

Bioretention Cell Design

Bioretention Cell

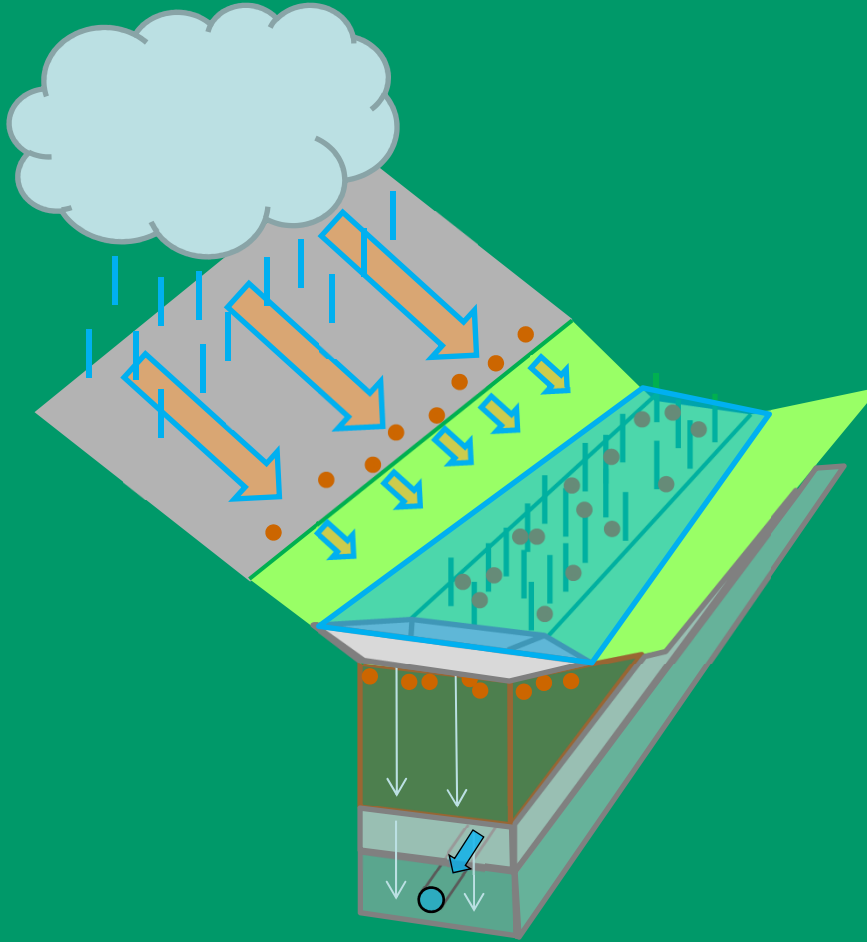


Bioretention Cell

- 🕒 L&D Vol. 2 Section 1117.5
- 🕒 Provides quality and quantity treatment



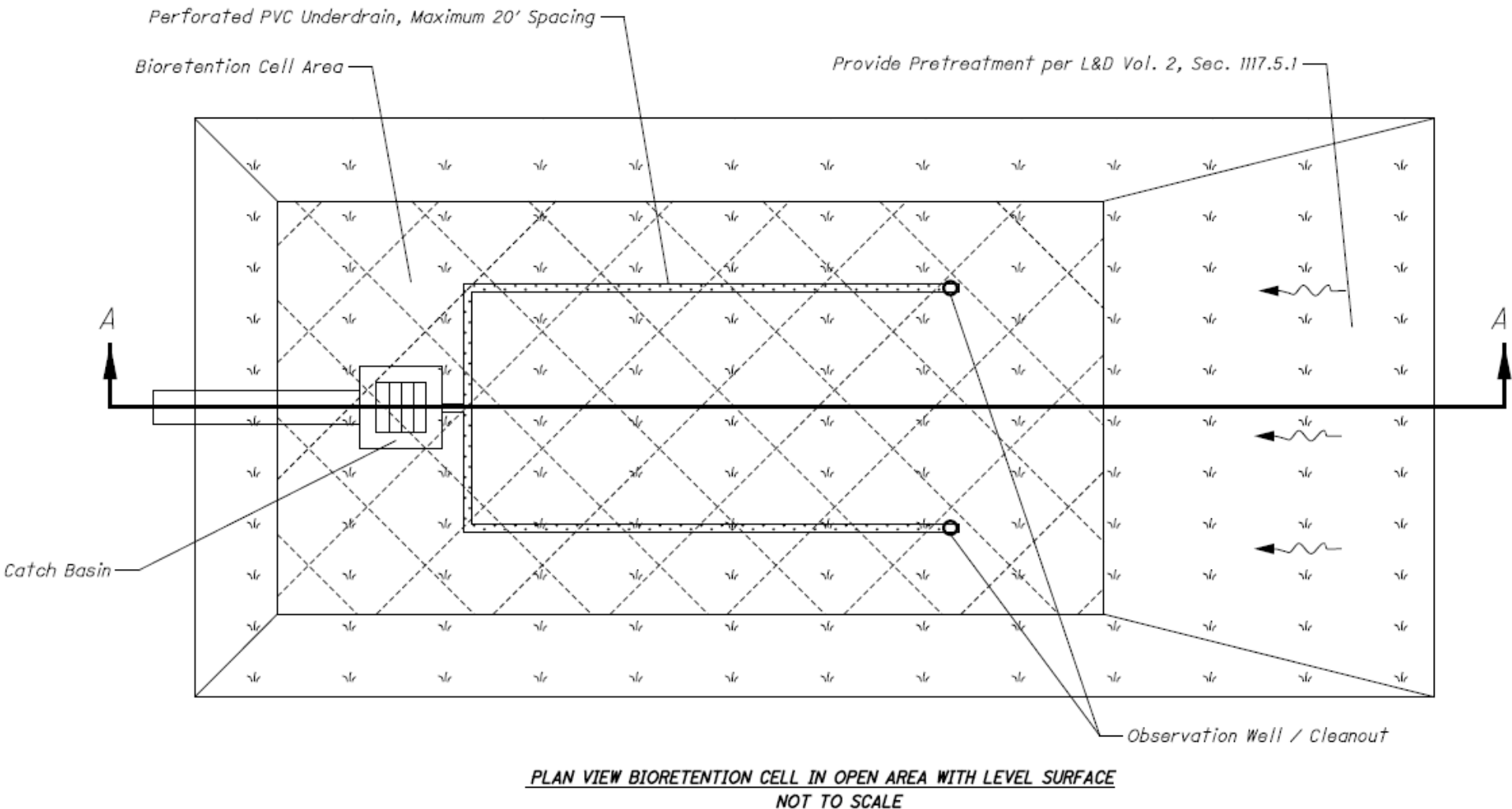
Bioretention Cell Treatment Processes



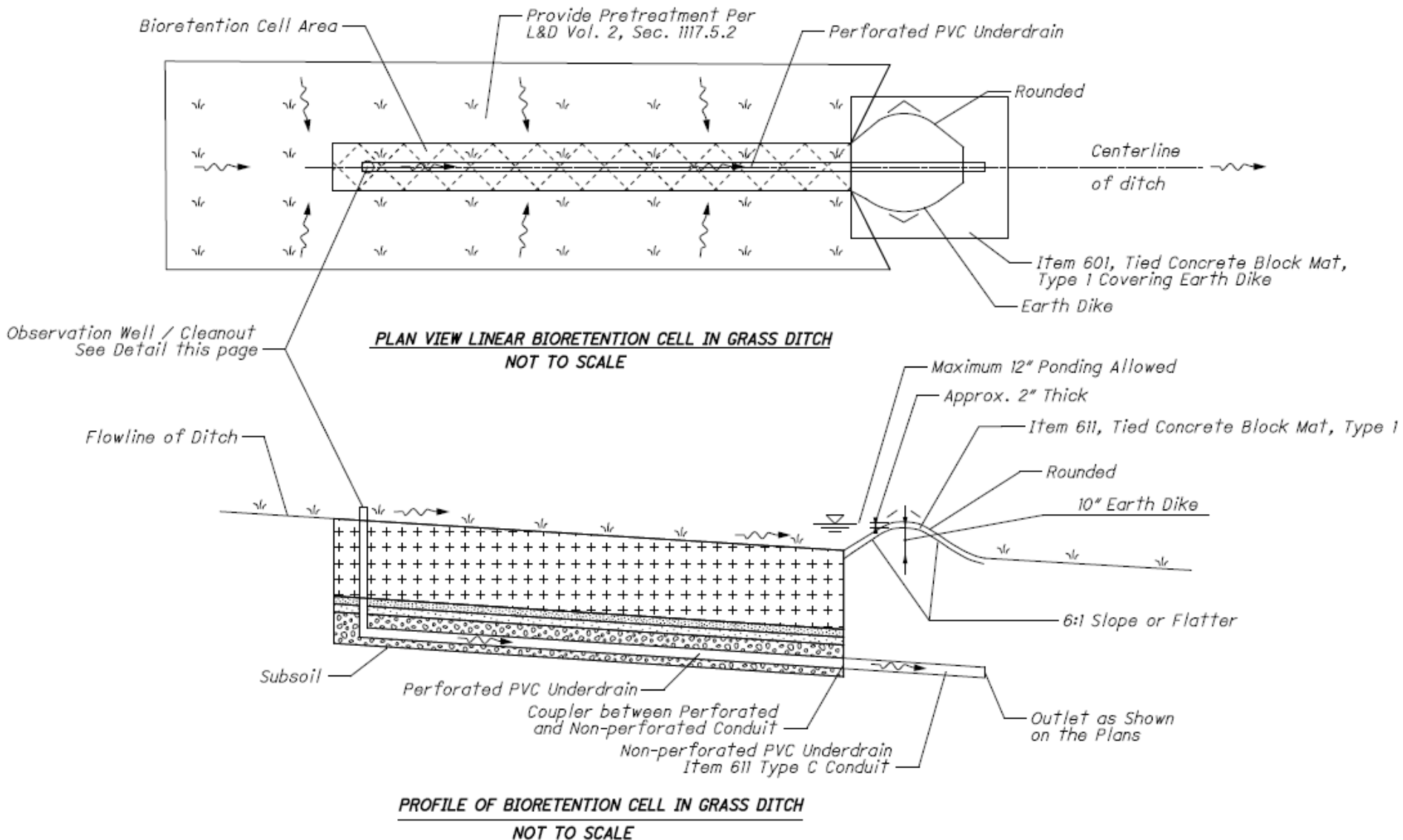
Design Process

- ④ Treatment Goals
- ④ Siting Analysis
- ④ Bioretention Cell Sizing
- ④ Pretreatment Design
- ④ Overflow
- ④ Other Considerations

Types of Bioretention – Flat Site



Types of Bioretention – Sloped



Siting Analysis

🕒 Flat basin sites

- 🕒 Interchanges
- 🕒 Intersections
- 🕒 Open spaces
- 🕒 5% of impervious area

🕒 Narrow and linear sites

- 🕒 Grass ditches
- 🕒 5% of impervious area



Siting Analysis

- ⌚ **Temporary ponding ≤ 1 ft**
 - ⌚ OK for the clear zone (with possible safety considerations)
- ⌚ **Flat basin sites**
 - ⌚ Larger footprint than detention basins
 - ⌚ Less safety concerns
- ⌚ **Linear sites – fit in most ditches**
- ⌚ **Urban streets – fit in sidewalk areas**

Siting Analysis



Design Process

- ④ Treatment Goals
- ④ Siting Analysis
- ④ **Bioretention Cell Sizing**
- ④ Pretreatment Design
- ④ Overflow
- ④ Other Considerations

Bioretention Cell Sizing

- ④ Determine the total impervious tributary area to the bioretention cell
- ④ Bioretention Area = $A_{imp} \times 5\%$
- ④ No WQ_v calculation
- ④ No WQ_v drawdown calculations
 - ④ Engineered soil media designed to filter at 1 to 4 in/hr
 - ④ Slows discharge to meet stream protection

Design Process

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- ④ Overflow
- ④ Other Considerations

Pretreatment Design

- ④ **Sheet flows: min. 5' filter strip**
- ④ **Concentrated flows:**
 - ④ Vegetated ditch or biofilter, at least 20' long
 - ④ Forebay for settling sediment, 10% WQ_v
- ④ **Decrease clogging and maintenance**
- ④ **Impact on cost and effort of maintenance**

