American Concrete Pipe Association

Precast Box Culvert Installation Procedures

Precast Box Culvert Installation

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Forterra

FORTERRA

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AGENDA

- SUBMITTAL PROCESS
- MANUFACTURING PROCESS
- INSTALLATION OF A PRECAST BOX CULVERT
- BOX CULVERT APPLICATIONS/FEATURES

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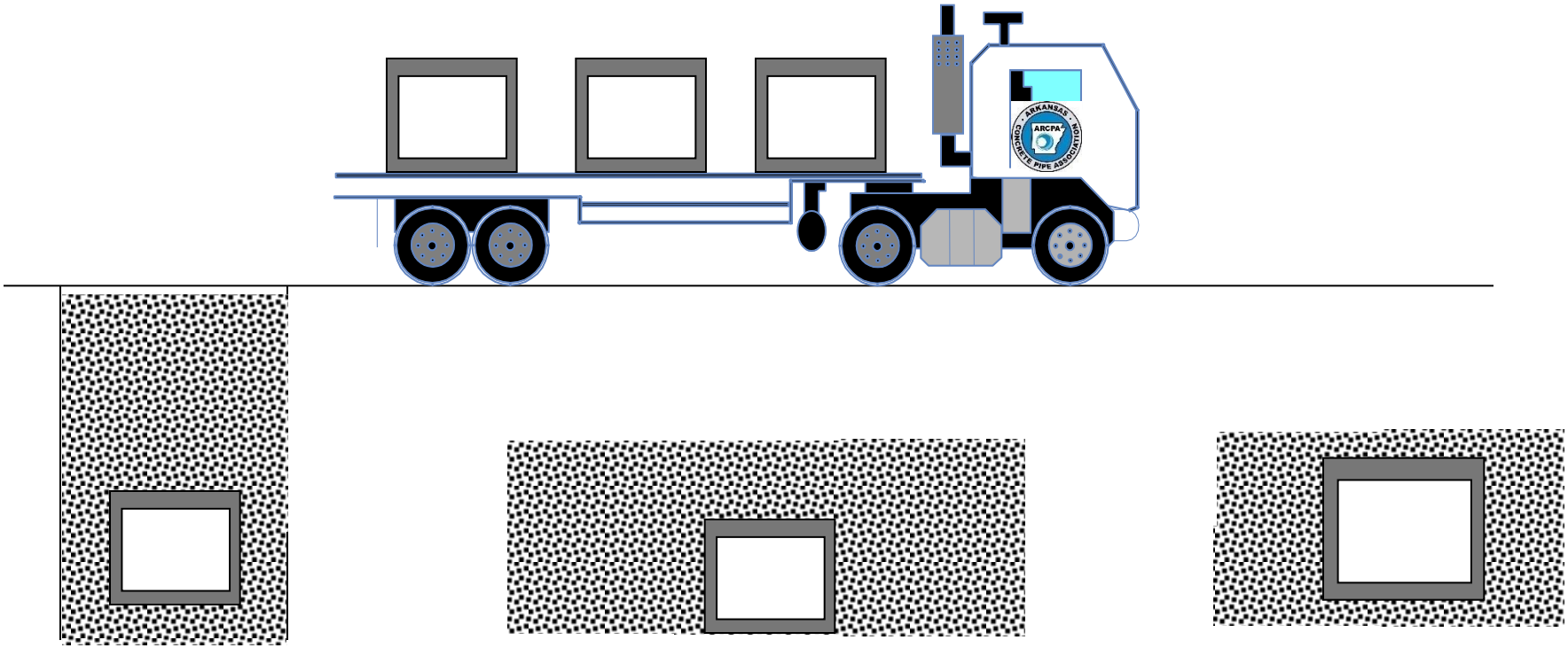
INSTALLATION METHODS



Trench

Embankment

Tunnel

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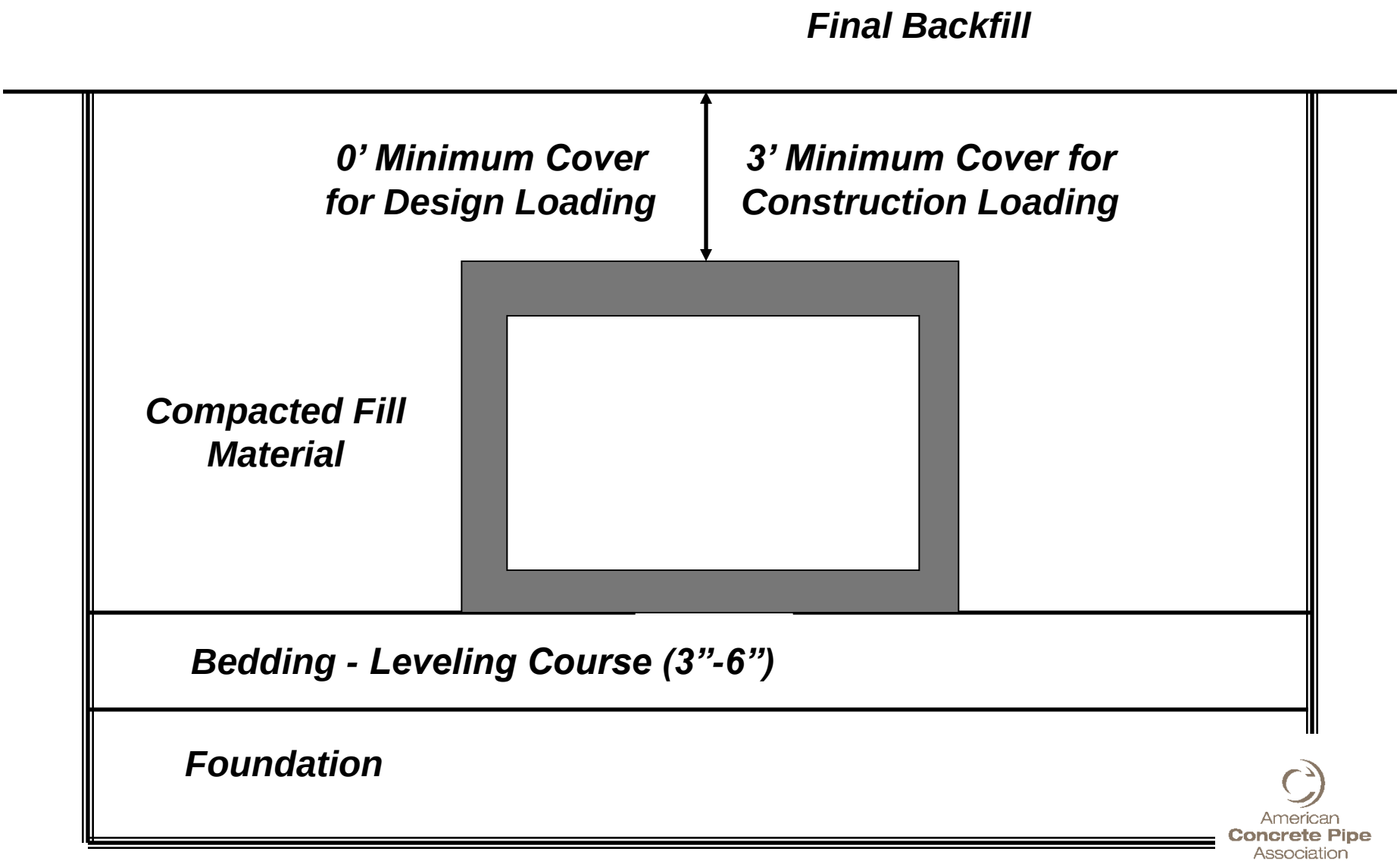
Trench Terminology



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Trench Terminology

Bedding - Leveling Course

- A bedding thickness of no less than 3 inches.
- If foundation is rock bedding should be a minimum of 6”.
- RCBs are designed for installed conditions not test conditions.
- Bedding should have a uniform flat surface.
- Coarse bedding materials are not beneficial due to irregular/sharp angles.
- Bedding width should equal the width of the box and the length of the box.

Compacted Fill Material

- This protects the box culvert during installation from impact damage.
- Should be placed in uniform layers along sides/over top of box sections.
- Should contain no debris, organic matter, frozen material or large stones.
- Placed and compacted to prevent settlement at the surface.
- Compaction and equipment loads should not exceed design strength.

