarticle 235-4(C). Approval of the backfill material is required prior to its use. Use select material as shown in the contract documents.

Take care during backfill and compaction operations to maintain alignment and prevent damage to the joints. Keep backfill free from stones, frozen lumps, chunks of highly plastic clay, or other objectionable material.

Grade and maintain all pipe backfill areas in such a condition that erosion or saturation will not damage the pipe foundation or backfill.

Excavatable flowable fill may be used for backfill when approved by the Engineer. When using excavatable flowable fill, ensure that the pipe is not displaced and does not float during backfill. Submit methods for supporting the pipe and material placement to the Engineer for review and approval.

Do not operate heavy equipment over any pipe until it has been properly backfilled with a minimum 3 feet of cover. Place, maintain, and finally remove the required cover that is above the proposed finished grade at no cost to the Department. Remove and replace, at no cost to the Department, pipe that becomes misaligned, shows excessive settlement, or has been otherwise damaged by the Contractor's operations.

### 300-8 INSPECTION AND MAINTENANCE

Prior to final acceptance, the Engineer will perform random video camera and or mandrel inspections to ensure proper jointing and that deformations do not exceed allowable limits. Replace pipes having cracks greater than 0.1 inches or deflections greater than 7.5 percent. Repair or replace pipes with cracks greater than 0.01 inches, exhibiting displacement across a crack, exhibiting bulges, creases, tears, spalls, or delamination. Maintain all pipe installations in a condition such that they will function continuously from the time the pipe is installed until the project is accepted.

### 300-9 MEASUREMENT AND PAYMENT

#### General

No measurement will be made of any work covered by this section except as listed below. Removal and disposal of existing pavement is a part of the excavation for the new pipe culvert installation. Repair of the pavement will be made in accordance with Section 654.

#### Foundation Conditioning

##### Using Local Material

Undercut excavation is all excavation removed by undercutting below the bottom of the trench as staked. *Undercut Excavation* will be measured as the actual number of cubic yards of undercut excavation, measured in its original position and computed by the average end area method, that has been removed as called for in the contract and will be paid for at double the contract unit price for *Unclassified Excavation* as provided in Article 225-7.

Local material used for conditioning the foundation will be measured and paid for in accordance with Article 225-7 for *Unclassified Excavation* or in accordance with Article 230-5 for *Borrow Excavation* depending on the source of the material.

Local material used to replace pipe undercut excavation will be measured and paid for in accordance with Article 225-7 or Article 230-5.

##### Using Other Than Local Material

No measurement and payment will be made for *Undercut Excavation*. The material used to replace pipe undercut excavation will be classified as foundation conditioning material.

*Foundation Conditioning Material, Minor Structures* will be measured and paid for as the actual number of tons of this material weighed in trucks on certified platform scales or other certified weighing devices.

No direct payment will be paid for undercut excavation. Payment at the contract unit price for *Foundation Conditioning Material, Minor Structures* will be full compensation for all work of pipe undercut excavation.

**Foundation Conditioning Fabric**

*Foundation Conditioning Fabric* will be measured and paid for in square yards. The measurement will be based on the theoretical calculation using length of pipe installed and two times the standard trench width. No separate measurement will be made for overlapping fabric or the vertical fabric dimensions required to encapsulate the foundation conditioning material.

**Bedding and Backfill - Select Material**

No measurement will be made for select bedding and backfill material required in the contract documents. The select bedding and backfill material will be included in the cost of the installed pipe.

Where unclassified excavation or borrow material meets the requirements for select bedding and backfill and is approved for use by the Engineer, no deductions will be made to these pay items to account for use in the pipe installation.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Foundation Conditioning Material, Minor Structures	Ton
Foundation Conditioning Fabric	Square Yard

**SECTION 310  
PIPE CULVERTS**

**310-1            DESCRIPTION**

Furnish and install drainage pipe at locations and size called for in the contract documents. The work includes construction of joints and connections to other pipes, endwalls, and drainage structures.

