



STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
ROADWAY DESIGN DIVISION
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INSTRUCTIONAL BULLETIN NO. 17-12

Regarding Revised Natural Stream Design Standard Drawings

Effective March 23, 2018 letting (January 10, 2018 Turn-in), the following standard drawings have been revised. Also, Chapter 5 of the Roadway Design Guidelines has been revised to incorporate these changes.

Revised Standard Drawings:

DRAWING NUMBER	REVISION DATE	DESCRIPTION
RD-L-8	09-15-17	STANDARD LEGEND FOR NATURAL STREAM DESIGN
D-NSD-21 ¹	09-15-17	BOULDER CLUSTERS
D-NSD-22 ²	09-15-17	BOULDER CROSS VANE
D-NSD-23 ²	09-15-17	BOULDER CROSS VANE WITH STEP
D-NSD-24 ²	09-15-17	BOULDER W-WEIR
D-NSD-25 ²	09-15-17	BOULDER VANES AND J-HOOK
D-NSD-26 ²	09-15-17	LOG VANES, ROOT WADS, AND BOULDER J-HOOK
D-NSD-27 ²	09-15-17	LOG AND BOULDER STEP POOLS
D-NSD-28 ^{2,3}	09-15-17	BOULDER RIFFLES
D-NSD-28A ^{2,3}	09-15-17	LOG RIFFLES

D-NSD-29 ²	09-15-17	CONSTRUCTED ALLUVIAL RIFFLE
D-NSD-31 ²	09-15-17	CLAY CHANNEL PLUG
D-NSD-32 ^{2,3}	09-15-17	WOOD TOE WITH GEO-LIFTS
D-NSD-32A ^{1,2,3}	09-15-17	BOULDER TOE WITH GEO-LIFTS
D-NSD-33 ^{1,2,3}	09-15-17	COIR FIBER EROSION CONTROL BLANKET AND COIR FIBER ROLLS
D-NSD-34 ²	09-15-17	LIVE STAKES AND LIVE SILTATION
D-NSD-35 ²	09-15-17	LIVE FASCINES
D-NSD-36 ²	09-15-17	BRUSH MATTRESS

Note 1: Minor revisions, revised pay item description

Note 2: Minor revisions, modified legend symbol

Note 3: Minor revisions, modified notes

These standard drawings and revised Chapter 5 of the Roadway Design Guidelines are available online.

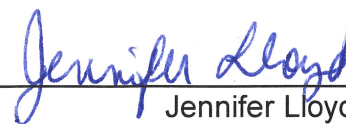
The Drainage Manual will be updated at a later date.

Standard Drawings:

<http://www.tn.gov/tdot/section/chief-engineer-design-standard-drawings-library>

Roadway Design Guidelines:

<http://www.tn.gov/tdot/topic/chief-engineer-design-design-guidelines>



Jennifer Lloyd, PE
Civil Engineering Director
Roadway Design Division

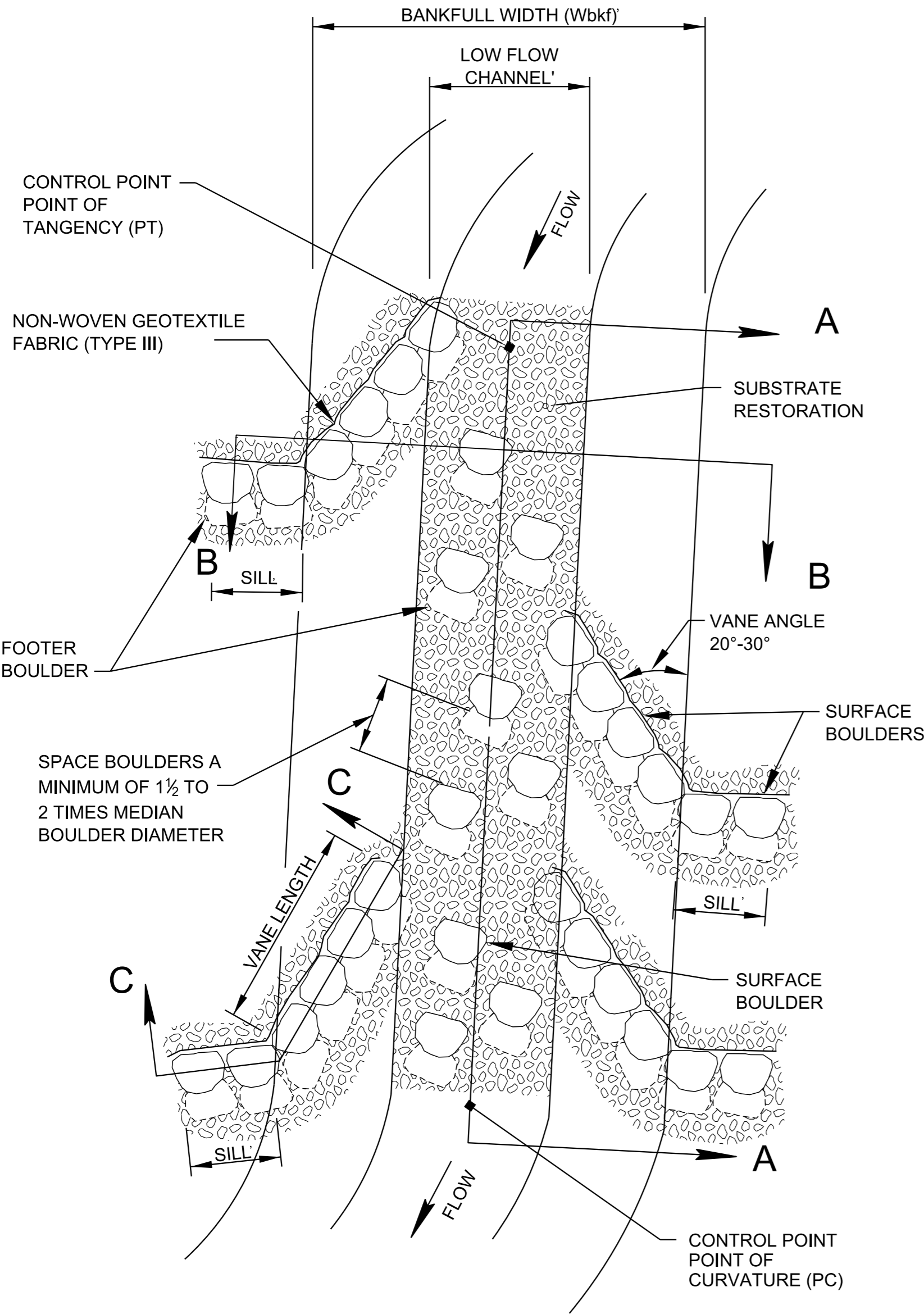
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STANDARD LEGEND

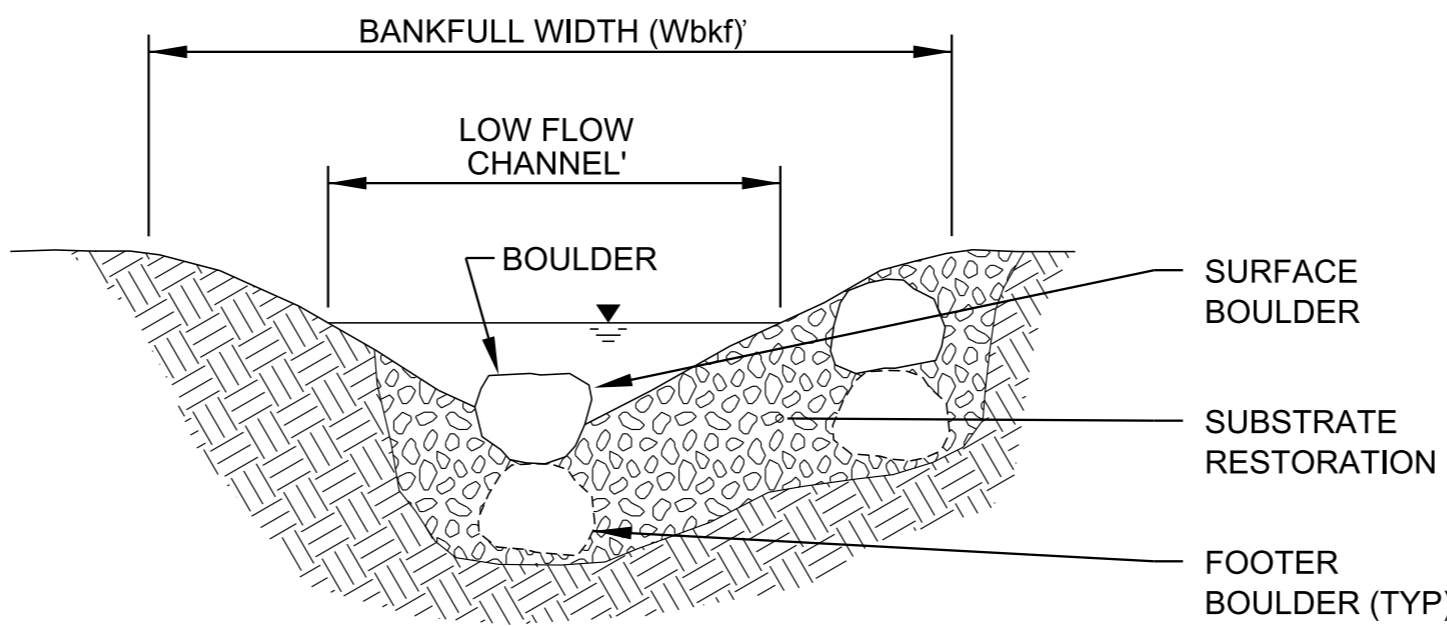
REV. 9-15-17: DELETED VARIOUS ITEMS. MODIFIED VARIOUS ITEMS. ADDED STD. DWG. NAMES. REDESIGNED VARIOUS ITEMS. ADDED LEGENDS FOR BOULDER TOE AND COIR FIBER EROSION CONTROL BLANKETS.

SYMBOL	ITEM	STD. DWG.
	LONGITUDINAL STONE TOE	D-NSD-13
	BOULDER CLUSTERS	D-NSD-21
	BOULDER CROSS VANE	D-NSD-22
	BOULDER CROSS VANE WITH STEP	D-NSD-23
	BOULDER W-WEIR	D-NSD-24
	BOULDER VANE	D-NSD-25
	J-HOOK	D-NSD-25
	LOG VANES, ROOT WADS AND BOULDER J-HOOK	D-NSD-26
	BOULDER STEP POOLS	D-NSD-27
	LOG STEP POOLS	D-NSD-27
	BOULDER RIFFLE	D-NSD-28

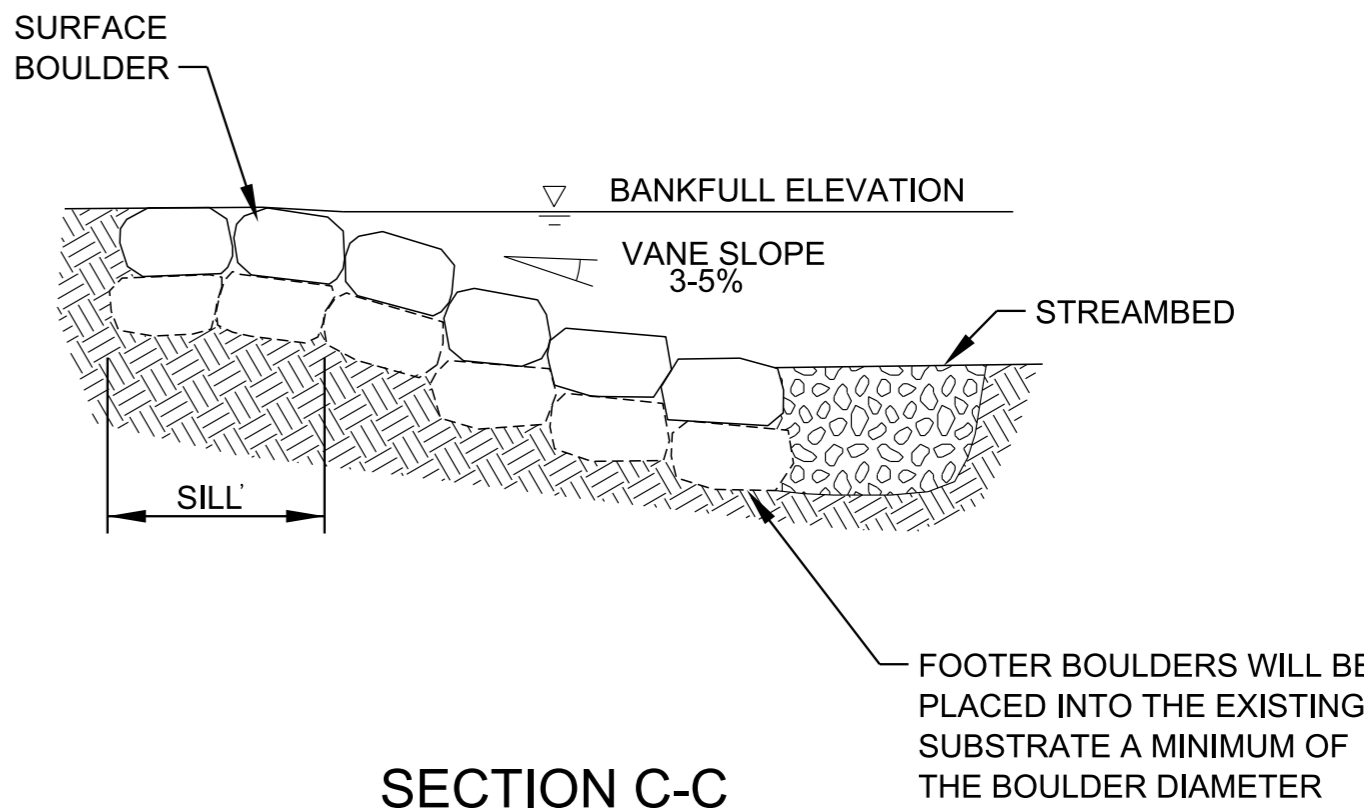
SYMBOL	ITEM	STD. DWG.
	BOULDER AND LOG RIFFLE	D-NSD-28
	LOG RIFFLE	D-NSD-28A
	CONSTRUCTED ALLUVIAL RIFFLE	D-NSD-29
	CLAY CHANNEL PLUG	D-NSD-31
	WOOD TOE WITH GEO-LIFTS	D-NSD-32
	BOULDER TOE WITH GEO-LIFTS	D-NSD-32A
	COIR FIBER EROSION CONTROL BLANKET	D-NSD-33
	COIR FIBER ROLLS	D-NSD-33
	LIVE SILTATION	D-NSD-34
	LIVE FASCINE	D-NSD-35
	BRUSH MATTRESS PATTERNING	D-NSD-36



PLAN VIEW



SECTION B-B



SECTION C-C

BOULDER CLUSTER NOTES

- (A) CONVERGING BOULDER CLUSTERS ARE HABITAT ENHANCEMENT MEASURES CONSISTING OF A GROUP OF ONE OR MORE LARGE IMMOBILE BOULDERS ARRANGED IN RIFFLE-RUN HABITATS TO CREATE AREAS OF CONCENTRATED CONVERGENT FLOW. THEY SHOULD ONLY BE USED WITH BOULDER MINI-VANES, WHICH PROTECT THE ADJACENT STREAM BANK FROM SCOUR BY REDUCING NEAR-BANK SHEAR STRESS.
- (B) BOULDER CLUSTERS AND MINI-VANES SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND CONFIGURATION INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BEGINNING AND ENDING STATIONS OF THE CONVERGING BOULDER CLUSTERS, THE BANKFULL WIDTH, MEDIAN BOULDER SIZE, VANE AND SILL LENGTHS, SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
- (D) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
- (E) SURFACE BOULDERS IN BOULDER CLUSTERS SHOULD PROTRUDE A MAXIMUM OF 3 INCHES ABOVE THE RIFFLE SLOPE.
- (F) THE MAXIMUM AMOUNT OF DROP FROM ONE MINI-VANE TO THE NEXT SHALL BE NO GREATER THAN THE HEIGHT SPECIFIED ON THE PROPOSED PROFILE. THE COMBINED AMOUNT OF DROP OVER ALL THE MINI-VANES SHALL NOT EXCEED THE TOTAL AMOUNT OF FALL IN THE RIFFLE SLOPE. THE MINI-VANES AT THE TOP AND BOTTOM OF THE TANGENT SECTIONS SHOULD BE PLACED ON THE OUTSIDE BANK OF THE ADJACENT MEANDER.
- (H) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS IN THE MINI-VANE BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (I) CONSTRUCT BOULDER CLUSTERS AND MINI-VANES BY:
- (1) FIRST SHAPE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADE AND DIMENSIONS.
 - (2) NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE BOULDERS FOR MINI-VANES, THE NON-WOVEN GEOTEXTILE FABRIC (TYPE III), AND SELECT MATERIAL FOR BACKFILL AND SUBSTRATE REPLACEMENT.
 - (3) PLACE FOOTER AND SURFACE BOULDERS AT THE INVERTS SPECIFIED IN THE PLANS AND THEN CHECK THE ELEVATIONS OF THE INVERTS WITH SURVEY EQUIPMENT. FOR MINI-VANES, PLACE BOULDERS TO MINIMIZE VOIDS AND TO PRODUCE A SMOOTH COMPACT SURFACE.
 - (4) ONCE THE INVERTS HAVE BEEN ESTABLISHED, FILL THE VOIDS BETWEEN BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURE.
 - (5) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE MINI-VANES, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED.
 - (6) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE). OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE MINI-VANES. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
 - (7) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
- (J) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ONSITE CONSTRUCTION OBSERVER.
- (K) BOULDER CLUSTERS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

209-03.32 STREAM MITIGATION - BOULDER CLUSTER PER EACH.

PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE BOULDER CLUSTERS AND MINI-VANES.

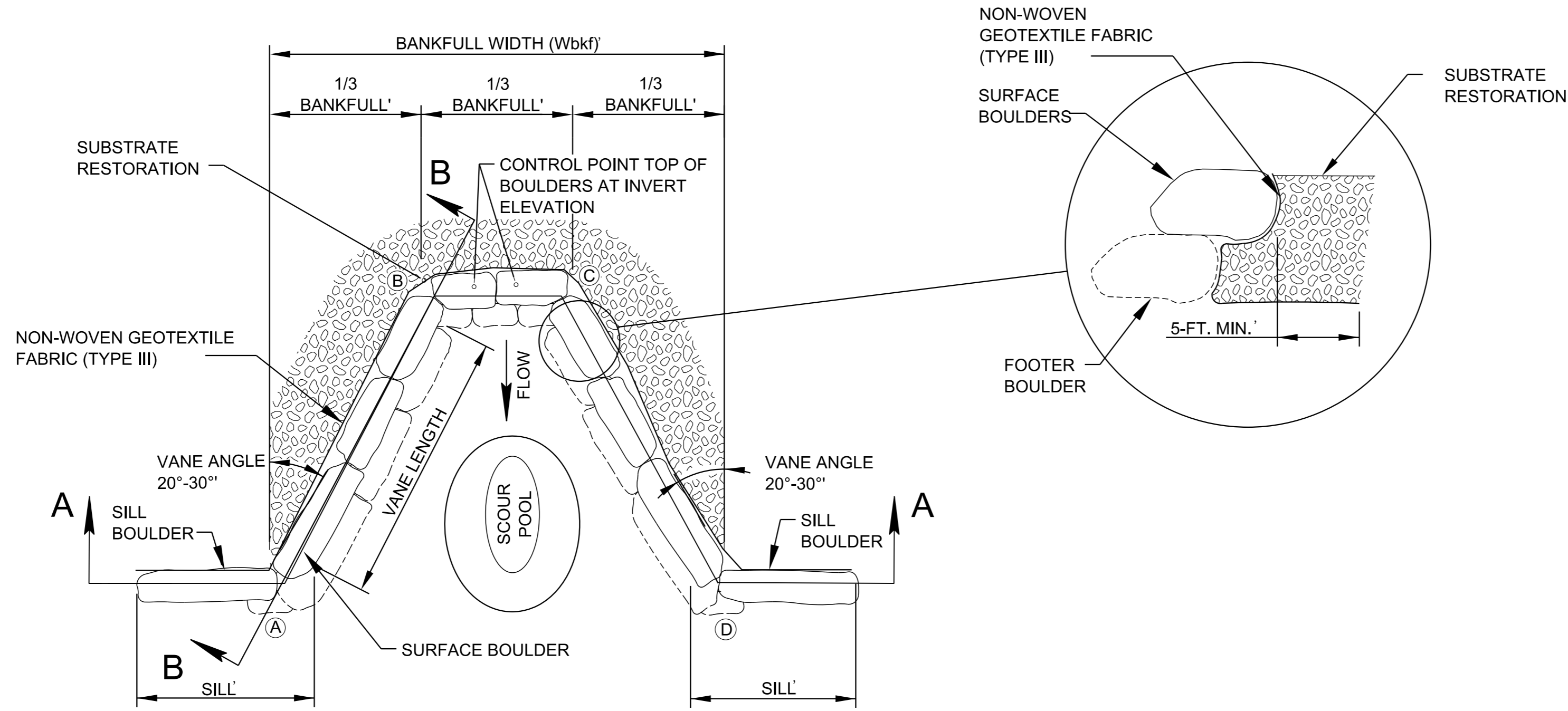
MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

MINOR REVISION -- FHWA APPROVAL NOT REQUIRED.

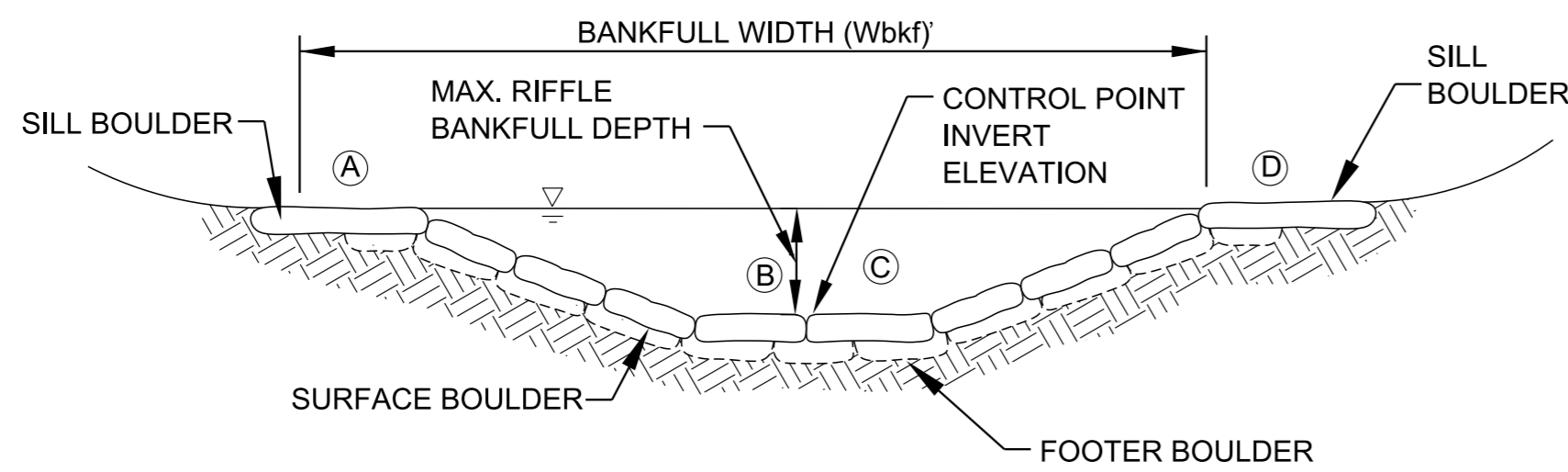
STATE OF TENNESSEE
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TRANSPORTATION

BOULDER
CLUSTERS

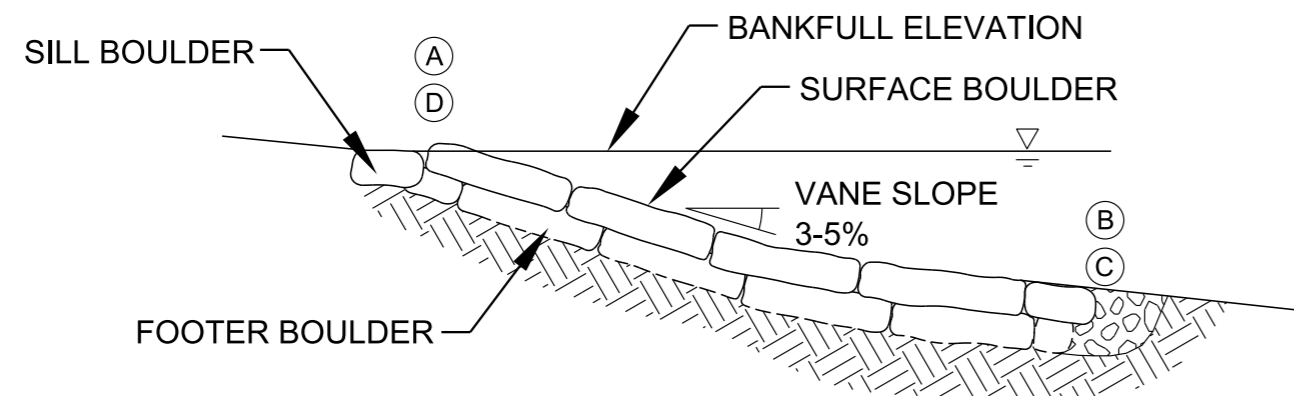




PLAN VIEW

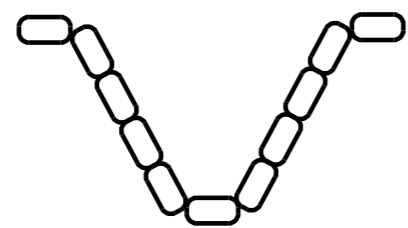


SECTION A-A



SECTION B-B

STREAM MITIGATION PLAN LEGEND:



BOULDER CROSS VANE

BOULDER CROSS VANE NOTES

- (A) BOULDER CROSS VANES ARE HYDRAULIC AND GRADE CONTROL MEASURES THAT ARE USED TO DIRECT FLOW AWAY FROM THE CHANNEL BANK, CONCENTRATE FLOWS INTO THE CENTER OF THE CHANNEL, AND ENHANCE HABITAT. THEY ARE COMMONLY USED FOR GRADE CONTROL AT THE UPSTREAM AND DOWNSTREAM EXTENT OF STREAM RESTORATION REACHES AND UPSTREAM OF PLANNED RIFFLES TO AID IN RIFFLE DEVELOPMENT AND MAINTENANCE.
- (B) BOULDER CROSS VANES SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND CONFIGURATION INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH, MEDIAN BOULDER SIZE, VANE AND SILL LENGTHS, AND INVERT ELEVATION, SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
- (D) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
- (E) THE WEIR OF THE BOULDER CROSS VANE IS TYPICALLY LOCATED IN THE CENTER THIRD OF THE STREAM CHANNEL, UNLESS THE STRUCTURE IS DESIGNED WITH OFF-SET VANES TO CONFORM TO BENDS IN THE CHANNEL. THE SURFACE BOULDERS COMPRISING THE WIER ARE SET AT THE INVERT ELEVATION OF THE STRUCTURE.
- (F) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS IN THE VANE BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (G) CONSTRUCT BOULDER CROSS VANE STRUCTURES BY:
- (1) FIRST SHAPE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADE AND DIMENSIONS.
 - (2) NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND SELECT MATERIAL FOR BACKFILL AND SUBSTRATE REPLACEMENT.
 - (3) PLACE FOOTER BOULDERS AND SURFACE BOULDERS AT THE CHANNEL INVERT AND THEN USE SURVEY EQUIPMENT TO CHECK THE ELEVATIONS OF THE INVERTS IN ACCORDANCE WITH THE STREAM MITIGATION PLANS.
 - (4) ONCE THE INVERTS HAVE BEEN ESTABLISHED, THE REMAINDER OF THE FOOTER AND SURFACE BOULDERS SHALL BE PLACED, MINIMIZING VOIDS.
 - (5) FILL THE VOIDS BETWEEN BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURE.
 - (6) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE STRUCTURE, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED.
 - (7) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
 - (8) ONCE THE STRUCTURE IS INSTALLED, EXCAVATE SCOUR POOL AND PLACE SELECT MATERIAL AS REQUIRED.
 - (9) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
- (H) THE SURFACE OF CROSS VANES SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE PLANS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.
- (I) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (J) BOULDER CROSS VANES SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

209-03.37 STREAM MITIGATION CROSS VANE STRUCTURE PER EACH

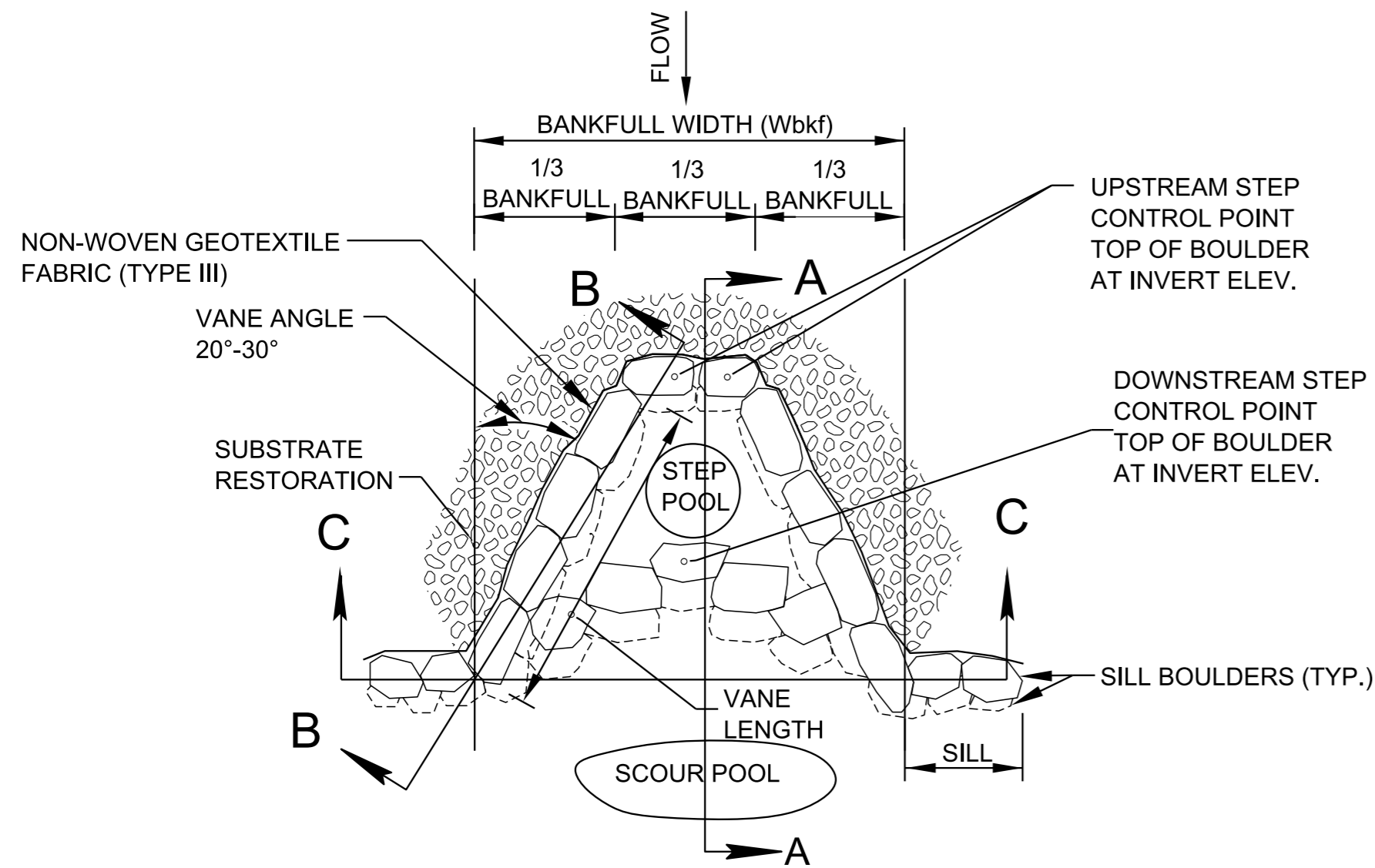
PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE BOULDER CROSS VANE.

