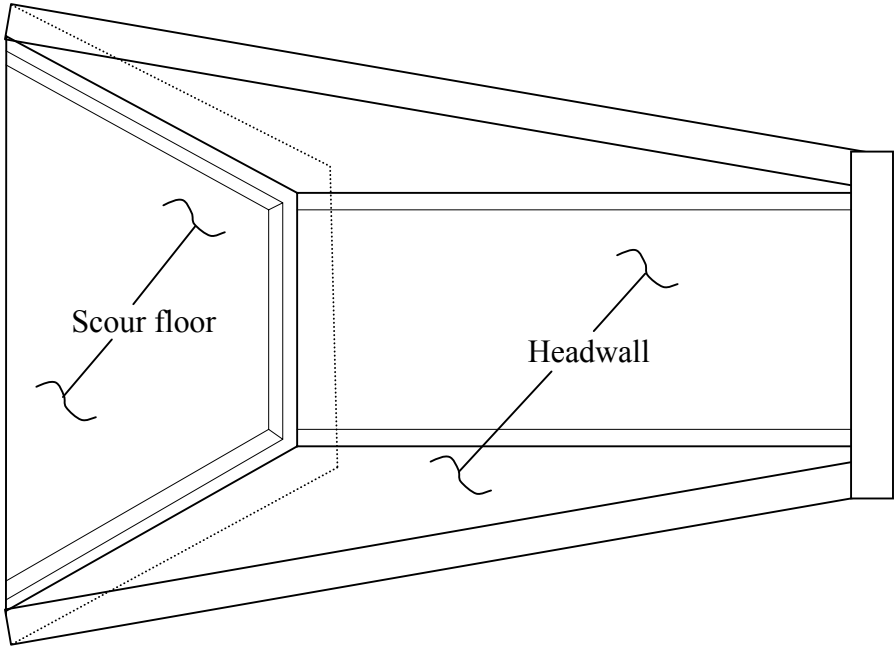
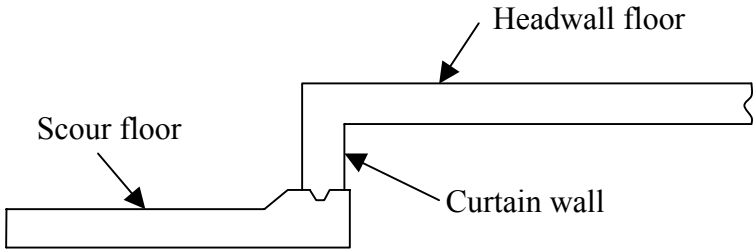


