DRAINAGE CALCULATIONS

WAR-123-28.55

PID 106224

FINAL TRACINGS SUBMITTAL

SEPTEMBER 2022

your trusted advisor
consultants
engineers
architects
planners

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HYDRAULIC NARRATIVE

HYDRAULIC NARRATIVE

The existing drainage along Beal Road, within the project limits, consists of three waterways:

1. A small ditch on the north side of the road, which flows through two drive pipes and empties into Stream 1 (Greens Run).
2. A small stream (Stream 2) on the south side of the road, which flow through two culverts and empties into Stream 1 (Greens Run).
3. A large stream (Stream 1) which flows north under the Beal Road bridge.

The proposed drainage along Beal Road, within the project limits, is very similar to the existing conditions and is as follows:

1. The small ditch on the north side of the road will be maintained. The two drive pipes will be replaced.
2. Stream 2 on the south side of the road will be piped to Stream 1 with a series of storm sewers.
3. Stream 1 will be maintained. The bridge over Stream 1 will be replaced with a three sided culvert. The storm sewer on the south side of the road will be piped through the side of the culvert.

BMP's are not necessary on this project since the EDA is less than one acre.

FLOW CALCULATIONS

WAR-123-28.55

PID 106224

DRAINAGE CALCULATION-RESIDENTIAL DRIVEWAYS LEFT

Due to the close proximity of the driveways, the downstream area was used for both locations.

DA=0.62 AC

TC=17 MIN.

C=0.50

I10=4.2 IN/HR

I50=5.3 IN/HR

Q10 = (0.5)(4.2)(0.62)=1.3 CFS

Q50 = (0.5)(5.3)(0.62)=1.6 CFS

Calculation of Flood Peak Discharges in Accordance with USGS Report 89-4126

Project Number: WAR-123-28.55, PID 106224

Stream Name: Tributary of Greens Run

Location: Franklin, OH (Warren County)

Directions: User input required for numbers in **red**, Output numbers in **blue.** If the Main Channel Slope is known, enter the value directly in the (SLOPE) line. If Main Channel Slope is not known, enter values for (CONTDA) and channel elevations to calculate.

(CONTDA)- Contributing Drainage Area (Sq Miles) = **0.2**

Length of Contributing Channel (Mile) = **0.9**

Distance 85% from Point of Study (Mile) = 0.8 Channel Elevation (feet) = **858** ft.

Distance 10% from Point of Study (Mile) = 0.1 Channel Elevation (feet) = **746** ft.

(SLOPE)- Main Channel Slope (Feet/Mile) = **158.87**

(STORAGE)- Percentage of Storage Area in Contributing Area = **2.30** %

Enter Region (A, B, or C) = **C** (See Geographic Region Map)

Computation of Peak Flows

Q2 = (RC)*(CONTDA)^0.782 * (SLOPE)^0.172 * (STORAGE+1)^ -0.297 = **42.79 CFS**

Q5 = (RC)*(CONTDA)^0.769 * (SLOPE)^0.221 * (STORAGE+1)^ -0.322 = **77.39 CFS**

Q10 = (RC)*(CONTDA)^0.764 * (SLOPE)^0.244 * (STORAGE+1)^ -0.335 = **103.21 CFS**

Q25 = (RC)*(CONTDA)^0.760 * (SLOPE)^0.264 * (STORAGE+1)^ -0.347 = **136.15 CFS**

Q50 = (RC)*(CONTDA)^0.757 * (SLOPE)^0.276 * (STORAGE+1)^ -0.355 = **161.38 CFS**

Q100 = (RC)*(CONTDA)^0.756 * (SLOPE)^0.285 * (STORAGE+1)^ -0.363 = **184.81 CFS**

Regression Constant (RC) Table

Region	Q2	Q5	Q10	Q25	Q50	Q100
A	56.1	84.5	104	129	148	167
B	40.2	58.4	69.3	82.2	91.2	99.7
C	93.5	133	159	191	214	236

CULVERT CALCULATIONS

UNIVERSAL CULVERT DESIGN

PID : 106224 **Date :** 12/21/2021 **Project :** WAR-123-28.55 **Location :** City of Franklin

Description : Culvert Sta. 12+09 to Sta. 13+36, Rt. **Designer :** E.J.T.

