A GREEN INFRASTRUCTURE CASE STUDY

On-farm green infrastructure to reduce sediment accumulation in municipal drain

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Ontario

Case Study: On-farm Green Infrastructure to reduce sediment accumulation in municipal drain

Location: Alvinston, ON (near Rokeby Line & Ebenezer Road)

Drains: McIntyre Weed Drain & Ferguson Drain

Best Management Practice: 3 in-field low level berms, 2 rock chutes, and 1 grassed waterway

Issue: gullies were forming in-field perpendicular to row crops. Landowner was concerned about farm equipment traversing the gullies, but also when it rained, he was concerned with how much sediment was running off his fields into the adjacent municipal drain.

Objectives:

At front of farm field, adjacent to McIntyre Weed Drain

1. Installation of 2 berms/WASCoBs with a rock chute to slow, settle and direct fast moving overland water into the McIntyre Weed Drain at the south end of the farm via a rock chute (15-acre watershed).
2. Installation of a grassed waterway ending in a rock chute entering the same drain. Spoils from the construction of the grassed waterway will be used to create the 2 berms needed for erosion control in Objective 1 (7-acre watershed).

Mid-field, adjacent to tiled Ferguson Drain (12-acre watershed)

1. Installation of 1 berm/WASCoB erosion control structure mid-farm field to be completed in conjunction with the project at the front of the farm.

Erosion Control Project Outline:

At front of farm field, adjacent to McIntyre Weed Drain

Project 1: Build a rock chute at edge of field near farm laneway to control all overflow of a 10-year storm from this watershed. Extend driveway as a low-level berm that would pond upland water. The upstream ponding would control the overflow, reduce overland water velocity, and retain sediment. Ponded water would enter drain at a slower rate, via upstream hickenbottom. The second berm would be “upstream” or 300 ft east of first berm, to again, slow water velocity of overland runoff coming from neighbouring farm.

Project 2: Build a rock chute at the south end of the watershed (front of farm field) entering the drain, eliminating bank erosion of McIntyre Weed Drain. Build a grassed waterway (also known as a diversion terrace) 850’ long by 24’ wide to direct overland runoff from the watershed into the rock chute and drain. Spoil from the grassed waterway excavation will be used to berm the berms in Project 1.

Mid-field, adjacent to tile Ferguson Drain

Project 3: Build 1 berm and connect upstream-of-berm hickenbottom to existing tile. The berm will slow overland runoff during large rain events and snow melt.

Contractor: Crump Enterprises Ltd., OMAFRA-certified Erosion Control Contractor

Cost: For three berms, two rock chutes, and a 850’ contoured and seeded grassed waterway: $

Grants available to landowner: $

Drainage superintendent: David Moores, Township of Brooke-Alvinston

Having reviewed the plans of this green infrastructure project, Mr. Moores stated: “I’m a big proponent of erosion control projects on any drain. Implementing in field erosion control structures, like berms and grassed waterways, can reduce farm runoff of sediments into municipal drains. Less sediment runoff means fewer drain cleanouts and fewer costs to upstream landowners. With phosphorus being a concern in Lake Erie, the more we can keep sediment and nutrients on the field where they are needed for crop growth, the better. [The work done here] looks great.”

Photos of in-field erosion:

Aerial photo of Projects 1 and 2 locations.

Project 1: Watershed Characteristics and Specifications for two berms and a rock chute calculated using the Ontario Agricultural Erosion Control Structures Software

Watershed Characteristics for "lower" berm installation:

Watershed Size: 15 ac
Watershed Length: 1500 ft
Elevation Difference: 21 ft
Watershed Flowpath Slope: 1.4%
Peak Flow Calculation Method: OMAFRA Publication 832 Tables
Runoff Curve Number: 88

Land Use or Cover:	Row Crops
Treatment or Practice:	Straight row
Hydrologic Condition:	Poor
Hydrologic Soil Group:	Group C
Percentage of Watershed:	100%
Runoff Curve Number:	88