# Typical RCB Scour Floor



Plan view



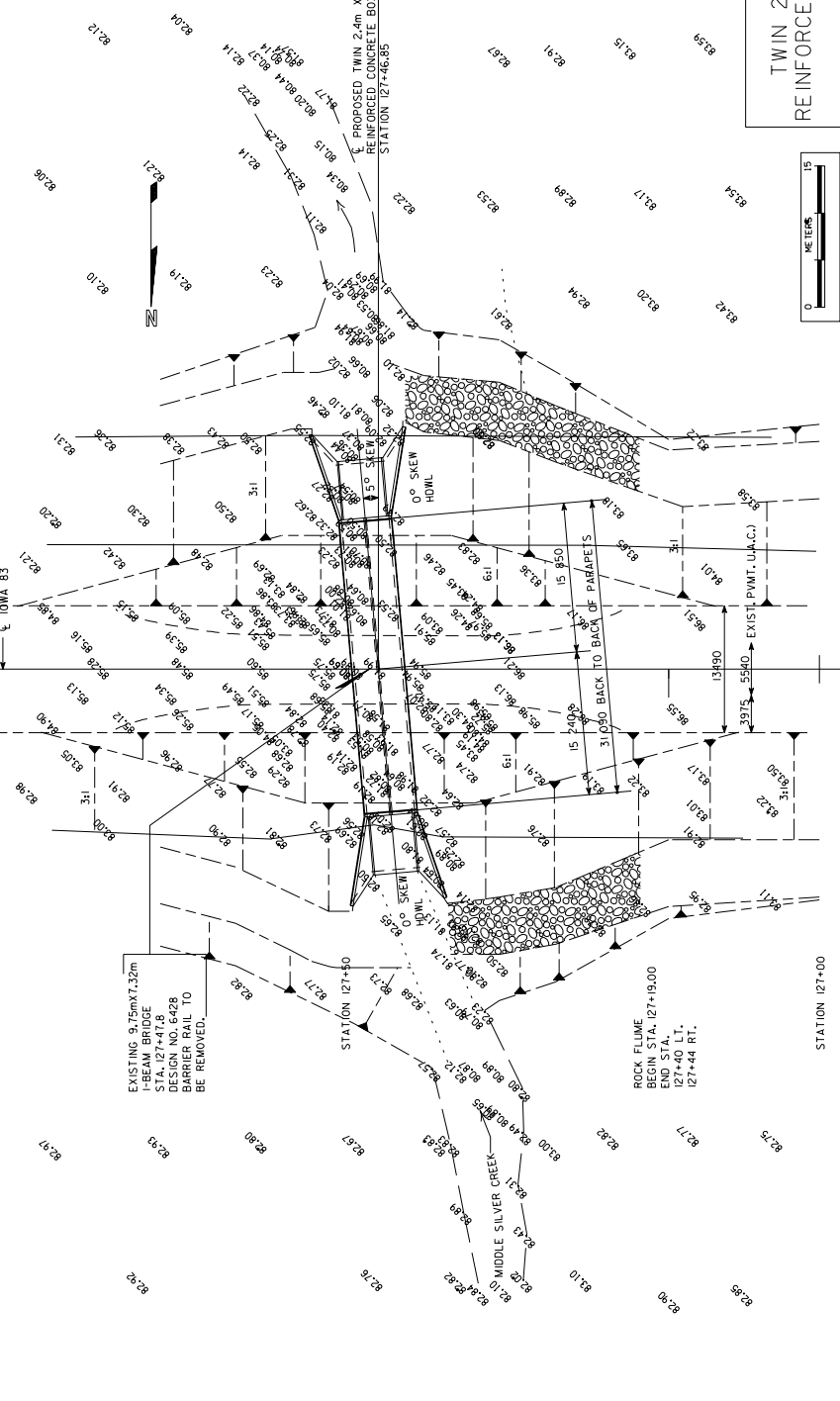
Section through scour floor

BM NO. 513 STA. 127+49.735, 4.071 RT FD "X" TOP SO. INDRAIL CENTER BRIDGE ELEV. 386.84

392 m	GR. ELEV. = 395.85
389 m	
386 m	FL. ELEV. = 380.36
383 m	DESIGN H.W. = 383.84
380 m	EXISTING GROUND
377 m	

LONGITUDINAL SECTION ALONG  $\phi$  CULVERT

ANTICIPATED SETTLEMENT =



PROPOSED GRADE  
ON IA 83  
(U.A.C.)

HYDRAULIC DATA  
DRAINAGE AREA = 573.9 Hg H  
DESIGN CSD = 44.04 CUS  
DESIGN HIGH WATER ELEV. = 383.84

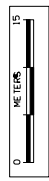
ALL UNITS ARE IN mm UNLESS  
OTHERWISE NOTED.  
DETAILS FOR THE ROCK FLUME SHOWN  
ELSEWHERE IN THE PLANS.

TRAFFIC ESTIMATE  
A.D.T. = 525 VPD (2001)  
A.D.T. = 2021 VPD (2021)  
152 TRUCKS

LOCATION  
1483 OVER BRANCH OF MIDDLE SILVER CREEK  
SECTION 7 & 8  
PLEASANT TOWNSHIP  
POTTAWATTAMIE COUNTY  
BRIDGE MAINT. NO. 7807.05083

PRELIMINARY

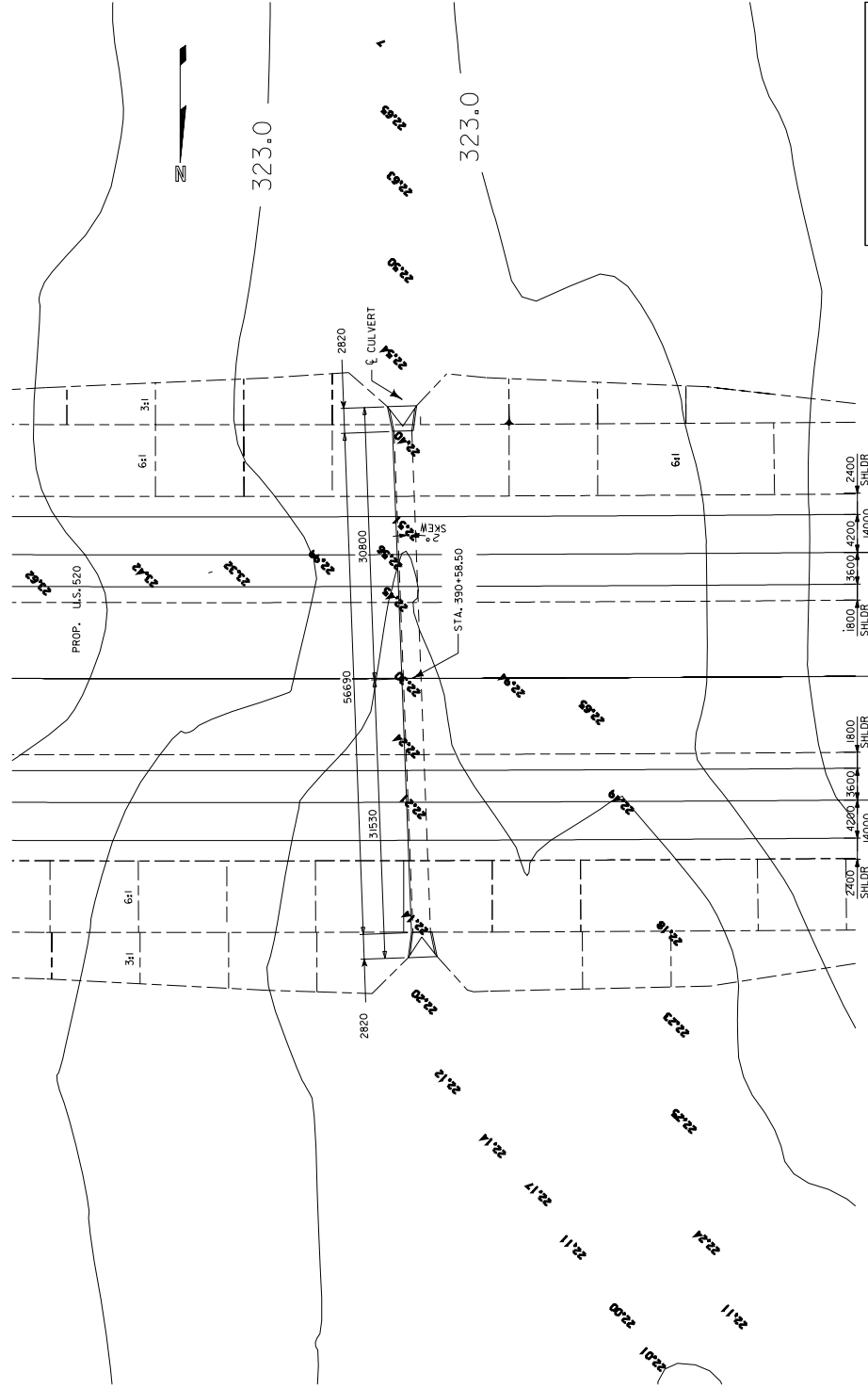
DESIGN FOR 5° SKEW (R.A.)  
TWIN 2.4m X 3.0m X 3.109m  
REINFORCED CONCRETE BOX CULVERT  
SITUATION PLAN  
STATION: 127+46.85  
POTTAWATTAMIE COUNTY  
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION  
DESIGN SHEET NO. 29412 OF FILE NO. 29412 DESIGN NO. 100



