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Buffalo Niagara Waterkeepers

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Feasibility & Design of Floodplain Reconnection of Buffalo Creek

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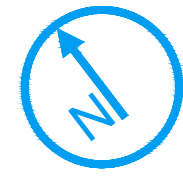
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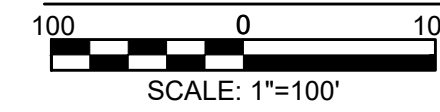
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1. Site Plan and Typical Section



PLAN VIEW



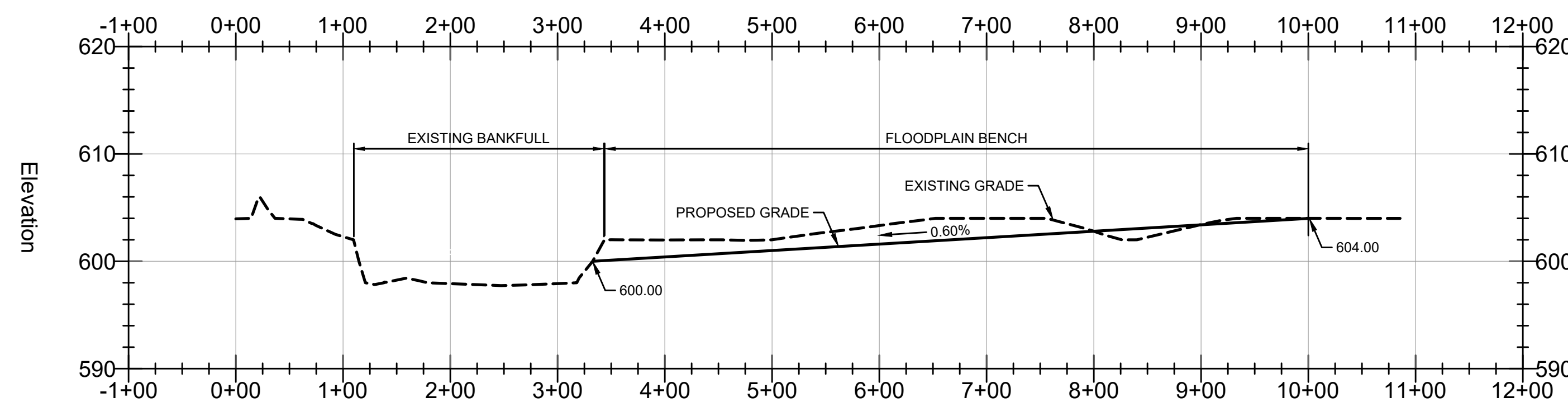
LEGEND

- WALKING TRAIL TO BE RESTORED
- BOUNDARY OF FLOODPLAIN
- PROPERTY LINE

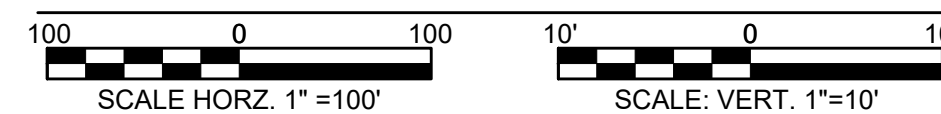
NOTES

1. DESIGN REQUIREMENTS FROM NATIONAL GRID WILL BE COORDINATED DURING THE FINAL DESIGN PHASE. BASED ON HISTORICAL PROJECTS, NATIONAL GRID USUALLY REQUIRES CLEARANCE AROUND THE ELECTRICAL TOWERS FOR ACCESS AND MAINTENANCE.
2. LOCATION AND DESIGN OF THE WALKING TRAIL WILL BE DISCUSSED AND COMPLETED DURING THE FINAL DESIGN PHASE. FOR THE PRELIMINARY DESIGN PHASE IT IS ASSUMED THE TRAIL WOULD BE RESTORED IN A SIMILAR LOCATION TO THE EXISTING.

Station



TYPICAL SECTION



IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS ACTING UNDER THE DIRECTION OF A LICENSED ENGINEER, TO ALTER THIS DOCUMENT.

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**PRELIMINARY
NOT FOR
CONSTRUCTION**
DATE: 12/19/2022

CLIENT
**BUFFALO NIAGARA
WATERKEEPER**

NO.	DATE	DESCRIPTION	BY
A	12/19/22	DRAFT 30% DESIGN PACKAGE	SG
		REVISION	INT.

DESIGNER / PROFESSIONAL ENGINEER RESPONSIBLE
 DESIGNED BY: S. GANNON
 CHECKED BY: M. MCENTIRE
 DRAWN BY: C. ERICKSON
 PROJECT NO: 1940102804
 DATE: DECEMBER 2022

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.
 333 WEST WASHINGTON ST., SYRACUSE, NY 13202
 315-466-8100

PROJECT
**FEASIBILITY AND DESIGN OF FLOODPLAIN
 RECONNECTION OF BUFFALO CREEK**
 ADDRESS
 BUFFALO, NEW YORK

SHEET DESCRIPTION
FLOOD BENCH - PLAN & TYPICAL SECTION
 DRAWING LOCATION

2. Bank and Channel Stabilization Features

Section 2 includes bank and channel stabilization features that should be further evaluated in the next phase. Prior to completing the 60% Submittal, a detailed ice jam analysis should be completed to identify the type and exact location for installing bank and channel stabilization features.

