



June 30, 2015

Scott Benjamin, P.E.
Walsh/Granite JV
4 Penn Center Blvd., Suite 100
Pittsburgh, PA 15276

**Re: S.R. 2034, Section 000
JV531 Bridge Replacement
S.R. 2034 (Sunset Drive) over Branch of Pike Run
West Pike Run Township, Washington County
Streamlined Type, Size and Location Submission**

Gentlemen:

HDR Engineering, Inc. is pleased to submit 1 copy of the Streamlined Type, Size and Location (TS&L) Submission for the proposed S.R. 2034 (Sunset Drive) over Branch of Pike Run structure. The Streamlined TS&L Submission is in accordance with RBRP Modified Design Manual, Part 4, PP1.9.3.3. Type, Size and Location approval is requested for this structure. Enclosed for your review and approval are the following items:

- Type, Size and Location Drawings (2 sheets)
- Design Calculations

The following information for the proposed structure TS&L is provided in accordance with RBRP Modified Design Manual, Part 4, Section PP 1.9.3.3:

1) Location:

S.R. 2034, Section 000
Segment 0050 Offset 0000
Station 23+19.57
S.R. 2034 (Sunset Drive) over Branch of Pike Run
West Pike Run Township, Washington County

2) Recommended Structure:

Single cell precast concrete box culvert with a 23'-0" x 7'-0" opening and post-tensioned longitudinally.
10'-0" precast end segment with integral wingwalls at the upstream end and a 14'-0" precast end segment with integral wingwalls at the downstream end.
Culvert is at-grade with a variable depth bituminous overlay.

- 3) **Span Lengths:**
One (1), 23'-0" clear span
- 4) **Roadway Width:**
Out-to-out: 26'-6 1/2", includes two 1'-9 1/4" wide structure mounted guide rails. Barrel extends 6" past back face of concrete barrier.
Curb-to-curb 22'-0", includes two 9'-0" lanes and two 2'-0" shoulders.
- 5) **Skew Angles:**
90° 00' 00"
- 6) **Vertical and Horizontal Clearance:**
 - Minimum Required Effective Opening Height: 3'-0" (BD-632M)
 - Existing Opening Height: 11'-0"
 - Provided Effective Opening Height Under Bridge: 6'-0"
- 7) **Type of Substructure Recommended:** N/A
- 8) **Deck Joints:** None
- 9) **Bearing Type and Location:** N/A
- 10) **Deck and Off Structure Drainage:**
 - On Structure: None required (natural)
 - Off Structure: None required (natural)
- 11) **Design Methodology for Superstructure:**
Load and Resistance Factor Design in accordance with AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010, as Supplemented by RBRP Modified Design Manual Part 4. Live load distribution is based on AASHTO live load distribution methods as modified by RBRP Modified Design Manual Part 4.

Additional information from QA Form D-512:

1. Project Information

S-Number: Pending
Design ADT: 185
Design ADTT: 17
Design Year: 2037

2. Culvert Type and Geometry

Fill Height: 0.67' Min – 1.12' Max

Length: 25'-7" (along centerline of roadway, begin structure to end structure)

Fish Passage: Yes

3. General

Backfill Unit Density: 120 psf

Railroad Live Load: No

pH Foundation Material: N/A

pH Water: 8.5

Method of Corrosion Protection: Epoxy Coated Rebar and Type II Cement

Anticipated Removal of Unsuitable Material: No

Anticipated Settlement: <1.0"

Inlet End Wall Provided: Precast End Section w/ Apron and Flared Wings

Inlet Scour Protection Provided: R-6 Min. Grouted Rock Protection 5'-0"

Outlet End Wall Provided: Precast End Section w/ Apron and Flared Wings

Outlet Scour Protection Provided: R-6 Min. Grouted Rock Protection 5'-0"

4. Design Requirements

Design Life: Greater than 100 years

Box Culvert Type: Precast

Why C.I.P: N/A

Computer Program Used: BXLRFD 2.6.0.0

Method of Abrasion Protection: None

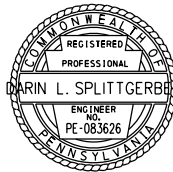
If you have any questions regarding this submission, please contact me, at (412) 497-6051. Thank you.