**310-2            MATERIALS**

Refer to Division 10:

Item	Section
Plain Concrete Pipe Culvert	1032-9(B)
Reinforced Concrete Pipe Culvert	1032-9(C)
Precast Concrete Pipe End Sections	1032-9(D)
Concrete Pipe Tees and Elbows	1032-9(E)
Corrugated Aluminum Alloy Pipe Culvert	1032-2(A)
Corrugated Aluminum Alloy Pipe Tees and Elbows	1032-2(B)

Corrugated Steel Culvert Pipe and Pipe Arch	1032-3(A)
Prefabricated Corrugated Steel Pipe End Sections	1032-3(B)
Corrugated Steel Pipe Tees and Elbows	1032-3(C)
Corrugated Steel Eccentric Reducers	1032-3(D)
HDPE Smooth Lined Corrugated Plastic Pipe	1032-10B
Polyvinylchloride (PVC) Pipe	1032-11(B)

Suppliers that provide metal pipe culverts, fittings, and all other accessories covered by this section shall meet the requirements of the Department's Brand Certification program for metal pipe culverts, and be listed on the Department's pre-approved list for suppliers of metal pipe culvert.

Do not use corrugated steel pipe in the following counties:

Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrell, and Washington.

### 310-3 PIPE INSTALLATION

Install pipe, pipe tees, and elbows in accordance with Section 300.

### 310-4 SIDE DRAIN PIPE

Side drain pipe is defined as storm drain pipe running parallel to the roadway to include pipe in medians, outside ditches, driveways, and under shoulder berm gutter along outside shoulders greater than 4 feet wide.

Where shown in the plans, side drain pipe may be class II reinforced concrete pipe, aluminized corrugated steel pipe, corrugated aluminum alloy pipe, HDPE pipe, or PVC pipe. Corrugated steel pipe is restricted in the counties listed in Article 310-2. Install side drain pipe in accordance to Section 300. Cover for side drain pipe shall be at least one foot.

### 310-5 PIPE END SECTIONS

Choose which material to use for the required end sections. Both corrugated steel and concrete pipe end sections will work on concrete pipe, corrugated steel pipe, and HDPE smooth lined corrugated plastic pipe.

### 310-6 MEASUREMENT AND PAYMENT

*Pipe* will be measured and paid for as the actual number of linear feet of pipe that has been incorporated into the completed and accepted work. Measurement of pipe will be made by counting the number of joints used and multiplying by the length of the joint to obtain the number of linear feet of pipe installed and accepted. Measurements of partial joints will be made

along the longest length of the partial joint to the nearest 0.1 of a foot. Select bedding and backfill material will be included in the cost of the installed pipe.

*Pipe end sections, tees, elbows, and eccentric reducers* will be measured and paid for as the actual number of each of these items that have been incorporated into the completed and accepted work.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
___" R.C. Pipe Culverts, Class _____.	Linear Feet
___" x ___" x ___" R.C. Pipe Tees, Class _____	Each
___" R.C. Pipe Elbows, Class _____.	Each
___" C.A.A. Pipe Culvert, ___" Thick	Linear Feet
___" x ___" x ___" C.A.A. Pipe Tees, ___" Thick	Each
___" C.A.A. Pipe Elbows, ___" Thick	Each
___" C.S. Pipe Culverts, ___" Thick	Linear Feet
___" x ___" C.S. Pipe Arch Culverts, ___" Thick	Linear Feet
___" x ___" x ___" C.S. Pipe Tees, ___" Thick	Each
___" C.S. Pipe Elbows, ___" Thick	Each
___" x ___" C.S. Eccentric Reducers, ___" Thick	Each
___" HDPE Pipe	Linear Feet
___" PVC Pipe	Linear Feet
___" Side Drain Pipe	Linear Foot
___" Pipe End Section	Each

**DRAINAGE PIPE:**

(7-18-06) (Rev 8-19-09)

SP3 R\_\_

**Description**

Where shown in the plans the Contractor may use Reinforced Concrete Pipe, Aluminum Alloy Pipe, Aluminized Corrugated Steel Pipe, HDPE Pipe, or PVC pipe in accordance with the following requirements.

