Technical Training
2008

Safety by the numbers

- It’s
- 2 ft. The distance to stay from excavation
- 4 ft. Depth requires egress
- 5 ft. Depth requires shielding
- 6 ft. Height to ground where fall protection begins
- 10 ft. Minimum clear distance to powerline
- 20 ft. Depth requires PE
- 2:1, 5 ft If 2:1 slope from bottom of excavation intercepts existing ground closer than 5’to traffic, shoring is required.

Environmental Stewardship

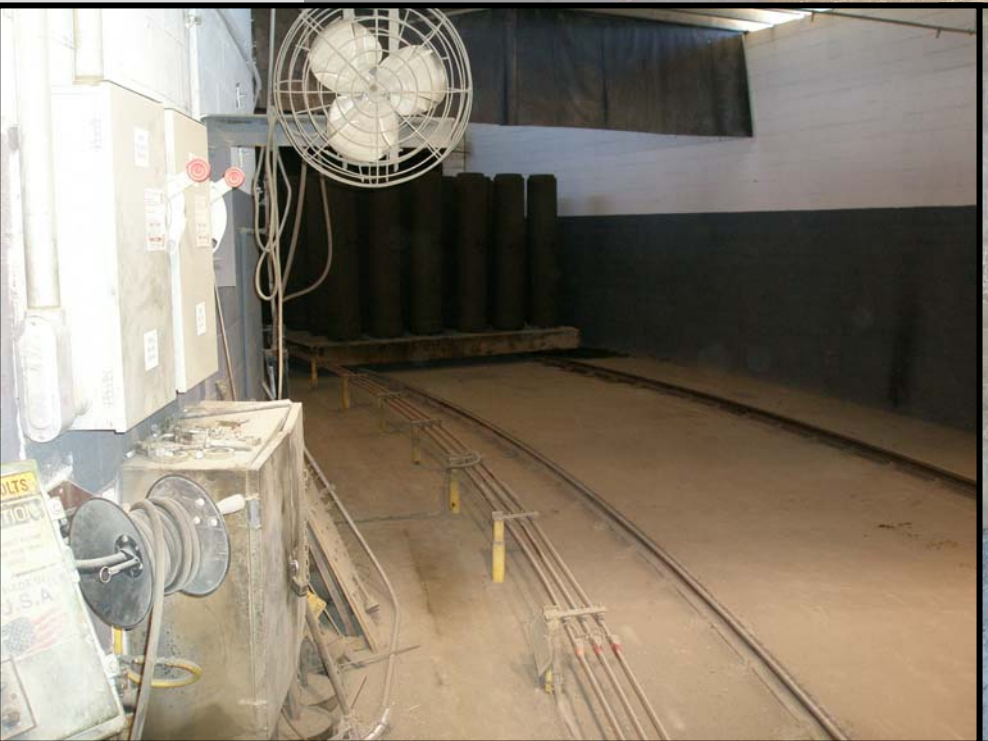
- Permitted footprint
- Changing elevations
- Bury pipe (permitted or not)/perched pipe
- Pump around
- No changes without permit mod.
- Scour holes
- Sluice gates

Pipe camera video

Acceptance

- Pipe Manufacturing and Storage
- Unloading and Handling
- Pipe Material Information
- Causes for Rejection
- Concrete Pipe Cracks
- Acceptance
- Material received
  - Section materials specialist (meet your section mat)
  - HiCams
  - Brand Certification


ACIDA
CERTIFIED
PLANT



Inspection after unloading

(why it may be stamped but unacceptable when it arrives on the project)

Wire showing – is it a form wire or reinforcing wire?

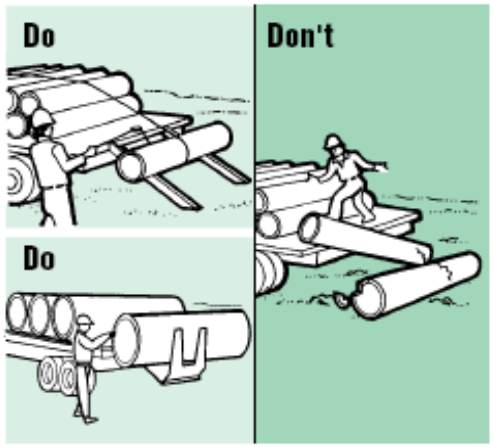
Bells and tongues broken – pipe is resting on this connection

Patching of concrete pipe is limited to the repair of minor defects. Minor defects do not include through-wall cracks of any dimension, 0.010 in (0.25 mm) cracks measuring 12 in (300 mm) or more in length or damage/defects to pipe ends where such damage would prevent making a satisfactory joint. Pipe sections that are damaged or otherwise defective shall be rejected. Rejection criteria are outlined in AASHTO M170, Section 15.

Unloading pipe

Hardie® Pipe
www.hardiepipe.com

DO: use a pneumatic unloading device
use cables and skids
use unloading equipment that supports the length of the pipe

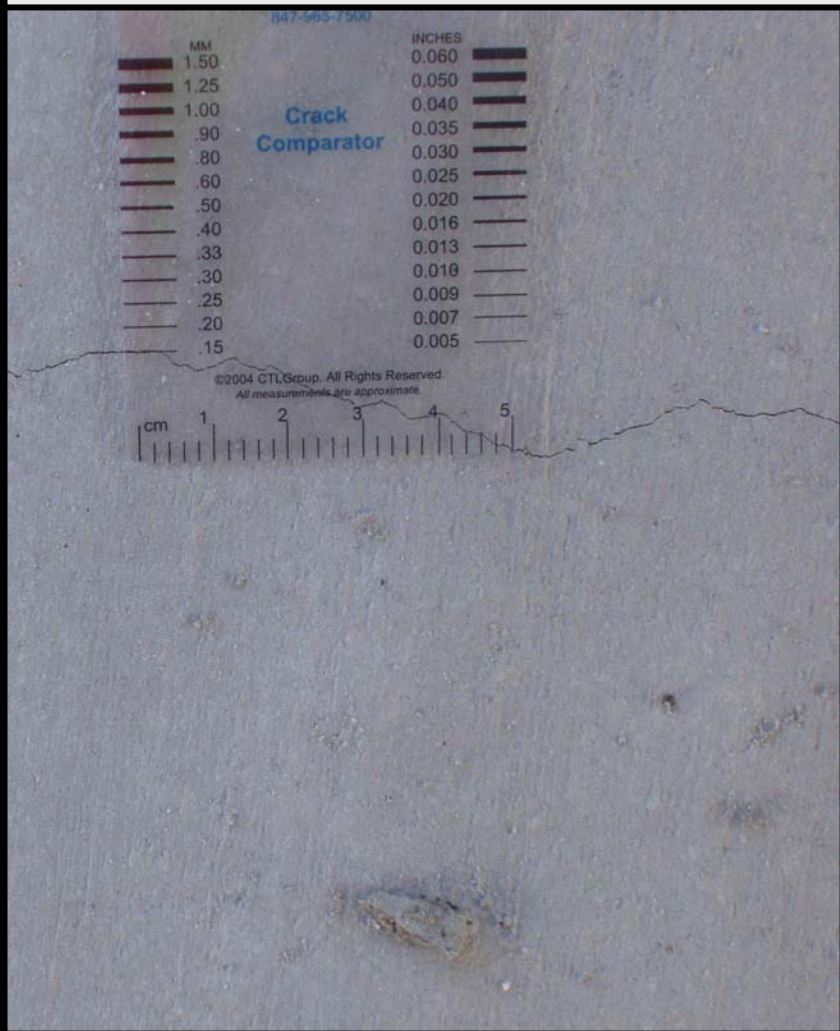


Don't: drop it off the trailer
let one joint strike another on the ground
use a bolt through the lifting hole

PHOTOGRAPHS

Precast Concrete Products That Should be Rejected,
Accepted, or Rejected Due to Unacceptable Repairs

Cracks seen just last week



More cracks and wire

Pipe and Drainage Structure Stakeout

- Review drawing
  - This can't afford to lay on desk or not get done
  - A chance to reduce amount of price adjustments for extra depth pipe

Pay Adjustment (per linear foot) = [(APE-AAE)± 1 foot] (0.15 X CUP)

Where: CUP = Contract Unit Price of Pipe Culvert

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

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

Pay Adjustment (per linear meter) = [(APE-AAE)± 0.3 m] (0.15 X CUP)

Where: CUP = Contract Unit Price of Pipe Culvert

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

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

Foundation

Unsuitable: Undercut (as directed) and place select material + loose compressible material for O.D. / 24” (not less than 3”)

Water: Make sure there’s no muck and then place 57 stone and select or loose compressible material for O.D. / 24” (not less than 3”)

Rock: Undercut (O.D.”./ 12 but not less than 6”) and backfill with unclassified, borrow or foundation conditioning (don’t forget loose compressible material)

Payment for Foundation Conditioning

Did you undercut?