Pretreatment Design



Pretreatment Design



Pretreatment Design



Pretreatment Design



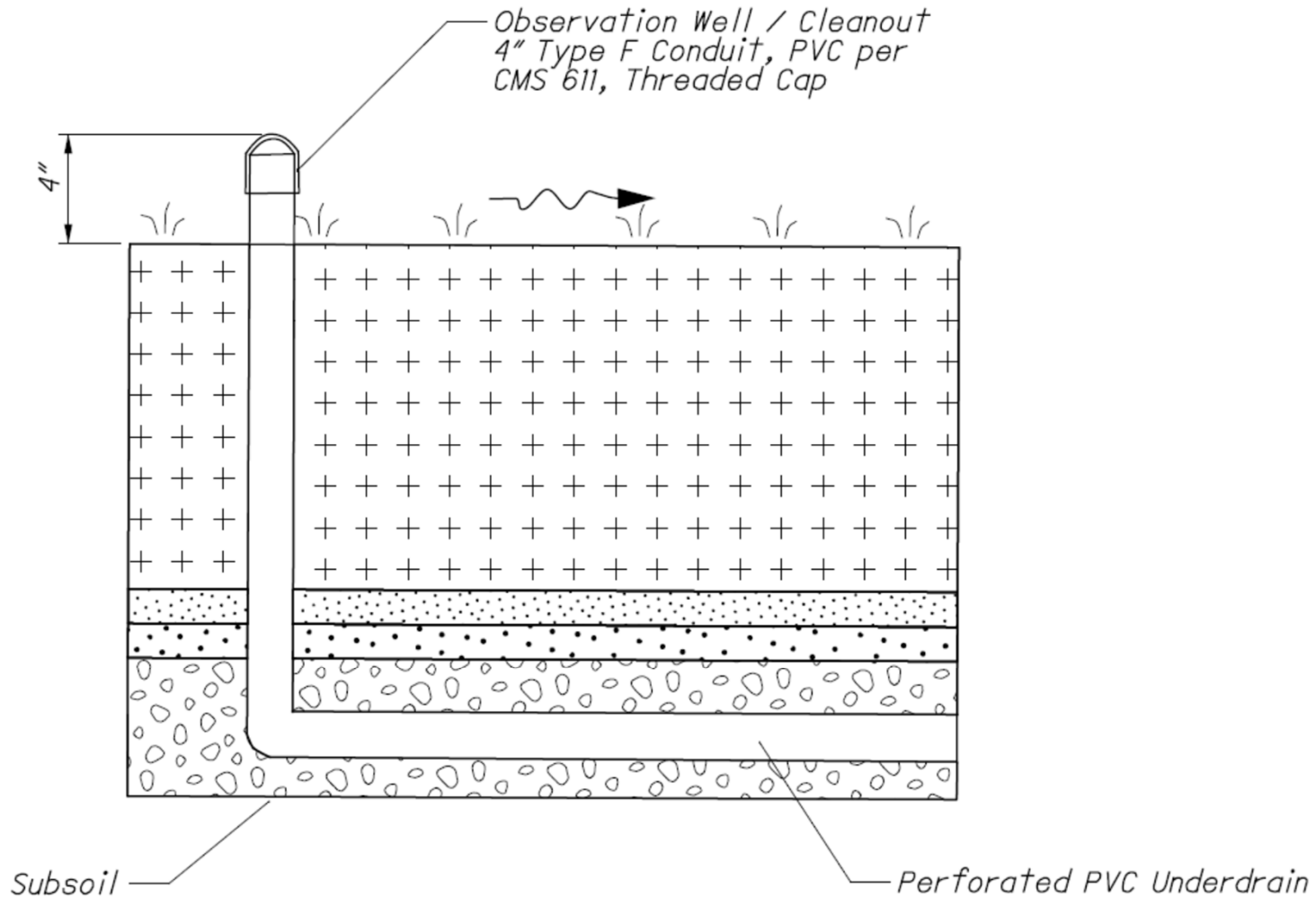
Pretreatment Design – Regular Maintenance

- ☉ Check observation wells 72 hours after a significant rain event at least twice per year. If clogged:
 - ☉ Remove and replace a portion of the engineered soil until desired permeability is achieved
- ☉ With good pretreatment, maintenance won't have to do this as often...

Observation Wells



Observation Wells

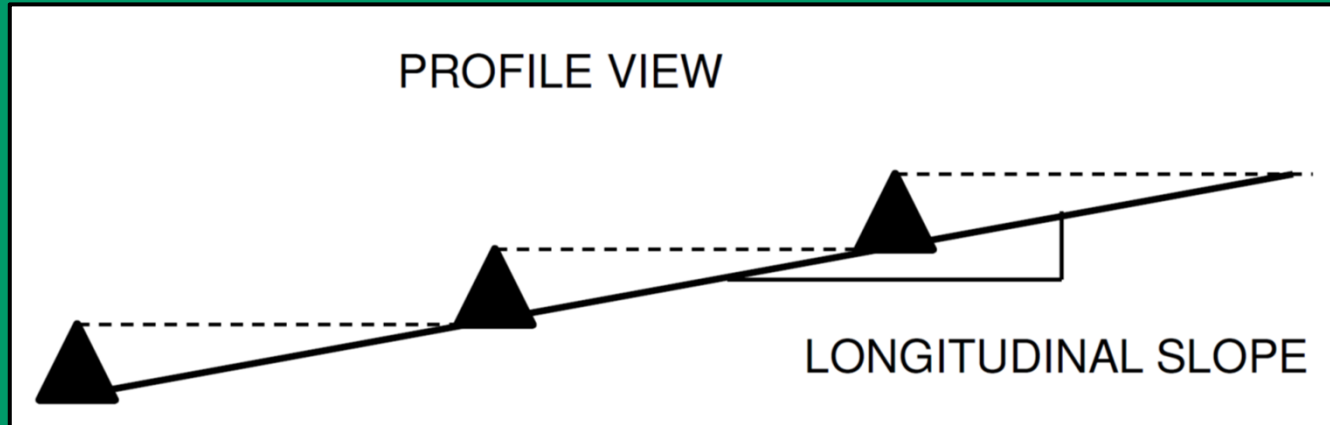


OBSERVATION WELL / CLEANOUT
NOT TO SCALE

Design Process

- ④ Treatment Goals
- ④ Siting Analysis
- ④ Bioretention Cell Sizing
- ④ Pretreatment Design
- ④ **Overflow**
- ④ Other Considerations