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

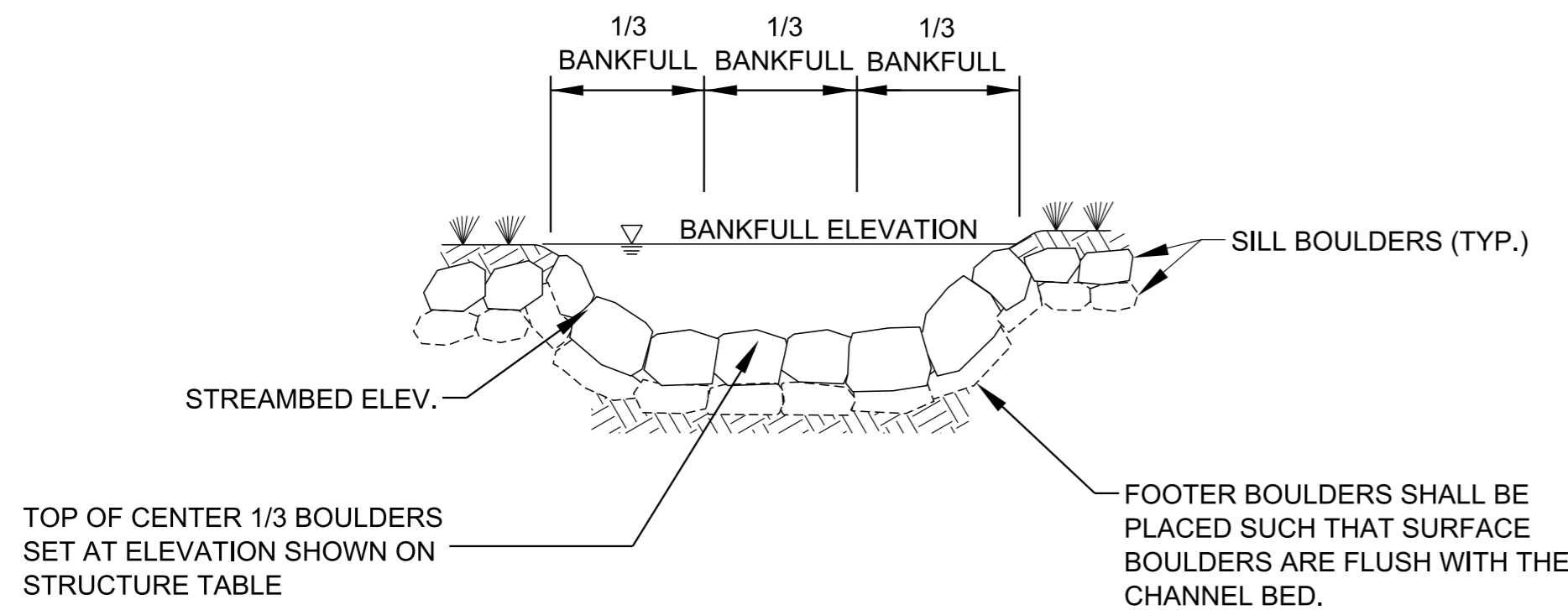
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STATE OF TENNESSEE
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TRANSPORTATION

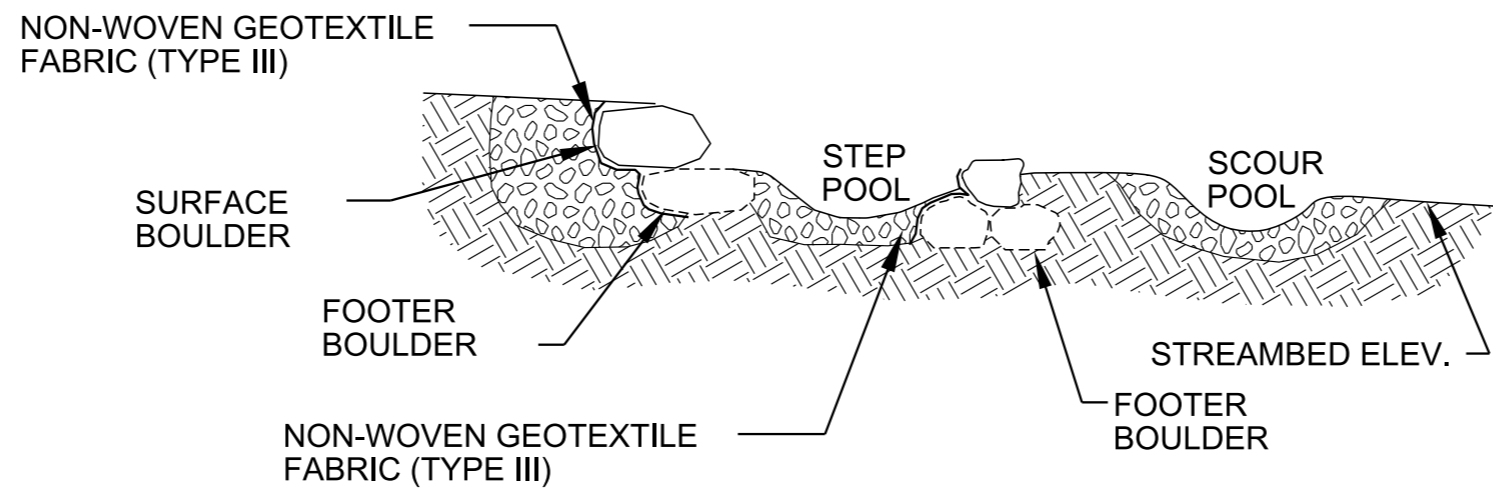
BOULDER
CROSS VANE



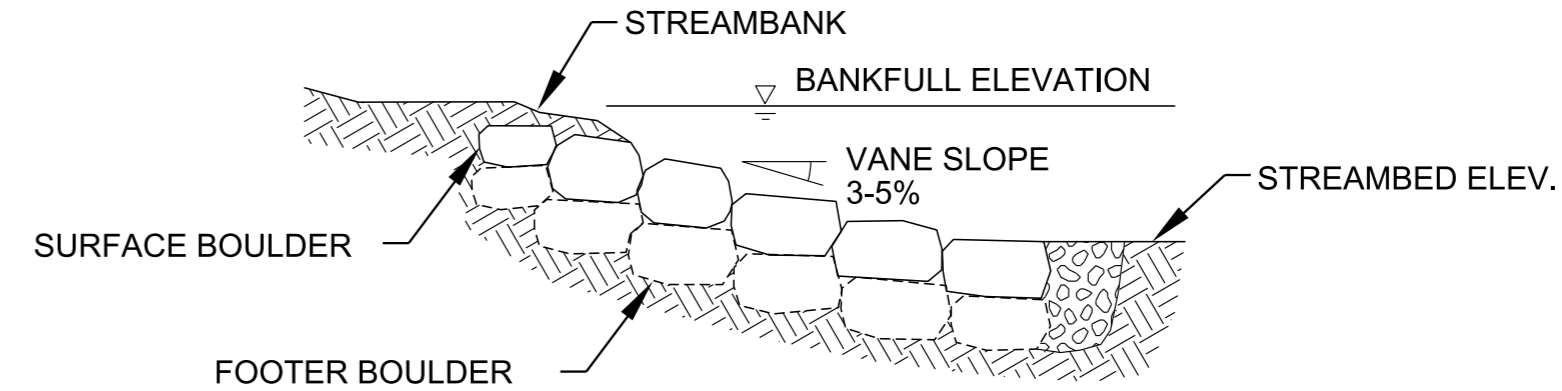
PLAN VIEW



SECTION C-C



SECTION A-A



SECTION B-B

BOULDER CROSS VANE WITH STEP NOTES

- (A) BOULDER CROSS VANES WITH STEPS ARE HYDRAULIC AND GRADE CONTROL MEASURES THAT ARE USED TO DIRECT FLOW AWAY FROM THE CHANNEL BANK, CONCENTRATE FLOWS INTO THE CENTER OF THE CHANNEL, AND ENHANCE HABITAT. THE ADDITION OF A STEP HELPS REDUCE THE ELEVATION DROP ACROSS THE STRUCTURE, THEREBY DISSIPATING ENERGY AND PROMOTING PASSAGE BY AQUATIC ORGANISMS.
- (B) BOULDER CROSS VANES WITH STEPS SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND CONFIGURATION INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH, MEDIAN BOULDER SIZE, VANE AND SILL LENGTHS, AND INVERT ELEVATIONS OF THE WEIR AND STEP, SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
- (D) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
- (E) THE WEIR AND THE STEP OF THE BOULDER CROSS VANE WITH STEP ARE TYPICALLY LOCATED IN THE CENTER THIRD OF THE STREAM CHANNEL, UNLESS THE STRUCTURE IS DESIGNED WITH OFF-SET VANES TO CONFORM TO BENDS IN THE CHANNEL. THE SURFACE BOULDERS COMPRISING THE WEIR AND STEP ARE SET AT THE INVERT ELEVATIONS OF THE STRUCTURE. THE STEP INVERT SHOULD BE AT OR ABOVE THE TOP OF THE UPSTREAM FOOTER BOULDER.
- (F) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS IN THE VANE BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (G) CONSTRUCT BOULDER CROSS VANE WITH STEP STRUCTURES BY
- (1) FIRST SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
 - (2) NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND SELECT MATERIAL FOR BACKFILL AND SUBSTRATE REPLACEMENT.
 - (3) PLACE FOOTER BOULDERS AND SURFACE BOULDERS AT THE CHANNEL INVERTS OF THE WEIR AND STEP, AND THEN USE SURVEY EQUIPMENT TO CHECK THE ELEVATIONS OF THE INVERTS IN ACCORDANCE WITH THE STREAM MITIGATION PLANS.
 - (4) ONCE THE INVERTS HAVE BEEN ESTABLISHED, THE REMAINDER OF THE FOOTER AND SURFACE BOULDERS SHALL BE PLACED, MINIMIZING VOIDS.
 - (5) FILL THE VOIDS BETWEEN BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURE.
 - (6) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE STRUCTURE, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED.
 - (7) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
 - (8) ONCE THE STRUCTURE IS INSTALLED, EXCAVATE SCOUR POOL AND PLACE SELECT MATERIAL AS REQUIRED.
 - (9) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
- (H) THE SURFACE OF CROSS VANE WITH STEP STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE PLANS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.
- (I) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (J) BOULDER CROSS VANES WITH STEPS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

209-03.54 STREAM MITIGATION - CROSS VANE STRUCTURE W/STEP PER EACH

PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE BOULDER CROSS VANE WITH STEP.

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

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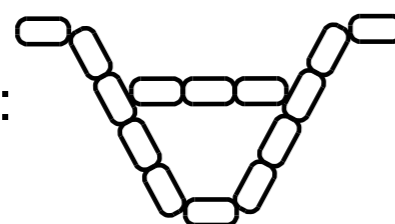
STATE OF TENNESSEE
DEPARTMENT OF
TRANSPORTATION

BOULDER CROSS
VANE WITH STEP

11-01-16

D-NSD-23

STREAM MITIGATION PLAN LEGEND:



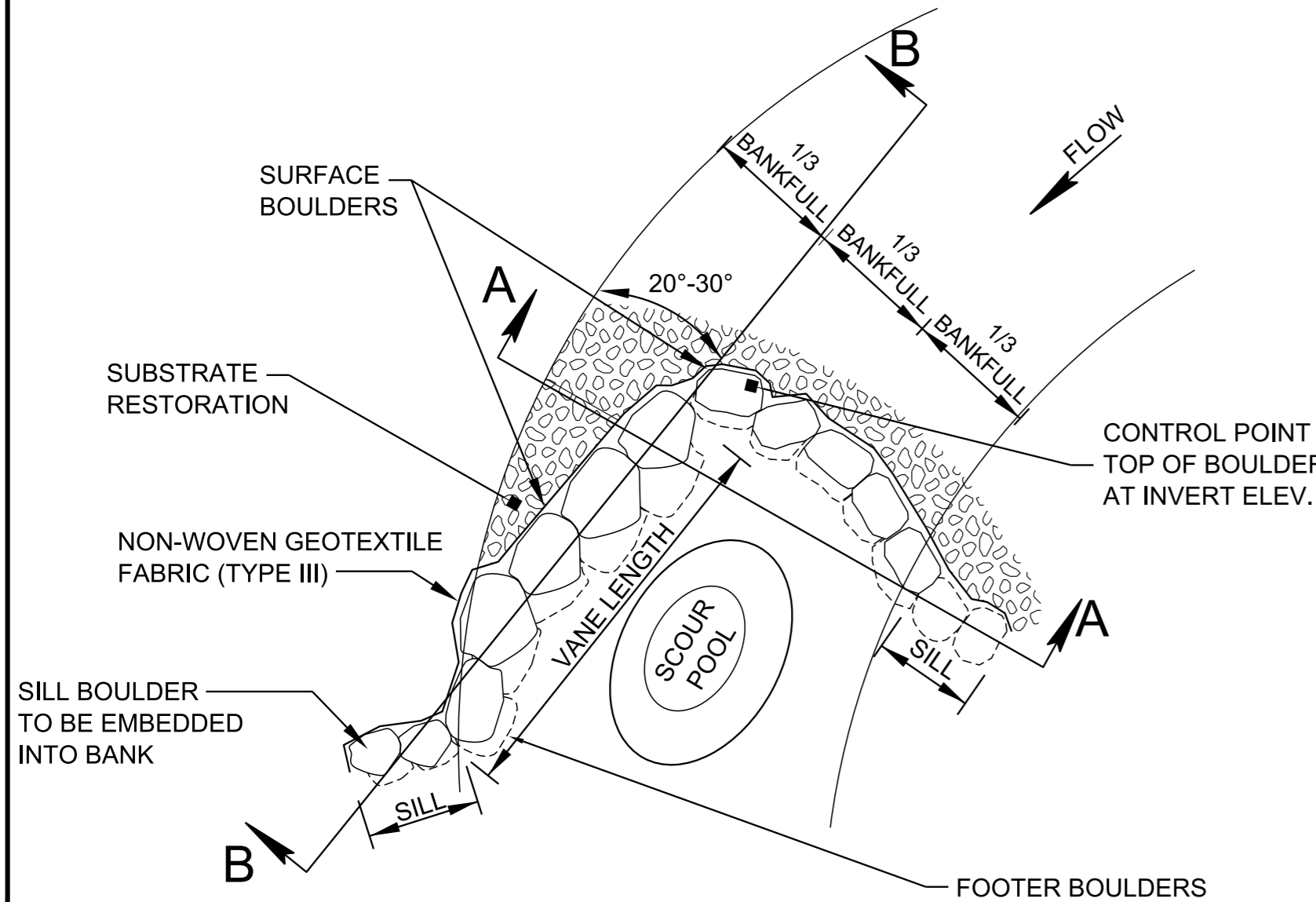
BOULDER CROSS VANE WITH STEP



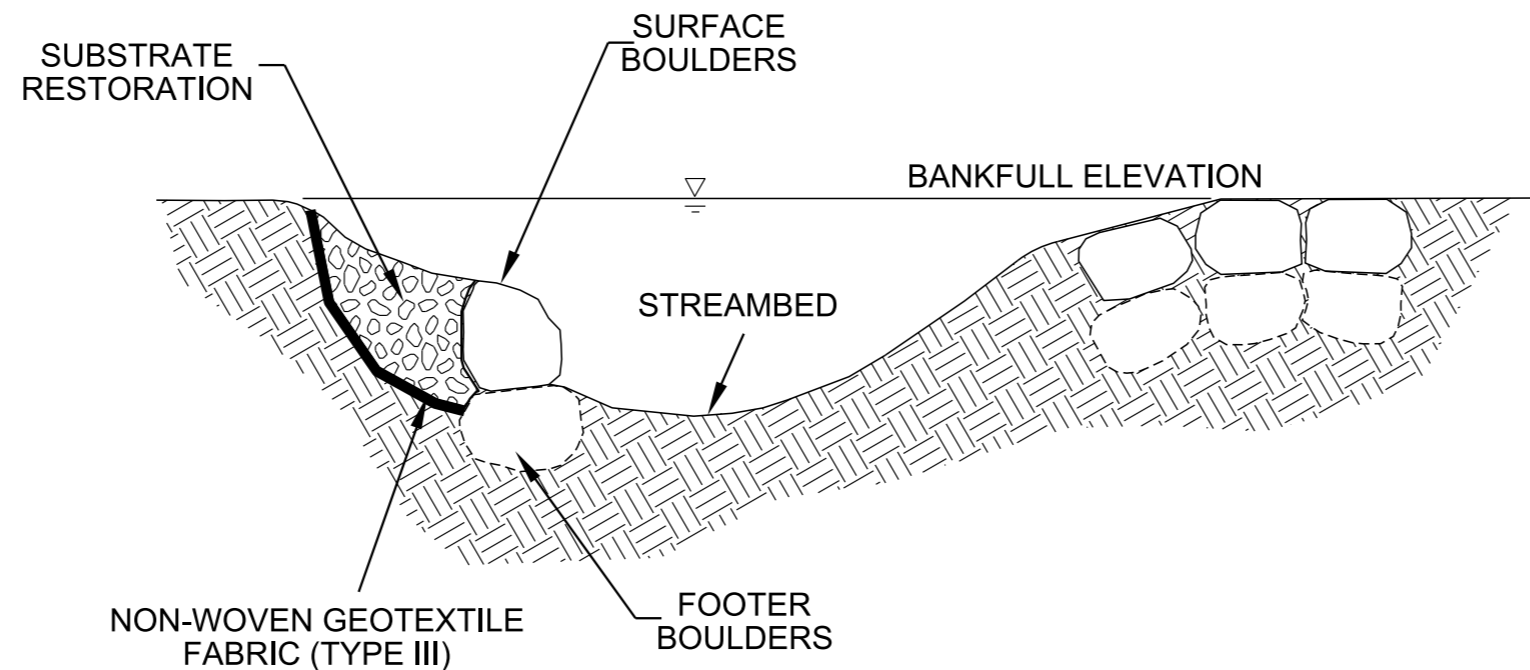
PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE BOULDER W-WEIR.