If yes, then did you use unclassified or borrow to backfill the undercut?

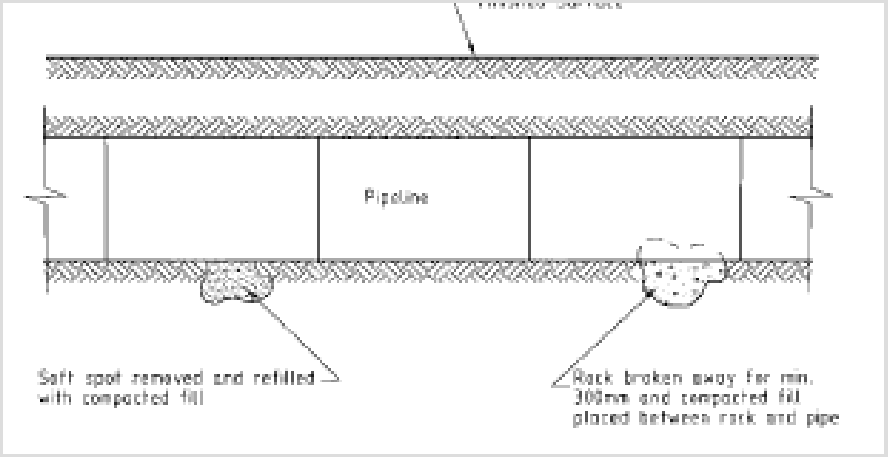
If yes, then measure the undercut by the average end area method and pay at double unclassified. Then pay for the borrow or unclassified.

Did you undercut?

If yes, then did you use material from off of the project (other than borrow which is always off of the project)?

If yes, then pay for the material as tons of Foundation Conditioning Material and do NOT pay for the undercut.

Pipe Foundation



Good amount of loose compressible material

Poor installation.
No loose compressible material nor is the pipe cradled.

Lay pipe on dry foundation

Section 300-4: Maintain the pipe foundation in a dry condition

What about paying me for an impervious dike?

“The impervious dike shall be constructed of an acceptable material in the locations noted on the plans or as directed”

No payment unless impervious dike shown in plans for that particular site.

Laying and Joining Pipe

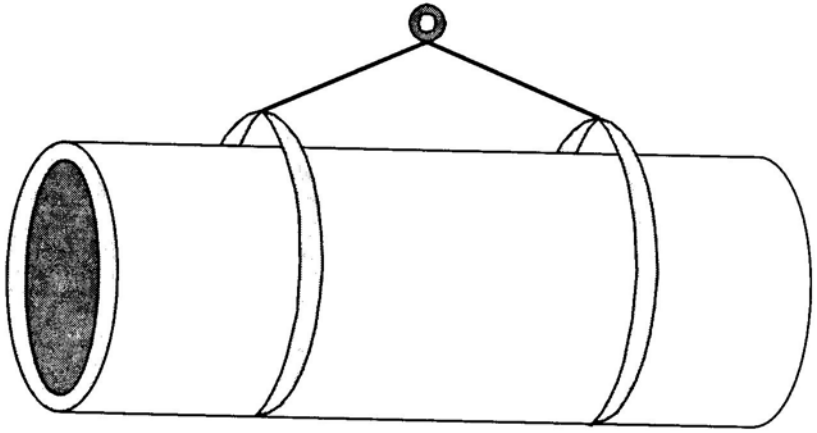
- Trenching and Shoring
- Check invert elevation
- Check laser
- Pipe handling (lift hole, strap, bar)
- Place pipe on foundation
  - Standard Drawings
- Install joint compound
- Join pipe

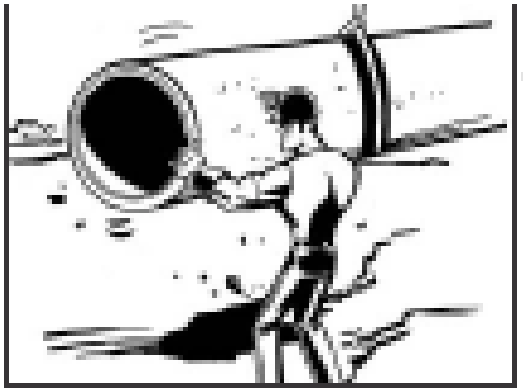
Laser

Check the grade on the laser at the beginning and occasionally during pipe installation.

Pipe handling

300-3: Use a lifting device that uniformly distributes the weight of the pipe long its axis or circumference.





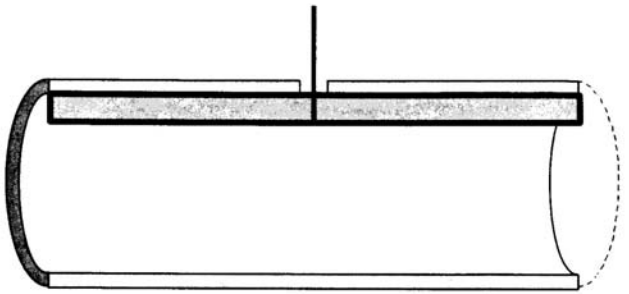


Figure 5-2

For pipe without a lifting hole, one acceptable method of lifting involves the use of a nylon strap or sling wrapped around the pipe. Figure 5-3 shows how, for shorter pipe lengths, one strap or sling can be used around the middle of the section when lifting or placing the pipe into the trench. For longer lengths, two nylon straps should be placed at the 1/3 and 2/3 points on the pipe, as shown in Figure 5-4.

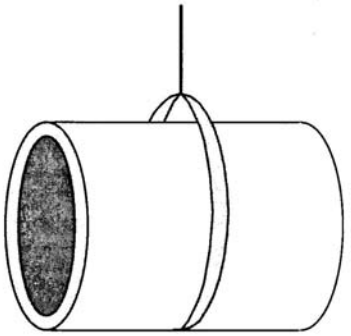
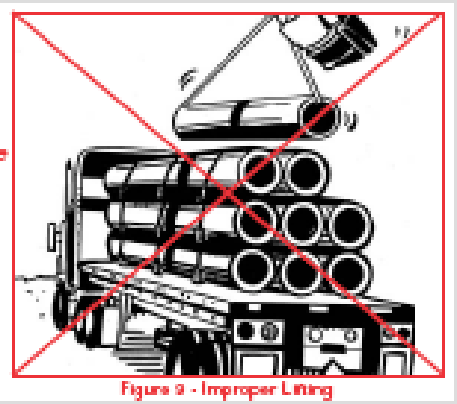


Figure 5-3

Hardie® Pipe
www.hardiepipe.com

Pipe handling (bad)