HEADWATER CONTROL CODES:

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

Inlet Invert Elevation (ft.) : 738.60 **Outlet Invert Elevation (ft.) :** 737.84 **Tailwater Elevation (ft.) :** 740.99 **Overflow Elevation (ft.) :** 746.00

Allowable Headwater Elevation (ft.) : 744.60 **or** Diameter + 2 ft. *(whichever is less)*

Pipe Length (ft.) : 127.00 **Culvert Slope (ft./ft.) :** 0.0060 **Design Manning 'n' :** 0.0120

Design Discharge (cfs) : 136.00 @ 25 yrs. **Flood Discharge (cfs) :** 185.00 @ 100 yrs.

CULVERT TYPE : ELLIPTICAL **Entrance Type :** Half Headwall **Entrance Loss (Ke) :** 0.20

FLOW (cfs.)	PIPE #	CULVERT SIZE	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	OVER FLOW (cfs.)	DESIGN CODE	BURIAL DEPTH (ft.)
136.00	1	43 x 68 in.	743.21	742.80	2 - E	11.63	2.41	2.87	0.0120	INLET	0.00	D	0.00
136.00	1	38 x 60 in.	744.24	744.01	2 - E	10.60	3.17	2.87	0.0120	INLET	0.00	D - 1	0.00
135.20	1	34 x 53 in.	746.06	746.04	2 - H	13.33	2.83	2.73	0.0120	INLET	0.80	D - 2	0.00
136.00	1	48 x 76 in.	742.75	N/A	1 - C	11.60	2.23	2.77	0.0120	INLET	0.00	D + 1	0.00
185.00	1	43 x 68 in.	744.96	744.46	2 - E	12.05	3.17	3.24	0.0120	INLET	0.00	F	0.00
167.30	1	38 x 60 in.	747.14	746.58	2 - E	13.04	3.17	3.01	0.0120	INLET	17.70	F - 1	0.00
135.20	1	34 x 53 in.	750.65	750.34	2 - H	13.33	2.83	2.73	0.0120	INLET	49.80	F - 2	0.00
185.00	1	48 x 76 in.	743.90	743.49	2 - E	12.56	2.72	3.25	0.0120	INLET	0.00	F + 1	0.00

CULVERT ANALYSIS

PID : 106224 **Date :** 12/21/2021 **Project :** WAR-123-28.55 **Location :** City of Franklin

Description : Existing Culvert: Beal Road Sta. 12+89, RT **Designer :** EJT

HEADWATER CONTROL CODES:

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

Pipe Number : 1 **Use HW :** 1 **Inlet Invert Elevation (ft.) :** 740.00 **Outlet Invert Elevation (ft.) :** 739.50

Pipe Quantity : 1

Culvert Type : Box **Pipe Length (ft.) :** 21.00 **Culvert Slope (ft./ft.) :** 0.0238

Corrugation Type :

Pipe Size : 4.5 x 4.5 ft.

Design Manning 'n' : (default)

Entrance Type : 0 degree (Extension of sides) **Loss Coef. Ke :** 0.5000

FLOW (cfs.)	HEAD LOSS (ft.)	HWI (ft.)	HWO (ft.)	FLOW TYPE	VELOCITY (fps.)	DN (ft.)	DC (ft.)	MANNING N	HEADWATER CONTROL	BURIED DEPTH (ft.)	TAILWATER ELEVATION (ft.)
136.00	2.08	745.35	N/A	1 - C	18.44	1.64	3.05	0.0120	INLET	0.00	742.50
185.00	3.59	747.22	745.66	2 - E	20.03	2.05	3.74	0.0120	INLET	0.00	742.50

STORM SEWER CALCULATIONS

STORM SEWER SYSTEM

PID : 106224 **Date :** 07/26/2022 **Project :** WAR-123-28.55 **Location :** City of Franklin