Vegetated Coir Logs

Vegetative plugs placed in densely-packed coconut fiber rolls (Figure 1)

Cross section

Not to scale

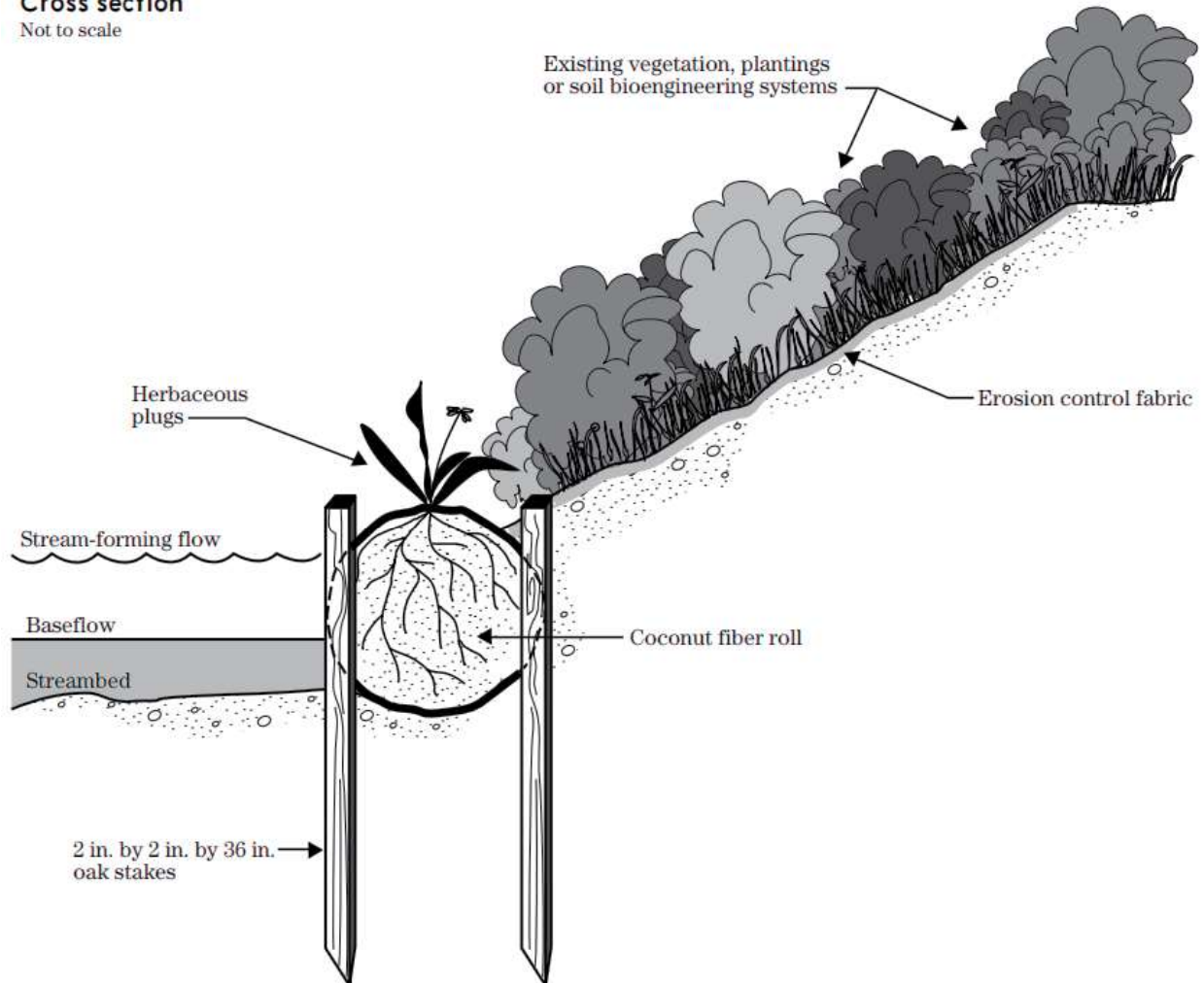


Figure 1. Vegetated coir logs (NRCS 1996).

Issue Solution Addresses

Vegetated coir logs prevent erosion by reinforcing the streambank and acting as a natural retaining wall against water velocity. The vegetated rolls are flexible and can mold to the existing curvature of the streambank. They are also highly effective in developing stream channel banks by trapping sediment behind the fiber rolls and improving conditions for vegetation establishment on the water's edge.

Ideal Location

Coir logs are suitable in low energy environments and work best in areas with minimal ice build-up. High energy environmental can dislodge the logs or cause the logs to break down before rooting the vegetative plugs. Gradual slopes less than 1V:2H (vertical:horizontal) are preferred.

Design and Construction Considerations

- **Site-Specific Conditions:** Vegetated coir logs are suitable in water velocities of 8 ft/s or less.
- **Materials:** Pre-constructed coir logs, coir netting (optional), vegetated plugs (pre-rooted is preferred), rot-resistant wooden stakes, and erosion control blanket (optional). Erosion control blankets and coir netting are recommended and can reduce the need for maintenance long-term.
- **Construction:** The density of vegetated plugs depends on the fiber roll diameter (Table 1). The root system shall be placed below the water level. The stakes shall be placed on both sides of the roll every 2-4 ft, depending on anticipated water velocity.

Table 1. Vegetated Plug Density

Log Diameter (inch)	Vegetated Plug Density (plug/linear foot)
8	1
12	2
16	3
20	5

- **Spacing:** If the shoreline is greater than 10 ft, the coir logs shall be laced together in a continuous line with no gapping between rolls.
- **Placement:** Install the first row of the coir logs parallel to the streambank such that the top two inches of the log are visible at mean water elevation. Additional vertical tiers can be added on the bank slope for further stabilization (Table 2).