Watershed Peak Flow Rates

Storm Return Period (years)	Flow Rate (ft^3/s)	Storm Volume (ft^3)	Storm Duration (hours)
2	4.1	8257	0.7
5	9.3	12047	0.4
10	13	16940	0.4
25	17.8	23070	0.4

OMAFRA Publication 832 Tables

Source Worksheet: Worksheet 1
Watershed Size: 15 ac
Watershed Grade: 1.4%
Runoff Curve Number: 88
Peak flow from watershed (10 year storm): 13 ft^3/s
Peak flow from watershed (25 year storm): 17.8 ft^3/s
Storm Duration (10 year storm): 0.4 hours
Storm Volume (10 year storm): 16940 ft^3

Nearest Upstream WASCoB: Worksheet 6
Horizontal Pipe Flow: 0.5 ft^3/s
Surface Water Transfer: 10.3 ft^3/s

Soil Erosion
- Upper Tier Municipality: County of Lambton
- Watershed Land Slope: 1.4%
- Soil Texture: Clay
- Crop: Rotational Corn (corn-soybeans-small grains) – conventional till
- Tillage Practice: Cross Slope
- Average Annual Soil Loss: 0.4 ton/ac/year

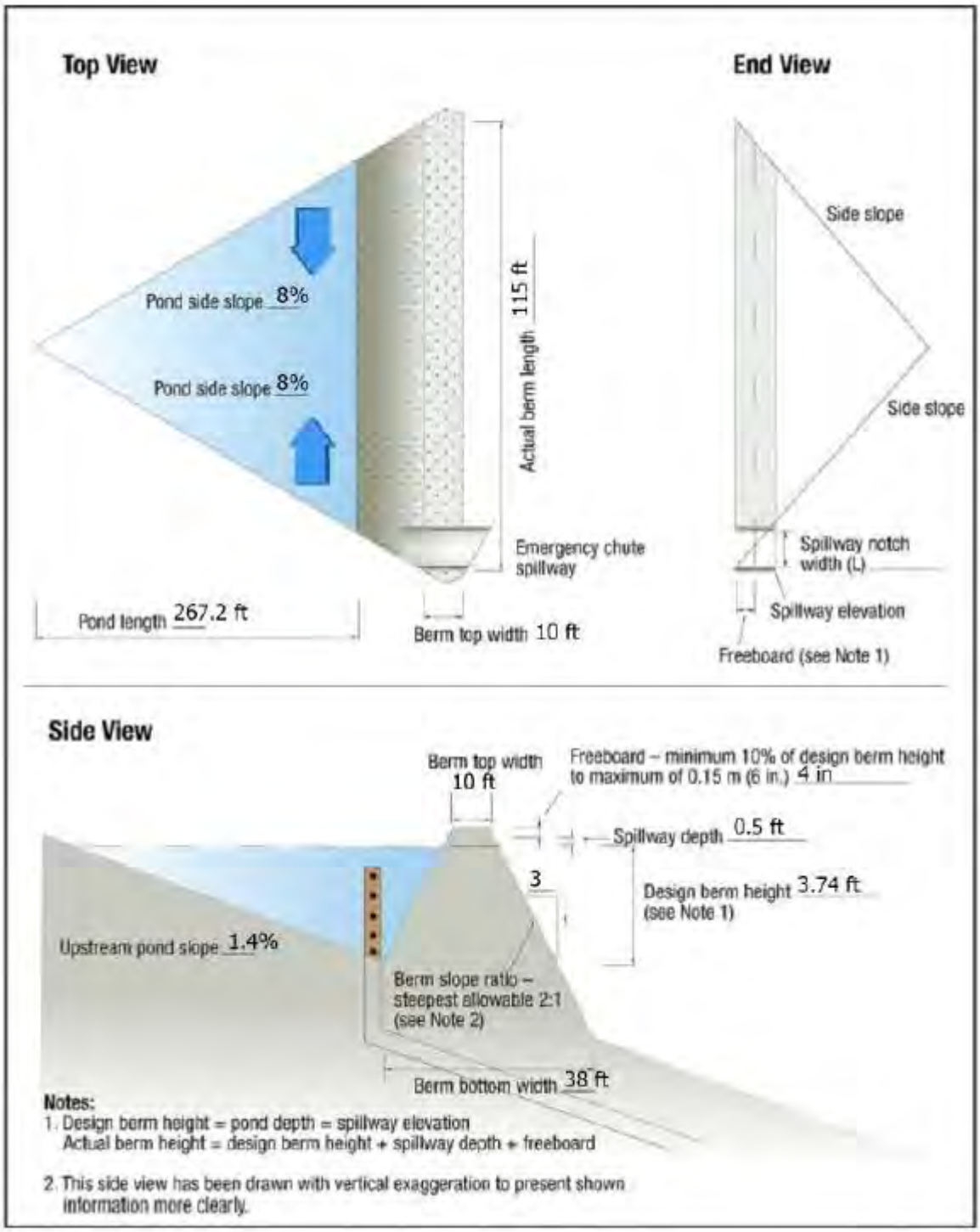
Volume Factor Method
- Ponding Area Slope: 1.4%
- Ponding Area Side Slope (left): 8%
- Ponding Area Side Slope (right): 8%
- Total Pond Storage: 18692 ft^3
- Pond Depth: 3.74 ft
- Pond Length: 267.2 ft
- Maximum Pond Width: 93.5 ft