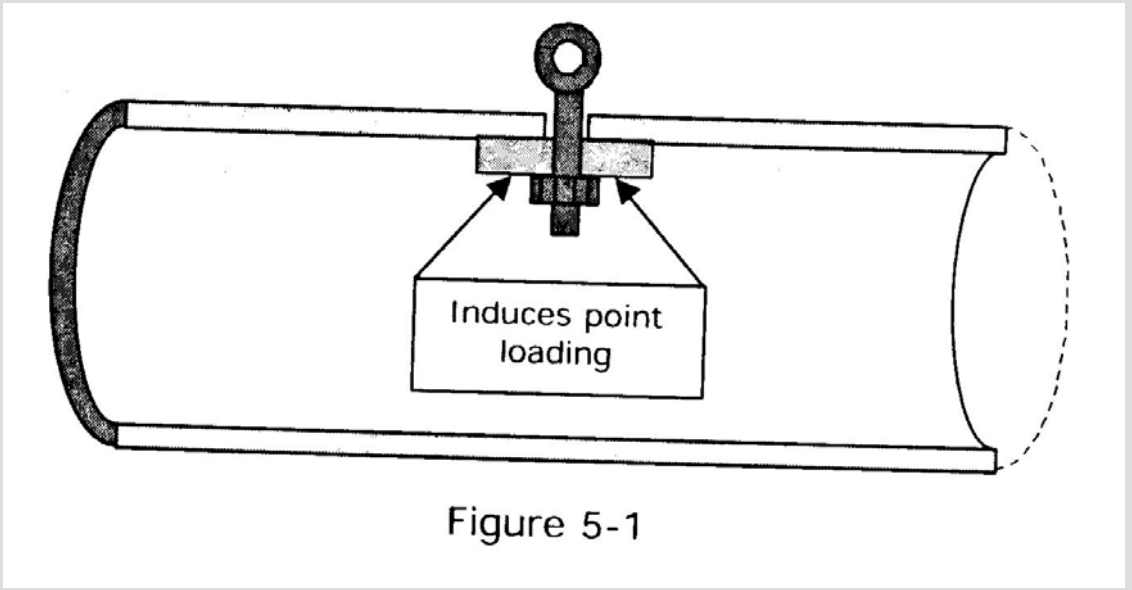


Figure 5-1

Hardie® Pipe
www.hardiepipe.com

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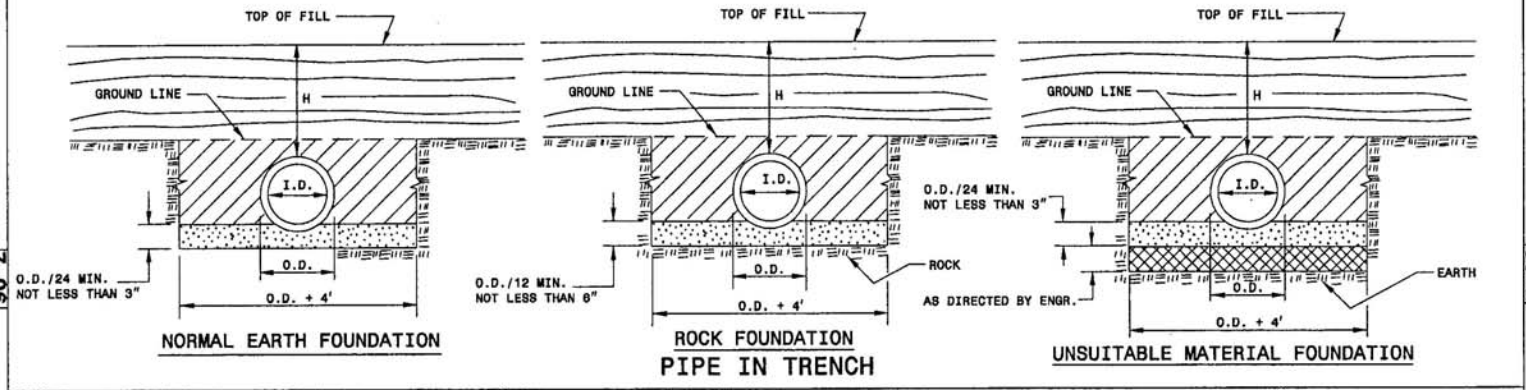
7-06

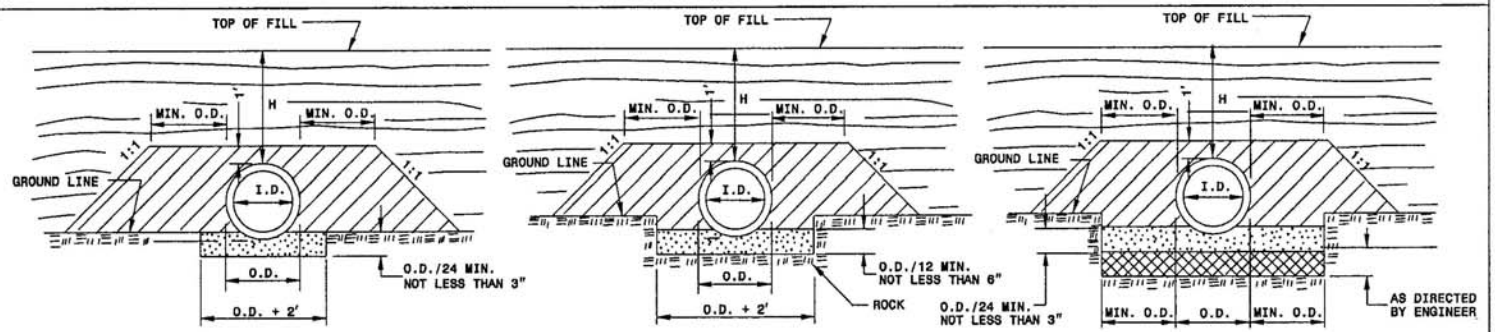
ENGLISH DETAIL DRAWING FOR

METHOD OF PIPE INSTALLATION

METHOD 'A'



PIPE IN TRENCH



PIPE ABOVE GROUND

GENERAL NOTES:

I.D. = THE MAXIMUM HORIZONTAL INSIDE DIMENSION.

O.D. = THE MAXIMUM HORIZONTAL OUTSIDE 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.

LOOSELY PLACED APPROVED SUITABLE LOCAL MATERIAL OR SELECT MATERIAL CLASS II OR III FOR ~~FOUNDATION CONDITIONING~~ BEDDING AS DIRECTED BY THE ENGINEER. (STONE WILL NOT BE ALLOWED)

UNDISTURBED EARTH MATERIAL

APPROVED SUITABLE LOCAL MATERIAL OR SELECT MATERIAL CLASS V OR VI FOR FOUNDATION CONDITIONING AS DIRECTED BY THE ENGINEER.

APPROVED BACKFILL OR SELECT BACKFILL MATERIAL. WHEN 'H' IS GREATER THAN 30', USE SELECT MATERIAL OF THE APPROPRIATE CLASS AS FOLLOWS:

SELECT MATERIAL	'H'
CLASS IV	OVER 50 FEET
CLASS III	OVER 40 FEET THROUGH 50 FEET
CLASS II	OVER 30 FEET THROUGH 40 FEET

THE CLASS OF SELECT MATERIAL USED FOR AN INDIVIDUAL PIPE INSTALLATION IS BASED ON THE MAXIMUM 'H' WHICH OCCURS ALONG THE PIPE INSTALLATION. A HIGHER CLASS SELECT MATERIAL, NOT TO EXCEED CLASS IV, MAY BE USED IN LIEU OF CLASS II OR III.

SELECT MATERIAL WILL NOT BE REQUIRED AROUND THOSE PORTIONS OF AN INDIVIDUAL PIPE INSTALLATION LOCATED UNDER THAT PART OF THE FILL WHERE 'H' IS 30 FEET OR LESS

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.

SHEET 1 OF 1

300D01

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ENGLISH DETAIL DRAWING FOR

METHOD OF PIPE INSTALLATION

METHOD 'A'

SHEET 1 OF 1

300D01

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DIVISION OF HIGHWAYS
RALEIGH, N.C.

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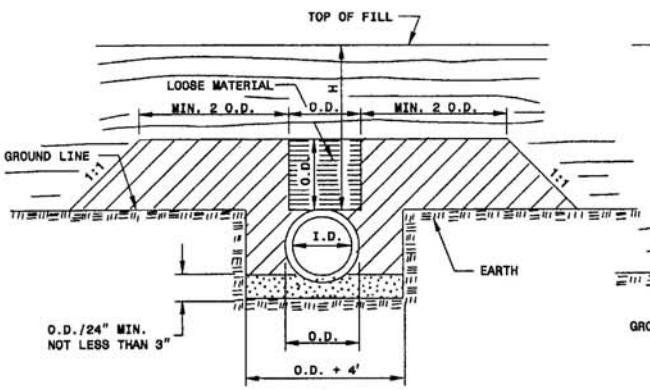
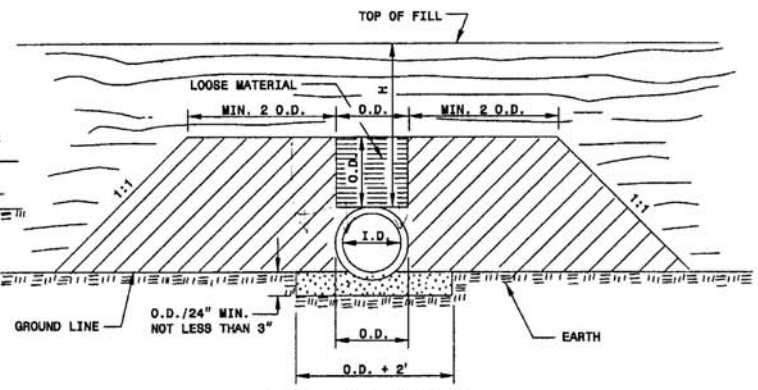
ENGLISH DETAIL DRAWING FOR

METHOD OF PIPE INSTALLATION

METHOD 'B'



PIPE IN TRENCH



PIPE ABOVE GROUND

GENERAL NOTES:

USE METHOD B PIPE INSTALLATION ONLY WHERE CALLED FOR ON THE PLANS.

I.D. = THE MAXIMUM HORIZONTAL INSIDE DIMENSION.

O.D. = THE MAXIMUM HORIZONTAL OUTSIDE 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.

LOOSELY PLACED APPROVED SUITABLE LOCAL MATERIAL OR SELECT MATERIAL TYPE II OR III FOR FOUNDATION CONDITIONING AS DIRECTED BY THE ENGINEER.(STONE WILL NOT BE ALLOWED)

SELECT MATERIAL OF THE APPROPRIATE CLASS AS FOLLOWS:

SELECT MATERIAL	'H'
CLASS IV	OVER 50 FEET
CLASS III	OVER 40 FEET THROUGH 50 FEET
CLASS II	OVER 30 FEET THROUGH 40 FEET

NOTE: A HIGHER CLASS SELECT MATERIAL, NOT TO EXCEED CLASS IV, MAY BE USED IN LIEU OF CLASS II OR III.

