Lorain Co.– LOR-20-2.05
PID No. 118318

Analysis Summary

The drainage design was done in accordance with requirements specified within the Ohio Department of Transportation Location and Design Manual, Volume 2. The relevant sections are noted below and shown within the report.

- Storm Sewer Design Criteria - Section 1104.3
- Ditch Design Criteria – Section 1102.3
- Pavement Drainage Criteria - Section 1103.3.1,2,3
- Erosion Control & BMP Design Criteria – Section 1111.2

Storm Drainage Summary

The storm drainage system was designed to maintain the existing drainage patterns present at the intersection to the maximum extent practicable. The existing storm drainage system under SR511 appears to drain to a low point on the east side of the road. To provide more sufficient hydraulic connectivity, the proposed drainage design reroutes this drainage with the main drainage system through this intersection, ultimately discharging to the East Fork Vermillion River which is the same conveyance that the existing drainage eventually flows to. Additionally, the break in the proposed drainage ditch on the west side of the south leg is approximately 100 feet north of the break in the existing ditch due to limits of the existing topography and the required geometry of the proposed roundabout, creating a very slight diversion.

To avoid acquiring additional right-of-way, the proposed ditch depths are limited to the minimum depth required. Because of this and the roundabout geometry, curb openings are proposed to drain the gutter to the ditches utilizing a curb opening similar to DM-4.1. To conservatively approximate the spacing requires of these curb cuts, they were input into CDSS as CB-3As.

The existing storm drain along the west side of SR511 (south leg) is being replaced with elliptical pipe of an equivalent size. Elliptical pipe was used in this location to allow for necessary additional cover over the pipe. Private storm drain lines coming from the Green Circle Growers parcel tie into the existing system, making determination of drainage area and discharge not practicable; therefore, the proposed pipe was sized to provide comparable hydraulic capacity to the existing condition.

ODOT provided direction to modify the initially-proposed Vegetated Biofilter (VBF) on the south side of US20 west of the roundabout to avoid impacts to the existing waterline. To eliminate these impacts, the revised VBF design requires a low point that will be drained by a catch basin and conveyed in the proposed storm drainage system. Additionally, **the revised VBF geometry reduces the total BMP treatment credit below the treatment requirement** as noted below.

BMP and Erosion Control

BMP Summary

The total project EDA for this project is 4.55 Acres. Per L&D V2, Section 1111.2, post-construction BMPs are required. The project does not create any new impervious area in new permanent right-of-way, so water quantity BMPs are not required per Section 1111.3.

The design team evaluated BMPs that treat only water quality and found that Vegetated Biofilters would provide the most effective treatment on the project site. Existing right-of-way on the south side of US 20 is utilized for proposed vegetated biofilters. The proposed BMPs provide 0.88 acres of treatment. **Therefore, the project does not meet the water quality treatment requirement of 0.92 acres due to ODOT direction to avoid utility impact as noted above.**

Erosion Control Summary

Erosion Control measures are proposed where necessary to ensure the stability of curb openings and pipe outfalls. The relatively flat slopes and small drainage areas of the proposed ditches do not necessitate additional temporary linings beyond seed and mulch for the majority of the site, with 3 ditch segments requiring temporary matting.

1102.2.5 Channel Linings and Bank Stabilization

Use soil bioengineering to stabilize banks for channel relocations or ditch stream captures.

Specify native plant species.

C1102.2.5

Bank stabilization using bioengineering is covered in the previously referenced USDA publication as well as the AASHTO Model Drainage Manual [AASHTO, 2005] and the USDA Engineering Field Handbook, Chapter 16 [USDA, 1996], part 650. The design procedures and methods for determining the effectiveness of the traditional channel linings are covered in HEC-15 [Kilgore & Cotton, 2005].

1102.3 Ditch Design Criteria

1102.3.1 Design AEP Storm

C1102.3.1

Determine the depth of flow and the shear stress based on the following recurrence interval:

SR-511
US-20

ADT	Depth of Flow Design AEP	Shear Stress Design AEP
≤3000	20%	50%
>3000	10%	20%

Use a minimum time of concentration of 15 minutes for analyzing the first ditch section.

If erosion has been an issue or the time calculated is significantly less, then a minimum time of 10 minutes can be assumed.

Where a flexible ditch lining is required for calculated stresses exceeding the allowable for seed, the minimum width of the lining is 4 feet. Additional required width is in increments of 3.5 feet. The installed width of all ditch linings is centered on the flow line of the ditch.

4 feet is a common commercially available width for flexible ditch lining. Additional width is achieved with a minimum 0.5 foot overlap.

The depth of flow is limited to an elevation 1 foot below the edge of pavement for the design discharge. The depth of flow in toe of slope ditches is further limited such that the design AEP discharge does not overtop the ditch bank.

1102.3.2 Ditch Protection

The shear stress for the Design AEP storm cannot exceed the values shown in Table 1102-1 for the various flexible linings.

Table 1102-1

Permanent Protection	
Protective Lining	**Allowable Shear Stress (lbs./ft²)**
Seed (659)	0.40
Sodding, Ditch Protection (660)	1.0
Temporary Protection	
Item 670 Ditch Erosion Protection Mat Type __	
B	1.50
C	2.0
E	2.25
G	1.75

The temporary linings will reach a value of 1.0 lbs./ft² upon vegetation establishment. Use the temporary lining shear stress values in Table 1102-1 on a temporary basis of 6 months or less.

Calculate the actual shear stress by the following equation:

$$\tau_{ac} = 62.4DS$$

Where:

D = Water surface depth (ft)

S = Channel slope (ft/ft)

τ_{ac} = Actual shear stress (lbs./ft²)

If the calculated shear stress exceeds that shown in table 1102-1 then use the following permanent shear stress values within the stated limitations:

A. Seeding and Erosion Control with Turf Reinforcing Mat, SS836, where the ditch slope is 10% or less. Allowable shear stress for each type is as follows:

Turf Reinforcing Mat Shear Stress	
Type	**Allowable Shear Stress (lbs./ft²)**
1	3
2	4
3	5
4	6

B. Type B, C or D Rock Channel Protection may be used to line the ditch if the nearest point of the

lining is outside the design clear zone or located behind guardrail or barrier. The actual shear stress is based upon the parameters of the channel slope and depth of flow for the 20% AEP discharge. The shear equation is valid for discharges less than 50 cfs with slopes less than 10%. Allowable shear stress for each type is as follows:

Rock Channel Protection Shear Stress	
Type	**Allowable Shear Stress (lbs./ft²)**
B	6
C	4
D	2

C. Type B or C RCP may be utilized for lining ditches on profile grades from 10%- 25% that carry flow from the end of a cut section down to the valley floor. Use HEC-15 [Kilgore & Cotton, 2005] procedures with a safety factor of 1.5 for steep gradient channels. Contact OHE for further guidance of RCP usage for 20% AEP discharges greater than or equal to 50 cfs.

D. Tied concrete block mat protection, Item 601, may be used for slopes and channels. Provide for slopes that are 2:1 or flatter. Provide for channels when side slopes are 2:1 or flatter and profile grades are 25% or less. The matting may be used within the clear zone when the top of the blocks are flush with the finished grade. Install per the manufacturer recommendations. The allowable shear stress for each type is 12 lbs/ft². Specify Type 1 underlayment as the standard option. Provide Type 2 Underlayment in areas where establishing vegetation is difficult, such as, areas with poor soils, flumes on steep slopes, or areas subjected to constant flow.

E. Articulating concrete block revetment system, Item 601, may be used for slopes and channels with 2:1 or flatter side slopes. The revetment may be used within the clear zone when the top of the blocks are flush with the finished grade. Install per the manufacturer recommendations. The allowable shear stress for each type is as follows:

Articulating Concrete Block Revetment System Shear Stress	
Type	**Allowable Shear Stress (lbs./ft²)**
1	17
2	20
3	23

F. Consider a concrete lining only as a last resort. Contact OHE, before using a concrete lining.

1102.3.3 Roughness

Suggested values for Manning's Roughness Coefficient **n** for the hydraulic analysis of various types of open water carrier linings are listed in Table 1102-2.

Table 1102-2

Manning's Roughness Coefficient	
Type of Lining	**n**
Bare Earth	0.02
Seeded	0.03
Sod	0.04
Turf Reinforcing Mat	0.04
Item 670	0.04
Concrete	0.015
Bituminous	0.015
Grouted Riprap	0.02
Tied Concrete Block	0.03
Rock Channel Protection	0.06 for ditches 0.04 for large channels

1102.3.4 Catch Basin Types

CB-4, CB-5 and CB-8 basins are suitable for the standard roadside designs covered in LD1. The bases can be expanded to accommodate larger diameter conduits by specifying SCD CB-4A , 5A, 8A.

The bar spacing can be decreased for safety reasons, by specifying Grate **E** for CB-4 and Grate **B** for CB-5. Provide 150 feet of Item 670, Ditch Erosion Protection, upstream of all CB-4, CB-5 and CB-8 basins, regardless of velocity.

The following catch basin types are generally recommended based on the size and shape of the ditch.

C1102.3.4

The tilt built into the basin top provides a self-cleaning feature when the basins are used on continuous grades. The wide bar spacing minimizes the possibility of clogging, resulting in an efficient design.

A. CB-4 for depressed medians wider than 40 feet.

B. CB-5 for 40-foot radius roadside or median ditches. Use Grate **B** where pedestrian traffic may be expected.

C. CB-8 for 20-foot radius roadside or depressed medians 40 feet or less in width.

D. CB-2-2-A in trapezoidal ditches where the basin is in a rural area. Locate the basin outside of the design clear zone or behind guardrail. The capacity of the side inlet window, for unsubmerged conditions, may be determined by the standard weir equation:

$$Q = CLH^{3/2}$$

Where **C** is a weir coefficient, generally 3.0, L is the length of opening in feet, **H** is the distance from the bottom of the window to the surface of the design flow in feet. The catch basin grate is considered as an access point for the storm sewer and its capacity to admit flow is ignored for continuous grades.