Maximum Flooding Time: 12 hours
Outlet Capacity: 0.4 ft^3/s

Riser and Horizontal Pipe Sizes
- Slope of Horizontal Pipe: 10%
- Horizontal Pipe Diameter: 6 in
- Riser Pipe Diameter: 6 in

Emergency Overflow Spillway
- Spillway Type: Rock Lined (high risk)
- Spillway Capacity: 28 ft^3/s
- Notch Depth: 0.5 ft
- Notch Width:

Berm Characteristics
- Design Height: 3.74 ft
- Actual Height: 4.6 ft
- Actual Length: 115 ft
- Side Slope: 3:1
- Top Width: 10 ft
- Bottom Width: 38 ft
- Earth Volume: 189 yd^3


Top View
End View
Pond side slope 8%
Pond side slope 8%
Actual berm length 115 ft
Emergency chute spillway
Pond length 267.2 ft
Berm top width 10 ft
Side slope
Side slope
Spillway notch width (L)
Spillway elevation
Freeboard (see Note 1)
Side View
Berm top width 10 ft
Freeboard – minimum 10% of design berm height to maximum of 0.15 m (6 in.) 4 in
Spillway depth 0.5 ft
3
Design berm height 3.74 ft (see Note 1)
Upstream pond slope 1.4%
Berm slope ratio – steepest allowable 2:1 (see Note 2)
Berm bottom width 38 ft
Notes:
1. Design berm height = pond depth = spillway elevation
Actual berm height = design berm height + spillway depth + freeboard
2. This side view has been drawn with vertical exaggeration to present shown information more clearly.

Watershed Characteristics and Specifications for Rock Chute adjacent to "lower" berm

Source Worksheet:	Worksheet 1
Watershed Size:	15 ac
Watershed Grade:	1.4%
Runoff Curve Number:	88
Peak flow from watershed (10 year storm):	13 ft^3/s

Horizontal Distance to Obtain Chute Fall:	16 ft
Rock Chute Fall:	4 ft
Grade to Fit:	25%
Input Device:	WASCoB, Top Width: 10 ft, Depth: 3 ft
Output Device:	Municipal Drain, Top Width: 12 ft, Depth: 4 ft

Chute Slope:	4:1
Side Slope:	2:1
Bottom Width:	4 ft
Chute Depth:	1.8 ft
Chute Width:	11.2 ft
Chute Length:	
Length of Entrance Apron:	12 ft
Length of Exit Apron:	8 ft
Total Chute Length:	36 ft

Rock Riprap:

Depth of Rock Riprap:	1.5 ft
Rock Riprap for Chute:	23.1 yd^3
Additional rock riprap:	10 yd^3
Total Rock Riprap to Order:	33.1 yd^3

Geotextile Underlay:

Type:	Non-Woven
Area:	632.9 ft^2

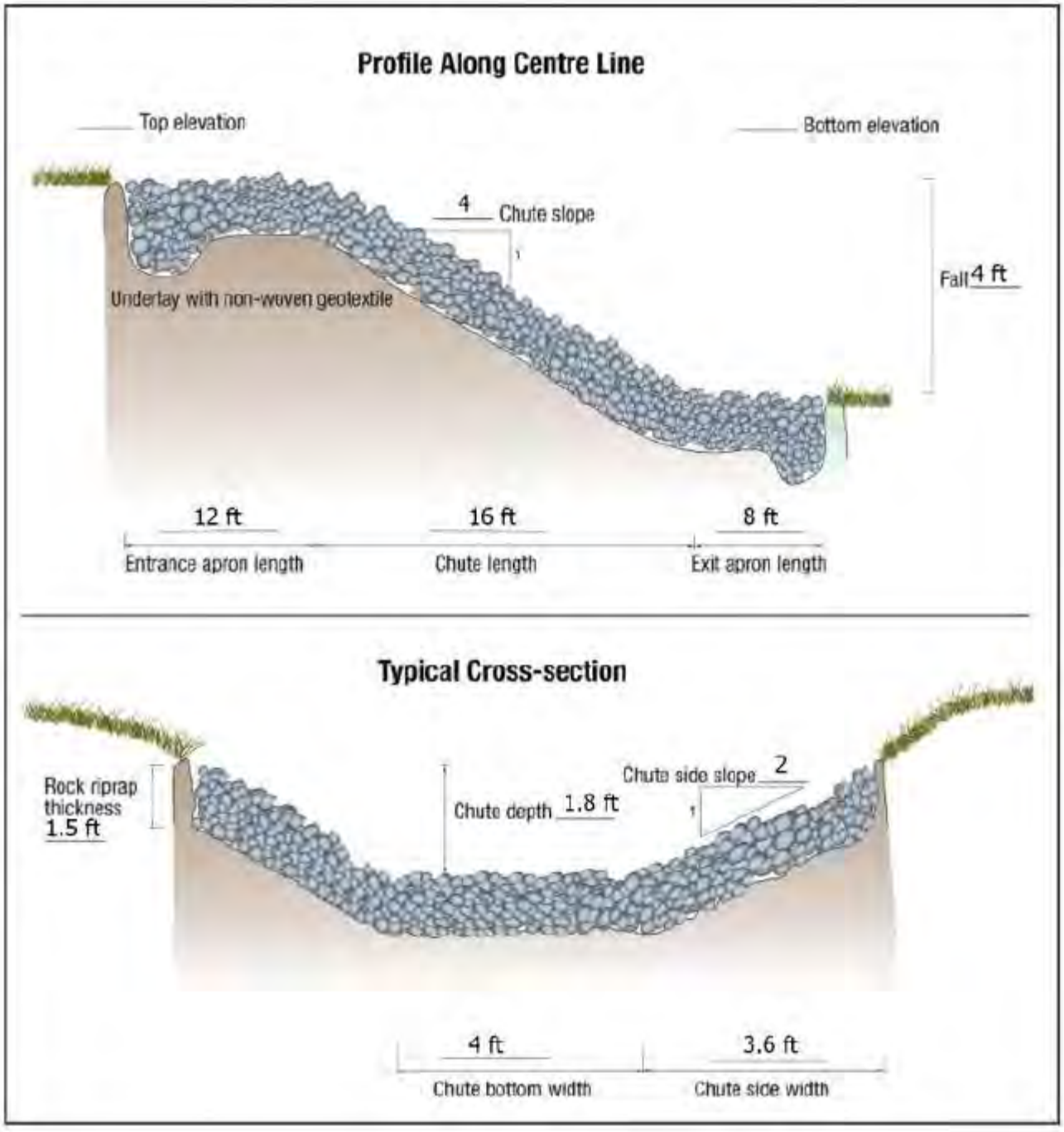


Photo of seeded low-level berm, “upstream” hickenbottom, and rock chute (looking North from Rokeby Line)

Photo of seeded low-level berm with the “upstream” hickenbottom, and rock chute (looking west)

