Drainage
<table>
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<th>DATE</th>
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<tbody>
<tr>
<td>DR-101</td>
<td>04-18-17</td>
<td>Pipe Culvert (Bedding and Backfill)</td>
</tr>
<tr>
<td>DR-102</td>
<td>04-21-15</td>
<td>Pipe Culvert (Cover and Camber)</td>
</tr>
<tr>
<td>DR-103</td>
<td>04-21-15</td>
<td>Pipe Culvert (Installation Details)</td>
</tr>
<tr>
<td>DR-104</td>
<td>04-19-16</td>
<td>Depth of Cover Tables for Concrete and Corrugated Pipe</td>
</tr>
<tr>
<td>DR-111</td>
<td>04-17-18</td>
<td>Box Culvert (Backfill)</td>
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<td>DR-121</td>
<td>10-17-17</td>
<td>Connected Pipe Joints</td>
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<td>10-18-16</td>
<td>Construction of Type &quot;C&quot; Concrete Adaptors for Pipe Culvert Connections</td>
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<tr>
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<td>Pipe Bends and Half Pipe</td>
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<td>DR-142</td>
<td>04-21-15</td>
<td>Culvert Pipe Tee Sections</td>
</tr>
<tr>
<td>DR-201</td>
<td>04-21-20</td>
<td>Concrete Aprons</td>
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<tr>
<td>DR-202</td>
<td>04-21-20</td>
<td>Low Clearance Concrete Pipe Aprons</td>
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<tr>
<td>DR-203</td>
<td>04-21-20</td>
<td>Metal Pipe Aprons and Beveled Ends</td>
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<td>DR-204</td>
<td>04-21-20</td>
<td>Metal Arch Aprons (for Corrugated Metal Pipe)</td>
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<td>DR-205</td>
<td>04-21-20</td>
<td>Concrete Apron with End Wall</td>
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<td>DR-206</td>
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<td>Low Clearance Concrete Pipe Apron With End Wall</td>
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<td>DR-211</td>
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<td>Metal Safety Slope Apron 6:1 Slope</td>
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<td>DR-212</td>
<td>04-21-20</td>
<td>Beveled Pipe and Guard</td>
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<td>DR-213</td>
<td>04-21-20</td>
<td>Pipe Apron Guard</td>
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<td>10-17-17</td>
<td>Subdrains for Fill or Foundation Drainage (Standard)</td>
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<td>DR-302</td>
<td>10-20-15</td>
<td>Subdrains Standard (Farm Tile Replacement)</td>
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<td>10-17-17</td>
<td>Subdrains (Longitudinal)</td>
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<td>Subdrain Outlets (Standard Subdrain, Pressure Release and Special)</td>
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<td>Precast Concrete Headwall for Subdrain Outlets</td>
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<td>Scour Protection for Bridge End Drain</td>
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<td>Rock Flume for Bridge End Drain</td>
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<td>Slotted Drain for Median Crossovers</td>
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<td>DR-503</td>
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<td>Safety Grates for Box Culverts</td>
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<tr>
<td>DR-504</td>
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<td>Diagonal Placed Drain for Median Crossovers</td>
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<td>Reinforced Concrete Pipe Culvert</td>
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<td>Reinforced Concrete Pipe Culvert with Tees</td>
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<td>Reinforced Concrete Pipe Culvert Letdown Structure</td>
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<td>04-18-17</td>
<td>Apron Tee Inlet</td>
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<tr>
<td>DR-613</td>
<td>04-17-18</td>
<td>Concrete Pipewith &quot;D&quot; Section</td>
</tr>
<tr>
<td>DR-621</td>
<td>04-18-17</td>
<td>Pipe Extension</td>
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<td>DR-622</td>
<td>10-17-17</td>
<td>Pipe Extension Horizontal Bend One or Both Ends</td>
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<td>04-18-17</td>
<td>Pipe Extension Letdown Structure with Metal Apron</td>
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<td>DR-626</td>
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<td>Pipe Extension - Adding Lanes</td>
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<tr>
<td>DR-627</td>
<td>10-15-19</td>
<td>Pipe Extension Horizontal Bend - Adding Lanes</td>
</tr>
<tr>
<td>DR-628</td>
<td>10-15-19</td>
<td>Pipe Extension Both Ends Horizontal Bend (Optional) - Adding Lanes</td>
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<tr>
<td>DR-629</td>
<td>04-18-17</td>
<td>Pipe Extension Letdown Structure Horizontal Bend (Optional) - Adding Lanes</td>
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<td>DR-631</td>
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<td>Corrugated Pipe Culvert Letdown Structure with Single Elbow</td>
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<td>DR-632</td>
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<td>Corrugated Pipe Culvert Letdown Structure with Double Elbow</td>
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<td>DR-641</td>
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<td>Concrete/Corrugated Pipe Culvert Letdown Structure with Metal Apron</td>
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<td>Apron Pipe Tee Inlet</td>
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<td>DR-651</td>
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<td>Unclassified Pipe Culvert</td>
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<td>DR-652</td>
<td>04-18-17</td>
<td>Unclassified Letdown Structure Single Elbow</td>
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<tr>
<td>DR-653</td>
<td>04-18-17</td>
<td>Unclassified Roadway Letdown Pipe with Metal Apron</td>
</tr>
</tbody>
</table>
Denotes pay limits for flooded backfill

TRENCH INSTALLATION

CLASS 'C' BEDDING & BACKFILL

ELONGATED PIPE

FILL INSTALLATION

(POROUS BACKFILL BEDDING)

TYPICAL SECTION - SOIL PLUG

Possible Contract Items:
- Flowable Mortar
- Flooded Backfill
- Excavation, Class 20

Possible Tabulations:
- 104-3
- 104-4

Refer to DR-104 for minimum and maximum allowable cover for the particular kind of pipe culvert.

1. The backfill adjacent to and above the pipe culvert may be placed in conjunction with normal embankment construction. Thoroughly tamp the embankment within the limits shown.
2. Take extra care to ensure complete and satisfactory tamping of backfill material in the area immediately adjacent to the lower portion of pipe.
3. Carefully shape excavation below groundline either using a template conforming to actual dimension and shape of the pipe or using other means. If using other means, check with a template conforming to the actual dimension and shape of the pipe.
4. For culverts backfilled by flooding, place a cohesive soil plug at the inlet, outlet, and, when necessary, sides, prior to flooding.
5. 4-inch Porous Backfill bedding, 2-inch Floodable Backfill bedding may be used under unsealed rigid pipe.
6. Extend Porous Backfill through the outlet end soil plug when used for bedding.
7. Quantity calculations are based upon a 1:1 slope and minimum trench dimension. Actual slope of trench may vary based upon Contractor's operations.
8. Ground Line at time of pipe installation. When existing ground exceeds 5 feet depth over pipe, backfill and compaction by flooding is not required more than 5 feet above the pipe.
9. Where a corrugated metal pipe culvert requiring elongation is to be installed (to counteract deformation caused by backfill), complete elongation using a means approved by the Engineer. Elongation may be developed either as part of shop fabrication or field installation. Install with elongated axis vertical.
Camber is the dimension line between inlet and outlet elevation. Some settlement of the structure is usually anticipated, resulting in the design flow line between inlet and outlet. Camber is developed uniformly from inlet and outlet to a point beneath the outside shoulder lines of the roadway and is uniform between those points, as indicated. The "Normal Camber indicated in the "Allowable Camber Tables" should be used unless specific camber values are indicated elsewhere in the plans.

1. Camber for concrete pipe is created by placing pipe sections tight at the bottom of the joint with variable opening at top of joint. Camber for corrugated metal pipe to be done as directed by the Engineer.
TYPICAL INSTALLATION PLAN
WHERE SPECIAL BERM IS REQUIRED

TYPICAL INSTALLATION PLAN
WHERE CULVERT MATCHES NORMAL FORESLOPE

SECTION A-A

SECTION B-B

DETAL OF SHAPING EARTH FORESLOPE AT CULVERT END
DESIGN CRITERIA FOR CONCRETE PIPE

The height of cover tables have been prepared from data in the "Concrete Pipe Design Manual" published by the American Concrete Pipe Association using the values listed below.

**FOR EMBANKMENT CONDITIONS**

- **Fill Material Density** = \( w = \frac{122}{} \) lbs. per cu. ft.
- **Settlement Ratio** = \( ns = 0.5 \)
- **Projection Ratio** = \( p = 0.9 \) (Class "C" bedding)
- **Coefficient of Internal Friction** = \( \phi = 0.37 \) (saturated yellow clay) and a coefficient of internal friction of 0.34.
- **Factor of Safety** = \( F.S. = 1.33 \) on Ultimate Strength

* Using a ratio of lateral to vertical earth pressure (\( k \)) of 0.34.

The values shown for concrete pipe were calculated for concrete pipe placed under embankment conditions. These values do not apply to the design and installation of sanitary sewer except where sanitary sewer would be placed under embankment conditions.

When undeclassified pipe is specified, furnish and install a class of pipe meeting the requirements on the chart.

For Steel Round Pipe, the Contractor may choose the type of corrugated pipe and installation to furnish as long as the selection conforms to the limits indicated for the type specified.

When furnishing Steel Arch Pipe, furnish pipe with corrugations as specified in plans.

Minimum allowable cover for concrete and metal pipe is 2 feet for roadway culverts and 1 foot for entrance culverts.

Maximum cover for all sizes and installations of concrete arch pipe is 12 feet.

For all sizes and installations of polyethylene pipe:
- Minimum cover = 2 feet
- Maximum cover = 24 feet for 12 to 24 inch pipes
  - 20 feet for 30 to 48 inch pipes

Where a pipe size not listed in the table is required, the "H" indicated for the next smaller size will apply.

Special installations may be designed to exceed indicated maximum allowable cover by specific modification of one or more of the following conditions:

1. **Bedding Class**
2. **Pipe Strength** (including special design pipe)
3. **Type of backfill or cover material**
4. **Compaction requirements for backfill or cover material**
5. **Controlled trench width**

Where site conditions favor such modifications, significant economy may result from special design installations and these should be considered. Special designs will usually particularly modification of construction requirements or design criteria as applicable.