Table 2. Interval Spacing

Slope (V:H)	Interval Spacing (ft)
1:1	5-10
1:2 > Slope > 1:1	10-20
1:4 > Slope > 1:2	20-40

- **Maintenance:** Replacement of the rolls may be required if the log begins to break apart due to elevated water velocity or ice damage. For the first year, it is encouraged to inspect the structure after the first few floods (~ 3 visits). Monitoring can reduce to once a year after that. Over time, sediment will cover the coir logs, and vegetation will establish.

Other design considerations include installation schedule (i.e., time of year), bank preparation, trench excavation methods, backfilling, compaction and drainage.

Permitting and Regulatory Considerations

The extent of permit requirements will depend on the location and final design of the project. Consult with your local municipality, NYSDEC, and USACE before beginning any stabilization activities.

Rough Order of Magnitude Cost

The total cost is approximately \$1,000/20 linear ft. This price includes materials, transportation, and installation. Costs vary with design, site access, installation timeframe, supplier, and labor rates.

Applications and Effectiveness

- Protect slopes and encourage deposition of sediment

- Coir logs expedite vegetative cover by providing stabilized medium
- Molds to existing curvature of streambank
- Minimal disturbance of streambank

Brush Mattresses

Living ground cover of layered branch cuttings (Figure 2)

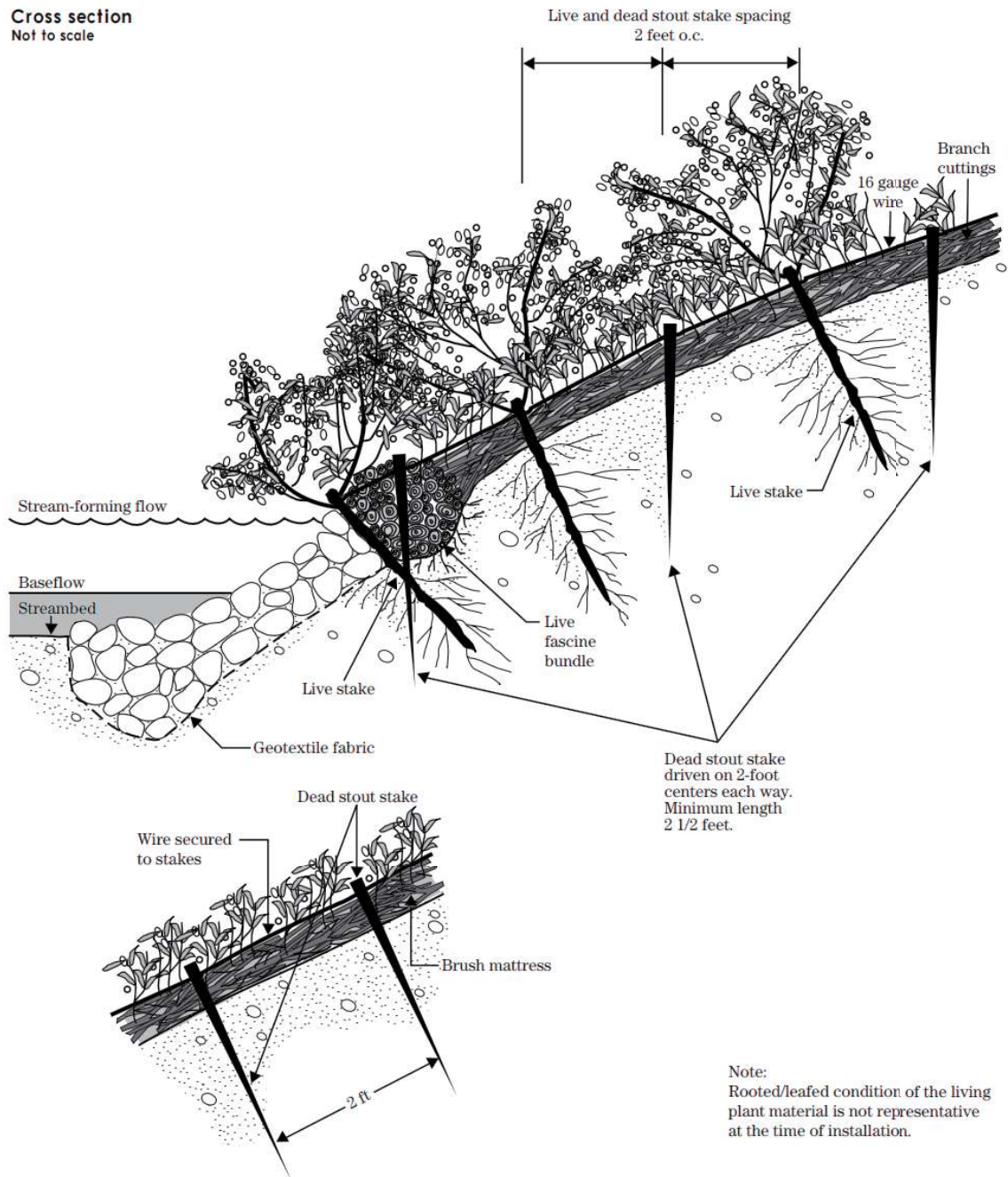


Figure 2. Brush mattresses (NRCS 1996).

Issue Solution Addresses

Brush mattresses slow water velocities along the streambank and reduce erosion. The open space between the woody material allows for sediment deposition and water drainage. The build-up of sediment enhances the colonization of native plants.

Ideal Location

Brush mattresses are best suited for perennial streams with low to medium water velocities. Constant water flow and sunny conditions will encourage the growth of the wood cuttings. Brush mattresses can be installed on slopes 1V:2H or flatter.