Sincerely yours,

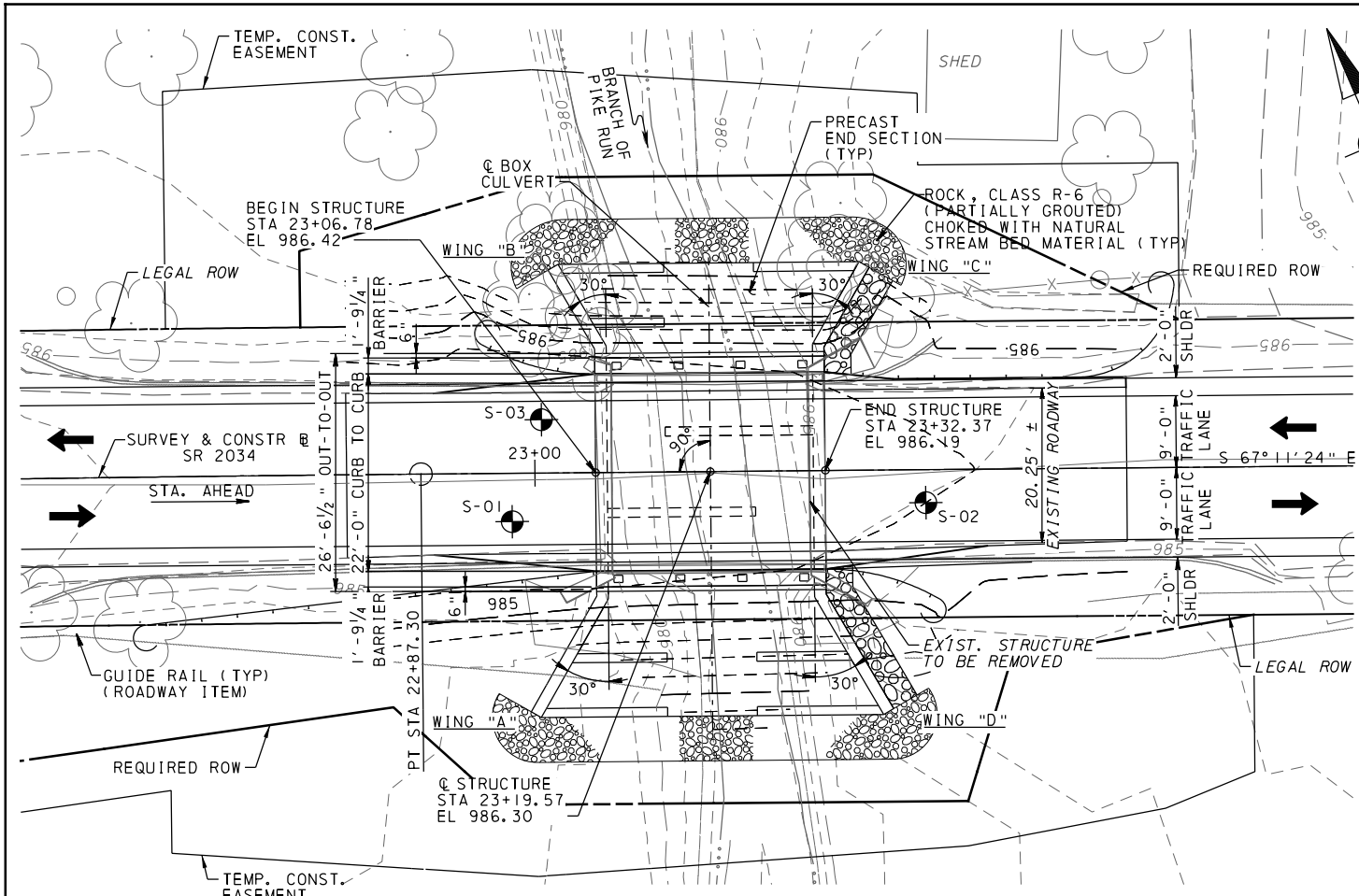
HDR ENGINEERING, INC.

for

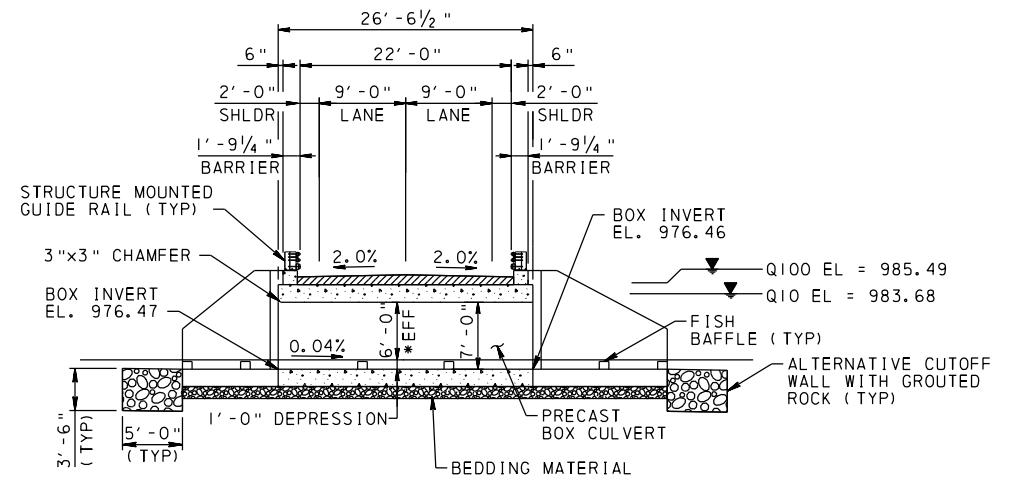
Jason Fuller, P.E.
Deputy Project Manager



Enclosure



PLAN
5 0 5 10 FEET



* MIN VERTICAL CLEARANCE REQUIRED = 3'-0"
MIN VERTICAL CLEARANCE PROVIDED = 6'-0"