### CONCRETE CULVERT PIPE

#### CLASS "B" BEDDING

<table>
<thead>
<tr>
<th>Diameter of Pipe 'D'</th>
<th>1500D (Class II)</th>
<th>2000D (Class III)</th>
<th>3000D (Class IV)</th>
<th>3750D (Class V)</th>
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#### CLASS "C" BEDDING

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<th>2000D (Class III)</th>
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<td>16</td>
<td>22</td>
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### CONCRETE CULVERT PIPE

- **DR-104**
- **DEPTH OF COVER TABLES**
- **FOR CONCRETE AND CORRUGATED PIPE**
<table>
<thead>
<tr>
<th>Diameter of Pipe</th>
<th>Minimum Cover Above Pipe</th>
<th>16 Gauge</th>
<th>14 Gauge</th>
<th>12 Gauge</th>
<th>10 Gauge</th>
<th>8 Gauge</th>
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<thead>
<tr>
<th>Diameter of Pipe</th>
<th>Minimum Cover Above Pipe</th>
<th>16 Gauge</th>
<th>14 Gauge</th>
<th>12 Gauge</th>
<th>10 Gauge</th>
<th>8 Gauge</th>
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<td>Number Range</td>
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**REVISIONS:** Added general note regarding maximum cover on concrete arch pipes.

**DEPTH OF COVER TABLES**

**APPROVED BY DESIGN METHODS ENGINEER**
<table>
<thead>
<tr>
<th>SPAN</th>
<th>RISE</th>
<th>MINIMUM COVER ABOVE PIPE</th>
<th>(H) MAXIMUM ALLOWABLE COVER IN FEET</th>
</tr>
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<tr>
<td>Inches</td>
<td>Inches</td>
<td>Feet</td>
<td>12 GA. (0.093&quot;)</td>
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**STEEL ARCH PIPE**

<table>
<thead>
<tr>
<th>RISE</th>
<th>MINIMUM COVER ABOVE PIPE</th>
<th>Corner Radius, Rc, changes from 18 inches to 31 inches for the 6 in. x 2 in. corrugation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 in. x 2 in. CORRUGATIONS</td>
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</tr>
<tr>
<td>Inches</td>
<td>Inches</td>
<td>Feet</td>
</tr>
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<td>55</td>
<td>18</td>
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<td>36</td>
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<tr>
<td>247</td>
<td>158</td>
<td>36</td>
</tr>
</tbody>
</table>

**MINIMUM ALLOWABLE COVER IN FEET**

- 16 GA. (0.064")
- 14 GA. (0.078")
- 12 GA. (0.109")
- 10 GA. (0.138")
- 8 GA. (0.168")

**Minimum Cover Above Pipe**

- Corner Radius, Rc, changes from 18 inches to 31 inches for the 6 in. x 2 in. corrugation.
Denotes pay limits for flooded backfill

Possible Contract Items:
- Flooded Backfill
- Excavation, Class 20
- Compaction with Moisture Control
- Compacting Backfill Adjacent to Bridges, Culverts or Structures

Possible Tabulations:
103-6
104-4
Wrap all joints on concrete roadway pipe culverts.

Use Type 3 Connections on all culvert pipes, unless specified otherwise. Refer to Materials I.M. 465.01 for Connector requirements.

Minimum 2 threads showing at all threaded ends.

Connections not required on pipe sections installed by trenchless methods.

For belled concrete pipe joints, connectors may be installed on the inside of the pipe.

**TYPE 1**

One connector at the top of the pipe section.

**TYPE 2 (Sealed Joint)**

Two connectors near the top of the pipe section. For details of reinforcement, refer to AASHTO M 170 for the class of pipe required. Refer to Materials I.M. 491.09 for seal requirements.

**TYPE 3 (Non-Sealed Joint)**

Two connectors near the top of the pipe section. For details of reinforcement, refer to AASHTO M 170 for the class of pipe required.

Possible Tabulations:

<table>
<thead>
<tr>
<th>Pipe Size (in)</th>
<th>Connector and Bolt Size (in)</th>
<th>Hole for Connector (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 27</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>30 to 80</td>
<td>3.5</td>
<td>1.0</td>
</tr>
<tr>
<td>96 to 132</td>
<td>7</td>
<td>1.5</td>
</tr>
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</table>

If holes are field drilled, place a ribbon of butyl sealant around bolts before placing 3 in. x 3 in. x 3/4 in. plate on bolts through corrugated metal pipe and tightening nuts.

If connector is Type 3, use 1/2 inch round x 3/4 inch thick washer or 3 in. x 3 in. x 3/4 in. square plate (shaped to pipe radius).

Connectors with One Bend End and Bell End spacers allowed per Materials I.M. 461. Refer to Optional Bolts detail.

Engineering fabric for embankment erosion control.

Possible Tabulations:

104-3
104-5B
NEW CONSTRUCTION - TYPE 2 or 3 CONNECTION

TYPICAL INSTALLATION

Type 2 or 3 Connections
at each joint (typ.)

Sealed Joint
TYPE 2 CONNECTION

Fill the joint.
Sealer shall be installed.

Hole for connector

Connector

Top (Bottom for Half Pipe)

Single line reinforcing, as specified

Double line reinforcing, as specified

Connector

Hole for connector

Connector

Horizontal Axis

30°

30°

STORM SEWER OUTLET - TYPE 2 OR TYPE 3 CONNECTION

TYPICAL INSTALLATION

Intake or Manhole

Type 2 or 3 Connections

New Pipe

Existing Pipe

New Pipe

TYPICAL INSTALLATION

PIPE EXTENSION - TYPE 3 CONNECTION

Type 3 Connections

3

3

CONNECTED PIPE JOINTS
Pipe connector: See Standard Road Plan DR-121.

**Concrete Pipe to Concrete Pipe**

**Type "C-1"**

- Removable existing concrete where necessary.
- Flow

**Concrete Pipe to Concrete Box Culvert**

**Type "C-2"**

- Removable headwall if necessary.
- Remove headwall if necessary.
- Connect band (if necessary)
- Flow

**Concrete Pipe to Corrugated Pipe**

**Type "C-3"**

- Concrete pipe
- Pipe connector: See Standard Road Plan DR-121.
- Flow

**Corrugated Pipe to Concrete Pipe**

**Type "C-4"**

- Concrete pipe
- Concrete pipe elbow (if necessary)
- Flow

---

**Estimated Encasement Quantities Per Linear Foot for "C-2" Adaptors**

<table>
<thead>
<tr>
<th>Diameter, D</th>
<th>Concrete Cu. yds.</th>
<th>Wire Mesh lbs.</th>
<th>Concrete for Fill Concrete to Coat (C-2) Cu. yds.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.1</td>
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<td>0.6</td>
<td>8.1</td>
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<tr>
<td>84</td>
<td>0.7</td>
<td>8.7</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**2000 D (Class III) and 3000 D (Class IV) Pipe**

---

No payment will be made for individual adaptors.

The cost of furnishing all materials and constructing adaptor as indicated is incidental to the pipe culvert.

Removal and disposal of headwall, wingwall, or other concrete, as directed, will be paid for as "Removal of Existing Structures".

Form and construct Type "C-1" and "C-2" adaptors on the job site using methods approved by the engineer.

Type "C-3" and "C-4" adaptors may be shop fabricated using a method approved by the engineer for attaching a concrete collar (either tongue or groove end) to a standard section of corrugated pipe. Holes may be field drilled in corrugated pipe to match alignment with concrete pipe.

---

1. Thickness same as pipe thickness (D) but not less than 4 inches.
2. Grout opening between pipes.
3. Use minimum reinforcing of wire mesh 6" x 6" - W2. No. 8 wire - 30 lbs/100 sq. ft. Lap ends 6 inches.
4. Positive type joint coupling required.
5. 5/8 inch (min.) bolts in 7/8 inch (min.) holes. Four bolts around each connection at equal intervals. Existing pipe connector holes may be used if available. Place remaining two bolts at approximate equal intervals.
Fabricate concrete pipe elbows and Type "D" pipe sections according to AASHTO M 170 for the size and class of pipe specified. Meet the requirements of AASHTO M 32 for wire reinforcing.

Unless specified otherwise, bevel the Type "D" section on a 7.5 degree miter. The bevel may be provided on either the tongue end or groove end of the pipe. In certain cases, both ends of the pipe section may require the beveled end.

Type "D" pipe sections will be included in the measurement for pipe culvert. No payment will be made specifically for the Type "D" section bevel. This is incidental to the price bid.

The Contractor may substitute an approved elbow for "D" section bends of 15 degrees or less. Such elbows will not be measured for payment but will be considered incidental to price bid for culvert pipe.

Refer to the plans for degree of elbow required for each individual installation. Minimum length of elbow is to be 5'-0" measured along centerline of pipe. Design length of pipe will be considered to be 6'-0".

Fabricate elbows using a method approved by the Engineer and which results in a finished product indicated herein. The typical method for fabricating elbows is as follows: Steel rods, as specified, are attached to the normal wire reinforcing cage as indicated herein. After pipe is cast, make a cut 50% of the degree of elbow desired as indicated and cut the reinforcing rods and mesh on centerline of the cut. Rotate the severed section of pipe 180 degrees and re-weld the reinforcing to the opposite rods. Patch the remaining opening with cement mortar to complete a satisfactorily completed elbow as shown.

For pipe sizes up through 48" in diameter, bends may be accomplished in increments of 7.5 degrees by using standard "D" sections in appropriate combinations.

For pipe sizes from 54" to 72" in diameter, limit the "D" section to a maximum of 5 degree miter on any one end of pipe section.

For pipe sizes through 48" in diameter, bends from 15 to 45 degrees may be accomplished using a single elbow. Bends more than 45 degrees require two elbows unless approved otherwise by the Engineer.