Design and Construction Considerations

- **Site-Specific Conditions:** Brush mattresses are suitable in water velocities of 5 ft/s. Brush mattresses are commonly implemented with other shoreline stabilization methods to ensure proper protection. Rock bolsters provide toe stabilization against high water velocities and shear stress, Table 3. Note, shoreline protection is dependent on vegetation establishment.

Table 2. Brush Mattresses Configuration

Brush Mattress Type	Water Velocity (ft/sec)	Shear (lb/ft ²)
Staked only without rock bolster at toe	Initial Planting: < 4.0	0.4 – 3
	Established Vegetation: < 5.0	4.0 – 7.0
Staked with rock bolster at toe	Initial Planting: < 5	0.8 – 4.1
	Established Vegetation: < 12	4.0 – 8.0

- **Materials:** Live branch cuttings of a native growing species (e.g., willow) approximately 6 to 9 ft in length, biodegradable untreated twine, dead stout stakes (minimum length of 2.5 ft), 12 gauge galvanized wire, and live fascines. Additional materials may include rock bolster and geotextile fabric for toe stabilization.
- **Placement:** First, install the live fascines in a trench (8 to 10 inches deep and wide) at the streambank base. Place the live branches into the fascines so that the basal end (where the roots grow) faces the riverbed. Drive dead stout stakes into the brush mattress approximately 12 to 18 inches apart. Lastly, wrap metal wire around each stake and pull tightly across the live branches.
- **Maintenance:** Repair of the nature-based structure may be required dependent on stream velocity, flood frequency, sediment load, and timing. For the first year, inspect the structure for loose branches or live fascines after the first few floods (~ 3 visits). Add additional stakes as needed. For the first two dry seasons, water the branches every two weeks if a soaking rain does not occur during a three-week timeframe.

Other design considerations include installation schedule (i.e., time of year), bank preparation, stock type, trench excavation methods, backfilling, compaction and drainage.

Permitting and Regulatory Considerations

The extent of permit requirements will depend on the location and final design of the project. Consult with your local municipality, NYSDEC, and USACE before beginning any stabilization activities.

Rough Order of Magnitude Cost

Total cost ranges from \$38 to \$84/10 ft². This price includes materials, transportation, and installation. Costs vary with design, site access, installation timeframe, supplier and labor rates.

Applications and Effectiveness

- Applicable for steep fast-flowing streams
- Captures sediment and encourages vegetation establishment
- Requires good soil to stem contact and moist conditions for branches to grow
- Encourages conditions for colonization of native vegetation
- Immediate protection of streambank after installation

References

Natural Resources Conservation Service (NRCS). [date unknown]. Guidance on Agroforestry System Design – Riparian Forest Buffer. In: Sustaining Agroforestry Systems for Farms and Ranches. Washington DC (US): United States Department of Agriculture (USDA). Available from: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/landuse/forestry/sustain/guidance/?cid=nracsdev11_009302.

Natural Resources Conservation Service (NRCS). 1996. Engineering Field Handbook - Chapter 16: Streambank and Shoreline Protection. Washington DC (US): United States Department of Agriculture (USDA). Available from: https://efotg.sc.egov.usda.gov/references/public/IA/Chapter-16_Streambank_and_Shoreline_Protection.pdf.

WISCONSIN SUPPLEMENT
CHAPTER 16 - ENGINEERING FIELD HANDBOOK
STREAMBANK AND SHORELINE PROTECTION
STANDARD 580
COMPANION DOCUMENT 580-10
Allowable Velocity and Maximum Shear Stress

Type of Treatment	Allowable Shear lb/sq ft	Velocity ft/sec
Brush Mattresses¹		
Staked only w/ rock riprap toe (initial)	0.8 - 4.1	5
Staked only w/ rock riprap toe (grown)	4.0 - 8.0	12
Coir Geotextile Roll²		
Roll with coir rope mesh staked only without rock riprap toe	0.2 - 0.8	< 5
Roll with Polypropylene rope mesh staked only without rock riprap toe	0.8 - 3.0	< 8
Roll with Polypropylene rope mesh staked and with rock riprap toe	3.0 - 4.0	< 12
Live Fascine³		
LF Bundle w/ rock riprap toe	2.0 - 3.1	8
Soils⁴		
Fine colloidal sand	0.02-0.03	1.5
Sandy loam (noncolloidal)	0.03-0.04	1.75
Alluvial silt (noncolloidal)	0.045-0.05	2
Silty loam (noncolloidal)	0.045-0.05	1.75-2.25
Firm loam	0.075	2.5
Fine gravels	0.075	2.5
Stiff clay	0.26	3-4.5
Alluvial silt (colloidal)	0.26	3.75
Graded loam to cobbles	0.38	3.75
Graded silts to cobbles	0.43	4
Shales and hardpan	0.67	6
Gravel/Cobble⁴		
1-inch	0.33	2.5-5
2-inch	0.67	3-6
6-inch	2	4-7.5
12-inch	4	5.5-12
Vegetation⁴		
Class A turf (ret class)	3.7	6-8
Class B turf (ret class)	2.1	4-7
Class C turf (ret class)	1	3.5
Retardance Class D	0.6	Design of roadside channels HEC-15
Retardance Class E	0.35	
Long native grasses	1.2-1.7	4-6
Short native and bunch grass	0.7-0.95	3-4