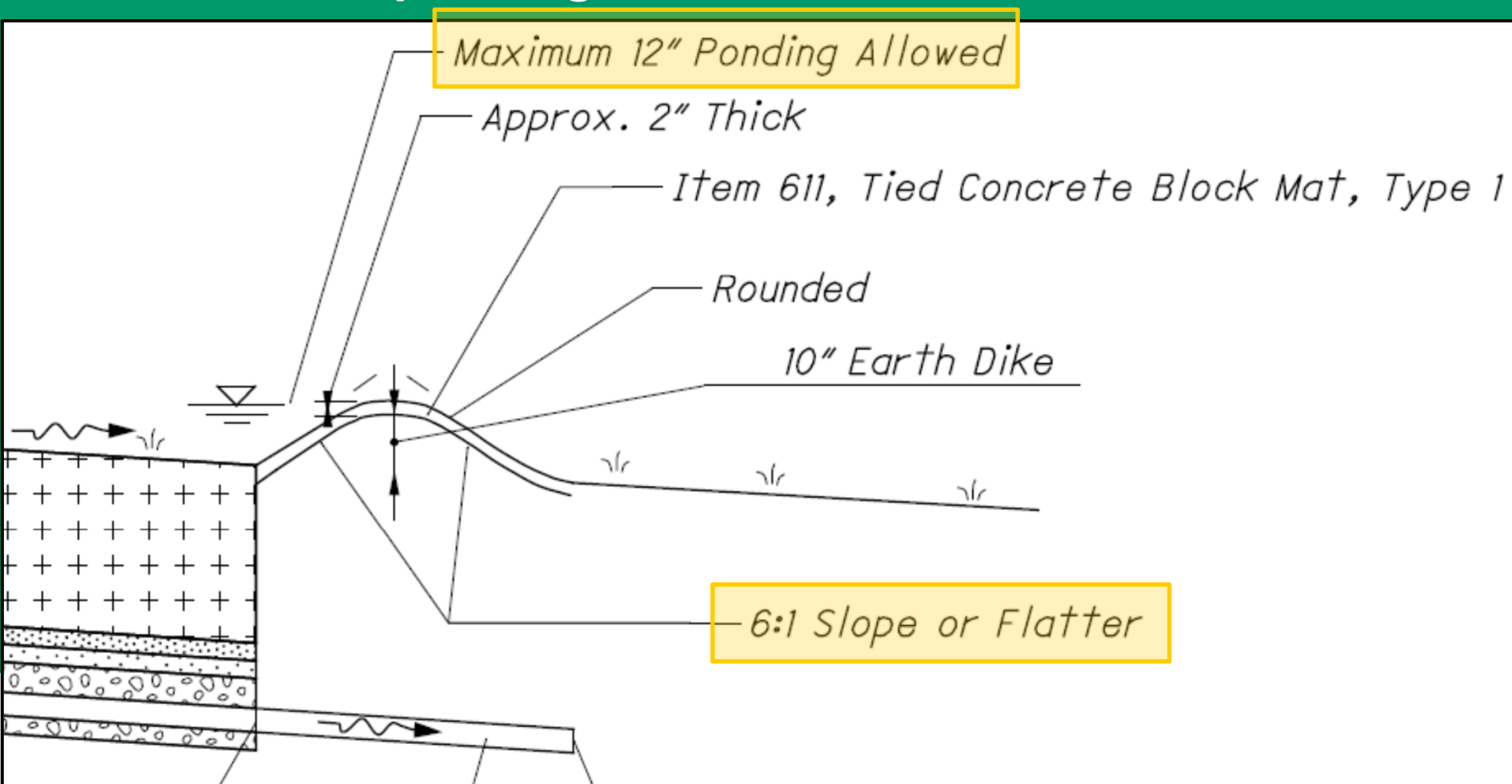
Overflow – Sloped Bioretention



- 🕒 **Bioretention cells may be in ditch**
- 🕒 **Ditch must still convey the design storm downstream safely**
- 🕒 **Best to not account for infiltration in conveyance calculations**

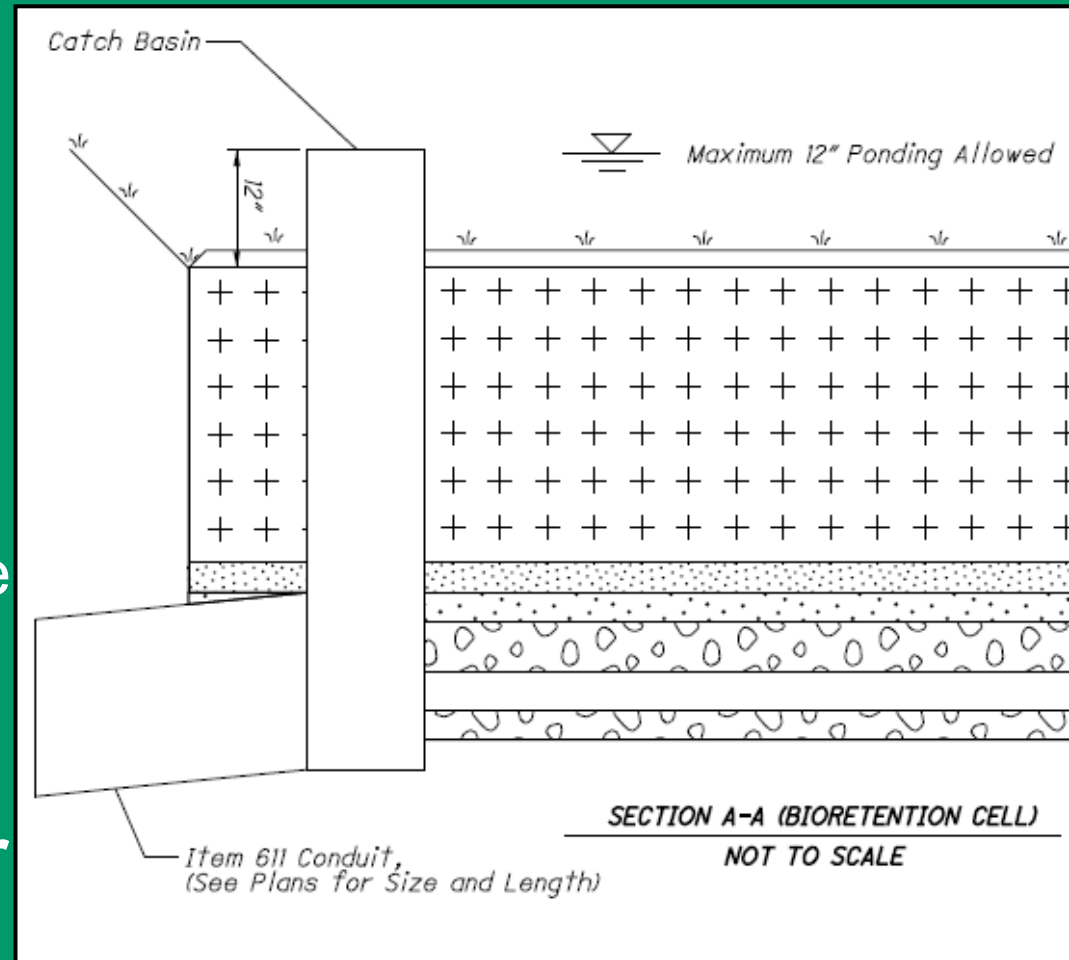
Safety

- 🕒 **Safety Grading within the Clear Zone – 6:1 max**
- 🕒 **Max. 12" ponding in Clear Zone**



