Hydraulics Updates and Impacts to Median Drain Design

INDIANA DEPARTMENT OF TRANSPORTATION

Presenters

Alex Schwinghamer
aschwinghamer@indot.in.gov

Susanna Oakley
soakley@lochgroup.com

What is Considered a Median Drain?

- Drainage system within the median of a divided highway
- Contains trapped flow
  - Displaced Left intersections
- Additional Requirements
  - Local ordinances
  - Legal constraints

IDM 203-7: Median Drains

- Brand new IDM section
- In final review stages
- Design Guidance
  - Serviceability Requirements
    - IDM Figure 203-7A
  - Median Types
  - Inlet Types
  - On-grade and sag requirements
  - Pipe sizing
  - Documentation

Serviceability IDM Fig. 203-7A

Type of Facility	Roadway Serviceability AEP	Allowable Outlet Velocity AEP	Allowable Spread AEP	Allowable Spread T
Freeway	2%	2%	2%	Edge of Travel Lane
Non-Freeway, 4 or More Lanes	2%	2%	10%	Across one-half travel lane
Two-Lane Facility: Transitional or Raised Median	2%	10%	10%	4 ft onto travel lane[1]
Confined Lane	2%	10%	10%	4 ft onto travel lane[1]
Ramp[2] V ≥ 50 mph V < 50 mph	 10% 10%	 10% 10%	 10% 10%	 Edge of travel lane 4 ft onto travel lane

Note: Consideration for a 2% AEP storm event should be used when in a depressed area, see section 203-4.04(10).

1. The minimum width of unimpeded travel lane should be 8 ft.
2. Ramp design frequency and allowable spread should be the same as the more restrictive corridor that it connects.

Serviceability IDM Fig. 203-7A

- *When to use 203-7A versus 203-4A*

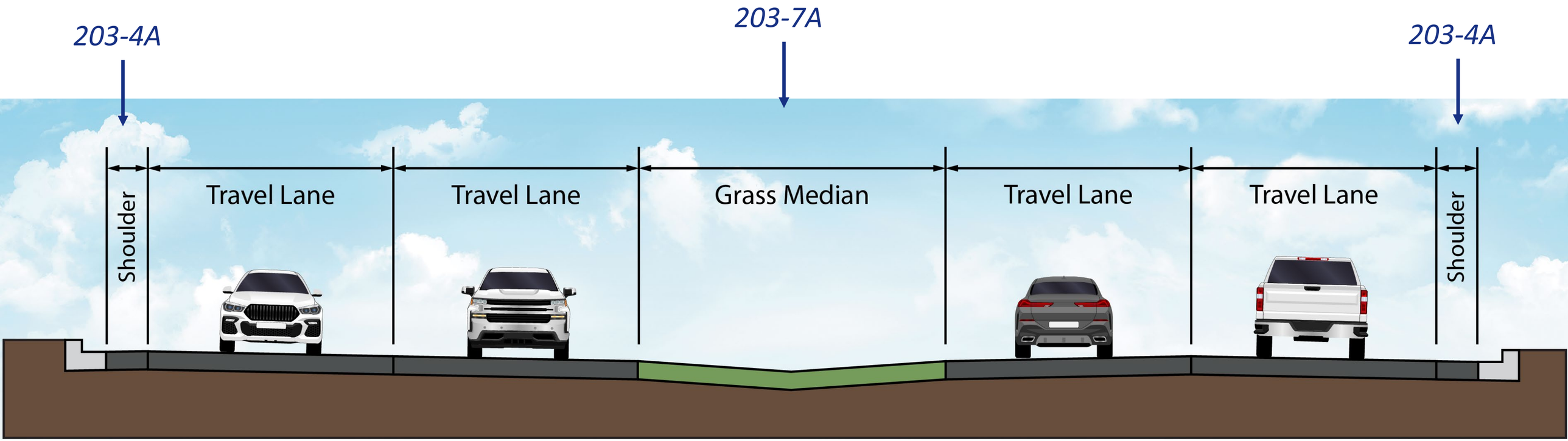
Type of Facility	Design Frequency	Allowable Spread, T
Freeway	2% Annual EP	Edge of travel lane
Non-Freeway, ≥ 4 Lanes	10 % Annual EP	Across one-half travel lane
Two-Lane Facility	10 % Annual EP	4 ft onto travel lane
Bridge Deck, Non-Freeway $V \geq 50$ mph $V < 50$ mph	10 % Annual EP 10% Annual EP	Edge of travel lane 3 ft onto travel lane
Ramp $V \geq 50$ mph $V < 50$ mph	10% Annual EP 10% Annual EP	Edge of travel lane 3 ft onto travel lane

Note:Consideration for a 2% annual EP storm event should be used when in a depressed area. See Section 203-4.04(10)

DESIGN FREQUENCY AND ALLOWABLE WATER SPREAD

Figure 203-4A

Serviceability IDM Fig. 203-7A



Types of Medians

- Pervious Depressed Medians
  - Consistent and Standard Section
  - Grass Interior
  - Guardrail, Cable Barrier, or No Barrier
- Impervious Depressed Medians
- Bifurcated Sections