Type of Treatment	Allowable Shear lb/sq ft	Velocity ft/sec
Soil Bioengineering⁴		
Wattles	0.2-1.0	3
Reed fascine	0.6-1.25	5
Coir roll	3-5	8
Vegetated coir mat	4-8	9.5
Live brush mattress (initial)	0.4-4.1	4
Live brush mattress (grown)	3.90-8.2	12
Brush layering (initial/grown)	0.4-6.25	12
Live fascine	1.25-3.10	6-8
Live willow stakes	2.10-3.10	3-10
Hard Surfacing⁴		
Gabions	10	14-19
Concrete	12.5	>18
Boulder Clusters⁵		
Boulder		
Very large (>80-inch diameter)	37.4	25
Large (>40-in diameter)	18.7	19
Medium (>20-inch diameter)	9.3	14
Small (>10-inch diameter)	4.7	10
Cobble		
Large (>5-inch diameter)	2.3	7
Small (>2.5-inch diameter)	1.1	5
Gravel		
Very Course (>1.25-inch diameter)	0.54	3
Course (>.63-inch diameter)	0.25	2.5

¹ Brush mattresses (ERDC TN EMRRP-SR-23): <http://el.ercd.usace.army.mil/emrrp/pdf/sr23.pdf>.

² Coir Geotextile roll (ERDC TN EMRRP-SR-04): <http://el.ercd.usace.army.mil/emrrp/pdf/sr04.pdf>.

³ Live Fascine (ERDC TN EMRRP-SR-31): <http://el.ercd.usace.army.mil/emrrp/pdf/sr31.pdf>.

⁴ Stream Restoration Materials (ERDC TN EMRRP-SR-29): <http://el.ercd.usace.army.mil/emrrp/pdf/sr29.pdf>.

⁵ Boulder Clusters (ERDC TN EMRRP-SR-11): <http://el.ercd.usace.army.mil/emrrp/pdf/sr11.pdf>.

Additional Sources:

Wisconsin Department of Transportation, Erosion Control - Product Acceptability List (PAL): <http://www.dot.wisconsin.gov/library/research/docs/finalreports/tau-finalreports/erosion.pdf>

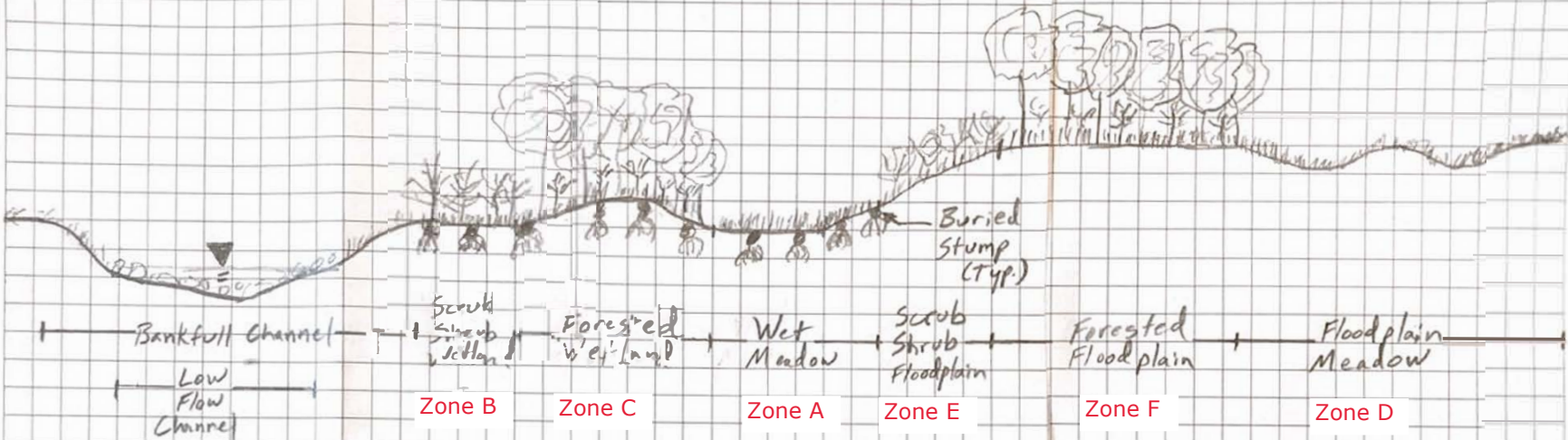
Texas Department of Transportation, Approved Products List: <http://www.dot.state.tx.us/mnt/erosion/contents.htm>

Reference:

Natural Resources Conservation Service (NRCS). 2009. Engineering Field Handbook - Chapter 16: Streambank and Shoreline Protection - Wisconsin Supplement. Washington DC (US): United States Department of Agriculture (USDA). Report No.: EFH Notice 210-WI-119. Available from: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_024948.pdf.

3. Planting Plan

Japanese Knotweed is prevalent along the shores of Buffalo Creek. The proposed floodplain bench will need to be clear cut to allow new plants to get established and prevent the Japanese Knotweed from taking over.



Notes:

1. No Seeding, planting, or mulching shall occur within the low flow channel.
2. Areas to be seeded & planted shall be compacted by running tracked equipment over the area such that tracks are parallel with the edge of the Creek.
3. Buried Stumps shall be spaced every 10' throughout the floodplain bench.
4. Scrub-Shrub and Forested Wetlands are provided closest to Buffalo Creek to help stabilize the soils during flood events
5. Historically, NYSDEC has requested tree stumps to be buried during floodplain construction. Buried stumps helps to reduce erosion and reduces the amount of material that needs to be hauled off-site.
6. Proposed planting zones can be eliminated, reduced, expanded or the location modified based on client preferences. Layout to be discussed and formalized during Final Design.