SECTION ALONG C OF CULVERT

5 0 5 10 FEET

BORING TABLE		
BORING	STATION	OFFSET
S-01	22+97	5.5' RT.
S-02	23+44	4.0' RT
S-03	23+01	5.0' LT

HYDRAULIC DATA
BRANCH OF PIKE RUN

RETURN PERIOD - 10 YR FLOOD
 WATER SURFACE EL = 983.68
 Q = 493 CFS
 V = 3.32 FPS

RETURN PERIOD - 100 YR FLOOD
 WATER SURFACE EL = 985.49
 Q = 1070 CFS
 V = 4.45 FPS

DRAINAGE AREA 3.71 SQ. MILES
 WATERWAY OPENING 138 SQ. FEET

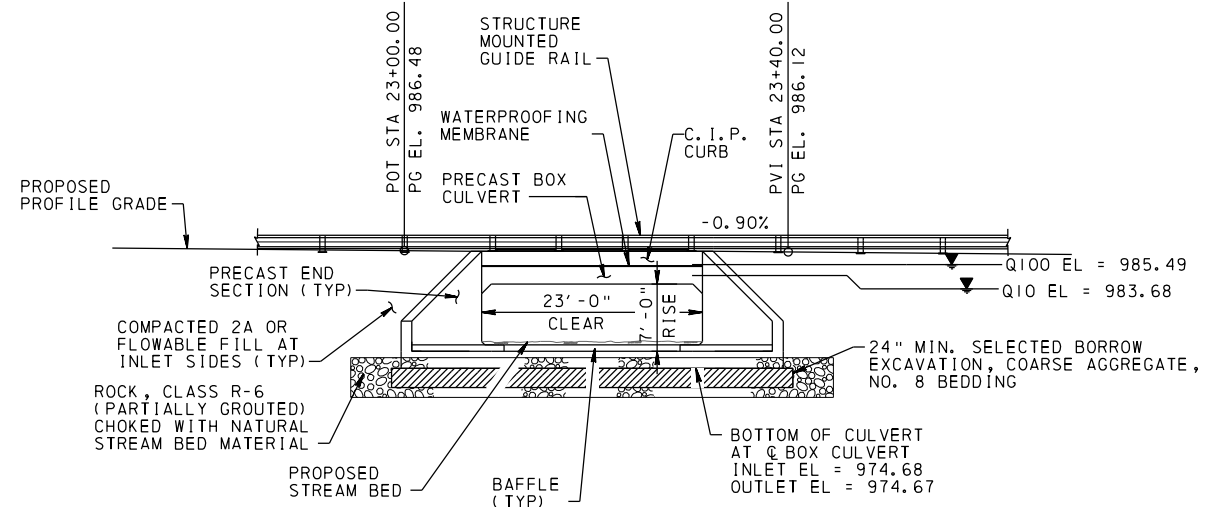
FLOOD OF RECORD - UNKNOWN
 WATER SURFACE ELEVATION (FLOOD) - UNKNOWN

HORIZONTAL CURVE DATA

SR 2034 SURV & CONSTR B
 BRIDGE ON TANGENT

VERTICAL CURVE DATA

BRIDGE ON TANGENT
 SEE ELEVATION FOR GRADE BREAKS



ELEVATION
5 0 5 10 FEET

- LEGEND:**
- ⊕ SOIL BORING
 - ➔ INDICATES TRAFFIC DIRECTION
 - - - EXISTING CONTOURS
 - — — PROPOSED CONTOURS

Mark	Description	By	Chk'd.	Recm'd	Date
REVISIONS					

JV 531 | BRIDGE KEY 34977 | BMS 62203405000000 | MPMS 51507

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

WASHINGTON COUNTY
 S.R. 2034 SECTION 000
 SEG. 0050 OFF. 0000
 S.R. 2034 STA. 23+19.57
 OVER BRANCH OF PIKE RUN
 23'-0" x 7'-0" PRECAST CONCRETE BOX CULVERT
 TYPE, SIZE AND LOCATION

RECOMMENDED _____ SHEET 1 OF 2
 S-

PREPARED BY:

HDR
 HDR ENGINEERING, INC.
 11 STANWIX STREET
 SUITE 800
 PITTSBURGH, PA 15222

SIGNATURE & DATE _____ **7-22-15**

DESCRIPTION	DWG. NO.	APP. DATE
PA STRUCTURE MOUNTED GUIDE RAIL BARRIER	BC-706M	11-26-13
ANCHOR SYSTEMS	BC-734M	10-26-10
WALL CONSTR & EXP JOINT DETAILS	BC-735M	10-26-10
REINFORCEMENT BAR FABRICATION DETAILS	BC-736M	5-18-12
BRIDGE DRAINAGE	BC-751M	11-26-13
TYPICAL WATERPROOFING AND EXPANSION DETAILS	BC-788M	5-18-12
MECHANICAL CONNECTION DETAILS	BC-798M	11-26-13
SUPPLEMENTAL DRAWINGS		

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 PLOT DATE: 07-15-2015 9:37:52 AM
 FILE: RBRP-JV531-0PELO1

GENERAL NOTES

PROVIDE MATERIALS AND PERFORM WORK IN ACCORDANCE WITH SPECIFICATIONS, RBRP MODIFIED PUB NO 408, AND THE CONTRACT SPECIAL PROVISIONS.

DESIGN SPECIFICATIONS:

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 2010, AND AS SUPPLEMENTED BY RBRP MODIFIED DM4.

LIVE LOAD DISTRIBUTION TO THE CULVERT IS BASED UPON RBRP MODIFIED DM-4 DISTRIBUTION FACTOR METHOD.

DESIGN IN ACCORDANCE WITH THE LRFD METHOD.

DEAD LOAD INCLUDES AN ADDITIONAL 30 LB/SF FOR FUTURE WEARING SURFACE.

DESIGN LIVE LOADS:

PHL-93 OR P-82 (204 KIP PERMIT LOAD)

USE A CONCRETE STRENGTH ($f'c$) OF 5000 PSI MINIMUM AT 28 DAYS FOR PRECAST BOX AND PRECAST END SECTIONS. REINFORCEMENT BAR $F_y = 60000$ PSI

USE CLASS A CEMENT CONCRETE FOR BAFFLES.

USE CLASS AA CEMENT CONCRETE FOR CAST-IN-PLACE CURB.

COORDINATE, LOCATE AND CONDUCT ALL WORK RELATED TO PUBLIC AND PRIVATE UTILITIES IN ACCORDANCE WITH RBRP MODIFIED PUB NO 408, SECTIONS 105.06 AND 107.12.

FOR CAST-IN-PLACE CONCRETE, PROVIDE GRADE 60 REINFORCING STEEL THAT MEETS THE REQUIREMENTS OF ASTM A 615/A 615M, A 996/A 996M OR A 706/A 706M. DO NOT WELD GRADE 60 REINFORCING STEEL BARS UNLESS SPECIFIED. DO NOT USE RAIL STEEL A 996/A 996M REINFORCEMENT BARS IN CURBS, BAFFLES OR CUT-OFF WALLS, OR WHERE BENDING OR WELDING OF THE REINFORCEMENT BARS IS INDICATED.

DO NOT EXCEED A 2 FT. DIFFERENCE IN FILL ELEVATION ON THE SIDES OF THE BOX CULVERT DURING PLACEMENT OF A BACKFILL. DO NOT ALLOW THE WHEELS OF ROLLERS TO COME CLOSER THAN 1 FT. TO THE FACES OF THE STRUCTURE DURING COMPACTION OF THE BACKFILL.

PROVIDE MINIMUM LAP AND EMBEDMENT LENGTH OF REINFORCEMENT IN ACCORDANCE WITH STANDARD DRAWING BC-736M, UNLESS NOTED OTHERWISE.

PROVIDE 2" CONCRETE COVER ON REINFORCEMENT BARS EXCEPT AS NOTED.

CHAMFER EXPOSED CONCRETE EDGES 1"X1" EXCEPT AS NOTED.