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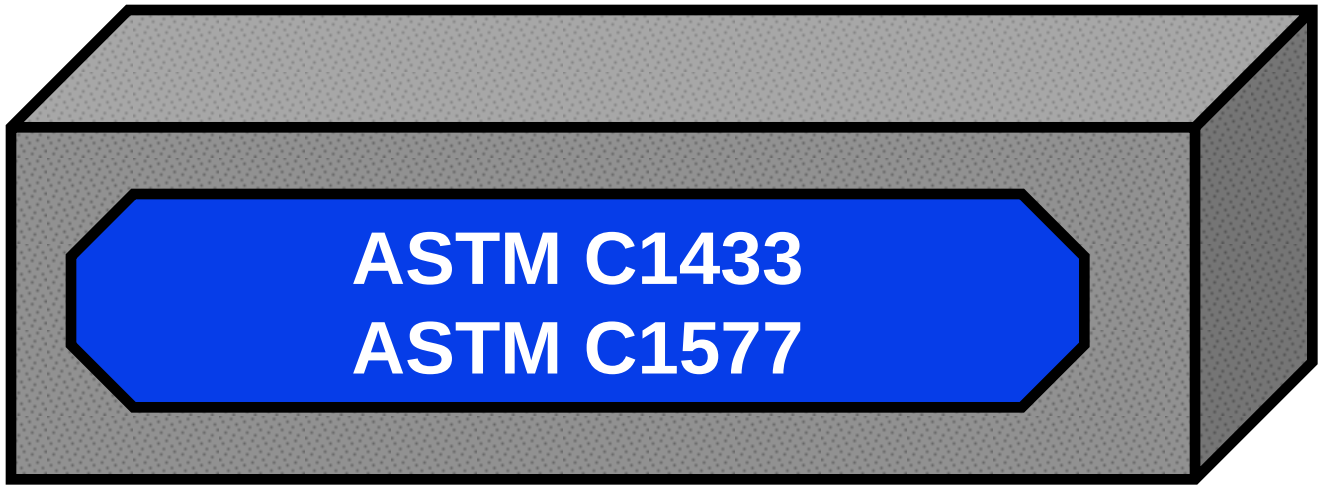
ASTM/AASHTO STANDARDS FOR RCB

- AASHTO M273
- AASHTO M259



Welded wire fabric 65,000 psi
Concrete 5,000 psi

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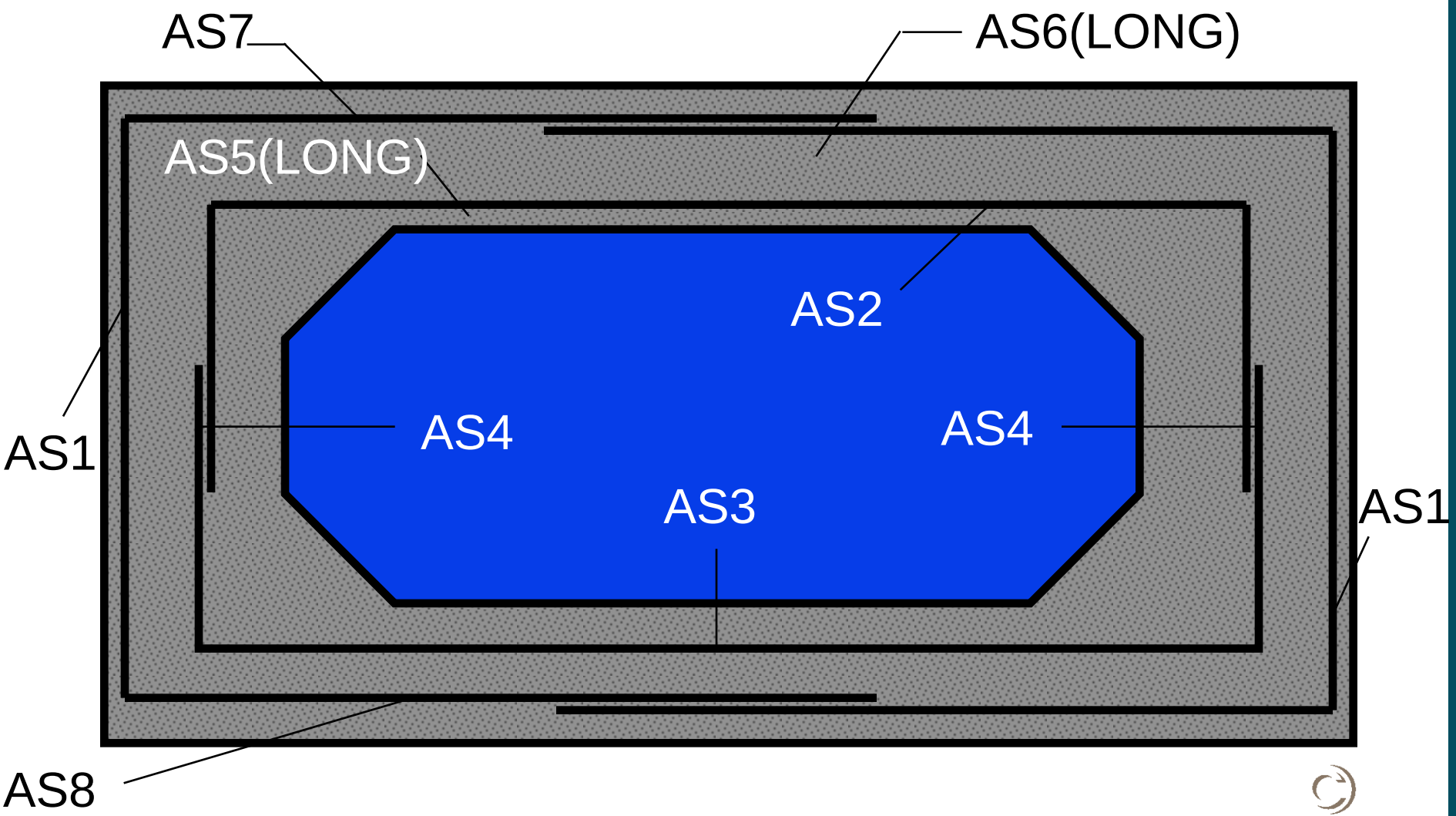
2 LAYERS OF STEEL



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2 LAYERS OF STEEL

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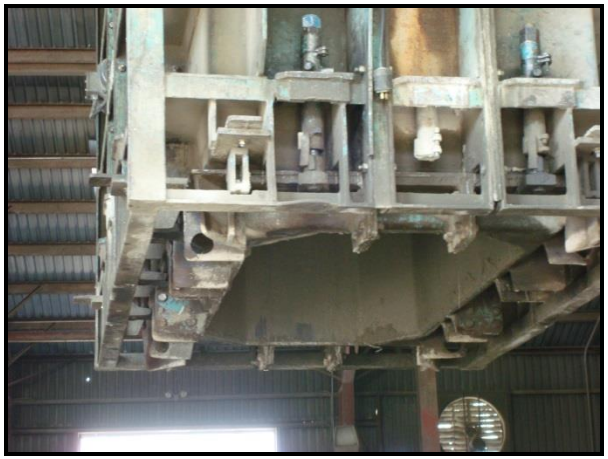

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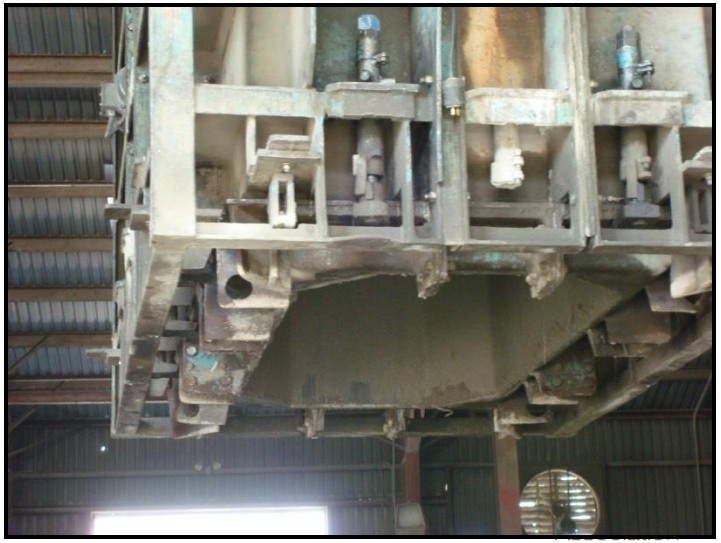
MANUFACTURING

<u>Dry Cast or Wet Cast</u>
5,000 psi concrete (min.)
65,000 psi steel
Steam Cured