SECTION XXXXXX

SEEDING AND PLANTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes seed, plantings, and associated work.

1.02 REFERENCES

- A. Improvement, restoration, and mitigation activities shall be performed in substantive compliance with Sections 401 and 404 of the Clean Water Act.

1.03 PERFORMANCE REQUIREMENTS

- A. The Contractor shall comply with all applicable Federal, State and Local codes, ordinances, regulations, statutes and standards.

1.04 SUBMITTALS

- A. The following items shall be submitted:
 1. Source and content data for all seed mixes and trees. Data for each container of seed used shall be submitted; data submitted as representative of multiple containers will not be accepted.
 2. Should hydroseeder be used, the Contractor shall submit all data including material and application rates.
 3. Submit certificates from plant nursery stock supplier for each group of live plant stock required, stating botanical name, common name, origin, age, date of packaging, and name and address of supplier. Submit at least 4 weeks prior to planting.
 4. Invoices for all plants and seed procured for the project shall be submitted.
 5. Source and content data for organic mulch (e.g., hay). If synthetic mulch is used, catalog data that includes the manufacturer, materials, and installation procedures, shall be submitted.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Seed
 1. Seed mixtures shall be of commercial stock of the current or prior season's crop and shall be delivered in unopened containers bearing the

- guaranteed analysis of the mix. Seed shall be labeled true to species and variety.
2. The seed supplier shall provide a seed analysis report including certified analyses of percent viability, percent weed seeds, and percent of other crop seed. The certifying laboratory shall be indicated on the seed tag or on associated submittals.
 3. Seed shall meet the standards of germination and purity set by New York State or the Association of Official Seed Certifying Agencies (AOSCA).
 4. The following weed seeds shall not be present in seed mixes:
 - a. smooth brome
 - b. tall fescue
 - c. purple loosestrife
 - d. common reed
 - e. cattail
 - f. reed canary grass
 - g. others included in the Federal Noxious Weeds list
1. Areas shall be planted according to the following zonation:
 - a. Zone A = Wet Meadow
 - b. Zone B = Scrub-Shrub Wetland
 - c. Zone C = Forested Wetland
 - d. Zone D = Floodplain Meadow
 - e. Zone E = Scrub-Shrub Floodplain
 - f. Zone F = Forested Floodplain

Zone A = Wet Meadow

Table 1. Wet Meadow Seed Mix

Content (%)	Common Name	Botanical Name
30	Indiangrass	<i>Sorghastrum nutans</i>
20	Virginia wildrye	<i>Elymus virginicus</i>
10	Deertongue	<i>Panicum clandestinum</i>
10	Switchgrass	<i>Panicum virgatum</i>
8	Canada wildrye	<i>Elymus canadensis</i>
5	Fox sedge	<i>Carex vulpinoidea</i>
5	Lurid sedge	<i>Carex lurida</i>
4	Blue vervain	<i>Verbena hastata</i>
1	Soft rush	<i>Juncus effusus</i>
2	New England aster	<i>Symphotrichum novae-angliae</i>
2	Joe pye weed	<i>Eupatorium fistulosum</i>
2	Boneset	<i>Eupatorium perfoliatum</i>
1	New York ironweed	<i>Veronia noveboracensis</i>

Zone B = Scrub-Shrub Wetland

Table 2. Scrub-Shrub and/Forested Wetland Seed Mix

Content (%)	Common Name	Botanical Name
25	Virginia Wild Rye	<i>Elymus virginicus</i>
15	Arrowwood	<i>Viburnum dentatum</i>
15	Silky Dogwood	<i>Cornus amomum</i>
15	Grey Dogwood	<i>Cornus racemosa</i>
11	Oats	<i>Avena sativa</i>
4	Fox Sedge	<i>Carex vulpinoidea</i>
3	Grass Leaved Goldenrod	<i>Euthamia graminifolia</i>
2	Lurid (Shallow) Sedge	<i>Carex lurida</i>
2	Blunt Broom Sedge	<i>Carex scoparia</i>
2	Awl Sedge	<i>Carex stipata</i>
2	Path Rush	<i>Juncus tenuis</i>
1	Calico Aster	<i>Aster lateriflorus</i>
1	New England Aster	<i>Aster novae-angliae</i>
1	Rough Avens	<i>Geum laciniatum</i>
1	Sensitive Fern	<i>Onoclea sensibilis</i>

Table 3. Scrub-Shrub Plantings

Common Name	Latin Name	Spacing (ft)	Stock Size (gals)	% of area
Speckled alder	<i>Alnus rugosa</i>	10	2	30
Silky dogwood	<i>Cornus amomum</i>	10	2	20
Pussy willow	<i>Salix discolor</i>	10	2	20
Arrowwood	<i>Viburnum dentatum</i>	10	2	15
Grey dogwood	<i>Cornus racemosa</i>	10	2	5
Elderberry	<i>Sambucus canadensis</i>	10	2	5
Nannyberry	<i>Viburnum lentago</i>	10	2	5

Zone C = Forested Wetland

Table 4. Forested Wetland Plantings

Common Name	Latin Name	Spacing (ft)	Stock Size (gals)	% of area
Black willow	<i>Salix nigra</i>	10	5	25
Eastern cottonwood	<i>Populus deltoides</i>	10	2	25
American sycamore	<i>Platanus occidentalis</i>	10	5	10
Pin oak	<i>Quercus palustris</i>	10	2	15
Speckled alder	<i>Alnus rugosa</i>	10	2	20
Basswood	<i>Tilia americana</i>	10	2	5