REFER TO THE WATERWAY PERMIT FOR TIME PERIODS IN WHICH WORK IS PROHIBITED.

VERIFY THAT THE EXISTING STRUCTURAL MEMBERS DO NOT CONTAIN LEAD OR OTHER TOXIC MATERIAL.

NOTIFY THE REGIONAL HEADQUARTERS OF THE PA FISH AND BOAT COMMISSION PRIOR TO CONSTRUCTION AND COOPERATE WITH THE FISH COMMISSION DURING CONSTRUCTION.

SOIL IS CORROSIVE. USE TYPE II CEMENT WITH A MAXIMUM WATER/CEMENT RATIO OF 0.45 AND EPOXY COATED REINFORCING STEEL IN ALL STRUCTURES. DO NOT USE ADDITIVES CONTAINING CHLORIDES IN THE SUBSTRUCTURE CONCRETE. QUALITY CONTROL CYLINDERS MUST ATTAIN STRENGTHS OF 1500 PSI PRIOR TO STRIPPING FORMWORK AND 2000 PSI PRIOR TO LOADING, OR AS DIRECTED BY THE DEVELOPMENT ENTITY'S ENGINEER OF RECORD.

PRIOR TO FOUNDATION CONSTRUCTION, THE DEVELOPMENT ENTITY REPRESENTATIVE WILL EVALUATE THE BEARING MATERIAL. REPLACE ALL SOFT, WEATHERED OR OTHERWISE INCOMPETENT BEDROCK WITH CLASS C CEMENT CONCRETE TO PROPOSED BOTTOM OF AGGREGATE AND AS-DIRECTED. REPLACE ALL SOFT OR OTHERWISE INCOMPETENT SOILS WITH NO. 8 COARSE AGGREGATE.

THE DEVELOPMENT ENTITY'S ENGINEER OF RECORD MAY CHANGE THE FOOTING ELEVATION OR ANY DIMENSIONS NECESSARY TO PROVIDE A PROPER FOUNDATION.

DEWATER EXCAVATIONS EXTENDING BELOW GROUNDWATER LEVEL.

REMOVE THE EXISTING FOUNDATION ELEMENTS IN THEIR ENTIRETY IN THE LOCATIONS WHERE THE EXISTING FOUNDATION ELEMENTS INTERFERE WITH THE PROPOSED STRUCTURE AND TO A MINIMUM OF TWO (2) FEET BELOW BEDDING.

DESIGN TEMPORARY EXCAVATIONS IN ACCORDANCE WITH THE SOIL AND ROCK PARAMETERS PROVIDED IN THE STRUCTURE FOUNDATION REPORT, INCLUDING ISSUED ADDENDUMS TO THE REPORT, AND IN ACCORDANCE WITH CURRENT OSHA REQUIREMENTS (29 CFR PART 1926.650-.265, SUBPART P). IF THE CONTRACTOR ELECTS TO NOT USE THE SOIL AND ROCK PARAMETERS PROVIDED IN THE STRUCTURE FOUNDATION FOR DESIGN OF THE TEMPORARY EXCAVATION SUPPORT SYSTEM, ASSUME TYPE C SOILS (UNLESS SOIL TYPE IS CONFIRMED BY DEVELOPMENT ENTITY'S ENGINEER OF RECORD).

THE SITE IS SEISMIC CLASS D.

BLASTING IS NOT PERMITTED.

LOAD RATING SUMMARY (ADTT = 17)

		PRECAST BOX CULVERT (W/FWS)					
		H20	HS20	ML-80	TK-527	PHL-93	P-82
		TOP SLAB	TOP SLAB	TOP SLAB	TOP SLAB	TOP SLAB	TOP SLAB
INVENTORY RATING (IR)	ELEMENT						
	LOCATION	0.11L	0.11L	0.11L	0.89L	0.11L	---
	LIMIT STATE	STR-I	STR-I	STR-I	STR-I	STR-I	---
	RATING FACTOR	2.49 (V)	2.06 (V)	1.67 (V)	1.80 (V)	1.52 (V)	---
OPERATING RATING (OR)	ULTIMATE CAPACITY	-28.98 K	-28.98 K	-28.98 K	28.98 K	-28.98 K	---
	ELEMENT	TOP SLAB	TOP SLAB	TOP SLAB	TOP SLAB	TOP SLAB	TOP SLAB
	LOCATION	0.11L	0.11L	0.11L	0.89L	0.11L	0.11L
	LIMIT STATE	STR-II	STR-II	STR-II	STR-II	STR-IA	STR-II
OPERATING RATING (OR)	RATING FACTOR	3.23 (V)	2.66 (V)	2.16 (V)	2.34 (V)	2.41 (V)	1.63 (V)
	ULTIMATE CAPACITY	-28.98 K	-28.98 K	-28.98 K	28.98 K	-28.98 K	-28.98 K

RATING NOTES:

- RATINGS IN THIS TABLE ARE BASED ON LOAD AND RESISTANCE FACTOR DESIGN (LRFD).
- THE ULTIMATE CAPACITY RELATES TO THE GOVERNING RATING. SHEAR RATINGS PROVIDE CAPACITY IN KIPS. MOMENT RATINGS PROVIDE CAPACITY IN KIP-FEET.
- V INDICATES RATING CONTROLLED BY SHEAR. M INDICATES RATING CONTROLLED BY MOMENT.