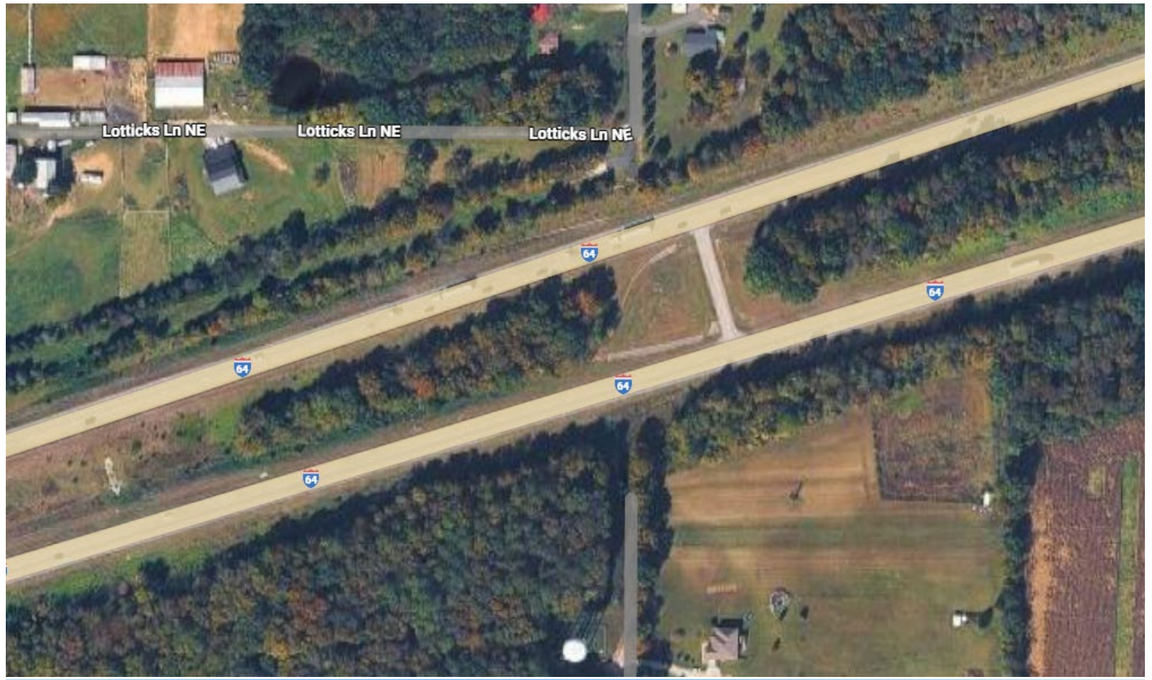
Types of Medians

- Pervious Depressed Medians
- Impervious Depressed Medians
  - Paved Interior
  - Concrete Median Barrier
- Bifurcated Sections

•••

Types of Medians

- Pervious Depressed Medians
- Impervious Depressed Medians
- Bifurcated Sections
  - Inconsistent, Wide (>60ft), and Non-Standard Sections
  - Vegetated Interior
  - To be designed like a culvert



Hydrology

- Watershed
  - Provide existing and proposed contours
  - Provide proposed cross sections if changed from existing
  - Include bypass of inlets outside of construction limits
- Runoff Coefficient (C)
  - Grass: 0.25
  - Pavement: 0.95
  - Loose Recycled Asphalt (RAP): 0.85
- Tc
  - TR-55
  - Minimum of 5 minutes

Inlet Types

- P-12
  - No clogging
  - Single grate length
  - Use if N-12 cannot fit
- N-12
- H-5/HA-5 Inlets
- HB-5
- Type 7

Inlet Types

- P-12
- N-12
  - No clogging
  - Double grate width
  - Most preferred
- H-5/HA-5 Inlets
- HB-5
- Type 7

Inlet Types

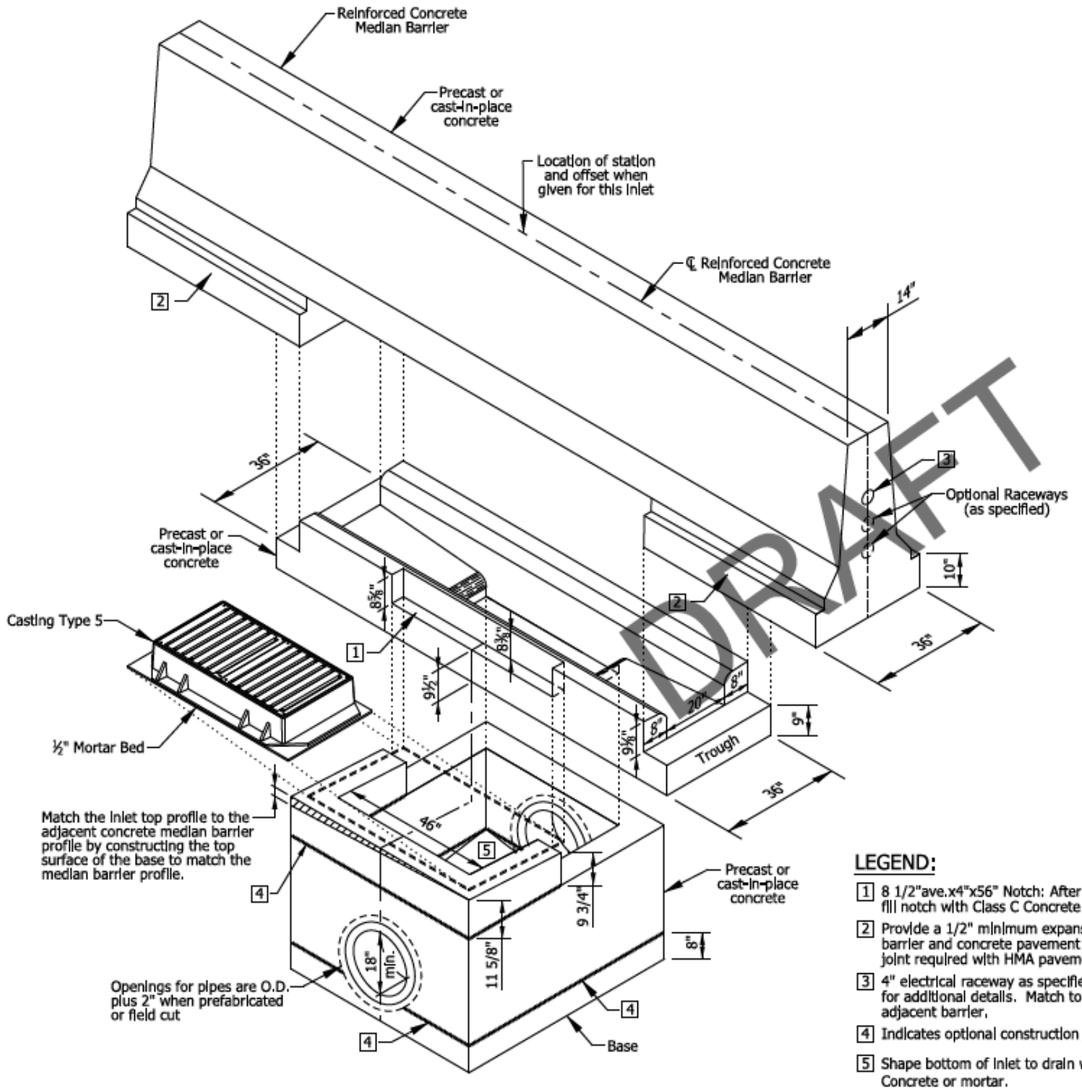
- P-12
- N-12
- H-5/HA-5 Inlets
  - 50% clogging
- HB-5
- Type 7