Watershed Characteristics and specifications for “upper” berm

Watershed Size:	9 ac
Watershed Length:	1200 ft
Elevation Difference:	7 ft
Watershed Flowpath Slope:	0.5833%
Peak Flow Calculation Method:	OMAFRA Publication 832 Tables
Runoff Curve Number:	88

Land Use or Cover:	Row Crops
Treatment or Practice:	Straight row
Hydrologic Condition:	Poor
Hydrologic Soil Group:	Group C
Percentage of Watershed:	100%
Runoff Curve Number:	88

Watershed Peak Flow Rates

Storm Return Period (years)	Flow Rate (ft^3/s)	Storm Volume (ft^3)	Storm Duration (hours)
2	2.4	5539	0.8
5	5.4	8535	0.5
10	7.6	12009	0.5
25	10.3	13842	0.4

OMAFRA Publication 832 Tables

Source Worksheet: Worksheet 2
Watershed Size: 9 ac
Watershed Grade: 0.5833%
Runoff Curve Number: 88
Peak flow from watershed (10 year storm): 7.6 ft^3/s
Peak flow from watershed (25 year storm): 10.3 ft^3/s
Storm Duration (10 year storm): 0.5 hours
Storm Volume (10 year storm): 12009 ft^3

This is the uppermost WASCoB of a multiple WASCoB system

Soil Erosion
- Upper Tier Municipality: County of Lambton
- Watershed Land Slope: 0.6%
- Soil Texture: Clay
- Crop: Rotational Corn (corn-soybeans-small grains) – no-till
- Tillage Practice: Up & Down Slope
- Average Annual Soil Loss: 0.1 ton/ac/year

Volume Factor Method
- Ponding Area Slope: 1.7%
- Ponding Area Side Slope (left): 8%
- Ponding Area Side Slope (right): 8%
- Total Pond Storage: 12391 ft^3
- Pond Depth: 3.48 ft
- Pond Length: 204.7 ft
- Maximum Pond Width: 87 ft

Maximum Flooding Time: 12 hours
Outlet Capacity: 0.3 ft^3/s

Riser and Horizontal Pipe Sizes
- Slope of Horizontal Pipe: 6%
- Horizontal Pipe Diameter: 6 in
- Riser Pipe Diameter: 6 in
- Orifice Plate is Required
  - Orifice Plate Diameter: 2.67 in

Emergency Overflow Spillway
- Spillway Type: Grass Lined (low risk)
- Spillway Capacity: 10.3 ft^3/s
- Notch Depth: 0.5 ft
- Notch Width: 11 ft

Berm Characteristics

Design Height: 3.48 ft
Actual Height: 4.3 ft
Actual Length: 108 ft
Side Slope: 3:1
Top Width: 3.9 ft
Bottom Width: 30 ft
Earth Volume: 109 yd^3