Description : Beal Road Storm Sewer, Right Side **Designer :** EJT

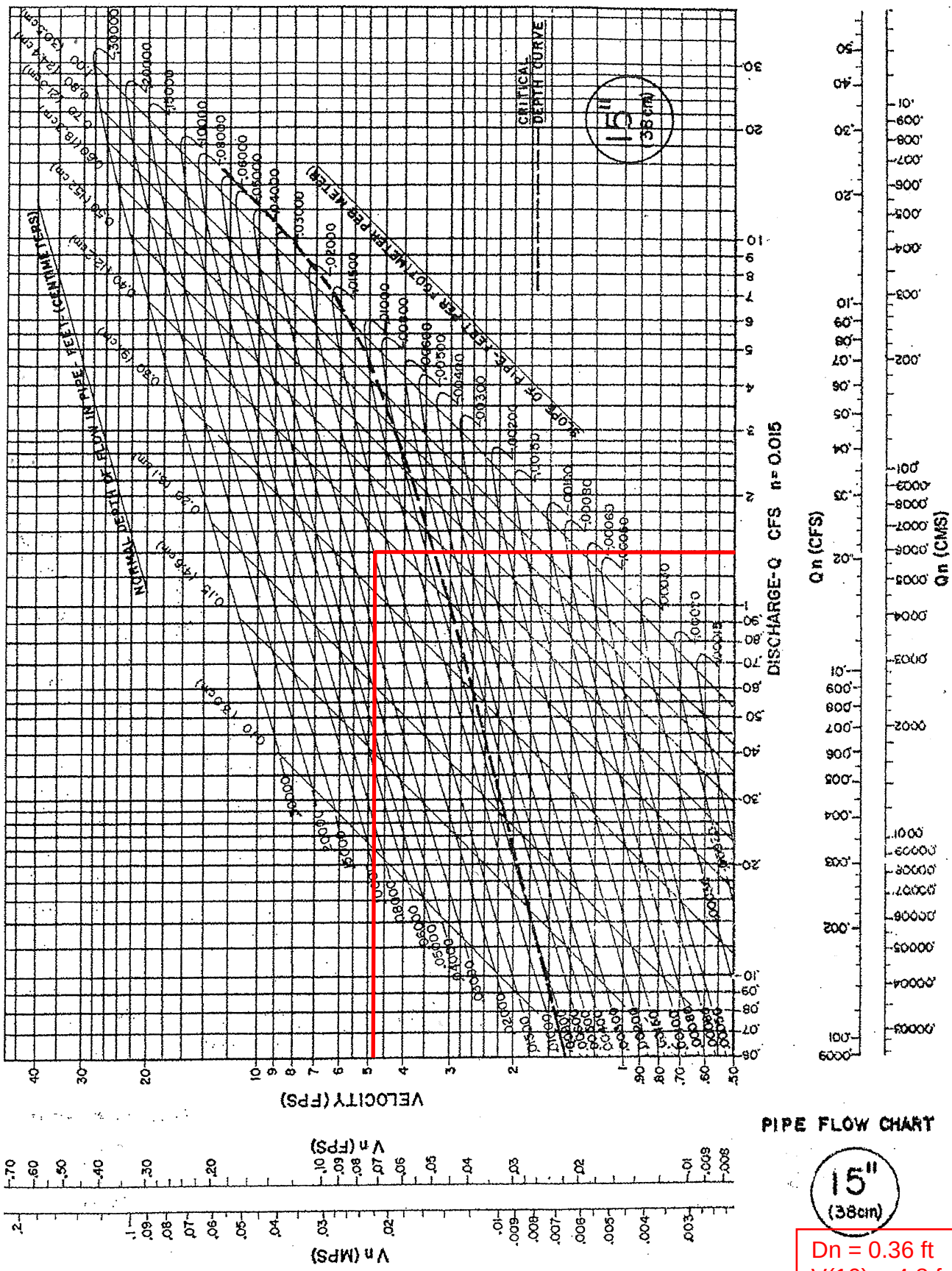
Rainfall Area: C **Just Full Capacity Frequency (yrs.) :** 25 **Hydraulic Gradient Frequency (yrs.) :** 100