Inlet Types

- P-12
- N-12
- H-5/HA-5 Inlets
- HB-5 – New
  - No clogging factor for spread
  - Minimum 18-inch outlet pipe due to larger debris
  - H-5 access grate
- Type 7

Inlet Types

- HB-5



NOTES:

1. For additiond details of Reinforced Concrete Median Barriers, see sheets 7 and 8.
2. The walls between the bottom slab and the upper permissible construction joint may be built of brick, concrete block or cast-in-place concrete, 8" nominal thickness for depths of 12' or less. Precast walls have a minimum thickness of 6" and are reinforced sufficiently to permit shipping and handling without damage.
3. Cast-in-place concrete shall be Class A or higher. When precast, provide concrete that meets the requirements of 702. Seal the exposed concrete surfaces of the barrier when specified in the plans.
4. Precast or cast-in-place inlets over 12 feet in depth, reinforce with #5 bars on 12" centers both vertically and horizontally, with 2" clearance from face.
5. Minimum inside pipe diameter to be 18". Ensure pipe openings are the outside diameter of the pipe being supplied plus 2" when fabricated or field cut. Fill all voids.
6. Slope the aprons on both sides of the casting toward the inlet windows and fill with Class C concrete or HMA pavement as specified. On superelevated sections, slope the aprons as shown in Section C-C.
7. PCJ indicates optional construction joint.

LEGEND:

1. 8 1/2"ave.x4"x56" Notch: After casting is placed, fill notch with Class C Concrete.
2. Provide a 1/2" minimum expansion joint between barrier and concrete pavement or shoulders. No joint required with HMA pavement or shoulders.
3. 4" electrical raceway as specified. See Sheet 3 for additional details. Match to raceways in adjacent barrier.
4. Indicates optional construction joint.
5. Shape bottom of inlet to drain with Class A Concrete or mortar.

INDIANA DEPARTMENT OF TRANSPORTATION

REINFORCED CONCRETE MEDIAN BARRIER
WITH INLET TYPE HB
INSTALLATION

SEPTEMBER 2026

STANDARD DRAWING NO. E 602-CCMB-06

DESIGN STANDARDS ENGINEER DATE

CHIEF ENGINEER DATE

Inlet Types

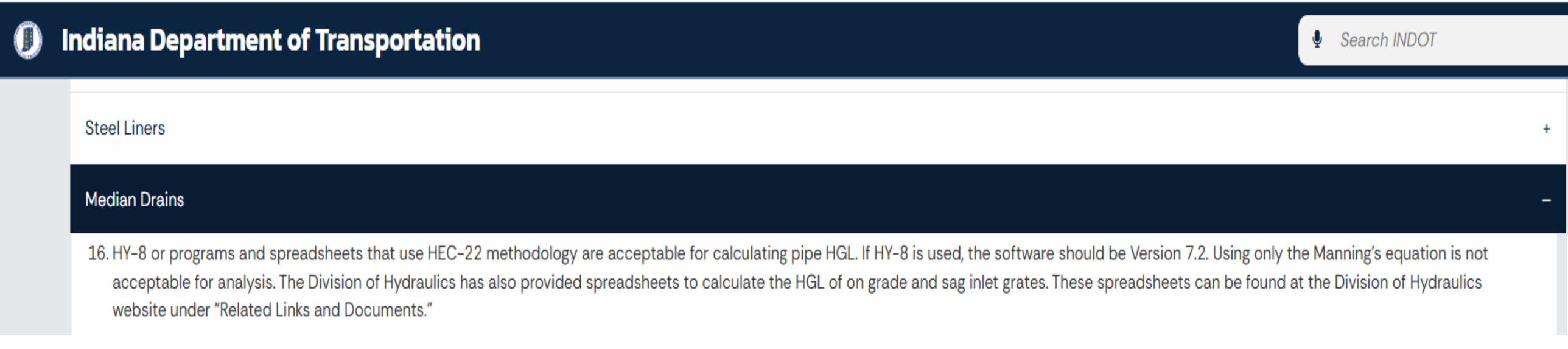
- P-12
- N-12
- H-5/HA-5 Inlets
- HB-5
- Type 7 – No Thank You
  - 50% clogging
  - Most prone to clogging
  - Not to be used in medians for projects

Pipes

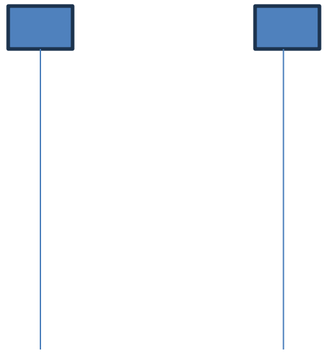
- Outlet for each inlet when possible
  - 400 ft limit for Connecting Pipes
  - No more than 4 to be connected
- H-5, P-12, N-12
  - Minimum Pipe Size: 12 inch
- HB-5
  - Minimum Pipe Size: 18 inch
- Modeling:
  - Single pipe: HY-8 V7.2
  - System of Pipes: HEC-22 modeling system
  - Manning’s Equation is not adequate (No Spreadsheets)

Pipes

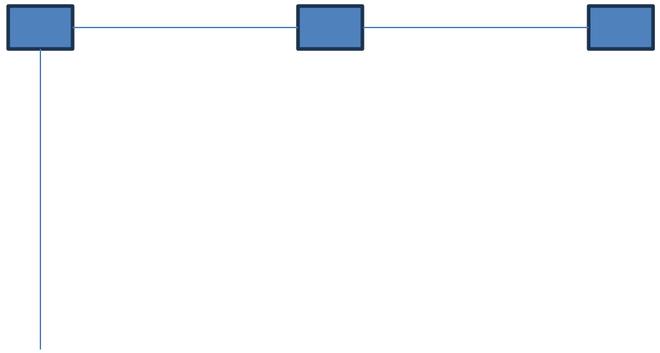
- Modeling:
  - Single pipe: HY-8 V7.2
  - System of Pipes: HEC-22 modeling system
  - Manning's Equation is not adequate (No Spreadsheets)



Pipes



HY-8 Only



HY-8 or Other Modeling Software

Calculating Bypass and Sag Points

- HEC-22
- Spreadsheets available on website
  - Grass Median Inlet Spread – *to be uploaded*
    - P-12, N-12, Type 7 inlets
  - Inlet Spacing INDOT Method v2.0 – *to be uploaded*
    - Storm Sewer Inlets
    - Includes HB-5 inlet and curb turnouts
  - *Both spreadsheets' updates*
    - Define if it is on-grade or sag
    - Define which inlet by-pass goes to
    - Calculates spread for the sag point