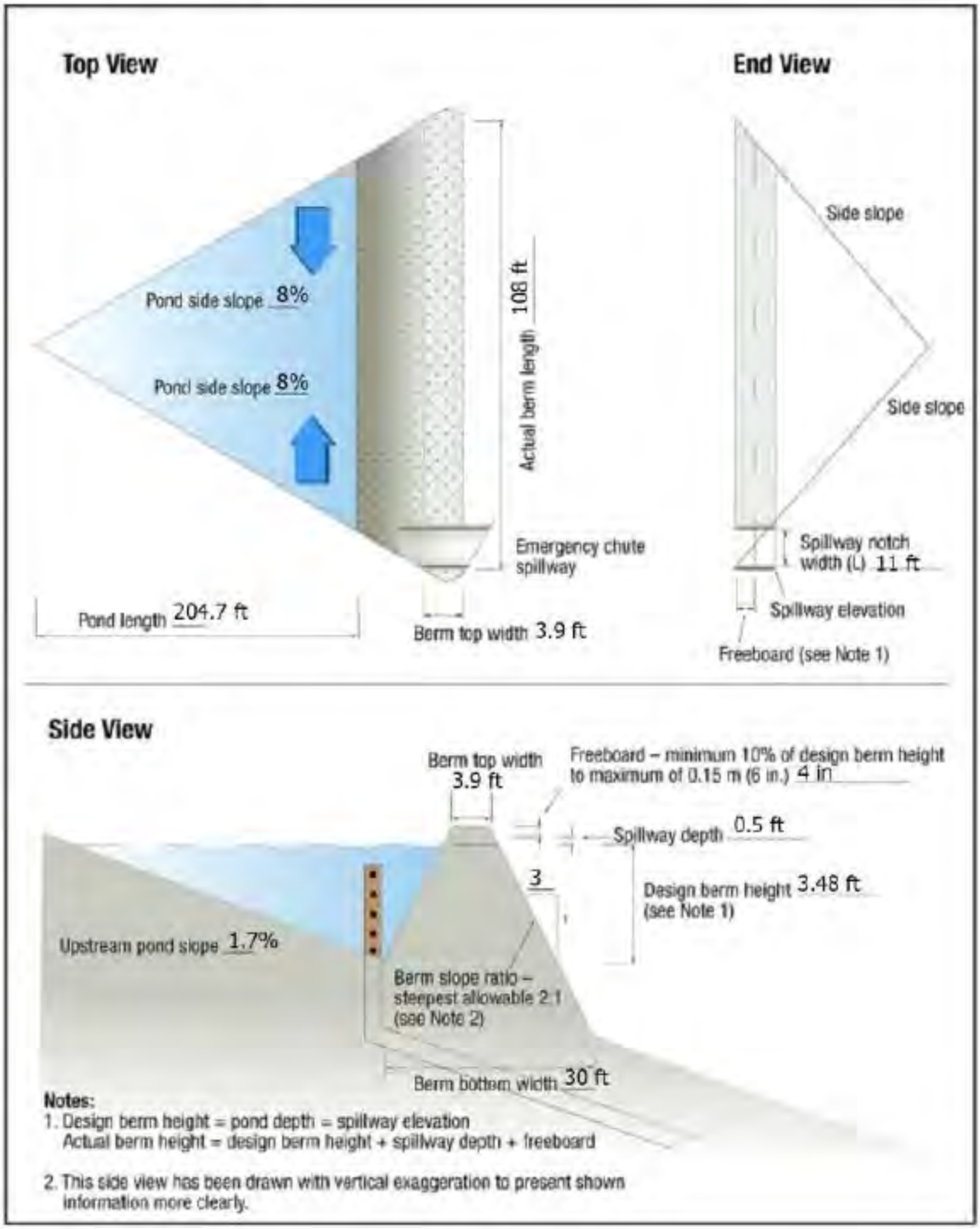


Photo of stripping topsoil prior to berm construction:

Attaching riser (hickenbottom) to existing tile

Photo of riser connection to tile

Topsoil stripped and riser connected to tile at “upper” berm.

Photo of “upper” berm, looking east

Project 2: Watershed Characteristics and Specifications for grassed waterway design and rock chute calculated using the Ontario Agricultural Erosion Control Structures Software

Watershed Characteristics and specifications for grassed waterway installation:

Grassed waterway

West side of farm draining to the south

Watershed Size:	7 ac
Watershed Length:	850 ft
Elevation Difference:	11 ft
Watershed Flowpath Slope:	1.2941%
Peak Flow Calculation Method:	OMAFRA Publication 832 Tables
Runoff Curve Number:	82

Land Use or Cover:	Row Crops
Treatment or Practice:	Contoured
Hydrologic Condition:	Good
Hydrologic Soil Group:	Group C
Percentage of Watershed:	100%
Runoff Curve Number:	82

Watershed Peak Flow Rates

Storm Return Period (years)	Flow Rate (ft^3/s)	Storm Volume (ft^3)	Storm Duration (hours)
2	0.9	4125	1.9
5	2.2	5289	0.9
10	3.4	7469	0.8
25	5	9739	0.7