Possible Tabulation:

<table>
<thead>
<tr>
<th>Size &quot;D&quot;</th>
<th>Bar Size</th>
<th>Number Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot; - 21&quot;</td>
<td>3&quot;</td>
<td>4</td>
</tr>
<tr>
<td>24&quot; - 42&quot;</td>
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</tr>
<tr>
<td>48&quot; - 84&quot;</td>
<td>3&quot;</td>
<td>8</td>
</tr>
</tbody>
</table>

Fabricate concrete pipe elbows and Type "D" pipe sections according to AASHTO M 170 for the size and class of pipe specified. Meet the requirements of AASHTO M 32 for wire reinforcing.

Unless specified otherwise, bevel the Type "D" section on a 7.5 degree miter. The bevel may be provided on either the tongue end or groove end of the pipe. In certain cases, both ends of the pipe section may require the beveled end.

Type "D" pipe sections will be included in the measurement for pipe culvert. No payment will be made specifically for the Type "D" section bevel. This is incidental to the price bid.

The Contractor may substitute an approved elbow for "D" section bends of 15 degrees or less. Such elbows will not be measured for payment but will be considered incidental to price bid for culvert pipe.

Refer to the plans for degree of elbow required for each individual installation. Minimum length of elbow is to be 5'-0" measured along centerline of pipe. Design length of pipe will be considered to be 6'-0".

Fabricate elbows using a method approved by the Engineer and which results in a finished product indicated herein. The typical method for fabricating elbows is as follows: Steel rods, as specified, are attached to the normal wire reinforcing cage as indicated herein. After pipe is cast, make a cut 50% of the degree of elbow desired as indicated and cut the reinforcing rods and mesh on centerline of the cut. Rotate the severed section of pipe 180 degrees and re-weld the reinforcing to the opposite rods. Patch the remaining opening with cement mortar to complete a satisfactorily completed elbow as shown.

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For pipe sizes from 54" to 72" in diameter, limit the "D" section to a maximum of 5 degree miter on any one end of pipe section.

For pipe sizes through 48" in diameter, bends from 15 to 45 degrees may be accomplished using a single elbow. Bends more than 45 degrees require two elbows unless approved otherwise by the Engineer.

Possible Tabulation:

<table>
<thead>
<tr>
<th>Size &quot;D&quot;</th>
<th>Bar Size</th>
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</thead>
<tbody>
<tr>
<td>12&quot; - 21&quot;</td>
<td>3&quot;</td>
<td>4</td>
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<tr>
<td>24&quot; - 42&quot;</td>
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<tr>
<td>48&quot; - 84&quot;</td>
<td>3&quot;</td>
<td>8</td>
</tr>
</tbody>
</table>
**CIRCUIT PIPE TEE SECTIONS**

- **Main Pipe**
- **Lateral Pipe**

**Main Pipe Flow**

**Lateral Pipe Flow**

**Lateral Tee**

**Flow**

**Handling Loop**

**PLAN OF ANGLE TEE**

**PLAN OF STRAIGHT TEE**

**CORRUGATED METAL PIPE**

**CONCRETE PIPE**

**DETAILS OF CONCRETE PIPE CAP**

- The handling loop may be omitted when the cap is placed in a buried installation.

**Installation of pipe cap**

- Incidental to other pipe culvert work.

**Repair damage**

- To protective coating resulting from installation of culvert as directed by the Engineer.

**CONCRETE PIPE CAP**

- The use of an approved pipe cap is required when so indicated on the detail project plans.

**Length of pipe section (L)**

- A minimum of 4 feet and a maximum of 6 feet.

**CONCRETE PIPE TEE**

- Tee sections may be required in any size from 12 inch diameter to 48 inch diameter (in 6 inch increments) on main pipe culverts equal to or greater in diameter than that of the tee. Angle tees may be required in any delta angle (of 5 degree increment) between 45 and 90 degrees. Consider a tee section delta angle 90 degrees (straight tees) unless noted otherwise in the project plans.

**Examples:**

- "18-36 inch Tee" means an 18 inch diameter 90 degree lateral tee attached to a 36 inch main pipe culvert.

- "24-48 inch 75 degree Tee" means a 24 inch diameter lateral tee attached to a 48 inch main pipe culvert at an angle of 75 degrees.

**Fabricate the tee**

- In such a manner as to be as free from obstruction on the inside of the pipe as is reasonable. Use a method approved by the Engineer.

**CIRCUIT METAL PIPE TEE**

- Repair damage to protective coating resulting from installation of culvert as directed by the Engineer.

**CONCRETE PIPE TEE**

- Length of main pipe section (L) is a minimum of 4 feet and a maximum of 6 feet. The length of main pipe section will be included in the measured length of structure.

**CONCRETE PIPE CAP**

- The use of an approved pipe cap is required when so indicated on the detail project plans. Ensure the dimensions of the pipe cap are such that the pipe cap neatly fits the groove end of the appropriate size of culvert pipe.

- The cap may be precast or it may be cast directly into the pipe and with a tight mortar joint between the cap and the pipe.

- Place an approved bituminous joint material between the cap and the pipe.

- Choose an approved pipe cap, the appropriate size of culvert pipe, and the pipe if the cap is positioned at the construction site.

- Installation of pipe cap is incidental to other pipe culvert work on the project.

**CULVERT PIPE TEE SECTIONS**

**PLAN**

**SECTION**

**E (Per AASHTO M 170)**

**Handling Loop**

**Reinforcing at least equivalent to sidewall of pipe.**
When specified in the contract documents, install pipe apron guards as shown on DR-213. Pipe apron guards are incidental to "Concrete Aprons."

Contract Item:
Apron, Concrete

Tabulations:
104-3
104-5C

Dimension "E" shown is the minimum and is considered the design length. Adjust for any difference between the actual length of concrete apron installed and the length indicated herein within the length of concrete culvert pipe furnished.

Install connected pipe joints as shown on DR-121.

Tongue end used on inlet end section. Groove end used on outlet end section.

### TYPE 1 APRONS

<table>
<thead>
<tr>
<th>DIAM</th>
<th>SLOPE</th>
<th>A</th>
<th>B</th>
<th>MINIMUM</th>
<th>F</th>
<th>G</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>2.1:1</td>
<td>4&quot;</td>
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<td>4'-4&quot;</td>
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### TYPE 2 APRONS

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<th>F</th>
<th>G</th>
<th>T</th>
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<td>1'-0&quot;</td>
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</table>
Comply with AASHTO M 206 for Apron Reinforcement.

Dimension "E" shown is minimum and is considered the design length. Appropriately adjust for any difference between the actual length of concrete apron installed and the length indicated herein for the length of concrete culvert pipe furnished.

Install connected pipe joints as shown on DR-121.

- Tongue end on inlet end section. Groove end on outlet end section. Inlet end section is shown.

Possible Contract Item:
Low Clearance Concrete Pipe Aprons

Possible Tabulations:
104-3
104-4

APPROXIMATE DIMENSIONS

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<tr>
<th>NOMINAL DIMENSIONS</th>
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<th>RISE</th>
<th>SLOPE</th>
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<td>Inches</td>
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<td>52 X 32</td>
<td>42</td>
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<td>31 1/2</td>
<td>3:1</td>
</tr>
<tr>
<td>59 X 36</td>
<td>48</td>
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<td>84</td>
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<td>62 1/2</td>
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</table>

ARCH PIPE
### NOMINAL DIMENSIONS

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<tr>
<th>SPAN X RISE</th>
<th>EQUIVALENT SPAN</th>
<th>RISE</th>
<th>APPROXIMATE DIMENSIONS</th>
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<tr>
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<td>169 X 107</td>
<td>132 1/2</td>
<td>169</td>
<td>105 1/2</td>
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</table>

### APPROXIMATE DIMENSIONS

- Tongue end on inlet end section. Tongue end on outlet end section. Inlet end section shown.
- 132 inch size is a three piece end section.

**ARCH PIPE (MULTI-SECTION APRON)**

- Pipe Connector
- Plan
- Section B-B
- Detail 'A'
- Elevation
- End

**Low Clearance**

**Concrete Pipe Aprons**
**Approximate Dimensions**

<table>
<thead>
<tr>
<th>Equivalent Diameter</th>
<th>Span</th>
<th>Rise</th>
<th>Slope</th>
<th>APPROXIMATE DIMENSIONS</th>
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<td>Inches</td>
<td>Inches</td>
<td>3:1</td>
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<td>72</td>
<td>1.6 to 1</td>
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**Elliptical Pipe**

**Section A-A**

Install connected pipe joints as shown on DR-121.

Comply with AASHTO M 207 for Apron Reinforcement.

Dimension "E" shown is minimum and is considered the design length. Appropriately adjust for any difference between the actual length of concrete apron installed and the length indicated hereon for the length of concrete culvert pipe furnished.

Tongue end on inlet end section. Groove end on outlet end section. Inlet end section shown.

**Drainage Requirements**

**Standard Road Plan**

**Revisions:**
- Added Designer Information.
- Approved by Iowa Department of Transportation.
**Metal Pipe Aprons and Beveled Ends**

Install aprons and hardware fabricated from galvanized steel complying with Section 4141 of the Standard Specifications. Alternate design details may be submitted to the Engineer for approval.

Aprons may be attached to culvert pipe as follows:

A. If normal culvert is of circumferential type, use an approved bolt or clamping device to fasten directly to culvert.

B. If normal culvert is of helical corrugation type:
   1. Use an approved joint finger securely fastened to inside diameter of apron to connect the culvert pipe using a special dimple band connector.
   2. "Dimple" bands are not allowed when a positive joint is specified.

Refer to Materials I.M. 441 for approved coupling devices.

Repair, to the Engineer's satisfaction, breaks or damage to the coating that occur during handling or installation.

Price bid for "Aprons, Metal" is full compensation for fabrication and installation of the metal apron.

1. On sizes 60 inches and larger, the reinforced edge should be supplemental with a galvanized stiffener angle attached with bolts.

2. Install Galvanized Toe Plate (same gage metal as apron) on all aprons 24 inch diameter and larger.

**Possible Contract Item:**
- Apron, Metal

**Possible Tabulations:**
- 104-3
- 104-5C

**Alternate Design Details May Be Submitted to the Engineer for Approval.**

Refer to Materials I.M. 441 for approved coupling devices.

