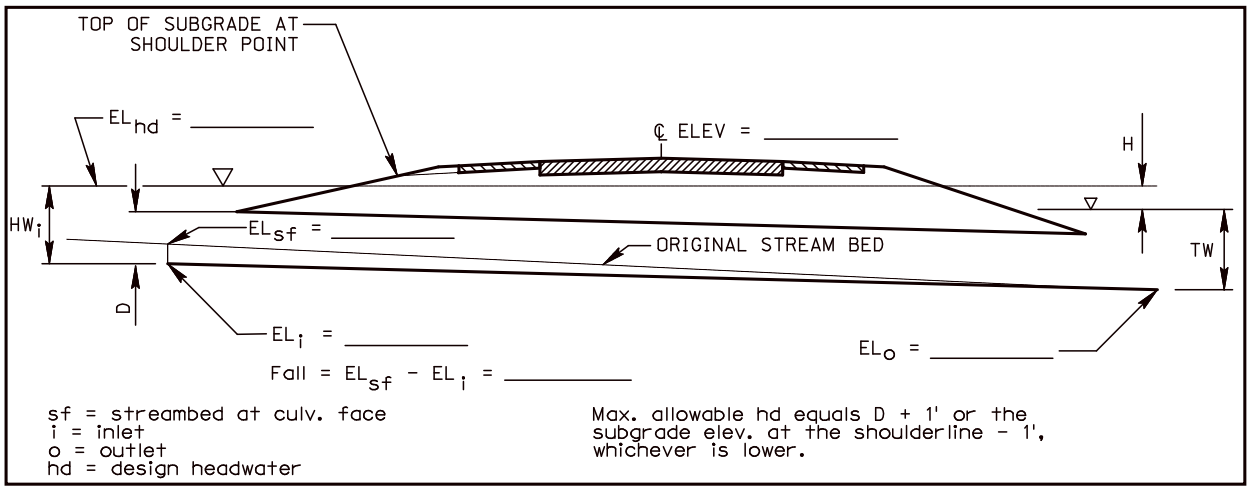
APPENDIX E
DESIGN FORMS AND CHECKLISTS

This Page Left Intentionally Blank



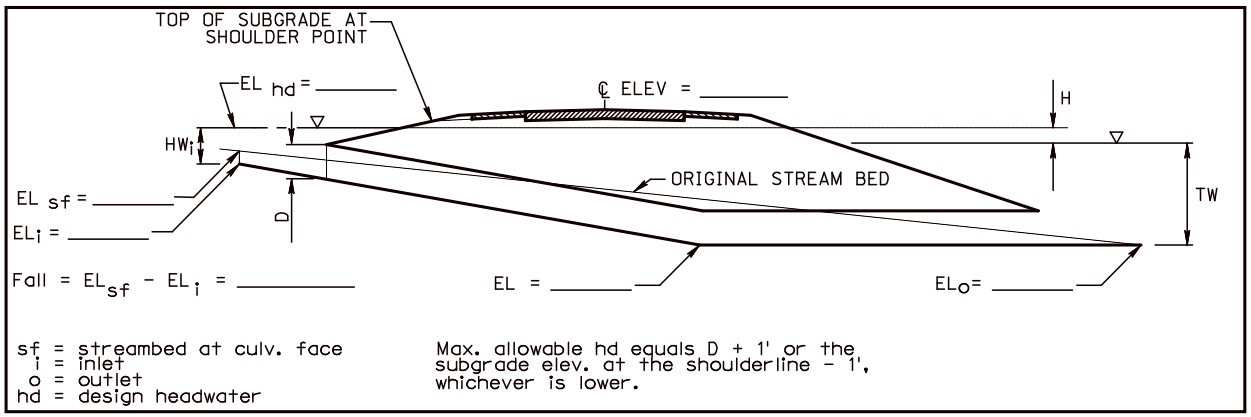
Project Location: _____

Project No: _____ Control No: _____ Designer: _____

Culvert Station: _____ Stream Name: _____

1- Roadway Design Standard _____
2- Average Daily Traffic (and date) _____
3- Design Frequency _____
   Comments _____
4- Design Discharge _____
5- Design Tailwater Level _____
6- Vertical Orientation (Broken Back, Breaks?) _____
7- Slope:
   Upstream: _____ Culvert: _____ Downstream: _____
8- Horizontal Orientation _____
9- Skew _____
10- Fill Height (See the "Pipe Material Policy"):
   Maximum _____ Minimum _____
11- Culvert Shape:
   Circular: _____ Box or Rectangular: _____ Arch: _____ Elliptical: _____
12- Culvert Type:
   Concrete: _____ Metal: _____ Plastic: _____
13- End Treatment, (FES, Headwall, etc.) _____
14- Design Headwater:
   Depth: _____ Elevation: _____
15- Elevations of Buildings / Upstream Considerations _____
   Comments _____
16- Outlet Velocity _____
17- Downstream Considerations _____
18- Velocity Protection Device _____
19- Velocity Control Device _____
20- Alternates Considered _____
21- Economic Comparison of Alternatives _____
22- Comments _____
_____
_____
_____
_____