OMAFRA Publication 832 Tables

Watershed Size:	7 ac
Watershed Grade:	1.2941%
Runoff Curve Number:	82
Peak flow from watershed (10 year storm):	3.4 ft^3/s
Waterway Length:	850 ft
Elevation Difference:	11 ft
Average Grade:	1.3%
Soil Texture:	Clay
Vegetative Cover:	Grass-legume mixture
Permissable Velocity of Flow:	4 ft/s

Final Waterway Dimensions:

Top Width:	24.3 ft
Depth:	2 ft
Freeboard:	0.33 ft
Side Slope:	6:1

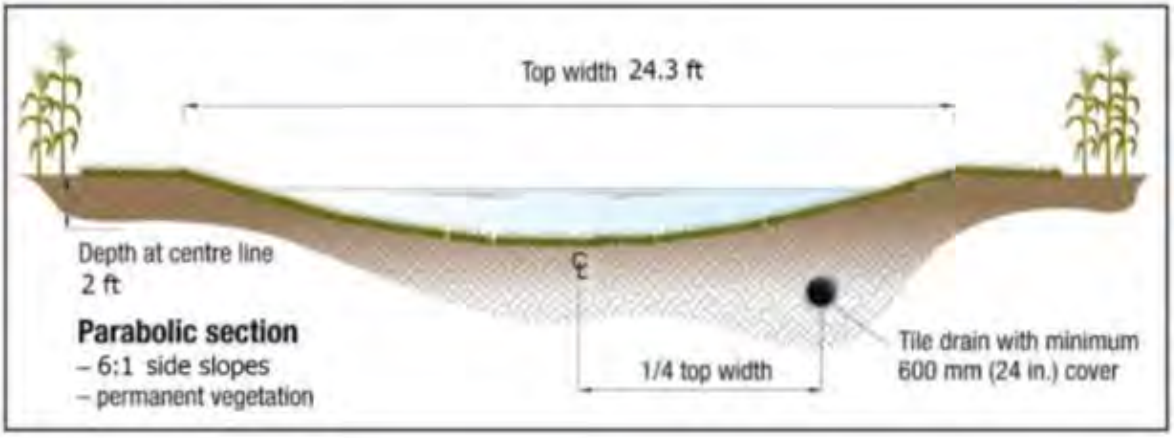


Photo of Grassed waterway "roughed in" (looking north)

Photo of excavator and dozer finising grassed waterway; 4-wheeler spreading cover crop prior to harrowing

Photo of grassed waterway after seeding and rock chute (looking north)

Photo of hauling subsoil from grassed waterway spoils to berms

Watershed Characteristics and specifications for rock chute installation:

South West corner Rock Chute

Rock chute connecting Grassed waterway to drain

Source Worksheet:	Worksheet 8
Watershed Size:	7 ac
Watershed Grade:	1.2941%
Runoff Curve Number:	82

Peak flow from watershed (25 year storm): 5 ft^3/s

Horizontal Distance to Obtain Chute Fall:	20 ft
Rock Chute Fall:	4 ft
Grade to Fit:	20%
Input Device:	Grassed Waterway, Top Width: 20 ft, Depth: 2 ft