NOT TO SCALE

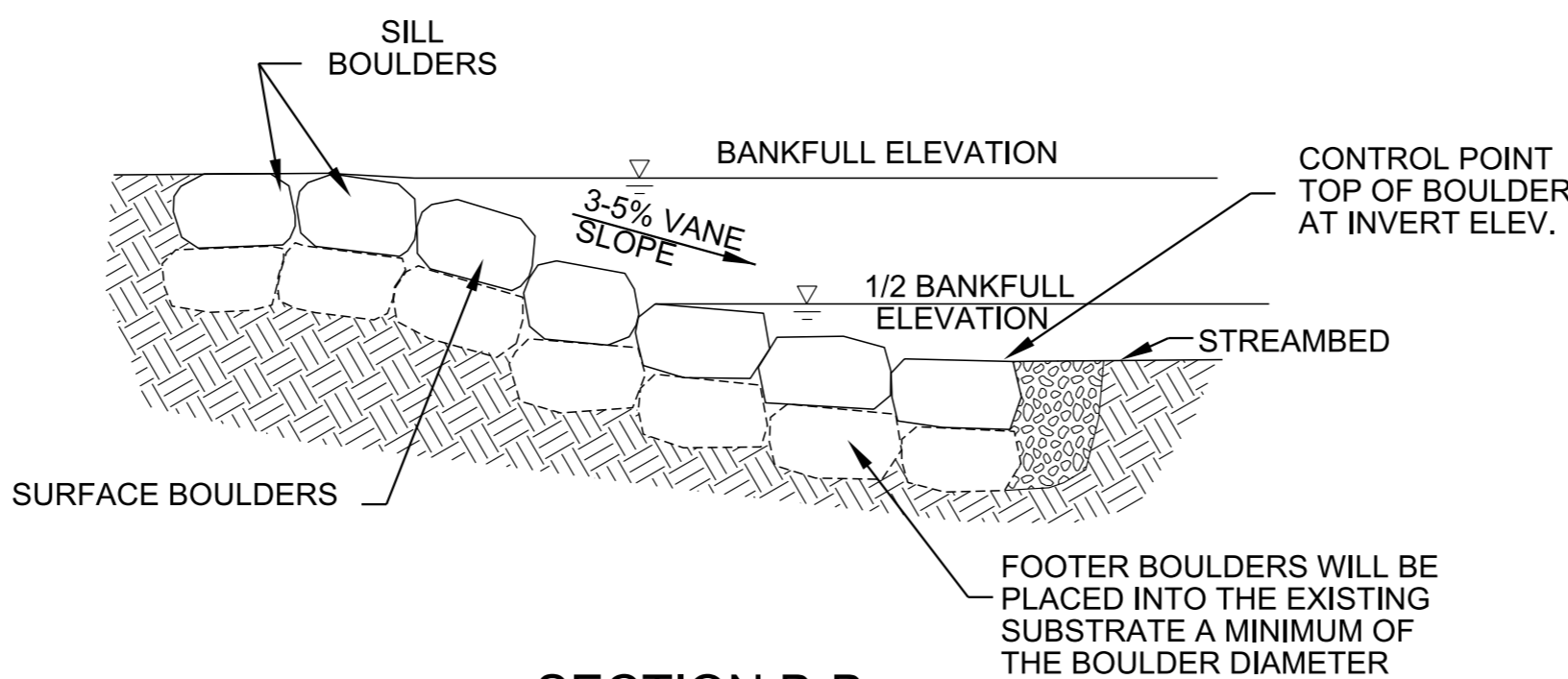
BOULDER
W-WEIR



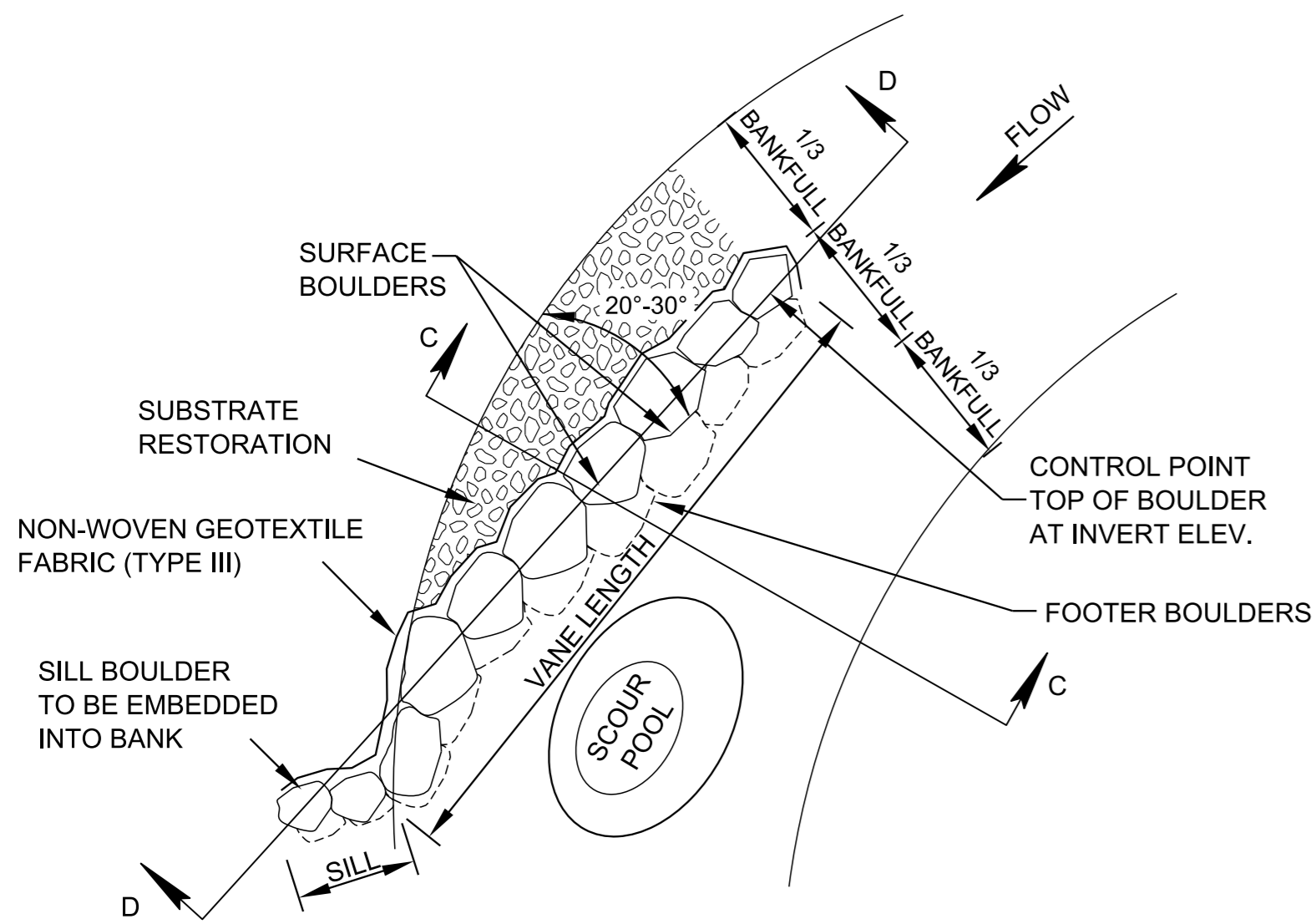
J-HOOK
PLAN VIEW



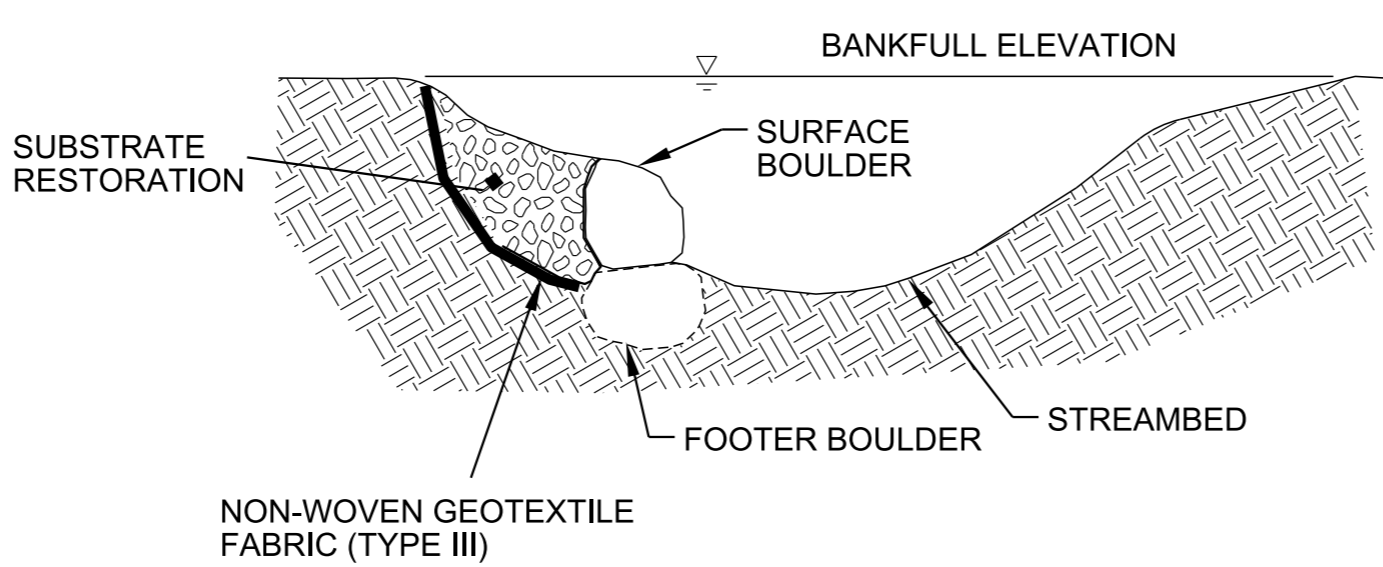
SECTION A-A



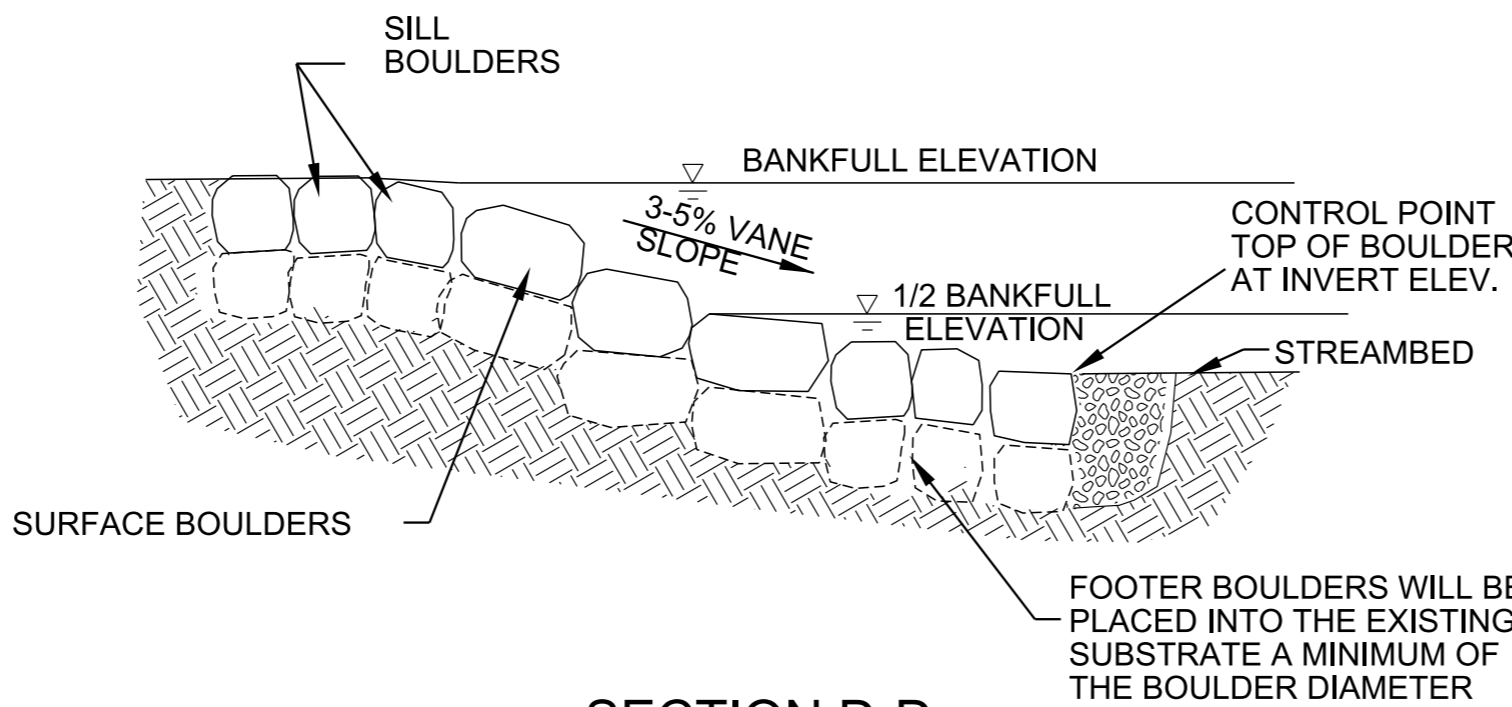
SECTION B-B



BOULDER VANE
PLAN VIEW



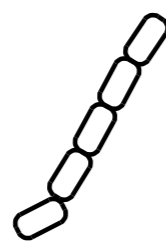
SECTION C-C



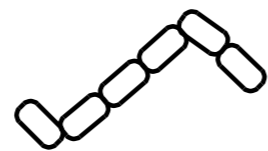
SECTION D-D

BOULDER VANES AND J-HOOK NOTES	
(A)	BOULDER VANES AND BOULDER VANES WITH J-HOOKS ARE HYDRAULIC MEASURES THAT ARE USED ALONG THE OUTSIDE BANKS OF MEANDER BENDS TO DIRECT FLOW AWAY FROM THE STREAM BANK, CONCENTRATE FLOWS INTO THE CENTER OF THE CHANNEL, AND ENHANCE HABITAT. WHEN BOULDER J-HOOKS ARE USED IN COMBINATION WITH BOULDER VANES, THEY ALSO PROVIDE GRADE CONTROL.
(B)	BOULDER VANES AND J-HOOKS SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND CONFIGURATION INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH; MEDIAN BOULDER SIZE; VANE, J-HOOK, AND SILL LENGTHS AND INVERT ELEVATIONS; SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
(C)	REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
(D)	BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
(E)	THE BOULDER J-HOOK SHOULD BE CONSTRUCTED FROM THE END OF THE BOULDER VANE, ACROSS THE REMAINING TWO-THIRDS OF THE BANKFULL CHANNEL, TERMINATING WITH A BOULDER SILL. THE SURFACE BOULDERS IN THE CENTER OF THE J-HOOK ARE SET AT THE INVERT ELEVATION OF THE STRUCTURE.
(F)	A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS IN THE VANE BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
(G)	CONSTRUCT BOULDER VANES AND BOULDER VANES WITH J-HOOKS BY: (1) FIRST SHAPE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS. (2) NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND SELECT MATERIAL FOR BACKFILL AND SUBSTRATE REPLACEMENT. (3) PLACE FOOTER BOULDERS AND SURFACE BOULDERS AT THE CHANNEL INVERT AND THEN USE SURVEY EQUIPMENT TO CHECK THE ELEVATIONS OF THE INVERTS IN ACCORDANCE WITH THE STREAM MITIGATION PLANS. (4) ONCE THE INVERTS HAVE BEEN ESTABLISHED, THE REMAINDER OF THE FOOTER AND SURFACE BOULDERS SHALL BE PLACED, MINIMIZING VOIDS. (5) FILL THE VOIDS BETWEEN BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURE. (6) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE STRUCTURE, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED. (7) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III). (8) ONCE THE STRUCTURE IS INSTALLED, EXCAVATE SCOUR POOL AND PLACE SELECT MATERIAL AS REQUIRED. (9) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
(H)	THE SURFACE OF BOULDER VANES AND J-HOOKS SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE PLANS, THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.
(I)	ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
(J)	BOULDER VANES AND J-HOOKS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER: 209-03.60 STREAM MITIGATION - ROCK VANE PER EACH 209-03.38 STREAM MITIGATION - J-HOOK PER EACH PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE BOULDER VANE AND J-HOOK.