E. Use a CB-2-2-B basin where minor, non-clogging flows are involved such as yard sections and the small triangular area created by the guardrail treatment for a depressed median at bridge terminals. Provide CB-2-3 through CB-2-6 basins where a larger base is required to accommodate conduits greater than 21 inches in span or sewer junctions, or where a CB-2-2-B will not provide adequate access to the sewer.

F. In urban areas use Standard Side Ditch Inlets to drain small areas of trapped water behind curbs and/or between driveways.

For lower ADT highways consider using CB-5, CB-2-2-A, within the safety limitations as discussed in Section D above, and CB-2-2-B. Where additional capacity is required use CB-4.

For catch basin details refer to the Hydraulic SCDs.

1102.3.5 Calculated Catch Basin Spacing

Provide catch basins to intercept flow from open water carriers when the depth of flow or shear exceeds the maximum allowable for the design storm for all highway classifications.

When the calculated depth of flow or shear exceeds the maximum allowable at the checkpoint in the ditch, a catch basin or ditch lining will be required. However, the capacity of the catch basin may be

C1102.3.5

CB-4, CB-5 and CB-8, include an earth dike. The dike is approximately 12 inches above the flowline of the grate, immediately downstream from the catch basin and serves to block the flow on continuous grades and create a sump condition.

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - South Ditch **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
202+67	203+00	R	33.00	4.00	3.00	3.00	0.0152	0.10	0.10	0.85	0.09	Seed	3.59	5	0.030	15.52	1.03	0.07	0.32	0.07	4.44
												Seed	4.05	10	0.040	15.61	0.89	0.09	0.36	0.09	4.56
203+00	203+50	R	49.00	4.00	3.00	3.00	0.0163	0.11	0.21	0.85	0.18	Seed	3.52	5	0.030	16.12	1.38	0.11	0.64	0.11	4.64
												Seed	3.96	10	0.040	16.30	1.19	0.14	0.72	0.14	4.82
203+50	204+00	R	50.00	4.00	3.00	3.00	0.0160	0.11	0.32	0.85	0.27	Seed	3.46	5	0.030	16.65	1.57	0.14	0.95	0.14	4.82
												Seed	3.89	10	0.040	16.91	1.35	0.17	1.07	0.17	5.05
204+00	204+50	R	50.00	4.00	3.00	3.00	0.0160	0.11	0.43	0.85	0.37	Seed	3.41	5	0.030	17.13	1.72	0.16	1.26	0.16	4.97
												Seed	3.83	10	0.040	17.46	1.49	0.21	1.41	0.21	5.23
204+50	205+00	R	50.00	4.00	3.00	3.00	0.0200	0.11	0.54	0.85	0.46	Seed	3.36	5	0.030	17.55	2.00	0.21	1.55	0.17	5.03
												Seed	3.77	10	0.040	17.95	1.72	0.27	1.74	0.22	5.31
205+00	205+15	R	15.00	4.00	3.00	3.00	0.0231	0.03	0.57	0.85	0.49	Seed	3.35	5	0.030	17.67	2.13	0.24	1.63	0.17	5.02
												Seed	3.76	10	0.040	18.08	1.84	0.31	1.83	0.21	5.29

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - South Ditch Sag **Designer :** BTS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:** 0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	3.00	**Type 2:** 4.00	**Type 3:**	5.00
RCP	**Type B:**	6.00			

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
205+64	205+15	R	54.00	4.00	3.00	3.00	0.0037	0.11	0.11	0.85	0.09	Seed	3.50	5	0.030	16.32	0.67	0.03	0.33	0.11	4.68
												Seed	3.94	10	0.040	16.53	0.57	0.03	0.37	0.15	4.87

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - South Ditch, After Sag **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
205+64	206+00	R	36.00	4.00	3.00	3.00	0.0333	0.08	0.08	0.85	0.07	Seed	3.59	5	0.030	15.50	1.21	0.10	0.24	0.05	4.29
												Seed	4.05	10	0.040	15.58	1.06	0.13	0.27	0.06	4.37
206+00	206+50	R	51.00	4.00	4.00	4.00	0.0137	0.11	0.19	0.85	0.16	Seed	3.51	5	0.030	16.20	1.22	0.09	0.56	0.10	4.84
												Seed	3.95	10	0.040	16.38	1.04	0.12	0.64	0.13	5.07
206+50	207+00	R	41.00	4.00	4.00	4.00	0.0195	0.11	0.30	0.85	0.25	Seed	3.46	5	0.030	16.63	1.59	0.15	0.88	0.12	4.99
												Seed	3.89	10	0.040	16.87	1.38	0.19	0.99	0.16	5.25
207+00	207+38	R	20.00	4.00	3.00	4.50	0.0050	0.12	0.42	0.85	0.36	Seed	3.43	5	0.030	16.92	1.14	0.07	1.23	0.22	5.67
												Seed	3.86	10	0.040	17.21	0.98	0.09	1.38	0.28	6.09
207+38	207+67	R	61.00	4.00	2.60	5.00	0.0069	0.09	0.52	0.85	0.44	Seed	3.35	5	0.030	17.66	1.35	0.10	1.47	0.22	5.70
												Seed	3.76	10	0.040	18.08	1.15	0.12	1.65	0.28	6.14

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - North Ditch **Designer :** BTS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:** 0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	3.00	**Type 2:** 4.00	**Type 3:**	5.00
RCP	**Type B:**	6.00			

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
202+67	203+00	L	32.00	2.00	4.00	4.00	0.0156	0.10	0.10	0.72	0.07	Seed	3.36	5	0.030	17.57	1.12	0.09	0.24	0.09	2.73
												Seed	3.81	10	0.040	17.64	0.99	0.11	0.27	0.11	2.90
203+00	203+50	L	50.00	2.00	4.00	3.75	0.0160	0.17	0.27	0.72	0.19	Seed	3.31	5	0.030	18.10	1.56	0.16	0.65	0.16	3.23
												Seed	3.74	10	0.040	18.26	1.35	0.20	0.73	0.20	3.52
203+50	204+00	L	50.00	2.00	4.00	3.00	0.0140	0.17	0.44	0.72	0.32	Seed	3.26	5	0.030	18.56	1.75	0.19	1.04	0.21	3.50
												Seed	3.68	10	0.040	18.82	1.50	0.23	1.17	0.27	3.86
204+00	204+50	L	53.00	2.00	4.00	2.25	0.0151	0.17	0.61	0.72	0.44	Seed	3.22	5	0.030	19.00	2.02	0.24	1.42	0.25	3.58
												Seed	3.63	10	0.040	19.33	1.71	0.30	1.60	0.31	3.96
204+50	205+00	L	50.00	2.00	4.00	3.00	0.0220	0.17	0.78	0.72	0.56	Seed	3.19	5	0.030	19.34	2.44	0.35	1.80	0.26	3.79
												Seed	3.59	10	0.040	19.73	2.05	0.44	2.02	0.32	4.22
205+00	205+50	L	52.00	2.00	4.00	4.00	0.0173	0.17	0.95	0.72	0.69	Seed	3.16	5	0.030	19.71	2.31	0.32	2.17	0.30	4.36
												Seed	3.54	10	0.040	20.18	1.95	0.39	2.43	0.36	4.90
205+50	206+00	L	47.00	2.00	4.00	4.00	0.0149	0.17	1.12	0.72	0.81	Seed	3.13	5	0.030	20.06	2.29	0.31	2.53	0.33	4.65

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Seed	3.51	10	0.040	20.58	1.92	0.38	2.84	0.41	5.25
206+00	206+50	L	48.00	2.00	4.00	4.00	0.0104	0.17	1.30	0.72	0.93	Seed	3.09	5	0.030	20.44	2.09	0.25	2.88	0.39	5.10
												Seed	3.46	10	0.040	21.04	1.75	0.31	3.23	0.47	5.79
206+50	206+61	L	11.00	2.00	4.00	4.00	0.0045	0.04	1.33	0.72	0.96	Seed	3.08	5	0.030	20.56	1.56	0.14	2.96	0.48	5.87
												Seed	3.45	10	0.040	21.18	1.30	0.17	3.31	0.59	6.69

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - North Ditch, RAB to DR-05 **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
207+38	207+00	L	58.00	2.00	4.25	4.25	0.0069	0.20	0.20	0.72	0.14	Seed	3.54	5	0.030	15.90	1.09	0.07	0.51	0.17	3.46
												Seed	3.99	10	0.040	16.05	0.92	0.09	0.58	0.21	3.83
207+00	206+61	L	36.00	2.00	4.00	4.00	0.0097	0.13	0.33	0.72	0.24	Seed	3.50	5	0.030	16.32	1.43	0.13	0.84	0.21	3.65
												Seed	3.93	10	0.040	16.55	1.21	0.16	0.94	0.26	4.06

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - North Ditch, RAB Crest to DR-04 **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
207+38	207+59	L	23.00	2.00	4.50	4.50	0.0134	0.01	0.01	0.72	0.01	Seed	3.57	5	0.030	15.68	0.55	0.02	0.02	0.02	2.19
												Seed	4.01	10	0.040	15.93	0.40	0.03	0.03	0.03	2.29