Repair, to the Engineer's satisfaction, breaks or damage to the coating that occur during handling or installation.

**Price Bid for "Aprons, Metal" is Full Compensation for Fabrication and Installation of the Metal Apron.**

- On sizes 60 inches and larger, the reinforced edge should be supplemental with a galvanized stiffener angle attached with bolts.

- Install Galvanized Toe Plate (same gage metal as apron) on all aprons 24 inch diameter and larger.

When specifically required as part of detail project plans, ends of pipe culvert may be provided with beveled ends as shown.

Either Full Bevel or Step Bevel may be used unless one type is specified. The slope of the bevel is 3:1 unless specified otherwise.

Beveled ends, when required, are incidental to the price bid for the culvert.
**TYPICAL CROSS SECTION**

**PLAN VIEW**

**Pipe Culvert**
Measurement length of culvert pipe

**APPROX. SLOPE**

**DIMENSIONS (In Inches)**

<table>
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<tr>
<th>SPAN/RISE</th>
<th>EQUIV DIA</th>
<th>GAGE</th>
<th>A (+1&quot;)</th>
<th>B (Max.)</th>
<th>H (+1&quot;)</th>
<th>L (+1&quot;)</th>
<th>W (+2&quot;)</th>
<th>APPROX SLOPE</th>
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<td>71-7</td>
<td>8</td>
<td>24</td>
<td>36</td>
<td>2 1/10</td>
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<td>16</td>
<td>8</td>
<td>6</td>
<td>29</td>
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</table>

Possible Tabulations:
- Aprons, Metal, Arch

Possible Contract Items:
- Aprons, Metal, Arch

Install aprons and hardware fabricated from galvanized steel complying with Section 4141 of the Standard Specifications. Alternate design details may be submitted to the Engineer for approval.

Comply with the following:
1. All 3-piece bodies are to have 12-gage sides and 10-gage center panels. Multiple panel bodies are to have lap seams which are to be tightly joined by galvanized rivets or bolts.
2. For the 77"x52" and 83"x57" sizes, the refored edge is to be supplemented by galvanized angles. The angles are to be attached by galvanized nuts and bolts.
3. Angle reinforcement is to be placed under the center panel seams on the 17"x13" and 63"x37" sizes.
4. Galvanized Toe plate is to be available as an accessory when specified on the order and is to be the same gage as the end section.

**NOTE 4**

Install aprons and hardware fabricated from galvanized steel complying with Section 4141 of the Standard Specifications. Alternate design details may be submitted to the Engineer for approval.

Comply with the following:
1. All 3-piece bodies are to have 12-gage sides and 10-gage center panels. Multiple panel bodies are to have lap seams which are to be tightly joined by galvanized rivets or bolts.
2. For the 77"x52" and 83"x57" sizes, the refored edge is to be supplemented by galvanized angles. The angles are to be attached by galvanized nuts and bolts.
3. Angle reinforcement is to be placed under the center panel seams on the 17"x13" and 63"x37" sizes.
4. Galvanized Toe plate is to be available as an accessory when specified on the order and is to be the same gage as the end section.

Aprons may be attached to culvert pipe as follows:
A. If culvert is of circumferential corrugation, use an approved bolt or clamp to fasten apron directly to culvert.
B. If culvert is of helical corrugation type:
   1. Use an approved sizing ring securely fastened to inside diameter of apron to connect to the culvert pipe using a special dimple band connector.
   2. "Dimple" bands are not allowed when a positive joint is specified.

Refer to Materials I.M. 441 for approved coupling devices.

Repair to the Engineer's satisfaction, breaks or damage to the coating that occur during handling or installation.

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Tabulations:
- Aprons, Metal, Arch

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
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Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
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Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
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Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
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Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
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Possible Contract Items:
- Aprons, Metal, Arch

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Possible Contract Items:
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- Aprons, Metal, Arch

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Possible Contract Items:
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Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
- 10A-3

Possible Contract Items:
- Aprons, Metal, Arch

Possible Tabulations:
For the End Wall, match the thickness and reinforcing used for the pipe apron.

Dimension shown is the minimum and is considered the design length. Adjust for any difference between the actual length of concrete apron installed and the length indicated herein within the length of concrete culvert pipe furnished.

Install connected pipe joints as shown on DR-121.

When specified in the contract documents, install pipe apron guards as shown on DR-213. Adjust connection locations to avoid conflict with end wall. Pipe apron guards are incidental to "Concrete Aprons".

Tongue end used on inlet end section. Groove end used on outlet end section.

### TYPE 1 APRONS

<table>
<thead>
<tr>
<th>DIAM</th>
<th>SLOPE</th>
<th>A</th>
<th>B</th>
<th>MINIMUM</th>
<th>C</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>T</th>
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#### Possible Tabulation:

- **CONCRETE APRON**
- Possible Tabulation: 104-3
Comply with AASHTO M 206 for Apron Reinforcement.

Dimension "E" shown is minimum and is considered the design length. Appropriately adjust for any difference between the actual length of concrete apron installed and the length indicated hereon for the length of concrete culvert pipe furnished.

Install connected pipe joints as shown on DR-121.

Possible Tabulations:
Low Clearance Concrete Pipe Aprons

Possible Contract Item:
ARCH PIPE

Alternate Design

Top Elevation

END WALL

Low Clearance Concrete Pipe Aprons

Possible Tabulations:
104-3
104-4

ARCH PIPE
### APPROXIMATE DIMENSIONS

<table>
<thead>
<tr>
<th>Equivalent Diameter</th>
<th>Span In</th>
<th>Rise In</th>
<th>Slope</th>
<th>Approx. Dimensions</th>
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<td></td>
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<td>23</td>
<td>14</td>
<td>3:1</td>
<td>26  27  46  72  38</td>
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<td>30</td>
<td>19</td>
<td>3:1</td>
<td>32  36  53  72  48</td>
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<tr>
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<td>72</td>
<td>1.6 to 1</td>
<td>90  108 124 90 113</td>
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</table>

Comply with AASHTO M 207 for Apron Reinforcement.

Dimension "E" shown is minimum and is considered the design length. Appropriately adjust for any difference between the actual length of concrete apron installed and the length indicated hereon for the length of concrete culvert pipe furnished.

Install connected pipe joints as shown on DR-121.

Tongue end on inlet end section, Groove end on outlet end section. Inlet end section shown.
Install aprons and hardware fabricated from galvanized steel complying with Section 441 of the Standard Specifications. Alternates design details may be submitted to the Engineer for approval.

Apron may be attached to culvert pipe as follows:

1. If normal culvert is of circumferential corrugation type, use an approved bolt or clamp to fasten apron directly to apron.
2. If normal culvert is of helical corrugation type:
   1. Use an approved sizing ring securely fastened to inside diameter of apron to connect to the culvert pipe using special dimple band connector.
   2. "Dimple" bands will not be allowed when a positive joint is specified.

Refer to Materials M. 441 for approved coupling devices.

Repair, to the Engineer’s satisfaction, breaks or damage to the coating that occur during handling or installation.

Price bid for "Aprons, Safety Slope" is full compensation for fabrication and installation of the apron.

<table>
<thead>
<tr>
<th>Pipe Dia (In.)</th>
<th>Min. Thick</th>
<th>Dimensions (Inches)</th>
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<td>60</td>
<td>16</td>
<td>18</td>
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Possible Contract Item:
Aprons, Safety Slope

Possible Tabulation: 104-3
For reinforcing steel used in construction of "Beveled Pipe and Guard", use deformed bars meeting the requirements of Article 4151.03 of the Standard Specifications and hot-dip galvanized according to ASTM A123.

Use Class 'C' Concrete in the construction of Beveled Pipe and Guard.

Cut the pipe to fit the foreslope. Cut slots into the pipe for placement of the No. 8 bars. After the foreslope has been placed, fit the No. 8 bars into the slots cut in the pipe so they will be in proper position when the concrete collar is poured.

Price bid for "Beveled Pipe and Guard", each, is full compensation for furnishing all materials and constructing the Beveled Pipe and Guard.

Special Note:
A silt fence ditch check is required immediately upstream from the inlet. Refer to EC-201 for construction details.

Possible Contract Item:
Beveled Pipe and Guard

Possible Tabulations:
104-3
112-8

TABLE OF DIMENSIONS

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
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<th>B</th>
<th>C</th>
<th>D</th>
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REINFORCING BAR LIST

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<td>132.3</td>
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Possible Contract Item:
Beveled Pipe and Guard

Possible Tabulations:
104-3
112-8
Provide guard dimensions to fit with Type of apron provided (DR-201, DR-202, DR-205, or DR-206). "V" Bar is to completely rest on apron.

Use ASTM A615, Grade 40, or merchant quality, smoothed or deformed steel bars in construction of the guard. Comply with fabrication requirements of Section 2404 of the Standard Specifications.

Hot-dip galvanize the completed apartment guard according to ASTM A123.

Use bolts, nuts, washers, and fasteners complying with Article 4153.06 of the Standard Specifications.

All guards are to have at least one intermediate cross bar. If pipe size is 60 inches or greater, use two intermediate cross bars equally spaced.

Provide guard dimensions to fit with Type of apron provided (DR-201, DR-202, DR-205, or DR-206). "V" Bar is to completely rest on apron.

Use ASTM A615, Grade 40, or merchant quality, smoothed or deformed steel bars in construction of the guard. Comply with fabrication requirements of Section 2404 of the Standard Specifications.

Hot-dip galvanize the completed apartment guard according to ASTM A123.

Use bolts, nuts, washers, and fasteners complying with Article 4153.06 of the Standard Specifications.