SITUATION PLAN

330 m	EBL	P.G. ELEV. = 326.021	330 m
327 m	P.G. ELEV. = 326.032		327 m
324 m	F.L. ELEV. = 322.50		324 m
321 m			321 m
318 m			318 m
315 m			315 m

LONGITUDINAL SECTION ALONG CENTERLINE PIPE



LOCATION  
 T. 88N. R. 19W  
 SECTION 10  
 CLAY TOWNSHIP  
 HARDIN COUNTY

PRELIMINARY  
 DESIGN FOR 2% SKEW (R.A.)

REINFORCED CONCRETE PIPE  
 PLAT PLAN  
 STATION: 390+58.50  
 HARDIN COUNTY  
 IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION  
 DESIGN SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_ FILE NO. \_\_\_\_\_ SHEET NUMBER



PLAT PLAN

## Checklist for Situation Plans for Box Culverts

### General

- \_\_\_\_\_ Benchmark description
- \_\_\_\_\_ Vertical curve data
- \_\_\_\_\_ Horizontal curve data
- \_\_\_\_\_ Traffic estimate
- \_\_\_\_\_ Hydraulic data table including Drainage Area,  $Q_{50}$  cfs (cms), and Design High Water Elevation. For Large Culverts (20 ft. (6.1 m) span or longer structures) also include  $Q_{100}$  cfs (cms) and  $Q_{500}$  cfs (cms) or Roadway Overtopping Q.
- \_\_\_\_\_ Location table
- \_\_\_\_\_ Size in Title Block
- \_\_\_\_\_ Skew angle of actual design shown in Title Block
- \_\_\_\_\_ Project number, file number, design number, CADD file name
- \_\_\_\_\_ Scale bar (shown on the preliminary Situation Plan but will be removed in Final Design during the development of the final Situation Plan).
- \_\_\_\_\_ North arrow
- \_\_\_\_\_ Staging details
- \_\_\_\_\_ DNR or 404 Permit numbers
- \_\_\_\_\_ Engineering certification notes and signature for structures needing DNR Flood Plain Permit
- \_\_\_\_\_ Note: “All units are in XXX unless otherwise noted.”

### Plan View

- \_\_\_\_\_ Label “Situation Plan”
- \_\_\_\_\_ Ground elevations, contours, and topography. Label contour elevations.
- \_\_\_\_\_ Existing utilities, fencelines, tiles, etc.
- \_\_\_\_\_ Existing structures, including description and design number, if known
- \_\_\_\_\_ Proposed length (back-to-back of parapet)
- \_\_\_\_\_ Proposed station on road construction centerline
- \_\_\_\_\_ Skew angle of culvert to road
- \_\_\_\_\_ Skew of headwalls, if different than skew to road
- \_\_\_\_\_ Proposed lane and shoulder widths
- \_\_\_\_\_ Proposed embankment and ditch shaping
- \_\_\_\_\_ Label all centerlines
- \_\_\_\_\_ Label stationing on at least two “tic” marks in the plan view
- \_\_\_\_\_ Future proposed work by others (e.g., bike trail, ramp, etc.)
- \_\_\_\_\_ Stream name and direction of flow
- \_\_\_\_\_ Location and designation of soil test holes
- \_\_\_\_\_ Check that all text and dimensioning is legible and not placed on top of other text or features such as riprap details or contour lines
- \_\_\_\_\_ Label type, location and limits of features such as riprap and channel changes. Provide typical cross section.

### **Longitudinal Section**

- \_\_\_\_\_ Roadway section drawn perpendicular to road
- \_\_\_\_\_ Projection is along centerline of culvert (therefore, true length not shown for skewed culverts)
- \_\_\_\_\_ Existing ground line and proposed grade line shown and labeled
- \_\_\_\_\_ Existing structure
- \_\_\_\_\_ Proposed flowlines at inlet, outlet, or other features (slope taper, drop inlet, flume, etc.)
- \_\_\_\_\_ Profile grade elevation at intersection of culvert and road centerline
- \_\_\_\_\_ Berm slope labeled (e.g., 6:1, 3:1)
- \_\_\_\_\_ Design highwater elevation

## Checklist for Plat Plans for Pipe Culverts

### General

- \_\_\_\_\_ Material, type and size in Title Block
- \_\_\_\_\_ Project number, CADD file name
- \_\_\_\_\_ North arrow
- \_\_\_\_\_ Staging details