Overflow – Flat Sites

- For flat sites, use a catch basin raised 1 ft for ponding
- Locate catch basin outside of clear zone
- Size the catch basin and discharge pipe for the design storm.



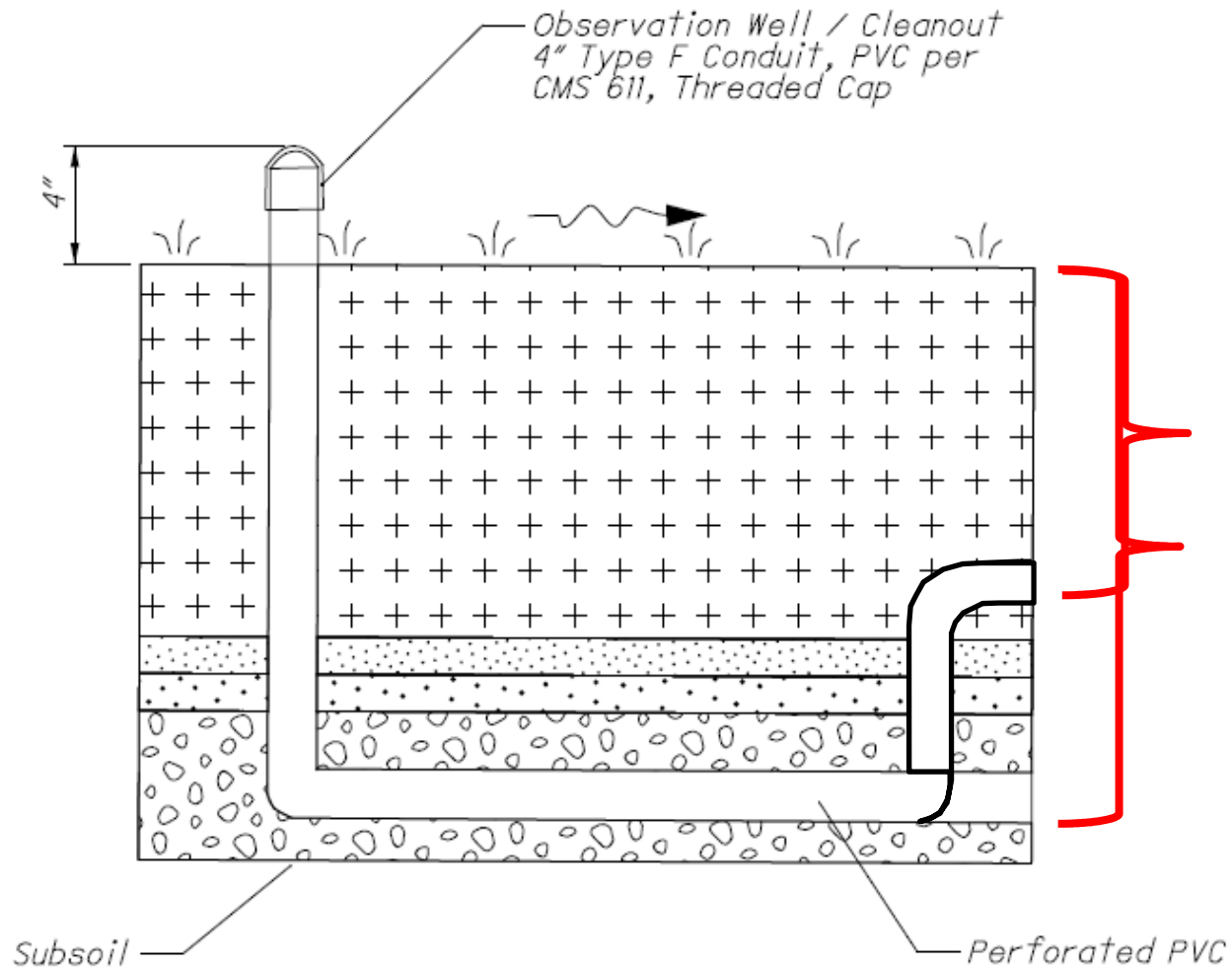
DDOT



Design Process

- ① Treatment Goals
- ② Siting Analysis
- ③ Bioretention Cell Sizing
- ④ Pretreatment Design
- ⑤ Overflow
- ⑥ Other Considerations

Hydraulic Drop



OBSERVATION WELL / CLEANOUT
NOT TO SCALE

Permeability

- ⌚ Avoid compaction of bottom of the bioretention cell, scarify bottom surface if necessary
- ⌚ Keep construction runoff out of cell
- ⌚ Use clean sand, CMS 703.20
 - ⌚ Fines will clog trench
- ⌚ Confirm permeability rate with testing after construction

Bioretention Plan Note

Sample Plan Note W101

W101 BIORETENTION CELL(S)

CONSTRUCT THE BIORETENTION CELL(S) AFTER ALL CONTRIBUTING DRAINAGE AREAS ARE STABILIZED AS SHOWN ON THE CONTRACT PLANS. DO NOT OPERATE HEAVY EQUIPMENT WITHIN THE PERIMETER OF A BIORETENTION CELL. USE ALL SUITABLE EXCAVATED MATERIAL IN THE WORK. ALTERNATIVELY, LEGALLY USE, RECYCLE, OR DISPOSE OF ALL EXCAVATED MATERIALS ACCORDING TO 105.16 AND 105.17.