Calculating Bypass and Sag Points

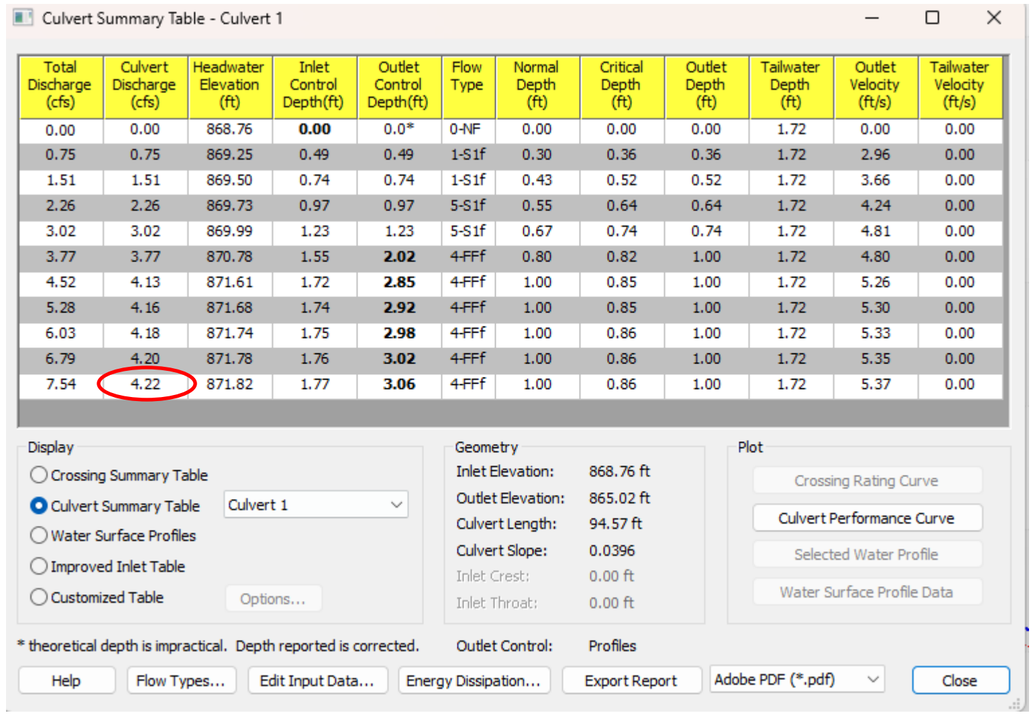
- Grass Median Inlets

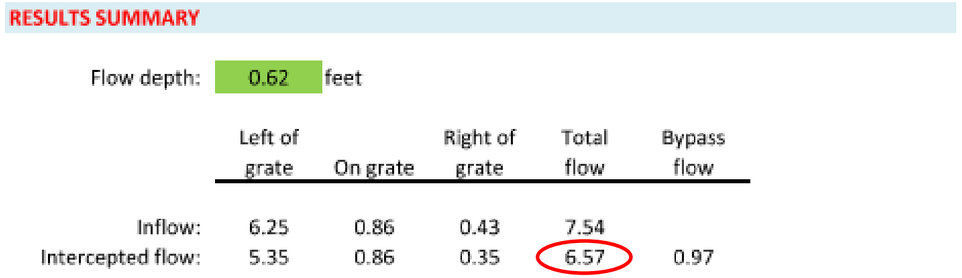
Grass Inlet Hydraulic Computations

Structure Info						hydrology		Pipe Hydraulics			Flow		Misc. Elevations					
Str. # (if none, simply do 1-30)	Inlet Type	Slope of P or N inlets (H:1)	clogging factor % (if not standard)	sag or on-grade	Str. # Bypass Goes To	Design Storm Frequency	Individual Drainage Area Q (cfs)	HGL of Pipe Analysis (ft)	Outlet Pipe Size (in)	Pipe Bypass from model (cfs)	Total Run-by Q going to inlet (cfs)	Total Q (cfs)	Known Bottom of grate Station	grate elev (ft)	on-grade Berm elev (ft)	On-grade Berm Thickness (ft) (if no input, assumes 3 ft *if berm present*)	Serviceability Elev. (Low Edge of Travel Lane)	Le
Str 1	P-12	10		on-grade	Str 2	50		100.63	15	0.5	0.00	5.00	18.00	100.1	100.5	4	102	
Str 2	P-12	8		on-grade	Str 3	50	7.8	100.20	15.00	0.40	0.50	8.36	15.00	100			102	
Str 3	P-12	10		sag		50					11.40	16.40		99.5	99.9		101	
Str 4	N-12	6		on-grade	Str 3	50	7.				3.52	11.42		99.75			101	
Str 5	P-12	10		on-grade	Str 4	50	6.6				3.66	10.34		100.25	100.5		102	
6	Type 7	8		on-grade	Str 5	50					4.93	7.93		99.5	99.5		101	
7	P-12	6		on-grade	6	50	1				10.38	25.38	15.00	99.75	100.75		101	
8	N-12	6		on-grade	7	50	3				0.00	35.00	13.00	100.25	100.75	5	101.25	
											0.00	0.00						
											0.00	0.00						