STREAM MITIGATION PLAN LEGEND:



BOULDER VANE



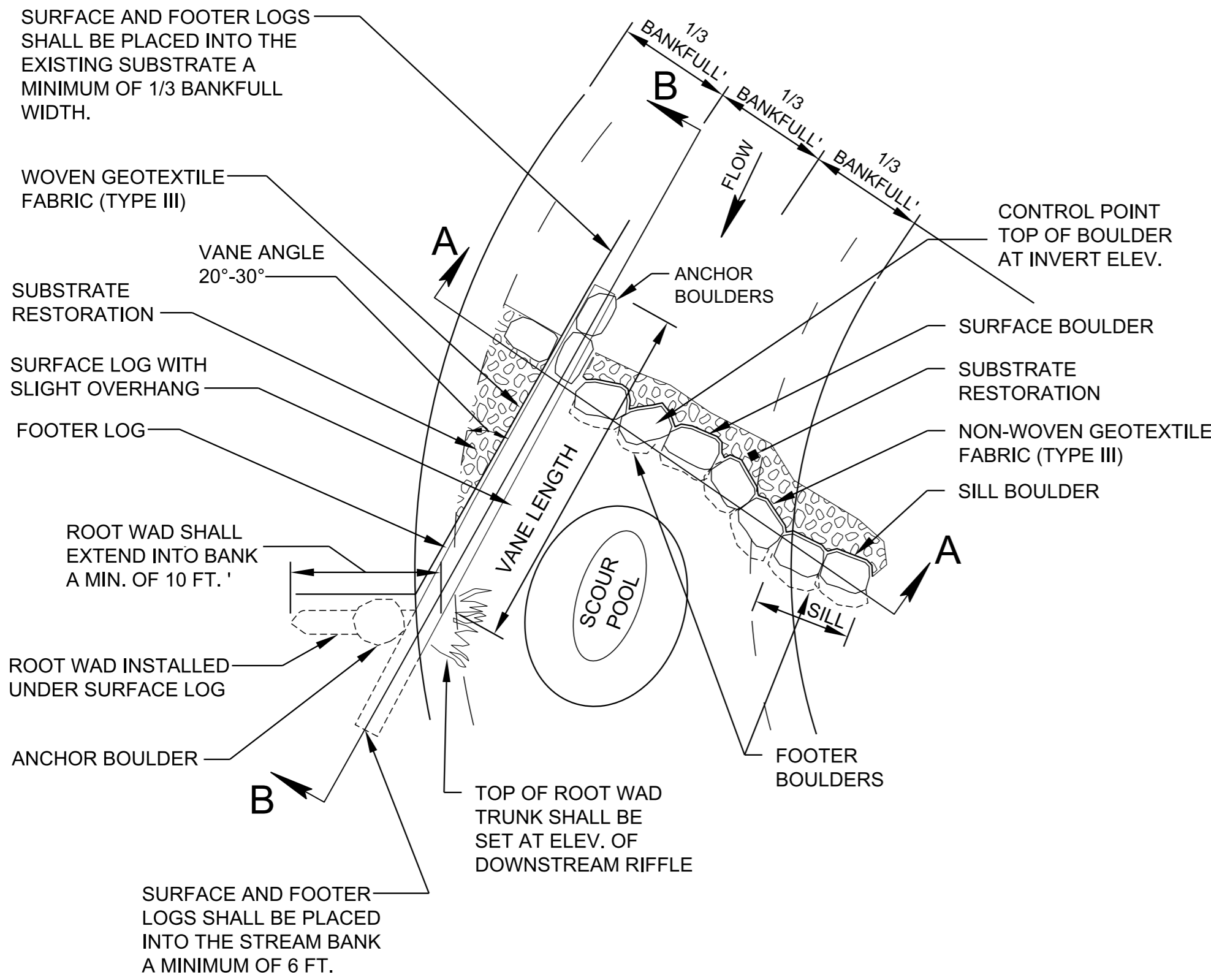
J-HOOK

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

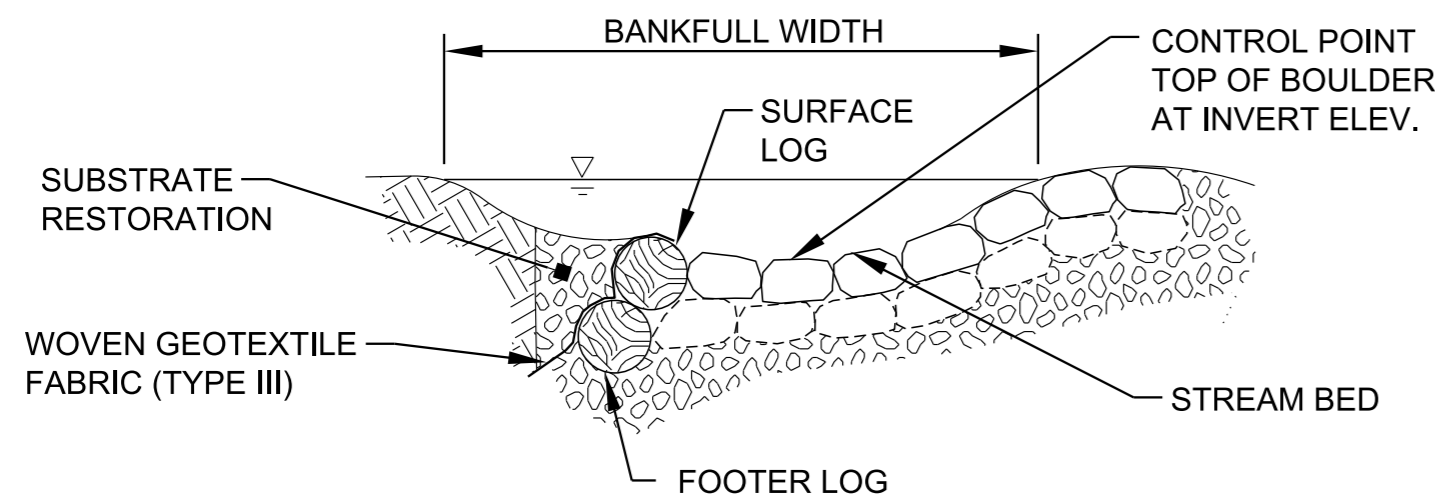
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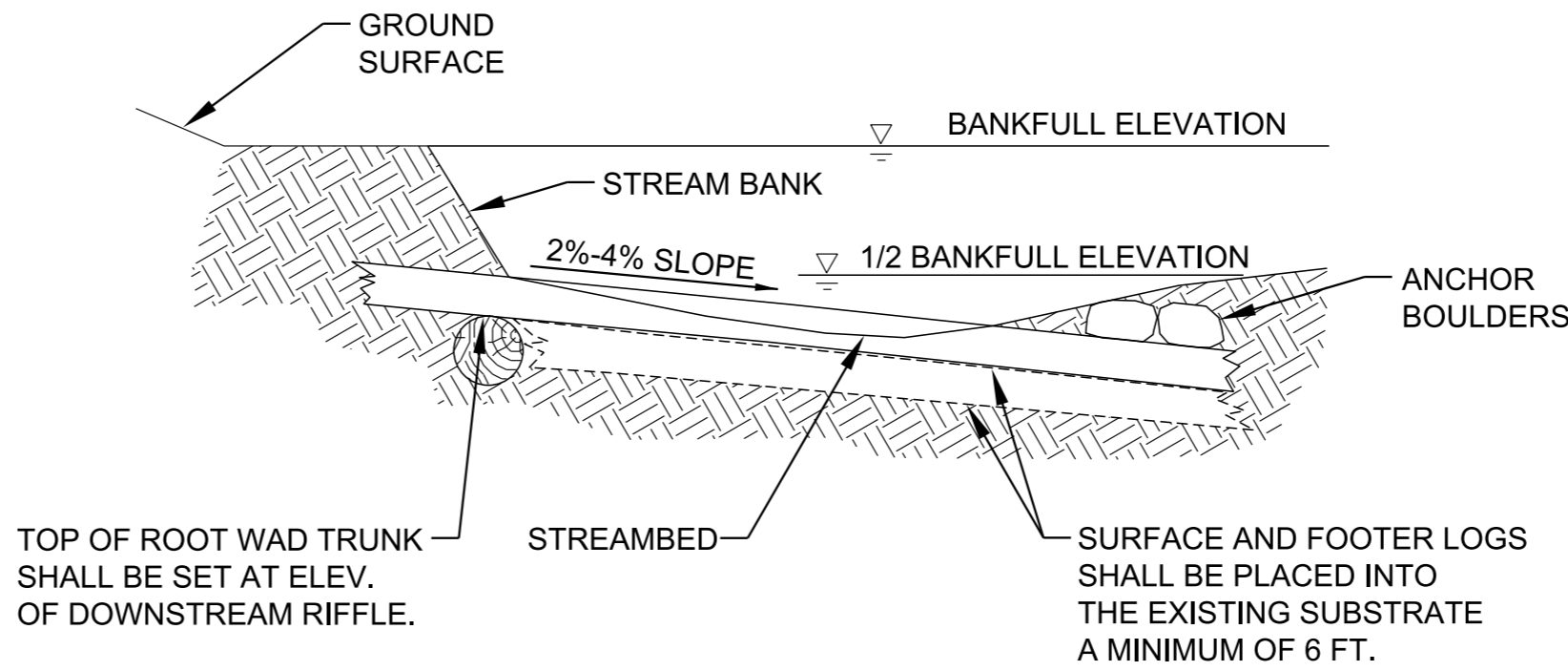
BOULDER VANES
AND J-HOOK



PLAN VIEW



SECTION A-A



SECTION B-B

LOG VANES, ROOT WADS AND BOULDER J-HOOK NOTES

- (A) LOG VANES AND LOG VANES WITH J-HOOKS ARE HYDRAULIC CONTROL MEASURES THAT ARE USED ALONG THE OUTSIDE BANKS OF MEANDER BENDS TO DIRECT FLOW AWAY FROM THE STREAM BANK, CONCENTRATE FLOWS INTO THE CENTER OF THE CHANNEL, AND ENHANCE HABITAT. WHEN BOULDER J-HOOKS ARE USED IN COMBINATION WITH LOG VANES, THEY ALSO PROVIDE GRADE CONTROL. ROOT WADS ARE USED AS A SILL TO PREVENT FLOW DIVERSION AND TO PROVIDE COVER HABITAT FOR FISH AND OTHER AQUATIC ORGANISMS IN THE DOWNSTREAM SCOUR POOL.
- (B) LOG VANES, ROOT WADS, AND J-HOOKS SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND CONFIGURATION INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH; MINIMUM LOG AND BOULDER DIMENSIONS; VANE, J-HOOK, AND SILL LENGTHS AND INVERT ELEVATIONS; SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
- (D) LOGS SHALL BE RELATIVELY STRAIGHT, RECENTLY HARVESTED AND DECAY RESISTANT SPECIES SUCH AS CEDAR, WHITE OAK, ETC.
- (E) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
- (F) THE LOG VANE SHALL EXTEND FROM THE STREAM BOTTOM ELEVATION AT ITS INSERTION INTO THE STREAM BED 1/3 BANKFULL WIDTH TO HALF THE BANKFULL ELEVATION AT ITS INSERTION INTO THE STREAM BANK (6-FOOT MINIMUM). THE SURFACE LOG SHALL BE PLACED ON ONE OR MORE FOOTER LOGS ALONG ITS LENGTH AND A ROOT WAD AT ITS INSERTION INTO THE BANK. ROOT WAD SHALL BE PLACED BENEATH THE SURFACE LOG AND PLACED SO THAT IT LOCKS THE SURFACE LOG INTO THE BANK SURFACE AND FOOTER LOGS AND ROOT WAD SHALL BE TIED SECURELY INTO THE BANK ALONG WITH A CUT-OFF SILL (6-FOOT MINIMUM) TO PREVENT THE POSSIBILITY OF STREAM FLOW DIVERTING AROUND THEM.
- (G) ANCHOR THE UPSTREAM END OF THE LOG VANE WITH BOULDERS PLACED ON TOP OF THE SURFACE LOG AND AT THE CHANNEL INVERT ELEVATION.
- (H) THE BOULDER J-HOOK SHOULD BE CONSTRUCTED FROM THE UPSTREAM END OF THE LOG VANE, ACROSS THE REMAINING TWO-THIRDS OF THE BANKFULL CHANNEL, TERMINATING WITH A BOULDER SILL. THE SURFACE BOULDERS IN THE CENTER OF THE J-HOOK ARE SET AT THE INVERT ELEVATION OF THE STRUCTURE.
- (I) CONSTRUCT LOG VANES, ROOT WADS, AND BOULDER J-HOOK BY:
- (1) FIRST SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
 - (2) NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE LOGS AND/OR BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND ALLUVIUM OR SELECT MATERIAL BACKFILL.
 - (3) PLACE FOOTER LOG OR BOULDERS AT THE CHANNEL INVERT, WITH THE SURFACE LOG OR BOULDERS SLIGHTLY UPSTREAM OF THE FOOTER LOG OR BOULDERS. SURFACE AND FOOTER LOGS SHOULD EXTEND A MINIMUM OF SIX FEET INTO EACH BANK AND THE STREAM BED.
 - (4) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE STRUCTURE, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED. FOR LOGS, NAIL GEOTEXTILE FABRIC (TYPE III) TO THE SURFACE LOG APPROXIMATELY ONE QUARTER OF THE CIRCUMFERENCE DOWN FROM THE TOP OF THE SURFACE LOG USING TWO-INCH GALVANIZED ROOFING NAILS ON ONE-FOOT SPACING ALONG THE ENTIRE LENGTH OF THE LOG.
 - (5) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE, WHILE CREATING A SMALL ALLUVIAL BAR BETWEEN THE LOG VANE AND THE OUTSIDE BANK. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
 - (6) ONCE THE STRUCTURE IS INSTALLED, EXCAVATE THE DOWNSTREAM SCOUR POOL AND PLACE SELECT MATERIAL AS REQUIRED.
 - (7) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS IN THE VANE LOGS AND J-HOOK BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (J) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
- (K) THE SURFACE OF LOG VANES, ROOT WADS, AND J-HOOKS SHALL BE FINISHED TO A NEAT AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE PLANS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.
- (L) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (M) LOG VANES, ROOT WADS AND BOULDER J-HOOK SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- | | |
|-----------|---|
| 209-03.34 | STREAM MITIGATION - LOG VANES PER LINEAR FOOT |
| 209-03.38 | STREAM MITIGATION - J-HOOK PER EACH |
| 209-03.62 | STREAM MITIGATION - ROOT WAD PER EACH |
- PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR TO CONSTRUCT THE LOG VANES, ROOT WADS AND BOULDER J-HOOK.