EXCAVATE THE BIORETENTION CELL TO THE DIMENSIONS, WITH VERTICAL SIDES, TO THE ELEVATIONS SPECIFIED. MINIMIZE THE COMPACTION OF THE BOTTOM OF THE BIORETENTION CELL. EXCAVATION WILL BE MEASURED AND PAID AS ITEM 203, EXCAVATION AS PER PLAN.

THE BIORETENTION CELL CONSISTS OF FOUR DISCRETE LAYERS: BIORETENTION PLANTING SOIL LAYER, FINE AGGREGATE LAYER, COARSE AGGREGATE NO. 78 LAYER, AND COARSE AGGREGATE NO. 57 LAYER AND AN UNDERDRAIN SYSTEM. THE MATERIALS AND VOLUMES FOR EACH LAYER ARE AS SHOWN:

BIORETENTION CELL		PROJECT QUANTITY (CY)
BIORETENTION PLANTING SOIL LAYER PLUS 3 INCH COVER		
COMPOSITION BY VOLUME		
5	PARTS SAND – CMS FINE AGGREGATE AS PER 703.20	
1	PART TOPSOIL – CMS 659.05	
2	PARTS COMPOST – CMS 659.06	
FINE AGGREGATE AS PER CMS 703.20		
COARSE AGGREGATE SIZE NO. 78 PER 703.20		
COARSE AGGREGATE SIZE NO. 57 PER 703.20		
TOTAL CUBIC YARDS		

CONSTRUCT THE UNDERDRAIN SYSTEM AS SPECIFIED.

PLACE THE BIORETENTION PLANTING SOIL IN 12 INCH LIFTS. THE BIORETENTION PLANTING SOIL LAYER PLUS 3 INCH COVER IS 3 INCHES GREATER THAN THE DEPTH SPECIFIED TO ACCOUNT FOR EXPECTED SETTLING OF THE UNCOMPACTED SOIL.

THE BIORETENTION PLANTING SOIL SHALL BE A UNIFORM MIX THAT IS FREE OF STONES, STUMPS, ROOTS, OR ANY OTHER OBJECT LARGER THAN TWO INCHES. THE SOIL MAY CONSIST OF EXISTING SOIL, FURNISHED SOIL, OR A COMBINATION OF BOTH PROVIDED THAT THE PH IS BETWEEN 5.2 – 8.0 AND MEETS THE COMPOSITION REQUIREMENTS LISTED ABOVE. PHOSPHORUS CONCENTRATIONS OF THE PLANTING SOIL SHALL FALL BETWEEN 15 AND 80 MG/KG (PPM) AND DETERMINED BY THE MEHLICH III TEST.

THOROUGHLY MIX THE BIORETENTION PLANTING SOIL PRIOR TO PLACEMENT.

PLACE OBSERVATION WELL AND CLEANOUT WHERE SPECIFIED. CONNECT THE OBSERVATION WELL AND CLEANOUT TO THE PERFORATED UNDERDRAIN WITH THE APPROPRIATE MANUFACTURED CONNECTIONS. EXTEND THE OBSERVATION WELL AND CLEANOUT 4 INCHES ABOVE THE SURFACE ELEVATION. CAP THE OBSERVATION WELL AND CLEANOUT WITH A THREADED SCREW CAP. CAP THE ENDS OF PERFORATED UNDERDRAIN PIPES NOT TERMINATING IN AN OBSERVATION WELL AND CLEANOUT OR CONNECTED TO OTHER CONDUITS. PLACE SEED, TURF, TREES, SHRUBS, OR OTHER PLANT MATERIALS FOR BIORETENTION FACILITIES AS SPECIFIED. PLANT MATERIALS WILL BE MEASURED

AND PAID FOR PER CMS ITEM(S) 659, 660, OR 661 DEPENDING ON THE PLANT MATERIALS SPECIFIED. APPLY NO PESTICIDES, HERBICIDES, LIME, AND FERTILIZERS. INSTALL ITEM 611 AS SPECIFIED. **INSTALL TEMPORARY EROSION CONTROL MAT TYPE A, B, C, OR E PER CMS 671 WITH EITHER STRAW MULCH OR COMPOST OR AS SPECIFIED IN THE PLANS.**

BIORETENTION CELLS WILL BE PAID FOR AS ITEM 601, BIORETENTION CELL CU YD. AND ITEM 601, TIED CONCRETE MAT SQ YD. EXCAVATION FOR BIORETENTION CELLS SHALL BE FOR VERTICAL SIDES ONLY AS SPECIFIED AND PAID FOR AS ITEM 203, EXCAVATION AS PER PLAN CU YD. PERFORATED UNDERDRAINS, OBSERVATION WELLS, AND ASSOCIATED FITTINGS AND COUPLERS WILL BE PAID FOR AS ITEM 605, UNDERDRAIN AS PER PLAN. NON PERFORATED OUTLET PIPES FOR BIORETENTION CELLS SHALL BE PAID FOR AS ITEM 611. SEEDING AND MULCHING FOR THE BIORETENTION CELL SHALL BE PAID FOR AS ITEM 659 SEEDING AND MULCHING SQ YD. EROSION CONTROL MATS SHALL BE PAID FOR AS ITEM 671, EROSION CONTROL MATS SQ YD.

Designer Note: This plan note shall be used on all projects that have bioretention cell(s) identified in the plan.

Add plan note that states: "ITEM 203, EXCAVATION, AS PER PLAN VERTICAL SIDES ONLY" on plan sheets showing bioretention cell cross section.

Bioretention Plan Note

BIORETENTION CELL		PROJECT QUANTITY (CY)
BIORETENTION PLANTING SOIL LAYER PLUS 3 INCH COVER		
	COMPOSITION BY VOLUME	
5	PARTS SAND – CMS FINE AGGREGATE AS PER 703.20	
1	PART TOPSOIL – CMS 659.05	
2	PARTS COMPOST – CMS 659.06	
FINE AGGREGATE AS PER CMS 703.20		
COARSE AGGREAGE SIZE NO. 78 PER 703.20		
COARSE AGGREAGE SIZE NO. 57 PER 703.20		
TOTAL CUBIC YARDS		

BMP Calcs Spreadsheet



Ohio Department of Transportation - Office of Hydraulic Engineering Post-Construction BMP Calculation Spreadsheet

Bioretention Cell

Drainage Area #	Tributary Area within Existing R/W (acres)	Impervious Trib. Area Outside Existing R/W (acres)	Trib. Area in new permanent R/W (acres)	Impervious Tributary Area ¹ (acres)
Bio. #1	10.00	2.00	4.00	12.00
Bio. #2	2.00	0.50	1.00	2.50
Bio. #3	0.00	0.00	0.00	0.00
Bio. #4	0.00	0.00	0.00	0.00
Bio. #5	0.00	0.00	0.00	0.00