Calculating Bypass and Sag Points

- Consider Bypass from Pipes





Calculating Bypass and Sag Points

- Grass Median Inlets

Ditch info														Results						common errors			
y	Left Station Top of Bank	Left Top of Bank Elev	Left Station Toe of Slope	Left Toe of Slope Elev	Flowline Station	Flowline Elev	Right Station Toe of Slope	Right Toe of Slope Elev	Right Station Top of Bank	Right Top of Bank Elev	Manning's n	Channel Slope if on-grade (ft/ft)	If N-12 or P12, side of channel	Clogging Factor	Flow Depth over Inlet or over Berm (ft)	HGL Elev (ft)	Q intercepted (cfs)	Individual Structure Run By (Cfs)	Inlet side cover depth	P or N Inlet fits?	Channel size adequate?	water encroaches onto road?	Flowline station on correct side of channel?
2	0	100.9	10	100.41	16	100	20	100.26	30	101.5	0.04	0.018	right	0%	0.015	100.52	4.78	0.22	1.40	yes			
2	0	101.12	7.01	100.84	15.8	100	22.53	100.84	30.34	100.97	0.04	0.029	left	0%	0.624	100.62	5.23	2.85	1.12	yes			
1	0	100.75	10	99.75	15	99.5	22	100.25	29	100.8	0.035		left	0%	0.613	100.51	16.27	0.00	1.25	yes			
1	0	100.9	12	100.4	15	99.75	20	100.3	31	100.8	0.035	0.024	left	0%	0.781	100.53	3.01	8.41	1.15	top of inlet			
2	0	101.4	11	100.75	14	100.25	19	100.5	30	101.5	0.035	0.015	center (Be	0%	0.349	100.85	6.82	3.52	0.25	no			
1	0	100.75	7	99.75	15	99.5	22	100.25	29	100.8	0.035	0.029	right	50%	0.381	99.88	4.27	3.66	1.30				
1	0	100.9	8	100.4	15	99.75	20	100.3	31	100.8	0.035	0.024	right	0%	0.164	100.91	20.45	4.93	1.05	yes			
5	0	101.4	10	101.25	14	100.25	19	100.5	30	101.5	0.035	0.015	left	0%	0.539	101.29	24.62	10.38	1.15	no		yes	
														0%	#N/A	#N/A	#N/A	#N/A		#N/A		#N/A	
														0%	#N/A	#N/A	#N/A	#N/A		#N/A		#N/A	

Calculating Bypass and Sag Points

- Grass Median Inlets

Paste these results in the memo and report								
Str. #	Inlet Type	Location	Grate Elev	Berm Elev	Serviceability Elev	Inlet HGL	Pipe HGL	Pipe size
Str 1	P-12	on-grade	100.1	100.5	102	100.52	100.63	15.00
Str 2	P-12	on-grade	100		102	100.62		
Str 3	P-12	sag	99.5	99.9	101	100.51		
Str 4	N-12	on-grade	99.75		101	100.53		
Str 5	P-12	on-grade	100.25	100.5	102	100.85		
6	Type 7	on-grade	99.5	99.5	101	99.88		
7	P-12	on-grade	99.75	100.75	101	100.91		
8	N-12	on-grade	100.25	100.75	101.25	101.29		

Calculating Bypass and Sag Points

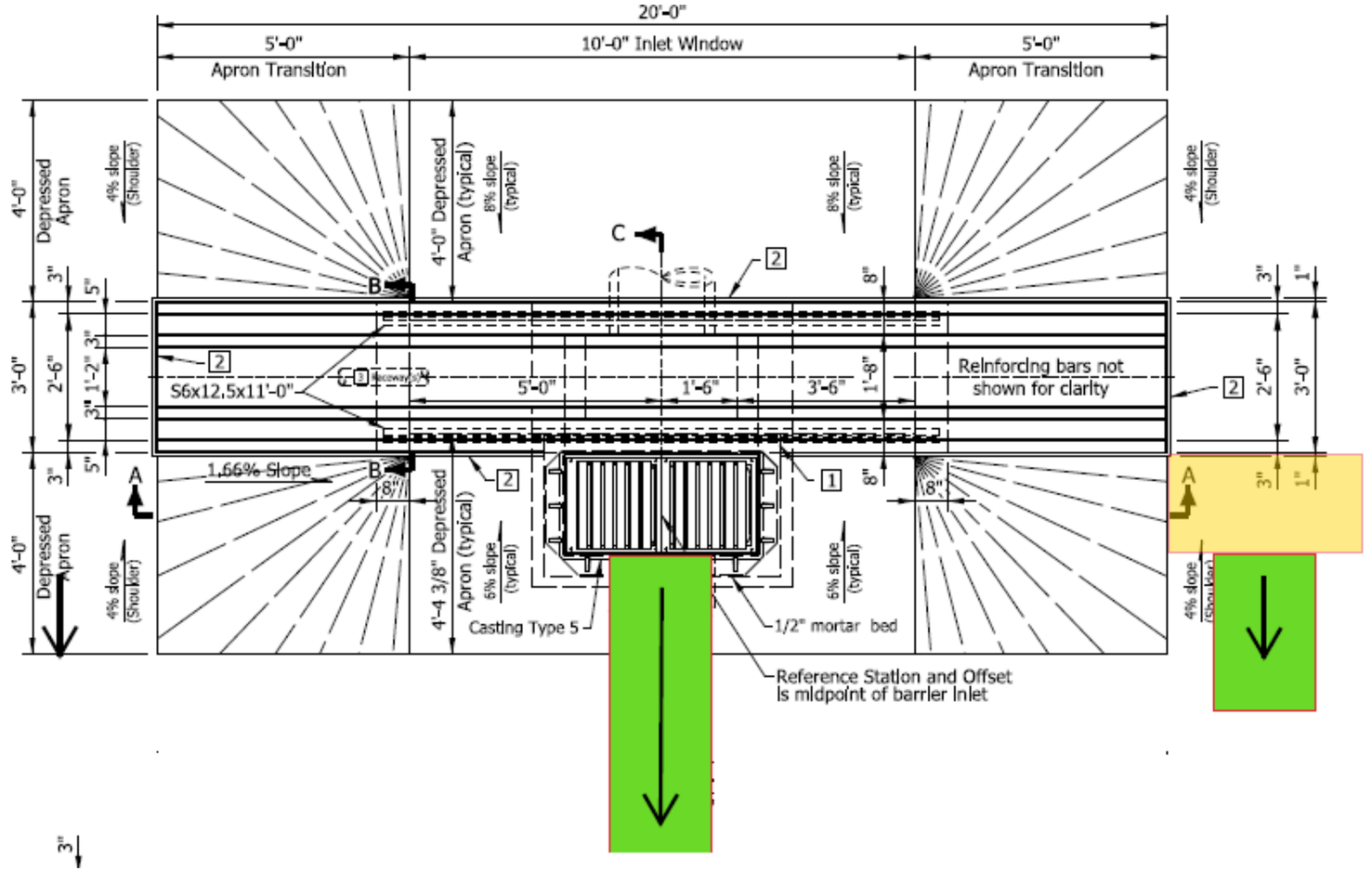
DATA ENTRY SECTION: **COMPUTATION SECTION:** (Do not enter d