Mark	Description	By	Chk'd.	Recm'd	Date
REVISIONS					

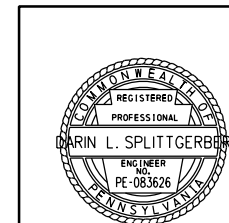
JV 531 | BRIDGE KEY 34977 | BMS 62203400500000 | MPMS 51507

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

WASHINGTON COUNTY
S.R. 2034 SECTION 000

SEG. 0050 OFF. 0000
S.R. 2034 STA.23+19.57
OVER BRANCH OF PIKE RUN
23'-0" x 7'-0" PRECAST CONCRETE BOX CULVERT

GENERAL NOTES



RECOMMENDED _____

SHEET 2 OF 2

S-

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CULVERT USER MODULE

Step 1: Enter Calculation Book Information

JV No	Designer		Checker		Calculation Type
	Initials	Date	Initials	Date	
531	ECS	6/25/2015	DLS	6/29/2015	DRAFT

Step 2: Enter Structure Length, Roadway Width, and Number of Culvert Segments

Structure Length = **26.542** ft (Structure Out-To-Out Distance along Centerline of Culvert)
 Roadway Width = **22.000** ft (Curb-To-Curb Distance Perpendicular to Centerline of Roadway)
 No. Segments = **5.000** (Number of Barrel Segments within the Structure Length)
 Note: Segment Length = (Structure Length)/(No. Segments)

Step 3: Select a Standard Culvert Design for Analysis

Design No. **188**

Step 4: Modify Culvert Design Details if Necessary

Standard Design No.	Clear Span ¹ (ft)	Clear Rise (ft)	Fill (ft)	Member Thicknesses (in)			Top Slab Reinforcement			Bottom Slab Reinforcement			Wall Reinforcement	Concrete f _c (ksi)	Continuity Slab Thickness (in)
				Top Slab	Bottom Slab	Walls	T1	T2	T3	B1	B2	B3	W1		
							Prov'd A _s (X @ X)	Prov'd A _s (X @ X)	Prov'd A _s (X @ X)	Prov'd A _s (X @ X)	Prov'd A _s (X @ X)	Prov'd A _s (X @ X)	Prov'd A _s (X @ X)		
188	23.00	7.00	See Step 5	22.0	21.5	15.5	#5 @ 5.5"	#8 @ 5.5"	#8 @ 5.5"	#4 @ 5.5"	#8 @ 5.5"	#8 @ 5.5"	#4 @ 5.5"	5.0	0.00

Step 5: Define the Custom Fills to be Analyzed

Analyze	Print PDF Calcs	Fill Depth (ft)	Ratings				Service Checks				General Rebar Checks	Detailing Checks
			Top Slab	Bott. Slab	Left Wall	Right Wall	Top Slab	Bott. Slab	Left Wall	Right Wall		
X	X	0.669	1.60	1.93	3.02	3.02	OK	OK	OK	OK	OK	OK
X	X	1.124	1.52	1.80	2.92	2.92	OK	OK	OK	OK	OK	OK

Step 6: Run the Program

Step 7: Save Electronic Files
See "Directions" for details.

According to BXLRRD Rating, Design Scenario 2 is the controlling box culvert design scenario. Continue with design scenario 2 from this point forward.

DRAFT PRECAST BOX CULVERT DESIGN

CALCULATIONS & ANALYSIS RATINGS

CLEAR SPAN x CLEAR HEIGHT x FILL

23.000' x 7.000' x 1.124'

Designer: ECS
Date: 6/25/2015

Checker: DLS
Date: 6/29/2015

TABLE OF CONTENTS

DESCRIPTION	PAGE
ASSUMPTIONS	1
BXLRFD DATA SUMMARY	2
BXLRFD INPUT SUMMARY	3
BXLRFD BARRIER DEAD LOAD	6
STEEL REINFORCEMENT	7
LAP LENGTH CALCULATIONS	10
BXLRFD RATING SUMMARY	13
BXLRFD OUTPUT FILE	16

HDR Computation

Project: PENNDOT P3	Computed: JDD	Date: 6/25/2015
Subject: PRECAST BOX CULVERT DESIGN	Checked: JS	Date: 6/29/2015
Task: PRECAST CULVERT DESIGN ASSUMPTIONS	Sheet: 1	Of: 16

ASSUMPTIONS

- Single cell precast box culvert.
- See Sheet 2/16 for details of precast culvert and roadway geometry.
- No shear reinforcement.
- PA Structure Mounted Guide Rail Barrier is used for analysis.
- 12" x 12" Haunches.
- Material properties per BD-632M (Sheet 4 of 13) and per these calculations (Sheet 2 of 16).
- Concrete clear cover per BD-632M, Sheet 4 of 13:
 - Top bars in top slab: 2.5" clear cover (all cases considered).
 - Top bars in bottom slab: 2.0" clear cover.
 - All other bars: 1.5" clear cover.
- Additional 30 PSF included for future wearing surface per PennDOT DM-4, Section 12.11.2.1 and BD-632M, Sheet 4 of 13, Note #6.
- Refer to "BXLRFD Input" summary for additional assumptions.

HDR Computation

Project: PENNDOT P3
 Subject: PRECAST BOX CULVERT DESIGN
 Task: BXLRFD DATA SUMMARY

Computed: ECS
 Checked: DLS
 Sheet: 2

Date: 6/25/2015
 Date: 6/29/2015
 Of: 16

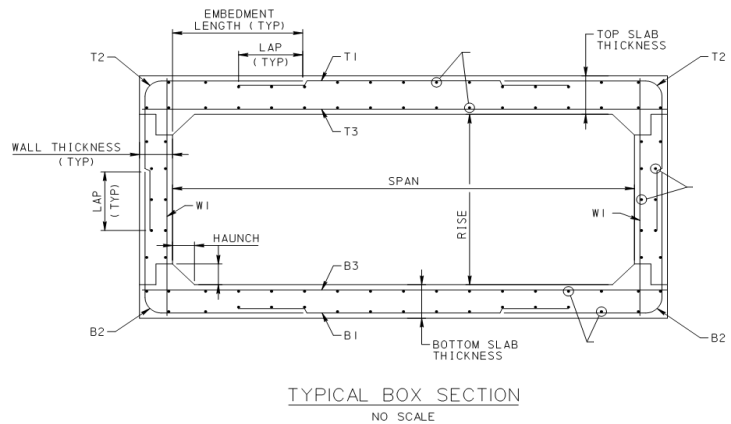
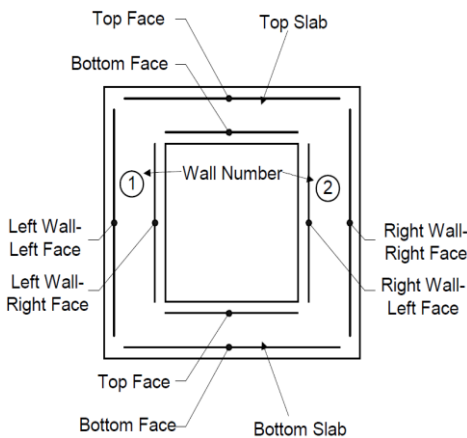
23' x 7' Opening