LOOSE COMPRESSIBLE MATERIAL. THE BOTTOM THIRD OF THIS MATERIAL WILL BE UNBALED HAY OR STRAW. PLACE THE REMAINING APPROVED BACKFILL IN A LOOSE UNCOMPACTED CONDITION. WHEN 'H' IS LESS THAN 30' THE LOOSE MATERIAL AND HAY IS NOT REQUIRED.

PREPARE THE PIPE FOUNDATION AND BEDDING OF THE PIPE IN ACCORDANCE WITH METHOD 'A' INSTALLATION. PLACE BACKFILL MATERIAL TO THE WIDTH REQUIRED BY THE DRAWING AND TO A DEPTH OVER THE PIPE EQUAL TO D. THEN EXCAVATE THE BACKFILL MATERIAL DIRECTLY OVER THE PIPE AND BACKFILL THE TRENCH WITH MATERIAL DEPOSITED IN THE LOOSEST POSSIBLE CONDITION. COMPLETE THE EMBANKMENT IN ACCORDANCE WITH SECTION 235 OF THE SPECIFICATIONS.

DO NOT OPERATE HEAVY EQUIPMENT OVER THE PIPE CULVERT UNTIL THE BACKFILL, INCLUDING THE TRENCH OF LOOSE COMPRESSIBLE MATERIAL, HAS BEEN COMPLETED.

SHEET 1 OF 1

300D02

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ENGLISH DETAIL DRAWING FOR

METHOD OF PIPE INSTALLATION

METHOD 'B'

SHEET 1 OF 1

300D02

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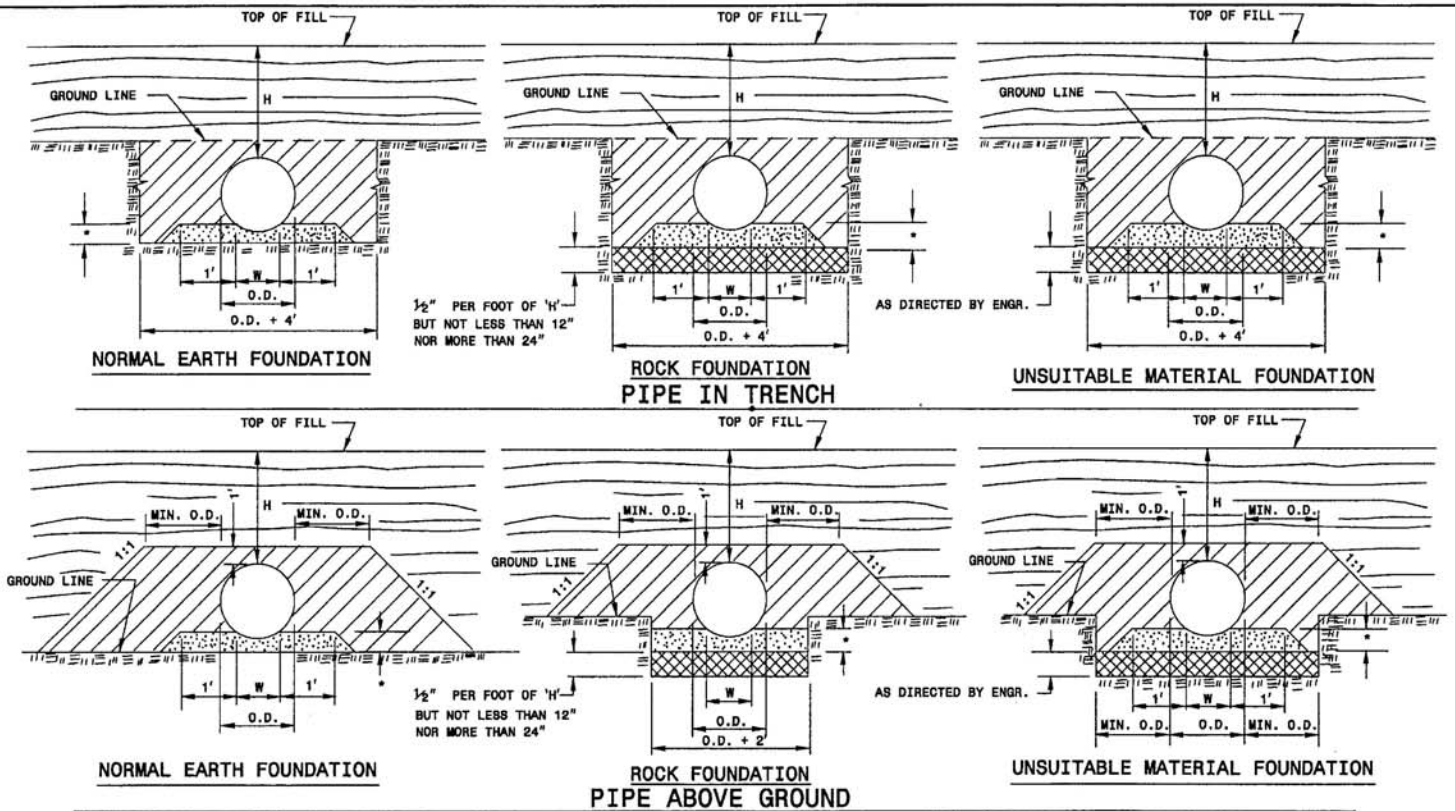
ENGLISH DETAIL DRAWING FOR

METHOD OF STRUCTURAL PLATE PIPE & PIPE ARCH INSTALLATION

METHOD 'A'

SHEET 1 OF 1

300D03



GENERAL NOTES:

O.D. = THE MAXIMUM HORIZONTAL OUTSIDE 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.

W = WIDTH OF SHAPED BEDDING.

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

* O.D./12 NOT LESS THAN 6" MIN.

LOOSELY PLACED APPROVED SUITABLE LOCAL MATERIAL OR SELECT MATERIAL CLASS II OR III FOR FOUNDATION CONDITIONING AS DIRECTED BY THE ENGINEER.(STONE WILL NOT BE ALLOWED)

UNDISTURBED EARTH MATERIAL
SELECT MATERIAL

APPROVED SUITABLE LOCAL MATERIAL OR SELECT MATERIAL TYPE V OR VI FOR FOUNDATION CONDITIONING AS DIRECTED BY THE ENGINEER.

APPROVED BACKFILL OR SELECT MATERIAL. WHEN 'H' IS GREATER THAN 30', SELECT MATERIAL OF THE APPROPRIATE CLASS WILL BE USED AS FOLLOWS:

	'H'
CLASS IV	OVER 50 FEET
CLASS III	OVER 40 FEET THROUGH 50 FEET
CLASS II	OVER 30 FEET THROUGH 40 FEET

THE CLASS OF SELECT BACKFILL MATERIAL TO BE USED FOR AN INDIVIDUAL PIPE INSTALLATION WILL BE BASED ON THE MAXIMUM H WHICH OCCURS ALONG THE PIPE INSTALLATION. A HIGHER CLASS SELECT MATERIAL, NOT TO EXCEED CLASS IV, MAY BE USED IN LIEU OF CLASS II OR III. SELECT MATERIAL WILL NOT BE REQUIRED AROUND THOSE PORTIONS OF AN INDIVIDUAL PIPE INSTALLATION LOCATED UNDER THAT PART OF THE FILL WHERE 'H' IS 30 FEET OR LESS

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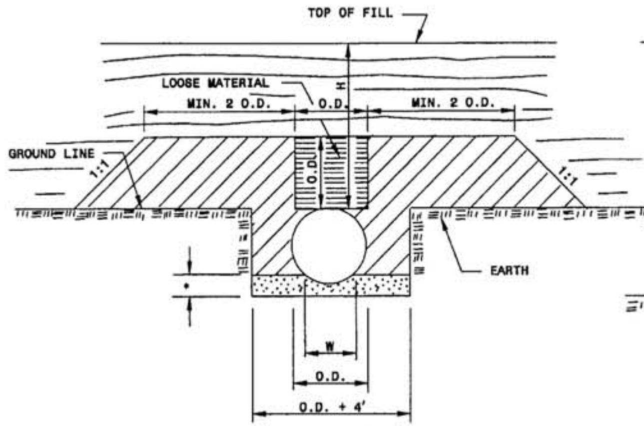
ENGLISH DETAIL DRAWING FOR

METHOD OF STRUCTURAL PLATE PIPE & PIPE ARCH INSTALLATION

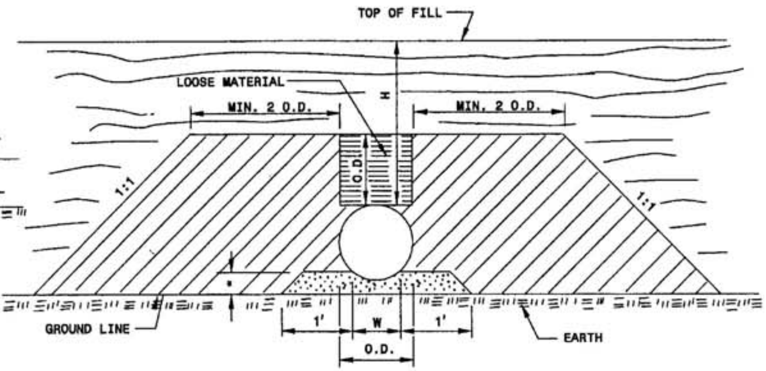
METHOD 'A'

SHEET 1 OF 1

300D03



PIPE IN TRENCH



PIPE ABOVE GROUND

GENERAL NOTES:

USE METHOD 'B' PIPE INSTALLATION ONLY WHERE CALLED FOR ON THE PLANS.