### Plan View

- \_\_\_\_\_ Label "Plat Plan"
- \_\_\_\_\_ Ground elevations, contours, and topography. Label contour elevations.
- \_\_\_\_\_ Existing utilities, fencelines, tiles, etc.
- \_\_\_\_\_ Existing structures, including description and design number, if known
- \_\_\_\_\_ Proposed length, including dimensions needed for Typical, e.g., lengths left and right, total length, dimensions A, B, C, etc.
- \_\_\_\_\_ Proposed station on road construction centerline
- \_\_\_\_\_ Skew angle of culvert to road
- \_\_\_\_\_ Skew angle of extension to existing pipe, if other than 0 degrees
- \_\_\_\_\_ Proposed lane and shoulder widths
- \_\_\_\_\_ Proposed embankment and ditch shaping, including ditching inlet or outlet
- \_\_\_\_\_ Label all centerlines
- \_\_\_\_\_ Label stationing on at least two "tic" marks in the plan view
- \_\_\_\_\_ Future proposed work by others (e.g., bike trail, ramp, etc.)
- \_\_\_\_\_ Check that all text and dimensioning is legible and not placed on top of other text or features such as contour lines

### Longitudinal Section

- \_\_\_\_\_ Roadway section drawn perpendicular to road
- \_\_\_\_\_ Projection is along centerline of culvert (therefore, true length not shown for skewed culverts)
- \_\_\_\_\_ Existing ground line and proposed grade line shown and labeled
- \_\_\_\_\_ Existing structure
- \_\_\_\_\_ Proposed flowlines at inlet, outlet, or other breaks as needed for Typical
- \_\_\_\_\_ Label degree of elbows
- \_\_\_\_\_ Profile grade elevation at intersection of culvert and road centerline
- \_\_\_\_\_ Berm slope labeled (e.g., 6:1, 3:1)

## Determining Culvert Lengths

### Required Length

The required length of a culvert is generally determined by one of two methods:

1. by the clear zone; or,
2. by fitting the culvert to the typical cross section, such as the barnroof.

Both methods must be checked and then compared; the **greater** of the two distances is the required culvert length.

The first method uses Table 3.1 from AASHTO's Roadside Design Guide, which gives a range of minimum clear zone distances which are acceptable for safety. This clear zone is measured from the edge of the driving lane to the back of the RCB parapet or the top opening of the pipe apron. (Note that the clear zone is measured from the edge of the driving lane [typically 3.6 m or 12 ft], not from the edge of any additional pavement that will be used as part of the shoulder.) Only in rare circumstances shall any replacement or extended culvert be shorter than required by Table 3.1. (One exception is the inlet end of a median drain with an apron guard.)

The second method computes the culvert length by fitting the culvert to the roadway barnroof section. In other words, the computed length is determined by intersecting the barnroof with the back of the RCB parapet or the top opening of the pipe apron. See "Determining Culvert Lengths Using the Computations Section on Pink Sheets" in this appendix for this method. This is the primary purpose of the Computations Section on the pink sheets.

To repeat the statement above, the **greater** of the two distances from these methods is the required culvert length.

### Computations Section on Pink Sheet

The Computations section on the pink sheet should be used to determine the lengths of pipe and box culverts. The terms from the pink sheet are defined below to aid in the calculation of lengths based on the typical cross section (e.g., barnroof section) for a given project. The calculated length must be compared to the minimum length required by clear zone criteria. The greater of the two lengths will govern. See comments on line 12.

1. **Profile Grade** - Grade at a pre-determined station. Taken from the Road Plan and Profile sheet. If the structure is skewed, the Grade Rt and Lt could vary. Use the grade at the station where the parapet or top of pipe opening is perpendicular to road centerline.
2. **Vertical Drop (Subgrade or Hinge Point)** - Vertical distance down from Profile Grade to Subgrade Point to Hinge Point. For any given project, the Vertical Drop generally stays constant except in areas with superelevations. See the following drawing that depicts the Vertical Drop and the Working Point Elevation.
3. **Working Point Elevation** - Line 1 minus Line 2.  
Either the subgrade elevation or the hinge point elevation is used as the Working Point Elevation. See the typical grading section below. Which point to use in the computation of

culvert length depends on the elevation of the top of the culvert. If the top of the pipe opening (or RCB parapet) is above the hinge point elevation, then the subgrade is used as the working point. If the top of the pipe opening (or RCB parapet) is below the hinge point elevation, then the hinge point is used as the working point.

### Subgrade Elevation

Profile grade elevation

-Pavement and subbase thickness

-Subgrade cross slope times distance (typically  $1\% \times A$ )

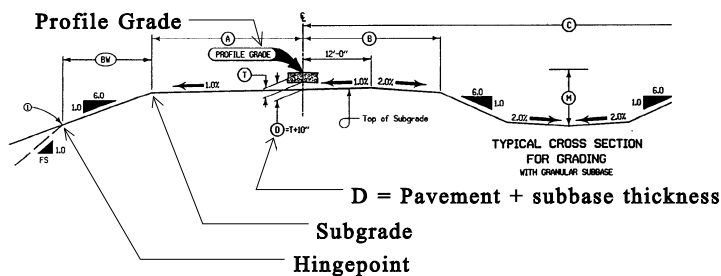
= Subgrade elevation

### Hinge point Elevation

Subgrade elevation

-BW (6:1 slope)

= Hinge point elevation



4. **Flowline** - This is the actual proposed culvert flowline elevation, not the ground elevation.
5. **Difference** - Line 3 minus line 4 = vertical difference between the Working Point Elevation and the culvert Flowline Elevation.
6. **(D+T) or (H+Hdwl)**  
 $D + T$  (for pipes only) = Diameter of pipe + the thickness of pipe (see RF-1).  
 $H + HDWL$  (for RCBs only) = Nominal height of the box (e.g., 2400 mm) + the height of parapet (600 mm) and frost trough (100mm).
7. **Difference** - Height Difference (line 5) minus  $D+T$  or  $H+HDWL$  (line 6). Gives the actual vertical distance between the top of structure to soil at the working point (hinge point or subgrade).
8. **Slope** - Embankment Slope from the working point (subgrade or hinge point) to the top of pipe opening or parapet. The slope is generally 6:1 when using the subgrade as the working point or 3:1 when using the hinge point.