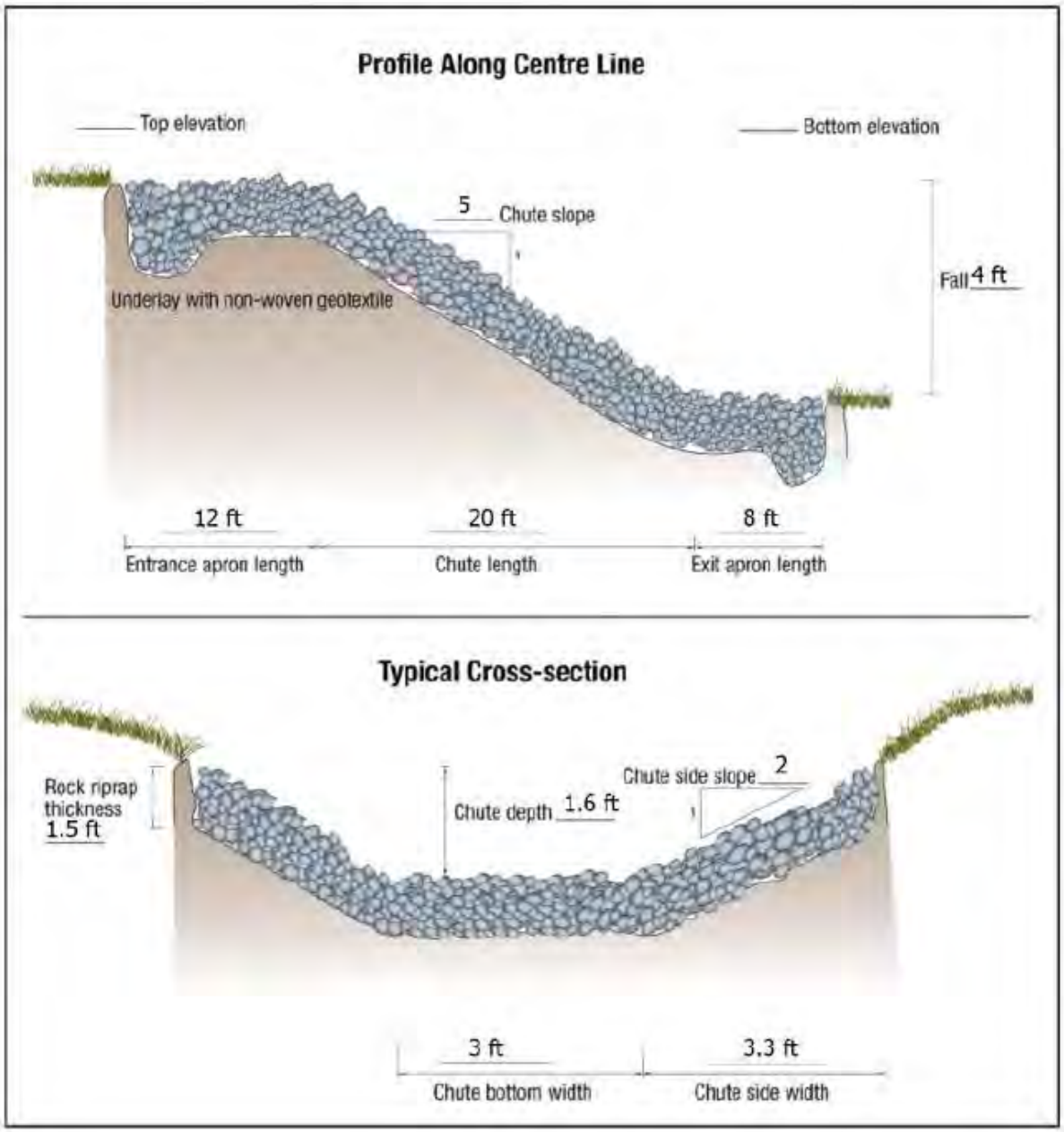
Chute Slope:	5:1
Side Slope:	2:1
Bottom Width:	3 ft
Chute Depth:	1.6 ft
Chute Width:	9.8 ft
Chute Length:	
Length of Entrance Apron:	12 ft
Length of Exit Apron:	8 ft
Total Chute Length:	40 ft

Rock Riprap:

Depth of Rock Riprap:	1.5 ft
Rock Riprap for Chute:	22.6 yd^3
Additional rock riprap:	10 yd^3
Total Rock Riprap to Order:	32.6 yd^3

Geotextile Underlay:

Type:	Non-Woven
Area:	635.7 ft^2



Notch at rock chute to hold riprap and geotextile fabric

Photos of rock chute completed to specifications with apron into municipal drain

Project 3: Watershed Characteristics and Specifications for 1 berm, mid-farm field calculated using the Ontario Agricultural Erosion Control Structures Software

Watershed Characteristics and specifications for berm installation:

Watershed size: 12 acres

Peak Flow: 10.6 cubic feet/second for 25 year storm

Pond storage capacity of 16,701 cubic feet

Maximum flood time: 24 hrs*

*should be less because hickenbottom was tied into a 6” header, when the specifications called for a 3” horizontal

Photo of completed berm, looking west