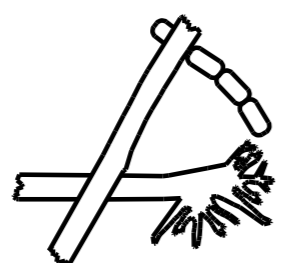
MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

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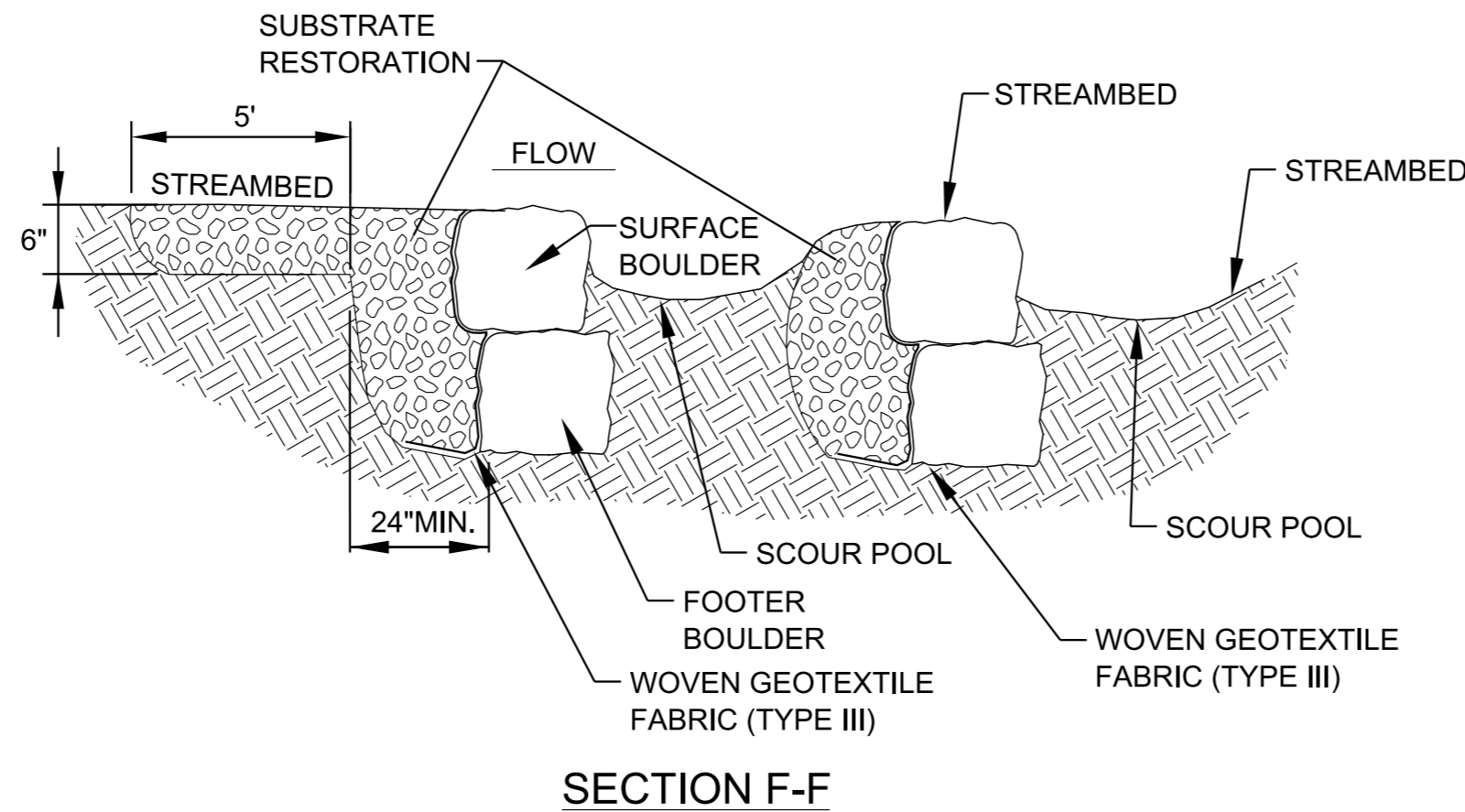
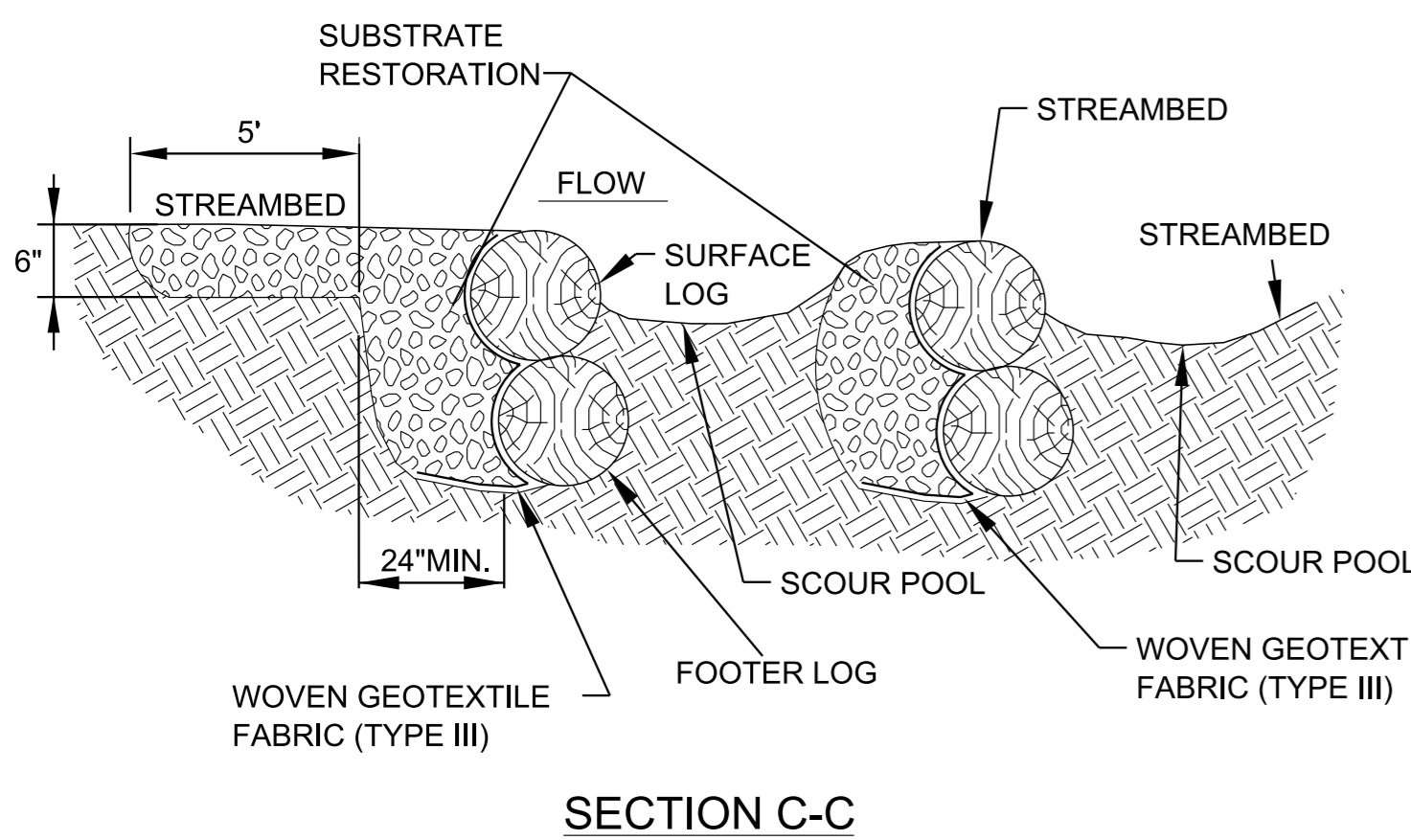
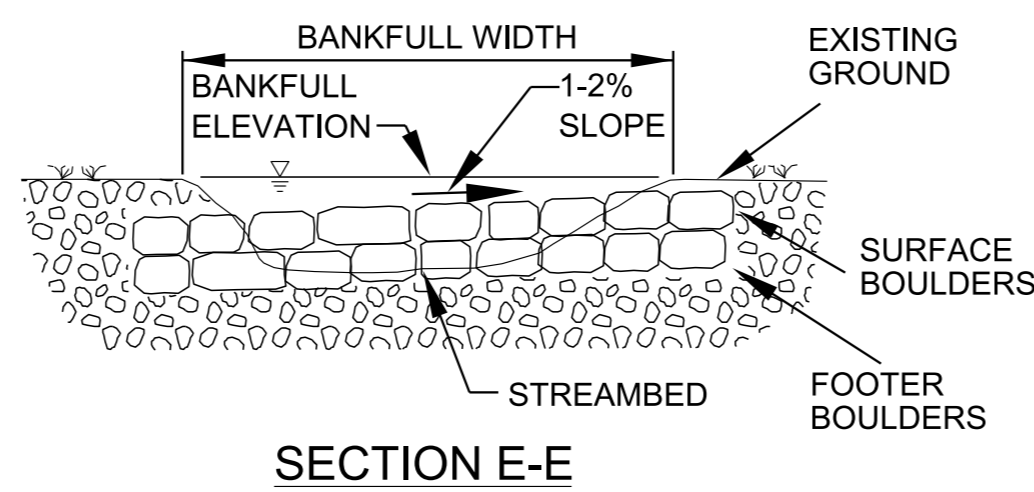
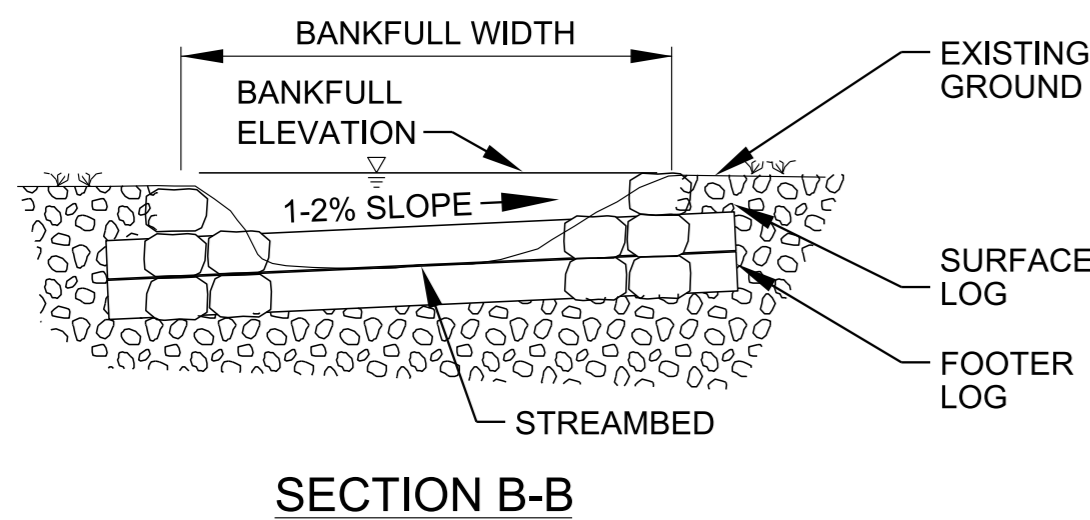
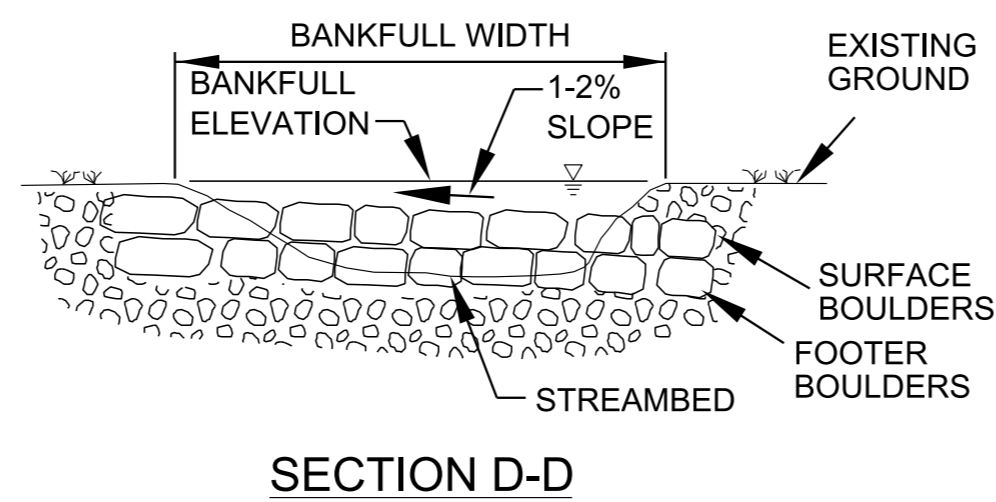
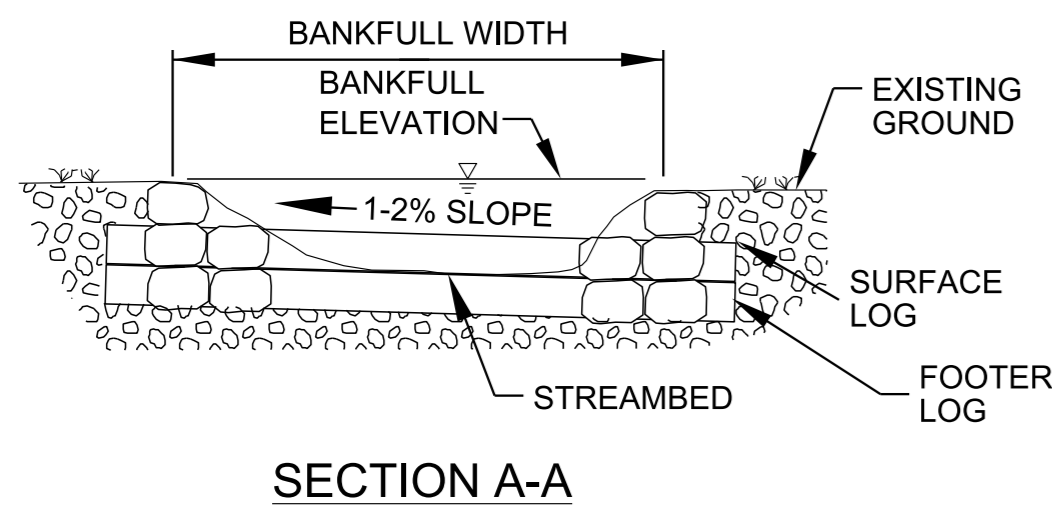
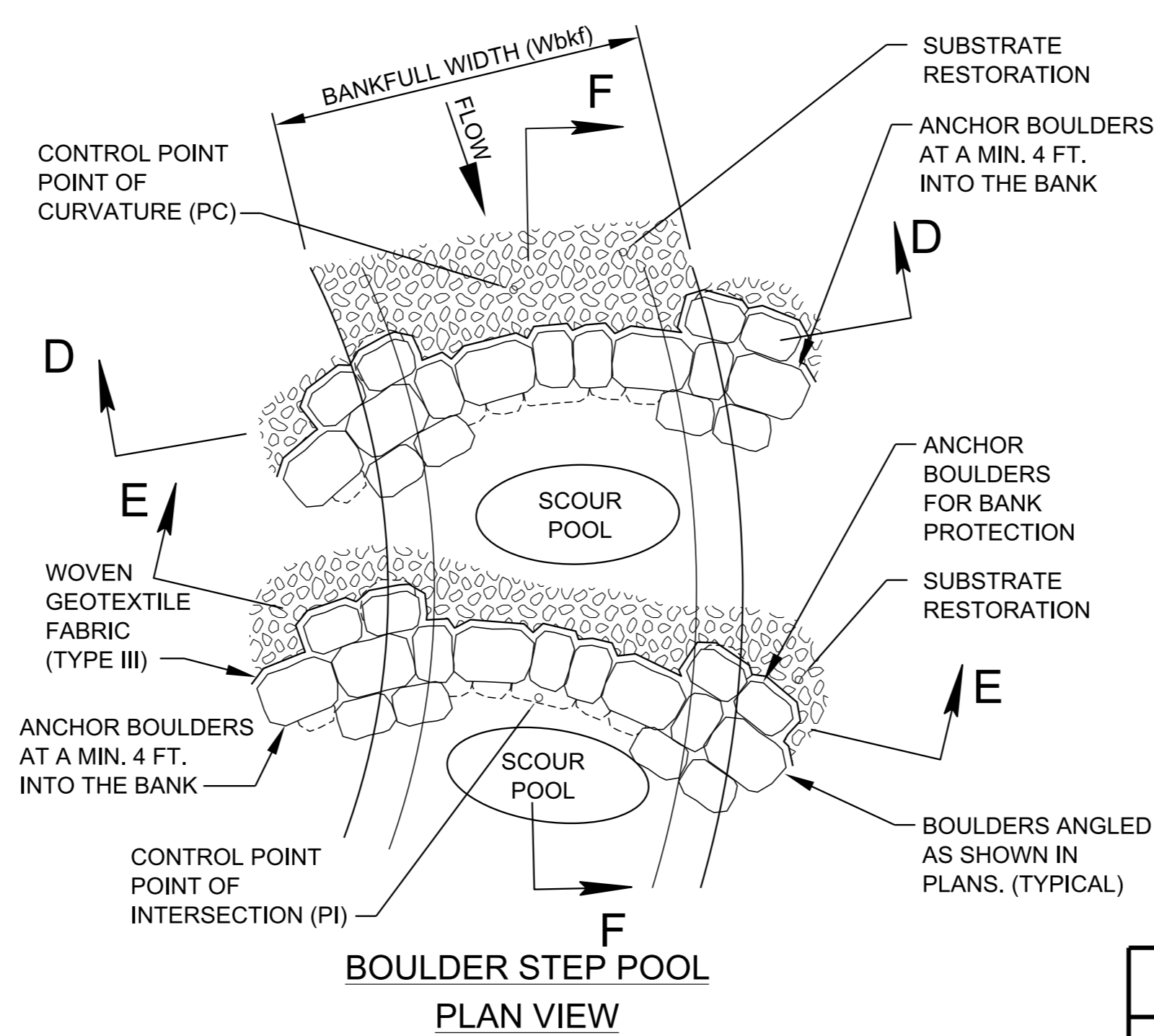
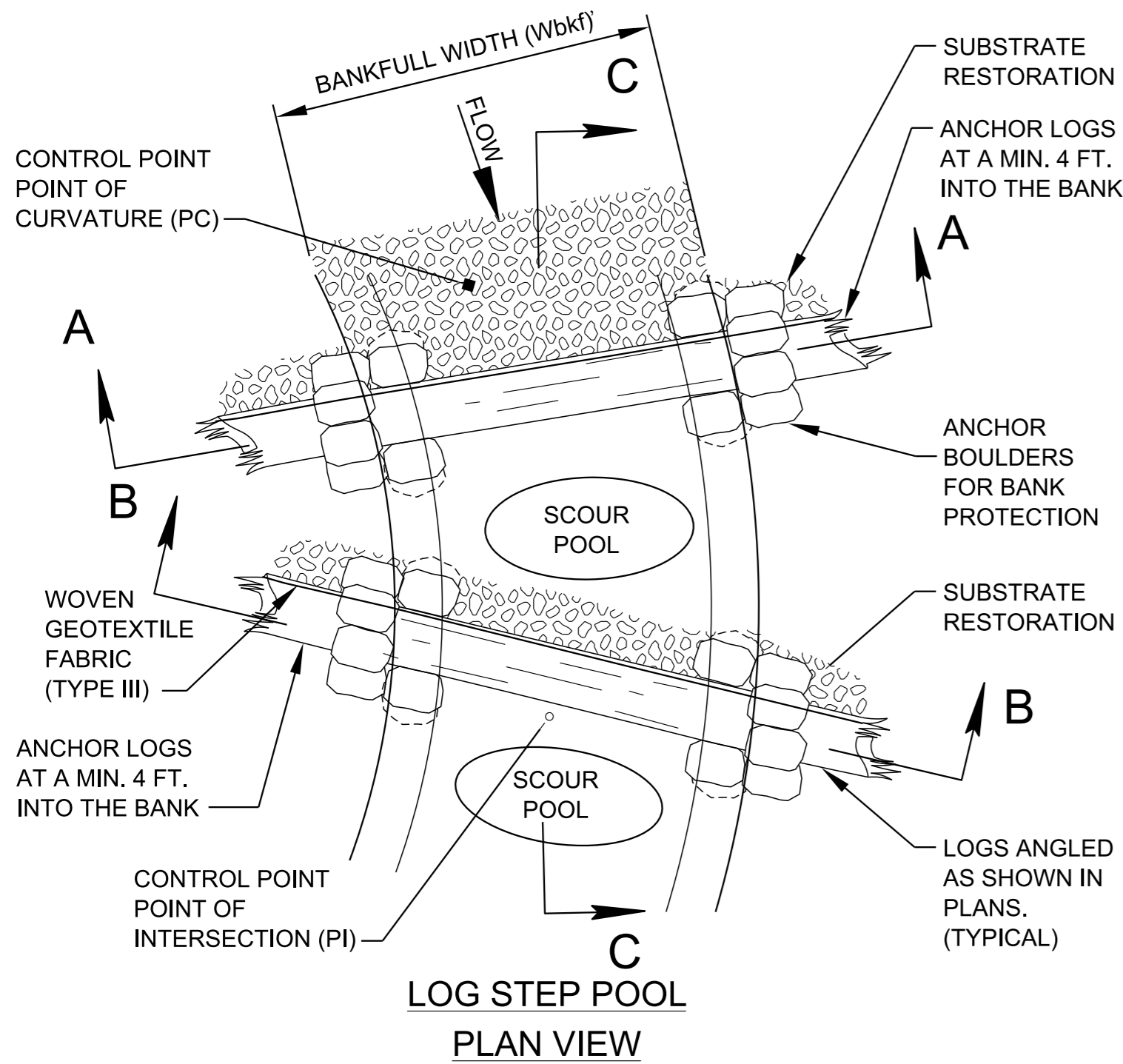
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LOG VANES,
ROOT WADS,
AND BOULDER
J-HOOK