All guards are to have at least one intermediate cross bar. If pipe size is 60 inches or greater, use two intermediate cross bars equally spaced.
PLAN VIEW OF TYPICAL STANDARD SUBDRAIN INSTALLATIONS

**Type 1 Installation**
- Subdrain (Type 1 installation)
- Granular Backfill
- Fore Slope
- Shoulder
- Roadway Pavement
- Subdrain Outlet (DR-306)
- Granular Blanket (Uncompacted)
- Granular Material for Blanket (Uncompacted)
- Perforated Plastic or Polyethylene Corrugated Tubing
- Porous Backfill (Uncompacted)
- Variable width

**Type 2 Installation**
- Subdrain (Type 2 installation)
- Granular Backfill
- Weep Hole
- Shoulder
- Roadway Pavement
- Subdrain Outlet (DR-305)
- Granular Blanket (Uncompacted)
- Granular Material for Blanket (Uncompacted)
- Perforated Plastic or Polyethylene Corrugated Tubing
- Porous Backfill (Uncompacted)
- Variable width

**Type 3 Installation**
- Subdrain (Type 3 installation)
- Granular Backfill
- Weep Hole
- Shoulder
- Roadway Pavement
- Subdrain Outlet (DR-305)
- Granular Blanket (Uncompacted)
- Granular Material for Blanket (Uncompacted)
- Perforated Plastic or Polyethylene Corrugated Tubing
- Porous Backfill (Uncompacted)
- Variable width

**Type 4 Installation**
- Subdrain (Type 4 installation)
- Granular Backfill
- Weep Hole
- Shoulder
- Roadway Pavement
- Subdrain Outlet (DR-305)
- Granular Blanket (Uncompacted)
- Granular Material for Blanket (Uncompacted)
- Perforated Plastic or Polyethylene Corrugated Tubing
- Porous Backfill (Uncompacted)
- Variable width

**Possible Contract Items:**
- Standard Subdrain
- Trench Drain
- Granular Material for Blanket and Subdrain
- Subdrain Outlet (DR-305)
- Subdrain Outlet (DR-306)

**Possible Tabulations:**
- 104-5C

For specific information for individual locations, refer to the detail project plans, soils survey sheets, and tabulations of subdrains.

Dispose of material excavated from trenches for subdrain as directed by the Engineer. No extra compensation will be made for such disposal.

Cap blind ends of subdrains with a metal cap or by other methods approved by the Engineer. Install all perforated pipe with the perforations centered on flowline of the bottom side of the subdrain.

Place Granular Material for Blankets as indicated on the plans.

1. Perforated Subdrain (Polyethylene Corrugated Tubing).
2. Granular Material for Blanket (Uncompacted).
3. Porous Backfill (Uncompacted).
4. For Subdrain outlet construction details, see DR-305 and DR-306.
5. 10 inches for 4 inch subdrain; 12 inches for 6 inch subdrain.

For Subdrain outlet construction details, see DR-305 and DR-306.

**Possible Tabulations:**
- 104-5C

**References to the DR-304 have been changed to the DR-306.**
When the existing tile lines are intercepted by roadway construction, replace them within the R.O.W. limits of the project, or outfall them in a ditch or channel. Where the roadway intersects the tile line in an undesirable alignment, as shown in Case 'A', relocate the tile line to accomplish a more nearly right angle. Where the existing tile line alignment is more parallel to the roadway and within the construction limits, relocate the tile outside the R.O.W. line, as shown in Case 'B'. In cases where new construction requires existing subdrain to outlet into the roadway ditch, as shown in Case 'C', provide the Standard Subdrain Outlet shown in DR-305.

Replace tile lines within the R.O.W. limits according to the replacement schedule shown below. Install an inspection access at each end of replaced tile line. Replace tile lines outside the R.O.W. limits using the same size of pipe as existing line.

### REPLACEMENT SCHEDULE - CASE 'A'

<table>
<thead>
<tr>
<th>Existing Tile Size</th>
<th>Proposed Subdrain Size</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>6</td>
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<td>21</td>
<td>24</td>
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<tr>
<td>&gt;24</td>
<td>30</td>
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</tbody>
</table>

**NOTES:**
- Install relocated or replacement subdrain so as to cause a minimum of disturbance to existing field tile. Connect to lines of existing tile drains in such a way as to leave the existing tile drains in a functional condition.
- Cap blind ends of subdrains with a metal cap or as approved by the Engineer.

When concrete culvert pipe of 2000D (Class III) or stronger is required, furnish and install a Type 1 connection at no additional cost to the Contracting Authority.

Possible Contract Items:
- Standard Subdrain
- Subdrain Outlet

Possible Tabulation:
- 104-5C

**TYPICAL PLAN FOR REPLACING OR RELOCATING EXISTING FIELD TILE**

- **Case 'A':** Where the tile line is severed by the roadway and the line is reconnected.
- **Case 'B':** Where the tile line is within the R.O.W. and the line is relocated in a more parallel alignment.
- **Case 'C':** Where the tile line is severed by the roadway and the line is not reconnected but outletted.

**NOTES:**
- 4-inch diameter inspection access with cap. Minimum of 3 feet above ground. Use PVC meeting the requirements of Article 4146.03 of the Standard Specifications.
- Inspection access is required to allow inspection by the upstream and downstream property owners. Perforated pipe may be used to allow ditch drainage into subdrain if approved by adjacent property owners.
- Dimension A indicates the R.O.W. limits in which replacement of tile subdrain according to the replacement schedule is required.
- Replacement sizes provide equivalent capacity based on a 6-inch settlement assuming a 0.20% slope with n=0.013 for concrete pipe and n=0.025 for corrugated pipe (Manning's Formula).
- Replace in kind (size and type) or with 'PE' slotted pipe, a minimum of one size larger than existing line.
- When multiple drains are connected to one outlet, the outlet is to provide full capacity for all connected drain systems.
- Depth as required.
When culverts which are less than 1 foot below the trench bottom are encountered within a tabulated subdrain, stop the trench 3 feet from the culvert and resume 3 feet beyond the culvert.

On new construction projects, place the subdrain after the special backfill, if required, and prior to granular or paved shoulder material.

Except for backslope installations, if the Contractor's operations result in a trench, place and compact granular shoulder material in the trench to be level with the adjacent surface prior to opening lanes to traffic.

Perforated Subdrain (Corrugated Polyethylene Tubing).

Porous Backfill for Subdrain (compacted).

Subdrain outlet, See DR-306.

2 foot section of corrugated metal pipe of diameter 2” larger than subdrain or 2 foot section of double-walled PE or PVC pipe of the same diameter as subdrain. Pipe will be paid for as “Subdrain Outlet (DR-303).”

Connect PE or PVC outlet with an appropriate coupler. Connect CMP outlet one of two ways: (1) Inside-fit reducer coupler (1 foot minimum fit inside CMP); or (2) Insert 1 foot of the 4 inch subdrain into 6 inch CMP and fully seal entire opening with grout.

Place porous backfill in direct contact with a minimum of 2 inches of pavement and continuous to shoulder material as per note 10 or 11.

If the trench is inadvertently carried over the culvert, repair the trench as detailed on this sheet. If obstruction is 1 foot or more below trench bottom, carry subdrain line over in continuous alignment. No payment will be made for trench repair.

10 inches for 4 inch subdrain. 12 inches for 6 inch subdrain.

Possible Contract Items:
- Subdrain, Longitudinal, (Backslope)
- Subdrain, Longitudinal, (Shoulder)
- Subdrain Outlet (DR-303)
- Subdrain Outlet (DR-305)

Possible Tabulation:
- DR-303
- DR-306

Referencs to the DR-304 have been changed to the DR-306.
**TYPE 5 INSTALLATION**
SECTION A-A
Subgrade Treatment Subdrain

**TYPE 6 INSTALLATION**
SECTION C-C
For Drain Placement Prior to Subbase or Pavement Placement

**TYPE 7A INSTALLATION**
SECTION C-C
For New Widening Unit if Thinner than Existing Pavement

**TYPE 7B INSTALLATION**
SECTION C-C
For New Widening Unit if Thicker than Existing Pavement

**TYPE 8A INSTALLATION**
SECTION C-C
Composite Pavement with Existing Shoulder

**TYPE 8B INSTALLATION**
SECTION C-C
For New Widening Unit if Thicker than Existing Pavement

**TYPE 9 INSTALLATION**
SECTION C-C
For New Widening Unit if Thinner than Existing Pavement

**TYPE 10 INSTALLATION**
SECTION C-C
Special Backfill

**Type 11 INSTALLATION**
SECTION B-B
Backslope

**Type 12 INSTALLATION**
SECTION D-D

**Type 13 INSTALLATION**
SECTION C-C
Possibly Existing Pavement

**Type 14 INSTALLATION**
SECTION C-C
Possibly Existing Pavement

Perforated Subdrain (Corrugated Polyethylene Tubing).
Porcupine Backfill for Subdrain (compacted).
Place porous backfill in direct contact with a minimum of 2 inches of pavement and continuous to shoulder material as per note 11 or 12.
Install subdrain as cut proceeds.
On existing Granular or Earth Shoulders, replace with 4 inch minimum depth granular shoulder material.
On Paved Shoulders, refer to Section 2902 of the Standard Specifications for finishing shoulder.
Cut "V" notch just prior to subbase (if proposed) or pavement placement to assure uncontaminated contact.
Place top of subdrain trench at the bottom of pavement. Backfill trench so that a wedge of porous backfill has a minimum vertical contact of 2 inches with the pavement.

**References:**
Referecnes to the DR-304 have been changed to the DR-306.
1. **Perforated Subdrain (Polyethylene Corrugated Tubing).**
2. If corrugated metal pipe is used, an outlet 2 inches larger than existing subdrain pipe is required. If double-walled PE or PVC pipe is used, an outlet pipe of the same diameter as the existing subdrain pipe may be used.
3. The pipes should be coupled in one of the two following ways: (1) Use an inside fit reducer coupler (coupler must be inserted a minimum of 12 inches into C.M.P.), or (2) insert 12 inches of the existing subdrain pipe into the corrugated metal outlet pipe, then fully seal the entire opening with grout.
4. If a concrete headwall is used, refer to DR-306.
5. For existing subdrain pipes larger than 12 inches in diameter, use Special Outlet, Type C.