ROADWAY DATA	
STRUCTURE OUT-TO-OUT DISTANCE =	26.542 FT
CURB-TO-CURB DISTANCE =	22.000 FT
PA STRUCTURE MOUNTED GUIDE RAIL BARRIER WIDTH =	21.3 IN
NUMBER OF SEGMENTS =	5.0
CONTINUITY SLAB THICKNESS =	0.00 IN
UPSTREAM INVERT EL =	--
DOWNSTREAM INVERT EL =	--
SLOPE OF CULVERT FLOOR =	-- FT/FT
MINIMUM PAVEMENT EL =	--
MIN PAVE EL HORIZ OFFSET FROM U.S. INVERT =	-- FT
MAXIMUM PAVEMENT EL =	--
MAX PAVE EL HORIZ OFFSET FROM U.S. INVERT =	-- FT
MAXIMUM PAVEMENT EL AT CURB =	--
MINIMUM PAVEMENT THICKNESS =	13.49 IN
MAXIMUM PAVEMENT THICKNESS =	13.49 IN
TOTAL THEORETICAL FILL =	13.49 IN

Total depth of asphalt above the top of the continuity slab.
 Max. pavement thickness = Min. pavement thickness = Constant pavement thickness
 Theoretical total fill (continuity slab thickness + pavement thickness)

STRUCTURE DATA																	
f _c (ksi)	Clear Span (ft)	Clear Height (ft)	Segment Width (ft)	Top Slab			Bottom Slab			Walls					Haunches		
				Top Slab Thick (in.)	-	Bot. Steel Area (T3) (in ² /ft)	Bot. Slab Thick (in.)	Top Steel Area (B3) (in ² /ft)	-	Wall Thickness (in)	Wall 1 Left Face Steel Area (in ² /ft)	Wall 1 Right Face Steel Area (in ² /ft)	Wall 2 Left Face Steel Area (in ² /ft)	Wall 2 Right Face Steel Area (in ² /ft)	Horizontal Dimension (in)	Vertical Dimension (in)	
5.0	23.00	7.00	5.308	22.00	-	1.724 #8 @ 5.5"	21.50	1.724 #8 @ 5.5"	-	15.50	1.724 #8 @ 5.5"	0.436 #4 @ 5.5"	0.436 #4 @ 5.5"	1.724 #8 @ 5.5"	12.00	12.00	
				Top Steel Area			Bottom Steel Area										
				Left	T2 Reinf 1 = 1.724 in ² /ft	T2 Reinf 1 = #8 @ 5.5"	T2 Range 1 = 4.80 ft	B2 Reinf 1 = 1.724 in ² /ft	B2 Reinf 1 = #8 @ 5.5"	B2 Rang 1 = 4.80 ft							
				Middle	T1 Reinf 2 = 0.676 in ² /ft	T1 Reinf 2 = #5 @ 5.5"	T1 Range 2 = 18.20 ft	B1 Reinf 2 = 0.436 in ² /ft	B1 Reinf 2 = #4 @ 5.5"	B1 Rang 2 = 18.20 ft							
				Right	T2 Reinf 3 = 1.724 in ² /ft	T2 Reinf 3 = #8 @ 5.5"	T2 Range 3 = 23.00 ft	B2 Reinf 3 = 1.724 in ² /ft	B2 Reinf 3 = #8 @ 5.5"	B2 Rang 3 = 23.00 ft							

Note: Transverse reinforcement for slabs and walls are defined in the "Rebar Checks" sheet.



HDR Computation

Project:	PENNDOT P3	Computed:	JDD	Date:	#####
Subject:	PRECAST BOX CULVERT DESIGN	Checked:	JS	Date:	#####
Task:	BXLRFD INPUT SUMMARY	Sheet:	3	Of:	16