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : East Leg - South Ditch **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
208+61	209+00	R	64.00	4.00	4.00	4.00	0.0175	0.03	0.03	0.90	0.03	Seed	3.48	5	0.030	16.46	0.70	0.04	0.11	0.04	4.30
												Seed	3.92	10	0.040	16.67	0.61	0.05	0.12	0.05	4.39
209+00	209+50	R	46.00	4.00	4.00	4.00	0.0196	0.06	0.10	0.90	0.09	Seed	3.40	5	0.030	17.16	1.07	0.08	0.31	0.07	4.54
												Seed	3.82	10	0.040	17.49	0.95	0.10	0.34	0.08	4.67
209+50	210+00	R	47.00	4.00	4.00	4.00	0.0149	0.06	0.16	0.90	0.15	Seed	3.34	5	0.030	17.82	1.20	0.09	0.49	0.09	4.75
												Seed	3.74	10	0.040	18.24	1.02	0.11	0.55	0.12	4.97
210+00	210+50	R	43.00	4.00	4.00	4.00	0.0209	0.06	0.23	0.90	0.21	Seed	3.29	5	0.030	18.30	1.49	0.14	0.68	0.10	4.83
												Seed	3.68	10	0.040	18.79	1.28	0.17	0.76	0.13	5.05
210+50	211+00	R	54.00	4.00	4.00	4.00	0.0185	0.06	0.29	0.90	0.26	Seed	3.23	5	0.030	18.88	1.54	0.14	0.86	0.12	4.99
												Seed	3.61	10	0.040	19.46	1.33	0.18	0.96	0.16	5.25
211+00	211+50	R	51.00	4.00	4.00	4.00	0.0078	0.06	0.36	0.90	0.32	Seed	3.17	5	0.030	19.55	1.25	0.09	1.02	0.17	5.40
												Seed	3.54	10	0.040	20.26	1.06	0.11	1.14	0.22	5.76
211+50	212+00	R	50.00	4.00	4.00	4.00	0.0060	0.06	0.42	0.90	0.38	Seed	3.11	5	0.030	20.25	1.20	0.08	1.19	0.21	5.64

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Seed	3.46	10	0.040	21.07	1.02	0.10	1.32	0.26	6.06
212+00	212+50	R	50.00	4.00	4.00	4.00	0.0060	0.06	0.49	0.90	0.44	Seed	3.05	5	0.030	20.91	1.25	0.08	1.34	0.22	5.76
												Seed	3.39	10	0.040	21.85	1.06	0.10	1.49	0.28	6.20
212+50	213+00	R	50.00	4.00	4.00	4.00	0.0040	0.06	0.55	0.90	0.50	Seed	2.99	5	0.030	21.65	1.12	0.07	1.49	0.26	6.11
												Seed	3.32	10	0.040	22.72	0.95	0.08	1.65	0.33	6.61
213+00	213+50	R	53.00	4.00	3.50	3.50	0.0509	0.07	0.62	0.90	0.56	Seed	2.97	5	0.030	21.97	2.74	0.43	1.66	0.14	4.95
												Jute Mat	2.96	5	0.040	22.04	2.28	0.51	1.66	0.16	5.12
												Temp. Mat	2.96	5	0.040	22.04	2.28	0.51	1.66	0.16	5.12
												Temp. Mat	3.29	10	0.040	23.09	2.36	0.54	1.84	0.17	5.19
213+50	213+96	R	42.00	4.00	2.50	2.50	0.0500	0.04	0.66	0.90	0.59	Seed	2.94	5	0.030	22.29	2.83	0.44	1.75	0.14	4.71
												Jute Mat	2.94	5	0.040	22.33	2.35	0.52	1.74	0.17	4.84
												Temp. Mat	2.94	5	0.040	22.33	2.35	0.52	1.74	0.17	4.84
												Temp. Mat	3.26	10	0.040	23.38	2.44	0.56	1.94	0.18	4.89

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : East Leg - North Ditch **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
208+90	209+00	L	11.00	4.00	4.50	4.50	0.0136	0.23	0.23	0.58	0.13	Seed	3.63	5	0.030	15.16	1.13	0.08	0.49	0.10	4.87
												Seed	4.10	10	0.040	15.19	0.99	0.10	0.55	0.12	5.10
209+00	209+50	L	36.00	4.00	4.25	4.25	0.0278	0.20	0.43	0.58	0.25	Seed	3.59	5	0.030	15.50	1.79	0.19	0.89	0.11	4.95
												Seed	4.05	10	0.040	15.57	1.53	0.25	1.01	0.14	5.21
209+50	210+00	L	51.00	4.00	4.00	3.50	0.0137	0.20	0.62	0.58	0.36	Seed	3.53	5	0.030	16.02	1.63	0.14	1.28	0.17	5.27
												Seed	3.98	10	0.040	16.18	1.40	0.18	1.44	0.21	5.61
210+00	210+50	L	53.00	0.00	4.00	3.00	0.0113	0.20	0.82	0.58	0.48	Seed	3.48	5	0.030	16.46	2.01	0.34	1.66	0.49	3.40
												Seed	3.91	10	0.040	16.71	1.66	0.40	1.86	0.57	3.97
210+50	211+00	L	53.00	4.00	4.00	3.00	0.0170	0.30	1.13	0.58	0.65	Seed	3.44	5	0.030	16.87	2.12	0.23	2.24	0.22	5.55
												Seed	3.86	10	0.040	17.19	1.82	0.30	2.52	0.28	5.95
211+00	211+24	L	22.00	4.00	4.00	3.00	0.0091	0.13	1.26	0.58	0.73	Seed	3.41	5	0.030	17.08	1.78	0.16	2.49	0.28	5.96
												Seed	3.83	10	0.040	17.43	1.52	0.20	2.79	0.35	6.46

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : South Leg - West Ditch 1 **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
306+33	306+00	L	33.00	2.00	4.00	4.00	0.0212	0.10	0.10	0.55	0.06	Seed	2.96	2	0.030	15.48	1.12	0.09	0.16	0.06	2.52
												Seed	3.58	5	0.040	15.55	0.98	0.11	0.20	0.09	2.69
306+00	305+50	L	50.00	2.00	4.00	4.00	0.0100	0.10	0.20	0.55	0.11	Seed	2.88	2	0.030	16.27	1.08	0.07	0.32	0.12	2.95
												Seed	3.48	5	0.040	16.45	0.94	0.10	0.38	0.16	3.25
305+50	304+99	L	51.00	2.00	4.00	4.00	0.0020	0.10	0.30	0.55	0.17	Seed	2.77	2	0.030	17.52	0.68	0.03	0.46	0.23	3.85
												Seed	3.33	5	0.040	17.88	0.58	0.04	0.55	0.30	4.36

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : South Leg - West Ditch 2 **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
304+82	304+50	L	32.00	2.00	4.00	4.00	0.0563	0.24	0.24	0.55	0.13	Seed	2.98	2	0.030	15.26	2.04	0.29	0.40	0.08	2.67
												Seed	3.62	5	0.040	15.30	1.78	0.39	0.48	0.11	2.88
304+50	304+00	L	51.00	2.00	4.00	3.75	0.0049	0.09	0.33	0.55	0.18	Seed	2.90	2	0.030	16.12	0.99	0.06	0.53	0.19	3.50
												Seed	3.50	5	0.040	16.29	0.85	0.08	0.64	0.25	3.96
304+00	303+50	L	50.00	2.00	4.00	3.25	0.0050	0.09	0.42	0.55	0.23	Seed	2.82	2	0.030	16.89	1.06	0.07	0.66	0.22	3.60
												Seed	3.40	5	0.040	17.19	0.92	0.09	0.79	0.28	4.06
303+50	303+00	L	50.00	2.00	4.00	3.00	0.0040	0.09	0.51	0.55	0.28	Seed	2.75	2	0.030	17.69	1.04	0.06	0.78	0.26	3.80
												Seed	3.31	5	0.040	18.10	0.90	0.08	0.93	0.33	4.31
303+00	302+62	L	38.00	2.00	4.00	2.65	0.0026	0.09	0.60	0.55	0.33	Seed	2.69	2	0.030	18.36	0.95	0.05	0.89	0.31	4.07
												Seed	3.23	5	0.040	18.88	0.81	0.07	1.07	0.40	4.64

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : South Leg - West Ditch 3 **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
302+62	302+50	L	12.00	2.00	4.00	2.70	0.0083	0.02	0.02	0.55	0.01	Seed	2.97	2	0.030	15.37	0.54	0.02	0.04	0.03	2.22
												Seed	3.60	5	0.040	15.41	0.48	0.02	0.04	0.04	2.29
302+50	302+00	L	49.00	2.00	4.00	2.75	0.0061	0.09	0.11	0.55	0.06	Seed	2.87	2	0.030	16.41	0.75	0.04	0.18	0.10	2.69
												Seed	3.47	5	0.040	16.60	0.66	0.05	0.22	0.13	2.91
302+00	301+50	L	50.00	2.00	4.00	2.90	0.0060	0.09	0.21	0.55	0.11	Seed	2.78	2	0.030	17.34	0.92	0.05	0.32	0.14	2.96
												Seed	3.35	5	0.040	17.65	0.80	0.07	0.38	0.18	3.26
301+50	301+00	L	50.00	2.00	4.00	2.50	0.0120	0.09	0.30	0.55	0.17	Seed	2.72	2	0.030	17.97	1.32	0.10	0.45	0.14	2.91
												Seed	3.28	5	0.040	18.39	1.15	0.14	0.54	0.18	3.19
301+00	300+42	L	56.00	2.00	4.00	2.30	0.0125	0.10	0.41	0.55	0.22	Seed	2.67	2	0.030	18.62	1.44	0.13	0.60	0.16	3.03
												Seed	3.21	5	0.040	19.12	1.26	0.17	0.72	0.21	3.34

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : North Leg - West Ditch, Between DR-04 and DR-03 **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
307+84	308+00	L	27.00	2.00	4.75	4.25	0.0256	0.09	0.09	0.65	0.06	Seed	2.97	2	0.030	15.37	1.18	0.11	0.18	0.07	2.60
												Seed	3.60	5	0.040	15.43	1.08	0.14	0.22	0.09	2.77
308+00	308+50	L	32.00	2.00	4.25	4.00	0.0375	0.09	0.19	0.65	0.12	Seed	2.94	2	0.030	15.68	1.73	0.21	0.36	0.09	2.73
												Seed	3.56	5	0.040	15.78	1.53	0.27	0.44	0.12	2.95
308+50	308+79	L	29.00	2.00	4.00	4.00	0.0069	0.09	0.28	0.65	0.18	Seed	2.90	2	0.030	16.12	1.11	0.08	0.54	0.18	3.42
												Seed	3.50	5	0.040	16.28	0.96	0.10	0.65	0.23	3.85