**Material**

<b>Item</b>	<b>Section</b>
Corrugated Aluminum Alloy Pipe	1032-2(A)
Aluminized Corrugated Steel Pipe	1032-3(A)(7)
Corrugated Polyethylene Pipe (HDPE)	1032-10
Reinforced Concrete Pipe – Class II or III	1032-9(C)
Polyvinyl-Chloride (PVC)	1032-11

Corrugated Steel Pipe will not be permitted in counties listed in Article 310-2 of the 2006 *Standard Specifications*.

Only pipe with smooth inside walls will be allowed for storm drain systems. Storm drain systems are defined as pipe under curb and gutter, expressway gutter, and shoulder berm gutter that connects drainage structures and is not open ended.

**Construction Methods**

Pipe Culverts shall be installed in accordance with the contract documents.

Where allowed by the plans, use any of the several alternate pipes shown herein, but only one type of pipe will be permitted between drainage structures or for the entire length of a cross line pipe.

**Measurement and Payment**

Measurement will be in accordance with Section 310-6 of the 2006 *Standard Specifications*.  
\_\_\_ " *Drainage Pipe* will be paid for as the actual number of linear feet installed and accepted.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
___ " Drainage Pipe	Linear Foot

## NCDOT MATERIAL SELECTION GUIDELINE FOR DRAINAGE PIPE

TYPE OF PIPE INSTALLATION	REINFORCED CONCRETE (RCP) AASHTO M170	CORRUGATED STEEL (CSP) AASHTO M36	CORRUGATED ALUMINUM (CAAP) AASHTO M196	HDPE AASHTO M294	PVC - ASTM F949 AASHTO M304
<b>STATEWIDE TIER</b>					
Side drains	YES	YES	YES	YES	YES
Open ended cross drains	YES	NO*	NO*	NO	NO
Storm drain systems	YES	NO*	NO*	NO	NO
Transverse median drains	YES	NO*	NO*	NO	NO
Slope drains	NO	YES	YES	YES	YES
<b>REGIONAL &amp; SUBREGIONAL TIER</b>					
Side drains	YES	YES	YES	YES	YES
Open ended cross drains	YES	YES	YES	YES	YES
Storm drain systems	YES	NO	NO	YES	YES
Transverse median drains	YES	YES	YES	YES	YES
Slope drains	NO	YES	YES	YES	YES

\*CSP and CAAP are YES for these conditions when the slope of pipe is greater than 10%. These materials should also be considered when the fill heights dictate a special design.

**Notes:**

1. All pipe types are subject to the maximum and minimum fill height requirements as found in Chapter 5 of the Roadway Design Manual. The appropriate class of pipe for RCP and gage thickness for CSP / CAAP should be selected based on the fill height.
2. RCP is not allowed for grades over 10%
3. For counties listed in Article 310-2 of the Standard Specifications CSP is not allowed. In other counties CSP requires an acceptable coating in accordance with 1032-4.
4. Site specific conditions may limit a particular material beyond what is identified in the table. These conditions include, but are not limited to, abrasion, environmental, soil resistivity and pH, high ground water, and special loading conditions. The Hydraulic Design Engineer will determine if additional restrictions are necessary.
5. Only pipe with smooth wall inside walls will be allowed for storm drain systems.

**Definitions:**

**Statewide Tier** – The Strategic Highway Corridor Network as approved by the Board of Transportation

**Regional Tier** – US and NC routes not on the Statewide Tier

**Subregional Tier** – SR Routes

**Side drains** – Storm drain pipes running parallel to the roadway to include pipes in medians, outside ditches, driveways, and under shoulder berm gutter along outside shoulders greater than 4 feet wide. May or may not be open ended.