One Form
Adjustable or Set Form



SUBMITTAL PROCESS

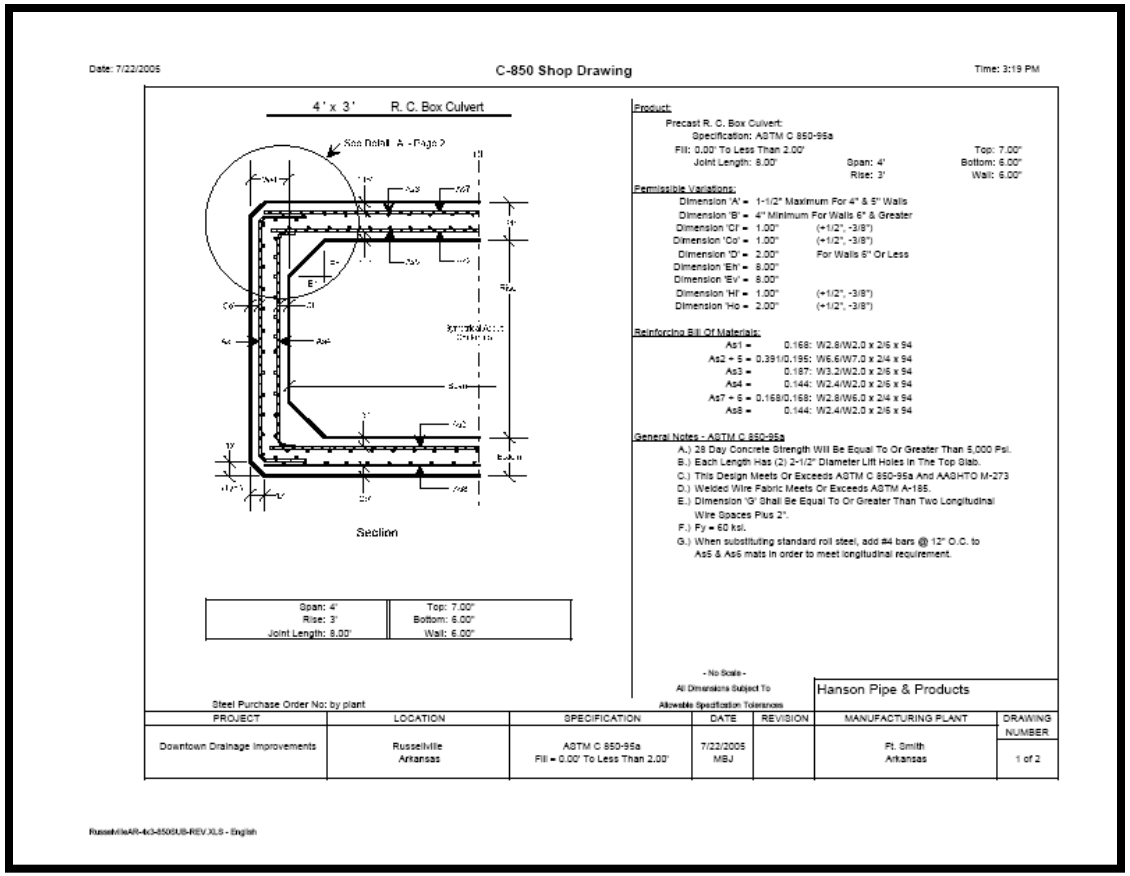
MANUFACTURER TO CONTRACTOR

CONTRACTOR TO ENGINEER/OWNER

DRAWINGS FOR REVIEW AND APPROVAL

DRIVES PRODUCTION/LAY SCHEDULE

ENSURES STRUCTURE MEETS DESIGN SPECIFICATIONS



Date: 7/22/2005 — C-850 Shop Drawing — Time: 3:19 PM

4' x 3' R. C. Box Culvert

Section

Span: 4'	Top: 7.00'
Rise: 3'	Bottom: 6.00'
Joint Length: 8.00'	Wall: 6.00'

Product:

Precast R. C. Box Culvert:
Specification: ASTM C 850-95a
Fill: 0.00' To Less Than 2.00'
Joint Length: 8.00' — Span: 4' — Rise: 3' — Top: 7.00' — Bottom: 6.00' — Wall: 6.00'

Permissible Variations:

Dimension 'A' =	1-1/2" Maximum For 4" & 5" Walls	
Dimension 'B' =	4" Minimum For Walls 6" & Greater	
Dimension 'Ci' =	1.00"	(+1/2", -3/8")
Dimension 'Co' =	1.00"	(+1/2", -3/8")
Dimension 'D' =	2.00"	For Walls 6" Or Less
Dimension 'Ei' =	8.00"	
Dimension 'Eo' =	8.00"	
Dimension 'Hi' =	1.00"	(+1/2", -3/8")
Dimension 'Ho' =	2.00"	(+1/2", -3/8")

Reinforcing Bill Of Materials:

As1 =	0.168:	W2.8/W2.0 x 2/6 x 94
As2 + 5 =	0.391/0.195:	W6.6/W7.0 x 2/4 x 94
As3 =	0.187:	W3.2/W2.0 x 2/6 x 94
As4 =	0.144:	W2.4/W2.0 x 2/6 x 94
As7 + 6 =	0.168/0.168:	W2.8/W6.0 x 2/4 x 94
As8 =	0.144:	W2.4/W2.0 x 2/6 x 94

General Notes - ASTM C 850-95a

A.) 28 Day Concrete Strength Will Be Equal To Or Greater Than 5,000 Psi.
B.) Each Length Has (2) 2-1/2" Diameter Lift Holes In The Top Slab.
C.) This Design Meets Or Exceeds ASTM C 850-95a And AASHTO M-273
D.) Welded Wire Fabric Meets Or Exceeds ASTM A-185.
E.) Dimension 'G' Shall Be Equal To Or Greater Than Two Longitudinal Wire Spaces Plus 2".
F.) Fy = 60 ksi.
G.) When substituting standard roll steel, add #4 bars @ 12" O.C. to As5 & As6 mats in order to meet longitudinal requirement.

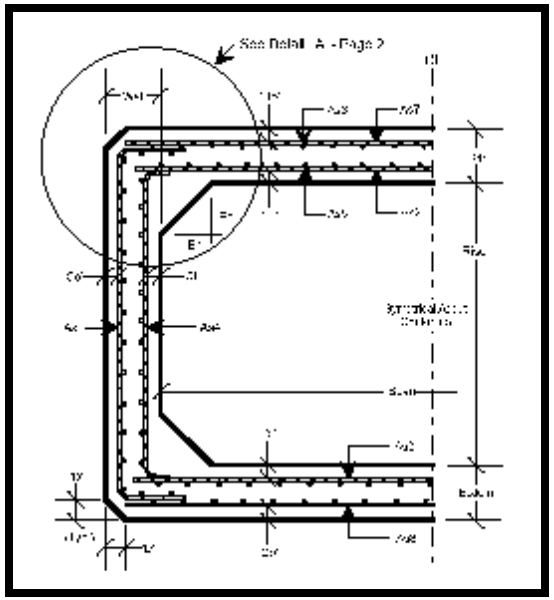
- No Scale -
All Dimensions Subject To Allowable Specification Tolerances

Hanson Pipe & Products

Steel Purchase Order No: by plant

PROJECT	LOCATION	SPECIFICATION	DATE	REVISION	MANUFACTURING PLANT	DRAWING NUMBER
Downtown Drainage Improvements	Russellville Arkansas	ASTM C 850-95a Fill = 0.00' To Less Than 2.00'	7/22/2005 MBJ		Ft. Smith Arkansas	1 of 2

RussellvilleAR-4x3-850SUB-REV.XLS - English



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Practical Exercise

<u>Situation</u>
You have a typical section for a trench detail.

<u>Task</u>
Identify the terminology related with a trench detail.

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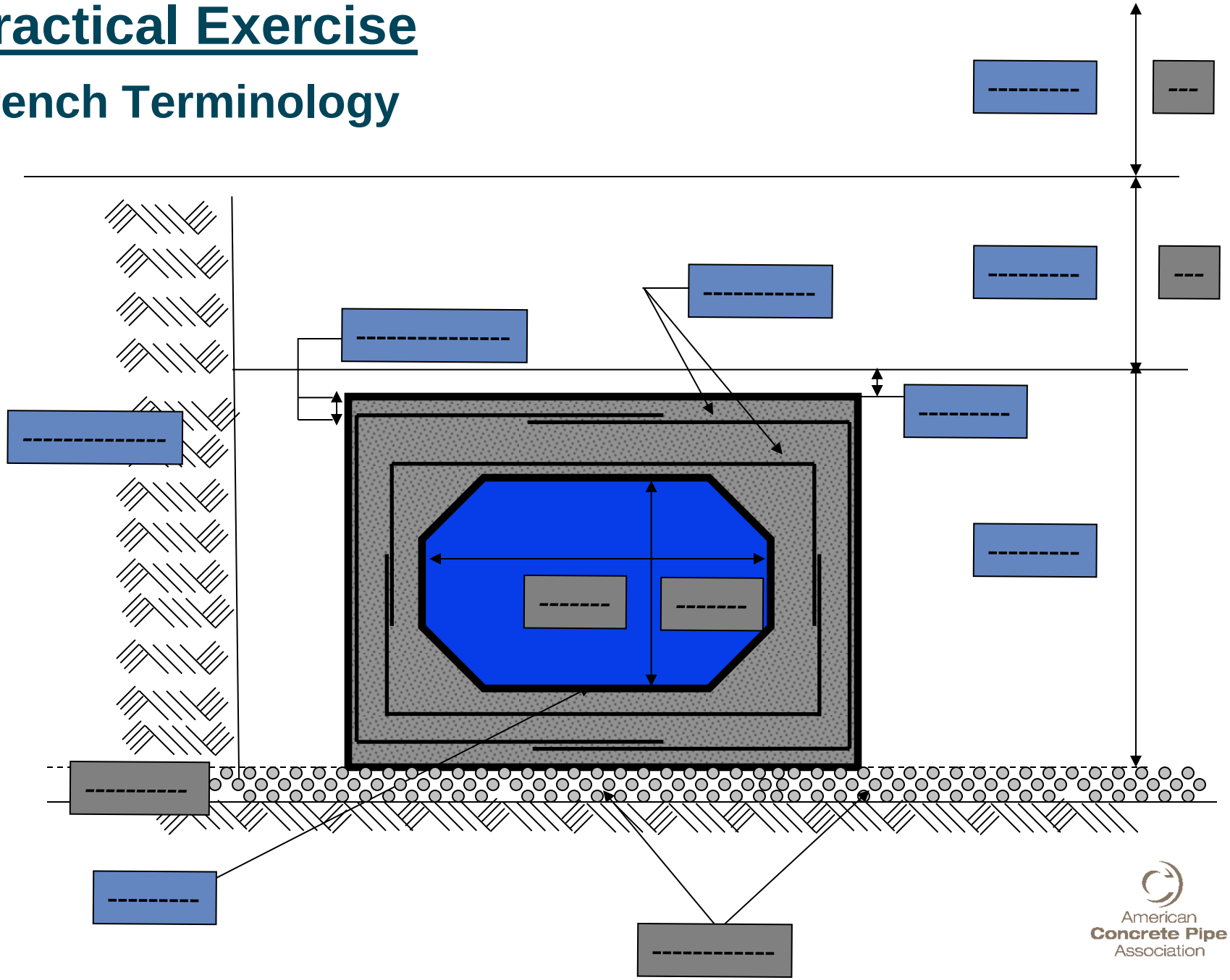
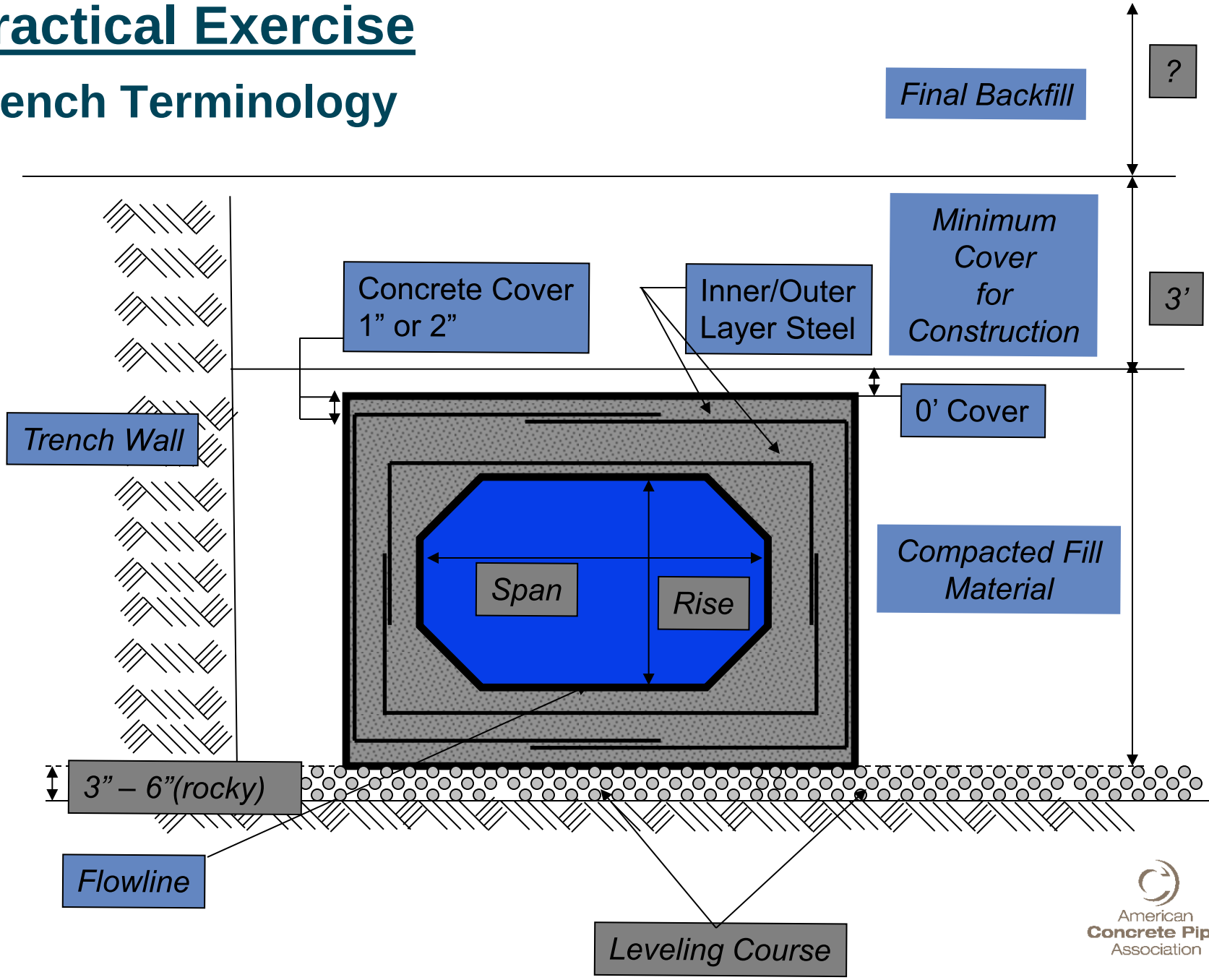
Practical Exercise