O.D. = THE MAXIMUM HORIZONTAL OUTSIDE 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.

W = WIDTH OF SHAPED BEDDING

LOOSELY PLACED APPROVED SUITABLE LOCAL MATERIAL OR SELECT MATERIAL CLASS II OR III FOR FOUNDATION CONDITIONING AS DIRECTED BY THE ENGINEER. (STONE WILL NOT BE ALLOWED)

SELECT MATERIAL OF THE APPROPRIATE CLASS AS FOLLOWS:

SELECT BACKFILL	'H'
CLASS IV	OVER 50 FEET
CLASS III	OVER 40 FEET THROUGH 50 FEET
CLASS II	OVER 30 FEET THROUGH 40 FEET

NOTE: A HIGHER CLASS SELECT MATERIAL, NOT TO EXCEED CLASS IV, MAY BE USED IN LIEU OF CLASS II OR III.

LOOSE COMPRESSIBLE MATERIAL. THE BOTTOM THIRD OF THIS MATERIAL WILL BE UNBALED HAY OR STRAW. PLACE THE REMAINING APPROVED BACKFILL IN A LOOSE UNCOMPACTED CONDITION. WHEN 'H' IS LESS THAN 30' THE LOOSE MATERIAL AND HAY IS NOT REQUIRED.

PREPARE THE PIPE FOUNDATION IN ACCORDANCE WITH METHOD 'B' INSTALLATION. PLACE BACKFILL MATERIAL TO THE WIDTH REQUIRED BY THE DRAWING AND TO A DEPTH OVER THE PIPE EQUAL TO 'D'. EXCAVATE THE BACKFILL MATERIAL DIRECTLY OVER THE PIPE AND BACKFILL THE TRENCH WITH MATERIAL DEPOSITED IN THE LOOSEST POSSIBLE CONDITION. COMPLETE THE EMBANKMENT IN ACCORDANCE WITH SECTION 235 OF THE SPECIFICATIONS.

DO NOT OPERATE HEAVY EQUIPMENT OVER THE PIPE CULVERT UNTIL THE BACKFILL, INCLUDING THE TRENCH OF LOOSE COMPRESSIBLE MATERIAL, HAS BEEN COMPLETED.

* O.D./12 NOT LESS THAN 6" MIN.

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ENGLISH DETIAL DRAWING FOR
METHOD OF STRUCTURAL PLATE
PIPE & PIPE ARCH INSTALLATION
METHOD 'B'

SHEET 1 OF 1

300D04

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ENGLISH DETIAL DRAWING FOR
METHOD OF STRUCTURAL PLATE
PIPE & PIPE ARCH INSTALLATION
METHOD 'B'

SHEET 1 OF 1

300D04

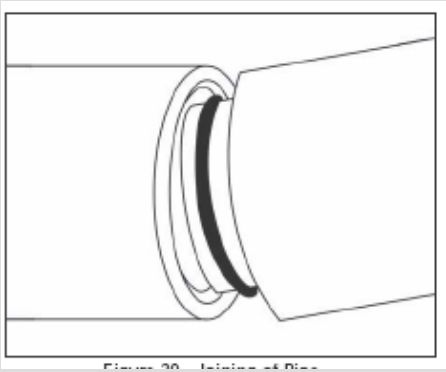
Install Joint Compound

Flexible plastic joint material

Do not put it against the shoulder. Put it half way and give it a chance to engage the bell.

Joining pipe

Do keep the pipe entrance angle low to increase
The chances that the joint material will engage all
Around.



Do not ram with hoe

Do home the pipe fully with strap
bar, block or come-along

Hardie® Pipe
www.hardiepipe.com

Size and placement of flexible pipe joint material

From NC Products, they recommend:

12" - 18" use 1" conseal
24" - 60 use 1 1/4" conseal
66" & 72 use 1" conseal

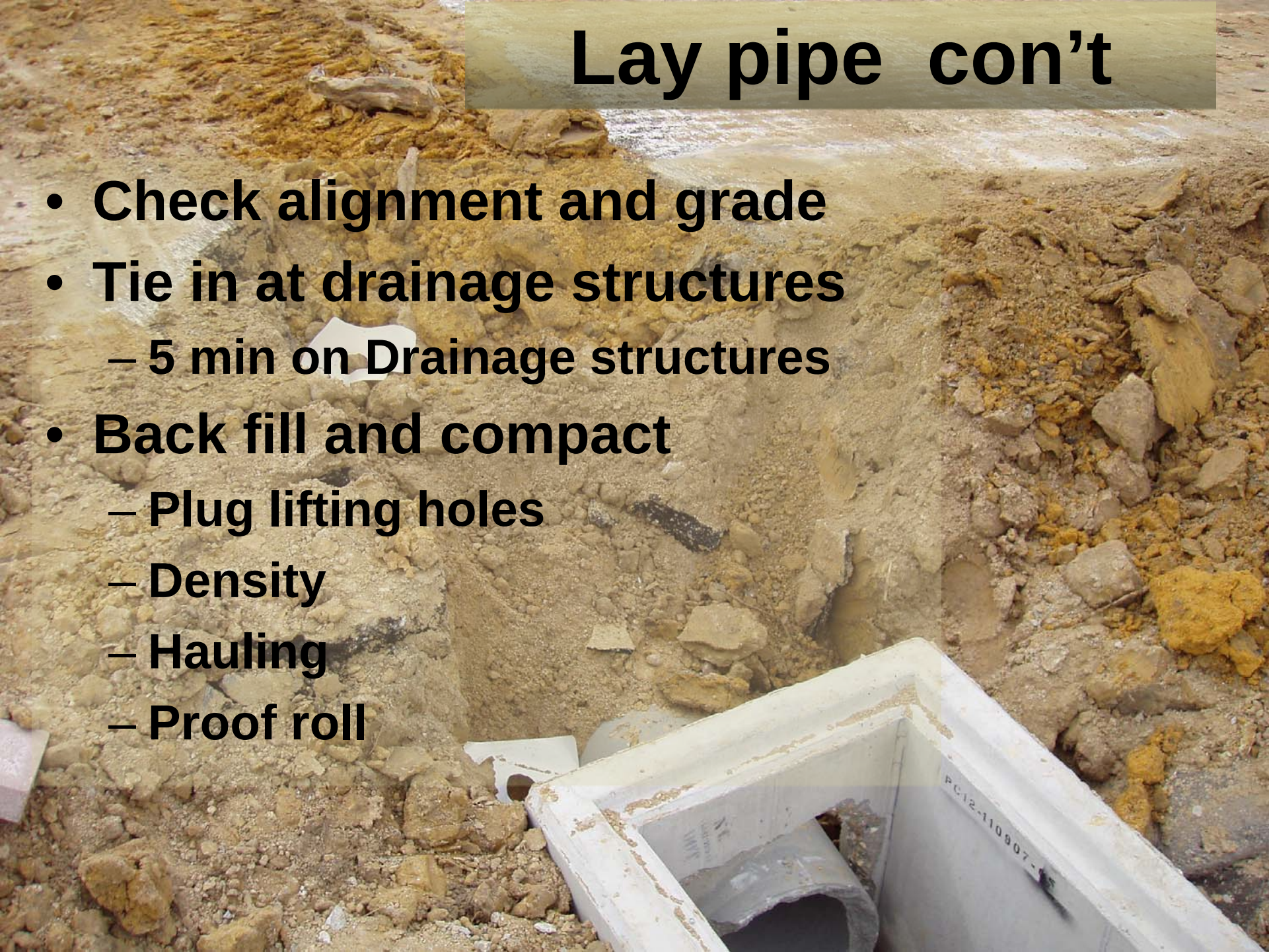
Good homing techniques

reparing the bedding at the socket end of the pipe to be joined.