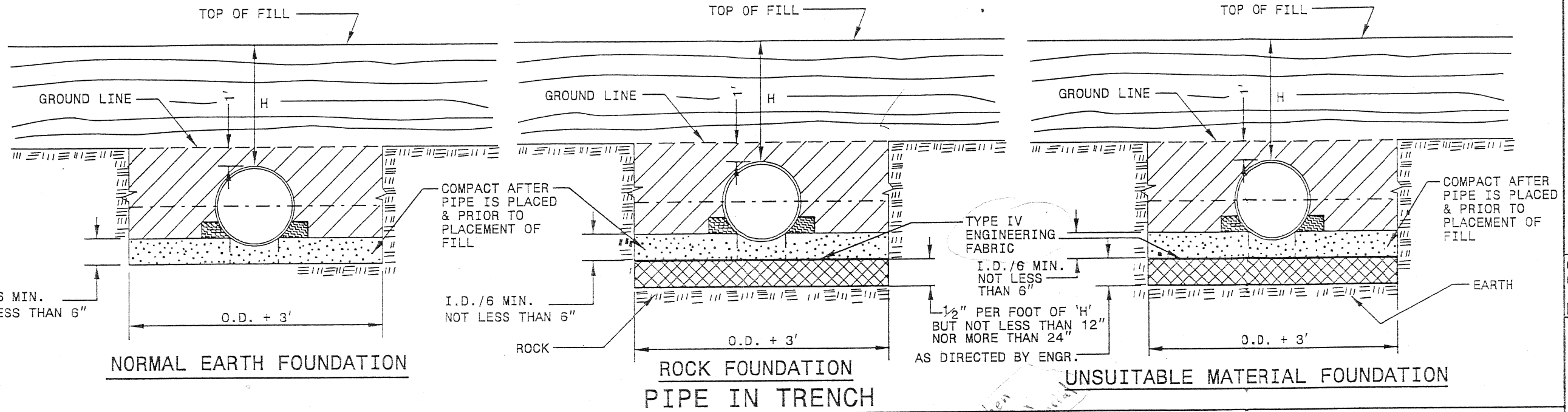
**Storm drain systems** – Lateral drain pipe under curb and gutter, expressway gutter, and shoulder berm gutter (with shoulders 4 feet wide or less) that connect drainage structures and is not open ended. Also includes cross drains connecting two or more systems or system outlets.

**Transverse median drains** – shallow cross drain pipe that collects drainage in a median ditch or curb section and deposits it outside ditches or natural drainage channels. May or may not be open ended.





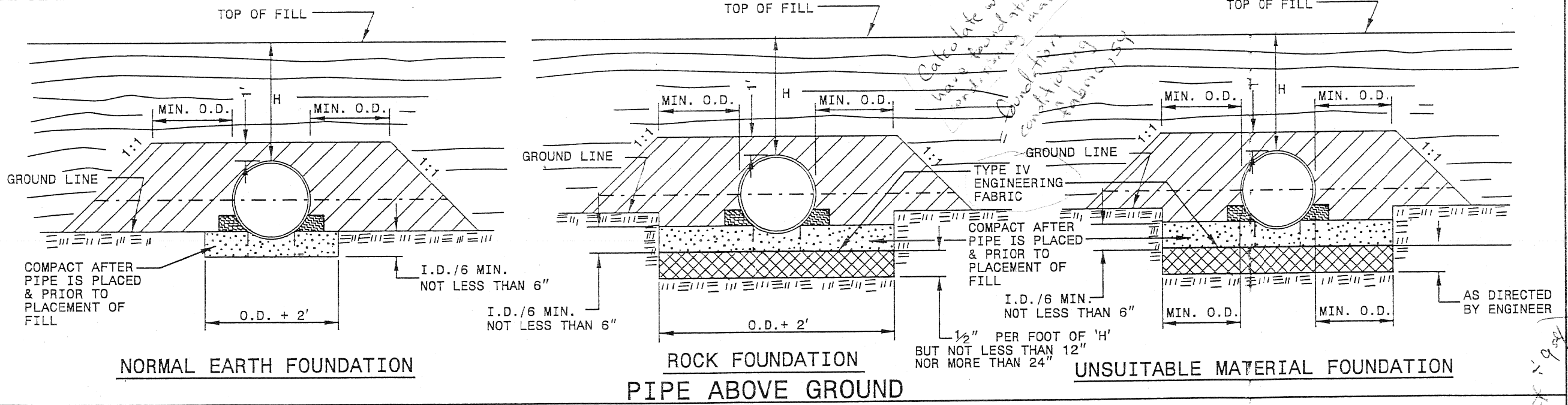
ENGLISH DETAIL DRAWING FOR  
METHOD OF PIPE INSTALLATION



NORMAL EARTH FOUNDATION

ROCK FOUNDATION  
PIPE IN TRENCH

UNSUITABLE MATERIAL FOUNDATION



NORMAL EARTH FOUNDATION

ROCK FOUNDATION  
PIPE ABOVE GROUND

UNSUITABLE MATERIAL FOUNDATION

GENERAL NOTES:

I.D. = THE MAXIMUM HORIZONTAL INSIDE DIAMETER DIMENSION.