DITCH ANALYSIS

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : North Leg - West Ditch, Project North to DR-03 **Designer :** BTS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
312+95	312+50	L	45.00	2.00	4.00	4.00	0.0089	0.20	0.20	0.65	0.13	Seed	2.94	2	0.030	15.69	1.08	0.08	0.38	0.14	3.10
												Seed	3.56	5	0.040	15.80	0.95	0.10	0.46	0.18	3.42
312+50	312+00	L	50.00	2.00	4.00	4.00	0.0080	0.20	0.40	0.65	0.26	Seed	2.88	2	0.030	16.34	1.29	0.10	0.74	0.20	3.63
												Seed	3.47	5	0.040	16.54	1.11	0.13	0.89	0.26	4.11
312+00	311+50	L	50.00	2.00	4.00	3.00	0.0100	0.20	0.59	0.65	0.39	Seed	2.83	2	0.030	16.86	1.58	0.15	1.09	0.24	3.69
												Seed	3.41	5	0.040	17.15	1.38	0.19	1.31	0.31	4.16
311+50	311+06	L	46.00	2.00	4.00	2.00	0.0457	0.20	0.79	0.65	0.51	Seed	2.80	2	0.030	17.11	2.99	0.54	1.44	0.19	3.13
												Jute Mat	2.80	2	0.040	17.17	2.45	0.63	1.44	0.22	3.32
												Temp. Mat	2.80	2	0.040	17.17	2.45	0.63	1.44	0.22	3.32
												Temp. Mat	3.38	5	0.040	17.44	2.60	0.70	1.74	0.24	3.47
310+32	310+00	L	32.00	2.00	4.00	2.80	0.0031	0.20	0.99	0.65	0.64	Seed	2.76	2	0.030	17.61	1.21	0.08	1.77	0.42	4.89
												Seed	3.32	5	0.040	17.95	1.04	0.10	2.14	0.54	5.65
310+00	309+50	L	52.00	2.00	4.00	3.00	0.0019	0.20	1.19	0.65	0.77	Seed	2.69	2	0.030	18.42	1.06	0.06	2.07	0.52	5.61

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Seed	3.23	5	0.040	18.91	0.90	0.08	2.49	0.65	6.53
309+50	309+00	L	52.00	2.00	4.00	3.50	0.0019	0.20	1.38	0.65	0.90	Seed	2.62	2	0.030	19.22	1.08	0.06	2.36	0.54	6.06
												Seed	3.14	5	0.040	19.84	0.92	0.08	2.83	0.68	7.08
309+00	308+79	L	21.00	2.00	4.00	4.00	0.0048	0.20	1.58	0.65	1.03	Seed	2.60	2	0.030	19.44	1.54	0.14	2.68	0.46	5.64
												Seed	3.12	5	0.040	20.11	1.31	0.17	3.21	0.57	6.58

less than the capacity of the ditch and thereby control the catch basin spacing. Figure 1102-1 is used to check the capacity of a catch basin grate in a sump. To use Figure 1102-1, double the calculated discharge at the ditch checkpoint to compensate for possible partial clogging of the grate.

In cut sections, carry the accumulated ditch flow as far as the capacity, allowable depth, or shear of flow will permit. The first catch basin in the roadside or median ditch will determine the need for a storm sewer system required for the remainder of the cut. Extend shear control as far as inexpensive flexible ditch linings will permit.

When locating ditch catch basins, provide positive outlets for underdrains and access to longitudinal sewer systems.

1102.3.6 Arbitrary Maximum Catch Basin Spacing

Catch basins are required at the low point of all sags. Omit the earth dike shown on the standard construction drawings when used in a sag. The maximum distance between catch basins in depressed medians in fill sections is as follows:

Depressed Median Catch Basin Spacing (Fill Sections)		
Median Width (ft)	**Desirable Spacing (ft)**	**Maximum Spacing (ft)**
84	1250	1500
60	1000	1250
40	800	1000

Where underdrains are utilized, place catch basins at a maximum spacing of 1000 feet to provide a positive outlet for the underdrains.

1103 Pavement Drainage

1103.1 General

Refer to the LD1 for pavement cross-slope design criteria.

When curb or barrier is provided, determine the proper type of pavement inlet or catch basin to control the spread of water into the traveled lane. Maximize the allowable spread without exceeding the allowable depth of flow at the face of curb or

C1103.1

When paved shoulders are provided, the drainage cost can be decreased due to the large volume of flow that can be carried on the pavement shoulder.

Additional information concerning pavement drainage can be obtained from HEC-22 [Brown et al., 2009].

barrier.

Reduce the need for bridge scuppers by intercepting the flow prior to the bridge.

1103.2 Design AEP Storm

C1103.2

Locate pavement inlets or catch basins to limit the spread of flow on the traveled lane to those shown in Table 1103-1. Base the design on the following recurrence interval:

Facility	Design (AEP)
Interstates, Freeways & Expressways	10%
US-20 High Volume Highways (Over 6000 ADT)	20%
SR-511 All other Highways	50%

For underpasses or other depressed roadways where ponded water can be removed only through the storm sewer system, check the spread for a 2% AEP storm on Interstates, Freeways & Expressways, and other High-Volume highways as defined above. Use a 4% AEP storm on other multiple lane highways. Ponding is permitted to cover all but one through lane of a multiple lane roadway or one-half of a lane on a 2-lane highway. No ponding is permitted into the traveled lanes of an interstate highway for the 2% AEP sag check.

The depth of flow or ponding at the curb cannot exceed 1 inch below the top of the curb for the design storm discharge regardless of the type of highway. A maximum depth of 6 inches is permitted where a barrier is provided.

These criteria are intended for sag locations with no outlet except through the storm sewer system. Examples include sag locations with barrier wall, underpasses, or other depressed cut sections without an alternative outlet. Typically, these criteria do not apply to 2-lane or other curbed roadway facilities where water can overtop the curb. Contact OHE if encountered.

The criteria for interstate sags are based on Code of Federal Regulation 23 CFR 650.115 requirements.

Table 1103-1

Facility	Allowable Pavement Spread* (ft)
Interstates, Freeways & Expressways	0
High Volume Highways (Over 6000 ADT)	
US-20 ≥ 45 mph	4
< 45 mph 2 lanes	6
4 lanes	8
All other Highways	
SR-511 2 lanes	6
≥4 lanes	8

* Pavement spread applies only to the through

Where lanes are less than the standard 12 ft. lane width, reduce the allowable spread an equal amount. Therefore, 11 ft. lanes on All other Highways with 2 lanes will have an allowable spread of 5 ft. instead of 6 ft.

In some instances, using the legal speed instead of the design speed will result in a more practical pavement spread design. Contact OHE if encountered.

lane and assumes a 12 ft. lane width.

The speeds listed in the manual are design speeds.

If design requirements cannot be met, contact OHE for guidance in a Performance Based Practical Design.

PBPD focuses on performance improvements that benefit both project and system needs rather than strict adherence to published standards. Standards are not abandoned but all factors are considered to produce a balanced decision that does not compromise safety.

1103.3 Estimating Design Discharge

C1103.3

Estimate runoff contributing to curbed pavements by the rational method, as explained in Sections 1101.2.1, 1101.2.2 and 1101.2.3.

The time of concentration $\mathbf{t_c}$ is the actual time of concentration calculated according to Section 1101.2.2 with an absolute minimum time of 10 minutes.

Contact OHE when the contributing drainage area is difficult to determine, and the calculations indicate the need for more basins than existing or the required spacing between basins is less than or equal to 100 feet.

The profile and cross section of the roadway may need to be modified to obtain a reasonable basin spacing by using a rolling gutter profile. If the geometrics cannot be revised, a contributing drainage area will need to be assumed. Use the entire contributing drainage area for the storm sewer design.

1103.4 Capacity of Pavement Gutters

C1103.4

Use the following equation to determine flow capacity for a standard curb and straight pavement slope:

$$Q = \frac{0.56ZS^{1/2}Y^{8/3}}{n}$$

Where:

Q = Discharge (cfs)

Z = $1/S_x$

n = Manning's Coefficient of Roughness (Table 1102-2)

S = Longitudinal pavement slope (ft/ft)

Y = Depth of flow in gutter section at curb (ft)

The longitudinal slope can vary on the approach to the inlet or catch basin, especially in a sag. When flatter grades are located at a sump, using the flatter slope will underestimate the overall gutter capacity and result in overestimated spread values. Examine the approach lengths of the grades to determine an average slope. If one of the grades has a much longer approach length, use this most predominant slope.

On curbed facilities, design sag vertical curves to prevent inadequate drainage near the bottom. This can be achieved by providing a minimum longitudinal slope of 0.3 percent at the two points 50 ft. from the bottom. This yields a maximum value of K = 167 for the vertical curve, which is typically called the drainage maximum.