	Inlet Number	Station	sag or on-grade	if on-grade, bypass goes to	On-Site Area: Average Width (feet)	On-Site Area: Rational C	Off-Site Area: DA (acres)	Off-Site Area: Rational C	Off-Site Area: Time of Conc. (min)	Slope of P.G. (S_L) (ft/ft)	Pavement Cross Slope (S_x) (ft/ft)	Gutter Cross Slope (S_w) (ft/ft)	Gutter Width (w) (feet)	Allowable Spread (feet)	Inlet Type	Curb Turnout (CTO) Width (if applicable) (feet)	Inlet Drainage Area (ac)	CA	Intensity (in/hr)	Q (cfs)	Spread (feet)	Re Cor anc
1	45	48+80.	on-grade	44			0.1377	0.9	5	0.005	0.03	0.03	2	8	CTO	7	0.138	0.124	7.20	0.89	6.09	12
2	44	47+75.	on-grade	43			0.1092	0.8181	5	0.005	0.03	0.03	2	8	6		0.109	0.089	7.20	0.81	5.86	11
3	43	46+80.	on-grade	42			0.1175	0.7196	5	0.005	0.03	0.03	2	8	CMI		0.118	0.085	7.20	0.94	6.21	13
4	42	45+85.	on-grade	41			0.1231	0.6962	5	0.005	0.03	0.03	2	8	CTO	7	0.123	0.086	7.20	0.62	5.30	8.
5	41	44+90.	on-grade	40			0.1277	0.6781	5	0.005	0.03	0.03	2	8	5		0.128	0.087	7.20	0.69	5.52	9.
6	40	43+95.	on-grade	39			0.1341	0.6554	5	0.005	0.03	0.03	2	8	CTO	7	0.134	0.088	7.20	0.81	5.89	11
7	39	43+50.	sag				0.1415	0.6314	5		0.03	0.03	2	8	CTO	7	0.142	0.089	9.13	0.95	4.26	#DI
8	38A	43+00.	on-grade	39			0.0562	0.6003	5	0.0062	0.03	0.03	2	8	CTO	7	0.056	0.034	7.20	0.26	3.68	3.
9	38B	42+65.	on-grade	38A			0.0691	0.5722	5	0.0105	0.03	0.03	2	8	CTO	7	0.069	0.040	7.20	0.28	3.45	2.
10																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
11																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
12																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
13																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
14																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
15																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
16																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
17																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
18																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
19																	0.000	0.000	7.20	0.00	#DIV/0!	#DI
20																	0.000	0.000	7.20	0.00	#DIV/0!	#DI

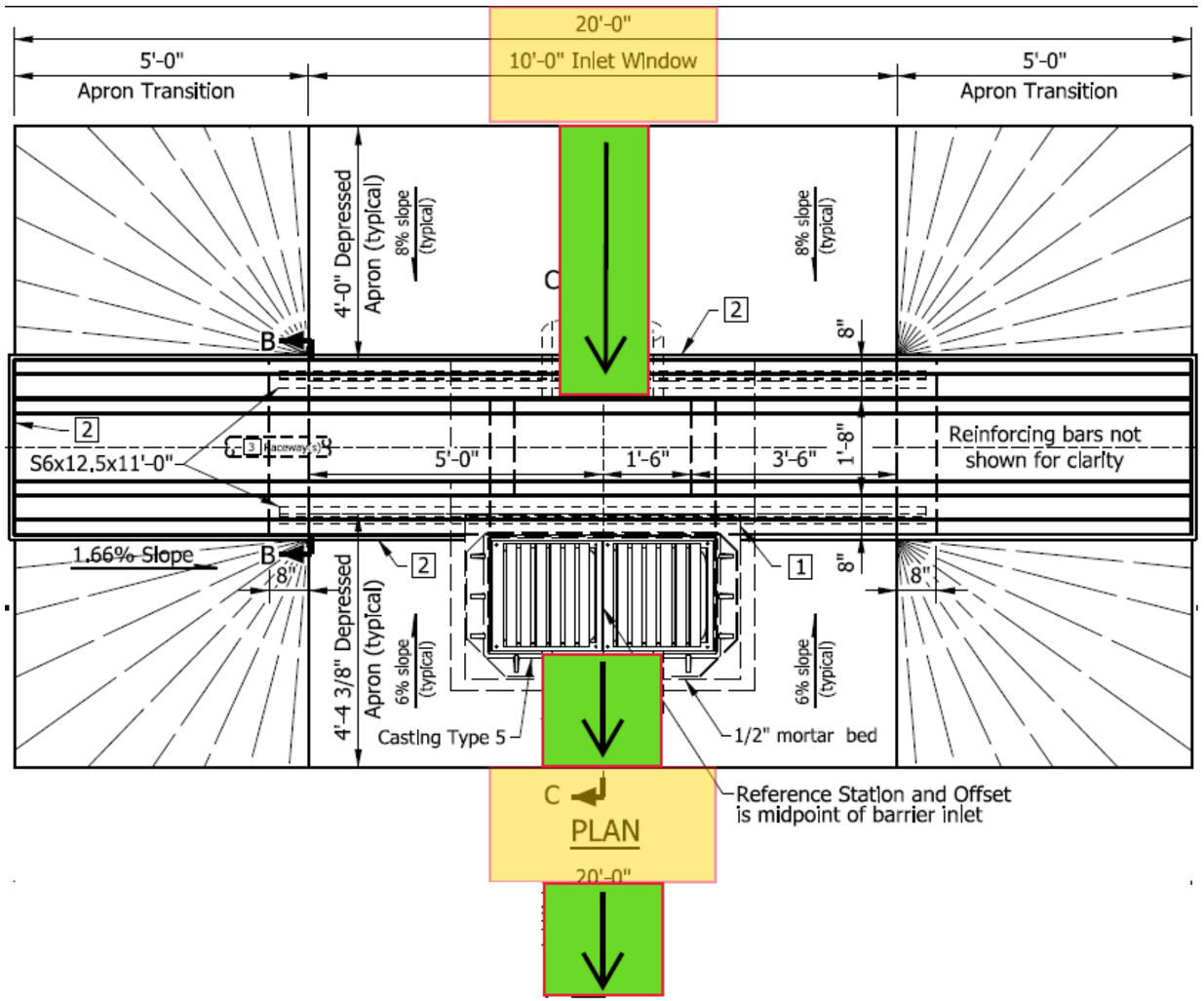
Flanking Requirements

- Backup in case main inlet clogs
  - Water will go across travel lanes if no flanking inlet
- All ultimate sag points
  - Includes sag points created by paved median cross overs
  - Does not include artificial sag points created by low berms
- 1 inlet if flow coming from one direction
- 2 inlets if flow coming from both directions
- Flanking Inlet are not included in Spread Calcs
- Flanking Inlets may be tied into the sag inlet
  - Unless HB-5 inlet to be used and not in sequence