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 740.66

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (25 yrs.)	(100	DISCHARGE (cfs.) (25 yrs.)	(100	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'
1	2	13+75	124.0	59.52	60.00	2.25	2.70	134.2	160.8	56	12.0	0.0060	738.96	9.65	156.47	0.0073	743.65	745.00	1.35	1.37	HW Half He
begin		13+66	124.00	59.52									738.89				743.57	745.00			0.015
2	4	13+66	0.00	0.00	60.02	2.25	2.70	134.1	160.8	56	91.0	0.0060	738.78	9.65	156.47	0.0073	743.57	745.00	1.43	1.55	HW Half He
		12+75	124.00	59.52									738.24				742.90	744.00			0.015
3	4	12+75	0.50	0.30	15.00	5.10	2.70	1.5	0.8	12	5.0	0.0500	740.75	7.08	7.43	0.0007	742.90	743.50	0.60	1.75	CB 2-2B
begin		12+75	124.50	59.82									740.50				742.90	744.00			0.015
4	5	12+75	0.00	0.00	60.18	2.25	2.70	134.6	161.6	56	66.0	0.0060	738.23	9.66	156.47	0.0074	742.90	744.00	1.10	1.10	MH JUNCTIO
		12+09	124.50	59.82									737.84				742.02	743.84			0.015
5	6	12+09	0.00	0.00	60.29	2.25	2.70	134.4	161.3	62	101.0	0.0024	736.24	7.56	149.79	0.0032	741.41	743.84	2.43	2.43	MH 3
final		11+08	124.50	59.82									736.00				740.66	745.00			0.013