**Possible Contract Item:**
Subdrain Outlet (DR-305)

**Possible Tabulation:**
104-5C
Extend subdrain 3 inches minimum (6 inches maximum) into precast subdrain headwall. Connect using one of the following methods:
- Gasketed connection approved by the Engineer.

Shape adjacent slope to match slope of precast subdrain headwall:
1. Perforated Subdrain (Polyethylene Corrugated Tubing).
2. On projects where existing shoulder material is removed, replace the shoulder material according to Article 2902.03, C of the Standard Specifications.
3. "Y" or "T" connection will not be allowed. Place subdrain on 1 foot minimum radius.
4. Direction of flow:
5. 6 inch minimum drop in elevation between longitudinal subdrain and outlet. 12 inch minimum drop for projects using recycled PCC subbase.
6. Precast concrete headwall:
7. Revel the trench to provide a minimum of 3 inches of porous backfill surrounding all portions of subdrain pipe.
8. Place class 'A' crushed stone or Special Backfill over outlet and carefully compact to avoid damaging outlet pipe.

Possible Contract Item:
Subdrain Outlet, DR-306

Possible Tabulation:
104-5C
194-9
Comply with Section 2419 of the Standard Specifications.

1. ASTM A36 Steel galvanized according to ASTM A123 or ASTM F2329 after shop welding is complete.
2. After installing retaining rod, fill recess with bituminous material complying with ASTM C990 to prevent moisture infiltration.
3. Granular material complying with Section 4133 of the Standard Specifications.
4. Maximum diameter 2 inches. Fill hole with soil tight plug after placing headwall and before placing backfill.

### BENT BAR SHAPES
- #4 Horizontal Bar
- #4 Vertical Bar

### DETAIL ‘A’
(Recess for Retaining Rod)
Price bid for "Bridge End Drain, DR-401" is full compensation for furnishing, installing, and constructing the Bridge End Drain as shown.

1. Continue 4 inch sloped curb to edge of flume per section B-B. Refer to BR-201, BR-202, BR-203, BR-204, or BR-205 for details of 4 inch curb.

2. DI-1 and DI-2 distances measured from center of Bolt Pattern.

3. Abut Transition Mat (see EC-105) panels to the edge of the pavement to prevent from being undercut by water. Cut panels to fit around guardrail posts to ensure pavement edge contract. No deduction will be made for area of Transition Mat removed for guardrail posts.

Possible Contract Items:
- Bridge End Drain, DR-401
- Paved Shoulder, Portland Cement Concrete (Paved Shoulder Panel for Bridge End Drain)

Incidental to Paved Shoulder:
- Modified Subbase
- Polymer Grid

Incidental to Bridge End Drain:
- Transition Mat
- Seeding and Fertilizing
- Soil Fill
- Special Ditch Control (Wood Excelsior Mat)
- Turf Reinforced Mat, Type 2
- Watering for Sod, Special Ditch Control, or Slope Protection
- Mobilization for Watering

Possible Tabulation:
104-5A

Possible Tabulation:
104-5A

SCOUR PROTECTION
FOR BRIDGE END DRAIN
1. Continue 4 inch sloped curb to edge of flume per section B-B. Refer to BR-201, BR-202, BR-203, BR-204, or BR-205 for details of 4 inch curb.

2. Abut Transition Mat (see EC-105) panels to the edge of the pavement to prevent from being undercut by water. Cut panels to fit around guardrail posts to ensure pavement edge contact. No deduction will be made for area of Transition Mat panel removed for guardrail posts.

3. Extend TRM (see EC-104) flume 4 feet beyond toe of slope.

4. Install modified subbase and polymer grid under PCC shoulder panels as shown in Section A-A on BR-201, BR-202, BR-203, BR-204, or BR-205.

5. Transition the flume flow line depth from 3 inches at the downstream edge of Transition Mat to 8 inches with an approximate transition rate of 1 inch vertical per 1 foot horizontal.

6. Transition the flume flow line depth from 8 inches at the toe of slope to 0 inches with an approximate transition rate of 2 inches vertical per 1 foot horizontal.
Price bid for "Bridge End Drain, DR-402" is full compensation for furnishing, installing, and constructing the Bridge End Drain as shown.

1. Extend rock flume to toe of backslope. If no backslope exists, extend rock flume a minimum of 4 feet beyond the toe of foreslope.

2. Continue 4 inch sloped curb to edge of flume per section B-B. Refer to BR-201, BR-202, BR-203, BR-204, or BR-205 for details of 4 inch curb.

3. DI-1 and DI-2 distances measured from center of Bolt Pattern.

Possible Contract Items:
- Paved Shoulder, Portland Cement Concrete (Paved Shoulder Panel for Bridge-End Drain)
- Bridge End Drain, DR-402
- Modified Subbase
- Polymer Grid
- Erosion Stone Base Material
- Erosion Stone
- Engineering Fabric
- Excavation, hauling, and disposing of material

Possible Tabulation:
- 104-8A

DI-1 and DI-2 distances measured from center of Bolt Pattern.
1. Continue 6 inch sloped curb to edge of flume per section B-B. Refer to BR-201, BR-202, BR-203, BR-204, or BR-205 for details of 4 inch curb.
2. Extend flume to toe of backslope. If no backslope exists, extend rock flume a minimum of 4 feet beyond the toe of foreslope.
3. Install modified subbase and polymer grid under PCC shoulder panels as shown in Section A-A on BR-201, BR-202, BR-203, BR-204 or BR-205.
4. Transitions from 2 inches at edge of pavement to 8 inches within 3 feet.
5. Transition the flume flow line depth from 8 inches at the toe of slope to 0 inches with an approximate transition rate of 2 inches per 1 foot horizontal.
Install the Type "A" Diaphragm (anti-seep device for use on letdown structures) directly below the upstream shoulder of the dike.

Type "A" Diaphragm consists of a sheet of corrugated metal of the dimensions indicated herein and of the same thickness as the pipe used for culvert pipe. Fabricate this sheet from one or more sheets of corrugated metal. Lap a minimum of one corrugation and weld or rivet at a minimum of 3 inch centers along the seam if two or more sheets are used. Weld the sheet on both sides to a standard half connecting band of dimensions indicated herein. Securely attach this assembly to the pipe by means of two 3/8 inch diameter rods of appropriate length placed in two adjacent valleys of the corrugated pipe and threaded with double nut and washer.

Details are shown using corrugated metal culvert pipe. Make appropriate modifications as indicated, subject to the approval of the Engineer, as necessary where concrete culvert pipe is used. Use plastic diaphragms when connecting to plastic pipe.

1. Normal half of connecting band may be used in lieu of rods when approved by the Engineer.
2. Use flat steel band of equivalent dimensions where Type "A" Diaphragm is to be installed on Concrete Culvert pipe.
3. Weld corrugated metal sheet to the connecting band using a continuous weld. Shape to fit outside pipe diameter.

Details are shown using corrugated metal culvert pipe. Make appropriate modifications as indicated, subject to the approval of the Engineer, as necessary where concrete culvert pipe is used. Use plastic diaphragms when connecting to plastic pipe.

1. Normal half of connecting band may be used in lieu of rods when approved by the Engineer.
2. Use flat steel band of equivalent dimensions where Type "A" Diaphragm is to be installed on Concrete Culvert pipe.
3. Weld corrugated metal sheet to the connecting band using a continuous weld. Shape to fit outside pipe diameter.
### TABLE OF QUANTITIES

<table>
<thead>
<tr>
<th>Standard Road Plan</th>
<th>PV-500</th>
<th>PV-503</th>
<th>PV-600</th>
<th>PV-609</th>
<th>PV-612</th>
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<td>limits of 18&quot; CMP and Slotted Drain</td>
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<td>110'</td>
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<td>Possible Items:</td>
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</table>

#### Notes
1. Beveled pipe and guard. See DR-212.
2. During construction of crossover pavement, cover slotted drain with duct tape or wood block.
3. Slotted grate 6 inches high x 1/2 inches opening width. Use 1/2 inch material for spacers and bearing bars (sides).

#### Diagrams
- **Longitudinal Section Through CMP Slotted Drain Assembly**
- **PCC Pavement Situation**
- **HMA Pavement Situation**
- **Possible Tabulation:**
  - 112-8
### INSTALLATION TYPES

Grates bars to be perpendicular to direction of traffic flow.

#### INSTALLATION PLAN

- **Straight Type 1 Culvert**
- **Skewed Type 2 Culvert**
- **Flared Type 3 Culvert**
- **Flared-Skewed Type 4 Culvert**

#### GRATE & CROSS BAR SIZE REQUIREMENTS

<table>
<thead>
<tr>
<th>Length of Span</th>
<th>Nominal Pipe Size</th>
<th>O.D. Size</th>
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<tr>
<td>less than 12'</td>
<td>3.5''</td>
<td>3.5''</td>
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<td>12'-16'</td>
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<td>4.0''</td>
</tr>
<tr>
<td>greater than 16'</td>
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**Note:**
- Equal spaces 24 inches minimum, 30 inches maximum, edge of sidewall to center of bracket or center to center of bracket.
- Cross Bar diameter equal to or greater than Grate Bar diameter.
- If more than 20 feet, midspan support is required. Refer to sheets 3 and 4.

#### SAFETY GRATES

The dimensions shown in the "Tabulation of Safety Grate Treatment" are from the original construction plans. Verify these dimensions at the site before fabricating components.

Submit shop drawings. Approval of drawings is not required as part of the fabrication process. Drawings will be used to document the item as constructed.

Use correct pipe diameters and correct dimensions. Ensure safety grate fits properly into the headwall opening.

Reinforcing steel may be encountered when drilling holes through the existing structure wall.

Install bolts and lock nuts complying with Article 4153.06 of the Standard Specifications at all locations as shown. Use brackets that comply with ASTM A36 and are galvanized per ASTM A123. Use steel washers meeting the dimensional requirements of Materials I.M. 453.07.