Humes™

Lay pipe con't

- Check alignment and grade
- Tie in at drainage structures
  - 5 min on Drainage structures
- Back fill and compact
  - Plug lifting holes
  - Density
  - Hauling
  - Proof roll



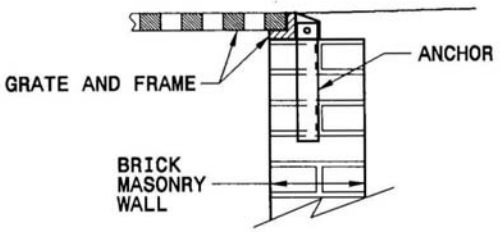
Drainage Structures

The use of traffic bearing masonry drainage structures is governed by Section 5-13 of the Roadway Design Manual as follows:

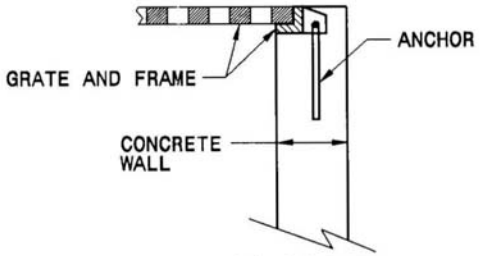
- Traffic bearing drop inlets (Std. No. 840.36) shall be used within a traveling lane (detour or permanent).
- Traffic bearing drop inlets (Std. No.'s 840.35 or 840.36) shall also be used within 4'-0" of lanes except when placed in a concrete traffic island.
- Traffic bearing steel frames and flat steel grates (Std. No.840.37) are to be used where it has been determined that traffic bearing drop inlets are needed on controlled access projects in locations that pedestrian traffic is not anticipated. On controlled access projects where pedestrian traffic is anticipated, a flat, narrow slot frame and grate (Std. No. 840.29) should be used. TheTraffic Engineering and Safety Systems Branch or the Hydraulics Unit may specify other locations where these must be used due to safety considerations.

Design Services has further clarified the use of traffic bearing drainage structures as follows:
- Drainage structures that are used in 2'-6" curb and gutter are not required to be traffic bearing. However, if the pipe size is large enough such that a wall of the drainage structure will be under the travel lane instead of under the curb and gutter, the drainage structure should be traffic bearing.
- Drainage structures that are used in shoulder berm gutter or expressway gutter and are within 4'-0" of a travel lane are required to be traffic bearing.
- Precast waffle boxes are not recognized as traffic bearing structures.
- Solid wall precast boxes are considered traffic bearing structures.

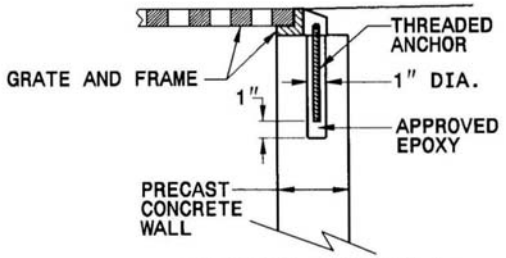
Precast Detail



BRICK MASONRY CONSTRUCTION



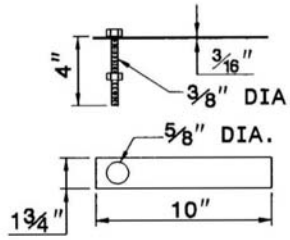
CONCRETE CONSTRUCTION



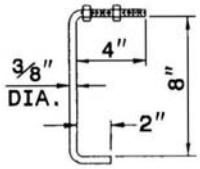
PRECAST CONCRETE CONSTRUCTION

DETAIL SHOWING ANCHORAGE OF FRAME FOR GRATED DROP INLET

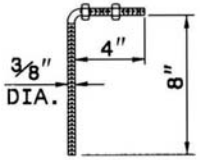
NOTE:
CONSTRUCT GRATED DROP INLET TO COINCIDE WITH NORMAL OR SUPERELEVATED SHOULDER OR PAVEMENT SLOPE.



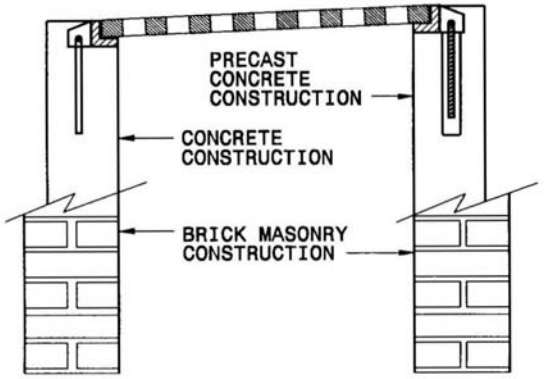
MASONRY ANCHOR
3/8" DIA. BOLT WITH PLATE



CONCRETE ANCHOR
3/8" DIA. BENT BAR



PRECAST CONCRETE ANCHOR
3/8" DIA. BENT BAR



FRAME AND GRATE INSTALLATION FOR NORMAL CROWN AND SUPERELEVATED SECTIONS

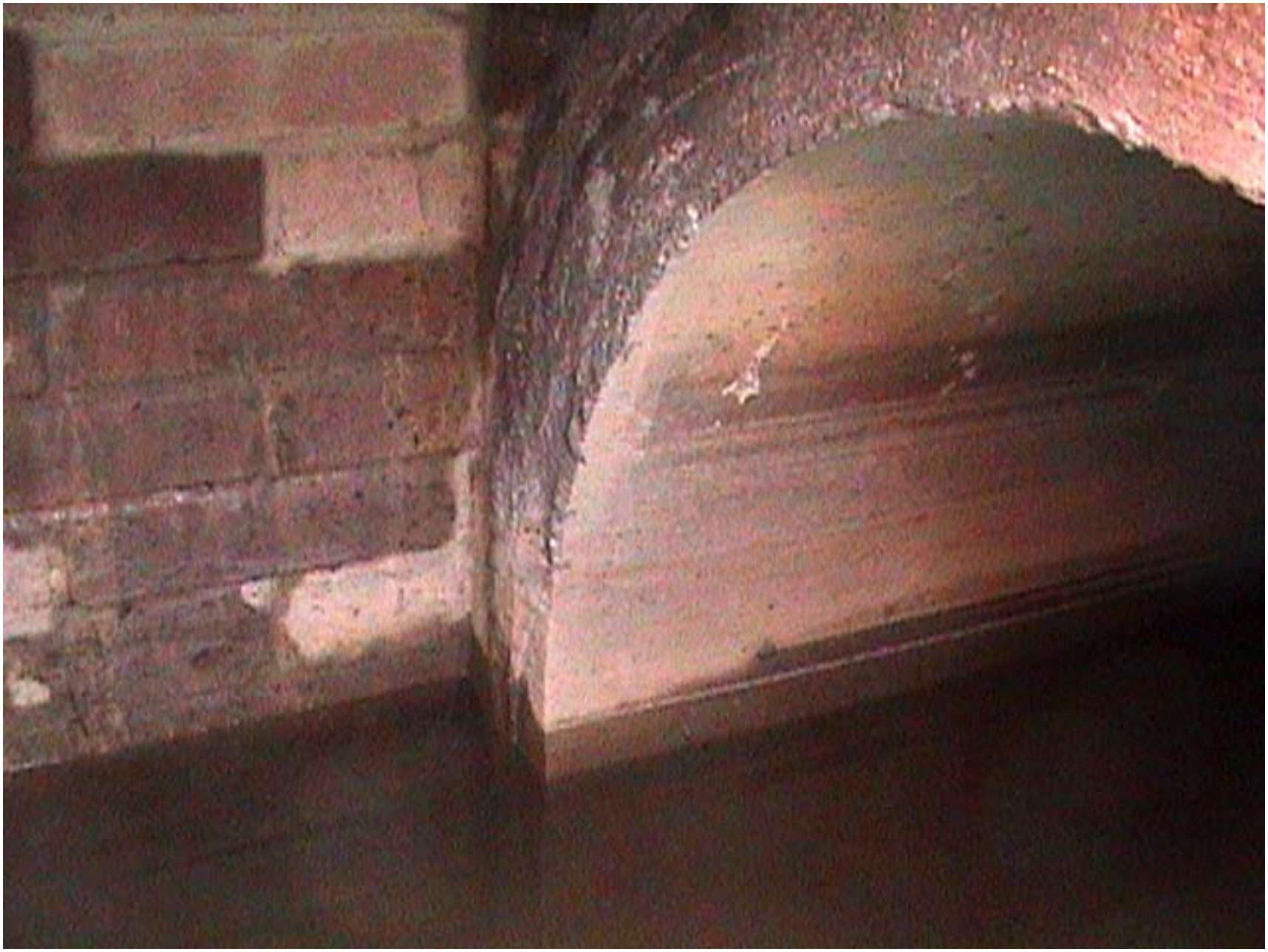
Good & the bad

Frame completely on box. Concrete will flow under frame. Anchors in brick.

Where do we begin? End?