9. **Working Point (Subgrade or Hinge Point) to End of Foreslope** - Line 7 multiplied by line 8 = the horizontal distance from the working point to the top of the pipe opening (or the RCB parapet).

1. **Distance = Centerline to Working Point** - On 2-lane roadways, this is the horizontal distance from the centerline of roadway (or survey centerline) to the working point (Subgrade or Hingepoint) used in calculating Vertical Drop on Line 2

On 4-lane roadways, this is the horizontal distance from the construction centerline (typically the median) to the working point (Subgrade or Hingepoint).

11. **(1.5:1) or (Dimen. B) for pipes only** - Line 9 determines the culvert length only to the top of the pipe, so the distance from the top of the pipe to the end of the apron must be accounted for. For 1200mm or smaller pipes, use the “B” dimension of the pipe (see Road Standards); for 1350mm or greater pipes, use 1.5 x D. For box culverts, Line 11 is zero.

12. **Length** - This is the total calculated length of the culvert from the roadway centerline to either the end of the pipe or the back of RCB parapet. This is the sum of lines 9, 10 and 11. Then compare this calculated length to the minimum length to be sure it meets the minimum clear distance as follows:

For RCBs, minimum length = Lane width + Clear zone

For pipes, minimum length = Lane width + Clear zone + Apron >B= dimension

Select the greater of calculated length or minimum length.

13. **Secant of Skew Angle** - If structure is skewed, list the secant of the angle the structure is to centerline of roadway.

14. **Length on Skew** - Line 12 times line 13 gives the actual length along the centerline of the culvert.

15. **Add for Hdwl Skew** - The length (line 12 or 14) of the structure is calculated along the centerline of the culvert. However, if the parapet of the headwall is not parallel to the roadway (e.g., a 0 degree skewed headwall with a 10 degree skewed barrel), then one corner of the headwall will fall closer to the roadway than the centerline of the culvert. This corner must be extended to equal the length that was calculated on the centerline (line 12 or 14). This situation will also pertain to all pipes; a length must be added to get the end of the apron beyond this point.

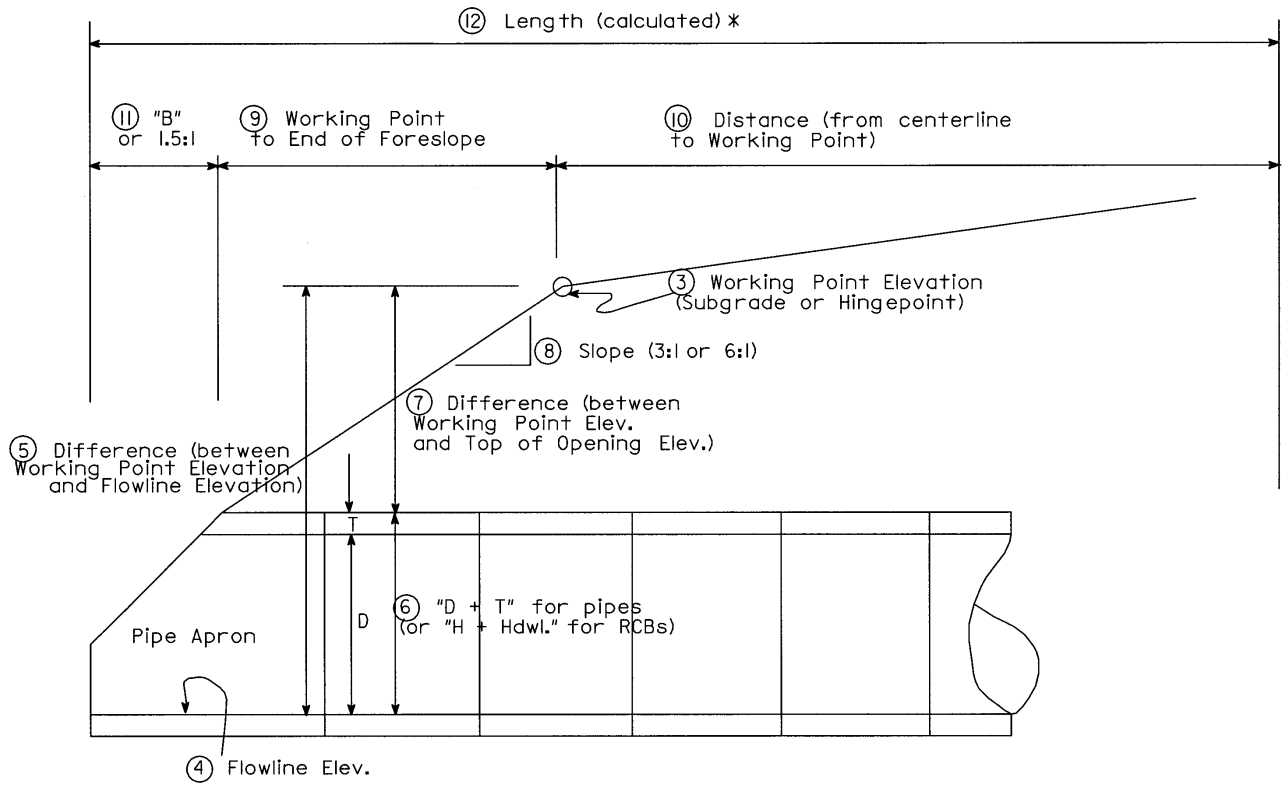
16. **Length** - Add “Length on Skew” (line 14) and “Add for Hdwl Skew” (line 15).