Flanking Requirements

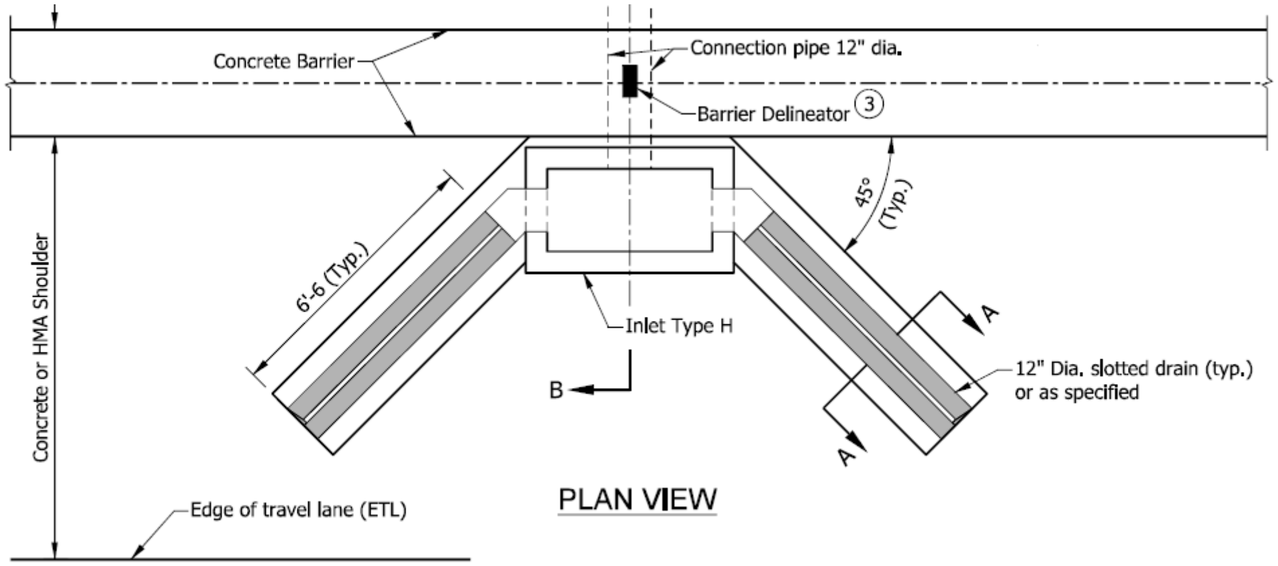


Flanking Requirements



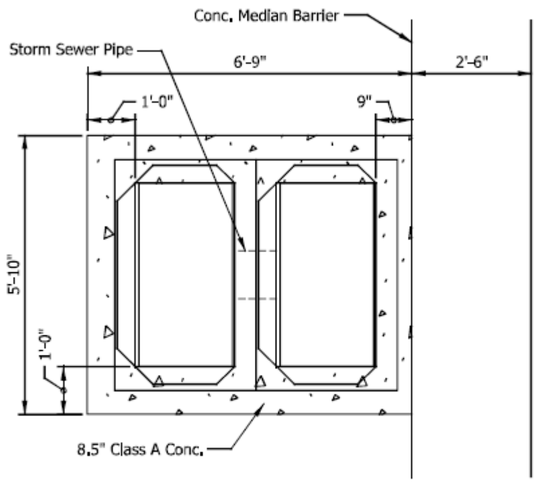
Snow Melt Requirements

- Only needed for paved median drains
  - Still need on outside shoulder too where appliable
- Slotted Drains for H-5’s
  - Current formation
  - Issues with clogging
- Double H-5’s
  - Substitute for slotted drain formation
- H5 for HB-5
  - In sequence with HB-5
  - Can be used concurrent with flanking inlet

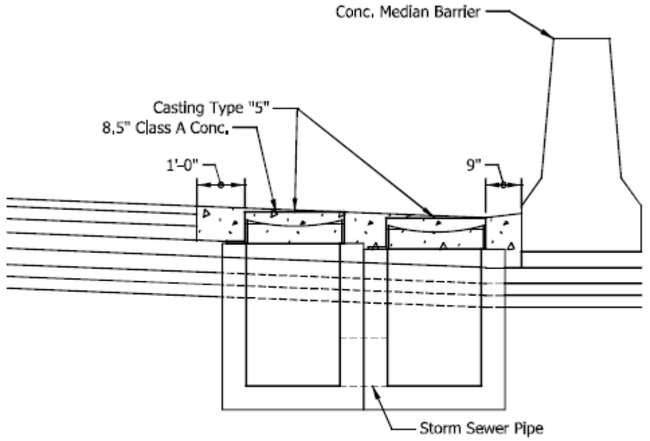


Snow Melt Requirements

- Only needed for paved median drains
- Slotted Drains for H-5’s
  - Current formation
  - Issues with clogging
- Double H-5’s
  - Substitute for slotted drain formation
  - More Maintainable
- H5 for HB-5
  - In sequence with HB-5
  - Can be used concurrent with flanking inlet