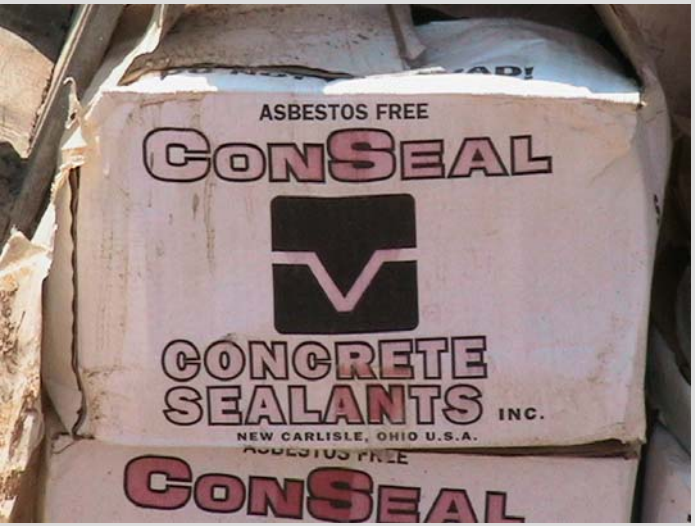
Connect to drainage structures and fill lifting holes


1. 8. 2000




22. 3. 2004

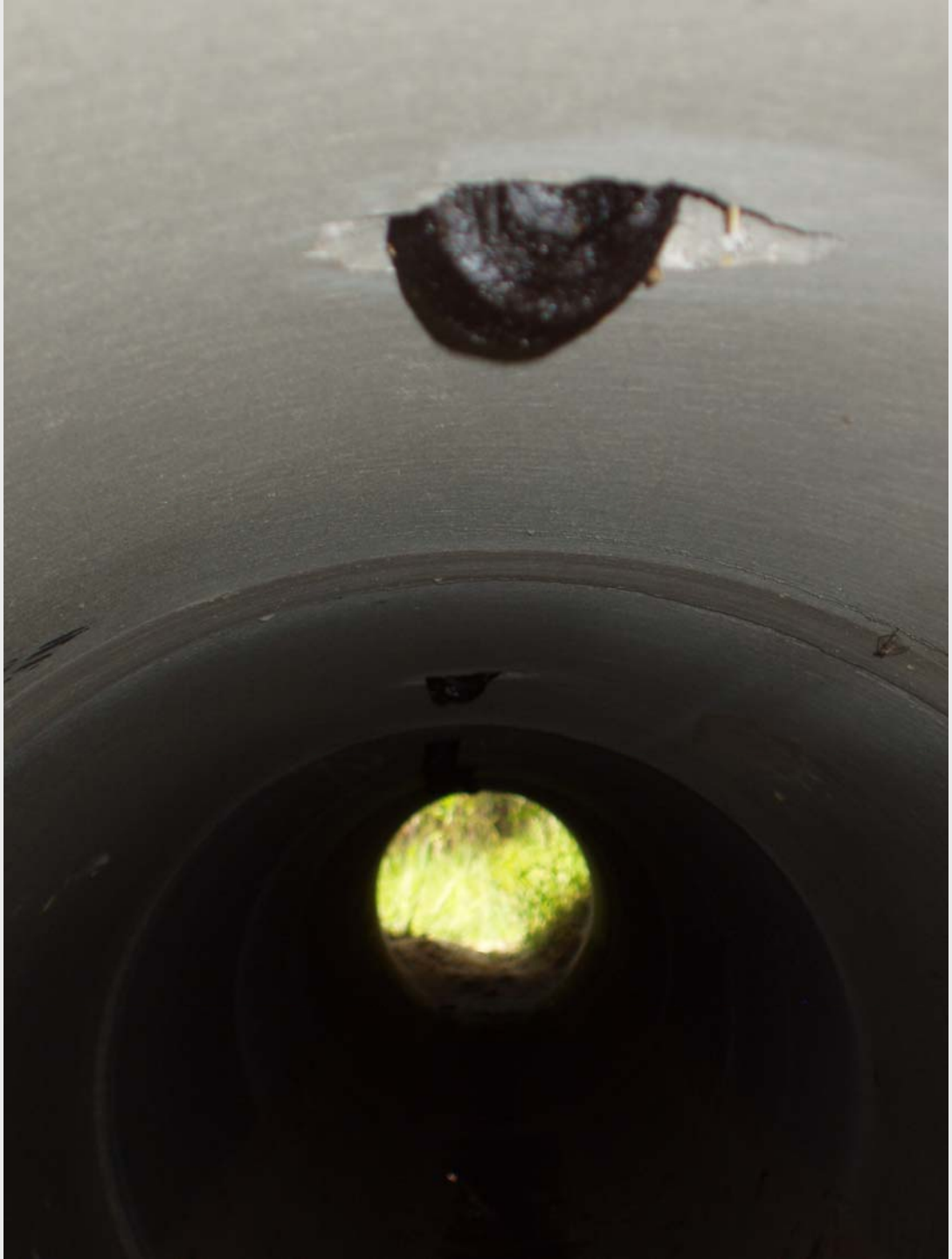

12. 6. 2003



Spec. 840-3 says “assemble and grout together the precast drainage structure units”.
Std. 840.45 (2 of 2) (precast drainage str.) says “seal joint with flexible butyl rubber base AASHTO M198 Type B”

Std. 840.46 (1 of 1) (traffic bearing precast drainage str.) says “Seal joints with an approved Sealant (see section 840 of NCDOT Std. Specs.)”

Why plug lifting holes with grout



Tunneling in Wake Forest


NOV 19 2002

NCDOT Geotechnical Engineering Unit

Eastern Regional Office (Div's 1-7)

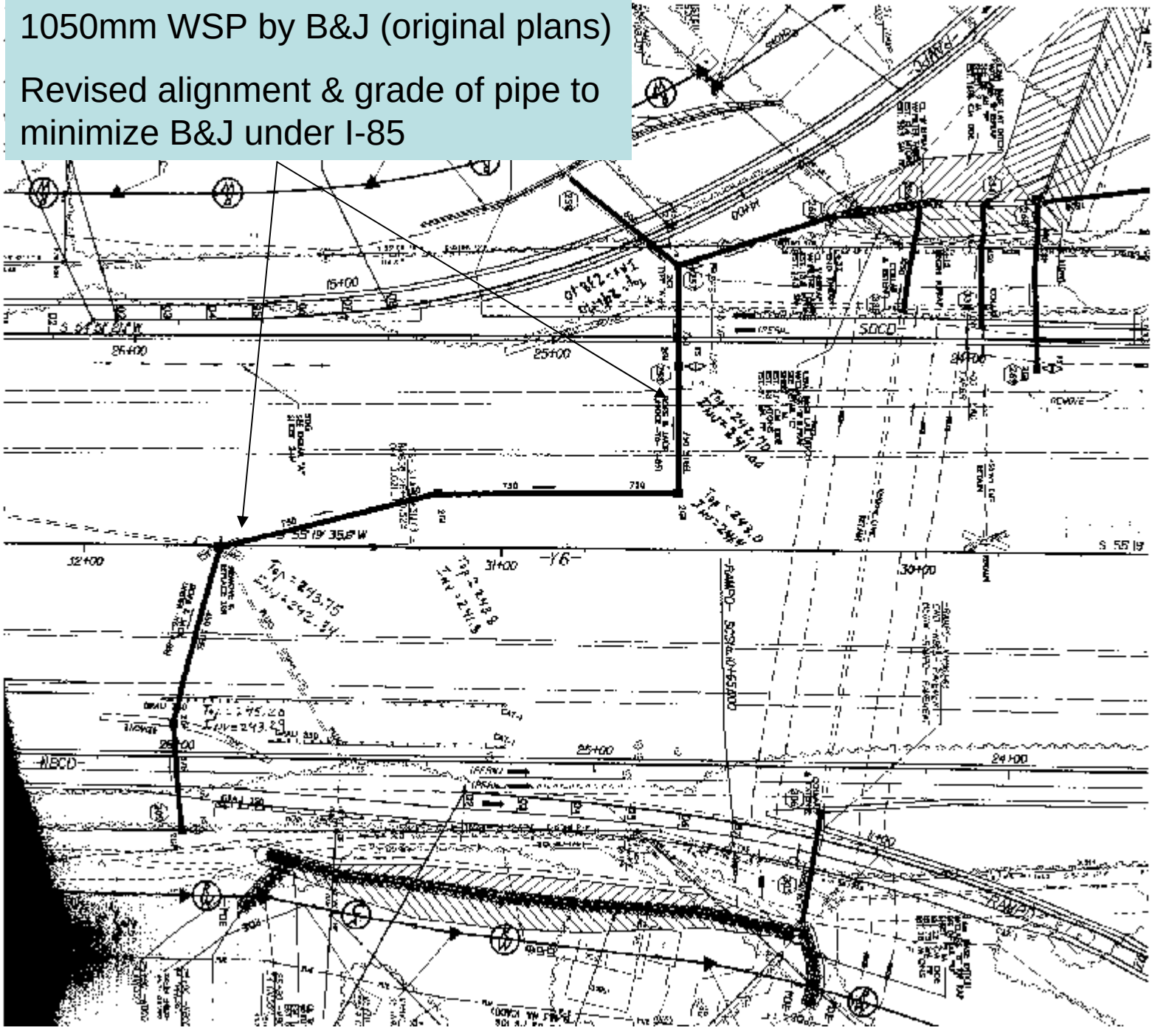
Chris Kreider, P.E.