Furnish Schedule 40 Pipe meeting the requirements of Article 4153.05 of the Standard Specifications. Galvanize all pipes, fittings, and hardware after all cutting, welding, drilling and fabrication. In the shop drawings, show members planned for field cutting and drilling to provide for installation tolerances. Repair galvanizing of those members according to Materials I.M. 410.

Gas Metal-Arc and Flux-Cored Arc welding may be used for welding incidental items as indicated on this sheet, provided that the fabricator furnishes certifications for the gas and uses approved filler metal and qualified welders approved by the Iowa DOT.

Payment for "Safety Grate, (Type 1, 2, 3, or 4), Culvert" is full compensation for furnishing all materials and work necessary to fabricate and install the grate system as required for each headwall opening.

- Equal spaces 24 inches minimum, 30 inches maximum, edge of sidewall to center of bracket or center to center of bracket.
- Cross Bar diameter equal to or greater than Grate Bar diameter.
- If more than 20 feet, midspan support is required. Refer to sheets 3 and 4.

Possible Contract Items:
- Safety Grate, (Type 1, 2, 3, or 4), Culvert

Possible Tabulation:

106-24
1. Drill \( \frac{3}{8} \) inch diameter holes using equipment designed to cut through concrete and reinforcing steel.
2. Bend plates or strips without cracking material.
3. \( \frac{3}{8} \) inch bolt, lock nut and washers. All holes are to be \( \frac{7}{8} \) inch diameter.
4. Shim thickness equal to difference in diameters of Grate Bar and Cross Bar.
INSTALLATION PLAN WITH MIDSPAN SUPPORT

CASE 1

CASE 2

1. If more than 20 feet, midspan support is required. Refer to sheets 3 and 4.
2. Length of span (20 feet maximum).

See Detail 'C'

See Detail 'C'

See Detail 'C'

See Detail 'C'

See Detail 'C'

See Detail 'C'

Headwall

Sidewall
Drill \( \frac{1}{2} \) inch diameter holes using equipment designed to cut through concrete and reinforcing steel.

Set approved anchor bolts using epoxy grout as described in Materials I.M. 453.08 for anchor bolts.

Drill 1\( \frac{3}{4} \) inch diameter holes using equipment designed to cut through concrete and reinforcing steel.
Beveled pipe and guard. See Standard Road Plan DR-212.

Requires approximately 7 degree elbow.

Place the top edge of beveled pipe and guard at a point where the distance between the edges of the shoulders are approximately 22 feet apart.

Median ditch flow line.

### TABLE OF QUANTITIES

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<thead>
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<th>Standard Road Plan No</th>
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<td>16.0'</td>
<td>28.0'</td>
<td></td>
<td></td>
<td></td>
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Possible Contract Items:
- Beveled Pipe and Guard
- Culvert, Unclassified Entrance Pipe, 18" Dia.
- Embankment in Place
- Excavation, class 10, Roadway and Borrow
- Special Backfill

Possible Tabulation:

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<th>Bid Item</th>
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Possible Tabulation:

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</table>
Possible Tabulation:
104-3

Dr. 201 for circular concrete.
Dr. 202 for low clearance concrete.
Dr. 203 for circular metal.
Dr. 205 for circular concrete with end wall.
Dr. 206 for low clearance concrete with end wall.

Skew angle is the angle which one end of the pipe is ahead (by stationing) of line perpendicular to the R. (Example: skew Rt. ahead 30 degrees).

Refer to the following:

Dr. 201 for circular concrete.
Dr. 202 for low clearance concrete.
Dr. 203 for circular metal.
Dr. 205 for circular concrete with end wall.
Dr. 206 for low clearance concrete with end wall.

Skew angle is the angle which one end of the pipe is ahead (by stationing) of line perpendicular to the R. (Example: skew Rt. ahead 30 degrees).

Refer to the following:

Dr. 201 for circular concrete.
Dr. 202 for low clearance concrete.
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Refer to the following:

Dr. 201 for circular concrete.
Dr. 202 for low clearance concrete.
Dr. 203 for circular metal.
Dr. 205 for circular concrete with end wall.
Dr. 206 for low clearance concrete with end wall.

Skew angle is the angle which one end of the pipe is ahead (by stationing) of line perpendicular to the R. (Example: skew Rt. ahead 30 degrees).
REINFORCED CONCRETE PIPE CULVERT

1. Refer to the following:
   - DR-201 for circular concrete
   - DR-202 for low clearance concrete
   - DR-203 for circular metal
   - DR-205 for circular concrete with end wall
   - DR-206 for low clearance concrete with end wall

2. See DR-142.

Possible Tabulation:
104-3

\[ \theta \] is the dimension to \( \theta \) of Tee from outlet end of pipe. Either one or two Tees are required as specified.

\[ \theta \] is the angle which one end of the pipe is ahead (by stationing) of a line perpendicular to the \( \theta \).

(Example: skew Rt. ahead 30 degrees).

\( \theta \) is \( \theta \) of roadway, dike, survey, or other as detailed on the plans.

Skew angle is the angle which one end of the pipe is ahead (by stationing) of a line perpendicular to the \( \theta \).

\[ \theta \] is the dimension to \( \theta \) of Tee from outlet end of pipe. Either one or two Tees are required as specified.

\[ \theta \] is \( \theta \) of roadway, dike, survey, or other as detailed on the plans.

Skew angle is the angle which one end of the pipe is ahead (by stationing) of a line perpendicular to the \( \theta \).

(Example: skew Rt. ahead 30 degrees).

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(Example: skew Rt. ahead 30 degrees).

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Skew angle is the angle which one end of the pipe is ahead (by stationing) of a line perpendicular to the \( \theta \).

(Example: skew Rt. ahead 30 degrees).

\[ \theta \] is the dimension to \( \theta \) of Tee from outlet end of pipe. Either one or two Tees are required as specified.
**APRON**

LT. or RT.  

LOCATION (Other F.L.)

**SECTION**

L E N T H

Inlet F.L.

Dike or Roadway

Outlet

**PLAN**

Outlet F.L.

**DIAGRAM**

is from bend to end of outlet.

Possible Tabulation:

104-3

**BEND**

is from bend to end of outlet.

**NOTE:**

1. Refer to the following:
   - DR-201 for circular concrete.
   - DR-202 for low clearance concrete.
   - DR-203 for circular metal.
   - DR-205 for circular concrete with end wall.
   - DR-206 for low clearance concrete with end wall.

2. Bend may be accomplished by use of metal elbow, Pipe Adapter (DR-122), Type "U" Section, or Concrete Elbow (DR-141) as specified.

**REVISIONS:**

- Modified note 1 to include references to additional apron types.
Earth Dike

Apron

Flow Line

Tee

Pipe Cap

**PLAN**

**SECTION A-A**

Note: This is a control of roadway, dike, survey, or other as detailed on the plans.

Use when specified. This type of inlet assembly may be substituted for the inlet apron shown on drawings of standard type drainage structures.

1. Refer to the following:
   - DR-201 for circular concrete
   - DR-202 for low clearance concrete
   - DR-203 for circular metal
   - DR-205 for circular concrete with end wall
   - DR-206 for low clearance concrete with end wall

2. See DR-142

Possible Tabulation:
104-3

Refer to the following:
- DR-201 modified for inlet apron with end wall
- DR-205 for circular concrete with end wall
- DR-206 for low clearance concrete with end wall

Type drainage structures.

Replace inlet apron shown on drawings of standard plans.

Located of roadway, dike, survey, or other as detailed on the plans.

Used when specified. This type of inlet assembly may be substituted for the inlet apron shown on drawings of standard type drainage structures.

1. Refer to the following:
   - DR-201 for circular concrete
   - DR-202 for low clearance concrete
   - DR-203 for circular metal
   - DR-205 for circular concrete with end wall
   - DR-206 for low clearance concrete with end wall

2. See DR-142

Possible Tabulation:
104-3

Refer to the following:
- DR-201 modified for inlet apron with end wall
- DR-205 for circular concrete with end wall
- DR-206 for low clearance concrete with end wall

Type drainage structures.

Replace inlet apron shown on drawings of standard plans.

Located of roadway, dike, survey, or other as detailed on the plans.

Used when specified. This type of inlet assembly may be substituted for the inlet apron shown on drawings of standard type drainage structures.

1. Refer to the following:
   - DR-201 for circular concrete
   - DR-202 for low clearance concrete
   - DR-203 for circular metal
   - DR-205 for circular concrete with end wall
   - DR-206 for low clearance concrete with end wall

2. See DR-142

Possible Tabulation:
104-3

Refer to the following:
- DR-201 modified for inlet apron with end wall
- DR-205 for circular concrete with end wall
- DR-206 for low clearance concrete with end wall

Type drainage structures.

Replace inlet apron shown on drawings of standard plans.
Refer to the following:
DR-201 for circular concrete.
DR-202 for low clearance concrete.
DR-205 for circular concrete with end wall.
DR-206 for low clearance concrete with end wall.

Type "D" Section with single bevel. See Standard Road Plan DR-141 for details.

Possible Tabulation:
104-3
1. Refer to the following:
   - DR-201 for circular concrete.
   - DR-202 for low clearance concrete.
   - DR-203 for circular metal.
   - DR-205 for circular concrete with end wall.
   - DR-206 for low clearance concrete with end wall.

2. Optional Type "D" section only when specified in tabulation:

3. Existing structure.

Possible Tabulation:
104-3
**PLAN**

```
Dike or Roadway
F.L. Other
F.L. Other
F.L. Other
F.L. Other
A + B = Length

Existing
Skew
C
L
C
L
A head
L T.
Structure
Lt. Skew
Extension
Skew
Apron
Rt. Skew
Extension
Skew
C
L
Bend
L
C
Structure
```

**SECTION**

Possible Tabulation:
104-3

---

**INFO**

Extend in the direction specified with skew measured from centerline of existing structure.

1. Refer to the following:
   - DR-201 for circular concrete.
   - DR-202 for low clearance concrete.
   - DR-203 for circular metal.
   - DR-205 for circular concrete with end wall.
   - DR-206 for low clearance concrete with end wall.