17. **Length Present Structure** - If designing an extension, determine the length of the existing structure from the road centerline to the front (not the back) of the RCB parapet

or to the first pipe barrel section.

18. **Extension** - Length (line 16) minus Length Present Structure (line 17). This gives the extension length needed.

# Pink Sheet----Computations Section



\* Compare calculated length to the "clear zone" minimum length. Use the greater length.

# Sample Pink Sheet

Form 621001  
3-93



**Iowa Department of Transportation**  
Highway Division  
Bridge Survey Record  
**FIELD NOTES FOR CULVERTS**

Township 72N Range 11W Section 25 Civil Township Locust Grove  
 Station Present Structure or Stream                      Station Proposed Culvert 344 + 70  
 Drainage Area in Acres 6 El. Hi. Water                      Character Water Shed R  
 Upstream Land Use Cult. Anticipate Any Change? No  
 Bench Mark No.                       
 Type and Elev. of Low Upstream Buildings                       
**Present Structure:** Type None Design No.                      Br. Rdwy.                       
 Spans                      Ht.                      Length: B. to B. Pts.                      Pipe                      Flume                       
 Elevation: Grade                      Inlet                      Outlet                      Flume Outlet                       
 Condition                      Skew Angle                       
**Proposed Culvert:** Type 1501, RF-1 & CMP Fin. Rdwy. Width (Sh-Sh) 40'  
 Spans 24" Ht.                      Length New Constr: CMP 82' RF-1 60' + 1-RF-3 Aprons Flume 1-RF-5  
 Elevation: Grade 731.20 F.L. Lt. 701.0 F.L. Rt. 725.4 F.L. Other 721.5, 702.1  
 Ext. Lt.                      Rt.                      Total Length Lt. 126' Rt. 46' Skew Angle 0 (Lt.) (Rt.) Ahead  
                     Contr. Dike                      Sta.                      El.                      Type Road Contr. Ditch outlet  
 Design Q 18 C.F.S. Frequency 50 Yr. Design High Water Elev. 728.1 Depth 2.7 Ft.  
 Design Fill Height 5 Ft. Pipe Class 2000 D. Class Bedding C ADT =                      VPD  
 Disposition of Present Structure                       
 Remarks A = 76', B = 60', C = 2', E = 20', Q = 6.5'  
Two -16° CMP elbows, One RF-2 Type C-3 adapter

**Computations**

	Left	Right
① Profile Grade Elev.	<u>731.20</u>	<u>731.20</u>
② Vert. Drop {Subgrade or Hinge Point}	<u>- 4.7</u>	<u>- 1.9</u>
③ Working Point Elev.	<u>= 726.50</u>	<u>= 729.3</u>
④ Flow Line	<u>- 701.0</u>	<u>- 725.4</u>
⑤ Difference	<u>= 25.50</u>	<u>= 3.9</u>
⑥ (D + "T") or (H + Hdwl.)	<u>- 2.3</u>	<u>- 2.3</u>
⑦ Difference	<u>= 23.2</u>	<u>= 1.6</u>
⑧ Slope (6:1, 3:1 etc.)	<u>× 3</u>	<u>× 6</u>
⑨ Working Point to End of Foreslope	<u>69.6</u>	<u>9.6</u>
⑩ Dist. = t to Working Point	<u>+ 48.0</u>	<u>+ 28.0</u>
⑪ (1½:1) or (Dimen. "B")	<u>+ 3.6</u>	<u>+ 3.6</u>
⑫ Length, Calc. or Min (12+30+3.6)	<u>121.2</u>	<u>41.2 (45.6 min.)</u>
⑬ Secant of Skew Angle	<u>×</u>	<u>×</u>
⑭ Length on skew	<u>                    </u>	<u>                    </u>
⑮ Add for hdwl. skew	<u>+</u>	<u>+</u>
⑯ Length	<u>                    </u>	<u>                    </u>
⑰ Length pres. struct.	<u>-</u>	<u>-</u>
⑱ Extension	<u>                    </u>	<u>                    </u>

# Sample Pink Sheet

Form 621001  
3-93



**Iowa Department of Transportation**  
Highway Division  
Bridge Survey Record  
**FIELD NOTES FOR CULVERTS**

Ramp "D"

Township 72N Range 11W Section 29 Civil Township Locust Grove  
 Station Present Structure or Stream — Station Proposed Culvert 4527+56.00  
 Drainage Area in Acres 14 El. Hi. Water — Character Water Shed F  
 Upstream Land Use Cultivated Anticipate Any Change? No  
 Bench Mark No. —  
 Type and Elev. of Low Upstream Buildings —  
**Present Structure:** Type None Design No. — Br. Rdwy. —  
 Spans — Ht. — Length: B. to B. Ppts. — Pipe — Flume —  
 Elevation: Grade — Inlet — Outlet — Flume Outlet —  
 Condition — Skew Angle —  
**Proposed Culvert:** Type 1201 RF-1 Fin. Rdwy. Width (Sh-Sh) 26'  
 Spans 24'0" Ht. — Length New Constr: RCB — Pipe 94' + 2 Aprons Flume —  
 Elevation: Profile Grade 756.45 F.L. Lt. 748.4 F.L. Rt. 740.8 F.L. Other 741.1  
 Ext. Lt. — Rt. — Total Length Lt. 50' Rt. 56' Skew Angle 20° (L) (Rt.) Ahead  
Road Contr. Dike Lt. Sta. 4527+70 El. 751.3 Type M Contr. Ditch —  
 Design Q 23 C.F.S. Frequency 50 Yr. Design High Water Elev. 751.8 Depth 3.4 Ft.  
 Design Fill Height 7 Ft. Pipe Class 2000 D. Class Bedding C ADT = — VPD —  
 Disposition of Present Structure —  
 Remarks F = 30' , 5° bend (RF-13)