Use the following equations to determine flow capacity for a composite gutter section:

$$Q_1 = (0.56ZS_{x(1)}{}^{1/2}Y^{8/3})/n_{(1)}$$

Composite Gutter Section: In most cases, the top width of the water surface in a pavement gutter far exceeds the height of the curb. The hydraulic radius does not accurately describe the gutter cross section in this situation, thereby requiring a

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - South Gutter **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 4.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
205+35	Begin																		
206+66	CB-3	132.00	0.90	0.07	5.20	2.28	10.00	0.0030	0.0833	0.0160	2.00	0.0000	4.41	******	******	0.29	0.187	3.30	Sag
1+95	Begin																		
206+81	CB-3A	60.00	0.90	0.08	4.88	0.79	10.00	0.0053	0.0833	0.0160	2.00	0.0000	4.41	0.33	0.00	0.33	0.179	2.78	
206+66	CB-3	15.00	0.90	0.01	3.31	0.39	10.00	0.0030	0.0833	0.0160	2.00	0.0000	4.41	******	******	0.04	0.086	1.04	End

SUMP DATA

Total Flow (cfs) : 0.32 **Ponded Depth (ft.) :** 0.017 **Spread on Pavement (ft.) :** 1.60

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : West Leg - North Gutter **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 4.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
205+35	Begin																		
206+61	CB-3	124.00	0.90	0.07	5.04	2.15	10.00	0.0030	0.0833	0.0150	2.00	0.0000	4.41	******	******	0.27	0.184	3.14	Sag
207+44	Begin																		
206+61	CB-3	95.00	0.90	0.07	5.06	1.64	10.00	0.0030	0.0833	0.0150	2.00	0.0000	4.41	******	******	0.29	0.189	3.50	End

SUMP DATA

Total Flow (cfs) : 0.56 **Ponded Depth (ft.) :** 0.046 **Spread on Pavement (ft.) :** 1.96

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : East Leg - South Gutter **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 4.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
208+40	Begin																		
209+15	CB-3A	110.00	0.90	0.14	4.95	1.04	10.00	0.0100	0.0833	0.0160	2.00	0.0000	4.41	0.55	0.00	0.56	0.191	3.55	
210+75	CB-3A	155.00	0.90	0.09	5.58	1.60	10.00	0.0090	0.0833	0.0160	2.00	0.0000	4.41	******	******	0.36	0.167	2.03	End

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : East Leg - North Side **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 4.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
208+10	Begin																		
208+80	CB-3A	75.00	0.90	0.17	5.21	0.71	10.00	0.0100	0.0833	0.0148	2.00	0.0000	4.41	0.64	0.02	0.65	0.202	4.37	
210+80	CB-3A	180.00	0.90	0.11	6.09	1.80	10.00	0.0090	0.0833	0.0160	2.00	0.0000	4.41	******	******	0.45	0.182	2.95	End

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : South Leg - West Gutter **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
306+79	Begin																		
304+75	CB-3A	205.00	0.90	0.15	7.37	4.12	11.49	0.0021	0.0833	0.0160	2.00	0.0000	3.45	0.45	0.01	0.47	0.231	6.00	
304+44	CB-3	55.00	0.90	0.03	4.42	1.25	10.00	0.0021	0.0833	0.0160	2.00	0.0000	3.68	******	******	0.11	0.141	1.69	End

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : South Leg - East Gutter **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
306+38	Begin																		
304+75	CB-3A	161.00	0.90	0.10	7.43	3.29	10.72	0.0021	0.0833	0.0160	2.00	0.0000	3.57	0.32	0.00	0.32	0.206	4.45	
304+44	CB-3A	31.00	0.90	0.02	3.73	0.81	10.00	0.0021	0.0833	0.0160	2.00	0.0000	3.68	******	******	0.06	0.112	1.34	End

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : North Leg - West Gutter **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
310+96	Begin																		
308+79	CB-3	220.00	0.90	0.11	6.49	3.86	10.34	0.0030	0.0830	0.0130	2.00	0.0000	3.63	******	******	0.37	0.201	4.72	Sag
307+62	Begin																		
308+79	CB-3	126.00	0.90	0.11	5.08	2.21	10.00	0.0030	0.0833	0.0130	2.00	0.0000	3.68	******	******	0.37	0.203	4.83	End

SUMP DATA

Total Flow (cfs) : 0.74 **Ponded Depth (ft.) :** 0.064 **Spread on Pavement (ft.) :** 3.07

INLET SPACING DESIGN

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : North Leg - East Curb **Designer :** BTS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.41

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
310+97	Begin																		
309+10	CB-3A	185.00	0.90	0.14	10.00	1.62	11.62	0.0122	0.0833	0.0160	2.00	0.0000	3.43	0.44	0.00	0.44	0.171	2.26	
308+74	CB-3	220.00	0.90	0.03	10.00	4.82	14.82	0.0030	0.0833	0.0120	2.00	0.0000	3.03	******	******	0.09	0.123	1.48	Sag
308+12	Begin																		
308+74	CB-3	67.00	0.84	0.08	5.02	1.17	10.00	0.0030	0.0833	0.0120	2.00	0.0000	3.68	******	******	0.26	0.181	3.22	End

SUMP DATA

Total Flow (cfs) : 0.35 **Ponded Depth (ft.) :** 0.021 **Spread on Pavement (ft.) :** 1.65

Provide premium joints on the storm sewer where an out-to-out clearance of 5 feet cannot be provided between parallel storm and sanitary sewers.

Submit exceptions to the above in the early stages of the design to OHE for review and approval.

1104.2.2.2 Under Paved Shoulder

The above applies to paved shoulder areas unless the cost of any other possible location is prohibitive.

1104.2.3 Access

For storm sewers under 36 inches in diameter located under or near the edge of pavement, provide access at intervals up to 300 feet maximum. For sewers sized 36 to 60 inches provide manholes spaced every 500 feet maximum and for larger sewers provide manholes spaced every 750 to 1000 feet maximum.

For manhole, inlet and catch basin details refer to the Hydraulic SCDs.

C1104.2.3

Most standard inlets and catch basins provide satisfactory access to small diameter shallow sewers. They can also be used where changes in pipe size or minor horizontal/vertical changes in alignment occur. Larger changes may require manholes.

It may be necessary to locate longitudinal trunk sewers away from the curb to provide for a utility strip between the curb and the sidewalk and to avoid a conflict with the underdrains. This will require properly spaced manholes in the sewer line.

1104.2.4 Rock Excavation

If it is known that bedrock will be encountered in the excavation for storm sewer installation, relocate the storm sewer. If bedrock cannot be avoided, separate the quantities of the storm sewer in rock and include Item 611, As Per Plan, in the plans.

1104.3 Storm Sewer Design Criteria

1104.3.1 Design AEP Storm

Size all storm sewers using open channel, just full capacity design to flow just full for a 10% AEP storm. The size is determined by working downstream from the first sewer run. It is acceptable to use a discharge of a more frequent occurrence if consistent with local criteria or to avoid extensive replacement of an existing downstream drainage system.

C1104.3.1

Just full is the depth of flow for maximum discharge. Just full capacity design assumes a free water surface at a depth of 93.8% of the pipe diameter for circular conduits. Maximum flow and velocity are considered to occur at this depth.

This design methodology provides a conservative margin of safety by providing additional headroom due to increased pipe diameters.

1104.3.2 Hydraulic Grade Line

Determine the elevation of the hydraulic grade line

C1104.3.2

Ordinarily, the hydraulic grade line is above the top

at the upper end of each sewer run using a 4% AEP storm.

Start at the storm sewer system outlet and work upstream. It is acceptable to use a hydraulic grade line of a more frequent occurrence if consistent with local criteria and / or to avoid extensive replacement of an existing downstream drainage system.

The starting elevation for the hydraulic grade line determination is the higher of either: the downstream tailwater channel water surface elevation or (dc+D)/2 at the system outlet as explained in Section 1105.6.1.

Use the same intensity **i** in the Rational Equation Q = CiA to determine the check discharge for all sewer runs as that calculated for the last, or downstream run, in a continuous sewer system.

The hydraulic grade line must not exceed the following:

A. 12 inches below the near edge of pavement for sections without curb.

B. The elevation of a curb opening inlet or grate elevation of a pavement catch basin, as shown on the SCD.

For underpasses or other depressed roadway sags where ponded water can only be removed through the storm sewer system, check the HGL for a 2% AEP storm on Interstates, Freeways & Expressways, and other High-Volume Highways (over 6000 ADT). One directional lane of travel for a multiple lane highway or one-half of a lane on a 2-lane highway must be passable. No encroachment of ponded water is permitted into any traveled lanes on interstate sags for the 2% AEP HGL sag check.

1104.3.3 Runoff Coefficient

Determine the runoff coefficient per Section 1101.2.2.

1104.3.4 Time of Concentration

Determine the time of concentration as explained in Section 1101.2.1. Use a minimum time of concentration of 15 minutes to the first ditch catch basin and 10 minutes to the first pavement inlet. Use the actual calculated time of concentration

of the pipe, causing the system to operate under pressure. If, however, any run in the system does not flow full, (pipe slope steeper than the friction slope) the hydraulic grade line will follow the friction slope until it reaches the normal depth of flow in the steep run. From that point, the hydraulic grade line will coincide with the normal depth of flow until it reaches a run flatter than the friction slope for that run.

These criteria are not intended to lower existing high-water elevations.

The check discharge is the 4% AEP event.

Hydraulic grade line requirement A is for ditch sections and B is for curbed sections.

These criteria are intended for sag locations with no outlet except through the storm sewer system. Examples include sag locations with barrier wall, underpasses, or other depressed cut sections without an alternative outlet.

Typically, these criteria do not apply to 2-lane or other curbed roadway facilities where water can overtop the curb. Contact OHE if encountered.

The criteria for interstate sags are based on Code of Federal Regulation 23 CFR 650.115 requirements.

when values greater than these minimums occur.

1104.3.5 Pipe Roughness Coefficient

Use a Manning's **n** of 0.015 for sewers 60 inches in diameter and under, and 0.013 for larger sewers. The typical **n** value for smooth pipe, concrete, vitrified clay, bituminous lined corrugated steel or thermoplastic is 0.012.

C1104.3.5

The increased **n** values are recommended to compensate for minor head losses incurred at catch basins, inlets and manholes located in a storm sewer system.

1104.3.6 Minimum Pipe Size

Use a minimum pipe diameter of 15 inches for Interstates, Freeways & Expressways, including ramps. Use 12 inches for other highways.

C1104.3.6

Where an existing storm sewer is to remain in service, it is not necessary to replace hydraulically adequate pipes to meet these criteria.

1104.3.7 Maximum Slope

The maximum slope is 4:1 H:V or the slope that produces a velocity exceeding 10 fps. Provide drop structures for energy dissipation when slopes or velocities exceed the allowable limits.

For storm sewers along embankment slopes that exceed 3:1 H:V, designate as Type F, Broken Back per Figure 1104-1.

C1104.3.7

A broken back is not intended for culverts or at the outlet of an extensive storm sewer network. Provide a manhole drop structure instead. Avoid having the flow impact the backside of the manhole due to the potential for the structure to erode or shift.