FILE: C-STR_P3-23.000x7.000x1.124.dat					
COMMAND	PARAMETER	INPUT	UNITS	CODE / COMMENTS	
TTL	Line 1 Line 2 Line 3	See right See right See right		JV 185 - Precast Concrete Box Culvert Culvert Size: 23.000' x 7.000' x 1.124' (Clear Span x Clear Height x Fill) Computed: ECS (Date: 06/25/2015); Checked: DLS (Date:06/29/2015)	
CTL	System of Units Structure Type Type of Run Precast or Cast-in-place Bottom Slab Top Slab Support Frame Support	 1 AR P Y		Default: US Customary Units Box culvert has 1 cell Analyze, spec.check, and rate members. Geometry and reinforcement are known. Precast structure Bottom slab is present Leave blank for precast culverts. Leave Blank for culverts with bottom slabs.	
MAT	f'c for All Members f'c for Top Slab Reinforcement Grade Reinforcement Type Alpha Rebar Size or Wire Diam. Epoxy Coated Bars Concrete Unit Weight for DL Concrete Unit Weight for E	 B 150.0 145.0	ksi ksi ksi degrees # lb/ft ³ lb/ft ³	Default = 5.0 ksi (in accordance with BD-632M, Sheet 4 of 13). Leave blank for precast culverts. Default = 60 ksi (in accordance with BD-632M, Sht. 4 of 13). Reinforcement bars used. Leave blank for designs that exclude shear reinf. (per D-10 preferences) Leave blank for analysis runs. N/A (Not used for precast culverts). See AASHTO LRFD Table 3.5.1-1 & C3.5.1. • For $f'c \leq 5.0$ ksi, Unit Weight = $0.145 + 0.005 k/ft^3 = 0.150 k/ft^3 = 150 \text{ lb/ft}^3$ • For $5.0 < f'c \leq 15.0$ ksi, Unit Weight = $0.140 + (0.001)(f'c) + 0.005 k/ft^3 = 145 + (1.0)(f'c) \text{ lb/ft}^3$ See AASHTO LRFD Table 3.5.1-1. • For $f'c \leq 5.0$ ksi, Unit Weight = $0.145 k/ft^3 = 145 \text{ lb/ft}^3$ • For $5.0 < f'c \leq 15.0$ ksi, Unit Weight = $0.140 + (0.001)(f'c) k/ft^3 = 140 + (1.0)(f'c) \text{ lb/ft}^3$.	
DIM	Clear Span Clear Height Top Slab Thickness Bottom Slab Thickness Left Wall Thickness Right Wall Thickness Interior Wall Thickness Fill Grade Top Slab Grade U-channel Left Wall Height U-channel Right Wall Height	23.00 7.00 22.00 21.50 15.50 15.50 %	ft ft in. in. in. in. in. in. in. in. ft ft	Based on hydraulic requirements. Based on hydraulic requirements. As required by design. Minimum thickness for precast culverts ($S \geq 8$ ft): • Min. = 12 in for $S > 12'$ (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 13 in for $S > 12'$ (per BD-632M, Sheet 4 of 13). • Controlling Min. = 13 in As required by design. Minimum thickness for precast culverts ($S \geq 8$ ft): • Min. = 12.5 in for $S > 12'$ (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 13 in for $S > 12'$ (per BD-632M, Sheet 4 of 13). • Controlling Min. = 13 in As required by design. Minimum thickness for precast culverts ($S \geq 8$ ft): • Min. = 12 in for $S > 12'$ (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 13 in for $S > 12'$ (per BD-632M, Sheet 4 of 13). • Controlling Min. = 13 in As required by design. Minimum thickness for precast culverts ($S \geq 8$ ft): • Min. = 12 in for $S > 12'$ (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 13 in for $S > 12'$ (per BD-632M, Sheet 4 of 13). • Controlling Min. = 13 in Leave blank for a one cell culvert. Leave blank for a culverts at grade. Default = 0.0%. Top slab thickness does not vary. Leave blank for a box culvert. Leave blank for a box culvert.	
LDC	Earth Weight/Density Height of Fill Number of Lanes Live Load Surcharge Live Load Overlay Weight/Density Overlay Thickness Future Wearing Surface Max LL Distr Length Segment Length Mult Presence Reduction PA Traffic Factor Fatigue Dynamic Load Allow Ductility Factor Redundancy Factor Importance Factor P-82 Max Dynamic Load Allow Live Load Override Min Equiv. Fluid Press Max Equiv Fluid Press Barrier Dead Load Approach Slab DL Left Wall Approach Slab LL Left Wall Approach Slab DL Right Wall Approach Slab LL Right Wall Ratings without FWS Backfill Type	140 1.124 1 3.0 A 0.00 0.00 30.00 22 5.308 0.35	lb/ft ³ ft ft lb/ft ³ in lb/ft ² ft ft lb/ft ³ lb/ft ³ kips/ft	Wt. avg. of 5" continuity slab (150 pcf) & 13.488" constant overlay thickness (140 pcf). Theoretical fill = continuity slab thickness + minimum pavement thickness 22' curb-to-curb / 12' per lane = 1.83 lanes --> use 1 lanes Per DM-4, Section 3.11.6.4, 3.0 for box culverts PHL-93,P-82, ML-80, TK527, HS20 and H20 Set = 0.00 since fill is defined in Parameters #1 & #2 Set = 0.00 since fill is defined in Parameters #1 & #2 PennDOT DM-4, Section 12.11.2.1; BD-632M, Note #6. Curb-to-curb distance. Refer to BXLRFD User's Manual - Fig. 5.10-1 5 Segments at 5.308' = 26.542' Default = 1.0 (only value allowed by BXLRFD) This parameter is no longer used and should be left blank. This parameter is no longer used and should be left blank. Default = 1.0 (DM-4, Section 1.3.3) Default = 1.0 (DM-4, Section 1.3.4) Default = 1.0 (DM-4, Section 1.3.5) Default = 1.2 (DM-4, Section 3.6.2.1) Default = 0 (the program determines when live load is applicable) Default = 45 lb/ft ³ (the min. specified in DM-4 Table 3.11.5.5-2) Default = 70 lb/ft ³ (the max. specified in DM-4 Table 3.11.5.5-2) See separate calcs: 0.3 kif per PennDOT BD-617M, Sht. 1 of 17 + extra barrier No approach slab per D-10. No approach slab per D-10. No approach slab per D-10. No approach slab per D-10. Default = N Default = O (Conservative assumption for LL through fill, BXLRFD Manual 3.3.17.2)	

HDR Computation

Project: PENNDOT P3	Computed: JDD	Date: #####
Subject: PRECAST BOX CULVERT DESIGN	Checked: JS	Date: #####
Task: BXLRFD INPUT SUMMARY	Sheet: 4	Of: 16