Trench Terminology



Practical Exercise

Trench Terminology



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INSTALLATION

BEDDING*****DELIVERY*****HOMING*****JOINT MATERIAL*****FABRIC*****INITIAL BACKFILL*****FINAL BACKFILL

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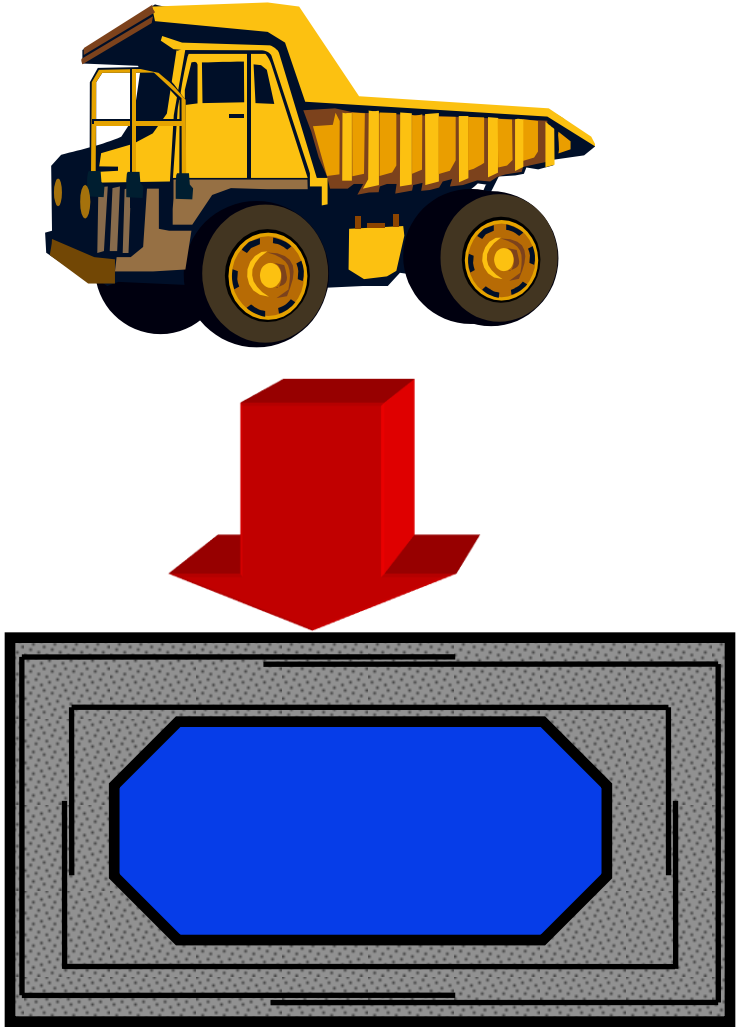
Loads on Box Culverts

Earth Live



<u>Construction Load</u>
Structure not Designed for C-Loads
3' Minimum of backfill

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Installation

- Scheduling/Unloading should be discussed to insure efficient delivery process.
- Prepare site, excavate trenches to the minimum required for box culvert installation.
- Divert drainage.
- Establish a good level grade using fine to medium granular material.
- Bedding – Leveling course should be a minimum of three (3) inches, except in rocky foundation it should be six (6) inches minimum.
- Make sure the first few box sections are installed correctly,this will influence line and grade to follow.
- Place joint material on the bottom half of the groove & top half of the tongue of box.
- Make certain to check that boxes are aligned correctly prior to pushing home.
- Keep the weight of the box section, being set, on the crane and use winches to pull the joint home/dozer to home.
- Place backfill around structure to finished grade.

Installation

Scheduling/Unloading
Placing Sequence

<u>Unloading RCBs</u>

Caution must be exercised
Handled per Manufacturer's recomm.
Distribute load properly
Lifted not dragged
Crane with stablilizers

Installation

Scheduling/Unloading
Placing Sequence

<u>Unloading RCBs</u>

Caution must be exercised
Handled per Manufacturer's recomm.
Distribute load properly
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Crane with stablilizers

Installation

Site Preparation
Dewatering/Divert Drainage

<u>Dewatering</u>
Control of Surface and subsurface water is required to maintain dry conditions for installation

Installation

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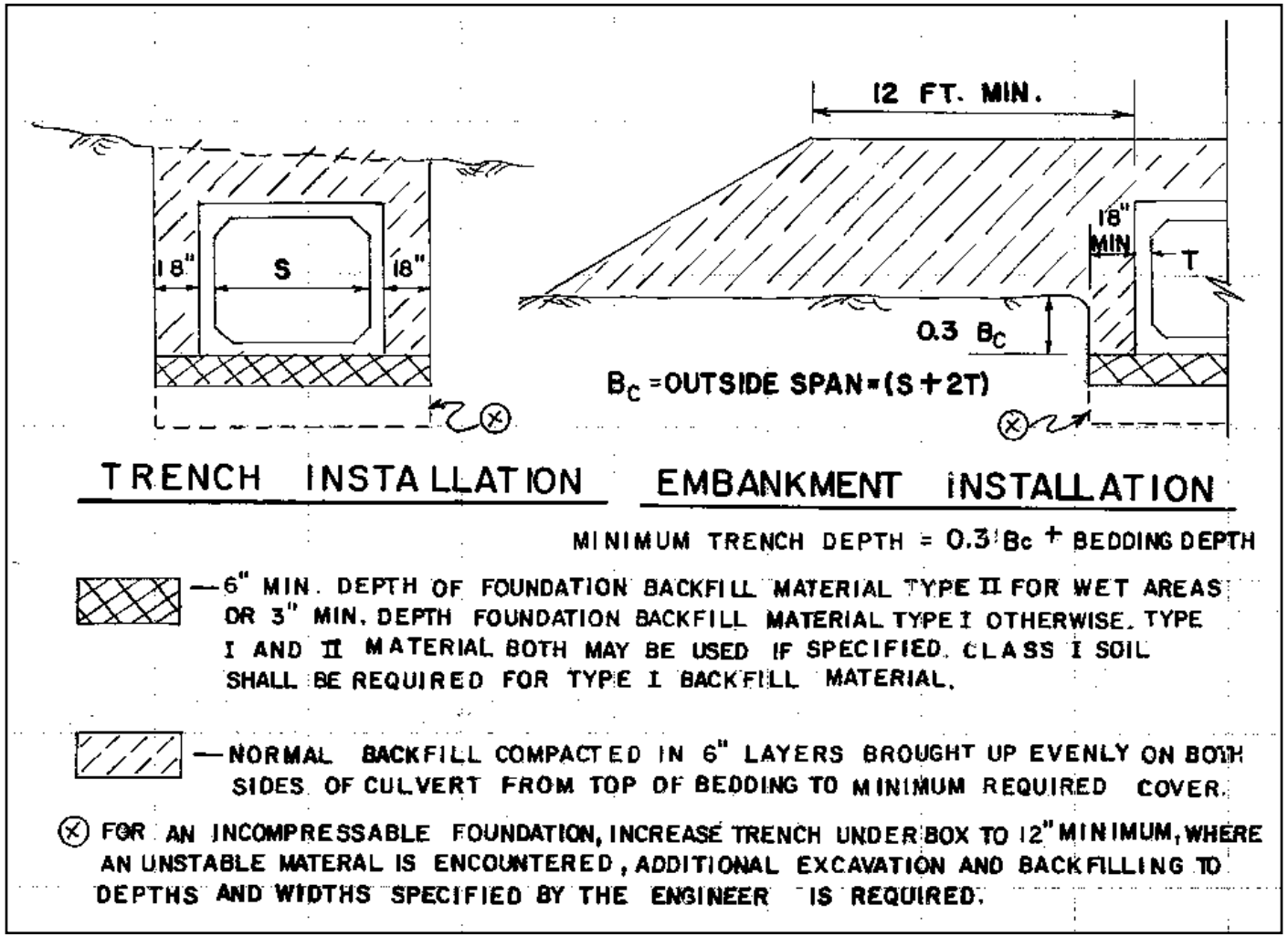
Dewatering/Divert Drainage