2. Existing structure.

3. Dimension Rt. or Lt. is measured at C of pipe along laying length.

4. Bend may be accomplished by use of metal elbow, Adapter (DR-122), Type "D" Section, or Concrete Elbow (DR-141) as specified.

---

**DESIGNER INFO**

Possible Tabulation:
104-3

---

**STANDARD ROAD PLAN**

DR-622

**REVISIONS:**
- Added Designer Info button.
- Revised for low clearance concrete with end wall.
Possible Tabulation:
104-3

Extend on line of existing structure to Lt., Rt., or both as specified. Adaptors may be required, see DR-122.

Refer to the following:
- DR-201 for circular concrete.
- DR-202 for low clearance concrete.
- DR-203 for circular metal.
- DR-204 for arch metal.
- DR-205 for circular concrete with end wall.
- DR-206 for low clearance concrete with end wall.

Optional Type "D" section only when specified in tabulation.

Existing structure.

See DR-122.
Extend on line of existing structure to Lt., Rt. or both as specified. Adapters may be required, see DR-122.

Optional Type "D" section or elbow for vertical drop only when specified in tabulation.

1. Refer to the following and specify if inlet or outlet:
   DR-201 for circular concrete.
   DR-202 for low clearance concrete.
   DR-203 for circular concrete with end wall.
   DR-204 for low clearance concrete with end wall.

2. Existing structure.

3. If less than 12 inch cover over pipe in median, install median pipe and dike.

Possible Tabulation:

DR-122 Adaptor
Extend in the direction specified with skew measured from centerline of existing structure. Dimension Rt. or Lt. is measured at E of pipe along laying length.

1. Refer to the following and specify if inlet or outlet:
   - DR-201 for circular concrete.
   - DR-202 for low clearance concrete.
   - DR-205 for circular concrete with end wall.
   - DR-206 for low clearance concrete with end wall.

2. Existing structure.

3. If less than 12 inch cover over pipe in median, install median pipe and dike.

4. Bend may be accomplished by use of Adaptor (DR-122), Type "C" Section, or Concrete Elbow (DR-141) as specified.

Possible Tabulation:

104-3
Extend in the direction specified with skew measured from centerline of existing structure. Dimension Rt. or Lt. is measured at C of pipe along laying length.

1. Refer to the following and specify if inlet or outlet:
   - DR-201 for circular concrete.
   - DR-202 for low clearance concrete.
   - DR-205 for circular concrete with end wall.
   - DR-206 for low clearance concrete with end wall.

2. Existing structure.
3. If less than 12 inch cover over pipe in median, install median pipe and dike.
4. Bend may be accomplished by use of Adaptor (DR-122), Type "D" Section, or Concrete Elbow (DR-141) as specified.

$A + B + C = \text{Extension Length}$

Possible Tabulation:

- DR-122 Adaptor
- DR-141
- DR-122
- DR-201
- DR-202
- DR-205
- DR-206
- DR-141

Refer to the following and specify if inlet or outlet:

- DR-201 for circular concrete.
- DR-202 for low clearance concrete.
- DR-205 for circular concrete with end wall.
- DR-206 for low clearance concrete with end wall.

Existing structure.

If less than 12 inch cover over pipe in median, install median pipe and dike.

Bend may be accomplished by use of Adaptor (DR-122), Type "D" Section, or Concrete Elbow (DR-141) as specified.

$A + B + C = \text{Extension Length}$

Possible Tabulation:

- DR-122 Adaptor
- DR-141
- DR-122
- DR-201
- DR-202
- DR-205
- DR-206
- DR-141

Refer to the following and specify if inlet or outlet:

- DR-201 for circular concrete.
- DR-202 for low clearance concrete.
- DR-205 for circular concrete with end wall.
- DR-206 for low clearance concrete with end wall.

Existing structure.

If less than 12 inch cover over pipe in median, install median pipe and dike.

Bend may be accomplished by use of Adaptor (DR-122), Type "D" Section, or Concrete Elbow (DR-141) as specified.
Concrete Pipe Length = A + M + L (L is Optional)

Corr. Pipe Length = B + C + E

If bend is required, extend in the direction specified with skew measured from centerline of existing structure. Dimension Rt. or Lt. is measured at E of pipe along laying length.

1. Refer to the following:
   - DR-201 for circular concrete.
   - DR-202 for low clearance concrete.
   - DR-205 for circular concrete with end wall.
   - DR-206 for low clearance concrete with end wall.
2. Existing structure.
3. If less than 12 inch cover over pipe in median, install median pipe and dike.
4. Optional Type "D" Section only when specified in the tabulation.
5. Install C-3 adapter beyond proposed shoulder line. Flowline approximately 6 feet below shoulder elevation.
6. Bend may be accomplished by use of Type "D" Section or Concrete Elbow (DR-141) as specified.
7. Refer to the following:
   - DR-203 for the circular metal.
   - DR-204 for arch metal.
Standard type joint couplings are required. See Materials I.M. 441.

1) Refer to the following:
   DR-203 for the circular metal.
   DR-204 for arch metal.

2) See DR-631. If more than one diaphragm is specified, install 15 feet apart or as specified.

Possible Tabulation:
104-3

REVISION
04-18-17
SHEET 1 of 1

CORRUGATED PIPE CULVERT
LETDOWN STRUCTURE
WITH SINGLE ELBOW
Standard type joint couplings are required. See Materials I.M. 441.

Connection to outlet, if required, is incidental and will not be paid for separately.

1. Refer to the following:
   DR-203 for the circular metal.
   DR-204 for arch metal.

2. See DR-601, if more than one diaphragm is specified, install 15 feet apart or as specified.

Possible Tabulations:
104-3

Materials: I.M. 441, DR-501

Corrugated Pipe Culvert
Letdown Structure
With Double Elbow

A+B+C = Pipe Length

SECTION

PLAN

Apron
Corrugated Pipe
Apron
Type "A" Diaphragm
Skew angle is the angle which one end of the pipe is ahead (by stationing) of a line perpendicular to the \( \theta \).

(Example: Skew Rt. ahead 30 degrees)

Standard type joint couplings are required. See Materials I.M. 441.

1. Refer to the following:
   - DR-201 for circular concrete
   - DR-202 for low clearance concrete
   - DR-205 for circular concrete with end wall
   - DR-206 for low clearance concrete with end wall

2. Refer to the following:
   - DR-203 for the circular metal
   - DR-204 for arch metal.

3. See DR-121

4. See DR-122

5. Optional "D" section only when specified in the tabulation. Refer to DR-141

Possible Tabulation:

<table>
<thead>
<tr>
<th>DR-204</th>
<th>DR-203</th>
<th>DR-206</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR-201</td>
<td>DR-121</td>
<td>DR-122</td>
</tr>
<tr>
<td>DR-141</td>
<td>DR-121</td>
<td>DR-122</td>
</tr>
</tbody>
</table>

Standard type joint couplings are required. See I.M. 441.

(Example: Skew Rt. ahead 30 degrees)

Revised: Modified details on the Plan view.

APPROVED BY DESIGN METHODS ENGINEER
Possible Tabulation:
104-3

Refer to the following:
- DR-201 for circular concrete.
- DR-202 for low clearance concrete.
- DR-203 for circular metal.
- DR-204 for arch metal (metal pipe only).
- DR-205 for circular concrete with end wall.
- DR-206 for low clearance concrete with end wall.

Possible alignment if Type "D" Section or angle Tee is used.

Type "A" Diaphragm when specified, see DR-601.

Outlet structure.

Type "D" Section or angle Tee when specified.

Connection to outlet, if required, is incidental and will not be paid for separately.

 appropriation.

APRON PIPE TEE INLET
Skew angle is the angle which one end of the pipe is ahead (by stationing) of line perpendicular to the B.

Refer to the following:
- DR-201 for circular concrete.
- DR-202 for low clearance concrete.
- DR-203 for circular metal.
- DR-204 for arch metal (metal pipe only).
- DR-205 for circular concrete with end wall.
- DR-206 for low clearance concrete with end wall.

Possible Tabulation:
104-3
Plan

UNCLASSIFIED LETDOWN STRUCTURE SINGLE ELBOW

SECTION

UNCLASSIFIED LETDOWN STRUCTURE SINGLE ELBOW

PLAN

\( B \) is of roadway, dike, survey, or other as detailed on the plans.

Skew angle is the angle which one end of the pipe is ahead (by stationing) of a line perpendicular to the \( B \).

(Example: skew Rt. ahead 30 degrees)

Standard type joint couplings are required. See Materials I.M. 441.

When the concrete option is used, use connected joints (DR-121) for the outer three joints.

1. Refer to the following:
   - DR-201 for circular concrete.
   - DR-202 for low clearance concrete.
   - DR-203 for circular metal.
   - DR-204 for arch metal (metal pipe only).
   - DR-205 for circular concrete with end wall.
   - DR-206 for low clearance concrete with end wall.

2. Type "A" Diaphragm, see DR-601. If more than one diaphragm is specified, install them 15 feet apart or as specified.

3. Bend may be accomplished by use of metal elbow, Pipe Adapter (DR-122), Type "D" Section, or Concrete Elbow (DR-141) as specified. Bend is considered incidental to the Length of pipe.

Possible Tabulation:

| 104-3 |

REVISIONS:

Modified note 1 to include references to additional apron types.

APPROVED BY DESIGN METHODS ENGINEER
\( B \) is \( \frac{1}{3} \) of roadway, dike, survey, or other as detailed on the plans.

Skew angle is the angle which one end of the pipe is ahead (by stationing) of a line perpendicular to the \( B \).

(Example: skew Rt. ahead 30 degrees)

Standard type joint couplings are required. See Materials I.M. 441.

Refer to the following:
- DR-201 for circular concrete.
- DR-202 for low clearance concrete.
- DR-203 for circular metal.
- DR-204 for arch metal (metal pipe only).
- DR-205 for circular concrete with end wall.
- DR-206 for low clearance concrete with end wall.

Optional "D" Section only when specified in tabulation.

See DR-121

See DR-122

Possible Tabulation: 104-3