Exhibit E.1 Culvert Design Checklist/Data



Project Location: _____

Project No: _____ Control No: _____ Designer: _____

Culvert Station: _____ Stream Name: _____

1- Roadway Design Standard _____
2- Average Daily Traffic (and date) _____
3- Design Frequency _____
   Comments _____
4- Design Discharge _____
5- Design Tailwater Level _____
6- Vertical Orientation (Broken Back, Breaks?) _____
7- Slope:
   Upstream: _____ Culvert: _____ Culvert: _____
   Culvert: _____ Downstream: _____
8- Horizontal Orientation _____
9- Skew _____
10- Fill Height (See the "Pipe Material Policy"):
   Maximum_____ Minimum_____
11- Culvert Shape:
   Circular: _____ Box or Rectangular: _____ Arch: _____ Elliptical: _____
12- Culvert Type:
   Concrete: _____ Metal: _____ Plastic: _____
13- End Treatment (FES, Headwall, etc.) _____
14- Design Headwater:
   Depth: _____ Elevation: _____
15- Elevations of Buildings / Upstream Considerations _____
   Comments _____
16- Outlet Velocity _____
17- Downstream Considerations _____
18- Velocity Protection Device _____
19- Velocity Control Device _____
20- Alternates Considered _____
21- Economic Comparison of Alternatives _____
22- Comments _____

Exhibit E.2 Culvert Design Checklist/Data

PROJECT: _____ STATION: _____ CULVERT DESIGN FORM

C.N. _____ SHEET _____ OF _____ DESIGNER/DATE: _____ / _____

REVIEWER/DATE: _____ / _____

HYDROLOGICAL DATA

☐ METHOD: _____

☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____

☐ CHANNEL SHAPE: _____

☐ ROUTING: _____ ☐ OTHER: _____

DESIGN FLOWS/TAILWATER

R.I. (YEARS) FLOW (cfs) TW (ft)

_____ _____ _____

_____ _____ _____

_____ _____ _____

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	Headwater Calculations: Inlet Control HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	Outlet Control TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATIONS	OUTLET VELOCITY	COMMENTS

TECHNICAL FOOTNOTES:

(1) Use Q/NB for box culverts

(2) HW_i/D = HW/D or HW_i/D from design charts

(3) Fall = $EL_{sf} - EL_i$; fall is zero for culverts on grade

(4) $EL_{hi} = HW_i + EL_i$ (Invert of inlet control section)

(5) TW based on downstream control or flow depth in channel.

(6) h_o = TW or $(d_c+D/2)$ (Whichever is greater)

(7) $H = [1+k_e+(29n^2L)/R^{1.33}]\ V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

COMMENTS/DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: _____

SHAPE: _____

MATERIAL: _____ n _____

ENTRANCE: _____

DEFINITIONS:

A. Cross-Sectional Area of the Barrel
a. Approximate
d_c. Critical Depth
D. Interior Height of Culv. Barrel
f. Culvert Face
g. Acceletration Due to Gravity (32.2 ft/s/s)
hd. Design Headwater
hi. Headwater in Inlet Control
ho. Headwater in Outlet Control
i. Inlet Control Section
k_e. Entrance Loss Coefficient
L. Length of Culvert Barrel
N. Number of Culvert Barrels
NB. Number of Boxes
o. Outlet
Q. Uniform Discharge, cfs
S. Slope of Culvert
s_f. Streambed at Culvert Face
TW. Tailwater Depth Above the Outlet Invert
V. Average Velocity in Culv. Barrel (V=Q/A)

Exhibit E.3 Culvert Design Form

Drainage Computation Form

Location: ____________
Project Name: ____________
Project No.: ____________

Return Period: ____________
Zone: ____________
Drainage Area: ____________
Pipe Material: ____________
N Value: ____________

Computed By: ____________
Date: ____________
Checked By: ____________
Date: ____________
Page: ____________

HYDROLOGY												STORM SEWER HYDRAULICS					
STR. No.	Sta.	From / To	Inlet Time T_i (min)	Travel Time T_t (min)	Time of Conc. T_c (min)	Rainfall Intensity I (in/hr)	INCREMENTAL			CUMULATIVE		Length (ft)	Slope (%)	Size (in)	Capacity Q_{full} (cfs)	Vel V_{full} (fps)	Remarks
							Area A (acres)	Runoff Coeff. C	C x A	C x A	Runoff Q (cfs)						

Exhibit E.4 Drainage Computation Form

Hydraulic Grade Line Computation Form

Location: _____
Project Name: _____
Project No.: _____

Return Period: _____
Zone: _____

Computed By: _____
Date: _____
Checked By: _____
Date: _____
Page: _____

HYDRAULIC GRADE LINE CALCULATIONS																														
STR. No.	Sta.	PIPE DATA															ENERGY LOSSES						EGL Eleva.	Vel. Head (ft)	HGL Eleva.
		From / To	Pipe Size (in)	n	Pipe Length (ft)	Pipe Slope (%)	Area A (acres)	Runoff q (cfs)	V (q) (fps)	Capacity Q full (cfs)	q/Q full	d/D	Normal Depth (ft)	Critical Depth (ft)	Type of Flow	H_f (ft)	H_j2 (ft)	H_e (ft)	H_m (ft)	H_b (ft)			

Exhibit E.5 Hydraulic Grade Line Computation Form