### Computations

Left		Right	
① Profile Grade Elev.	4527+40 = 756.64	Profile Grade Elev.	4527+65 = 756.31
② Vert. Drop (Subgrade or Hinge Point)	- 5.0	Vert. Drop (Subgrade or Hinge Point)	- 5.0
③ Working Point Elev.	= 751.64	Working Point Elev.	= 751.31
④ Flow Line	- 748.4	Flow Line	- 740.8
⑤ Difference	= 3.24	Difference	= 10.51
⑥ (D + "T") or (H + Hdwl.)	- 2.3	(D + "T") or (H + Hdwl.)	- 2.3
⑦ Difference	= 0.94	Difference	= 8.21
⑧ Slope (6:1, 3:1 etc.)	× 3	Slope (6:1, 3:1 etc.)	× 3
⑨ Working Point to End of Foreslope	2.8	Working Point to End of Foreslope	24.6
⑩ Dist. = t to Working Point	+ 40.0	Dist. = t to Working Point	+ 24.0
⑪ (1½:1) or (Dimen. "B")	+ 3.6	(1½:1) or (Dimen. "B")	+ 3.6
⑫ Length, Calc. or Min ( $\frac{16+20+3.6}{2}$ )	46.4	Length, Calc. or Min ( $\frac{20+3.6}{2}$ )	52.2
⑬ Secant of Skew Angle 20°	× 1.06	Secant of Skew Angle 20°	× 1.06
⑭ Length on skew	49.4	Length on skew	55.3
⑮ Add for hdwl. skew	+ -	Add for hdwl. skew	+ -
⑯ Length Use →	50'	Length Use →	56'
⑰ Length pres. struct.	- -	Length pres. struct.	- -
⑱ Extension	- -	Extension	- -

## **Guidelines for Using the 1000-Series Drainage Structure Typical in Office of Design's Details Manual (Green Book)**

The following remarks should be considered when designing pipe culverts. Pay careful attention to the graphics and notes listed in the 1000-Series of the Green Book. A common mistake made when designing culverts is not listing all dimensions in the Remarks space on pink sheets. Also, needed items such as the angle of bends or RF-14 connected pipe joints are often forgotten and not placed in Remarks. These items plus many others on the pink sheet are necessary to properly complete the culvert tabulations in the road plans. Discussion is also provided for Typical 4304 and 4311 for foreslope shaping at culverts.

### **Type 1101**

This is used primarily for concrete pipes under pavements. See 1601 for Unclassified pipes under unpaved sideroads and entrances.

Note that "Lt." and "Rt." are to end of apron. "Length" of pipe section is Lt. + Rt. minus apron lengths.

May be used without aprons (e.g., temporary pipes).

Must specify material such as concrete, CMP, or PEP.

If RF-1 (concrete) is used, RF-14 type 3 connected pipe joints must be specified in Remarks.

If RF-1, use 2000D (100D) as a minimum under paved roads.

### **Type 1102**

Tee pipes are generally not recommended except in a side ditch outside the clear zone.

Same comments as for type 1101.

Specify  $G_1$  dimension and indicate size of tee. See RF-21 for description of tee. Must note tee in the Remarks space of pink sheet. Also, tabulate  $G_1$  in Remarks space.

Type 1504 is similar except it has a half-round flume.

See also type 1202.

### **Type 1201**

Normally used with concrete pipe. See type 1401 for a similar culvert as a sideditch letdown and type 1602 for an unpaved road.

May be used as a cross road pipe if the slope of an 1101 would be steeper than approximately 5%. If the fall across the roadway is greater than approximately 8 feet (2.4 m), or if the fill above the bend is greater than approximately 10 feet (3.0 m), consider using type 1501 for ease of construction.

Gradient of pipe beyond bend should be less than 1%.

Needs RF-14 connected pipe joints (type 3).

Specify length "F" and desired bend type and bend angle in Remarks space.

See "special note" on standard RF-13, especially on large pipe.

Use an elbow if the bend is more than 10 degrees. Tabulate bend in Remarks.

### **Type 1202**

Generally used in conjunction with types 1102 or 1504.

To be used as the inlet to a crossroad pipe when all the flow is coming down a steep sideditch (slope greater than approximately 4%). This inlet will prevent the sideditch water from bypassing the inlet and overtopping the adjacent ditch block and will allow the sideditch water to "turn the corner" within the pipe.

Tabulate pipe cap, if needed (RF-21) in Remarks.

### **Type 1301**

Commonly used to extend existing structures.

Length Rt. & Lt. is measured to end of apron.

Length of pipe = A + B, **not** Lt. + Rt.

Tabulate A and B in Remarks space.

When extending a pipe with a pipe, if the slope of extension is different from the slope of existing pipe, RF-2 type C-1 connection will be required. Tabulate RF-2 connection in Remarks space.

### **Type 1302**

Commonly used to extend existing structures.