Zone D = Floodplain Meadow

Table 5. Floodplain Meadow Seed Mix

Content (%)	Common name	Latin name
18.5	Indiangrass	<i>Sorghastrum nutans</i>
18	Switchgrass	<i>Panicum virgatum</i>
15	Virginia wildrye	<i>Elymus virginicus</i>
15	Canada wildrye	<i>Elymus canadensis</i>
6	Little bluestem	<i>Schizachyrium scoparium</i>
5	Partridge pea	<i>Chamaecrista fasciculata</i>
4	New England aster	<i>Aster novae-angliae</i>
3	Wingstem	<i>Verbesina alternifolia</i>
2	Grass Leaved goldenrod	<i>Euthamia graminifolia</i>
2	Tall goldenrod	<i>Solidago altissima</i>
2	Common milkweed	<i>Asclepias syriaca</i>
1.5	Purpletop	<i>Tridens flavus</i>
1.5	Ticklegrass	<i>Agrostis scabra</i>
1	Annual sunflower	<i>Helianthus annuus</i>
1	Autumn bentgrass	<i>Agrostis perennans</i>
1	Purple bergamot	<i>Monarda media</i>
1	Blackeyed Susan	<i>Rudbeckia hirta</i>
1	Cutleaf coneflower	<i>Rudbeckia laciniata</i>
1	Yarrow	<i>Achillea millefolium</i>
0.5	Common evening primrose	<i>Oenothera biennis</i>

Zone E = Scrub-Shrub Floodplain

Table 6. Scrub-Shrub Floodplain Plantings

Common Name	Latin Name	Spacing (ft)	Stock Size (gals)	% of area
Speckled alder	<i>Alnus rugosa</i>	10	2	25
Silky dogwood	<i>Cornus amomum</i>	10	2	5
Pussy willow	<i>Salix discolor</i>	10	2	5
Arrowwood	<i>Viburnum dentatum</i>	10	2	20
Grey dogwood	<i>Cornus racemosa</i>	10	2	20
American hornbeam	<i>Carpinus caroliniana</i>	10	2	20
Nannyberry	<i>Viburnum lentago</i>	10	2	5

Zone F = Forested Floodplain

Table 7. Floodplain Forest Plantings

Common Name	Latin Name	Spacing (ft)	Stock Size (gals)	% of area
Black willow	<i>Salix nigra</i>	10	2	10
Box elder	<i>Acer negundo</i>	10	2	10
River birch	<i>Picea glauca</i>	10	2	10
Quaking aspen	<i>Populus tremuloides</i>	10	2	20
American sycamore	<i>Platanus occidentalis</i>	10	2	20
Basswood	<i>Tilia americana</i>	10	2	20
Speckled alder	<i>Alnus rugosa</i>	10	2	20

B. Plantings

1. Plant materials shall comply with state and federal laws with respect to inspection for plant diseases and insect infestations.
2. Plants shall be in accordance with the current edition of the American Standard for Nursery Stock (ANSI Z60.1-2004) unless otherwise specified.
3. Plants shall be free of disease and insects, eggs, or larvae, and have healthy, well-developed root systems such that the root ball does not fall apart upon plant removal from the pot or tray.
4. All woody seedlings shall have a heavy fibrous root system that has been developed by proper horticultural treatment, transplanting, and root pruning.
5. Plants shall be tagged true to species name and variety and not contain weeds.

- a. Plants shall arrive at the job site free from physical damage.
 - b. Each species shall be handled and packed in a manner reviewed for that plant. Precautions that are customary in good trade practice shall be taken to insure the arrival of the plants at the Site in good condition. Plants that arrive dried out, exposed to excessive heat, or that have been in storage for protracted periods of time, will not be accepted. If, upon inspection, the plants or root stocks display mold or decay, the material will not be accepted.
- C. Existing live native trees and shrubs of the following species that are located within the project disturbance limits may be salvaged to the extent practicable prior to clearing and grading for use within the mitigation area when grading is complete. Species included on the “New York State Prohibited and Regulated Invasive Plants” list shall not be salvaged and include:
- 1. European alder (*Alnus glutinosa*)
 - 2. Honeysuckle (*Lonicera* spp.)
 - 3. Japanese barberry (*Berberis thunbergii*)
 - 4. Multiflora rose (*Rosa multiflora*)
 - 5. Buckthorn (*Rhamnus* spp.)
 - 6. Norway maple (*Acer platanoides*)
 - 7. Norway spruce (*Picea abies*)
- D. Salvaging may include staging of shrub clumps complete with root systems. Methods of material staging to promote survival is the Contractor's responsibility. Plant material shall be stockpiled adjacent to the work area to minimize transport distance. Materials shall be placed in the mitigation area within wetland areas as soon as practicable after completion of grading. Tree or shrub clumps shall not be separated but shall be moved as an individual unit.
- E. The Contractor shall remove and maintain the full root ball (i.e., extending outward to the dripline and downward to the extent of the fibrous root network) of the salvaged plants to the extent practicable.
- F. Areas that don't receive transplanted salvaged material shall be planted with the tree and shrub species provided in the Tables in Section 2.
- G. The numbers of trees and shrubs in the tables shall be planted at a density of 450 stems per acre, alternating species to achieve distribution throughout.
- H. Potted trees and shrubs and salvaged transplants shall be planted from mid-April to late May or from September through December.
- I. Seed mixes shall be from Ernst Conservation Seeds or equivalent and shall be placed after completion of tree and shrub plantings where applicable.
- J. Seed shall be sown between March 15th and May 15th or between August 15th and September 30th, except as otherwise approved by the Engineer. Areas requiring stabilization outside of these timeframes shall be seeded with an oats cover crop applied at a rate of 20 pounds per acre and mulch shall be applied.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Plant materials shall be installed in Planting Zones per the depths and quantities specified in Part 2 of this specification.