DRIVE PIPE CALCULATIONS

Fig. 1100-201



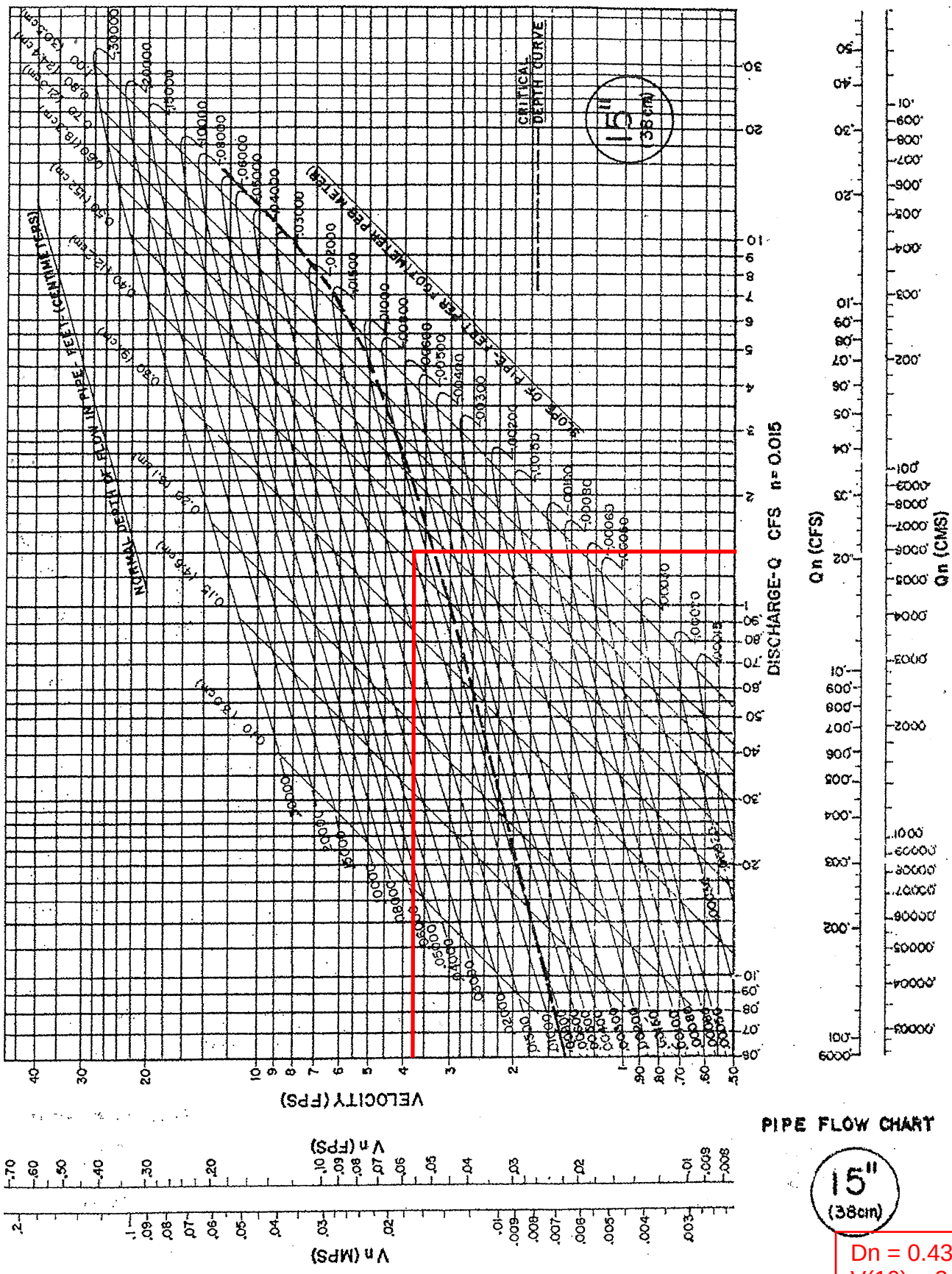
Dn = 0.36 ft
V(10) = 4.8 fps

C = 0.5
A = 0.62 Acres
I(10) = 4.4
Tc = 15 min.

Q(10) = CIA = 0.50 X 4.4 X 0.62 = 1.4 cfs
S = 2.00%

DRIVE PIPE: STA. 12+06, LT.

Fig. 1100-201



PIPE FLOW CHART

15" (38cm)

Dn = 0.43 ft
V(10) = 3.8 fps

C = 0.5
A = 0.62 Acres
I(10) = 4.4
Tc = 15 min.

Q(10) = CIA = 0.50 X 4.4 X 0.62 = 1.4 cfs
S = 1.00%

DRIVE PIPE: STA. 12+88, RT

DITCH CALCULATIONS

DITCH ANALYSIS

PID : 106224 **Date :** 12/20/2021 **Project :** WAR-123-28.55 **Location :** Franklin, Ohio

Description : Beal Road Ditch, Sta. 13+25 to Sta. 13+06, LT. **Designer :** EJT

Rainfall Area : C

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**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.)
13+25	13+06	L	19.00	2.00	4.00	4.00	0.0642	0.62	0.62	0.50	0.31	Seed	3.74	5	0.030	17.10	3.03	0.59	1.16	0.15	3.18
												Jute Mat	3.74	5	0.040	17.13	2.49	0.69	1.16	0.17	3.39
												Temp. Mat	3.74	5	0.040	17.13	2.49	0.69	1.16	0.17	3.39
												Temp. Mat	4.19	10	0.040	17.12	2.58	0.74	1.30	0.18	3.47

DITCH ANALYSIS

PID : 106224 **Date :** 12/20/2021 **Project :** WAR-123-28.55 **Location :** Franklin, Ohio

Description : Beal Road Ditch, Sta. 12+69 to Sta. 12+25, LT. **Designer :** EJT

Rainfall Area : C

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat		**Type 1:**	2.00	**Type 2:**	3.00	**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.)
12+69	12+50	L	19.00	2.00	3.10	4.00	0.0200	0.66	0.66	0.50	0.33	Seed	3.74	5	0.030	17.15	2.11	0.26	1.23	0.21	3.51
												Seed	4.19	10	0.040	17.18	1.78	0.33	1.38	0.26	3.88
12+50	12+25	L	25.00	2.00	3.10	4.00	0.0200	0.04	0.70	0.65	0.36	Seed	3.71	5	0.030	17.34	2.14	0.28	1.32	0.22	3.57
												Seed	4.16	10	0.040	17.41	1.82	0.34	1.48	0.27	3.94

DITCH ANALYSIS

PID : 106224 **Date :** 12/20/2021 **Project :** WAR-123-28.55 **Location :** Franklin, Ohio

Description : Beal Road Ditch, Sta. 11+85 to Sta. 11+25, LT. **Designer :** EJT

Rainfall Area : C

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat		**Type 1:**	2.00	**Type 2:**	3.00	**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.)
11+85	11+50	L	35.00	2.00	3.20	4.00	0.0100	0.78	0.78	0.50	0.39	Seed	3.72	5	0.030	17.34	1.73	0.17	1.45	0.28	4.01
												Seed	4.16	10	0.040	17.40	1.45	0.22	1.62	0.35	4.48
11+50	11+25	L	25.00	2.00	3.70	4.00	0.0400	0.04	0.82	0.65	0.42	Seed	3.70	5	0.030	17.49	2.82	0.49	1.54	0.20	3.52
												Jute Mat	3.69	5	0.040	17.52	2.30	0.58	1.54	0.23	3.78
												Temp. Mat	3.69	5	0.040	17.52	2.30	0.58	1.54	0.23	3.78
												Temp. Mat	4.14	10	0.040	17.57	2.40	0.61	1.72	0.24	3.88

DITCH ANALYSIS

PID : 106224 **Date :** 08/09/2022 **Project :** WAR-123-28.55 **Location :** Franklin, Ohio

Description : Beal Road Ditch, Sta. 13+25 to Sta. 13+57, RT. **Designer :** EJT

Rainfall Area : C

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**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.