1104.3.8 Outlet Velocity Protection

Provide outlet velocity protection for all Storm Sewers with an outlet velocity greater than 5 fps.

Provide rock channel protection for erosion control per Figure 1002-4 using the 10% Design AEP Storm.

Provide a filter with the RCP. Use a geotextile fabric filter when not under water. Use an aggregate filter when the RCP is under water. The cost of the filter is included in the unit bid price for Item 601, Rock Channel Protection with Filter.

C1104.3.8

A filter is provided with the RCP to prevent soil piping through the rock. Aggregate filter is specified for placement under water as the fabric filter is buoyant and may cause difficulty during installation. Use aggregate filter for RCP placed under the OHWM.

1104.4 Storm Sewer Hydraulic Design Procedure

Provide storm sewer computations. Tabulate the calculations for lateral connections to the longitudinal trunk sewer separately from the trunk sewer calculations.

Software is available at the OHE Hydraulic Software and Design Resources web page and can be used for these calculations. OpenRoads SUDA may also be used for these calculations. Other software packages may be utilized with approval

C1104.4

With the layout suggested in Section 1104.3, start with the upper catch basin or inlet and determine the value of CA for the contributing flow (CA is the product of the weighted coefficient of runoff and the drainage area). Next, determine the time of concentration for the first area and the corresponding rainfall intensity **i** from the proper curve shown on Figure 1101-2. The design discharge **Q** to use to determine the required size of the first sewer from MH No. 1 to MH No. 2 is the product of CA x i. At manhole No. 2, determine the

LOR-20 Hydrology - Storm System Design Flows

						Calculations By:	AQA	Date:	8/30/2024
						Checked By:	BTS	Date:	8/30/2024

Rational Method

Drainage Area		Input Summary				Q (cfs)					
Drainage Area ID	Station	Area Prop.	Tc (min)	Weighted C_{value}	Intensity Value (10 Yr)	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
DR1	309+10	0.140	10.0	0.90	4.94	0.46	0.56	0.62	0.71	0.77	0.83
DR2	308+74	0.120	10.0	0.83	4.94	0.37	0.44	0.49	0.56	0.61	0.66
DR3	308+79	1.875	10.0	0.65	4.94	4.51	5.40	6.06	6.90	7.52	8.10
DR4	308+80	0.010	10.0	0.90	4.94	0.03	0.04	0.04	0.05	0.06	0.06
DR5	206+61	1.710	12.6	0.72	4.48	4.05	4.88	5.50	6.29	6.86	7.42
DR7	205+15	0.400	15.0	0.47	4.13	0.56	0.68	0.77	0.88	0.96	1.04
DR6	206+61	0.194	10.0	0.30	4.94	0.21	0.26	0.29	0.33	0.36	0.38
EXDR1	-0+50	21.300	26.7	0.42	3.02	19.38	23.89	27.33	31.71	34.97	38.18
DR10	306+34	1.197	17.1	0.85	3.87	2.85	3.47	3.94	4.52	4.96	5.38
DR14	212+24	1.200	14.4	0.42	4.21	1.53	1.86	2.10	2.40	2.63	2.84
DR15	213+61	0.98	15.0	0.44	4.13	1.30	1.58	1.78	2.05	2.24	2.42

Lorain County - Zone A $i=a/(b+tc)^c$ $Q=C*I*A$

Rainfall Intensity

Frequency (yr)	a	b	c	i(tc=5)	i(tc=15)	i(tc=30)	i(tc=60)
2	46.18400	9.00000	0.85900	4.79	3.01	1.99	1.22
5	56.98500	10.25000	0.85100	5.61	3.65	2.46	1.53
10	64.16700	11.00000	0.84200	6.22	4.13	2.81	1.77
25	66.52800	11.00000	0.81100	7.02	4.74	3.27	2.10
50	65.70200	10.75000	0.78200	7.61	5.18	3.62	2.35
100	64.48900	10.50000	0.75400	8.17	5.61	3.96	2.61

LOR-20 Hydrology - Storm System Design Flows

		Calculations By:	AQA	DATE:	8/30/2024
		Checked By:	BTS	DATE:	8/30/2024

Time of Concentration Calculations

Drainage Area	Sheet Flow - $t_o = [1.8(1.1 - C)L^{1/2}]/s^{1/3}$					Shallow Concentrated Flow $V = 3.281ks^{0.5}$					Open Channel/Piped Flow										Time Of Conc.	Time Of Conc.
ID	Slope	Length	C		Time	Slope	k	V	L	Time	Elevation	Length	Slope	n	SS Lt	SS Rt	BW	Depth	V	Time	T_C (min)	T_C (min)
DR1	T_c=10 min.																					
DR2	T_c=10 min.																					
DR3	T_c=10 min.																					
DR4	T_c=10 min.																					
DR5	2.0000	100	0.3		11.4	4.0000	0.491	3.22	75	0.4	844.00	841.50	170	0.0147	0.035	4.0	4.0	2.0	1.0	3.61	0.8	12.6	15.0
DR7	T_c=15 min.																					
DR6	T_c=10 min.																					
EXDR1	1.5000	100	0.3		12.6	1.2500	0.274	1.01	200	3.3	864.00	850.00	1675	0.0084	0.035	2.0	4.0	1.0	1.0	2.59	10.8	26.7	26.7
DR10	1.5000	100	0.3		12.6	2.1000	0.305	1.45	395	4.5	--	--	--	--	--	--	--	--	--	--	0.0	17.1	17.1
DR14	2.3000	100	0.3		10.9	5.0000	0.213	1.56	140	1.5	837.30	834.60	330	0.0082	0.035	3.0	4.0	2.0	1.0	2.72	2.0	14.4	15.0
DR15	T_c=10 min.																					

s = Slope in ft/ft.
L = Length in feet.
C = Coefficient of Runnoff
k = Intercept Coefficient for Shallow Concentrated Flow Calculations
V is velocity in ft/s.
T_C is time of concentration in minutes.

LOR-20 Hydrology - Storm System Design Flows

Weighted C Value Calculations

											Calculations By:	AQA		Date:	8/30/2024
											Checked By:	BTS		Date:	8/30/2024

Runoff Factors	Pavements & paved Shoulders	Grass Shoulders		Contributing Areas				Misc						Total Drainage Area (ACRES)	Composite C Values
	Pavement	Berms and Slopes 4:1 or Flatter	Berms and Slopes steeper than 4:1	Residential (Single-Family) 0.3-0.5	Residential (Multi-Family) 0.4-0.7	Woods	Cultivated 0.3-0.6								
	0.90	0.50	0.70	0.40	0.30	0.40	0.30	0.40	0.50	0.90	0.50	0.25	0.30		
Area/Node	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)	Area (ACRES)		
DR1	0.144													0.14	0.90
DR2	0.105						0.013							0.12	0.83
DR3	1.105						0.770							1.875	0.65
DR4	0.010													0.010	0.90
DR5	1.190						0.520							1.710	0.72
DR7	0.110						0.290							0.400	0.47
DR6							0.194							0.194	0.30
EXDR1	4.430						16.870							21.300	0.42
DR10	1.097						0.100							1.197	0.85
DR14	0.230						0.970							1.200	0.42
DR15	0.230						0.750							0.980	0.44

STORM SEWER SYSTEM

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : Storm Drain - North Leg, West Leg, East Leg - South **Designer :** BTS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 0.00 **Tailwater Elevation (ft.):** 0.00

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
DR1	DR2	309+10	0.14	0.13	10.00	4.94	5.59	0.6	0.7	12	32.0	0.0078	838.25	2.84	2.94	0.0006	838.69	841.40	2.71	2.15	CB 3A
begin		308+74	0.14	0.13									838.00				838.68	841.10			0.015
DR2	DR3	308+74	0.12	0.10	10.19	4.91	5.49	1.1	1.3	12	53.0	0.0113	838.00	3.80	3.53	0.0016	838.43	841.10	2.67	2.10	CB 3
		308+79	0.26	0.23									837.40				838.22	839.90			0.015
DR3	DR4	308+79	1.88	1.23	10.42	4.86	5.49	7.1	8.0	18	82.0	0.0073	836.90	4.99	8.38	0.0077	838.22	841.10	2.88	2.70	CB 2-3
		2+97	2.14	1.45									836.30				837.60	842.00			0.015
DR4	DR5	2+97	0.01	0.01	10.69	4.81	5.08	7.0	7.4	24	114.0	0.0053	835.80	4.52	15.30	0.0014	837.06	842.00	4.94	4.20	CB 2-3
		206+61	2.15	1.46									835.20				836.89	841.40			0.015
DR5	DR6	206+61	1.71	1.23	12.60	4.48	5.08	12.1	13.7	24	65.0	0.0046	835.20	4.80	14.33	0.0049	836.89	841.40	4.51	4.20	CB 8
		206+61	3.86	2.69									834.90				836.57	841.60			0.015
DR7	DR6	205+15	0.40	0.19	15.00	4.13	4.66	0.8	0.9	15	147.0	0.0327	840.45	4.88	10.88	0.0002	840.70	843.50	2.80	1.80	CB 2-2B
begin		206+61	4.26	2.88									835.65				836.46	841.60			0.015
DR6	DR9	206+61	0.19	0.06	15.50	4.06	4.65	11.9	13.6	24	53.0	0.0113	834.90	6.86	22.44	0.0048	836.22	841.60	5.38	4.70	CB 2-3
		206+61	4.45	2.93									834.30				835.96	843.00			0.015
EXDR	DR9	0+00	21.30	9.05	26.70	3.02	3.45	27.3	31.2	24	450.0	0.0178	842.30	9.44	28.12	0.0252	847.60	846.60	-1.00	2.30	CB 2-2B
begin		206+61	25.75	11.98									834.30				836.24	843.00			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
DR9	DR10	206+61	0.00	0.00	27.49	2.97	3.33	35.6	39.9	30	74.0	0.0284	833.70	12.73	64.42	0.0126	835.55	843.00	7.45	6.80	MH 3
		306+34	25.75	11.98									831.60				834.62	840.50			0.015
DR10	DR11	306+34	1.20	1.02	27.59	2.96	3.33	38.5	43.3	30	150.0	0.0133	831.60	9.51	44.16	0.0148	834.62	840.50	5.88	6.40	CB 8A
		209+04	26.95	13.00									829.60				832.39	838.70			0.015
DR11	DR12	209+04	0.00	0.00	27.85	2.94	3.33	38.3	43.3	36	450.0	0.0040	829.10	5.86	39.33	0.0056	832.39	838.70	6.31	6.60	MH 3
		213+60	26.95	13.00									827.30				829.87	832.10			0.015
DR12	DR13	213+60	0.00	0.00	29.13	2.87	3.32	37.2	43.2	36	47.0	0.0064	825.80	7.27	49.68	0.0056	828.33	832.10	3.77	3.30	MH 3
final		214+10	26.95	13.00									825.50				828.07	825.50			0.015