Western Regional Office (Div's 8 – 14)

Dean Hardister, P.E.

1050mm WSP by B&J (original plans)

Revised alignment & grade of pipe to minimize B&J under I-85



Project Diary

- Record conversations, observations, spot checks made, and work done, including material used, in the diary.

Checklist (page 3-9)

1. Study the Specifications, plans, permits, erosion control phasing and Special Provisions.
2. Does pipe staking appear to be correct? If not, contact the Engineer.
3. Did the permits require the culvert to be buried?
4. Observe pipe sections after delivery to the site. Record any joint or section rejected and reason for the same. Ensure that concrete pipe has been stamped with the Department's Seal of Approval. For flexible pipe, see that the pipe, fittings, and other accessories have been provided by a supplier having met the requirements of the Department's Brand Certification Program and listed on the Department's preapproved list. Ensure the flexible pipe has been inspected by the Materials and Tests Unit. If unloading or handling is careless, notify Contractor's supervisory personnel. Mark any rejected pieces of pipe.
5. Verify the class of pipe and installation method against the drainage summary sheet within the plans.
6. See that Department Policy & Procedures for Excavation, Trenching, and Shoring are being strictly followed. Notify the Engineer if an unsafe condition exists, stop work if imminent danger exists.
7. Monitor the Contractor's control of the pipe grade, including pipe camber.
8. If unsuitable material or rock is encountered, consult with the Engineer for the method of conditioning to be used.
9. If local material is used to backfill undercut areas, measure undercut and record in Pay Record Book as pipe foundation undercut.
10. If other than local material is used, establish the method of material measurement and payment. Ensure the material has been approved for use.
11. Temporary water diversion is the responsibility of the Contractor. See that this is adequate to prevent foundation damage and erosion problems.
12. See that shaped bedding is properly constructed.

13. See that pipe is laid, joints properly connected, and protected in accordance with Specification requirements. Check line and grade before starting and periodically thereafter.
14. Plug lifting holes with either concrete or grout mixture.
15. See that backfill is placed in layers of 6 inches or less, unless otherwise authorized, with both sides brought up at the same time. See that heavy equipment is not operated over any pipe until it has been backfilled with a minimum of 3 feet of cover.
16. Run density tests to verify that the methods of compaction are satisfactory. If results are not satisfactory, require the Contractor to change methods and obtain required density. Record on the density form that it is in a pipe backfill.
17. Backfill to be shaped to drain when work is suspended or completed.
18. If select backfill material is required, be sure this has been tested and approved prior to use.
19. Perform periodic inspections of completed drainage facilities to assure they are maintained in accordance with Specifications including 5% deflexion for flexible pipe. See that all damage is repaired prior to placement of base and pavement.
20. See that all necessary erosion control devices have been properly installed. If silt basins are constructed at ends of pipe, see that these are cleaned out as needed. Monitor all devices to ensure they are functioning properly and that they are receiving proper maintenance.
21. If pipe is structural plate, notify the Engineer before any phase of construction is begun.
22. Record conversations, observations, spot checks made, and work done, including material used, in the diary.
23. Keep pay records as required.

Cross Pipe End Treatments
inside the clear zone

Extend pipe beyond the clear zone and use headwall on pipes that are 36” dia. and greater

If the pipe cannot be extend then:

Use a cross pipe end section for pipes 30” dia. and smaller.

Use guardrail for pipe 36” and greater with endwall on inlet end and cross pipe end unit with safety bars on the outlet end or protect with guardrail.

Side Pipe End Treatment

Side Pipe End Treatments
inside the clear zone

Place pipe beyond clear zone

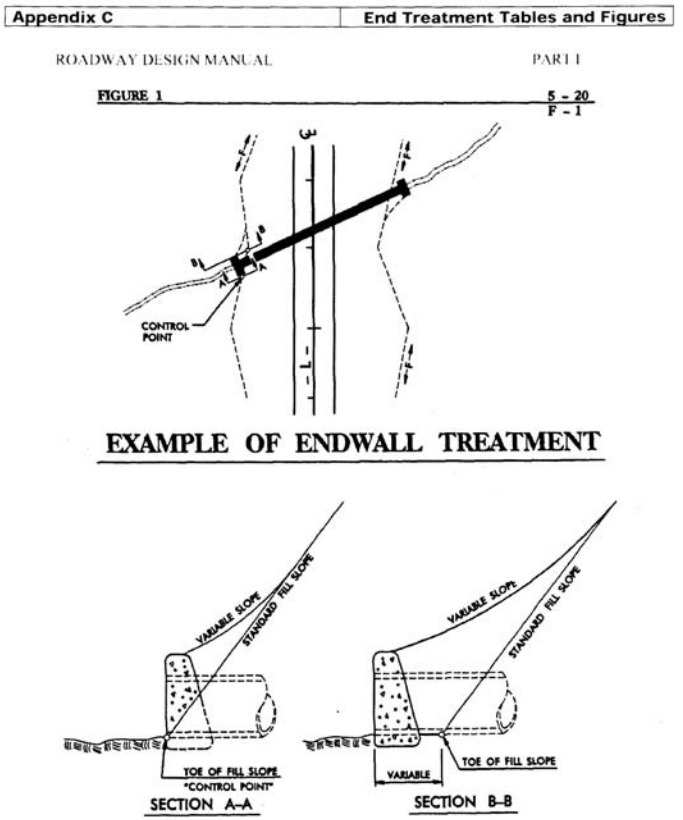
If pipe cannot be moved beyond clear zone

Use a drop inlet on inlet end.
If a drop inlet cannot be used, use a Parallel Pipe end section on inlet end for pipe 24” in dia. or less.

Note: For multilane roads with design speeds less than 50mph and all 2 lane roads no special end treatment is required.

End Treatments

End walls



Appendix C | End Treatment Tables and Figures

ROADWAY DESIGN MANUAL PART I

FIGURE 1 5 - 20 F - 1

REV. DATE 01/02/02

Headwalls and Clear Zone

[U.S. Customary Units]

DESIGN SPEED	DESIGN ADT	FORESLOPES			BACKSLOPES		
		1V:6H of flatter	1V:5H TO 1V:4H	1V:3H	1V:3H	1V:5H TO 1V:4H	1V:6H or Flatter
40 mph or less	UNDER 750	7 – 10	7 – 10	**	7 – 10	7 – 10	7 – 10
	750 – 1500	10 – 12	12 – 14	**	10 – 12	10 – 12	10 – 12
	1500 – 6000	12 – 14	14 – 16	**	12 – 14	12 – 14	12 – 14
	OVER 6000	14 – 16	16 – 18	**	14 – 16	14 – 16	14 – 16
45–50 mph	UNDER 750	10 – 12	12 – 14	**	8 – 10	8 – 10	10 – 12
	750 – 1500	12 – 14	16 – 20	**	10 – 12	12 – 14	14 – 16
	1500 – 6000	16 – 18	20 – 26	**	12 – 14	14 – 16	16 – 18
	OVER 6000	18 – 20	24 – 28	**	14 – 16	18 – 20	20 – 22
55 mph	UNDER 750	12 – 14	14 – 18	**	8 – 10	10 – 12	10 – 12
	750 – 1500	16 – 18	20 – 24	**	10 – 12	14 – 16	16 – 18
	1500 – 6000	20 – 22	24 – 30	**	14 – 16	16 – 18	20 – 22
	OVER 6000	22 – 24	26 – 32 *	**	16 – 18	20 – 22	22 – 24
60 mph	UNDER 750	16 – 18	20 – 24	**	10 – 12	12 – 14	14 – 16
	750 – 1500	20 – 24	26 – 32 *	**	12 – 14	16 – 18	20 – 22
	1500 – 6000	26 – 30	32 – 40 *	**	14 – 18	18 – 22	24 – 26
	OVER 6000	30 – 32 *	36 – 44 *	**	20 – 22	24 – 26	26 – 28
65–70 mph	UNDER 750	18 – 20	20 – 26	**	10 – 12	14 – 16	14 – 16
	750 – 1500	24 – 26	28 – 36 *	**	12 – 16	18 – 20	20 – 22
	1500 – 6000	28 – 32 *	34 – 42 *	**	16 – 20	22 – 24	26 – 28
	OVER 6000	30 – 34 *	38 – 46 *	**	22 – 24	26 – 30	28 – 30

* Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear-zone distances greater than the clear-zone shown in Table 3.1. Clear zones may be limited to 30 ft for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

** Since recovery is less likely on the unshielded, traversable 1V:3H slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the through traveled lane and the beginning of the 1V:3H slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the foreslope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 3.2.

Pictures of headwalls in CRRZ