FILE: C-STR_P3-23.000x7.000x1.124.dat				
COMMAND	PARAMETER	INPUT	UNITS	CODE / COMMENTS
HCH	Top Left x	12.00	in.	Minimum allowed per PennDOT District 10-0 = 12" Minimum allowed per DM-4, Section 12.11.1 = 6". Use 12" as the standard for all culverts.
	Top Left y	12.00	in.	Minimum allowed per PennDOT District 10-0 = 12" Minimum allowed per DM-4, Section 12.11.1 = 6". Use 12" as the standard for all culverts.
	Top Right x		in.	Leave Blank. Uses "Top Left x" value by default.
	Top Right y		in.	Leave Blank. Uses "Top Left y" value by default.
	Bottom Left x		in.	Leave Blank. Uses "Top Left x" value by default.
	Bottom Left y		in.	Leave Blank. Uses "Top Left y" value by default.
	Bottom Right x		in.	Leave Blank. Uses "Top Left x" value by default.
	Bottom Right y		in.	Leave Blank. Uses "Top Left y" value by default.
	Top Interior x		in.	Leave blank. No interior wall.
	Top Interior y		in.	Leave blank. No interior wall.
	Bottom Interior x		in.	Leave blank. No interior wall.
	Bottom Interior y		in.	Leave blank. No interior wall.
	CVR	Top Slab Top Cover	2.50	in.
Top Slab Bottom Cover		1.50	in.	Default: 1.50 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
Bottom Slab Top Cover		2.00	in.	Default: 2.00 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
Bottom Slab Bot Cover		1.50	in.	Default: 1.50 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
All Wall Covers		1.50	in.	Default: 1.50 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
Footing Top Cover			in.	Leave blank (no footing).
Footing Bottom Cover			in.	Leave blank (no footing).
TSR	Slab Number	1		Single cell culvert.
	Face	T		Top slab, top reinforcement.
	Range Distance 1	4.800	ft	Over full width.
	Reinforcement Size 1	8		Range 1 Reinforcement: #8 @ 5.5"
	Spacing 1	5.5	in.	
	Range Distance 2	18.200		
	Reinforcement Size 2	5		Range 2 Reinforcement: #5 @ 5.5"
	Spacing 2	5.5		
	Range Distance 3	23.000		
	Reinforcement Size 3	8		Range 3 Reinforcement: #8 @ 5.5"
Spacing 3	5.5			
TSR	Slab Number	1		Single cell culvert.
	Face	B		Top slab, bottom reinforcement.
	Range Distance	23	ft	Over full width.
	Reinforcement Size	8		Reinforcement: #8 @ 5.5"
Spacing	5.5	in.		
BSR	Slab Number	1		Single cell culvert.
	Face	T		Bottom slab, top reinforcement.
	Range Distance	23	ft	Over full width.
	Reinforcement Size	8		Reinforcement: #8 @ 5.5"
Spacing	5.5	in.		
BSR	Slab Number	1		Single cell culvert.
	Face	B		Bottom slab, bottom reinforcement.
	Range Distance 1	4.800	ft	Over full width.
	Reinforcement Size 1	8		Range 1 Reinforcement: #8 @ 5.5"
	Spacing 1	5.5	in.	
	Range Distance 2	18.200	ft	
	Reinforcement Size 2	4		Range 2 Reinforcement: #4 @ 5.5"
	Spacing 2	5.5	in.	
	Range Distance 3	23.000	ft	
	Reinforcement Size 3	8		Range 3 Reinforcement: #8 @ 5.5"
Spacing 3	5.5	in.		
WLR	Wall Number	1		Left wall.
	Face	L		Left face of wall.
	Range Distance	7.000	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	8		Reinforcement: #8 @ 5.5"
Spacing	5.5	in.		
WLR	Wall Number	1		Left wall.
	Face	R		Right face of wall.
	Range Distance	7.000	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	4		Reinforcement: #4 @ 5.5"
Spacing	5.5	in.		
WLR	Wall Number	2		Right wall.
	Face	L		Left face of wall.
	Range Distance	7.000	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	4		Reinforcement: #4 @ 5.5"
Spacing	5.5	in.		

HDR Computation

Project: PENNDOT P3
 Subject: PRECAST BOX CULVERT DESIGN
 Task: BXLRFD INPUT SUMMARY

Computed: JDD
 Checked: JS
 Sheet: 5

Date: #####
 Date: #####
 Of: 16

FILE: C-STR_P3-23.000x7.000x1.124.dat				
COMMAND	PARAMETER	INPUT	UNITS	CODE / COMMENTS
WLR	Wall Number	2		Right wall.
	Face	R		Right face of wall.
	Range Distance	7.000	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	8		Reinforcement: #8 @ 5.5"
	Spacing	5.5	in.	
OIN	Input File Echo	1		Print echo of input file.
	Input Commands	1		Print the input commands.
	Input Summary			Leave Blank. Default: 1. See BXLRFD User's Manual Table 6.26-1
OUR	Section Properties			Leave blank. Default: 0 (BXLRFD Table 6.27-1). Do not print section properties
	Live Load Rating	1		Use "1" to print capacities in the output file
	Rating Summary			Leave blank. Default: 1 (BXLRFD Table 6.27-1). Print Rating Summary
	DL Effects and Capacities			Leave blank. Default: 1 (BXLRFD Table 6.27-1). Print DL effects and capacities
	Flexural Reinforcement			Leave blank. Default: N/A for Analysis Run (BXLRFD Table 6.27-1).
	Shear Design			Leave blank. Default: N/A for Analysis Run (BXLRFD Table 6.27-1).
	Foundation Pressure			Leave blank. Default: 0 (BXLRFD Table 6.27-1). Do not print foundation pressure
	Quantities			Leave blank. Default: 1 (BXLRFD Table 6.27-1). Print Quantities
	Serviceability Table	1		Print serviceability table
	Serviceability Summary			Leave blank. Default: 1 (BXLRFD Table 6.27-1). Print serviceability summary table.
Foundation Pressure Summary			Leave blank. Default: 1 (BXLRFD Table 6.27-1). Print foundation pressure summary table	

INPUT FILE (Analysis)
 TTL JV 185 - Precast Concrete Box Culvert
 TTL Culvert Size: 23.000' x 7.000' x 1.124' (Clear Span x Clear Height x Fill)
 TTL Computed: ECS (Date: 06/25/2015); Checked: DLS (Date:06/29/2015)
 CTL ,1,AR,P,Y,,
 MAT ,,B,,,,150,145
 DIM 23,7,22,21.5,15.5,15.5,,,,,
 LDC 140,1.124,1,3,A,0,0,30,22,5.308,,,,,,,,,0.35,,,,,
 HCH 12,12,,,,,,,,,
 CVR 2.5,1.5,2,1.5,1.5,,
 TSR 1,T,4.8,8,5.5,18.2,5,5.5,23,8,5.5
 TSR 1,B,23,8,5.5
 BSR 1,T,23,8,5.5
 BSR 1,B,4.8,8,5.5,18.2,4,5.5,23,8,5.5
 WLR 1,L,7,8,5.5
 WLR 1,R,7,4,5.5
 WLR 2,L,7,4,5.5
 WLR 2,R,7,8,5.5
 OIN 1,1,
 OUR ,1,,,,,1,,