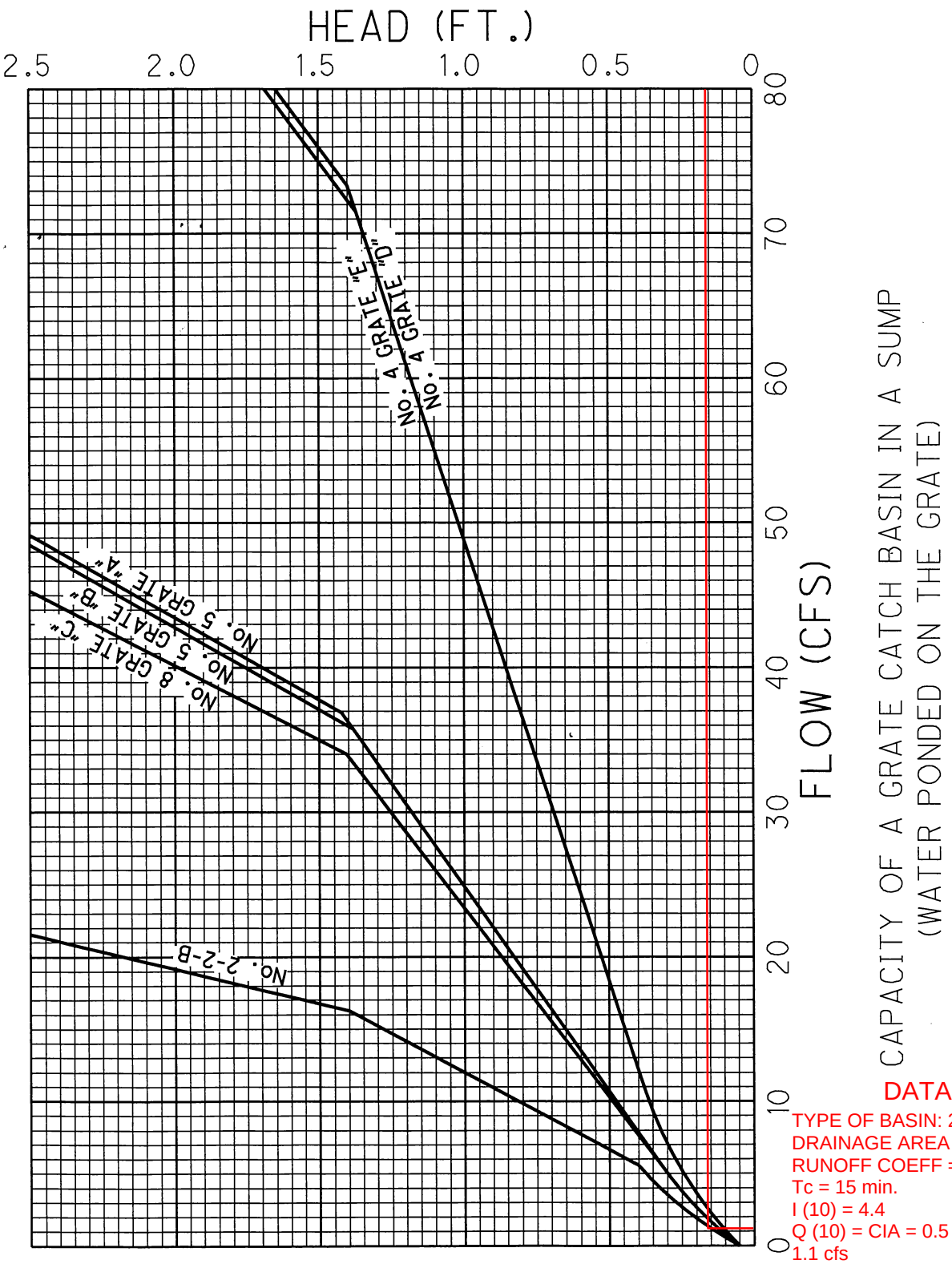
STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
13+25	13+50	R	25.00	2.00	4.00	6.00	0.0400	0.04	0.04	0.60	0.02	Seed	3.96	5	0.030	15.36	1.15	0.09	0.09	0.04	2.38
												Seed	4.42	10	0.040	15.42	0.98	0.12	0.11	0.05	2.48
13+50	13+57	R	7.00	2.00	4.00	6.00	0.0286	0.01	0.05	0.60	0.03	Seed	3.94	5	0.030	15.46	1.09	0.09	0.12	0.05	2.48
												Seed	4.40	10	0.040	15.55	0.88	0.12	0.13	0.06	2.64