O.D. = THE MAXIMUM HORIZONTAL OUTSIDE DIAMETER DIMENSION.

H = THE FILL HEIGHT MEASURED VERTICALLY AT ANY POINT ALONG THE PIPE FROM THE TOP OF THE PIPE TO THE TOP OF THE EMBANKMENT AT THAT POINT.

TAKE CARE TO FULLY COMPACT HAUNCH ZONE OF PIPE BACKFILL.

LOOSELY PLACED SELECT MATERIAL CLASS III OR CLASS II, TYPE 1 FOR PIPE BEDDING. LEAVE SECTION DIRECTLY BENEATH PIPE UNCOMPACTED AS PIPE SEATING AND BACKFILL WILL ACCOMPLISH COMPACTION.

DO NOT OPERATE HEAVY EQUIPMENT OVER ANY PIPE CULVERT UNTIL THE PIPE CULVERT HAS BEEN PROPERLY BACKFILLED AND COVERED WITH AT LEAST 3 FEET OF APPROVED MATERIAL.

----- SPRINGLINE OF PIPE

[Hatched pattern] SELECT BACKFILL MATERIAL CLASS III OR CLASS II, TYPE 1 ABOVE AND BELOW SPRINGLINE.

[Wavy pattern] APPROVED SUITABLE LOCAL MATERIAL.

[Horizontal lines pattern] UNDISTURBED EARTH MATERIAL

[Cross-hatched pattern] SELECT MATERIAL CLASS V OR VI FOR FOUNDATION CONDITIONING. ENCAPSULATE WITH ENGINEERING FABRIC AS DIRECTED BY THE ENGINEER.