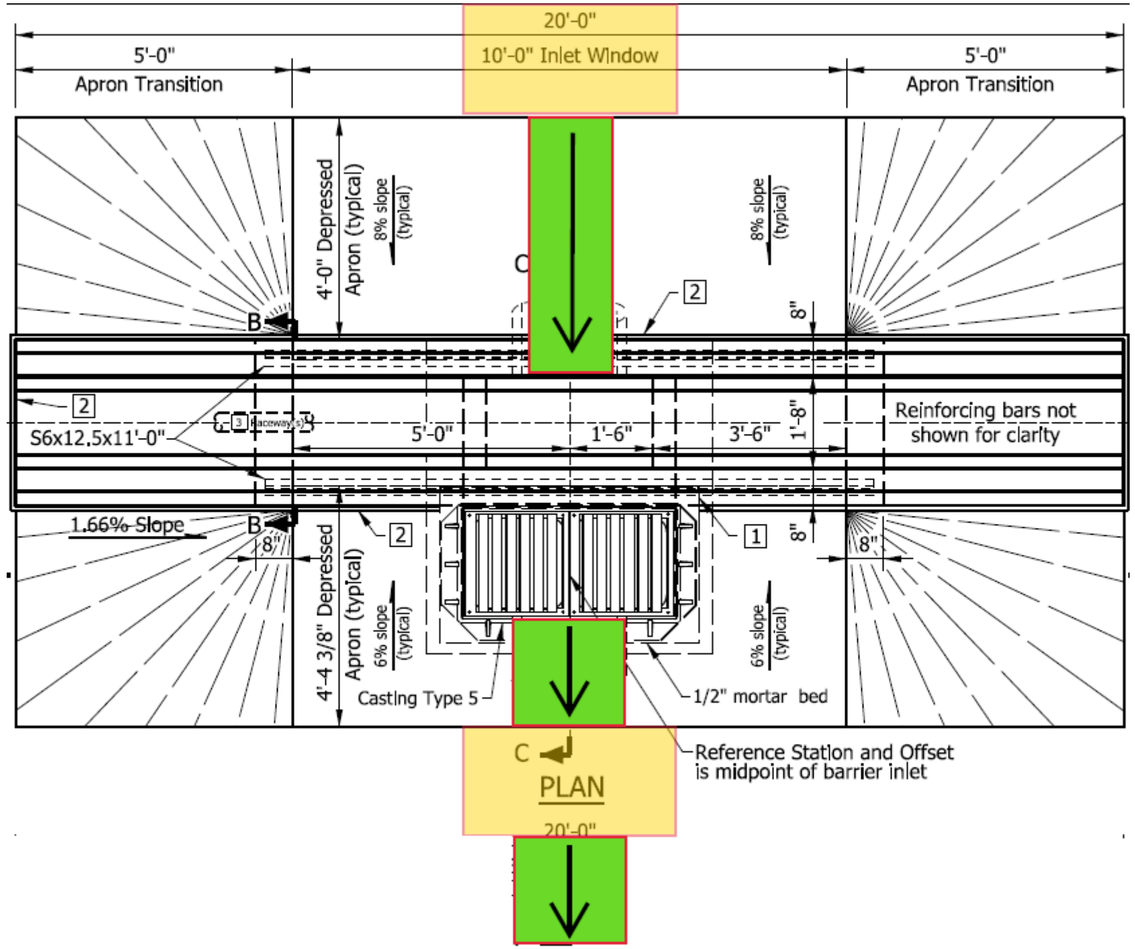
Dual HA-5 Concrete Apron Detail
Plan View



Dual HA-5 Concrete Apron Detail
Section View

Snow Melt Requirements

- Only needed for paved median drains
- Slotted Drains for H-5’s
  - Current formation
  - Issues with clogging
- Double H-5’s
  - Substitute for slotted drain formation
- H5 for HB-5
  - H5’s in sequence with HB-5
  - Can be used concurrent with flanking inlet



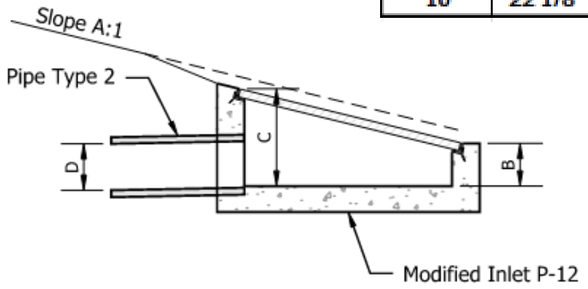
Downstream Constraints

- Outlet pipe 12 inches above side ditch flowline
  - If less than 12 inches above the flowline, HGL Check required from downstream ditch
    - Include the ditch's full flow
- Outlet pipe above AEP 1% HGL elevation of detention facility
  - If below: Downstream constraint is AEP 1% HGL of detention
- Headwater of nearby Downstream Culvert
  - AEP 1% WSEL
- Outlets to Larger Natural Stream
  - Joint Probability Analysis – IDM Figure 203-2G

INDOT Approval Memos

Design Basis and Future Modifications
The analysis and design information included in this document are based on current geometric and site conditions. If any road, ditch, or other site conditions change, a re-evaluation of the structure's hydraulics and capacity will be necessary to maintain design compliance.

Modified Type P-12 Inlet			
A	B	C	D
10	22 1/8"	27 3/4"	15"



SUBJECT: Hydraulic Review
Des. #: N/A
Asset Name: CLV-92841
County: Allen
Location: Under SR 3, 0.05 miles north of Stableford Dr
Crossing: UNT
DNR CIF Permit Required (Y/N): No
Legal Drain (Y/N): No

Parameter	Existing Structure	Proposal 1
Edge of Travel Lane Elevation (Serviceability) (ft.)	869.96	869.96
Edge of Travel Lane Elevation (Cover) (ft.)	870.31	870.31
Q50 Headwater Elevation* (ft.)	NA	869.18
Type of Inlet	E7	P12 Mod.**
Flanking Inlet Details	None	1-Flanking Inlet
Pipe Size (in.)	12	15
Outlet Invert Elevation (ft.)	866.30	866.66
Inlet Invert Elevation (ft.)	866.51	866.81
Inlet Rim Elevation (ft.)	Unknown	868.65
Drainpipe Approximate Length (ft.)	56.00	55.18
Pipe Material	Smooth	Smooth
Riprap Details	None	Revetment

** Represents the greater of the two headwater elevations resulting from inlet capacity limitations and pipe hydraulic performance under Q50 conditions.*
*** Total Depth increased by 3"*

Additional Design Guidance

- No detention in median
- No drainage from outside ditch
- Separate outlet pipe from cross pipes
- Slotted drains not to be used for spread calcs
  - Trench drains may be used for spread calcs
- Erosion Control
  - Not into side ditch: riprap apron IDM Figure 203-2J
  - On Embankment: Riprap to stretch to the toe of slope (3*Dia all the way down)
  - Riprap sizing: IDM Figure 203-2D
- INDOT Hydraulics Website
  - https://www.in.gov/indot/engineering/hydraulic-engineering/
  - Developing Design Guidance

Erosion Control

Lessons Learned

- 1 Report per Ultimate Sag
- HRA Uploads
  - Submit as Storm Sewer instead of under a single CLV #
  - Put in the comments how many median inlets are included
- Design only consider P12 even where N12s will be used
  - This prevents the need for redesign if the N12 doesn’t fit
  - Can consider existing N12s calcs for bypass only

Questions?