STORM SEWER SYSTEM

PID : 118318 **Date :** 08/30/2024 **Project :** LOR-20 **Location :**

Description : Storm Drain - East Leg - North **Designer :** BTS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 0.00 **Tailwater Elevation (ft.):** 0.00

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
DR14	DR15	211+24		1.20	0.50	14.40	4.21	4.74	2.1	2.4	15	235.0	0.0332	833.51	6.56	10.98	0.0018	833.92	835.50	1.58	0.74	CB 8
begin		213+61		1.20	0.50									825.70				826.63	834.60			0.015
DR15	DR16	213+61		0.98	0.21	15.00	4.13	4.72	2.9	3.3	15	49.0	0.0571	825.70	8.72	14.40	0.0035	826.13	834.60	8.47	7.65	CB 2-3
final		214+10		2.18	0.71									822.90				823.89	822.93			0.015

1111 Post-Construction Storm Water Structural Best Management Practices

1111.1 General

For ODOT projects, submit any proposed alternative post-construction BMP designs that are not found in Section 1113 to OHE. A review and approval of the alternative BMP by OHE and Ohio EPA is required. Local-Let Local Public Agency projects may use an alternative post-construction BMP criterion with Ohio EPA approval.

Locate BMPs so that they are protected in accordance with the LD1.

C1111.1

Post-Construction Storm Water Best Management Practices (BMPs) are provided for long term management of storm water runoff quality and quantity so that a receiving stream's physical, chemical and biological characteristics are protected, and stream functions are maintained.

Ohio EPA's construction general permit includes requirements for post-construction BMPs on most projects that meet the disturbance threshold for an NOI. The construction general permit allows roadway projects administered by public entities, such as ODOT, to follow the criteria in this manual as an alternative to the specific post-construction BMP requirements in the permit. Many of the post-construction BMP design criteria in this manual are consistent with Ohio EPA's permit, but some criteria have been tailored to fit linear roadway construction as opposed to standard site development.

Local entities with local post-construction guidance may have more restrictive language regarding selection and use of BMPs as compared to the Department. Storm water discharge from ODOT right-of-way is not subject to local storm water requirements. While the local entity cannot force the Department to use their standards, it may be possible for the Department to incorporate the needs of the local entity subject to review and approval of OHE.

1111.2 Project Thresholds for Post-Construction BMP

Projects that do not require an NOI per Section 1109 do not require post-construction BMPs. Since Routine Maintenance Projects do not require an NOI, they do not require post-construction BMPs. For projects that do require an NOI, the requirement for post-construction BMPs is based on the Project EDA. While the requirement for an NOI is based on Total EDA, the requirement for post-construction BMP treatment is only based on Project EDA (Total EDA – Contractor EDA). Contractor EDA is stabilized after construction to match existing conditions.

The following types of projects do not require post-

C1111.2

As described in Section 1109, EDA is defined as any activity that exposes bare ground or an erodible material to storm water as well as anywhere that Item 659, Seeding, or Item 660, Sodding, is being provided. Contractor EDA is generally outside of the ODOT right-of-way and therefore is unable to be addressed by post-construction BMPs.

Projects may have a Total EDA ≥ 1 acre but a Project EDA < 1 acre. For these types of projects, an NOI is required because the Total EDA threshold is met, but a post-construction BMP is not required because the Project EDA threshold is not met.

construction BMPs.

- Project EDA < 1 acre
- Routine Maintenance Projects as defined in Section 1109.2
- Projects including only earth disturbance from utility line, fence, guardrail, or noise wall installation

Provide post-construction BMPs for all projects with Project EDA ≥ 1 acre except those listed above.

For projects requiring post-construction BMPs, evaluate the following items:

- Need for Water Quantity and Quality Treatment vs. only Water Quality Treatment (Section 1111.3)
- Project Type – Redevelopment or New Construction (Section 1111.6)
- If New Construction, calculate the Treatment Percent (Section 1111.7)
- Applicable BMP to be implemented (Section 1113)

All projects, including Local Public Agency projects, ODOT-let and Local-Let, are required to provide post-construction BMPs as indicated in this section. Coordinate with the LPA when a project requires post-construction BMPs outside ODOT right-of-way. Inform the LPA of maintenance responsibilities associated with post-construction BMPs.

Projects that include construction activities only associated with utility line, fence, guardrail, or noise wall installation do not require post construction BMPs. These types of projects may require an NOI if the Total EDA threshold is met, but not a post-construction BMP.

1111.3 Water Quality and Water Quantity Treatment

Post-construction storm water treatment is divided into two categories: water quality treatment and water quantity treatment. Projects exceeding the minimum thresholds in Section 1111.2 must address water quality and potentially water quantity treatment in the post-construction BMP.

BMPs to address water quantity are not required for projects that meet any of the following criteria:

- Redevelopment projects as defined in Section 1111.6.1.
- New Construction Projects as defined in Section 1111.6.2 where less than 1 acre of new impervious area is created in new permanent right-of-way area being acquired for the

C1111.3

Water quality treatment provides for reduction of pollutants from storm water runoff before leaving the site. Water quantity treatment is reducing the volume or peak flow rate of storm water runoff in order to protect the receiving stream's physical characteristics.

Ohio Department of Transportation - Office of Hydraulic Engineering

Post-Construction BMP Calculation Spreadsheet

Post Construction - Project Summary

Project Data

		Units
Project EDA	4.6	acres
Is the Project Routine Maintenance per L&D Vol. 2, Sec. 1112.2	No	
BMPs Required?	**BMPs Required**	NA
Ain (New Impervious Area in New Permanent R/W	0	acres
Does Entire Site Drain to Large River (>100 sq. miles)?	No	
Water Quality Treatment Required	**Yes**	
Water Quantity Treatment Required	**No**	

Treatment Percent and Treatment Requirement

Aix (Project EDA that is inside the existing right-of-way)	4.67	acres
Ain (New Impervious Area in New Permanent R/W)	0	acres
T% (Treatment Percent)	**20.00**	**%**
Treatment Requirement	**0.92**	**acres**

BMPs Provided

BMP Name	BMP Type	Contributing Drainage Area (acres)	Contributing Drainage Area in ODOT R/W (acres)
VBF1	Vegetated Biofilter	0.25	0.25
VBF2	Vegetated Biofilter	0.25	0.09
VBF3	Vegetated Biofilter	0.32	0.09
VBF4	Vegetated Biofilter	0.60	0.28
VBF5	Vegetated Biofilter	1.10	0.10
VBF6	Vegetated Biofilter	1.25	0.07

Treatment Provided

Total Area with ODOT R/W Treated (acres)	**0.88**
Treatment Requirements (acres)	**0.92**
Treatment Check	**Check Design**

BMP Submittal Requirements (Per L&D, Vol. 2, Sec. 1116.2)

1. Estimated Project Earth Disturbed Area	Yes	**Good**
2. Treatment Percent Calculation	Yes	**Good**
3. BMP Selected for use	Yes	**Good**
4. Drainage area mapping for post-construction BMPs that show the total contributing drainage area and the amount of contributing area within ODOT right-of-way	Yes	**Good**
5. Plan sheets showing locations of post-construction BMP	Yes	**Good**
6. Calculations for each BMP	Yes	**Good**
7. Explanation for any area that is not treated	Yes	**Good**

Water Quality Flow Rate (WQ_F)

Drainage Area #1	Area (acres)	Coefficient of Runoff (C)
Tributary Area within Existing R/W	0.25	0.9
Impervious Trib. Area Outside Existing R/W	0.00	0.9
Tributary Area Land Use #3		
Tributary Area Land Use #4		
Total Tributary Area	0.25	0.900
BMP Type	Vegetated Biofilter	
Time of Concentration (minutes)	NA	
Intensity, i (in/hr)	0.65	
Water Quality Flow (WQ_F)	**0.144**	**cfs**

Drainage Area #2	Area (acres)	Coefficient of Runoff (C)
Tributary Area within Existing R/W	0.25	0.9
Impervious Trib. Area Outside Existing R/W	0.00	0.9
Tributary Area Land Use #3		
Tributary Area Land Use #4		
Total Tributary Area	0.25	0.900
BMP Type	Vegetated Biofilter	
Time of Concentration (minutes)	NA	
Intensity, i (in/hr)	0.65	
Water Quality Flow (WQ_F)	**0.149**	**cfs**

Drainage Area #3	Area (acres)	Coefficient of Runoff (C)
Tributary Area within Existing R/W	0.32	0.9
Impervious Trib. Area Outside Existing R/W	0.00	0.9
Tributary Area Land Use #3		
Tributary Area Land Use #4		
Total Tributary Area	0.32	0.900
BMP Type	Vegetated Biofilter	
Time of Concentration (minutes)	NA	
Intensity, i (in/hr)	0.65	
Water Quality Flow (WQ_F)	**0.185**	**cfs**