CATCH BASIN
GRATE CAPACITY
CALCULATIONS

CAPACITY OF A GRATE CATCH BASIN IN A SUMP

1102-1

REFERENCE SECTION
1102.3.5



DATA

TYPE OF BASIN: 2-2-B
DRAINAGE AREA = 0.50 ACRES
RUNOFF COEFF = 0.50
Tc = 15 min.
I (10) = 4.4
Q (10) = CIA = 0.5 X 4.4 X 0.5 = 1.1 cfs
HEAD = 0.16 FT GRATE IS OK

NOI ACREAGE CALCULATIONS

WAR-123-28.55
PID 106224

January 2008

NOTICE OF INTENT (NOI) ACREAGE CALCULATION FORM	1112-1 Reference Section 1112

	Area (acres)
Project Earth Disturbing Activities	0.87
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	—
Batch Plant: Yes = 2.0; No = 0	0
Off-Project Waste / Borrow Pit: Add 1.0 acre per 15,000 CY of waste or borrow 1100/15000	0.07
Miscellaneous Other Off-Project Areas: Off-Project staging areas, stock yards, etc.	—
Contractor Earth Disturbing Activities Subtotal	0.07
Total Earth Disturbing Activities (add Project EDA and Contractor EDA) TOTAL	0.94
NOI Earth Disturbing Activities (see below to determine value) TOTAL	—

Project Earth Disturbing Activities - Enter the area of permanent earth disturbing activities directly related to project activities. Earth disturbing activity is defined as any activity that exposes bare ground or an erodible material to storm water and anywhere Item 659 Seeding, SS 870 Seeding, Item 660 Sodding, or SS 870 Sodding is being furnished.

Contractor Earth Disturbing Activities:

Field Office - These sizes were determined with regard to size of the trailer, parking, and some stock area for equipment and materials.

Batch Plant - It is assumed that a typical batch plant would occupy 2 acres of ground. The designer should investigate the location of the project relative to existing plants, facilities, etc. to estimate whether a batch plant might be used by the Contractor. This is not needed for existing plants, it is only for plants set up for the specific project.