3.02 TREE AND SHRUB PLANTINGS

- A. Individual size #2 specimens of the species identified in Section 2 shall be planted at a density of one per 100 square feet (436 trees per acre) in the areas treated with glyphosphate, a minimum of two weeks after treatment. The numbers in the tables shall be planted, alternating species and trees and shrubs to achieve distribution throughout the zones and vary the layering. Tree and shrub species mixes shall be planted in the specified zones.
- B. Alternative species and/or seed mixes may be used with Engineer approval only.
- C. Potted trees and shrubs shall be planted in the floodplain from mid-April to late May or from September through December.
- D. Potted trees and shrubs shall be planted in the wetland zones between May and September.
- E. The planting hole diameter shall be at least 1.5 times the diameter of the root ball and dug to a depth such that the root flare is even with the finished grade when the plant is placed in the hole.
- F. If the planting hole is initially dug too deeply, soil shall be added back into the hole to attain the proper elevation.
- G. 100 grams of slow-release 10-10-10 fertilizer shall be placed in each planting hole prior to placing woody potted stock.
- H. Burlap and wire baskets shall be removed from root balls prior to planting.
- I. Cut roots encircling the root ball with a sharp knife and install the plant as soon as possible once it has been removed from the pot.
- J. Backfill the planting hole and firmly work soil into and around the root ball with care taken to fill in air spaces.
- K. Tamp the backfill with foot pressure sufficient to prevent the root ball from shifting or leaning.
- L. Form earthen water-holding saucers (4 inches deep with a similar diameter as the planting hole) around each plant.
- M. In the floodplain zones, water all plants immediately after planting. Apply water directly to the root ball and adjacent soil. Fill the water holding saucer with water. Watering shall be in such a manner as to prevent exposing plant roots.
- N. Following installation, remove all tags, labels, strings, etc. from all plants.

3.03 SEED AND MULCH

- A. Hand broadcast of the seed mixes shall be performed during two seasonal windows: April 1 to June 15, October 15 through December 1, or as otherwise practicable and reviewed by the Engineer. If site soils require stabilization at times outside of these dates, they shall be temporarily mulched using one ton per acre of straw and 100 pounds per acre of oats.
- B. Seeding shall not be done during windy weather (greater than 5 mph or as reviewed by the Engineer).
- C. In forested and scrub-shrub zones, seeding shall be completed after tree and shrub placement.

- D. Hydroseeding may be accepted as an alternative method of applying seed and mulch. The Contractor shall submit all data regarding materials and application rates to the Engineer for review.
- E. Mulch shall be hand or machine spread over seeded areas to form a continuous blanket over the seed bed.
- F. If straw mulch or similar is used, approximately 1 to 1.5 inches uniform thickness at loose measurement shall be applied. Excessive amounts or bunching of mulch will not be permitted.
- G. If hydromulch is used, it shall be installed at a rate recommended by the Manufacturer.
- H. Unless otherwise specified, mulch shall be left in place and allowed to disintegrate.

3.04 MONITORING AND MAINTENANCE

- A. The Contractor shall warranty the plantings (potted stock) and seed for a period of one year from the date of installation. If planted in the spring, the warranty shall be assessed based on the survivability observed during the growing season the following year (i.e., after leaf-out). Based on the results of the Engineers' census in Year 1 of the monitoring period, the Contractor shall replace deceased planted stock or reseed areas based on the following criteria:
 - a. Minimum 85% survival of planted stock.
 - b. Minimum 80% ground coverage of seeded areas.
- B. Replacements shall be of the same size originally planted and subject to the first-year maintenance efforts prescribed herein.
- C. Alternative species and/or seed mixes may be used during replacement with Engineer approval only.

END OF SECTION

4. Cost Estimate

Project: Buffalo Creek Floodplain Reconnection
 Owner: Buffalo Niagara Waterkeepers
 County: Erie
 Municipality: Town of West Seneca

PROJECT COST ESTIMATE					
Item/Description	Qty	Units	Unit Cost	Amount	
Flood Benches					
<i>Formation of flood bench</i>				\$	2,931,000
Excavation and Material Disposal	76,000	CY	\$ 25	\$	1,900,000
Clearing/Grubbing	9	AC	\$ 20,000	\$	180,000
Seeding and/or planting	1	LS	\$ 614,000	\$	614,000
Temporary sediment and erosion control	2,700	LF	\$ 88	\$	237,000
<i>Land acquisition</i>	24	AC	\$3,500	\$	83,000
<i>Walking Trail Restoration</i>				\$	109,000
Earth Excavation	1500	CY	\$ 35.00	\$	53,000
Compacted Granular Fill	900	CY	\$ 42.00	\$	38,000
Fine Grading & Compacting	3,600	SY	\$ 5.00	\$	18,000
<i>Bank Stabilization Features</i>	2,700	LF	\$100	\$	270,000
<i>Allowance for utility owner requirement</i>				\$	50,000
Construction Cost Subtotal				\$	3,443,000
General Conditions / Project Management	10%				\$345,000
Contractor OH&P	15%				\$569,000
Construction Contingency	30%				\$1,308,000
Total Construction Cost					\$5,665,000
Summary					
Construction Costs					\$5,665,000
Engineering (Not including additional modeling & ice jam analysis)	10%				\$567,000
Construction Management	10%				\$567,000
Total					\$6,799,000