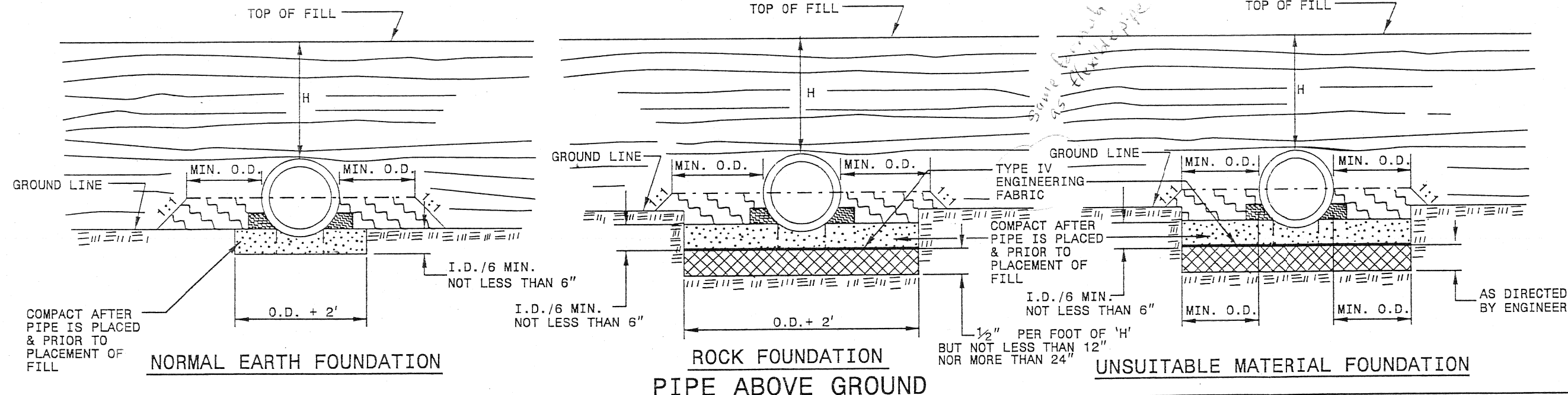
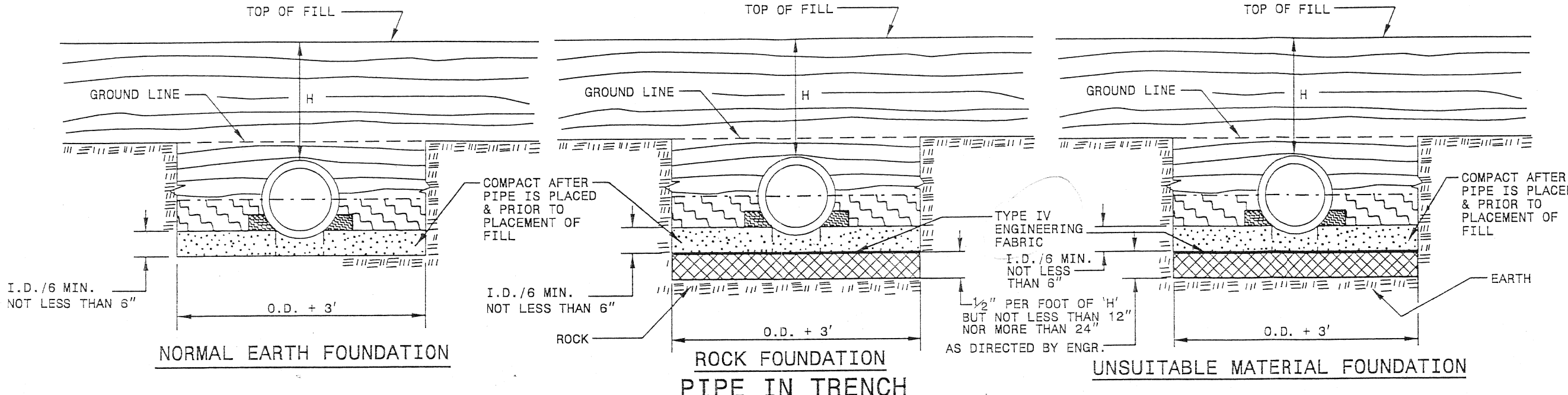
*Foundation Conditioning = 1/2 (6' width + length of pipe) @ project 1994*

7-06

7-06

ENGLISH DETAIL DRAWING FOR  
METHOD OF PIPE INSTALLATION  
RIGID PIPE

ENGLISH DETAIL DRAWING FOR  
METHOD OF PIPE INSTALLATION  
RIGID PIPE



GENERAL NOTES:

- I.D. = THE MAXIMUM HORIZONTAL INSIDE DIAMETER DIMENSION.
- O.D. = THE MAXIMUM HORIZONTAL OUTSIDE DIAMETER DIMENSION.
- H = THE FILL HEIGHT MEASURED VERTICALLY AT ANY POINT ALONG THE PIPE FROM THE TOP OF THE PIPE TO THE TOP OF THE EMBANKMENT AT THAT POINT.

- TAKE CARE TO FULLY COMPACT HAUNCH ZONE OF PIPE BACKFILL.
- LOOSELY PLACED SELECT MATERIAL CLASS III OR CLASS II, TYPE 1 FOR PIPE BEDDING. LEAVE SECTION DIRECTLY BENEATH PIPE UNCOMPACTED AS PIPE SEATING AND BACKFILL WILL ACCOMPLISH COMPACTION.

DO NOT OPERATE HEAVY EQUIPMENT OVER ANY PIPE CULVERT UNTIL THE PIPE CULVERT HAS BEEN PROPERLY BACKFILLED AND COVERED WITH AT LEAST 3 FEET OF APPROVED MATERIAL.

- SPRINGLINE OF PIPE
- SELECT BACKFILL MATERIAL CLASS III OR CLASS II, BELOW SPRINGLINE. *midline of pipe*
- APPROVED SUITABLE LOCAL MATERIAL ABOVE SPRINGLINE.
- UNDISTURBED EARTH MATERIAL
- SELECT MATERIAL CLASS V OR VI FOR FOUNDATION CONDITIONING. ENCAPSULATE WITH ENGINEERING FABRIC AS DIRECTED BY THE ENGINEER.