Skew angle of extension is different than skew of pipe. The extension skew is referenced to the existing pipe, not the centerline of road, e.g., bend is 15 degree Rt., not 15 degree Rt. ahead.

Note on the pink whether skew is the pipe skew or the extension skew.

If the extensions on both ends of an existing structure are skewed, note in Remarks how much each extension is skewed, e.g., "Right end or outlet is 15 degree Rt., Left end or inlet is 20 degree Rt."

May need RF-2 type C-1 connection if the slope of the pipe extension is different the existing pipe.

Need to tabulate RF-14 pipe joint connections for RF-1 extensions.

Use an elbow if the bend is more than 10 degrees. Tabulate bend in Remarks.

### **Type 1303, 1304**

These Typicals may be used for extensions if the slope of a straight extension would be greater than approximately 5%.

Tabulate A, B, C, D, and E and degree of elbow in Remarks.

The flowline of the elbow should be at or slightly above natural ground elevation.

The flowline of half-round pipes should be approximately 3 to 5 feet (1.0 to 1.5) m below natural ground at its terminus. This allows a natural scour hole to develop.

See type 1302 for skew note.

RF-14 type 3 pipe connectors must be noted in Remarks.

The diameter of a half-round is limited to 42 inches (1050 mm).

Maximum "B" = 24 feet (7.3 m). Lengths greater than this tend to settle, resulting in separated joints.

Using Type 1305 is often a good alternative to 1303 and 1304.

### **Type 1305**

Commonly used for extensions.

Designer must select either CMP or PEP for the outlet portion of the pipe.

Tabulate A, B, C, D, E, elbows, and RF-2 adapter in Remarks.

Minimum "C" = 2 feet (0.6 m).

The connection between the concrete and corrugated pipes should extend beyond proposed shoulder line. The flowline at this point should be approximately 6 feet (2 m) below shoulder elevation.

Specify elbows to nearest degree.

Length "B" portion should be approximately parallel to foreslope.

The minimum earth cover is shown as 2 feet (0.6 m). The desirable cover is equal to the diameter of the pipe, e.g., a 42-inch pipe should have approximately 42 inches of cover. This helps resist uplift forces.

Outlet aprons are not always necessary if the outlet draw is steep. Aprons may separate from the pipe if a scour hole develops.

### **Type 1401 & 1403**

Should be used for a side ditch letdown. See types 1201, 1501 and 1503 for paved roadways and type 1602 for unpaved roadways.

Note that the Location point is at the inlet of the pipe, not at the centerline of dike or roadway.

Dike (see standard RL-4) over letdown should be Type F, with a 20 foot (6 m) top width for structures 48 inches (1200 mm) and larger.

Maximum size is 60 inches (1500 mm) to prevent uplift of the CMP inlet. For larger culverts consider using concrete pipe or box culverts.

Outlet aprons are optional if outlet is next to RCB.

Tabulate elbows, diaphragms, A, B, & C in Remarks.

Dimension elbows to the nearest degree.

Length "B" portion should be approximately parallel to the fill slope over pipe on type 1403.

Minimum cover over length "C" is 1 foot (0.3 m). The minimum earth cover over length "B" is shown as 2 feet (0.6 m). The desirable cover over "B" is equal to the diameter of the pipe, e.g., a 42-inch pipe should have approximately 42 inches of cover. This helps resist uplift forces.

### **Type 1407**

May be used when inlet elevation must be lowered due to limited available earth cover.

Maximum height of the wall is dimension "A" on the RF-3 standard for aprons.

Tabulate in the Remarks space the number and size of planks required.

### **Type 1501 and 1503**

See comments for 1305

For type 1501, designer must select either CMP or PEP for the outlet portion of the pipe.

On pink sheet: Tabulate concrete pipe in the space (Pipe \_\_\_\_\_ + \_\_\_\_\_ Aprons). Tabulate CMP or PEP in the space (Flume \_\_\_\_\_), but revise this space as (CMP/PEP \_\_\_\_\_ + \_\_\_\_\_ Apron) or (Half-round Flume \_\_\_\_\_).

The flowline of half-round pipes should be approximately 3 feet (1 m) below natural ground at its terminus. This allows a natural scour hole to develop.  
RF-14 type 3 pipe connectors must be noted in Remarks.

#### **Type 1502**

Note that the location point is at the inlet. This culvert is generally used in a side ditch. If CMP is used, need type "A" diaphragm.  
Outlet structure not required.

#### **Type 1504**

Type 1102 is similar except it does not have a half-round flume.  
Teed pipes are generally not recommended except in a side ditch outside the clear zone.

#### **Type 1601**

Unclassified pipes are used under unpaved sideroads and entrances. See type 1101 for paved roadways.  
Note that the length Lt. & Rt. is to end of the pipe section, not to the end of the aprons.

#### **Type 1602**

Use when a bend under an unpaved road is needed. See type 1201 for a similar culvert under paved roadways and 1401 for sideditch letdowns.

Unclassified pipes are used under unpaved sideroads and entrances.

Tabulate bend in the Remarks space.

Type "A" diaphragms are not required when type 1602 is used under a roadway since "piping" is much less likely due to the length of pipe under fill and possible better compaction of bedding and backfill.

#### **Typical 4304 and 4311**

Typical 4304 should be used for all culverts where the calculation point is between the subgrade and the hinge point. Typical 4311 is used only when the calculation point is below the hinge point and when the culvert project is the only work being done, i.e., the existing foreslope will be changed only in the vicinity of the culvert. 4311 (and dimension W) should be specified in the Remarks column on the pink sheet. Typically, W may be given as three times the culvert width.