<u>Dewatering</u>
Control of Surface and subsurface water is required to maintain dry conditions for installation

Installation



GDOT

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Installation

Site Preparation

Establish Good Level Grade

<u>Bedding</u>

Key to smooth installation

Establish bedding at 3”-6” Minimum

Installation

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Installation

Site Preparation
Establish Good Level Grade

<u>Bedding</u>
Key to smooth installation
Establish bedding at 3”-6” Minimum

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Installation

Install first few boxes

Influences line and grade of remaining

Placement of RCBs

1st RCB sets the stage

Take your time and get it right

More time on #1 smoother it goes

Unloading RCBs

Caution must be exercised

Handled per Manufacturer's recomm.

Distribute load properly

Lifted not dragged

Crane with stablilzers

Installation

Install first few boxes
Influences line and grade
of remaining

<u>Placement of RCBs</u>
1st RCB sets the stage
Take your time and get it right
More time on #1 smoother it goes

Installation

Place Joint Material

<u>Placement of Gasket</u>
Wrap around joint completely
Do not overlap gasket material
Fabric at joints

Installation

Place Joint Material

<u>Placement of Gasket</u>
Wrap around joint completely
Do not overlap gasket material
Fabric at joints

Installation

Place Joint Material

<u>Placement of Membrane</u>

All box joints

Top external joint

Extend 1’ down sides

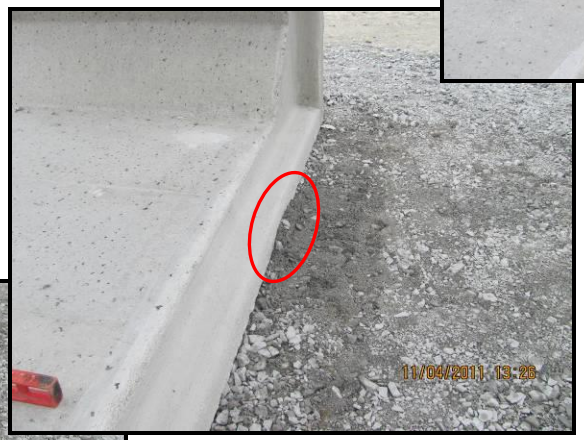
Min. width/12”-6” each side of c/l

Installation

Prevent Bedding Material from getting in joint

<u>Homing of box culverts</u>

Ensure bedding is smooth at face of joint. Smooth out in order to improve homing of RCBs



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Installation
Joining

<u>Homing of box culverts</u>
Several techniques driven by capabilities of crew, equipment and conditions

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Installation
Joining

<u>Homing of box culverts</u>
Technique based on Crew
Come along
Dozer
Trac hoe

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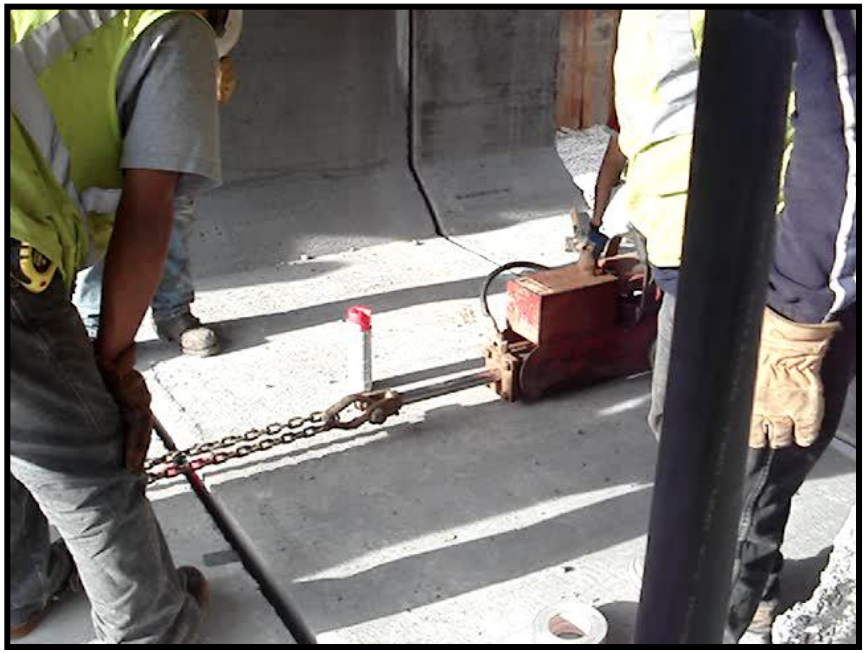
Installation
Joining

<u>Homing of box culverts</u>
Protect the Joint
Maintain Lift Pressure on Box



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Installation
Joining

<u>Homing of box culverts</u>
Keep Sections off Bedding
Reduce Friction/Push Required

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Installation
Joining

<u>Final Touches</u>
Alignment/String, tape measure
Pipe Ties (if required)

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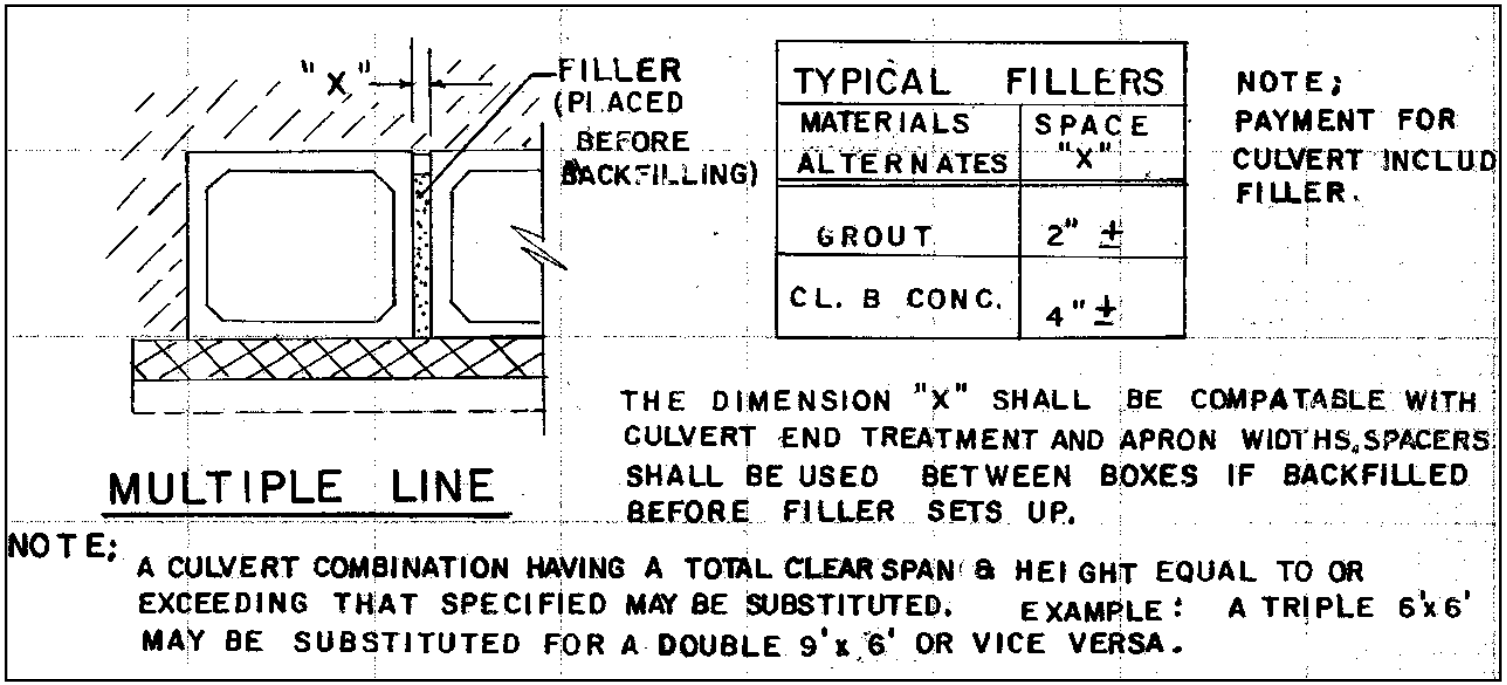
Installation
Joining

