



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 550+27 RT TO 550+82 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 810.03      **Outlet Invert Elevation (ft.) :** 809.84      **Tailwater Elevation (ft.) :** 810.28      **Overflow Elevation (ft.) :** 812.45  
**Allowable Headwater Elevation (ft.) :** 811.45      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 55.00      **Culvert Slope (ft./ft.) :** 0.0035      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 1.50      @ 10 yrs.      **Flood Discharge (cfs) :** 1.80      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
1.50	1	12 in.	810.78	810.79	1 - A	3.65	0.59	0.52	0.0120	OUTLET*	0.00	D	0.00
1.50	1	15 in.	810.71	810.73	1 - A	3.41	0.52	0.49	0.0120	OUTLET*	0.00	D + 1	0.00
1.80	1	12 in.	810.86	810.88	1 - A	3.88	0.67	0.57	0.0120	OUTLET*	0.00	F	0.00
1.80	1	15 in.	810.78	810.80	1 - A	3.61	0.58	0.53	0.0120	OUTLET*	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
1.50	1	12 in.	810.80	811.02	1 - A	3.65	0.91	0.52	0.0251	OUTLET*	0.00	D	0.00
1.50	1	15 in.	810.73	810.89	1 - A	3.41	0.81	0.49	0.0250	OUTLET*	0.00	D + 1	0.00
1.80	1	12 in.	810.90	811.30	2 - F	3.88	1.00	0.57	0.0251	OUTLET**	0.00	F	0.00
1.80	1	15 in.	810.81	810.99	1 - A	3.61	0.94	0.53	0.0250	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
Diameter exceeds 1.25 HWA	1.50	1	36 in.	810.56	810.65	1 - A	2.33	0.58	0.38	0.0281	OUTLET*	0.00	D	0.00
	1.50	1	42 in.	810.57	810.62	1 - A	2.14	0.55	0.36	0.0278	OUTLET*	0.00	D + 1	0.00
	1.80	1	36 in.	810.60	810.71	1 - A	2.80	0.64	0.42	0.0281	OUTLET*	0.00	F	0.00
	1.80	1	42 in.	810.61	810.68	1 - A	2.57	0.61	0.40	0.0278	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	0.75	2	36 in.	810.46	810.51	1 - B	1.17	0.42	0.27	0.0281	OUTLET*	0.00	D	0.00
	0.75	2	42 in.	810.49	810.51	1 - B	1.07	0.40	0.26	0.0278	OUTLET*	0.00	D + 1	0.00
	0.90	2	36 in.	810.48	810.53	1 - A	1.40	0.45	0.29	0.0281	OUTLET*	0.00	F	0.00
	0.90	2	42 in.	810.51	810.52	1 - B	1.29	0.43	0.28	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	1.50	1	60 in.	810.67	810.59	1 - C	1.29	0.55	0.33	0.0332	INLET	0.00	D	0.00
	1.50	1	66 in.	810.71	810.58	1 - C	1.28	0.53	0.32	0.0330	INLET	0.00	D + 1	0.00
	1.80	1	60 in.	810.69	810.64	1 - C	1.36	0.60	0.36	0.0332	INLET	0.00	F	0.00
	1.80	1	66 in.	810.72	810.63	1 - C	1.35	0.58	0.36	0.0330	INLET	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	0.75	2	60 in.	810.62	810.50	1 - C	1.05	0.39	0.23	0.0332	INLET	0.00	D	0.00
	0.75	2	66 in.	810.66	810.48	1 - C	1.04	0.38	0.23	0.0330	INLET	0.00	D + 1	0.00
	0.90	2	60 in.	810.63	810.50	1 - C	1.11	0.43	0.26	0.0332	INLET	0.00	F	0.00
	0.90	2	66 in.	810.67	810.50	1 - C	1.10	0.42	0.25	0.0330	INLET	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	1.50	1	60 in.	810.67	810.55	1 - C	1.53	0.49	0.33	0.0260	INLET	0.00	D	0.00
	1.50	1	66 in.	810.71	810.55	1 - C	1.51	0.47	0.32	0.0260	INLET	0.00	D + 1	0.00
	1.80	1	60 in.	810.69	810.61	1 - C	1.62	0.53	0.36	0.0260	INLET	0.00	F	0.00
	1.80	1	66 in.	810.72	810.59	1 - C	1.60	0.52	0.36	0.0260	INLET	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	0.75	2	60 in.	810.62	810.46	1 - C	1.24	0.35	0.23	0.0260	INLET	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
0.75	2	66 in.	810.66	810.46	1 - C	1.22	0.34	0.23	0.0260	INLET	0.00	D + 1	0.00
0.90	2	60 in.	810.63	810.50	1 - C	1.31	0.38	0.26	0.0260	INLET	0.00	F	0.00
0.90	2	66 in.	810.67	810.49	1 - C	1.30	0.37	0.25	0.0260	INLET	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 550+89 LT TO 551+48 LT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 809.81      **Outlet Invert Elevation (ft.) :** 809.60      **Tailwater Elevation (ft.) :** 810.58      **Overflow Elevation (ft.) :** 812.25  
**Allowable Headwater Elevation (ft.) :** 811.25      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 59.00      **Culvert Slope (ft./ft.) :** 0.0036      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 7.50      @ 10 yrs.      **Flood Discharge (cfs) :** 9.10      @ 25 yrs.

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)	
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>					<b>Entrance Loss (Ke) : 0.20</b>							
Diameter exceeds 1.25 HWA	7.50	1	24 in.	811.20	811.23	1 - A	4.90	1.01	0.97	0.0120	OUTLET*	0.00	D	0.00	
	7.50	1	21 in.	811.28	811.31	1 - A	5.19	1.11	1.01	0.0120	OUTLET*	0.00	D - 1	0.00	
	7.50	1	18 in.	811.42	811.48	1 - A	5.61	1.37	1.06	0.0120	OUTLET*	0.00	D - 2	0.00	
	7.50	1	27 in.	811.13	811.17	1 - B	4.51	0.95	0.94	0.0120	OUTLET*	0.00	D + 1	0.00	
	9.10	1	24 in.	811.36	811.40	1 - A	5.28	1.14	1.08	0.0120	OUTLET*	0.00	F	0.00	
	9.10	1	21 in.	811.46	811.51	1 - A	5.59	1.28	1.12	0.0120	OUTLET*	0.00	F - 1	0.00	
	9.10	1	18 in.	811.68	811.80	2 - F	6.17	1.50	1.17	0.0120	OUTLET**	0.00	F - 2	0.00	
	9.10	1	27 in.	811.29	811.32	1 - A	5.07	1.06	1.04	0.0120	OUTLET*	0.00	F + 1	0.00	
	3.75	2	15 in.	810.96	811.04	1 - B	3.63	0.93	0.78	0.0120	OUTLET*	0.00	D	0.00	
	3.75	2	12 in.	811.21	811.56	2 - F	4.80	1.00	0.83	0.0120	OUTLET	0.00	D - 1	0.00	
	3.75	2	18 in.	810.87	810.91	1 - B	3.07	0.80	0.74	0.0120	OUTLET*	0.00	D + 1	0.00	



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)	
4.55	2	15 in.	811.11	811.18	1 - A	4.41	1.14	0.86	0.0120	OUTLET*	0.00	F	0.00	
4.55	2	12 in.	811.55	812.02	2 - F	5.82	1.00	0.89	0.0120	OUTLET	0.00	F - 1	0.00	
4.55	2	18 in.	810.99	811.04	1 - B	3.72	0.90	0.82	0.0120	OUTLET*	0.00	F + 1	0.00	
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>				<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	7.50	1	36 in.	811.01	811.23	1 - A	3.74	1.22	0.86	0.0241	OUTLET*	0.00	D	0.00
	7.50	1	33 in.	811.06	811.27	1 - A	3.95	1.28	0.88	0.0241	OUTLET*	0.00	D - 1	0.00
	7.50	1	30 in.	811.12	811.33	1 - A	4.20	1.36	0.91	0.0244	OUTLET*	0.00	D - 2	0.00
	7.50	1	42 in.	810.93	811.14	1 - A	3.40	1.14	0.82	0.0237	OUTLET*	0.00	D + 1	0.00
	9.10	1	36 in.	811.16	811.38	1 - A	4.54	1.36	0.95	0.0241	OUTLET*	0.00	F	0.00
	9.10	1	33 in.	811.21	811.43	1 - A	4.79	1.43	0.98	0.0241	OUTLET*	0.00	F - 1	0.00
	9.10	1	30 in.	811.27	811.50	1 - A	4.93	1.54	1.01	0.0244	OUTLET*	0.00	F - 2	0.00
	9.10	1	42 in.	811.06	811.29	1 - A	4.13	1.26	0.91	0.0237	OUTLET*	0.00	F + 1	0.00
	3.75	2	18 in.	810.90	811.17	1 - A	3.07	1.37	0.74	0.0249	OUTLET*	0.00	D	0.00
	3.75	2	15 in.	811.04	811.62	2 - F	3.63	1.25	0.78	0.0250	OUTLET**	0.00	D - 1	0.00
	2.75	2	12 in.	811.58	813.68	2 - F	3.52	1.00	0.71	0.0251	OUTLET	1.00	D - 2	0.00
	3.75	2	21 in.	810.83	811.05	1 - A	2.71	1.14	0.71	0.0248	OUTLET*	0.00	D + 1	0.00
	4.55	2	18 in.	811.04	811.34	1 - A	3.72	1.37	0.82	0.0249	OUTLET*	0.00	F	0.00
	4.55	2	15 in.	811.26	812.14	2 - F	4.41	1.25	0.86	0.0250	OUTLET**	0.00	F - 1	0.00
	2.75	2	12 in.	812.12	815.14	2 - F	3.52	1.00	0.71	0.0251	OUTLET	1.80	F - 2	0.00
	4.55	2	21 in.	810.95	811.19	1 - A	3.28	1.32	0.78	0.0248	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	7.50	1	42 in.	810.93	811.18	1 - A	3.40	1.23	0.82	0.0278	OUTLET*	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	7.50	1	36 in.	811.01	811.26	1 - A	3.74	1.33	0.86	0.0281	OUTLET*	0.00	D - 1	0.00
	7.50	1	48 in.	810.88	811.12	1 - A	3.14	1.17	0.80	0.0275	OUTLET*	0.00	D + 1	0.00
	9.10	1	42 in.	811.06	811.32	1 - A	4.13	1.37	0.91	0.0278	OUTLET*	0.00	F	0.00
	9.10	1	36 in.	811.16	811.42	1 - A	4.54	1.49	0.95	0.0281	OUTLET*	0.00	F - 1	0.00
	9.10	1	48 in.	810.99	811.25	1 - A	3.81	1.29	0.88	0.0275	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	3.75	2	36 in.	810.62	810.89	1 - B	1.87	0.92	0.60	0.0281	OUTLET*	0.00	D	0.00
	3.75	2	42 in.	810.59	810.83	1 - B	1.70	0.86	0.58	0.0278	OUTLET*	0.00	D + 1	0.00
	4.55	2	36 in.	810.71	810.94	1 - A	2.27	1.02	0.67	0.0281	OUTLET*	0.00	F	0.00
	4.55	2	42 in.	810.66	810.92	1 - B	2.06	0.95	0.64	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	7.50	1	60 in.	810.82	811.08	1 - A	2.76	1.19	0.75	0.0332	OUTLET*	0.00	D	0.00
	7.50	1	66 in.	810.82	811.05	1 - A	2.62	1.14	0.73	0.0330	OUTLET*	0.00	D + 1	0.00
	9.10	1	60 in.	810.92	811.20	1 - A	3.35	1.31	0.83	0.0332	OUTLET*	0.00	F	0.00
	9.10	1	66 in.	810.90	811.16	1 - A	3.18	1.26	0.80	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	3.75	2	60 in.	810.59	810.79	1 - B	1.38	0.84	0.53	0.0332	OUTLET*	0.00	D	0.00
	3.75	2	66 in.	810.61	810.77	1 - B	1.31	0.82	0.51	0.0330	OUTLET*	0.00	D + 1	0.00
	4.55	2	60 in.	810.64	810.87	1 - B	1.68	0.92	0.58	0.0332	OUTLET*	0.00	F	0.00
	4.55	2	66 in.	810.66	810.84	1 - B	1.59	0.90	0.57	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	7.50	1	60 in.	810.82	811.01	1 - A	2.76	1.05	0.75	0.0260	OUTLET*	0.00	D	0.00
	7.50	1	66 in.	810.82	810.98	1 - A	2.62	1.02	0.73	0.0260	OUTLET*	0.00	D + 1	0.00
	9.10	1	60 in.	810.92	811.14	1 - A	3.35	1.16	0.83	0.0260	OUTLET*	0.00	F	0.00
	9.10	1	66 in.	810.90	811.10	1 - A	3.18	1.12	0.80	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
Diameter exceeds 1.25 HWA	3.75	2	60 in.	810.59	810.75	1 - B	1.38	0.75	0.53	0.0260	OUTLET*	0.00	D	0.00
	3.75	2	66 in.	810.61	810.73	1 - B	1.31	0.73	0.51	0.0260	OUTLET*	0.00	D + 1	0.00
	4.55	2	60 in.	810.64	810.81	1 - B	1.68	0.82	0.58	0.0260	OUTLET*	0.00	F	0.00
	4.55	2	66 in.	810.66	810.79	1 - B	1.59	0.80	0.57	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 554+00 RT TO 554+40 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 808.72      **Outlet Invert Elevation (ft.) :** 808.58      **Tailwater Elevation (ft.) :** 809.81      **Overflow Elevation (ft.) :** 812.16  
**Allowable Headwater Elevation (ft.) :** 811.16      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 40.00      **Culvert Slope (ft./ft.) :** 0.0035      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 12.40      @ 10 yrs.      **Flood Discharge (cfs) :** 15.10      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
12.40	1	21 in.	810.77	810.82	2 - F	6.41	1.75	1.31	0.0120	OUTLET*	0.00	D	0.00
12.40	1	18 in.	811.29	811.38	2 - F	7.49	1.50	1.33	0.0120	OUTLET**	0.00	D - 1	0.00
10.70	1	15 in.	812.71	812.97	2 - F	8.75	1.25	1.20	0.0120	OUTLET	1.70	D - 2	0.00
12.40	1	24 in.	810.58	810.63	1 - A	5.91	1.42	1.27	0.0120	OUTLET*	0.00	D + 1	0.00
15.10	1	21 in.	811.16	811.22	2 - F	7.14	1.75	1.44	0.0120	OUTLET**	0.00	F	0.00
15.10	1	18 in.	812.02	812.09	2 - F	8.77	1.50	1.41	0.0120	OUTLET**	0.00	F - 1	0.00
10.70	1	15 in.	814.20	814.50	2 - F	8.75	1.25	1.20	0.0120	OUTLET	4.40	F - 2	0.00
15.10	1	24 in.	810.83	810.89	1 - A	6.42	1.73	1.40	0.0120	OUTLET*	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
12.40	1	24 in.	810.72	811.04	1 - A	5.91	1.83	1.27	0.0247	OUTLET*	0.00	D	0.00





# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	12.40	1	21 in.	811.13	811.78	2 - F	6.41	1.75	1.31	0.0248	OUTLET**	0.00	D - 1	0.00
	9.90	1	18 in.	812.13	813.48	2 - F	6.38	1.50	1.21	0.0249	OUTLET**	2.50	D - 2	0.00
	12.40	1	27 in.	810.55	810.84	1 - A	5.58	2.05	1.22	0.0245	OUTLET*	0.00	D + 1	0.00
	15.10	1	24 in.	811.10	811.60	2 - F	6.42	2.00	1.40	0.0247	OUTLET**	0.00	F	0.00
	13.60	1	21 in.	811.78	812.65	2 - F	6.73	1.75	1.37	0.0248	OUTLET**	1.50	F - 1	0.00
	9.90	1	18 in.	813.24	815.20	2 - F	6.38	1.50	1.21	0.0249	OUTLET**	5.20	F - 2	0.00
	15.10	1	27 in.	810.81	811.11	1 - A	6.04	2.05	1.35	0.0245	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	12.40	1	36 in.	810.33	810.59	1 - A	4.54	1.81	1.12	0.0281	OUTLET*	0.00	D	0.00
	12.40	1	42 in.	810.22	810.48	1 - A	4.11	1.64	1.07	0.0278	OUTLET*	0.00	D + 1	0.00
	15.10	1	36 in.	810.52	810.80	1 - A	5.48	2.08	1.24	0.0281	OUTLET*	0.00	F	0.00
	15.10	1	42 in.	810.41	810.67	1 - A	5.00	1.84	1.18	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	12.40	1	60 in.	810.01	810.33	1 - A	3.30	1.54	0.97	0.0332	OUTLET*	0.00	D	0.00
	12.40	1	66 in.	809.98	810.29	1 - A	3.13	1.48	0.94	0.0330	OUTLET*	0.00	D + 1	0.00
	15.10	1	60 in.	810.16	810.48	1 - A	4.02	1.70	1.07	0.0332	OUTLET*	0.00	F	0.00
	15.10	1	66 in.	810.11	810.44	1 - A	3.81	1.64	1.04	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	6.20	2	60 in.	809.65	809.99	1 - B	1.65	1.08	0.68	0.0332	OUTLET*	0.00	D	0.00
	6.20	2	66 in.	809.66	809.97	1 - B	1.56	1.05	0.66	0.0330	OUTLET*	0.00	D + 1	0.00
	7.55	2	60 in.	809.74	810.07	1 - B	2.01	1.19	0.75	0.0332	OUTLET*	0.00	F	0.00
	7.55	2	66 in.	809.73	810.04	1 - B	1.90	1.15	0.73	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	12.40	1	60 in.	810.01	810.29	1 - A	3.30	1.36	0.97	0.0260	OUTLET*	0.00	D	0.00
	12.40	1	66 in.	809.98	810.24	1 - A	3.13	1.31	0.94	0.0260	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	15.10	1	60 in.	810.16	810.44	1 - A	4.02	1.50	1.07	0.0260	OUTLET*	0.00	F	0.00
	15.10	1	66 in.	810.11	810.40	1 - A	3.81	1.45	1.04	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	6.20	2	60 in.	809.65	809.96	1 - B	1.65	0.96	0.68	0.0260	OUTLET*	0.00	D	0.00
	6.20	2	66 in.	809.66	809.95	1 - B	1.56	0.93	0.66	0.0260	OUTLET*	0.00	D + 1	0.00
	7.55	2	60 in.	809.74	810.03	1 - B	2.01	1.06	0.75	0.0260	OUTLET*	0.00	F	0.00
	7.55	2	66 in.	809.73	810.01	1 - B	1.90	1.03	0.73	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 554+76 RT TO 555+08 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 808.46      **Outlet Invert Elevation (ft.) :** 808.35      **Tailwater Elevation (ft.) :** 809.67      **Overflow Elevation (ft.) :** 812.14  
**Allowable Headwater Elevation (ft.) :** 811.14      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 31.00      **Culvert Slope (ft./ft.) :** 0.0035      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 14.40      @ 10 yrs.      **Flood Discharge (cfs) :** 17.50      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
14.40	1	21 in.	810.79	810.81	2 - F	6.94	1.75	1.41	0.0120	OUTLET**	0.00	D	0.00
14.40	1	18 in.	811.56	811.53	2 - E	8.15	1.50	1.39	0.0120	INLET	0.00	D - 1	0.00
11.50	1	15 in.	813.52	813.54	2 - G	9.37	1.25	1.21	0.0120	OUTLET	2.90	D - 2	0.00
14.40	1	24 in.	810.51	810.57	1 - A	6.30	1.61	1.37	0.0120	OUTLET*	0.00	D + 1	0.00
17.50	1	21 in.	811.32	811.30	2 - E	7.28	1.75	1.53	0.0120	INLET	0.00	F	0.00
16.30	1	18 in.	812.52	812.38	2 - E	9.22	1.50	1.43	0.0120	INLET	1.20	F - 1	0.00
11.50	1	15 in.	815.83	815.39	2 - G	9.37	1.25	1.21	0.0120	OUTLET	6.00	F - 2	0.00
17.50	1	24 in.	810.82	810.87	2 - F	6.89	2.00	1.51	0.0120	OUTLET*	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
14.40	1	24 in.	810.73	811.10	2 - F	6.30	2.00	1.37	0.0247	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	14.40	1	21 in.	811.34	811.91	2 - F	6.94	1.75	1.41	0.0248	OUTLET**	0.00	D - 1	0.00
	11.00	1	18 in.	812.68	813.88	2 - F	6.68	1.50	1.27	0.0249	OUTLET**	3.40	D - 2	0.00
	14.40	1	27 in.	810.48	810.77	1 - A	5.94	2.05	1.32	0.0245	OUTLET*	0.00	D + 1	0.00
	17.50	1	24 in.	811.24	811.68	2 - F	6.89	2.00	1.51	0.0247	OUTLET**	0.00	F	0.00
	15.10	1	21 in.	812.21	812.92	2 - F	7.14	1.75	1.44	0.0248	OUTLET**	2.40	F - 1	0.00
	11.00	1	18 in.	814.07	815.85	2 - F	6.68	1.50	1.27	0.0249	OUTLET**	6.50	F - 2	0.00
	17.50	1	27 in.	810.80	811.10	1 - A	6.40	2.05	1.46	0.0245	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	14.40	1	36 in.	810.21	810.48	1 - A	4.81	2.00	1.21	0.0281	OUTLET*	0.00	D	0.00
	14.40	1	42 in.	810.10	810.36	1 - A	4.34	1.78	1.15	0.0278	OUTLET*	0.00	D + 1	0.00
	17.50	1	36 in.	810.42	810.71	1 - A	5.74	2.34	1.34	0.0281	OUTLET*	0.00	F	0.00
	17.50	1	42 in.	810.30	810.56	1 - A	5.27	2.00	1.28	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	14.40	1	60 in.	809.86	810.18	1 - A	3.47	1.66	1.04	0.0332	OUTLET*	0.00	D	0.00
	14.40	1	66 in.	809.82	810.14	1 - A	3.28	1.59	1.02	0.0330	OUTLET*	0.00	D + 1	0.00
	17.50	1	60 in.	810.02	810.35	1 - A	4.22	1.84	1.15	0.0332	OUTLET*	0.00	F	0.00
	17.50	1	66 in.	809.97	810.30	1 - A	3.99	1.76	1.12	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	7.20	2	60 in.	809.46	809.84	1 - B	1.74	1.16	0.73	0.0332	OUTLET*	0.00	D	0.00
	7.20	2	66 in.	809.45	809.82	1 - B	1.64	1.12	0.71	0.0330	OUTLET*	0.00	D + 1	0.00
	8.75	2	60 in.	809.55	809.92	1 - B	2.11	1.28	0.81	0.0332	OUTLET*	0.00	F	0.00
	8.75	2	66 in.	809.53	809.88	1 - B	2.00	1.24	0.79	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	14.40	1	60 in.	809.86	810.15	1 - A	3.47	1.46	1.04	0.0260	OUTLET*	0.00	D	0.00
	14.40	1	66 in.	809.82	810.11	1 - A	3.28	1.41	1.02	0.0260	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	17.50	1	60 in.	810.02	810.31	1 - A	4.22	1.61	1.15	0.0260	OUTLET*	0.00	F	0.00
	17.50	1	66 in.	809.97	810.26	1 - A	3.99	1.56	1.12	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	7.20	2	60 in.	809.46	809.82	1 - B	1.74	1.03	0.73	0.0260	OUTLET*	0.00	D	0.00
	7.20	2	66 in.	809.45	809.80	1 - B	1.64	1.00	0.71	0.0260	OUTLET*	0.00	D + 1	0.00
	8.75	2	60 in.	809.55	809.88	1 - B	2.11	1.13	0.81	0.0260	OUTLET*	0.00	F	0.00
	8.75	2	66 in.	809.53	809.86	1 - B	2.00	1.10	0.79	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 557+16 RT TO 557+49 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 807.62      **Outlet Invert Elevation (ft.) :** 807.50      **Tailwater Elevation (ft.) :** 808.85      **Overflow Elevation (ft.) :** 812.25  
**Allowable Headwater Elevation (ft.) :** 811.25      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 33.00      **Culvert Slope (ft./ft.) :** 0.0036      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 15.20      @ 10 yrs.      **Flood Discharge (cfs) :** 18.60      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
15.20	1	18 in.	810.95	810.92	2 - E	8.60	1.50	1.41	0.0120	INLET	0.00	D	0.00
13.30	1	15 in.	813.17	813.26	2 - G	10.84	1.25	1.23	0.0120	OUTLET	1.90	D - 1	0.00
8.00	1	12 in.	838.76	820.92	2 - G	10.19	1.00	0.99	0.0120	OUTLET	7.20	D - 2	0.00
15.20	1	21 in.	810.08	810.10	2 - F	7.16	1.75	1.44	0.0120	OUTLET**	0.00	D + 1	0.00
18.60	1	18 in.	812.06	811.92	2 - E	10.53	1.50	1.46	0.0120	INLET	0.00	F	0.00
13.30	1	15 in.	816.20	815.45	2 - G	10.84	1.25	1.23	0.0120	OUTLET	5.30	F - 1	0.00
8.00	1	12 in.	913.74	826.92	2 - G	10.19	1.00	0.99	0.0120	OUTLET	10.60	F - 2	0.00
18.60	1	21 in.	810.69	810.66	2 - E	7.73	1.75	1.56	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
15.20	1	24 in.	810.02	810.43	2 - F	6.44	2.00	1.41	0.0247	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	15.20	1	21 in.	810.71	811.37	2 - F	7.16	1.75	1.44	0.0248	OUTLET**	0.00	D - 1	0.00
	12.70	1	18 in.	812.19	813.66	2 - F	7.58	1.50	1.34	0.0249	OUTLET**	2.50	D - 2	0.00
	15.20	1	27 in.	809.72	810.02	1 - A	6.06	2.05	1.36	0.0245	OUTLET*	0.00	D + 1	0.00
	18.60	1	24 in.	810.61	811.11	2 - F	7.11	2.00	1.55	0.0247	OUTLET**	0.00	F	0.00
	17.70	1	21 in.	811.71	812.57	2 - F	7.91	1.75	1.54	0.0248	OUTLET**	0.90	F - 1	0.00
	12.70	1	18 in.	813.78	816.02	2 - F	7.58	1.50	1.34	0.0249	OUTLET**	5.90	F - 2	0.00
	18.60	1	27 in.	810.09	810.44	2 - F	6.57	2.25	1.51	0.0245	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	15.20	1	36 in.	809.43	809.70	1 - A	4.93	2.06	1.24	0.0281	OUTLET*	0.00	D	0.00
	15.20	1	42 in.	809.31	809.58	1 - A	4.44	1.82	1.19	0.0278	OUTLET*	0.00	D + 1	0.00
	18.60	1	36 in.	809.65	809.94	1 - A	5.85	2.46	1.38	0.0281	OUTLET*	0.00	F	0.00
	18.60	1	42 in.	809.52	809.79	1 - A	5.43	2.07	1.32	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	15.20	1	60 in.	809.06	809.39	1 - A	3.55	1.69	1.07	0.0332	OUTLET*	0.00	D	0.00
	15.20	1	66 in.	809.02	809.35	1 - A	3.36	1.63	1.04	0.0330	OUTLET*	0.00	D + 1	0.00
	18.60	1	60 in.	809.24	809.56	1 - A	4.35	1.89	1.19	0.0332	OUTLET*	0.00	F	0.00
	18.60	1	66 in.	809.18	809.51	1 - A	4.11	1.81	1.16	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	7.60	2	60 in.	808.64	809.03	1 - B	1.78	1.19	0.75	0.0332	OUTLET*	0.00	D	0.00
	7.60	2	66 in.	808.63	809.01	1 - B	1.68	1.15	0.73	0.0330	OUTLET*	0.00	D + 1	0.00
	9.30	2	60 in.	808.74	809.11	1 - B	2.17	1.31	0.83	0.0332	OUTLET*	0.00	F	0.00
	9.30	2	66 in.	808.72	809.08	1 - B	2.05	1.27	0.81	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	15.20	1	60 in.	809.06	809.36	1 - A	3.55	1.49	1.07	0.0260	OUTLET*	0.00	D	0.00
	15.20	1	66 in.	809.02	809.31	1 - A	3.36	1.44	1.04	0.0260	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	18.60	1	60 in.	809.24	809.53	1 - A	4.35	1.66	1.19	0.0260	OUTLET*	0.00	F	0.00
	18.60	1	66 in.	809.18	809.48	1 - A	4.11	1.60	1.16	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	7.60	2	60 in.	808.64	809.01	1 - B	1.78	1.05	0.75	0.0260	OUTLET*	0.00	D	0.00
	7.60	2	66 in.	808.63	808.99	1 - B	1.68	1.02	0.73	0.0260	OUTLET*	0.00	D + 1	0.00
	9.30	2	60 in.	808.74	809.07	1 - B	2.17	1.16	0.83	0.0260	OUTLET*	0.00	F	0.00
	9.30	2	66 in.	808.72	809.05	1 - B	2.05	1.13	0.81	0.0260	OUTLET*	0.00	F + 1	0.00





# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 561+12 RT TO 561+46 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 806.23      **Outlet Invert Elevation (ft.) :** 806.11      **Tailwater Elevation (ft.) :** 807.56      **Overflow Elevation (ft.) :** 810.82  
**Allowable Headwater Elevation (ft.) :** 809.82      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 34.00      **Culvert Slope (ft./ft.) :** 0.0035      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 17.80      @ 10 yrs.      **Flood Discharge (cfs) :** 21.70      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
17.80	1	21 in.	809.14	809.14	2 - E	7.40	1.75	1.54	0.0120	INLET	0.00	D	0.00
17.80	1	18 in.	810.39	810.30	2 - E	10.07	1.50	1.45	0.0120	INLET	0.00	D - 1	0.00
13.00	1	15 in.	813.90	813.67	2 - G	10.59	1.25	1.22	0.0120	OUTLET	4.80	D - 2	0.00
17.80	1	24 in.	808.63	808.67	2 - F	6.95	2.00	1.52	0.0120	OUTLET*	0.00	D + 1	0.00
21.70	1	21 in.	809.96	809.86	2 - E	9.02	1.75	1.63	0.0120	INLET	0.00	F	0.00
19.00	1	18 in.	811.86	811.64	2 - E	10.75	1.50	1.46	0.0120	INLET	2.70	F - 1	0.00
13.00	1	15 in.	820.60	816.64	2 - G	10.59	1.25	1.22	0.0120	OUTLET	8.70	F - 2	0.00
21.70	1	24 in.	809.10	809.10	2 - E	6.91	2.00	1.67	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
17.80	1	24 in.	809.07	809.57	2 - F	6.95	2.00	1.52	0.0247	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	17.50	1	21 in.	810.07	810.92	2 - F	7.85	1.75	1.53	0.0248	OUTLET**	0.30	D - 1	0.00
	12.50	1	18 in.	811.99	814.14	2 - F	7.15	1.50	1.33	0.0249	OUTLET	5.30	D - 2	0.00
	17.80	1	27 in.	808.61	808.96	2 - F	6.45	2.05	1.47	0.0245	OUTLET**	0.00	D + 1	0.00
	21.70	1	24 in.	809.87	810.47	2 - F	7.76	2.00	1.67	0.0247	OUTLET**	0.00	F	0.00
	17.50	1	21 in.	811.34	812.51	2 - F	7.85	1.75	1.53	0.0248	OUTLET**	4.20	F - 1	0.00
	12.50	1	18 in.	814.30	817.34	2 - F	7.15	1.50	1.33	0.0249	OUTLET	9.20	F - 2	0.00
	21.70	1	27 in.	809.10	809.52	2 - F	7.03	2.25	1.63	0.0245	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	17.80	1	36 in.	808.21	808.51	1 - A	5.26	2.38	1.35	0.0281	OUTLET*	0.00	D	0.00
	17.80	1	42 in.	808.08	808.36	1 - A	4.73	2.03	1.29	0.0278	OUTLET*	0.00	D + 1	0.00
	21.70	1	36 in.	808.44	808.79	1 - A	6.15	2.74	1.50	0.0281	OUTLET*	0.00	F	0.00
	21.70	1	42 in.	808.31	808.60	1 - A	5.76	2.32	1.43	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	17.80	1	60 in.	807.81	808.16	1 - A	3.77	1.86	1.16	0.0332	OUTLET*	0.00	D	0.00
	17.80	1	66 in.	807.75	808.10	1 - A	3.56	1.78	1.13	0.0330	OUTLET*	0.00	D + 1	0.00
	21.70	1	60 in.	808.00	808.34	1 - A	4.59	2.07	1.29	0.0332	OUTLET*	0.00	F	0.00
	21.70	1	66 in.	807.93	808.28	1 - A	4.34	1.98	1.25	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	8.90	2	60 in.	807.33	807.76	1 - B	1.88	1.29	0.82	0.0332	OUTLET*	0.00	D	0.00
	8.90	2	66 in.	807.31	807.73	1 - B	1.78	1.25	0.80	0.0330	OUTLET*	0.00	D + 1	0.00
	10.85	2	60 in.	807.44	807.84	1 - B	2.30	1.43	0.90	0.0332	OUTLET*	0.00	F	0.00
	10.85	2	66 in.	807.41	807.81	1 - B	2.17	1.38	0.88	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	17.80	1	60 in.	807.81	808.12	1 - A	3.77	1.63	1.16	0.0260	OUTLET*	0.00	D	0.00
	17.80	1	66 in.	807.75	808.07	1 - A	3.56	1.57	1.13	0.0260	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	21.70	1	60 in.	808.00	808.30	1 - A	4.59	1.81	1.29	0.0260	OUTLET*	0.00	F	0.00
	21.70	1	66 in.	807.93	808.24	1 - A	4.34	1.74	1.25	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	8.90	2	60 in.	807.33	807.73	1 - B	1.88	1.15	0.82	0.0260	OUTLET*	0.00	D	0.00
	8.90	2	66 in.	807.31	807.71	1 - B	1.78	1.11	0.80	0.0260	OUTLET*	0.00	D + 1	0.00
	10.85	2	60 in.	807.44	807.80	1 - B	2.30	1.27	0.90	0.0260	OUTLET*	0.00	F	0.00
	10.85	2	66 in.	807.41	807.78	1 - B	2.17	1.23	0.88	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 563+32 RT TO 563+77 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 805.46      **Outlet Invert Elevation (ft.) :** 805.30      **Tailwater Elevation (ft.) :** 806.82      **Overflow Elevation (ft.) :** 809.92  
**Allowable Headwater Elevation (ft.) :** 808.92      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 45.00      **Culvert Slope (ft./ft.) :** 0.0036      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 19.90      @ 10 yrs.      **Flood Discharge (cfs) :** 24.10      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
19.90	1	21 in.	808.80	808.85	2 - F	8.65	1.75	1.60	0.0120	OUTLET**	0.00	D	0.00
18.10	1	18 in.	810.38	810.55	2 - G	10.24	1.50	1.45	0.0120	OUTLET	1.80	D - 1	0.00
12.00	1	15 in.	815.95	815.34	2 - G	9.78	1.25	1.22	0.0120	OUTLET	7.90	D - 2	0.00
19.90	1	24 in.	808.10	808.14	2 - F	7.37	2.00	1.60	0.0120	OUTLET**	0.00	D + 1	0.00
24.10	1	21 in.	809.78	809.76	2 - E	10.02	1.75	1.67	0.0120	INLET	0.00	F	0.00
18.10	1	18 in.	812.18	812.29	2 - G	10.24	1.50	1.45	0.0120	OUTLET	6.00	F - 1	0.00
12.00	1	15 in.	828.60	819.31	2 - G	9.78	1.25	1.22	0.0120	OUTLET	12.10	F - 2	0.00
24.10	1	24 in.	808.68	808.70	2 - F	8.32	2.00	1.74	0.0120	OUTLET**	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
19.90	1	27 in.	808.09	808.60	2 - F	6.76	2.25	1.56	0.0245	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	19.90	1	24 in.	808.71	809.54	2 - F	7.37	2.00	1.60	0.0247	OUTLET**	0.00	D - 1	0.00
	16.10	1	21 in.	809.97	811.56	2 - F	7.26	1.75	1.48	0.0248	OUTLET**	3.80	D - 2	0.00
	19.90	1	30 in.	807.80	808.14	1 - A	6.37	2.28	1.51	0.0244	OUTLET*	0.00	D + 1	0.00
	24.10	1	27 in.	808.68	809.33	2 - F	7.40	2.25	1.72	0.0245	OUTLET**	0.00	F	0.00
	21.30	1	24 in.	809.66	810.74	2 - F	7.68	2.00	1.65	0.0247	OUTLET**	2.80	F - 1	0.00
	16.10	1	21 in.	811.41	813.74	2 - F	7.26	1.75	1.48	0.0248	OUTLET**	8.00	F - 2	0.00
	24.10	1	30 in.	808.19	808.64	2 - F	6.91	2.50	1.67	0.0244	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	19.90	1	36 in.	807.57	807.91	1 - A	5.54	2.74	1.43	0.0281	OUTLET*	0.00	D	0.00
	19.90	1	42 in.	807.44	807.74	1 - A	4.97	2.18	1.37	0.0278	OUTLET*	0.00	D + 1	0.00
	24.10	1	36 in.	807.82	808.19	1 - A	6.37	2.74	1.58	0.0281	OUTLET*	0.00	F	0.00
	24.10	1	42 in.	807.66	807.99	1 - A	6.01	2.50	1.51	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	19.90	1	60 in.	807.14	807.52	1 - A	3.94	1.97	1.23	0.0332	OUTLET*	0.00	D	0.00
	19.90	1	66 in.	807.08	807.45	1 - A	3.72	1.88	1.20	0.0330	OUTLET*	0.00	D + 1	0.00
	24.10	1	60 in.	807.34	807.71	1 - A	4.78	2.19	1.36	0.0332	OUTLET*	0.00	F	0.00
	24.10	1	66 in.	807.26	807.64	1 - A	4.51	2.09	1.32	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	9.95	2	60 in.	806.62	807.06	1 - B	1.97	1.37	0.86	0.0332	OUTLET*	0.00	D	0.00
	9.95	2	66 in.	806.60	807.03	1 - B	1.86	1.32	0.84	0.0330	OUTLET*	0.00	D + 1	0.00
	12.05	2	60 in.	806.73	807.15	1 - B	2.39	1.51	0.95	0.0332	OUTLET*	0.00	F	0.00
	12.05	2	66 in.	806.70	807.12	1 - B	2.25	1.45	0.93	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	19.90	1	60 in.	807.14	807.46	1 - A	3.94	1.73	1.23	0.0260	OUTLET*	0.00	D	0.00
	19.90	1	66 in.	807.08	807.41	1 - A	3.72	1.66	1.20	0.0260	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	24.10	1	60 in.	807.34	807.66	1 - A	4.78	1.91	1.36	0.0260	OUTLET*	0.00	F	0.00
	24.10	1	66 in.	807.26	807.59	1 - A	4.51	1.84	1.32	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	9.95	2	60 in.	806.62	807.03	1 - B	1.97	1.21	0.86	0.0260	OUTLET*	0.00	D	0.00
	9.95	2	66 in.	806.60	807.01	1 - B	1.86	1.17	0.84	0.0260	OUTLET*	0.00	D + 1	0.00
	12.05	2	60 in.	806.73	807.11	1 - B	2.39	1.33	0.95	0.0260	OUTLET*	0.00	F	0.00
	12.05	2	66 in.	806.70	807.08	1 - B	2.25	1.29	0.93	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 565+47 RT TO 565+85 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 804.71      **Outlet Invert Elevation (ft.) :** 804.58      **Tailwater Elevation (ft.) :** 806.16      **Overflow Elevation (ft.) :** 809.20  
**Allowable Headwater Elevation (ft.) :** 808.20      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 38.00      **Culvert Slope (ft./ft.) :** 0.0034      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 21.60      @ 10 yrs.      **Flood Discharge (cfs) :** 26.20      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
21.60	1	24 in.	807.57	807.58	2 - F	7.74	2.00	1.66	0.0120	OUTLET**	0.00	D	0.00
21.60	1	21 in.	808.42	808.37	2 - E	8.98	1.75	1.63	0.0120	INLET	0.00	D - 1	0.00
18.40	1	18 in.	810.30	810.31	2 - G	10.41	1.50	1.46	0.0120	OUTLET	3.20	D - 2	0.00
21.60	1	27 in.	807.20	807.26	1 - A	7.02	2.05	1.63	0.0120	OUTLET*	0.00	D + 1	0.00
26.20	1	24 in.	808.26	808.20	2 - E	8.34	2.00	1.79	0.0120	INLET	0.00	F	0.00
24.70	1	21 in.	809.58	809.39	2 - E	10.27	1.75	1.68	0.0120	INLET	1.50	F - 1	0.00
18.40	1	18 in.	812.60	812.26	2 - G	10.41	1.50	1.46	0.0120	OUTLET	7.80	F - 2	0.00
26.20	1	27 in.	807.63	807.64	2 - F	7.74	2.25	1.79	0.0120	OUTLET**	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
21.60	1	27 in.	807.57	808.04	2 - F	7.02	2.25	1.63	0.0245	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	21.60	1	24 in.	808.33	809.05	2 - F	7.74	2.00	1.66	0.0247	OUTLET**	0.00	D - 1	0.00
	16.80	1	21 in.	809.78	811.21	2 - F	7.35	1.75	1.50	0.0248	OUTLET**	4.80	D - 2	0.00
	21.60	1	30 in.	807.20	807.55	1 - A	6.61	2.28	1.58	0.0244	OUTLET*	0.00	D + 1	0.00
	26.20	1	27 in.	808.28	808.84	2 - F	7.74	2.25	1.79	0.0245	OUTLET**	0.00	F	0.00
	22.10	1	24 in.	809.44	810.36	2 - F	7.85	2.00	1.68	0.0247	OUTLET**	4.10	F - 1	0.00
	16.80	1	21 in.	811.44	813.56	2 - F	7.35	1.75	1.50	0.0248	OUTLET**	9.40	F - 2	0.00
	26.20	1	30 in.	807.66	808.09	2 - F	7.16	2.50	1.74	0.0244	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	21.60	1	36 in.	806.92	807.26	1 - A	5.72	2.74	1.49	0.0281	OUTLET*	0.00	D	0.00
	21.60	1	42 in.	806.78	807.09	1 - A	5.12	2.34	1.42	0.0278	OUTLET*	0.00	D + 1	0.00
	26.20	1	36 in.	807.19	807.57	1 - A	6.56	2.74	1.65	0.0281	OUTLET*	0.00	F	0.00
	26.20	1	42 in.	807.02	807.35	1 - A	6.21	2.73	1.58	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	21.60	1	60 in.	806.47	806.83	1 - A	4.06	2.08	1.28	0.0332	OUTLET*	0.00	D	0.00
	21.60	1	66 in.	806.40	806.78	1 - A	3.83	1.99	1.25	0.0330	OUTLET*	0.00	D + 1	0.00
	26.20	1	60 in.	806.68	807.05	1 - A	4.92	2.32	1.42	0.0332	OUTLET*	0.00	F	0.00
	26.20	1	66 in.	806.60	806.98	1 - A	4.64	2.21	1.38	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	10.80	2	60 in.	805.91	806.38	1 - B	2.03	1.44	0.90	0.0332	OUTLET*	0.00	D	0.00
	10.80	2	66 in.	805.89	806.36	1 - B	1.91	1.39	0.88	0.0330	OUTLET*	0.00	D + 1	0.00
	13.10	2	60 in.	806.04	806.47	1 - A	2.46	1.59	0.99	0.0332	OUTLET*	0.00	F	0.00
	13.10	2	66 in.	806.01	806.46	1 - B	2.32	1.53	0.97	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	21.60	1	60 in.	806.47	806.80	1 - A	4.06	1.82	1.28	0.0260	OUTLET*	0.00	D	0.00
	21.60	1	66 in.	806.40	806.74	1 - A	3.83	1.75	1.25	0.0260	OUTLET*	0.00	D + 1	0.00





# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	26.20	1	60 in.	806.68	807.00	1 - A	4.92	2.02	1.42	0.0260	OUTLET*	0.00	F	0.00
	26.20	1	66 in.	806.60	806.94	1 - A	4.64	1.94	1.38	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	10.80	2	60 in.	805.91	806.36	1 - B	2.03	1.27	0.90	0.0260	OUTLET*	0.00	D	0.00
	10.80	2	66 in.	805.89	806.34	1 - B	1.91	1.23	0.88	0.0260	OUTLET*	0.00	D + 1	0.00
	13.10	2	60 in.	806.04	806.44	1 - B	2.46	1.40	0.99	0.0260	OUTLET*	0.00	F	0.00
	13.10	2	66 in.	806.01	806.41	1 - B	2.32	1.36	0.97	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 566+15 RT TO 566+35 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 804.47      **Outlet Invert Elevation (ft.) :** 804.40      **Tailwater Elevation (ft.) :** 805.98      **Overflow Elevation (ft.) :** 808.58  
**Allowable Headwater Elevation (ft.) :** 807.58      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 20.00      **Culvert Slope (ft./ft.) :** 0.0035      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 21.70      @ 10 yrs.      **Flood Discharge (cfs) :** 26.40      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
21.70	1	24 in.	807.34	807.28	2 - E	6.91	2.00	1.67	0.0120	INLET	0.00	D	0.00
21.70	1	21 in.	808.20	807.93	2 - E	9.02	1.75	1.63	0.0120	INLET	0.00	D - 1	0.00
17.60	1	18 in.	810.10	809.51	2 - H	9.96	1.50	1.45	0.0120	INLET	4.10	D - 2	0.00
21.70	1	27 in.	806.97	807.02	1 - A	7.03	2.05	1.63	0.0120	OUTLET*	0.00	D + 1	0.00
26.40	1	24 in.	808.05	807.84	2 - E	8.40	2.00	1.80	0.0120	INLET	0.00	F	0.00
23.20	1	21 in.	809.39	808.84	2 - E	9.65	1.75	1.66	0.0120	INLET	3.20	F - 1	0.00
17.60	1	18 in.	812.48	811.21	2 - H	9.96	1.50	1.45	0.0120	INLET	8.80	F - 2	0.00
26.40	1	27 in.	807.41	807.40	2 - E	6.64	2.25	1.79	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
21.70	1	27 in.	807.34	807.57	2 - F	7.03	2.25	1.63	0.0245	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	21.70	1	24 in.	808.11	808.30	2 - F	7.76	2.00	1.67	0.0247	OUTLET**	0.00	D - 1	0.00
	17.80	1	21 in.	809.58	809.85	2 - F	7.79	1.75	1.54	0.0248	OUTLET**	3.90	D - 2	0.00
	21.70	1	30 in.	806.97	807.25	1 - A	6.62	2.28	1.58	0.0244	OUTLET*	0.00	D + 1	0.00
	26.40	1	27 in.	808.07	808.24	2 - F	7.77	2.25	1.79	0.0245	OUTLET**	0.00	F	0.00
	23.00	1	24 in.	809.25	809.36	2 - F	8.06	2.00	1.71	0.0247	OUTLET**	3.40	F - 1	0.00
	17.80	1	21 in.	811.28	811.68	2 - F	7.79	1.75	1.54	0.0248	OUTLET**	8.60	F - 2	0.00
	26.40	1	30 in.	807.45	807.66	2 - F	7.19	2.50	1.75	0.0244	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	21.70	1	36 in.	806.68	806.99	1 - A	5.75	2.74	1.50	0.0281	OUTLET*	0.00	D	0.00
	21.70	1	42 in.	806.55	806.82	1 - A	5.15	2.33	1.43	0.0278	OUTLET*	0.00	D + 1	0.00
	26.40	1	36 in.	806.97	807.31	1 - A	6.58	2.74	1.66	0.0281	OUTLET*	0.00	F	0.00
	26.40	1	42 in.	806.79	807.09	1 - A	6.25	2.72	1.58	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	21.70	1	60 in.	806.24	806.57	1 - A	4.08	2.07	1.29	0.0332	OUTLET*	0.00	D	0.00
	21.70	1	66 in.	806.17	806.52	1 - A	3.84	1.98	1.25	0.0330	OUTLET*	0.00	D + 1	0.00
	26.40	1	60 in.	806.45	806.78	1 - A	4.96	2.31	1.42	0.0332	OUTLET*	0.00	F	0.00
	26.40	1	66 in.	806.37	806.71	1 - A	4.68	2.20	1.39	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	10.85	2	60 in.	805.68	806.16	1 - B	2.04	1.44	0.90	0.0332	OUTLET*	0.00	D	0.00
	10.85	2	66 in.	805.65	806.14	1 - B	1.92	1.38	0.88	0.0330	OUTLET*	0.00	D + 1	0.00
	13.20	2	60 in.	805.81	806.23	1 - A	2.48	1.59	1.00	0.0332	OUTLET*	0.00	F	0.00
	13.20	2	66 in.	805.77	806.21	1 - B	2.34	1.53	0.97	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	21.70	1	60 in.	806.24	806.55	1 - A	4.08	1.82	1.29	0.0260	OUTLET*	0.00	D	0.00
	21.70	1	66 in.	806.17	806.50	1 - A	3.84	1.75	1.25	0.0260	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	26.40	1	60 in.	806.45	806.76	1 - A	4.96	2.02	1.42	0.0260	OUTLET*	0.00	F	0.00
	26.40	1	66 in.	806.37	806.69	1 - A	4.68	1.94	1.39	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	10.85	2	60 in.	805.68	806.14	1 - B	2.04	1.27	0.90	0.0260	OUTLET*	0.00	D	0.00
	10.85	2	66 in.	805.65	806.12	1 - B	1.92	1.23	0.88	0.0260	OUTLET*	0.00	D + 1	0.00
	13.20	2	60 in.	805.81	806.22	1 - B	2.48	1.40	1.00	0.0260	OUTLET*	0.00	F	0.00
	13.20	2	66 in.	805.77	806.19	1 - B	2.34	1.35	0.97	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 568+54 RT TO 569+27 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 803.63      **Outlet Invert Elevation (ft.) :** 803.37      **Tailwater Elevation (ft.) :** 805.02      **Overflow Elevation (ft.) :** 809.39  
**Allowable Headwater Elevation (ft.) :** 808.39      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 73.00      **Culvert Slope (ft./ft.) :** 0.0036      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 23.90      @ 10 yrs.      **Flood Discharge (cfs) :** 29.00      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
23.90	1	21 in.	807.89	808.33	2 - F	10.11	1.75	1.67	0.0120	OUTLET**	0.00	D	0.00
19.40	1	18 in.	810.25	811.63	2 - G	10.98	1.50	1.46	0.0120	OUTLET	4.50	D - 1	0.00
12.60	1	15 in.	825.83	820.55	2 - G	10.27	1.25	1.22	0.0120	OUTLET	11.30	D - 2	0.00
23.90	1	24 in.	806.82	807.00	2 - F	8.27	2.00	1.73	0.0120	OUTLET**	0.00	D + 1	0.00
27.40	1	21 in.	809.29	809.88	2 - F	11.49	1.75	1.70	0.0120	OUTLET**	1.60	F	0.00
19.40	1	18 in.	813.62	814.75	2 - G	10.98	1.50	1.46	0.0120	OUTLET	9.60	F - 1	0.00
12.60	1	15 in.	869.10	827.89	2 - G	10.27	1.25	1.22	0.0120	OUTLET	16.40	F - 2	0.00
29.00	1	24 in.	807.66	807.90	2 - F	9.57	2.00	1.85	0.0120	OUTLET**	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
23.90	1	27 in.	806.82	807.95	2 - F	7.37	2.25	1.71	0.0245	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
22.60	1	24 in.	807.78	809.87	2 - F	7.96	2.00	1.69	0.0247	OUTLET**	1.30	D - 1	0.00
16.70	1	21 in.	809.51	814.00	2 - F	7.10	1.75	1.50	0.0248	OUTLET	7.20	D - 2	0.00
23.90	1	30 in.	806.34	807.02	2 - F	6.89	2.50	1.66	0.0244	OUTLET**	0.00	D + 1	0.00
29.00	1	27 in.	807.70	809.26	2 - F	8.21	2.25	1.87	0.0245	OUTLET**	0.00	F	0.00
22.60	1	24 in.	809.11	812.11	2 - F	7.96	2.00	1.69	0.0247	OUTLET**	6.40	F - 1	0.00
16.70	1	21 in.	811.53	818.24	2 - F	7.10	1.75	1.50	0.0248	OUTLET	12.30	F - 2	0.00
29.00	1	30 in.	806.91	807.85	2 - F	7.50	2.50	1.84	0.0244	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
23.90	1	36 in.	805.98	806.42	1 - A	6.00	2.74	1.58	0.0281	OUTLET*	0.00	D	0.00
23.90	1	42 in.	805.82	806.20	1 - A	5.36	2.48	1.50	0.0278	OUTLET*	0.00	D + 1	0.00
29.00	1	36 in.	806.29	806.80	1 - A	6.81	2.74	1.74	0.0281	OUTLET*	0.00	F	0.00
29.00	1	42 in.	806.08	806.48	1 - A	6.44	2.98	1.66	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
23.90	1	60 in.	805.50	805.91	1 - A	4.23	2.18	1.35	0.0332	OUTLET*	0.00	D	0.00
23.90	1	66 in.	805.42	805.85	1 - A	3.99	2.08	1.32	0.0330	OUTLET*	0.00	D + 1	0.00
29.00	1	60 in.	805.73	806.14	1 - A	5.13	2.43	1.49	0.0332	OUTLET*	0.00	F	0.00
29.00	1	66 in.	805.63	806.06	1 - A	4.84	2.31	1.45	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
23.90	1	60 in.	805.50	805.84	1 - A	4.23	1.90	1.35	0.0260	OUTLET*	0.00	D	0.00
23.90	1	66 in.	805.42	805.77	1 - A	3.99	1.83	1.32	0.0260	OUTLET*	0.00	D + 1	0.00
29.00	1	60 in.	805.73	806.07	1 - A	5.13	2.12	1.49	0.0260	OUTLET*	0.00	F	0.00
29.00	1	66 in.	805.63	805.99	1 - A	4.84	2.03	1.45	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 570+49 RT TO 570+95 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 802.95      **Outlet Invert Elevation (ft.) :** 802.79      **Tailwater Elevation (ft.) :** 804.46      **Overflow Elevation (ft.) :** 809.39  
**Allowable Headwater Elevation (ft.) :** 808.39      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 46.00      **Culvert Slope (ft./ft.) :** 0.0035      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 24.50      @ 10 yrs.      **Flood Discharge (cfs) :** 29.60      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
24.50	1	21 in.	807.37	807.37	2 - F	10.34	1.75	1.67	0.0120	OUTLET**	0.00	D	0.00
22.70	1	18 in.	809.87	810.16	2 - G	12.85	1.50	1.48	0.0120	OUTLET	1.80	D - 1	0.00
15.00	1	15 in.	828.10	817.49	2 - G	12.22	1.25	1.24	0.0120	OUTLET	9.50	D - 2	0.00
24.50	1	24 in.	806.23	806.25	2 - F	8.41	2.00	1.75	0.0120	OUTLET**	0.00	D + 1	0.00
29.60	1	21 in.	808.79	808.70	2 - E	12.31	1.75	1.71	0.0120	INLET	0.00	F	0.00
22.70	1	18 in.	813.50	812.78	2 - G	12.85	1.50	1.48	0.0120	OUTLET	6.90	F - 1	0.00
15.00	1	15 in.	877.14	823.48	2 - G	12.22	1.25	1.24	0.0120	OUTLET	14.60	F - 2	0.00
29.60	1	24 in.	807.09	807.04	2 - E	9.42	2.00	1.86	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
24.50	1	27 in.	806.24	806.92	2 - F	7.46	2.25	1.73	0.0245	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
24.50	1	24 in.	807.25	808.40	2 - F	8.41	2.00	1.75	0.0247	OUTLET**	0.00	D - 1	0.00
20.40	1	21 in.	809.04	811.54	2 - F	8.62	1.75	1.61	0.0248	OUTLET**	4.10	D - 2	0.00
24.50	1	30 in.	805.72	806.19	2 - F	6.95	2.50	1.69	0.0244	OUTLET**	0.00	D + 1	0.00
29.60	1	27 in.	807.13	807.98	2 - F	8.32	2.25	1.89	0.0245	OUTLET**	0.00	F	0.00
27.40	1	24 in.	808.59	810.16	2 - F	9.14	2.00	1.82	0.0247	OUTLET**	2.20	F - 1	0.00
20.40	1	21 in.	811.13	814.80	2 - F	8.62	1.75	1.61	0.0248	OUTLET**	9.20	F - 2	0.00
29.60	1	30 in.	806.30	806.88	2 - F	7.58	2.50	1.85	0.0244	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
24.50	1	36 in.	805.33	805.72	1 - A	6.06	2.74	1.60	0.0281	OUTLET*	0.00	D	0.00
24.50	1	42 in.	805.17	805.51	1 - A	5.41	2.56	1.52	0.0278	OUTLET*	0.00	D + 1	0.00
29.60	1	36 in.	805.64	806.07	1 - A	6.86	2.74	1.76	0.0281	OUTLET*	0.00	F	0.00
29.60	1	42 in.	805.42	805.80	1 - A	6.48	3.20	1.68	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
24.50	1	60 in.	804.85	805.23	1 - A	4.26	2.22	1.37	0.0332	OUTLET*	0.00	D	0.00
24.50	1	66 in.	804.77	805.17	1 - A	4.02	2.12	1.33	0.0330	OUTLET*	0.00	D + 1	0.00
29.60	1	60 in.	805.07	805.45	1 - A	5.15	2.48	1.51	0.0332	OUTLET*	0.00	F	0.00
29.60	1	66 in.	804.98	805.38	1 - A	4.86	2.35	1.47	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
24.50	1	60 in.	804.85	805.18	1 - A	4.26	1.94	1.37	0.0260	OUTLET*	0.00	D	0.00
24.50	1	66 in.	804.77	805.12	1 - A	4.02	1.86	1.33	0.0260	OUTLET*	0.00	D + 1	0.00
29.60	1	60 in.	805.07	805.40	1 - A	5.15	2.15	1.51	0.0260	OUTLET*	0.00	F	0.00
29.60	1	66 in.	804.98	805.33	1 - A	4.86	2.06	1.47	0.0260	OUTLET*	0.00	F + 1	0.00





# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 572+50 RT TO 573+00 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 802.25      **Outlet Invert Elevation (ft.) :** 802.12      **Tailwater Elevation (ft.) :** 804.29      **Overflow Elevation (ft.) :** 807.35  
**Allowable Headwater Elevation (ft.) :** 806.35      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 50.00      **Culvert Slope (ft./ft.) :** 0.0026      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 38.10      @ 10 yrs.      **Flood Discharge (cfs) :** 46.00      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
38.10	1	30 in.	805.86	805.90	2 - F	8.42	2.50	2.09	0.0120	OUTLET**	0.00	D	0.00
38.10	1	27 in.	806.66	806.64	2 - E	9.58	2.25	2.06	0.0120	INLET	0.00	D - 1	0.00
33.50	1	24 in.	808.15	808.23	2 - G	10.66	2.00	1.91	0.0120	OUTLET	4.60	D - 2	0.00
38.10	1	33 in.	805.45	805.54	1 - A	7.58	2.51	2.05	0.0120	OUTLET*	0.00	D + 1	0.00
46.00	1	30 in.	806.71	806.66	2 - E	9.37	2.50	2.24	0.0120	INLET	0.00	F	0.00
42.50	1	27 in.	807.94	807.75	2 - E	10.69	2.25	2.12	0.0120	INLET	3.50	F - 1	0.00
33.50	1	24 in.	810.16	810.04	2 - G	10.66	2.00	1.91	0.0120	OUTLET	12.50	F - 2	0.00
46.00	1	33 in.	806.03	806.06	2 - F	8.86	2.75	2.25	0.0120	OUTLET**	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
38.10	1	36 in.	805.54	806.04	2 - F	6.96	3.00	2.01	0.0241	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
38.10	1	33 in.	806.00	806.62	2 - F	7.58	2.75	2.05	0.0241	OUTLET**	0.00	D - 1	0.00
36.10	1	30 in.	806.83	807.70	2 - F	7.98	2.50	2.04	0.0244	OUTLET**	2.00	D - 2	0.00
38.10	1	42 in.	805.13	805.56	1 - A	6.08	3.20	1.92	0.0237	OUTLET*	0.00	D + 1	0.00
46.00	1	36 in.	806.21	806.79	2 - F	8.24	3.00	2.21	0.0241	OUTLET**	0.00	F	0.00
43.60	1	33 in.	806.97	807.68	2 - F	8.59	2.75	2.19	0.0241	OUTLET**	2.40	F - 1	0.00
36.10	1	30 in.	808.21	809.28	2 - F	7.98	2.50	2.04	0.0244	OUTLET**	9.90	F - 2	0.00
46.00	1	42 in.	805.52	805.96	1 - A	7.34	3.20	2.12	0.0237	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
38.10	1	36 in.	805.54	806.24	2 - F	6.96	3.00	2.01	0.0281	OUTLET**	0.00	D	0.00
38.10	1	42 in.	805.13	805.60	1 - A	6.08	3.20	1.92	0.0278	OUTLET*	0.00	D + 1	0.00
46.00	1	36 in.	806.21	807.08	2 - F	8.24	3.00	2.21	0.0281	OUTLET**	0.00	F	0.00
46.00	1	42 in.	805.52	806.03	1 - A	7.34	3.20	2.12	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
38.10	1	60 in.	804.71	805.17	1 - A	4.66	3.18	1.72	0.0332	OUTLET*	0.00	D	0.00
38.10	1	66 in.	804.60	805.09	1 - A	4.37	2.96	1.67	0.0330	OUTLET*	0.00	D + 1	0.00
46.00	1	60 in.	804.99	805.46	1 - A	5.63	3.66	1.90	0.0332	OUTLET*	0.00	F	0.00
46.00	1	66 in.	804.88	805.34	1 - A	5.28	3.33	1.84	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
38.10	1	60 in.	804.71	805.10	1 - A	4.66	2.72	1.72	0.0260	OUTLET*	0.00	D	0.00
38.10	1	66 in.	804.60	805.02	1 - A	4.37	2.57	1.67	0.0260	OUTLET*	0.00	D + 1	0.00
46.00	1	60 in.	804.99	805.38	1 - A	5.63	3.06	1.90	0.0260	OUTLET*	0.00	F	0.00
46.00	1	66 in.	804.88	805.28	1 - A	5.28	2.87	1.84	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 575+65 RT TO 576+19 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 801.46      **Outlet Invert Elevation (ft.) :** 801.32      **Tailwater Elevation (ft.) :** 803.51      **Overflow Elevation (ft.) :** 808.23  
**Allowable Headwater Elevation (ft.) :** 807.23      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 54.00      **Culvert Slope (ft./ft.) :** 0.0026      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 39.10      @ 10 yrs.      **Flood Discharge (cfs) :** 47.20      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
39.10	1	27 in.	806.02	806.04	2 - F	9.91	2.25	2.08	0.0120	OUTLET	0.00	D	0.00
39.10	1	24 in.	807.60	807.76	2 - G	12.45	2.00	1.95	0.0120	OUTLET	0.00	D - 1	0.00
30.50	1	21 in.	810.96	811.22	2 - G	12.68	1.75	1.72	0.0120	OUTLET	8.60	D - 2	0.00
39.10	1	30 in.	805.17	805.22	2 - F	8.58	2.50	2.11	0.0120	OUTLET**	0.00	D + 1	0.00
47.20	1	27 in.	807.37	807.21	2 - E	11.87	2.25	2.16	0.0120	INLET	0.00	F	0.00
41.10	1	24 in.	809.72	809.71	2 - G	13.08	2.00	1.96	0.0120	OUTLET	6.10	F - 1	0.00
30.50	1	21 in.	817.29	814.75	2 - G	12.68	1.75	1.72	0.0120	OUTLET	16.70	F - 2	0.00
47.20	1	30 in.	806.06	806.03	2 - E	9.62	2.50	2.26	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
39.10	1	30 in.	806.20	807.22	2 - F	8.58	2.50	2.11	0.0244	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
34.90	1	27 in.	807.66	809.40	2 - F	8.84	2.25	2.01	0.0245	OUTLET	4.20	D - 1	0.00
26.30	1	24 in.	809.99	813.87	2 - G	8.37	2.00	1.79	0.0247	OUTLET	12.80	D - 2	0.00
39.10	1	33 in.	805.32	806.02	2 - F	7.71	2.75	2.08	0.0241	OUTLET**	0.00	D + 1	0.00
44.00	1	30 in.	807.64	808.93	2 - F	9.59	2.50	2.21	0.0244	OUTLET**	3.20	F	0.00
34.90	1	27 in.	809.62	812.11	2 - F	8.84	2.25	2.01	0.0245	OUTLET	12.30	F - 1	0.00
26.30	1	24 in.	813.69	818.61	2 - G	8.37	2.00	1.79	0.0247	OUTLET	20.90	F - 2	0.00
47.20	1	33 in.	806.34	807.16	2 - F	9.00	2.75	2.27	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
39.10	1	36 in.	804.82	805.60	2 - F	7.07	3.00	2.04	0.0281	OUTLET**	0.00	D	0.00
39.10	1	42 in.	804.38	804.88	1 - A	6.17	3.20	1.94	0.0278	OUTLET*	0.00	D + 1	0.00
47.20	1	36 in.	805.53	806.51	2 - F	8.35	3.00	2.24	0.0281	OUTLET**	0.00	F	0.00
47.20	1	42 in.	804.79	805.32	1 - A	7.45	3.20	2.14	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
39.10	1	60 in.	803.95	804.43	1 - A	4.73	3.24	1.74	0.0332	OUTLET*	0.00	D	0.00
39.10	1	66 in.	803.85	804.33	1 - A	4.43	3.01	1.70	0.0330	OUTLET*	0.00	D + 1	0.00
47.20	1	60 in.	804.24	804.71	1 - A	5.71	3.74	1.92	0.0332	OUTLET*	0.00	F	0.00
47.20	1	66 in.	804.13	804.58	1 - A	5.35	3.39	1.87	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
39.10	1	60 in.	803.95	804.36	1 - A	4.73	2.76	1.74	0.0260	OUTLET*	0.00	D	0.00
39.10	1	66 in.	803.85	804.28	1 - A	4.43	2.61	1.70	0.0260	OUTLET*	0.00	D + 1	0.00
47.20	1	60 in.	804.24	804.65	1 - A	5.71	3.12	1.92	0.0260	OUTLET*	0.00	F	0.00
47.20	1	66 in.	804.13	804.54	1 - A	5.35	2.92	1.87	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 578+05 RT TO 578+38 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 800.86      **Outlet Invert Elevation (ft.) :** 800.76      **Tailwater Elevation (ft.) :** 802.99      **Overflow Elevation (ft.) :** 807.95  
**Allowable Headwater Elevation (ft.) :** 806.95      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 38.00      **Culvert Slope (ft./ft.) :** 0.0026      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 40.80      @ 10 yrs.      **Flood Discharge (cfs) :** 49.30      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
40.80	1	27 in.	805.68	805.51	2 - E	10.26	2.25	2.10	0.0120	INLET	0.00	D	0.00
40.80	1	24 in.	807.40	807.18	2 - H	12.99	2.00	1.96	0.0120	INLET	0.00	D - 1	0.00
33.10	1	21 in.	811.30	810.49	2 - G	13.76	1.75	1.73	0.0120	OUTLET	7.70	D - 2	0.00
40.80	1	30 in.	804.74	804.69	2 - E	8.31	2.50	2.15	0.0120	INLET	0.00	D + 1	0.00
49.30	1	27 in.	807.15	806.67	2 - E	12.40	2.25	2.17	0.0120	INLET	0.00	F	0.00
42.90	1	24 in.	809.76	809.11	2 - H	13.66	2.00	1.96	0.0120	INLET	6.40	F - 1	0.00
33.10	1	21 in.	819.41	813.93	2 - G	13.76	1.75	1.73	0.0120	OUTLET	16.20	F - 2	0.00
49.30	1	30 in.	805.72	805.50	2 - E	10.04	2.50	2.29	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
40.80	1	30 in.	805.89	806.44	2 - F	8.83	2.50	2.15	0.0244	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
38.90	1	27 in.	807.46	808.43	2 - F	9.80	2.25	2.08	0.0245	OUTLET	1.90	D - 1	0.00
29.60	1	24 in.	810.00	812.40	2 - G	9.42	2.00	1.86	0.0247	OUTLET	11.20	D - 2	0.00
40.80	1	33 in.	804.92	805.36	2 - F	7.91	2.75	2.12	0.0241	OUTLET**	0.00	D + 1	0.00
48.70	1	30 in.	807.44	808.05	2 - F	10.36	2.50	2.28	0.0244	OUTLET**	0.60	F	0.00
38.90	1	27 in.	809.57	810.93	2 - F	9.80	2.25	2.08	0.0245	OUTLET	10.40	F - 1	0.00
29.60	1	24 in.	814.55	816.73	2 - G	9.42	2.00	1.86	0.0247	OUTLET	19.70	F - 2	0.00
49.30	1	33 in.	806.03	806.45	2 - F	9.25	2.75	2.31	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
40.80	1	36 in.	804.36	804.94	2 - F	7.24	3.00	2.08	0.0281	OUTLET**	0.00	D	0.00
40.80	1	42 in.	803.87	804.34	1 - A	6.31	3.20	1.99	0.0278	OUTLET*	0.00	D + 1	0.00
49.30	1	36 in.	805.14	805.80	2 - F	8.53	3.00	2.29	0.0281	OUTLET**	0.00	F	0.00
49.30	1	42 in.	804.30	804.77	1 - A	7.62	3.20	2.19	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
40.80	1	60 in.	803.42	803.87	1 - A	4.82	3.32	1.78	0.0332	OUTLET*	0.00	D	0.00
40.80	1	66 in.	803.31	803.76	1 - A	4.52	3.07	1.73	0.0330	OUTLET*	0.00	D + 1	0.00
49.30	1	60 in.	803.71	804.16	1 - A	5.82	3.86	1.97	0.0332	OUTLET*	0.00	F	0.00
49.30	1	66 in.	803.59	804.03	1 - A	5.46	3.48	1.91	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
40.80	1	60 in.	803.42	803.81	1 - A	4.82	2.82	1.78	0.0260	OUTLET*	0.00	D	0.00
40.80	1	66 in.	803.31	803.72	1 - A	4.52	2.66	1.73	0.0260	OUTLET*	0.00	D + 1	0.00
49.30	1	60 in.	803.71	804.10	1 - A	5.82	3.20	1.97	0.0260	OUTLET*	0.00	F	0.00
49.30	1	66 in.	803.59	803.99	1 - A	5.46	2.98	1.91	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 578+60 RT TO 578+93 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 800.72      **Outlet Invert Elevation (ft.) :** 800.63      **Tailwater Elevation (ft.) :** 802.86      **Overflow Elevation (ft.) :** 807.47  
**Allowable Headwater Elevation (ft.) :** 806.47      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 33.00      **Culvert Slope (ft./ft.) :** 0.0027      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 40.00      @ 10 yrs.      **Flood Discharge (cfs) :** 48.40      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
40.00	1	27 in.	805.42	805.21	2 - E	10.06	2.25	2.09	0.0120	INLET	0.00	D	0.00
40.00	1	24 in.	807.07	806.75	2 - H	12.73	2.00	1.95	0.0120	INLET	0.00	D - 1	0.00
32.40	1	21 in.	810.70	809.80	2 - H	13.47	1.75	1.72	0.0120	INLET	7.60	D - 2	0.00
40.00	1	30 in.	804.52	804.45	2 - E	8.15	2.50	2.13	0.0120	INLET	0.00	D + 1	0.00
48.40	1	27 in.	806.84	806.30	2 - E	12.17	2.25	2.17	0.0120	INLET	0.00	F	0.00
41.60	1	24 in.	809.34	808.56	2 - H	13.24	2.00	1.96	0.0120	INLET	6.80	F - 1	0.00
32.40	1	21 in.	818.03	813.01	2 - H	13.47	1.75	1.72	0.0120	INLET	16.00	F - 2	0.00
48.40	1	30 in.	805.47	805.22	2 - E	9.86	2.50	2.28	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
40.00	1	30 in.	805.61	806.00	2 - F	8.65	2.50	2.13	0.0244	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
38.60	1	27 in.	807.13	807.79	2 - F	9.72	2.25	2.07	0.0245	OUTLET	1.40	D - 1	0.00
29.40	1	24 in.	809.57	811.35	2 - G	9.36	2.00	1.85	0.0247	OUTLET	10.60	D - 2	0.00
40.00	1	33 in.	804.68	805.04	2 - F	7.75	2.75	2.10	0.0241	OUTLET**	0.00	D + 1	0.00
48.20	1	30 in.	807.13	807.50	2 - F	10.28	2.50	2.27	0.0244	OUTLET**	0.20	F	0.00
38.60	1	27 in.	809.19	810.08	2 - F	9.72	2.25	2.07	0.0245	OUTLET	9.80	F - 1	0.00
29.40	1	24 in.	813.75	815.28	2 - G	9.36	2.00	1.85	0.0247	OUTLET	19.00	F - 2	0.00
48.40	1	33 in.	805.76	806.06	2 - F	9.14	2.75	2.30	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
40.00	1	36 in.	804.16	804.66	2 - F	7.10	3.00	2.06	0.0281	OUTLET**	0.00	D	0.00
40.00	1	42 in.	803.69	804.12	1 - A	6.18	3.20	1.97	0.0278	OUTLET*	0.00	D + 1	0.00
48.40	1	36 in.	804.91	805.45	2 - F	8.45	3.00	2.27	0.0281	OUTLET**	0.00	F	0.00
48.40	1	42 in.	804.12	804.55	1 - A	7.48	3.20	2.17	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
40.00	1	60 in.	803.25	803.68	1 - A	4.72	3.23	1.76	0.0332	OUTLET*	0.00	D	0.00
40.00	1	66 in.	803.14	803.59	1 - A	4.43	3.00	1.72	0.0330	OUTLET*	0.00	D + 1	0.00
48.40	1	60 in.	803.54	803.95	1 - A	5.71	3.74	1.95	0.0332	OUTLET*	0.00	F	0.00
48.40	1	66 in.	803.42	803.85	1 - A	5.36	3.39	1.89	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
40.00	1	60 in.	803.25	803.64	1 - A	4.72	2.76	1.76	0.0260	OUTLET*	0.00	D	0.00
40.00	1	66 in.	803.14	803.55	1 - A	4.43	2.61	1.72	0.0260	OUTLET*	0.00	D + 1	0.00
48.40	1	60 in.	803.54	803.92	1 - A	5.71	3.12	1.95	0.0260	OUTLET*	0.00	F	0.00
48.40	1	66 in.	803.42	803.81	1 - A	5.36	2.92	1.89	0.0260	OUTLET*	0.00	F + 1	0.00





# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 579+59 RT TO 579+93 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 800.48      **Outlet Invert Elevation (ft.) :** 800.39      **Tailwater Elevation (ft.) :** 802.63      **Overflow Elevation (ft.) :** 806.88  
**Allowable Headwater Elevation (ft.) :** 805.88      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 34.00      **Culvert Slope (ft./ft.) :** 0.0026      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 41.10      @ 10 yrs.      **Flood Discharge (cfs) :** 49.70      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
41.10	1	27 in.	805.35	805.13	2 - E	10.34	2.25	2.11	0.0120	INLET	0.00	D	0.00
40.20	1	24 in.	807.10	806.77	2 - H	12.80	2.00	1.95	0.0120	INLET	0.90	D - 1	0.00
31.10	1	21 in.	811.11	810.01	2 - G	12.93	1.75	1.72	0.0120	OUTLET	10.00	D - 2	0.00
41.10	1	30 in.	804.39	804.31	2 - E	8.37	2.50	2.15	0.0120	INLET	0.00	D + 1	0.00
49.70	1	27 in.	806.85	806.28	2 - E	12.50	2.25	2.18	0.0120	INLET	0.00	F	0.00
40.20	1	24 in.	809.51	808.68	2 - H	12.80	2.00	1.95	0.0120	INLET	9.50	F - 1	0.00
31.10	1	21 in.	819.62	813.42	2 - G	12.93	1.75	1.72	0.0120	OUTLET	18.60	F - 2	0.00
49.70	1	30 in.	805.39	805.12	2 - E	10.12	2.50	2.30	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
41.10	1	33 in.	804.57	804.95	2 - F	7.93	2.75	2.13	0.0241	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
41.10	1	30 in.	805.56	805.98	2 - F	8.86	2.50	2.15	0.0244	OUTLET**	0.00	D - 1	0.00
36.90	1	27 in.	807.15	807.90	2 - F	9.29	2.25	2.05	0.0245	OUTLET	4.20	D - 2	0.00
41.10	1	36 in.	804.01	804.37	2 - F	7.26	3.00	2.09	0.0241	OUTLET**	0.00	D + 1	0.00
49.70	1	33 in.	805.71	806.02	2 - F	9.29	2.75	2.32	0.0241	OUTLET**	0.00	F	0.00
46.10	1	30 in.	807.14	807.56	2 - F	9.93	2.50	2.24	0.0244	OUTLET**	3.60	F - 1	0.00
36.90	1	27 in.	809.29	810.33	2 - F	9.29	2.25	2.05	0.0245	OUTLET	12.80	F - 2	0.00
49.70	1	36 in.	804.80	805.14	2 - F	8.57	3.00	2.29	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
41.10	1	36 in.	804.01	804.53	2 - F	7.26	3.00	2.09	0.0281	OUTLET**	0.00	D	0.00
41.10	1	42 in.	803.50	803.95	1 - A	6.32	3.20	2.00	0.0278	OUTLET*	0.00	D + 1	0.00
49.70	1	36 in.	804.80	805.37	2 - F	8.57	3.00	2.29	0.0281	OUTLET**	0.00	F	0.00
49.70	1	42 in.	803.95	804.39	1 - A	7.64	3.20	2.20	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
41.10	1	60 in.	803.05	803.49	1 - A	4.82	3.33	1.79	0.0332	OUTLET*	0.00	D	0.00
41.10	1	66 in.	802.94	803.40	1 - A	4.52	3.08	1.74	0.0330	OUTLET*	0.00	D + 1	0.00
49.70	1	60 in.	803.34	803.76	1 - A	5.83	3.88	1.97	0.0332	OUTLET*	0.00	F	0.00
49.70	1	66 in.	803.23	803.66	1 - A	5.47	3.49	1.92	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
41.10	1	60 in.	803.05	803.44	1 - A	4.82	2.83	1.79	0.0260	OUTLET*	0.00	D	0.00
41.10	1	66 in.	802.94	803.35	1 - A	4.52	2.67	1.74	0.0260	OUTLET*	0.00	D + 1	0.00
49.70	1	60 in.	803.34	803.73	1 - A	5.83	3.21	1.97	0.0260	OUTLET*	0.00	F	0.00
49.70	1	66 in.	803.23	803.61	1 - A	5.47	2.99	1.92	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 581+04 RT TO 581+45 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 800.11      **Outlet Invert Elevation (ft.) :** 800.00      **Tailwater Elevation (ft.) :** 802.25      **Overflow Elevation (ft.) :** 806.54  
**Allowable Headwater Elevation (ft.) :** 805.54      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 41.00      **Culvert Slope (ft./ft.) :** 0.0027      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 41.70      @ 10 yrs.      **Flood Discharge (cfs) :** 50.50      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
41.70	1	27 in.	805.08	804.93	2 - H	10.49	2.25	2.11	0.0120	INLET	0.00	D	0.00
40.30	1	24 in.	806.88	806.71	2 - H	12.83	2.00	1.95	0.0120	INLET	1.40	D - 1	0.00
30.50	1	21 in.	811.12	810.26	2 - G	12.68	1.75	1.72	0.0120	OUTLET	11.20	D - 2	0.00
41.70	1	30 in.	804.09	804.04	2 - E	8.50	2.50	2.16	0.0120	INLET	0.00	D + 1	0.00
50.00	1	27 in.	806.63	806.18	2 - H	12.58	2.25	2.18	0.0120	INLET	0.50	F	0.00
40.30	1	24 in.	809.41	808.80	2 - H	12.83	2.00	1.95	0.0120	INLET	10.20	F - 1	0.00
30.50	1	21 in.	820.52	813.99	2 - G	12.68	1.75	1.72	0.0120	OUTLET	20.00	F - 2	0.00
50.50	1	30 in.	805.12	804.90	2 - E	10.29	2.50	2.31	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
41.70	1	33 in.	804.28	804.77	2 - F	8.02	2.75	2.15	0.0241	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
41.70	1	30 in.	805.29	805.95	2 - F	8.96	2.50	2.16	0.0244	OUTLET**	0.00	D - 1	0.00
35.60	1	27 in.	806.92	808.12	2 - G	8.95	2.25	2.02	0.0245	OUTLET	6.10	D - 2	0.00
41.70	1	36 in.	803.69	804.13	2 - F	7.33	3.00	2.10	0.0241	OUTLET**	0.00	D + 1	0.00
50.50	1	33 in.	805.45	805.95	2 - F	9.39	2.75	2.34	0.0241	OUTLET**	0.00	F	0.00
44.80	1	30 in.	806.93	807.70	2 - F	9.63	2.50	2.22	0.0244	OUTLET**	5.70	F - 1	0.00
35.60	1	27 in.	809.14	810.86	2 - G	8.95	2.25	2.02	0.0245	OUTLET	14.90	F - 2	0.00
50.50	1	36 in.	804.51	804.97	2 - F	8.64	3.00	2.31	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
41.70	1	36 in.	803.69	804.32	2 - F	7.33	3.00	2.10	0.0281	OUTLET**	0.00	D	0.00
41.70	1	42 in.	803.16	803.63	1 - A	6.38	3.20	2.01	0.0278	OUTLET*	0.00	D + 1	0.00
50.50	1	36 in.	804.51	805.25	2 - F	8.64	3.00	2.31	0.0281	OUTLET**	0.00	F	0.00
50.50	1	42 in.	803.62	804.10	1 - A	7.73	3.20	2.22	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
41.70	1	60 in.	802.70	803.15	1 - A	4.87	3.35	1.80	0.0332	OUTLET*	0.00	D	0.00
41.70	1	66 in.	802.59	803.06	1 - A	4.56	3.10	1.75	0.0330	OUTLET*	0.00	D + 1	0.00
50.50	1	60 in.	803.00	803.44	1 - A	5.89	3.91	1.99	0.0332	OUTLET*	0.00	F	0.00
50.50	1	66 in.	802.88	803.33	1 - A	5.52	3.51	1.94	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
41.70	1	60 in.	802.70	803.10	1 - A	4.87	2.84	1.80	0.0260	OUTLET*	0.00	D	0.00
41.70	1	66 in.	802.59	803.01	1 - A	4.56	2.68	1.75	0.0260	OUTLET*	0.00	D + 1	0.00
50.50	1	60 in.	803.00	803.39	1 - A	5.89	3.23	1.99	0.0260	OUTLET*	0.00	F	0.00
50.50	1	66 in.	802.88	803.28	1 - A	5.52	3.01	1.94	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 581+99 RT TO 582+39 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 799.88      **Outlet Invert Elevation (ft.) :** 799.78      **Tailwater Elevation (ft.) :** 802.05      **Overflow Elevation (ft.) :** 806.08  
**Allowable Headwater Elevation (ft.) :** 805.08      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 40.00      **Culvert Slope (ft./ft.) :** 0.0025      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 42.50      @ 10 yrs.      **Flood Discharge (cfs) :** 51.30      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
42.50	1	27 in.	804.98	804.82	2 - H	10.69	2.25	2.12	0.0120	INLET	0.00	D	0.00
39.30	1	24 in.	806.85	806.66	2 - H	12.51	2.00	1.95	0.0120	INLET	3.20	D - 1	0.00
29.60	1	21 in.	811.43	810.31	2 - G	12.31	1.75	1.71	0.0120	OUTLET	12.90	D - 2	0.00
42.50	1	30 in.	803.94	803.88	2 - E	8.66	2.50	2.18	0.0120	INLET	0.00	D + 1	0.00
48.80	1	27 in.	806.55	806.08	2 - H	12.27	2.25	2.17	0.0120	INLET	2.50	F	0.00
39.30	1	24 in.	809.46	808.76	2 - H	12.51	2.00	1.95	0.0120	INLET	12.00	F - 1	0.00
29.60	1	21 in.	821.67	814.08	2 - G	12.31	1.75	1.71	0.0120	OUTLET	21.70	F - 2	0.00
51.30	1	30 in.	805.00	804.75	2 - E	10.45	2.50	2.32	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
42.50	1	33 in.	804.14	804.63	2 - F	8.10	2.75	2.17	0.0241	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
42.50	1	30 in.	805.20	805.84	2 - F	9.08	2.50	2.18	0.0244	OUTLET**	0.00	D - 1	0.00
34.70	1	27 in.	806.88	808.08	2 - G	8.73	2.25	2.01	0.0245	OUTLET	7.80	D - 2	0.00
42.50	1	36 in.	803.53	803.96	2 - F	7.41	3.00	2.12	0.0241	OUTLET**	0.00	D + 1	0.00
51.30	1	33 in.	805.34	805.82	2 - F	9.48	2.75	2.35	0.0241	OUTLET**	0.00	F	0.00
43.80	1	30 in.	806.85	807.60	2 - F	9.35	2.50	2.20	0.0244	OUTLET**	7.50	F - 1	0.00
34.70	1	27 in.	809.13	810.84	2 - G	8.73	2.25	2.01	0.0245	OUTLET	16.60	F - 2	0.00
51.30	1	36 in.	804.37	804.81	2 - F	8.71	3.00	2.33	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
42.50	1	36 in.	803.53	804.16	2 - F	7.41	3.00	2.12	0.0281	OUTLET**	0.00	D	0.00
42.50	1	42 in.	802.97	803.44	1 - A	6.44	3.20	2.03	0.0278	OUTLET*	0.00	D + 1	0.00
51.30	1	36 in.	804.37	805.10	2 - F	8.71	3.00	2.33	0.0281	OUTLET**	0.00	F	0.00
51.30	1	42 in.	803.44	803.91	1 - A	7.77	3.20	2.24	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
42.50	1	60 in.	802.50	802.96	1 - A	4.90	3.49	1.82	0.0332	OUTLET*	0.00	D	0.00
42.50	1	66 in.	802.39	802.85	1 - A	4.59	3.21	1.77	0.0330	OUTLET*	0.00	D + 1	0.00
51.30	1	60 in.	802.79	803.24	1 - A	5.92	4.13	2.01	0.0332	OUTLET*	0.00	F	0.00
51.30	1	66 in.	802.68	803.14	1 - A	5.54	3.64	1.95	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
42.50	1	60 in.	802.50	802.89	1 - A	4.90	2.94	1.82	0.0260	OUTLET*	0.00	D	0.00
42.50	1	66 in.	802.39	802.81	1 - A	4.59	2.77	1.77	0.0260	OUTLET*	0.00	D + 1	0.00
51.30	1	60 in.	802.79	803.19	1 - A	5.92	3.35	2.01	0.0260	OUTLET*	0.00	F	0.00
51.30	1	66 in.	802.68	803.08	1 - A	5.54	3.11	1.95	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 582+61 RT TO 582+94 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 799.72      **Outlet Invert Elevation (ft.) :** 799.63      **Tailwater Elevation (ft.) :** 801.90      **Overflow Elevation (ft.) :** 805.57  
**Allowable Headwater Elevation (ft.) :** 804.57      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 33.00      **Culvert Slope (ft./ft.) :** 0.0027      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 41.70      @ 10 yrs.      **Flood Discharge (cfs) :** 50.40      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
41.70	1	30 in.	803.70	803.60	2 - E	8.50	2.50	2.16	0.0120	INLET	0.00	D	0.00
41.70	1	27 in.	804.69	804.46	2 - H	10.49	2.25	2.11	0.0120	INLET	0.00	D - 1	0.00
37.80	1	24 in.	806.49	806.13	2 - H	12.03	2.00	1.94	0.0120	INLET	3.90	D - 2	0.00
41.70	1	33 in.	803.17	803.20	2 - F	7.95	2.75	2.15	0.0120	OUTLET*	0.00	D + 1	0.00
50.40	1	30 in.	804.72	804.42	2 - E	10.27	2.50	2.30	0.0120	INLET	0.00	F	0.00
46.80	1	27 in.	806.22	805.63	2 - H	11.77	2.25	2.16	0.0120	INLET	3.60	F - 1	0.00
37.80	1	24 in.	808.99	808.08	2 - H	12.03	2.00	1.94	0.0120	INLET	12.60	F - 2	0.00
50.40	1	33 in.	803.87	803.77	2 - E	8.49	2.75	2.33	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
41.70	1	33 in.	803.89	804.23	2 - F	7.95	2.75	2.15	0.0241	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
41.70	1	30 in.	804.90	805.29	2 - F	8.91	2.50	2.16	0.0244	OUTLET**	0.00	D - 1	0.00
34.50	1	27 in.	806.53	807.26	2 - G	8.68	2.25	2.00	0.0245	OUTLET	7.20	D - 2	0.00
41.70	1	36 in.	803.30	803.65	2 - F	7.27	3.00	2.10	0.0241	OUTLET**	0.00	D + 1	0.00
50.40	1	33 in.	805.05	805.32	2 - F	9.38	2.75	2.33	0.0241	OUTLET**	0.00	F	0.00
43.30	1	30 in.	806.52	806.89	2 - F	9.25	2.50	2.20	0.0244	OUTLET**	7.10	F - 1	0.00
34.50	1	27 in.	808.72	809.73	2 - G	8.68	2.25	2.00	0.0245	OUTLET	15.90	F - 2	0.00
50.40	1	36 in.	804.11	804.43	2 - F	8.63	3.00	2.31	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
41.70	1	36 in.	803.30	803.81	2 - F	7.27	3.00	2.10	0.0281	OUTLET**	0.00	D	0.00
41.70	1	42 in.	802.77	803.22	1 - A	6.31	3.20	2.01	0.0278	OUTLET*	0.00	D + 1	0.00
50.40	1	36 in.	804.11	804.66	2 - F	8.63	3.00	2.31	0.0281	OUTLET**	0.00	F	0.00
50.40	1	42 in.	803.23	803.67	1 - A	7.63	3.20	2.22	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
41.70	1	60 in.	802.31	802.74	1 - A	4.81	3.33	1.80	0.0332	OUTLET*	0.00	D	0.00
41.70	1	66 in.	802.20	802.65	1 - A	4.51	3.08	1.75	0.0330	OUTLET*	0.00	D + 1	0.00
50.40	1	60 in.	802.60	803.04	1 - A	5.81	3.88	1.99	0.0332	OUTLET*	0.00	F	0.00
50.40	1	66 in.	802.49	802.92	1 - A	5.45	3.49	1.93	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
41.70	1	60 in.	802.31	802.71	1 - A	4.81	2.83	1.80	0.0260	OUTLET*	0.00	D	0.00
41.70	1	66 in.	802.20	802.62	1 - A	4.51	2.67	1.75	0.0260	OUTLET*	0.00	D + 1	0.00
50.40	1	60 in.	802.60	802.99	1 - A	5.81	3.20	1.99	0.0260	OUTLET*	0.00	F	0.00
50.40	1	66 in.	802.49	802.88	1 - A	5.45	2.99	1.93	0.0260	OUTLET*	0.00	F + 1	0.00





# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 583+65 RT TO 583+86 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 799.46      **Outlet Invert Elevation (ft.) :** 799.40      **Tailwater Elevation (ft.) :** 801.71      **Overflow Elevation (ft.) :** 806.42  
**Allowable Headwater Elevation (ft.) :** 805.42      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 21.00      **Culvert Slope (ft./ft.) :** 0.0029      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 44.50      @ 10 yrs.      **Flood Discharge (cfs) :** 53.80      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
44.50	1	27 in.	804.89	804.41	2 - H	11.19	2.25	2.14	0.0120	INLET	0.00	D	0.00
42.40	1	24 in.	806.95	806.14	2 - H	13.50	2.00	1.96	0.0120	INLET	2.10	D - 1	0.00
33.00	1	21 in.	812.58	809.49	2 - H	13.72	1.75	1.73	0.0120	INLET	11.50	D - 2	0.00
44.50	1	30 in.	803.74	803.50	2 - E	9.07	2.50	2.22	0.0120	INLET	0.00	D + 1	0.00
52.70	1	27 in.	806.62	805.66	2 - H	13.25	2.25	2.19	0.0120	INLET	1.10	F	0.00
42.40	1	24 in.	809.98	808.18	2 - H	13.50	2.00	1.96	0.0120	INLET	11.40	F - 1	0.00
33.00	1	21 in.	826.39	813.08	2 - H	13.72	1.75	1.73	0.0120	INLET	20.80	F - 2	0.00
53.80	1	30 in.	804.91	804.37	2 - E	10.96	2.50	2.34	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
44.50	1	30 in.	805.14	805.05	2 - E	9.07	2.50	2.22	0.0244	INLET	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
42.20	1	27 in.	806.94	806.94	2 - G	10.61	2.25	2.12	0.0245	OUTLET	2.30	D - 1	0.00
32.40	1	24 in.	810.20	810.55	2 - G	10.31	2.00	1.89	0.0247	OUTLET	12.10	D - 2	0.00
44.50	1	33 in.	803.98	804.05	2 - F	8.35	2.75	2.21	0.0241	OUTLET**	0.00	D + 1	0.00
51.20	1	30 in.	806.93	806.63	2 - E	10.43	2.50	2.31	0.0244	INLET	2.60	F	0.00
42.20	1	27 in.	809.44	809.35	2 - G	10.61	2.25	2.12	0.0245	OUTLET	11.60	F - 1	0.00
32.40	1	24 in.	817.56	814.63	2 - G	10.31	2.00	1.89	0.0247	OUTLET	21.40	F - 2	0.00
53.80	1	33 in.	805.30	805.14	2 - E	9.06	2.75	2.40	0.0241	INLET	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
44.50	1	36 in.	803.28	803.59	2 - F	7.62	3.00	2.17	0.0281	OUTLET**	0.00	D	0.00
44.50	1	42 in.	802.65	803.07	1 - A	6.61	3.20	2.08	0.0278	OUTLET*	0.00	D + 1	0.00
53.80	1	36 in.	804.22	804.44	2 - F	8.94	3.00	2.38	0.0281	OUTLET**	0.00	F	0.00
53.80	1	42 in.	803.16	803.52	1 - A	7.99	3.20	2.29	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
44.50	1	60 in.	802.15	802.55	1 - A	5.02	3.43	1.86	0.0332	OUTLET*	0.00	D	0.00
44.50	1	66 in.	802.04	802.46	1 - A	4.70	3.16	1.81	0.0330	OUTLET*	0.00	D + 1	0.00
53.80	1	60 in.	802.45	802.86	1 - A	6.07	4.04	2.06	0.0332	OUTLET*	0.00	F	0.00
53.80	1	66 in.	802.33	802.74	1 - A	5.68	3.59	2.00	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
44.50	1	60 in.	802.15	802.53	1 - A	5.02	2.91	1.86	0.0260	OUTLET*	0.00	D	0.00
44.50	1	66 in.	802.04	802.44	1 - A	4.70	2.74	1.81	0.0260	OUTLET*	0.00	D + 1	0.00
53.80	1	60 in.	802.45	802.84	1 - A	6.07	3.30	2.06	0.0260	OUTLET*	0.00	F	0.00
53.80	1	66 in.	802.33	802.72	1 - A	5.68	3.07	2.00	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 584+63 RT TO 584+83 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 799.22      **Outlet Invert Elevation (ft.) :** 799.17      **Tailwater Elevation (ft.) :** 801.51      **Overflow Elevation (ft.) :** 806.40  
**Allowable Headwater Elevation (ft.) :** 805.40      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 20.00      **Culvert Slope (ft./ft.) :** 0.0025      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 45.60      @ 10 yrs.      **Flood Discharge (cfs) :** 55.10      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
45.60	1	27 in.	804.84	804.33	2 - H	11.47	2.25	2.15	0.0120	INLET	0.00	D	0.00
43.30	1	24 in.	807.02	806.12	2 - H	13.78	2.00	1.96	0.0120	INLET	2.30	D - 1	0.00
33.60	1	21 in.	813.35	809.61	2 - H	13.97	1.75	1.73	0.0120	INLET	12.00	D - 2	0.00
45.60	1	30 in.	803.63	803.36	2 - E	9.29	2.50	2.24	0.0120	INLET	0.00	D + 1	0.00
53.80	1	27 in.	806.65	805.62	2 - H	13.53	2.25	2.20	0.0120	INLET	1.30	F	0.00
43.30	1	24 in.	810.29	808.25	2 - H	13.78	2.00	1.96	0.0120	INLET	11.80	F - 1	0.00
33.60	1	21 in.	829.41	813.34	2 - H	13.97	1.75	1.73	0.0120	INLET	21.50	F - 2	0.00
55.10	1	30 in.	804.85	804.25	2 - E	11.22	2.50	2.36	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
45.60	1	30 in.	805.10	804.95	2 - E	9.29	2.50	2.24	0.0244	INLET	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
43.20	1	27 in.	806.97	806.92	2 - H	10.86	2.25	2.13	0.0245	INLET	2.40	D - 1	0.00
33.30	1	24 in.	810.52	810.64	2 - G	10.60	2.00	1.90	0.0247	OUTLET	12.30	D - 2	0.00
45.60	1	33 in.	803.88	803.91	2 - F	8.47	2.75	2.24	0.0241	OUTLET**	0.00	D + 1	0.00
52.30	1	30 in.	806.95	806.58	2 - E	10.65	2.50	2.33	0.0244	INLET	2.80	F	0.00
43.20	1	27 in.	809.61	809.41	2 - H	10.86	2.25	2.13	0.0245	INLET	11.90	F - 1	0.00
33.30	1	24 in.	819.04	814.84	2 - G	10.60	2.00	1.90	0.0247	OUTLET	21.80	F - 2	0.00
55.10	1	33 in.	805.26	805.03	2 - E	9.28	2.75	2.42	0.0241	INLET	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
45.60	1	36 in.	803.14	803.43	2 - F	7.71	3.00	2.20	0.0281	OUTLET**	0.00	D	0.00
45.60	1	42 in.	802.47	802.87	1 - A	6.67	3.20	2.11	0.0278	OUTLET*	0.00	D + 1	0.00
55.10	1	36 in.	804.12	804.30	2 - F	9.06	3.00	2.41	0.0281	OUTLET**	0.00	F	0.00
55.10	1	42 in.	803.00	803.35	1 - A	8.06	3.20	2.32	0.0278	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
45.60	1	60 in.	801.94	802.35	1 - A	5.06	3.69	1.89	0.0332	OUTLET*	0.00	D	0.00
45.60	1	66 in.	801.83	802.27	1 - A	4.73	3.36	1.84	0.0330	OUTLET*	0.00	D + 1	0.00
55.10	1	60 in.	802.25	802.67	1 - A	6.11	4.57	2.08	0.0332	OUTLET*	0.00	F	0.00
55.10	1	66 in.	802.13	802.54	1 - A	5.72	3.84	2.03	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
45.60	1	60 in.	801.94	802.33	1 - A	5.06	3.08	1.89	0.0260	OUTLET*	0.00	D	0.00
45.60	1	66 in.	801.83	802.24	1 - A	4.73	2.89	1.84	0.0260	OUTLET*	0.00	D + 1	0.00
55.10	1	60 in.	802.25	802.64	1 - A	6.11	3.53	2.08	0.0260	OUTLET*	0.00	F	0.00
55.10	1	66 in.	802.13	802.53	1 - A	5.72	3.25	2.03	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 586+21 RT TO 586+82 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 798.82      **Outlet Invert Elevation (ft.) :** 798.66      **Tailwater Elevation (ft.) :** 801.01      **Overflow Elevation (ft.) :** 806.40  
**Allowable Headwater Elevation (ft.) :** 805.40      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 61.00      **Culvert Slope (ft./ft.) :** 0.0026      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 46.00      @ 10 yrs.      **Flood Discharge (cfs) :** 55.60      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
46.00	1	27 in.	804.51	804.64	2 - G	11.57	2.25	2.15	0.0120	OUTLET	0.00	D	0.00
43.10	1	24 in.	806.73	807.14	2 - G	13.72	2.00	1.96	0.0120	OUTLET	2.90	D - 1	0.00
31.90	1	21 in.	813.35	812.18	2 - G	13.26	1.75	1.72	0.0120	OUTLET	14.10	D - 2	0.00
46.00	1	30 in.	803.28	803.32	2 - F	9.61	2.50	2.24	0.0120	OUTLET**	0.00	D + 1	0.00
55.60	1	27 in.	806.35	806.32	2 - H	13.98	2.25	2.20	0.0120	INLET	0.00	F	0.00
43.10	1	24 in.	810.11	809.97	2 - G	13.72	2.00	1.96	0.0120	OUTLET	12.50	F - 1	0.00
31.90	1	21 in.	830.38	817.33	2 - G	13.26	1.75	1.72	0.0120	OUTLET	23.70	F - 2	0.00
55.60	1	30 in.	804.52	804.43	2 - E	11.33	2.50	2.36	0.0120	INLET	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
46.00	1	33 in.	803.54	804.50	2 - F	8.51	2.75	2.25	0.0241	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
46.00	1	30 in.	804.78	806.31	2 - F	9.61	2.50	2.24	0.0244	OUTLET**	0.00	D - 1	0.00
36.20	1	27 in.	806.67	809.71	2 - G	9.10	2.25	2.03	0.0245	OUTLET	9.80	D - 2	0.00
46.00	1	36 in.	802.78	803.51	2 - F	7.74	3.00	2.21	0.0241	OUTLET**	0.00	D + 1	0.00
55.60	1	33 in.	804.93	806.14	2 - F	10.03	2.75	2.42	0.0241	OUTLET**	0.00	F	0.00
46.30	1	30 in.	806.66	808.80	2 - F	9.67	2.50	2.25	0.0244	OUTLET**	9.30	F - 1	0.00
36.20	1	27 in.	809.38	813.72	2 - G	9.10	2.25	2.03	0.0245	OUTLET	19.40	F - 2	0.00
55.60	1	36 in.	803.78	804.64	2 - F	9.10	3.00	2.42	0.0241	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
46.00	1	36 in.	802.78	803.86	2 - F	7.74	3.00	2.21	0.0281	OUTLET**	0.00	D	0.00
46.00	1	42 in.	802.09	802.68	1 - A	6.70	3.20	2.12	0.0278	OUTLET*	0.00	D + 1	0.00
55.60	1	36 in.	803.78	805.16	2 - F	9.10	3.00	2.42	0.0281	OUTLET**	0.00	F	0.00
55.60	1	42 in.	802.63	803.41	2 - F	8.09	3.50	2.33	0.0278	OUTLET**	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
46.00	1	60 in.	801.56	802.07	1 - A	5.07	3.64	1.90	0.0332	OUTLET*	0.00	D	0.00
46.00	1	66 in.	801.45	801.96	1 - A	4.75	3.32	1.84	0.0330	OUTLET*	0.00	D + 1	0.00
55.60	1	60 in.	801.87	802.39	1 - A	6.13	4.57	2.09	0.0332	OUTLET*	0.00	F	0.00
55.60	1	66 in.	801.75	802.25	1 - A	5.74	3.79	2.03	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
46.00	1	60 in.	801.56	801.99	1 - A	5.07	3.05	1.90	0.0260	OUTLET*	0.00	D	0.00
46.00	1	66 in.	801.45	801.89	1 - A	4.75	2.86	1.84	0.0260	OUTLET*	0.00	D + 1	0.00
55.60	1	60 in.	801.87	802.32	1 - A	6.13	3.49	2.09	0.0260	OUTLET*	0.00	F	0.00
55.60	1	66 in.	801.75	802.18	1 - A	5.74	3.22	2.03	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 592+18 RT TO 593+49 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 797.24      **Outlet Invert Elevation (ft.) :** 796.85      **Tailwater Elevation (ft.) :** 799.17      **Overflow Elevation (ft.) :** 802.70  
**Allowable Headwater Elevation (ft.) :** 801.70      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 131.00      **Culvert Slope (ft./ft.) :** 0.0030      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 48.90      @ 10 yrs.      **Flood Discharge (cfs) :** 58.90      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
48.90	1	33 in.	801.26	801.59	2 - F	9.15	2.75	2.31	0.0120	OUTLET**	0.00	D	0.00
48.90	1	30 in.	802.05	802.67	2 - F	10.29	2.50	2.28	0.0120	OUTLET**	0.00	D - 1	0.00
38.80	1	27 in.	803.46	804.76	2 - G	9.76	2.25	2.07	0.0120	OUTLET	10.10	D - 2	0.00
48.90	1	36 in.	800.83	800.98	2 - F	8.34	3.00	2.28	0.0120	OUTLET**	0.00	D + 1	0.00
58.90	1	33 in.	802.20	802.67	2 - F	10.47	2.75	2.47	0.0120	OUTLET**	0.00	F	0.00
49.10	1	30 in.	803.42	804.26	2 - F	10.33	2.50	2.29	0.0120	OUTLET**	9.80	F - 1	0.00
38.80	1	27 in.	805.48	807.27	2 - G	9.76	2.25	2.07	0.0120	OUTLET	20.10	F - 2	0.00
58.90	1	36 in.	801.49	801.75	2 - F	9.42	3.00	2.48	0.0120	OUTLET**	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
48.90	1	42 in.	800.66	801.48	2 - F	7.22	3.50	2.18	0.0237	OUTLET**	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
45.10	1	36 in.	801.48	803.31	2 - F	7.69	3.00	2.19	0.0241	OUTLET**	3.80	D - 1	0.00
37.60	1	33 in.	802.35	805.21	2 - F	7.03	2.75	2.04	0.0241	OUTLET**	11.30	D - 2	0.00
48.90	1	48 in.	800.36	800.90	1 - A	6.47	3.65	2.10	0.0235	OUTLET*	0.00	D + 1	0.00
58.90	1	42 in.	801.25	802.39	2 - F	8.36	3.50	2.40	0.0237	OUTLET**	0.00	F	0.00
45.10	1	36 in.	802.59	805.13	2 - F	7.69	3.00	2.19	0.0241	OUTLET**	13.80	F - 1	0.00
37.60	1	33 in.	803.88	807.92	2 - F	7.03	2.75	2.04	0.0241	OUTLET**	21.30	F - 2	0.00
58.90	1	48 in.	800.75	801.37	1 - A	7.79	3.65	2.31	0.0235	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
48.90	1	48 in.	800.36	801.02	1 - A	6.47	3.65	2.10	0.0275	OUTLET*	0.00	D	0.00
48.90	1	42 in.	800.66	801.86	2 - F	7.22	3.50	2.18	0.0278	OUTLET**	0.00	D - 1	0.00
41.00	1	36 in.	801.48	804.17	2 - F	6.99	3.00	2.09	0.0281	OUTLET**	7.90	D - 2	0.00
48.90	1	54 in.	800.20	800.74	1 - A	5.92	3.53	2.02	0.0273	OUTLET*	0.00	D + 1	0.00
58.90	1	48 in.	800.75	801.53	1 - A	7.79	3.65	2.31	0.0275	OUTLET*	0.00	F	0.00
56.70	1	42 in.	801.25	802.95	2 - F	8.23	3.50	2.36	0.0278	OUTLET**	2.20	F - 1	0.00
41.00	1	36 in.	802.59	806.39	2 - F	6.99	3.00	2.09	0.0281	OUTLET**	17.90	F - 2	0.00
58.90	1	54 in.	800.53	801.14	1 - A	7.12	4.11	2.23	0.0273	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
48.90	1	60 in.	800.08	800.71	1 - A	5.48	3.64	1.96	0.0332	OUTLET*	0.00	D	0.00
48.90	1	66 in.	799.96	800.55	1 - A	5.13	3.32	1.90	0.0330	OUTLET*	0.00	D + 1	0.00
58.90	1	60 in.	800.39	801.09	1 - A	6.60	4.43	2.16	0.0332	OUTLET*	0.00	F	0.00
58.90	1	66 in.	800.27	800.88	1 - A	6.18	3.78	2.10	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
48.90	1	60 in.	800.08	800.56	1 - A	5.48	3.05	1.96	0.0260	OUTLET*	0.00	D	0.00
48.90	1	66 in.	799.96	800.43	1 - A	5.13	2.86	1.90	0.0260	OUTLET*	0.00	D + 1	0.00





# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
58.90	1	60 in.	800.39	800.89	1 - A	6.60	3.47	2.16	0.0260	OUTLET*	0.00	F	0.00
58.90	1	66 in.	800.27	800.75	1 - A	6.18	3.21	2.10	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH

**Description :** Proposed Drive Pipe - 594+07 RT TO 594+31 RT

**Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 796.68      **Outlet Invert Elevation (ft.) :** 796.61      **Tailwater Elevation (ft.) :** 798.86      **Overflow Elevation (ft.) :** 801.47  
**Allowable Headwater Elevation (ft.) :** 800.47      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 24.00      **Culvert Slope (ft./ft.) :** 0.0029      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 50.80      @ 10 yrs.      **Flood Discharge (cfs) :** 61.30      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
50.80	1	36 in.	800.38	800.40	2 - F	8.67	3.00	2.32	0.0120	OUTLET*	0.00	D	0.00
50.80	1	33 in.	800.86	800.71	2 - E	8.55	2.75	2.34	0.0120	INLET	0.00	D - 1	0.00
48.70	1	30 in.	801.73	801.32	2 - E	9.92	2.50	2.28	0.0120	INLET	2.10	D - 2	0.00
50.80	1	42 in.	799.96	800.05	1 - A	7.77	2.51	2.23	0.0120	OUTLET*	0.00	D + 1	0.00
61.30	1	36 in.	801.10	800.95	2 - E	8.67	3.00	2.52	0.0120	INLET	0.00	F	0.00
57.20	1	33 in.	801.89	801.50	2 - E	9.63	2.75	2.45	0.0120	INLET	4.10	F - 1	0.00
48.70	1	30 in.	803.22	802.42	2 - E	9.92	2.50	2.28	0.0120	INLET	12.60	F - 2	0.00
61.30	1	42 in.	800.39	800.47	1 - A	8.51	3.02	2.45	0.0120	OUTLET*	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
50.80	1	48 in.	799.87	800.29	1 - A	6.98	3.65	2.14	0.0235	OUTLET*	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	50.80	1	42 in.	800.21	800.57	1 - A	7.77	3.20	2.23	0.0237	OUTLET*	0.00	D - 1	0.00
	50.80	1	36 in.	801.12	801.27	2 - F	8.67	3.00	2.32	0.0241	OUTLET**	0.00	D - 2	0.00
	50.80	1	54 in.	799.70	800.09	1 - A	6.39	3.21	2.06	0.0233	OUTLET*	0.00	D + 1	0.00
	61.30	1	48 in.	800.29	800.73	1 - A	7.94	3.65	2.36	0.0235	OUTLET*	0.00	F	0.00
	61.30	1	42 in.	800.85	801.11	2 - F	8.51	3.50	2.45	0.0237	OUTLET*	0.00	F - 1	0.00
	53.00	1	36 in.	802.32	802.28	2 - F	7.50	3.00	2.36	0.0241	OUTLET**	8.30	F - 2	0.00
	61.30	1	54 in.	800.05	800.49	1 - A	7.60	3.85	2.28	0.0233	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	50.80	1	48 in.	799.87	800.31	1 - A	6.98	3.65	2.14	0.0275	OUTLET*	0.00	D	0.00
	50.80	1	42 in.	800.21	800.60	1 - A	7.77	3.20	2.23	0.0278	OUTLET*	0.00	D - 1	0.00
	50.80	1	36 in.	801.12	801.44	2 - F	8.67	3.00	2.32	0.0281	OUTLET**	0.00	D - 2	0.00
	50.80	1	54 in.	799.70	800.11	1 - A	6.39	3.71	2.06	0.0273	OUTLET*	0.00	D + 1	0.00
	61.30	1	48 in.	800.29	800.74	1 - A	7.94	3.65	2.36	0.0275	OUTLET*	0.00	F	0.00
	61.30	1	42 in.	800.85	801.19	2 - F	8.51	3.50	2.45	0.0278	OUTLET**	0.00	F - 1	0.00
	51.10	1	36 in.	802.32	802.53	2 - F	8.69	3.00	2.33	0.0281	OUTLET**	10.20	F - 2	0.00
	61.30	1	54 in.	800.05	800.49	1 - A	7.60	4.11	2.28	0.0273	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	50.80	1	60 in.	799.58	799.99	1 - A	5.93	3.79	2.00	0.0332	OUTLET*	0.00	D	0.00
	50.80	1	66 in.	799.46	799.87	1 - A	5.56	3.43	1.94	0.0330	OUTLET*	0.00	D + 1	0.00
	61.30	1	60 in.	799.90	800.33	1 - A	7.15	4.57	2.20	0.0332	OUTLET*	0.00	F	0.00
	61.30	1	66 in.	799.78	800.20	1 - A	6.70	3.92	2.14	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	25.40	2	60 in.	798.62	799.20	1 - A	2.96	2.38	1.39	0.0332	OUTLET*	0.00	D	0.00
	25.40	2	66 in.	798.54	799.16	1 - A	2.78	2.27	1.36	0.0330	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	30.65	2	60 in.	798.84	799.34	1 - A	3.58	2.67	1.54	0.0332	OUTLET*	0.00	F	0.00
	30.65	2	66 in.	798.75	799.28	1 - A	3.35	2.52	1.50	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	50.80	1	60 in.	799.58	799.95	1 - A	5.93	3.15	2.00	0.0260	OUTLET*	0.00	D	0.00
	50.80	1	66 in.	799.46	799.84	1 - A	5.56	2.94	1.94	0.0260	OUTLET*	0.00	D + 1	0.00
	61.30	1	60 in.	799.90	800.31	1 - A	7.15	3.61	2.20	0.0260	OUTLET*	0.00	F	0.00
	61.30	1	66 in.	799.78	800.17	1 - A	6.70	3.31	2.14	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	25.40	2	60 in.	798.62	799.18	1 - B	2.96	2.08	1.39	0.0260	OUTLET*	0.00	D	0.00
	25.40	2	66 in.	798.54	799.14	1 - B	2.78	1.99	1.36	0.0260	OUTLET*	0.00	D + 1	0.00
	30.65	2	60 in.	798.84	799.31	1 - A	3.58	2.31	1.54	0.0260	OUTLET*	0.00	F	0.00
	30.65	2	66 in.	798.75	799.27	1 - B	3.35	2.20	1.50	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 595+38 RT TO 596+13 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 796.28      **Outlet Invert Elevation (ft.) :** 796.05      **Tailwater Elevation (ft.) :** 798.41      **Overflow Elevation (ft.) :** 801.31  
**Allowable Headwater Elevation (ft.) :** 800.31      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 75.00      **Culvert Slope (ft./ft.) :** 0.0031      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 51.00      @ 10 yrs.      **Flood Discharge (cfs) :** 61.50      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
51.00	1	36 in.	799.99	800.06	2 - F	8.55	3.00	2.32	0.0120	OUTLET*	0.00	D	0.00
51.00	1	33 in.	800.48	800.56	2 - F	9.40	2.75	2.35	0.0120	OUTLET**	0.00	D - 1	0.00
49.80	1	30 in.	801.36	801.45	2 - F	10.37	2.50	2.30	0.0120	OUTLET**	1.20	D - 2	0.00
51.00	1	42 in.	799.56	799.66	1 - A	7.39	2.47	2.23	0.0120	OUTLET*	0.00	D + 1	0.00
61.50	1	36 in.	800.72	800.76	2 - F	9.68	3.00	2.53	0.0120	OUTLET**	0.00	F	0.00
59.10	1	33 in.	801.51	801.54	2 - F	10.49	2.75	2.48	0.0120	OUTLET**	2.40	F - 1	0.00
49.80	1	30 in.	802.85	802.85	2 - F	10.37	2.50	2.30	0.0120	OUTLET**	11.70	F - 2	0.00
61.50	1	42 in.	799.99	800.09	1 - A	8.52	2.93	2.46	0.0120	OUTLET*	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
51.00	1	48 in.	799.48	799.96	1 - A	6.61	3.65	2.14	0.0235	OUTLET*	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
51.00	1	42 in.	799.82	800.32	1 - A	7.39	3.20	2.23	0.0237	OUTLET*	0.00	D - 1	0.00
47.50	1	36 in.	800.74	801.75	2 - F	7.96	3.00	2.24	0.0241	OUTLET**	3.50	D - 2	0.00
51.00	1	54 in.	799.31	799.75	1 - A	6.04	3.16	2.07	0.0233	OUTLET*	0.00	D + 1	0.00
61.50	1	48 in.	799.90	800.41	1 - A	7.95	3.65	2.36	0.0235	OUTLET*	0.00	F	0.00
61.50	1	42 in.	800.47	801.16	2 - F	8.52	3.50	2.46	0.0237	OUTLET**	0.00	F - 1	0.00
47.50	1	36 in.	801.95	803.23	2 - F	7.96	3.00	2.24	0.0241	OUTLET**	14.00	F - 2	0.00
61.50	1	54 in.	799.66	800.14	1 - A	7.28	3.74	2.28	0.0233	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>													
51.00	1	48 in.	799.48	800.02	1 - A	6.61	3.65	2.14	0.0275	OUTLET*	0.00	D	0.00
51.00	1	42 in.	799.82	800.62	2 - F	7.39	3.50	2.23	0.0278	OUTLET**	0.00	D - 1	0.00
44.10	1	36 in.	800.74	802.28	2 - F	7.39	3.00	2.16	0.0281	OUTLET**	6.90	D - 2	0.00
51.00	1	54 in.	799.31	799.78	1 - A	6.04	3.62	2.07	0.0273	OUTLET*	0.00	D + 1	0.00
61.50	1	48 in.	799.90	800.51	1 - A	7.95	3.65	2.36	0.0275	OUTLET*	0.00	F	0.00
59.20	1	42 in.	800.47	801.51	2 - F	8.38	3.50	2.41	0.0278	OUTLET**	2.30	F - 1	0.00
44.10	1	36 in.	801.95	804.01	2 - F	7.39	3.00	2.16	0.0281	OUTLET**	17.40	F - 2	0.00
61.50	1	54 in.	799.66	800.19	1 - A	7.28	4.11	2.28	0.0273	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>													
51.00	1	60 in.	799.18	799.73	1 - A	5.59	3.72	2.00	0.0332	OUTLET*	0.00	D	0.00
51.00	1	66 in.	799.07	799.60	1 - A	5.24	3.38	1.95	0.0330	OUTLET*	0.00	D + 1	0.00
61.50	1	60 in.	799.51	800.08	1 - A	6.75	4.57	2.21	0.0332	OUTLET*	0.00	F	0.00
61.50	1	66 in.	799.38	799.91	1 - A	6.31	3.86	2.14	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>													
51.00	1	60 in.	799.18	799.62	1 - A	5.59	3.10	2.00	0.0260	OUTLET*	0.00	D	0.00
51.00	1	66 in.	799.07	799.50	1 - A	5.24	2.91	1.95	0.0260	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
61.50	1	60 in.	799.51	799.97	1 - A	6.75	3.55	2.21	0.0260	OUTLET*	0.00	F	0.00
61.50	1	66 in.	799.38	799.83	1 - A	6.31	3.27	2.14	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 596+90 RT TO 597+31 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 795.83      **Outlet Invert Elevation (ft.) :** 795.71      **Tailwater Elevation (ft.) :** 798.08      **Overflow Elevation (ft.) :** 800.57  
**Allowable Headwater Elevation (ft.) :** 799.57      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 41.00      **Culvert Slope (ft./ft.) :** 0.0029      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 51.40      @ 10 yrs.      **Flood Discharge (cfs) :** 62.00      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
51.40	1	42 in.	799.13	799.23	1 - A	7.41	2.53	2.24	0.0120	OUTLET*	0.00	D	0.00
51.40	1	36 in.	799.57	799.60	2 - F	8.58	3.00	2.33	0.0120	OUTLET*	0.00	D - 1	0.00
51.40	1	33 in.	800.07	799.99	2 - E	8.65	2.75	2.35	0.0120	INLET	0.00	D - 2	0.00
51.40	1	48 in.	798.93	799.01	1 - B	6.63	2.26	2.15	0.0120	OUTLET*	0.00	D + 1	0.00
62.00	1	42 in.	799.57	799.66	1 - A	8.55	3.07	2.47	0.0120	OUTLET*	0.00	F	0.00
62.00	1	36 in.	800.30	800.21	2 - E	8.77	3.00	2.54	0.0120	INLET	0.00	F - 1	0.00
56.70	1	33 in.	801.12	800.85	2 - E	9.55	2.75	2.44	0.0120	INLET	5.30	F - 2	0.00
62.00	1	48 in.	799.28	799.38	1 - A	7.98	2.55	2.37	0.0120	OUTLET*	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
51.40	1	48 in.	799.05	799.49	1 - A	6.63	3.65	2.15	0.0235	OUTLET*	0.00	D	0.00





# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	51.40	1	42 in.	799.39	799.80	1 - A	7.41	3.20	2.24	0.0237	OUTLET*	0.00	D - 1	0.00
	49.40	1	36 in.	800.33	800.77	2 - F	8.25	3.00	2.29	0.0241	OUTLET**	2.00	D - 2	0.00
	51.40	1	54 in.	798.88	799.29	1 - A	6.05	3.23	2.07	0.0233	OUTLET*	0.00	D + 1	0.00
	62.00	1	48 in.	799.47	799.92	1 - A	7.98	3.65	2.37	0.0235	OUTLET*	0.00	F	0.00
	62.00	1	42 in.	800.05	800.43	2 - F	8.55	3.50	2.47	0.0237	OUTLET**	0.00	F - 1	0.00
	49.40	1	36 in.	801.56	801.96	2 - F	8.25	3.00	2.29	0.0241	OUTLET**	12.60	F - 2	0.00
	62.00	1	54 in.	799.22	799.68	1 - A	7.30	3.90	2.29	0.0233	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	51.40	1	48 in.	799.05	799.52	1 - A	6.63	3.65	2.15	0.0275	OUTLET*	0.00	D	0.00
	51.40	1	42 in.	799.39	799.86	1 - A	7.41	3.20	2.24	0.0278	OUTLET*	0.00	D - 1	0.00
	46.90	1	36 in.	800.33	801.07	2 - F	7.83	3.00	2.23	0.0281	OUTLET**	4.50	D - 2	0.00
	51.40	1	54 in.	798.88	799.31	1 - A	6.05	3.75	2.07	0.0273	OUTLET*	0.00	D + 1	0.00
	62.00	1	48 in.	799.47	799.96	1 - A	7.98	3.65	2.37	0.0275	OUTLET*	0.00	F	0.00
	61.20	1	42 in.	800.05	800.63	2 - F	8.50	3.50	2.45	0.0278	OUTLET**	0.80	F - 1	0.00
	46.90	1	36 in.	801.56	802.39	2 - F	7.83	3.00	2.23	0.0281	OUTLET**	15.10	F - 2	0.00
	62.00	1	54 in.	799.22	799.70	1 - A	7.30	4.11	2.29	0.0273	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	51.40	1	60 in.	798.75	799.22	1 - A	5.61	3.82	2.01	0.0332	OUTLET*	0.00	D	0.00
	51.40	1	66 in.	798.63	799.09	1 - A	5.25	3.45	1.95	0.0330	OUTLET*	0.00	D + 1	0.00
	62.00	1	60 in.	799.07	799.55	1 - A	6.76	4.57	2.22	0.0332	OUTLET*	0.00	F	0.00
	62.00	1	66 in.	798.95	799.41	1 - A	6.33	3.95	2.15	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	25.70	2	60 in.	797.78	798.43	1 - A	2.80	2.40	1.40	0.0332	OUTLET*	0.00	D	0.00
	25.70	2	66 in.	797.70	798.39	1 - B	2.62	2.28	1.37	0.0330	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	31.00	2	60 in.	798.01	798.58	1 - A	3.38	2.68	1.55	0.0332	OUTLET*	0.00	F	0.00
	31.00	2	66 in.	797.91	798.52	1 - A	3.16	2.53	1.50	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	51.40	1	60 in.	798.75	799.15	1 - A	5.61	3.17	2.01	0.0260	OUTLET*	0.00	D	0.00
	51.40	1	66 in.	798.63	799.05	1 - A	5.25	2.96	1.95	0.0260	OUTLET*	0.00	D + 1	0.00
	62.00	1	60 in.	799.07	799.51	1 - A	6.76	3.64	2.22	0.0260	OUTLET*	0.00	F	0.00
	62.00	1	66 in.	798.95	799.36	1 - A	6.33	3.33	2.15	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	25.70	2	60 in.	797.78	798.40	1 - B	2.80	2.09	1.40	0.0260	OUTLET*	0.00	D	0.00
	25.70	2	66 in.	797.70	798.36	1 - B	2.62	2.00	1.37	0.0260	OUTLET*	0.00	D + 1	0.00
	31.00	2	60 in.	798.01	798.55	1 - B	3.38	2.32	1.55	0.0260	OUTLET*	0.00	F	0.00
	31.00	2	66 in.	797.91	798.48	1 - B	3.16	2.21	1.50	0.0260	OUTLET*	0.00	F + 1	0.00



# UNIVERSAL CULVERT DESIGN

**PID :** 95358      **Date :** 01/20/2016      **Project :** LOR-82-Drainage Study      **Location :** Columbia Station, OH  
**Description :** Proposed Drive Pipe - 598+16 RT TO 599+00 RT      **Designer :** SJD

**HEADWATER CONTROL CODES:** INLET - Inlet Control.  
 OUTLET - Outlet Control.  
 OUTLET\* - Outlet Control with backwater curve used to compute headwater. See Figure III - 7E in HDS 5 for type flow.  
 OUTLET\*\* - Outlet Control - See Figure III - 7D in HDS 5 for type flow.  
 N/A - Flow is supercritical with low headwater and low tailwater. Control Section is at the inlet.

**Inlet Invert Elevation (ft.) :** 795.45      **Outlet Invert Elevation (ft.) :** 795.20      **Tailwater Elevation (ft.) :** 797.55      **Overflow Elevation (ft.) :** 800.33  
**Allowable Headwater Elevation (ft.) :** 799.33      or Diameter + 4 ft.      (*whichever is less*)  
**Pipe Length (ft.) :** 84.00      **Culvert Slope (ft./ft.) :** 0.0030      **Design Manning 'n' :** 0.0120  
**Design Discharge (cfs) :** 51.50      @ 10 yrs.      **Flood Discharge (cfs) :** 62.10      @ 25 yrs.

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
<b>CULVERT TYPE : CIRCULAR SMOOTH</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.20</b>							
51.50	1	36 in.	799.20	799.28	2 - F	8.67	3.00	2.33	0.0120	OUTLET**	0.00	D	0.00
51.50	1	33 in.	799.69	799.83	2 - F	9.51	2.75	2.36	0.0120	OUTLET**	0.00	D - 1	0.00
47.80	1	30 in.	800.59	800.78	2 - F	9.98	2.50	2.27	0.0120	OUTLET**	3.70	D - 2	0.00
51.50	1	42 in.	798.75	798.86	1 - A	7.50	2.52	2.24	0.0120	OUTLET*	0.00	D + 1	0.00
62.10	1	36 in.	799.93	800.02	2 - F	9.74	3.00	2.54	0.0120	OUTLET**	0.00	F	0.00
56.80	1	33 in.	800.75	800.85	2 - F	10.19	2.75	2.44	0.0120	OUTLET**	5.30	F - 1	0.00
47.80	1	30 in.	802.12	802.27	2 - F	9.98	2.50	2.27	0.0120	OUTLET**	14.30	F - 2	0.00
62.10	1	42 in.	799.19	799.30	1 - A	8.56	3.03	2.47	0.0120	OUTLET*	0.00	F + 1	0.00
<b>CULVERT TYPE : CIRCULAR CORRUGATED</b>			<b>Entrance Type : Half Headwall</b>			<b>Entrance Loss (Ke) : 0.90</b>							
<b>Corrugated Metal Pipe (2 2/3 x 1/2 in. corrugations)</b>													
51.50	1	48 in.	798.67	799.16	1 - A	6.71	3.65	2.16	0.0235	OUTLET*	0.00	D	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	51.50	1	42 in.	799.02	799.53	1 - A	7.50	3.20	2.24	0.0237	OUTLET*	0.00	D - 1	0.00
	45.20	1	36 in.	799.96	801.14	2 - F	7.61	3.00	2.19	0.0241	OUTLET**	6.30	D - 2	0.00
	51.50	1	54 in.	798.50	798.95	1 - A	6.13	3.22	2.08	0.0233	OUTLET*	0.00	D + 1	0.00
	62.10	1	48 in.	799.10	799.63	1 - A	7.98	3.65	2.38	0.0235	OUTLET*	0.00	F	0.00
	60.30	1	42 in.	799.68	800.47	2 - F	8.45	3.50	2.43	0.0237	OUTLET**	1.80	F - 1	0.00
	45.20	1	36 in.	801.19	802.73	2 - F	7.61	3.00	2.19	0.0241	OUTLET**	16.90	F - 2	0.00
	62.10	1	54 in.	798.85	799.33	1 - A	7.39	3.86	2.29	0.0233	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (3 x 1 in. corrugations)</b>														
	51.50	1	48 in.	798.67	799.26	1 - A	6.71	3.65	2.16	0.0275	OUTLET*	0.00	D	0.00
	51.50	1	42 in.	799.02	799.92	2 - F	7.50	3.50	2.24	0.0278	OUTLET**	0.00	D - 1	0.00
	41.80	1	36 in.	799.96	801.76	2 - F	7.04	3.00	2.11	0.0281	OUTLET**	9.70	D - 2	0.00
	51.50	1	54 in.	798.50	799.00	1 - A	6.13	3.72	2.08	0.0273	OUTLET*	0.00	D + 1	0.00
	62.10	1	48 in.	799.10	799.73	1 - A	7.98	3.65	2.38	0.0275	OUTLET*	0.00	F	0.00
	56.20	1	42 in.	799.68	800.87	2 - F	8.18	3.50	2.35	0.0278	OUTLET**	5.90	F - 1	0.00
	41.80	1	36 in.	801.19	803.63	2 - F	7.04	3.00	2.11	0.0281	OUTLET**	20.30	F - 2	0.00
	62.10	1	54 in.	798.85	799.42	1 - A	7.39	4.11	2.29	0.0273	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations)</b>														
Diameter exceeds 1.25 HWA	51.50	1	60 in.	798.37	798.93	1 - A	5.68	3.80	2.01	0.0332	OUTLET*	0.00	D	0.00
	51.50	1	66 in.	798.25	798.80	1 - A	5.32	3.43	1.96	0.0330	OUTLET*	0.00	D + 1	0.00
	62.10	1	60 in.	798.69	799.31	1 - A	6.85	4.57	2.22	0.0332	OUTLET*	0.00	F	0.00
	62.10	1	66 in.	798.57	799.14	1 - A	6.41	3.93	2.15	0.0330	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	25.75	2	60 in.	797.40	798.03	1 - A	2.84	2.39	1.41	0.0332	OUTLET*	0.00	D	0.00
	25.75	2	66 in.	797.32	797.99	1 - B	2.66	2.27	1.37	0.0330	OUTLET*	0.00	D + 1	0.00



# UNIVERSAL CULVERT DESIGN

	FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
	31.05	2	60 in.	797.63	798.22	1 - A	3.42	2.67	1.55	0.0332	OUTLET*	0.00	F	0.00
	31.05	2	66 in.	797.54	798.14	1 - A	3.21	2.52	1.51	0.0330	OUTLET*	0.00	F + 1	0.00
<b>Corrugated Metal Pipe (6 x 2 in. corrugations, Field Paved Invert)</b>														
Diameter exceeds 1.25 HWA	51.50	1	60 in.	798.37	798.82	1 - A	5.68	3.16	2.01	0.0260	OUTLET*	0.00	D	0.00
	51.50	1	66 in.	798.25	798.69	1 - A	5.32	2.95	1.96	0.0260	OUTLET*	0.00	D + 1	0.00
	62.10	1	60 in.	798.69	799.17	1 - A	6.85	3.62	2.22	0.0260	OUTLET*	0.00	F	0.00
	62.10	1	66 in.	798.57	799.03	1 - A	6.41	3.32	2.15	0.0260	OUTLET*	0.00	F + 1	0.00
Diameter exceeds 1.25 HWA	25.75	2	60 in.	797.40	797.98	1 - B	2.84	2.08	1.41	0.0260	OUTLET*	0.00	D	0.00
	25.75	2	66 in.	797.32	797.93	1 - B	2.66	1.99	1.37	0.0260	OUTLET*	0.00	D + 1	0.00
	31.05	2	60 in.	797.63	798.15	1 - B	3.42	2.31	1.55	0.0260	OUTLET*	0.00	F	0.00
	31.05	2	66 in.	797.54	798.07	1 - B	3.21	2.21	1.51	0.0260	OUTLET*	0.00	F + 1	0.00