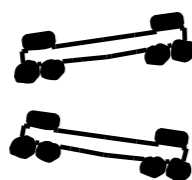
STREAM MITIGATION PLAN LEGEND:



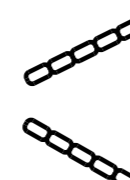
LOG VANES, ROOT WADS AND
BOULDER J-HOOK



STREAM MITIGATION PLAN LEGEND:



LOG STEP POOLS



BOULDER STEP POOLS

*BOULDER SHOWN ARE A GRAPHICAL REPRESENTATION AND DOES NOT REPRESENT ACTUAL # OF BOULDERS TO BE USED.

LOG AND BOULDER STEP POOLS NOTES

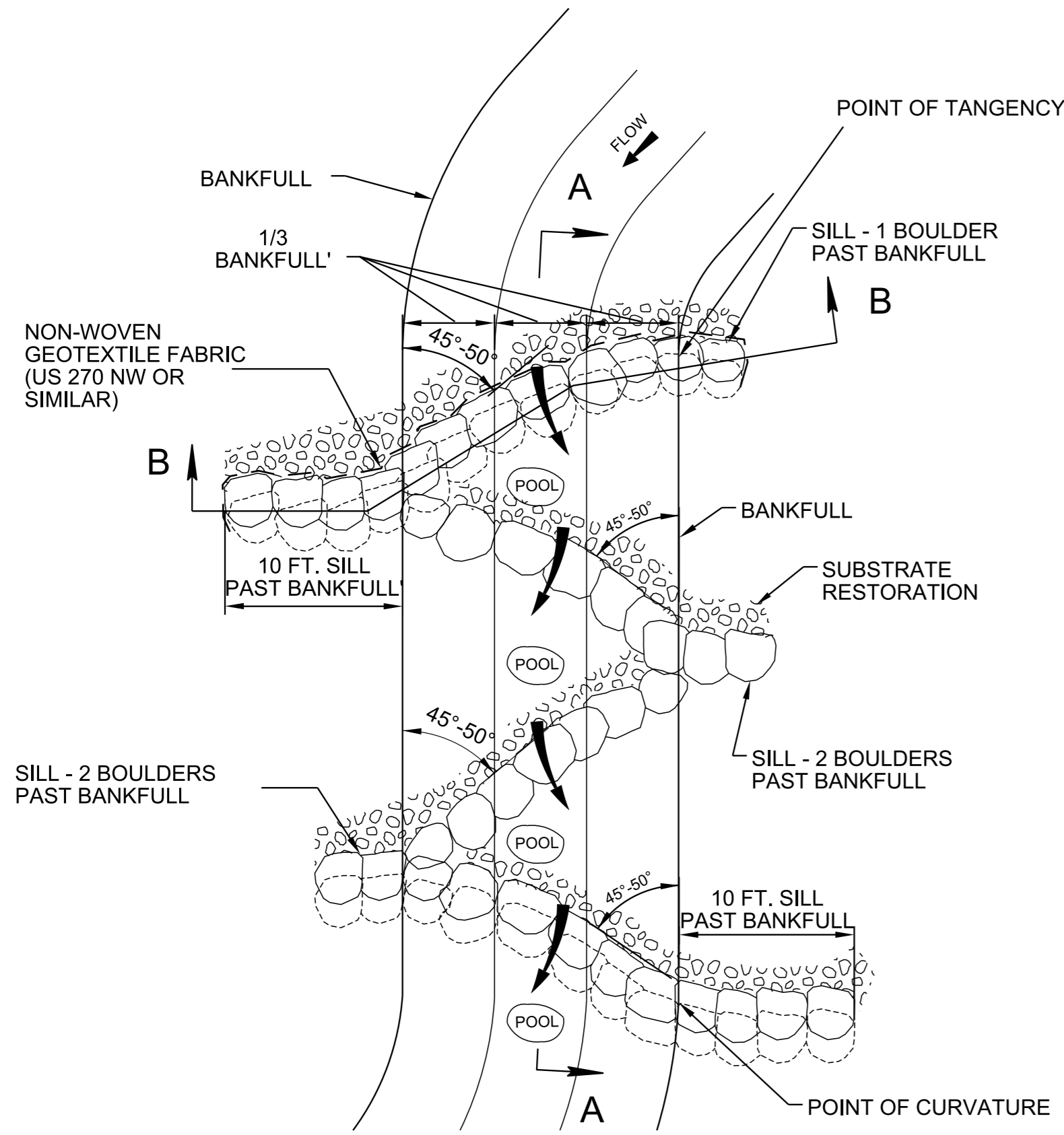
- (A) LOG AND BOULDER STEP POOLS ARE HYDRAULIC AND GRADE CONTROL MEASURES THAT ARE USED TO MAINTAIN GRADE, CONTROL FLOW VELOCITY, DISSIPATE ENERGY, AND DEVELOP RIFFLE-RUN-STEP POOL HABITAT IN STREAMS WITH SLOPES GREATER THAN 2%. THIS DETAIL CAN BE USED FOR CONSTRUCTING A SINGLE LOG OR BOULDER STEP POOL OR A SERIES OF MULTIPLE STEP POOLS.
- (B) LOG AND BOULDER STEP POOL STRUCTURES AND ASSOCIATED POOL HABITAT ENHANCEMENTS AND BANK STABILIZATION MEASURES (ROOT WADS, BRUSH LAYERING, LIVE STAKING, ETC.) SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND GEOMORPHIC POSITIONS INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH, MINIMUM LOG AND BOULDER DIMENSIONS, INVERT ELEVATIONS, ESTIMATED SCOUR DEPTH AND SELECT MATERIAL CLASSIFICATION SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
- (D) LOGS SHALL BE RELATIVELY STRAIGHT, RECENTLY HARVESTED AND DECAY RESISTANT SPECIES SUCH AS CEDAR, WHITE OAK, ETC.
- (E) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
- (F) LOCATE LOG OR BOULDER STEP STRUCTURES IN THE CHANNEL AT THE POINTS OF CURVATURE AND TANGENCY IN MEANDER BENDS, AND ALIGN THE STRUCTURE ALONG THE AXIS OF THE RADIUS.
- (G) CONSTRUCT STEP STRUCTURES WITH A MAXIMUM DROP OF A HALF FOOT (SIX INCHES) AND A SLOPE BETWEEN ONE PERCENT (1%) AND FOUR PERCENT (4%).
- (H) CONSTRUCT LOG OR BOULDER STEPS STRUCTURES BY:
- FIRST SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
 - NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE LOGS AND/OR BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND ALLUVIUM OR SELECT MATERIAL BACKFILL.
 - PLACE FOOTER LOG OR BOULDERS AND SURFACE BOULDERS AT THE CHANNEL INVERT, WITH THE SURFACE LOG OR BOULDERS SLIGHTLY UPSTREAM OF THE FOOTER LOG OR BOULDERS. SURFACE AND FOOTER LOGS SHOULD EXTEND A MINIMUM OF FOUR FEET INTO EACH BANK AND LOG STEPS SHOULD BE PINCHED OR ANCHORED INTO THE BANKS WITH BOULDERS.
 - THE FOLLOWING GUIDELINES APPLY WHEN INSTALLING MULTIPLE STEP POOL STRUCTURES IN SEQUENCE:
 - THE INVERT ELEVATION OF THE DOWNSTREAM STEP SHALL BE AT OR ABOVE THE TOP OF THE FOOTER FOR THE UPSTREAM STRUCTURE.
 - ALTERNATE INVERTS OF THE STRUCTURES FROM SIDE TO SIDE IN THE CHANNEL TO CREATE A MEANDERING FLOW PATH ACROSS THE STRUCTURES.
 - USE SURVEY EQUIPMENT TO CHECK THE ELEVATIONS OF THE INVERTS IN ACCORDANCE WITH THE STREAM MITIGATION PLANS.
 - ONCE THE INVERTS HAVE BEEN ESTABLISHED, FILL THE VOIDS BETWEEN LOGS OR BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURE.
 - PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE STRUCTURE, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED. FOR LOGS, NAIL GEOTEXTILE FABRIC (TYPE III) TO THE SURFACE LOG APPROXIMATELY ONE QUARTER OF THE CIRCUMFERENCE DOWN FROM THE TOP OF THE SURFACE LOG USING TWO-INCH GALVANIZED ROOFING NAILS ON ONE-FOOT SPACING ALONG THE ENTIRE LENGTH OF THE LOG.
 - BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
 - ONCE THE STRUCTURE IS INSTALLED, EXCAVATE THE DOWNSTREAM SCOUR POOL AND PLACE SELECT MATERIAL AS REQUIRED.
 - RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
- (I) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS IN THE VANE BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (J) THE SURFACE OF LOG AND BOULDER STEP POOL SHALL BE FINISHED TO A NEAT AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE PLANS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.
- (K) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (L) LOG AND BOULDER STEP POOLS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- 209-03.36 STREAM MITIGATION - STEP POOL PER EACH
- PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR TO CONSTRUCT LOG AND BOULDER STEP POOLS.

MATERIAL SHOWN ARE ONLY A GRAPHICAL
REPRESENTATION AND DO NOT DEPICT
THE ACTUAL DEPTH OR QUANTITY OF
MATERIALS TO APPROPRIATELY
CONSTRUCT OR STABILIZE THE CHANNEL.