<u>Homing of box culverts</u>
Come-along/tugger pulls home boxes

Installation

Multi-Barrel



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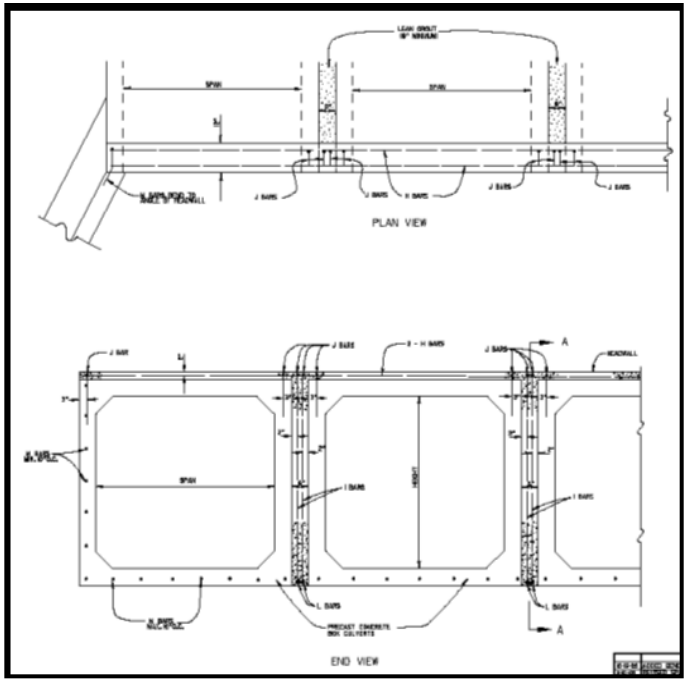
Installation
Multi-Barrel



Multi-Barrel
Create distributed load condition
Lean Grout (6” min.)
Lifts (8” max.)
1.5 Sacks pc/Ton material mixture
Or
3 to 6 inches Aggregate
Size No. 78 or No. 8 (min. Grade B)

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Installation
Multi-Barrel

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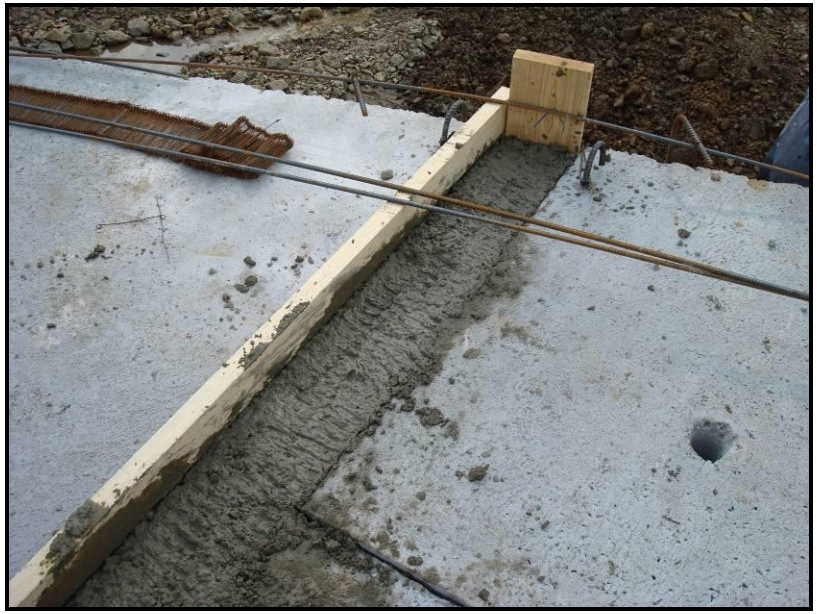

Installation - Multi-Cell

<u>Multi-Cell</u>
Reduces Installation Time
Requires Greater Lift Capability
Precast Headwall Attached

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Installation
Multi-Cell

<u>Multi-Cell</u>
Reduces Installation Time
Requires Greater Lift Capability
Precast Headwall Attached

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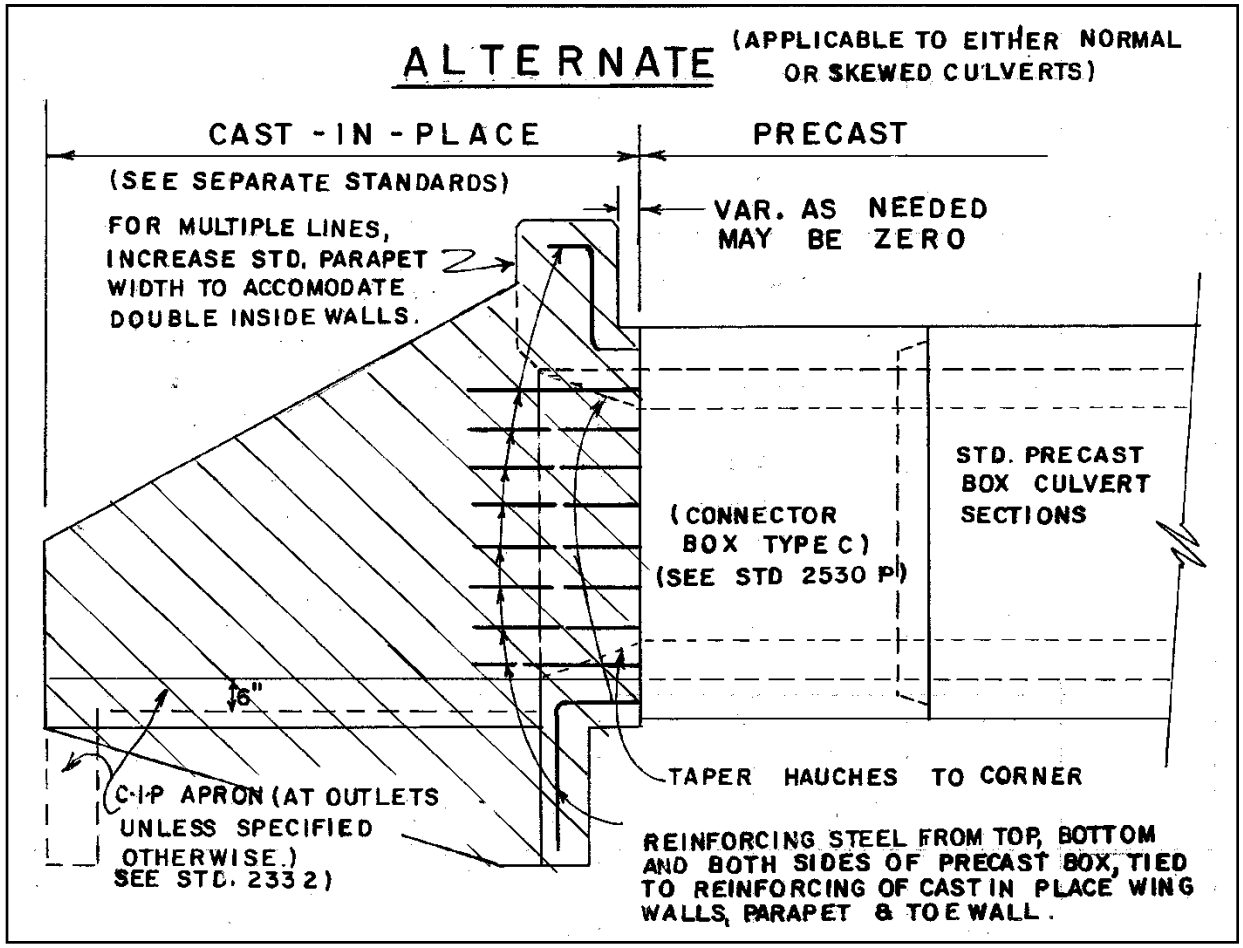
Installation
End Treatments

Headwalls
#4 Rebar @ 10” o.c. along top for headwall
#4 J Bar (2 per box) for headwall