Drainage Area #4	Area (acres)	Coefficient of Runoff (C)
Tributary Area within Existing R/W	0.60	0.9
Impervious Trib. Area Outside Existing R/W	0.00	0.9
Tributary Area Land Use #3		
Tributary Area Land Use #4		
Total Tributary Area	0.60	0.900
BMP Type	Vegetated Biofilter	
Time of Concentration (minutes)	NA	
Intensity, i (in/hr)	0.65	
Water Quality Flow (WQ_F)	**0.351**	**cfs**

Ohio Department of Transportation - Office of Hydraulic Engineering

Post-Construction BMP Calculation Spreadsheet

Drainage Area #5	Area (acres)	Coefficient of Runoff (C)
Tributary Area within Existing R/W	0.50	0.9
Impervious Trib. Area Outside Existing R/W	0.00	0.9
Tributary Area Land Use #3	0.60	0.3
Tributary Area Land Use #4		
Total Tributary Area	1.10	0.573
BMP Type	Vegetated Biofilter	
Time of Concentration (minutes)	NA	
Intensity, i (in/hr)	0.65	
Water Quality Flow (WQ_F)	**0.410**	**cfs**

Drainage Area #6	Area (acres)	Coefficient of Runoff (C)
Tributary Area within Existing R/W	0.58	0.9
Impervious Trib. Area Outside Existing R/W	0.00	0.9
Tributary Area Land Use #3	0.67	0.3
Tributary Area Land Use #4		
Total Tributary Area	1.25	0.578
BMP Type	Vegetated Biofilter	
Time of Concentration (minutes)	NA	
Intensity, i (in/hr)	0.65	
Water Quality Flow (WQ_F)	**0.470**	**cfs**

Ohio Department of Transportation - Office of Hydraulic Engineering

Post-Construction BMP Calculation Spreadsheet

Vegetated Biofilter

Location Information					Hydrology			Channel Characteristics					Analysis Results			
VBF	Route	Begin Station	End Station	Side	Total Drainage Area (acres)	EDA Treatment Credit (acres)[1]	WQ_F (cfs)	VBF Bottom Width (ft)[note2]	VBF Fore Slope (z:1)	VBF Back Slope (z:1)	VBF Longitudinal Slope (ft/ft)	Manning's Roughness Coefficient[3]	Depth of Runoff at WQ_F (inches)[4]	Velocity of Runoff at WQ_F (ft/sec)[4]	Standard Ditch Width (feet)[5]	Required Ditch Width (feet)
VBF#1	US 20	202+67	205+35	RT	0.25	0.25	0.144	4	3	3	0.016	0.15	1.38	0.29	2	4
VBF#2	US 20	205+35	207+63	RT	0.25	0.09	0.149	4	4	4	0.014	0.15	1.48	0.27	2	4
VBF#3	US 20	208+61	210+75	RT	0.32	0.09	0.185	4	4	4	0.020	0.15	1.51	0.33	2	4
VBF#4	US 20	210+75	213+30	RT	0.60	0.28	0.351	4	4	4	0.012	0.15	2.53	0.34	2	4
VBF#5	US 20	208+92	210+75	LT	1.10	0.10	0.410	4	4	3	0.018	0.15	2.48	0.42	2	4
VBF#6	US 20	210+75	211+24	LT	1.25	0.07	0.470	4	4	3	0.007	0.15	3.52	0.32	2	4

Total Treatment Credit Earned from VBFs (within R/W): 0.88 acres

(Treatment is for quality only, not quantity)

Yellow: Requires Input (See instructions tab)

BMP Design Considerations

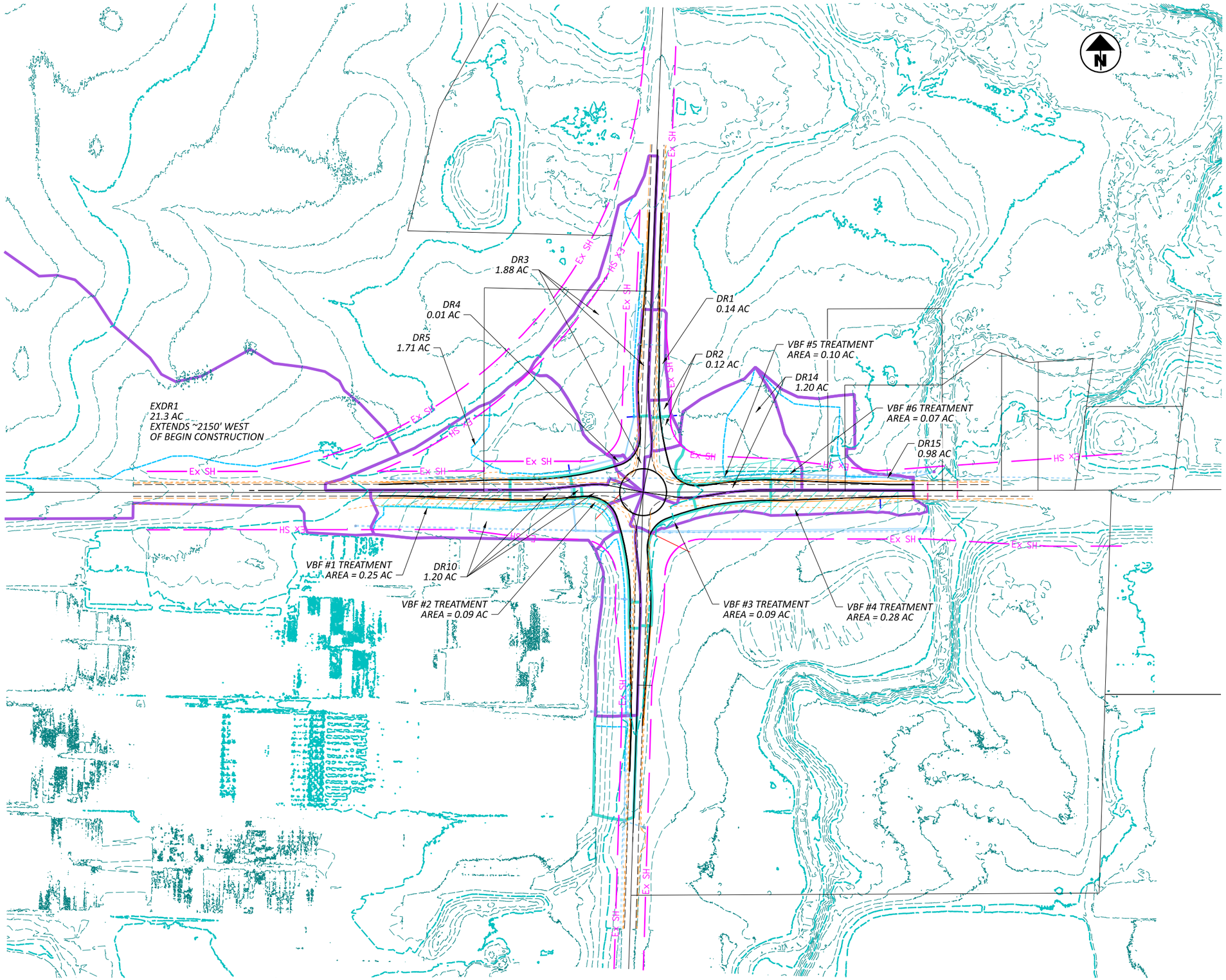
1	Do the VBF characteristics match the calculated flow and velocity checks using Manning's Equation above?	Yes	Good
2	Is the VBF a trapezoidal ditch with a flat bottom, not a radius ditch?	Yes	Good
3	Is the VBF width at least 4 feet?	Yes	Good
4	Is the depth of runoff for the WQ_F for each VBF less than or equal to 4 inches?	Yes	Good
5	Is the velocity of runoff for the WQ_F for each VBF less than or equal to 1.0 ft/sec?	Yes	Good
6	Does the "Total Drainage Area" include all onsite and off-site drainage to the VBF?	Yes	Good
7	Does each VBF include 4" of Item 659 Topsoil on the vegetated portion of the shoulder and foreslope?	Yes	Good
8	Does each VBF include Item 670, Ditch Erosion Protection?	Yes	Good
9	Are the station ranges and locations of the VBFs labeled on the Project Site Plan drawing?	Yes	Good

The Ohio Department of Transportation
District 12
5500 Transportation Blvd.
Garfield Heights, OH 44125-5396

NOTICE OF INTENT (NOI) ACREAGE CALCULATION FORM		1112-1 Reference Section 1112
Project: LOR-20-2.05 **PID:** 118318		**Area (acres)**
Project Earth Disturbing Activities		4.55
If the project is a Routine Maintenance Project, an NOI is not required. (See Section 1112)		
Contractor Earth Disturbing Activities		
Field Office:		
Enter 0.125 for Type A; 0.25 for Type B; or 1.00 for Type C		0.25
Batch Plant: Yes = 2.0; No = 0		0.00
Off-Project Waste / Borrow Pit:		
Add 1.0 acre per 15,000 CY of waste or borrow		0.43
Miscellaneous Other Off-Project Areas:		
Off-Project staging areas, stock yards, etc.		0.50
Contractor Earth Disturbing Activities	**Subtotal**	**1.18**
Total Earth Disturbing Activities (add Project EDA and Contractor EDA)	**TOTAL**	**5.73**
NOI Earth Disturbing Activities (see below to determine value)	**TOTAL**	**5.73**

Form Prepared By:

Mead Hunt, Inc.
4700 Lakehurst Court
Suite 110
Columbus, OH 43016



HORIZONTAL SCALE IN FEET
0 50 100 200

DRAINAGE AREA MAP

LOR-20-2.05

MODEL: Drainage Map - Plan 1 [Sheet] PAPERSIZE: 17x11 (in.) DATE: 8/30/2024 TIME: 5:29:53 PM USER: 03287
pw:\\ohiodot-pw.bentley.com:ohiodot-pw-02\Documents\01 Active Projects\District 03\Lorain\118318\401-Engineering_MeadHunt\Drainage\Sheets\118318_DP100.dgn

DESIGN AGENCY Mead & Hunt
CLIENT
DESIGNER AQA
REVIEWER BTS 08-30-2024
PROJECT ID 118318
SHEET P.0 TOTAL 51