Drainage Area #	Tributary Area in ODOT R/W (acres)	Minimum Bioretention Cell Surface Area (acres)	Bioretention Cell Surface Area Designed (acres)	Meets Design?
Bio. #1	14.00	0.60	0.60	Good
Bio. #2	3.00	0.13	0.15	Good
Bio. #3	0.00	0.00	0.00	Good
Bio. #4	0.00	0.00	0.00	Good
Bio. #5	0.00	0.00	0.00	Good

Total Treatment Credit from Bioretention (within R/W):²

17.00 acres

(Treatment is for quality and quantity)

Yellow: Requires Input (See instructions tab)

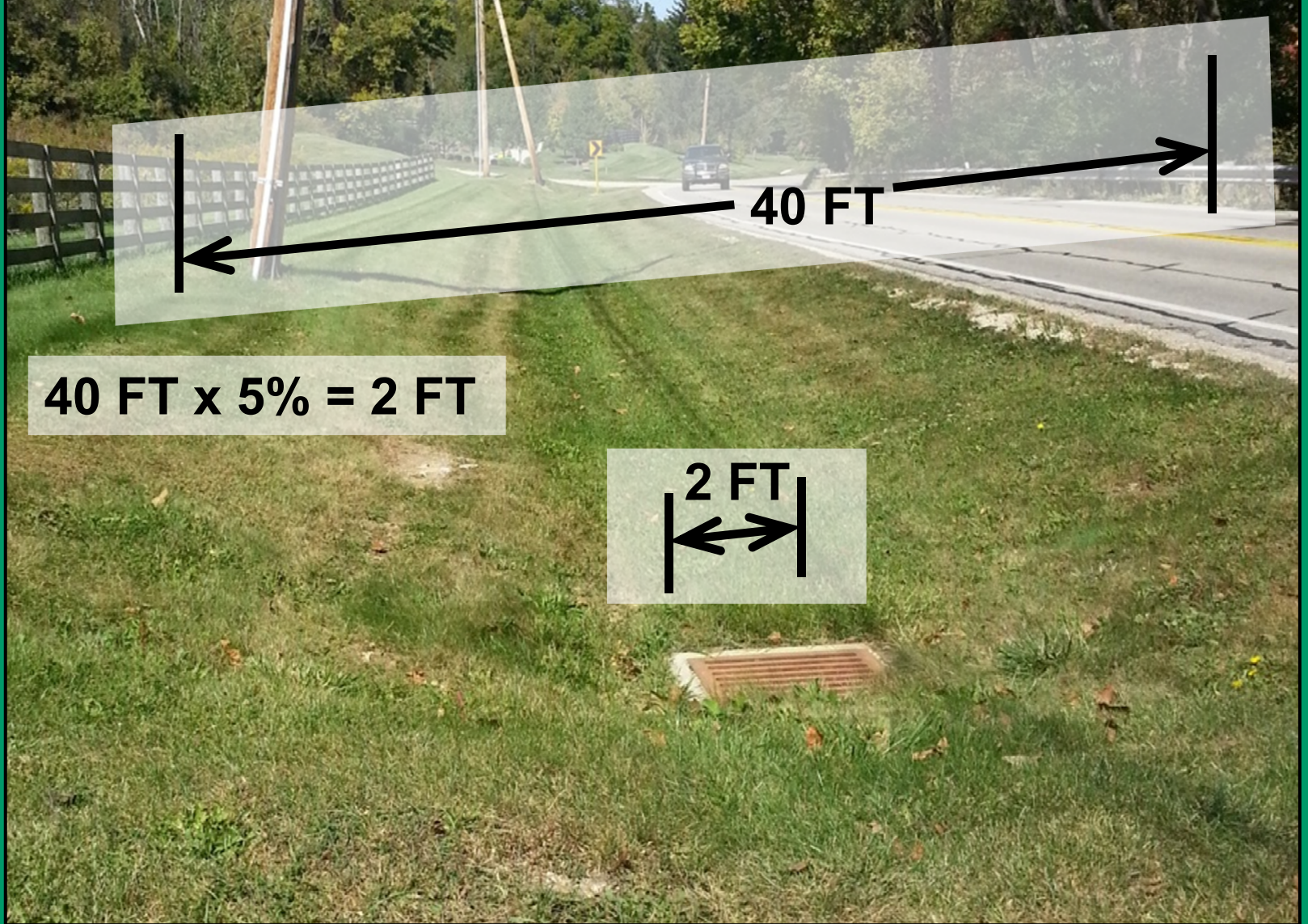
BMP Design Considerations

	Answer	Design Check
A. Has pretreatment been provided per L&D Vol. 2, Sec. 1117.5?	Yes	Good
B. Is the water quality flow (WQ ₁) through the bioretention cell limited to 1 foot per second?	Yes	Good
C. Has an overflow been provided 12 inches above the bioretention cell surface?	Yes	Good
D. Has the overflow been sized to convey the design check storm?	Yes	Good
E. Is the bioretention cell cross section designed per L&D Vol. 2, Sec. 1117.5.3.G and Figure 1117-8?	Yes	Good
F. Is temporary erosion control mat, Item 671 provided over the bioretention cell?	Yes	Good