Headwalls
#4 Rebar @ 10” o.c. along top

Installation
End Treatments



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Installation
End Treatments

Headwalls
#4 Rebar @ 10” o.c. top of headwall
#4 J Bar (2 per box) for headwall

Headwalls/Apron/Wingwalls
WWF exposed along top/walls/bottom

Installation
End Treatments - Precast

Headwalls/Apron/Wingwalls
Match Embankment Slope

Headwalls/Apron/Wingwall
Flared to Maximize Flow
Reduce Maintenance

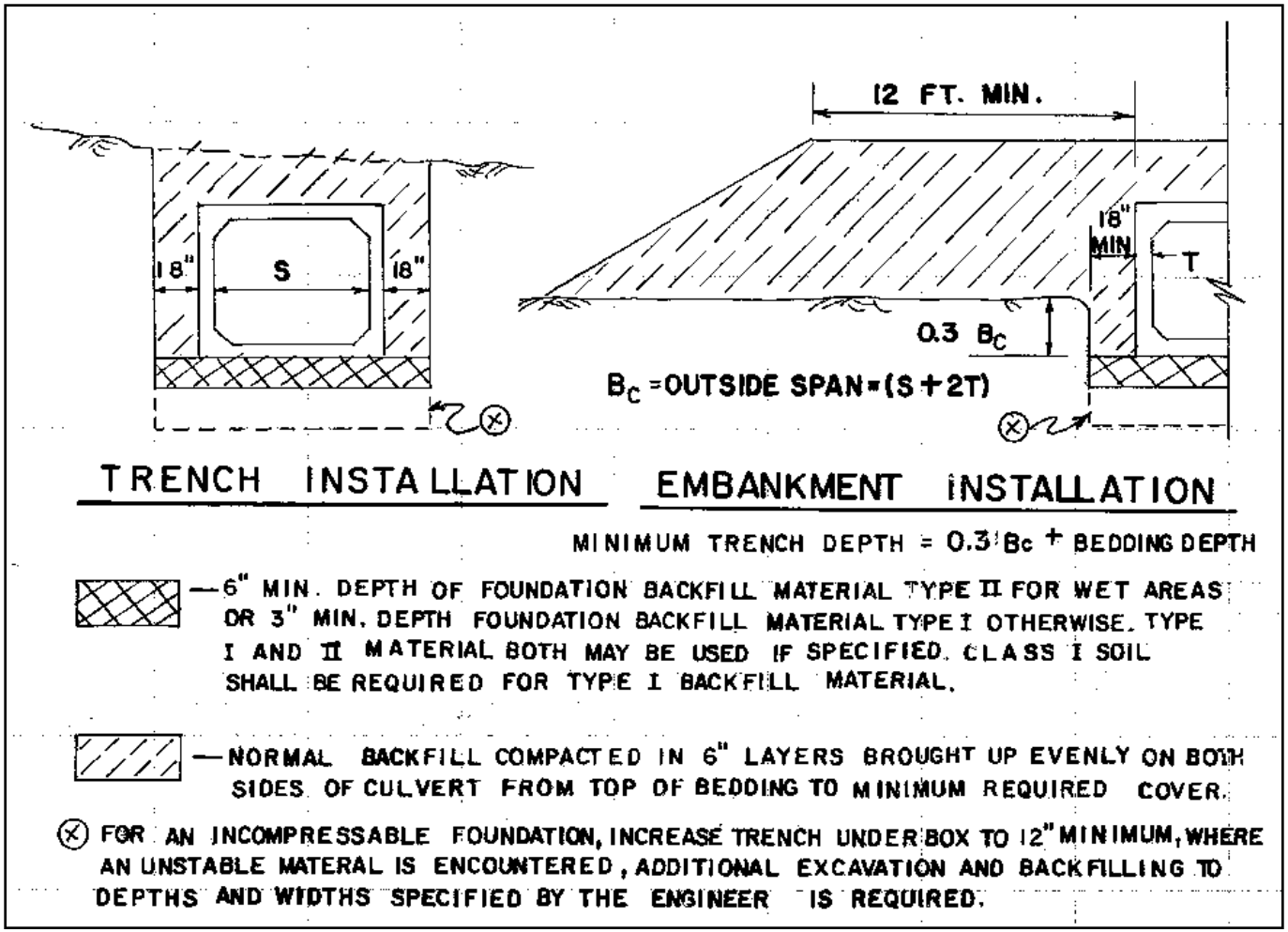
Toewall Prevents Scour

Installation
End Treatments (CIP)

Multi-Barrel

<u>Multi-Barrel</u>
Create distributed load condition
Flowable Fill
Compactable Material

Installation



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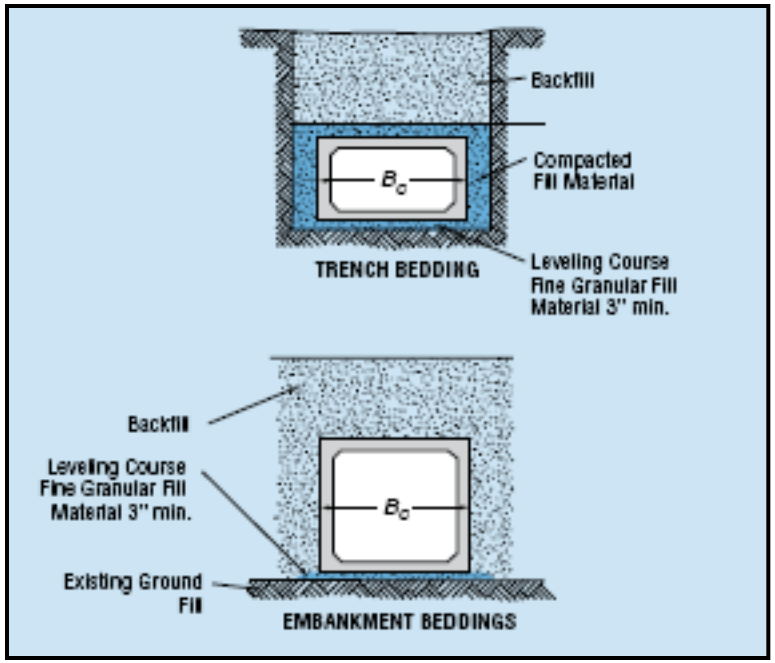
Complete Backfill



<u>Structural Backfill</u>

Backfill material placed in lifts (6” loose/4” compacted)

Backfill free of lumps/stumps/Rocks

Bedding/Leveling Course (4”-8”)

Installation

Structural/Final Backfill

Construction Loading

No construction loads with less than 3' of cover

No large rolling compactors

Trench Excavation

Minimize trench excavation

Backfill compacted in lifts

ACCELERATED PRECAST CONSTRUCTION CHARACTERISTICS

MULTI-BARREL**SKEWS**PENETRATIONS**LOW WATER CROSSING **ELBOWS**MINIMAL COVER**OPEN CHANNEL**BOTTOMLESS BOX LARGE BOX CULVERTS**MULTI-CELL**JACKING BOX CULVERTS

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Installation
Curved Alignment

Obrien County, Iowa
Hancock Concrete Products

Single 12’ x 10’
Curved Alignment

1” U-Tie 1’ above Centerline

End Section 2-1 or 3-1 Slope
0-15-30-45 degree skews

Large Box Culverts
Larger spans

<u>Large Box Culverts</u>
Allowed per Special Design
Up to 24’ Span (Wet Cast)
Requires Greater Lift Capability

23’ x 8’ Reducer

Twin 14’x11’
Single 20’ x 12’

SPECIAL DESIGN (compare)

- **Determine the weight of:**
  - an 8’ section of 8’x8’ RCB
  - Cast in place (9.5”x8”x9.5”) = 0.992 CY/FT
    - 2.01 tons/ft
  - Precast
    - (8”x8”x8”) = 1.8 tons/ft
    - (8”x7”x7”) = 1.63 tons/ft
  - Concrete = 150#/CF or 4050#/CY

- **Which does a contractor prefer:**
  - 5’x2’ Cast In Place
  - 5’x2’ Precast

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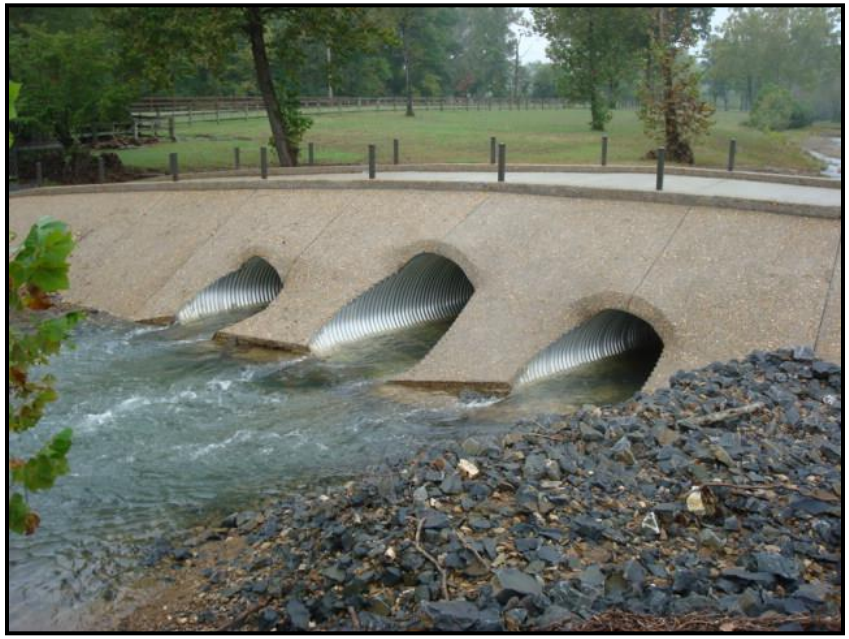
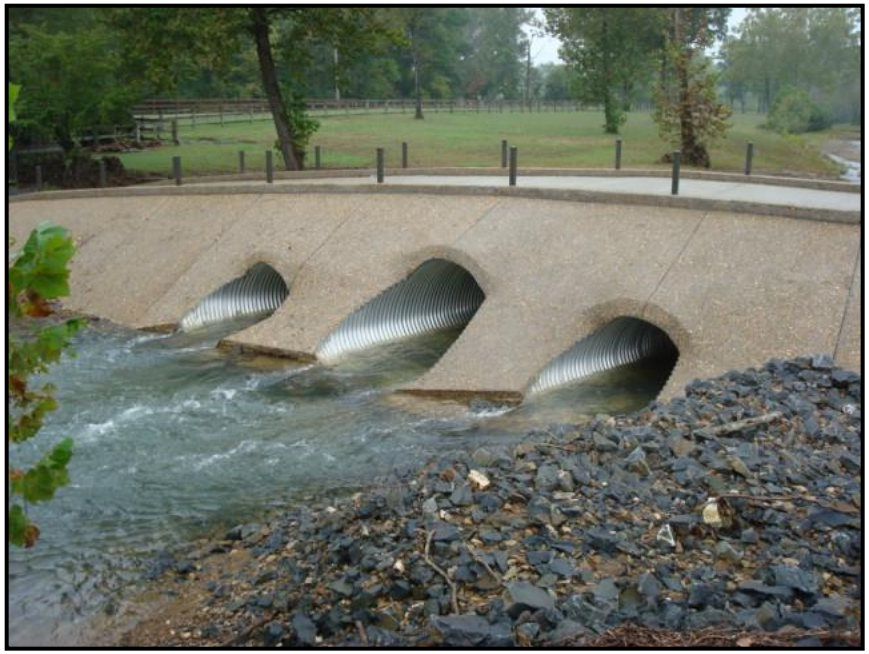
LOW WATER CROSSING
Before/After Replacement