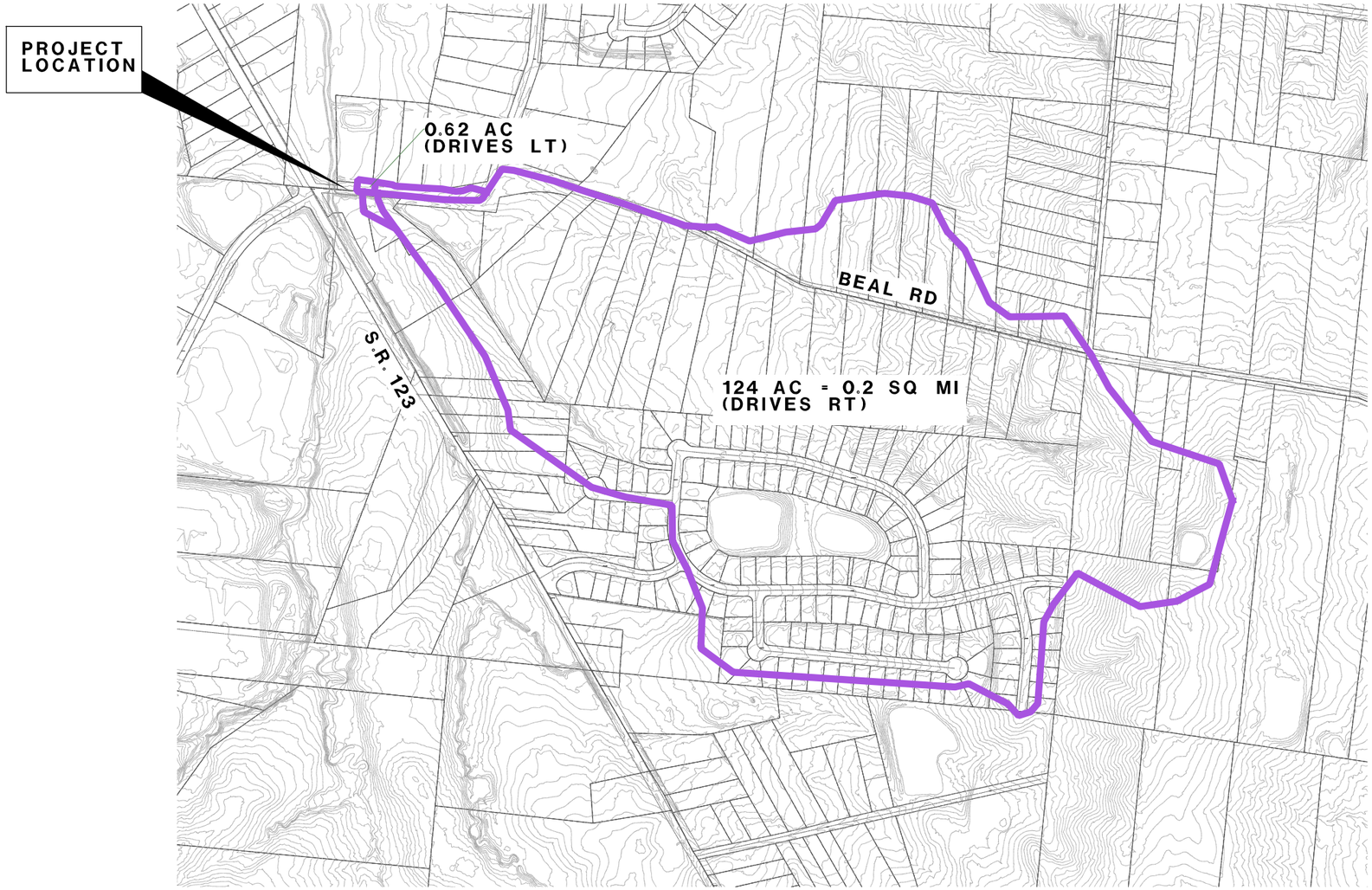
Off-Project Waste / Borrow - The specified estimation is based on approximately 10 feet of depth or fill over 1 acre. The designer may choose a different value based on knowledge of the project area, bedrock elevations, previous projects, etc. Consideration should be given for grindings, as well. (10ft. x 43560 s.f. / 27 = 16,133 c.y. ~ 15,000 c.y.)

NOI Earth Disturbing Activities - This is the combined Project and Contractor Earth Disturbed Area. Based on project conditions and activities, some flexibility in the area calculation should be provided to avoid the possibility of the estimated work being less than the actual work. This scenario would require submittal of an NOI for projects originally calculated to be less than one acre during construction.

For projects with an estimated NOI EDA less than one acre: No NOI is required. For projects with an estimated NOI EDA of one or more acre, but less than 4.9 acres, use 4.9 acres. For projects with an estimated NOI EDA greater than 4.9 acres, use the sum of the Project and Contractor Earth Disturbed Areas.

A Routine Maintenance Project consists of activities that do not change the line, grade, or hydraulic capacity of the existing condition and has less than 5 acres of earth disturbing activities (see section 1112.2).

DRAINAGE MAP



NOTE:
DUE TO THE CLOSE PROXIMITY OF THE DRIVES AND THE SMALL CHANGE IN DRAINAGE AREAS, THE DRAINAGE AREA FOR THE DOWNSTREAM CONDUIT WAS USED FOR BOTH LOCATIONS.

N

0 150 300 600 HORIZONTAL SCALE IN FEET

CALCULATED JRE
CHECKED SDC

DRAINAGE MAP

WAR-123-28.55

00

H:\2018\80554\ODOT\ProjectData\06224_SR123\Design\Roadway\Sheets\06224_Drainage Map.dgn Sheet 1/23/2020 7:59:23 AM Espelage