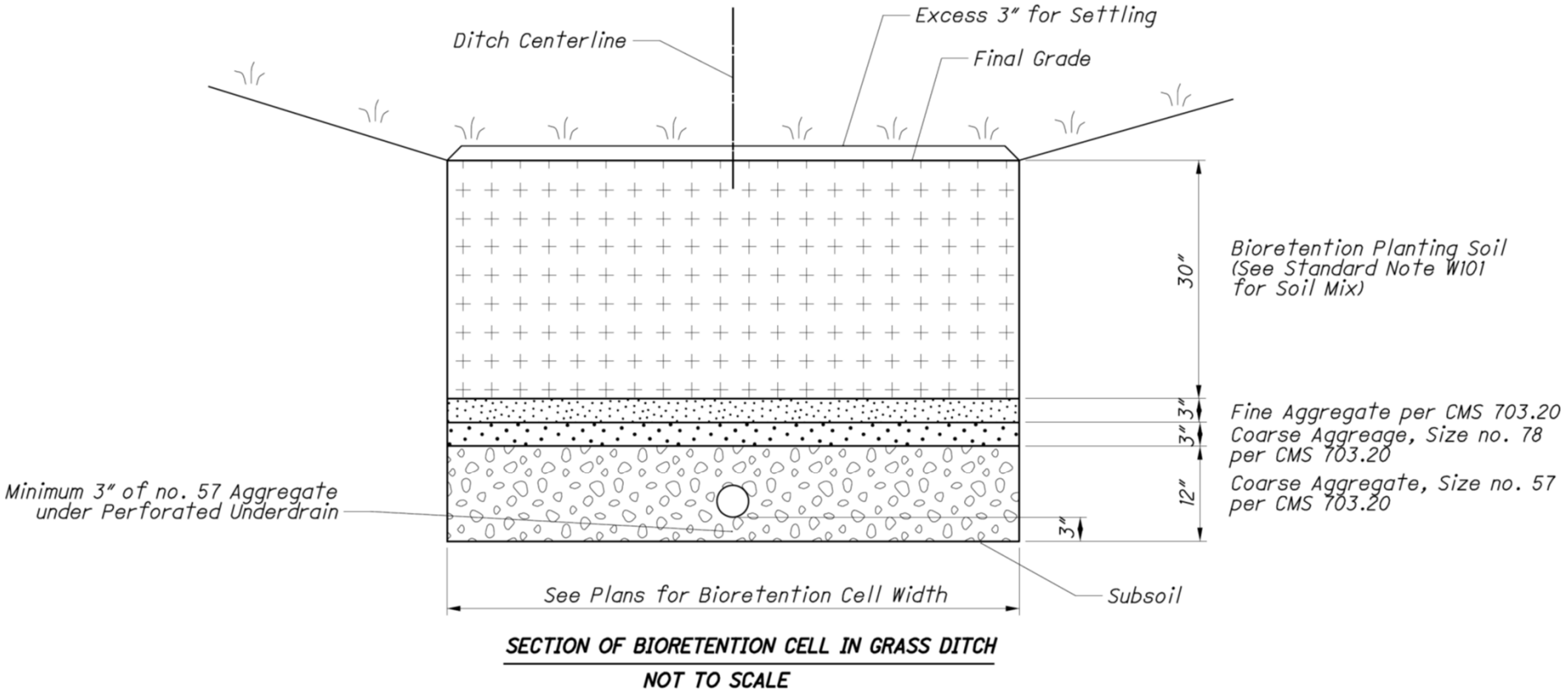
Footnotes can be viewed in the Excel Spreadsheet.

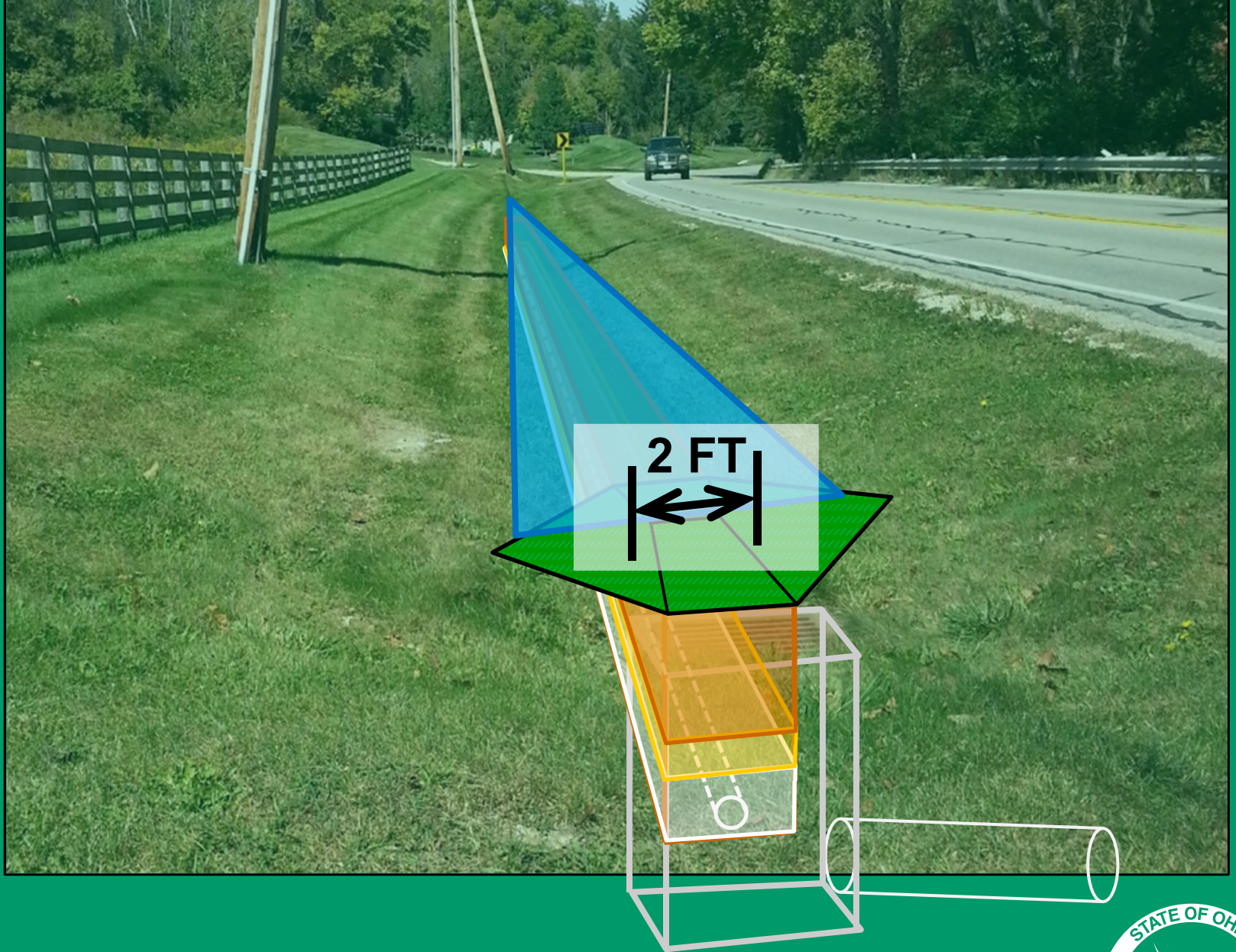


Fit in a Ditch



Bioretention Cross Section





Questions ?

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