<u>Features</u>
Triple Barrel CMP
Vertical Curve with Highpoint
Roadway Washes Away Each Event

LOW WATER CROSSING
Before/After Replacement



Features
Triple Barrel CMP
Vertical Curve with Highpoint
Roadway Washes Away Each Event

LOW WATER CROSSING
After Replacement

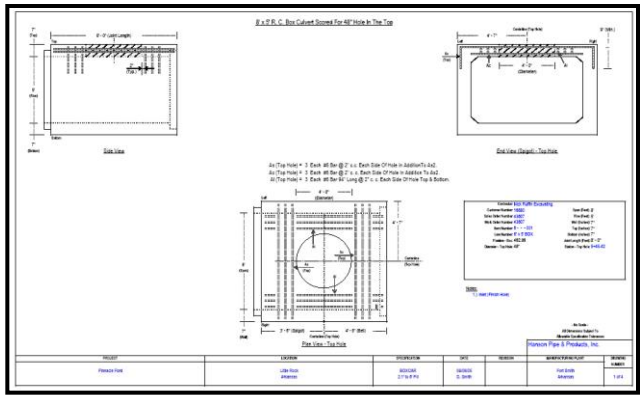
Features

Seven Barrel RCB Low Water Crossing
Replaced Triple Barrel CMP
Concrete Driving Surface with Curb
Rock Face Aesthetic Look

SKEWED END

RCBs are skewed
Left Forward Skew
Right Forward Skew
Limited: size/degree of skew

PENETRATION



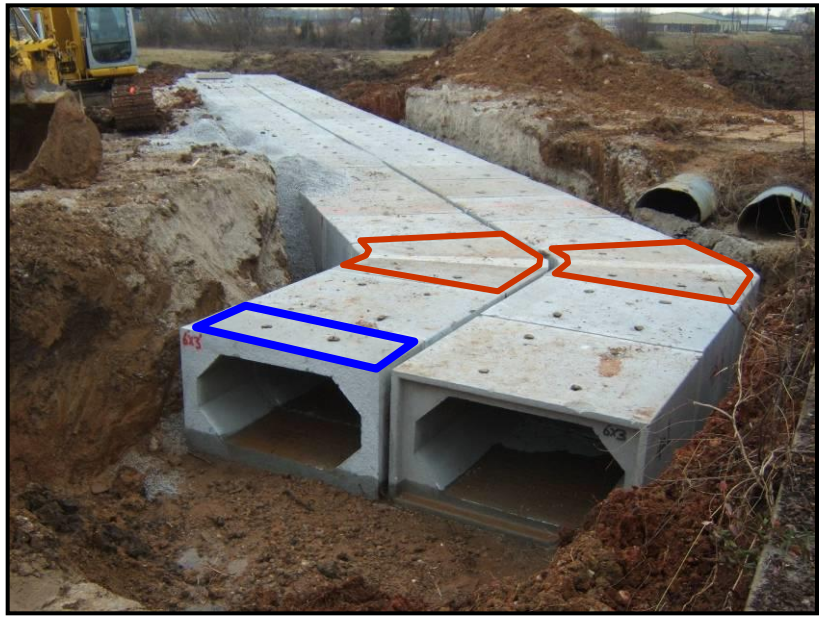
Features

Penetration Addressed in Plant

Can Design Field Penetration Solution

Top and Bottom Penetrations

Elbows/Bends



Features

Manufacture Any Bend Angle

Bends on Multi-Barrels

Saves Money/Eliminates Junction Box

Bridge Alternative
Multi-Barrel Capable

<u>Multi-Barrel</u>
Create distributed load condition
Flowable Fill
Compactable Material

MINIMUM COVER
Maximum Hydraulics

<u>0’ Cover</u>
Maximize Hydraulic Capacity
Place Road Surface directly on top

Miscellaneous

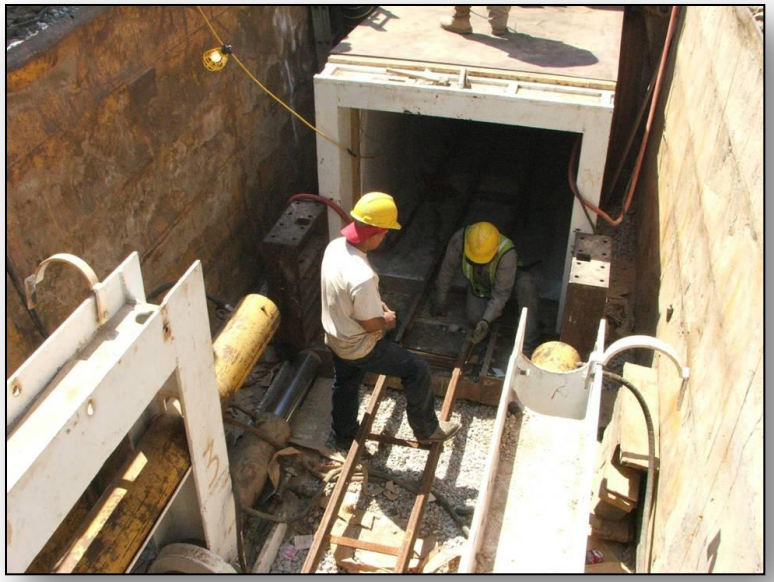
Decorative End Treatments
Rock or Brick
Angle Iron Attached

Pedestrian Water Crossing

Storage Container – Ft. Riley

Jacking

Box Culverts

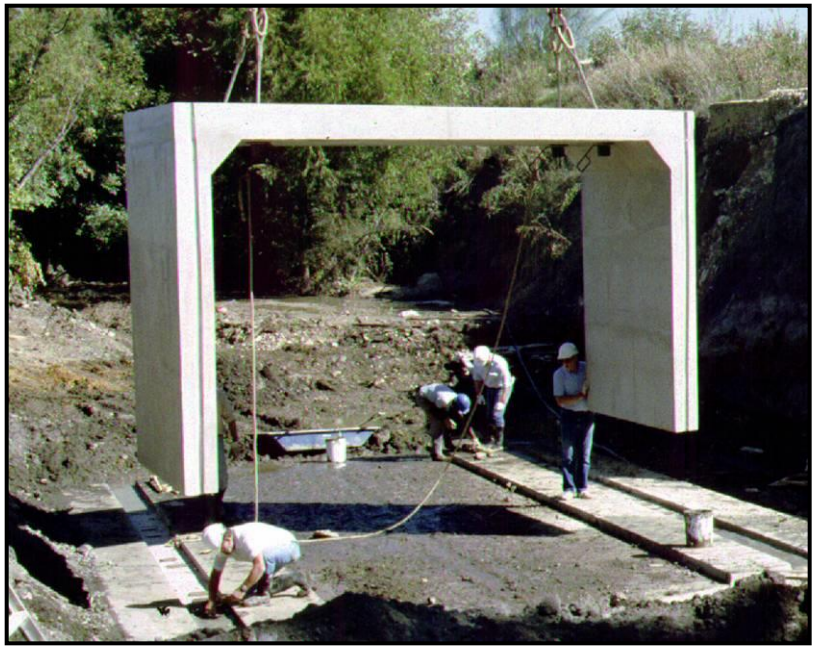


Factors

1. Nature of soil, water table & effects of dewatering
2. Jacking/Receiving Pit
3. Length, alignment and outside dimension of pipeline
4. Jacking Forces
5. Pipe Joints
6. Loads on shield and pipe
7. Size of overbore
8. Lubrication
9. Grouting
10. Spoils Removal

Bottomless Culvert

- 50’ Maximum Span
- 12’ Maximum Rise (stem wall)
- 45 Degree Max Skew
- Key way
- Multi-barrel applications
- Penetrations (top and/or sides)



6”x6”x3/8” masonite shim

Legs placed within keyway

PRECAST ADVANTAGES

- BETTER QUALITY CONTROL
- EASE OF INSTALLATION-PIPE CREW
- ELIMINATES DANGER OF OPEN TRENCHLESS ENVIRONMENTAL IMPACT
- ALLOWS IMMEDIATE BACKFILL
- NO LENGTHY CONSTRUCTION DELAYS-DETOURS-RUN AROUNDS
- NO LENGTHY DESIGN TIME
- DOT APPROVED
- SAVE TIME AND $$$$$$

ECONOMIC BRIDGE REPLACEMENT

American Concrete Pipe Association

American
Concrete Pipe
Association

Accelerated Precast Construction

Fundamentals Attributes

Reduce

Reduce Road User Impacts

Reduce Costs

Reduce Construction Time

Reduce Weather Related Time Delays

Improve

Improve Durability/Quality

Improve Work Zone Safety

Precast Box Culverts

Ease of Construction – Pipe Crew

No Lengthy Design Time

Reduced Open Trench Time

Minimize

Minimize Environmental Impact

Minimize Impact to Existing Roadway Alignment

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