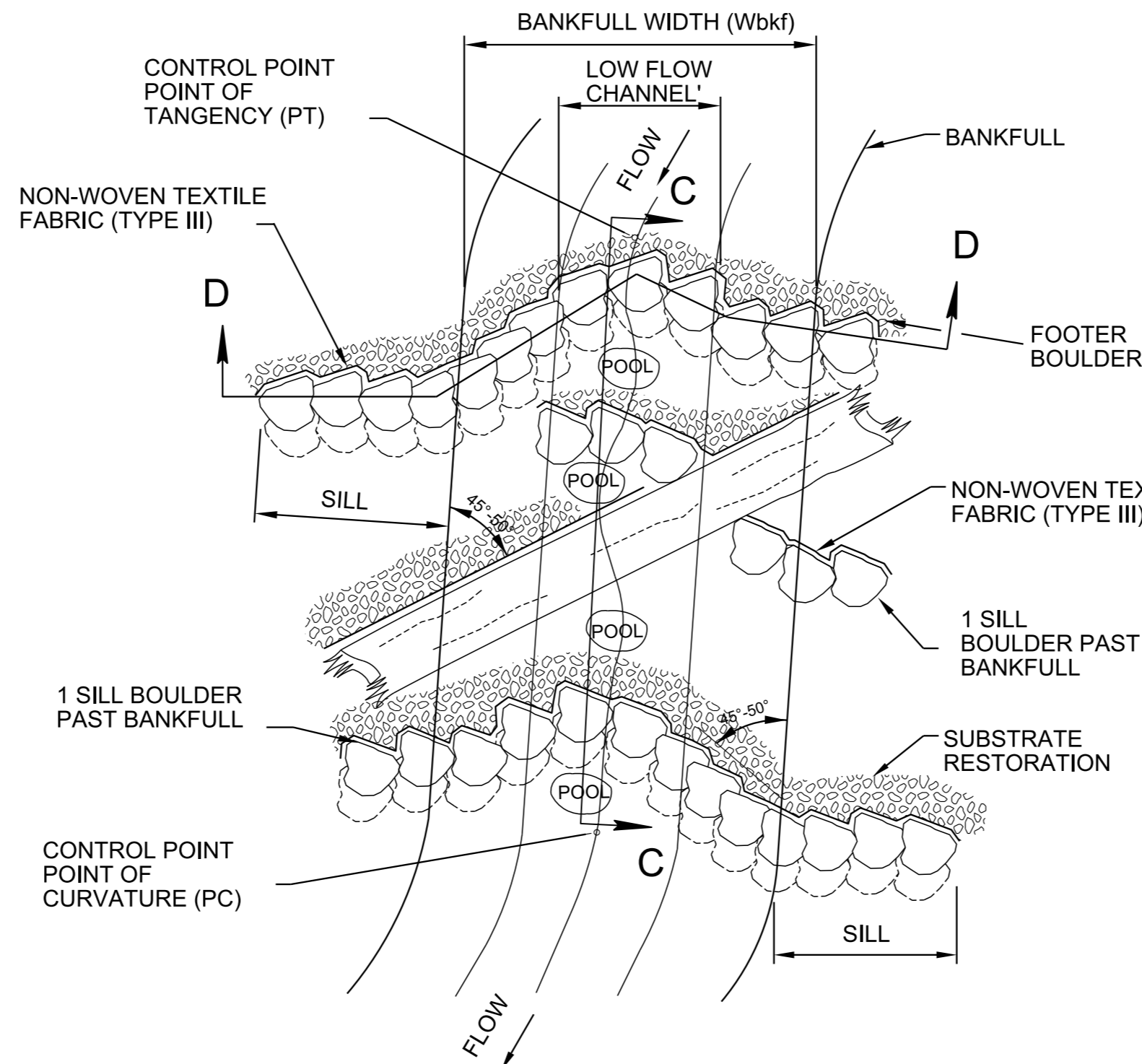
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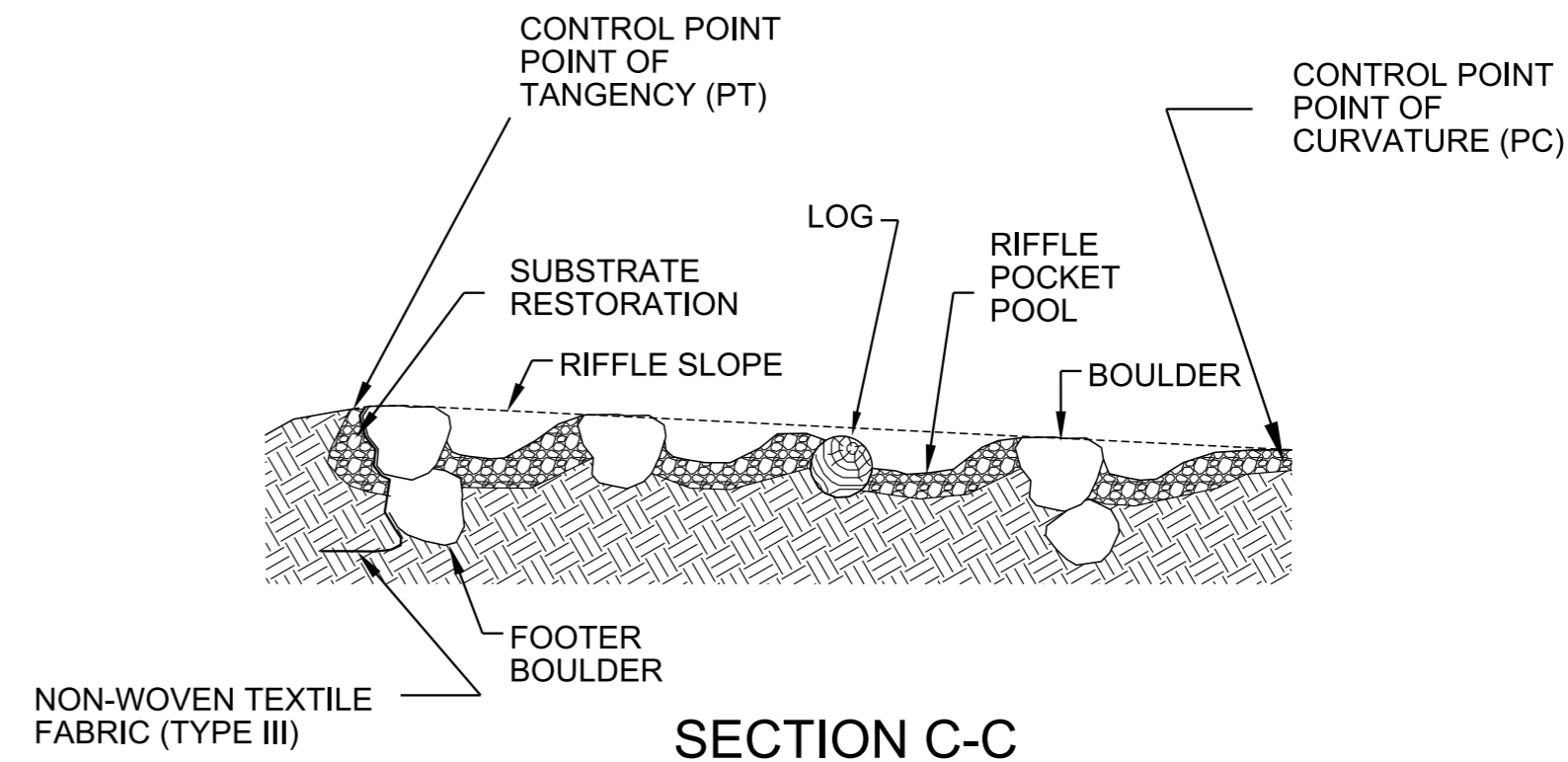
LOG AND
BOULDER
STEP POOLS



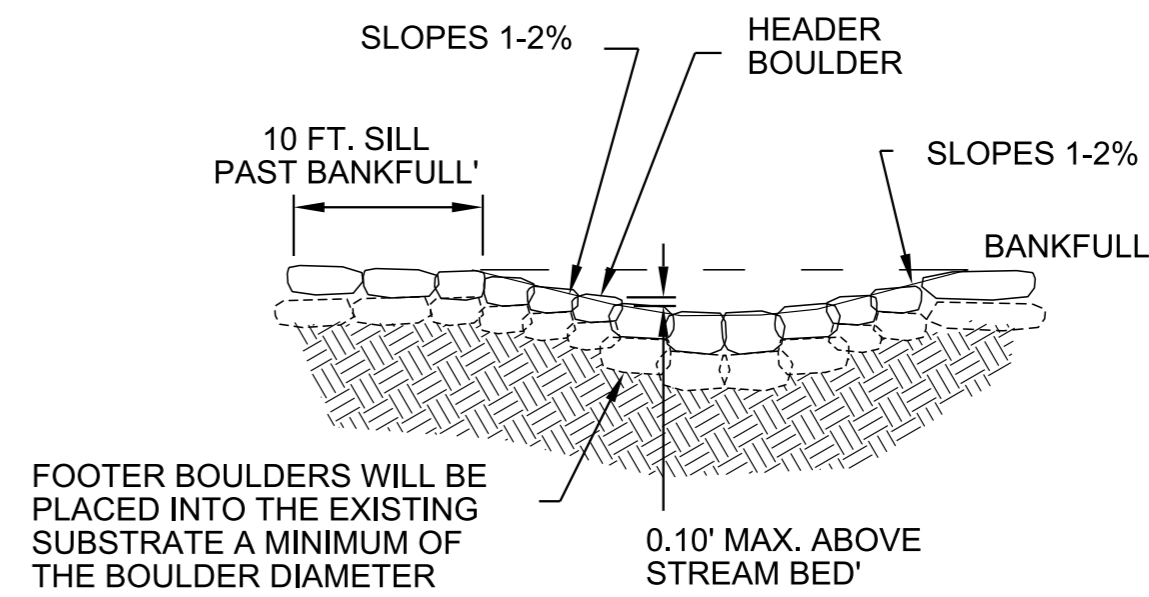
BOULDER RIFFLE
PLAN VIEW



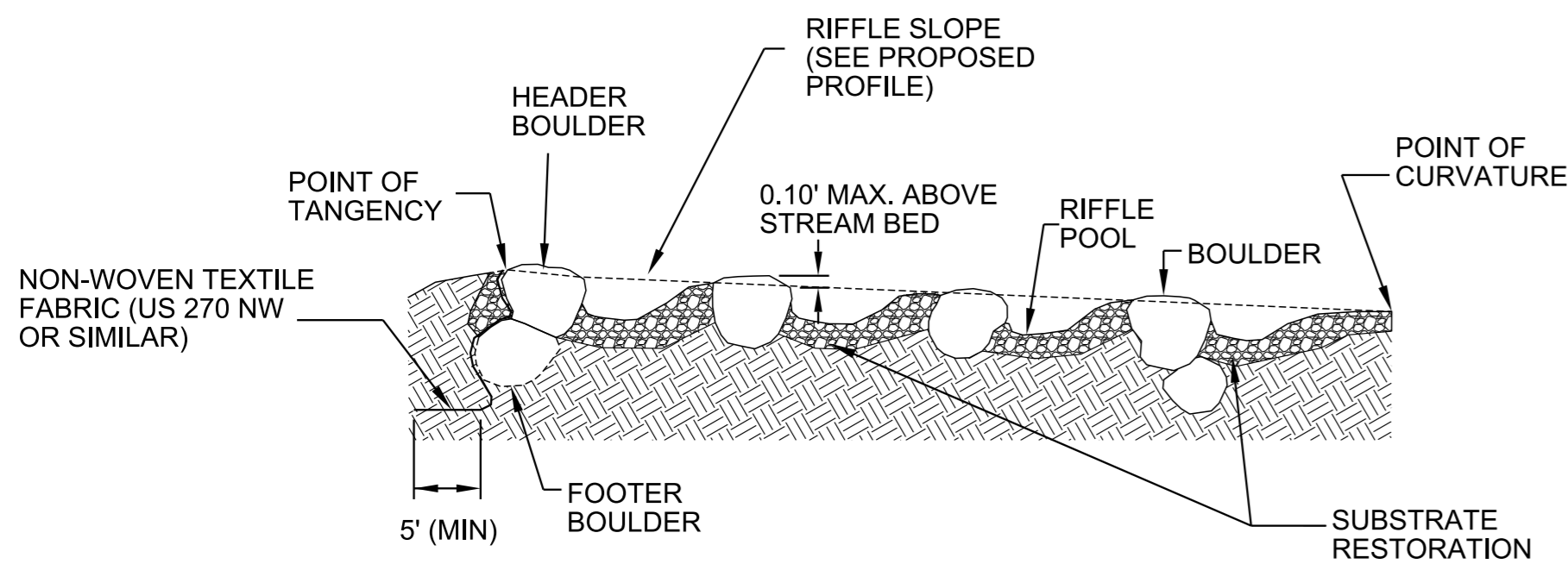
ALTERNATIVE BOULDER AND LOG RIFFLE
PLAN VIEW



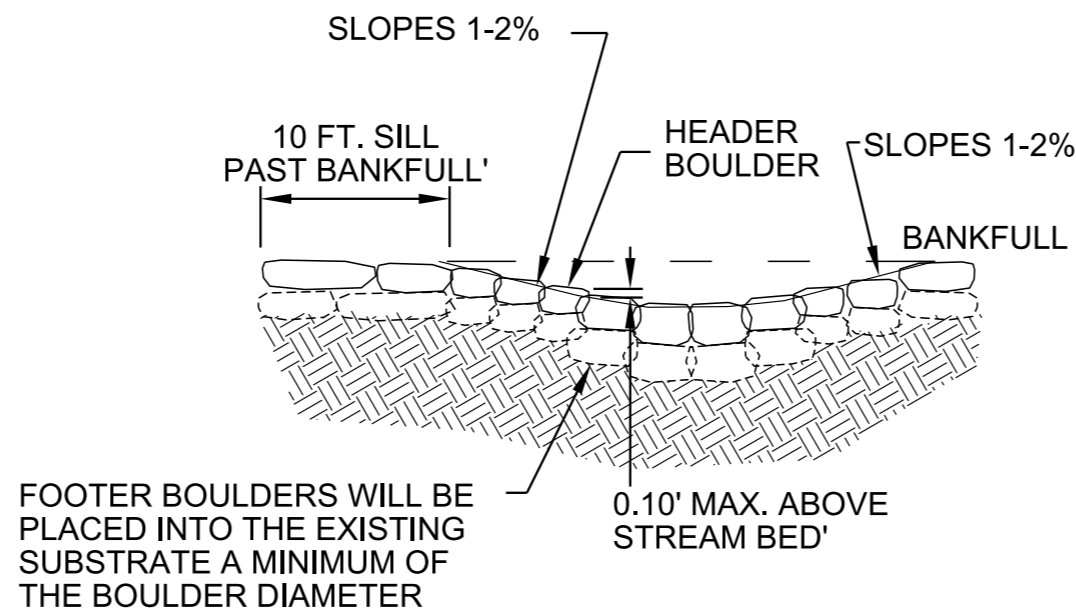
SECTION C-C



SECTION D-D



SECTION A-A

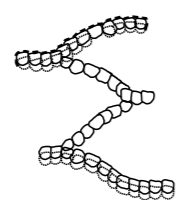


SECTION B-B

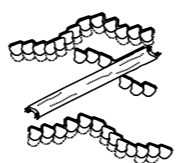
BOULDER RIFFLES NOTES

- (A) CONSTRUCT BOULDER AND LOG-BOULDER RIFFLE STRUCTURES BY:
- (1) SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
 - (2) EXCAVATE ENOUGH BED MATERIAL TO PLACE THE BOULDER MINI-VANES, RIFFLE LOGS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND ALLUVIUM OR SELECT MATERIAL BACKFILL.
 - (3) FOR THE UPSTREAM BOULDER MINI-VANE, PLACE FOOTER AND SURFACE BOULDERS, THE DOWNSTREAM MINI-VANES AND RIFFLE LOGS ARE INSTALLED WITHOUT FOOTERS. INSTALL VANES AND LOGS AT THE INVERTS SPECIFIED IN THE PLANS AND THEN CHECK THE ELEVATIONS OF THE INVERTS WITH SURVEY EQUIPMENT. PLACE BOULDERS TO MINIMIZE VOIDS AND TO PRODUCE A SMOOTH COMPACT SURFACE. ONCE THE INVERTS HAVE BEEN ESTABLISHED, FILL THE VOIDS BETWEEN BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURES.
 - (4) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF EACH MINI-VANE OR RIFFLE LOG. THE GEOTEXTILE SHALL EXTEND FROM THE BOTTOM OF THE FOOTER (WHERE PRESENT) TO THE FINISHED GRADE ELEVATION OF THE SURFACE BOULDERS OR LOG. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED. FOR RIFFLE LOGS, NAIL GEOTEXTILE FABRIC (TYPE III) TO THE SURFACE LOG APPROXIMATELY ONE QUARTER OF THE CIRCUMFERENCE DOWN FROM THE TOP OF THE SURFACE LOG USING TWO-INCH GALVANIZED ROOFING NAILS ON ONE-FOOT SPACING ALONG THE ENTIRE LENGTH OF THE LOG.
 - (5) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE). OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
- (B) BOULDER RIFFLES SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- 209-03.41 STREAM MITIGATION - BOULDER RIFFLE PER LINEAR FOOT
- PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR TO CONSTRUCT THE LOG RIFFLE, BOULDER RIFFLE, OR LOG AND BOULDER RIFFLES.
- (C) FOR LOG RIFFLES DETAILS, SEE D-NSD-28A.

STREAM MITIGATION PLAN LEGEND:



BOULDER RIFFLE



BOULDER AND LOG RIFFLE

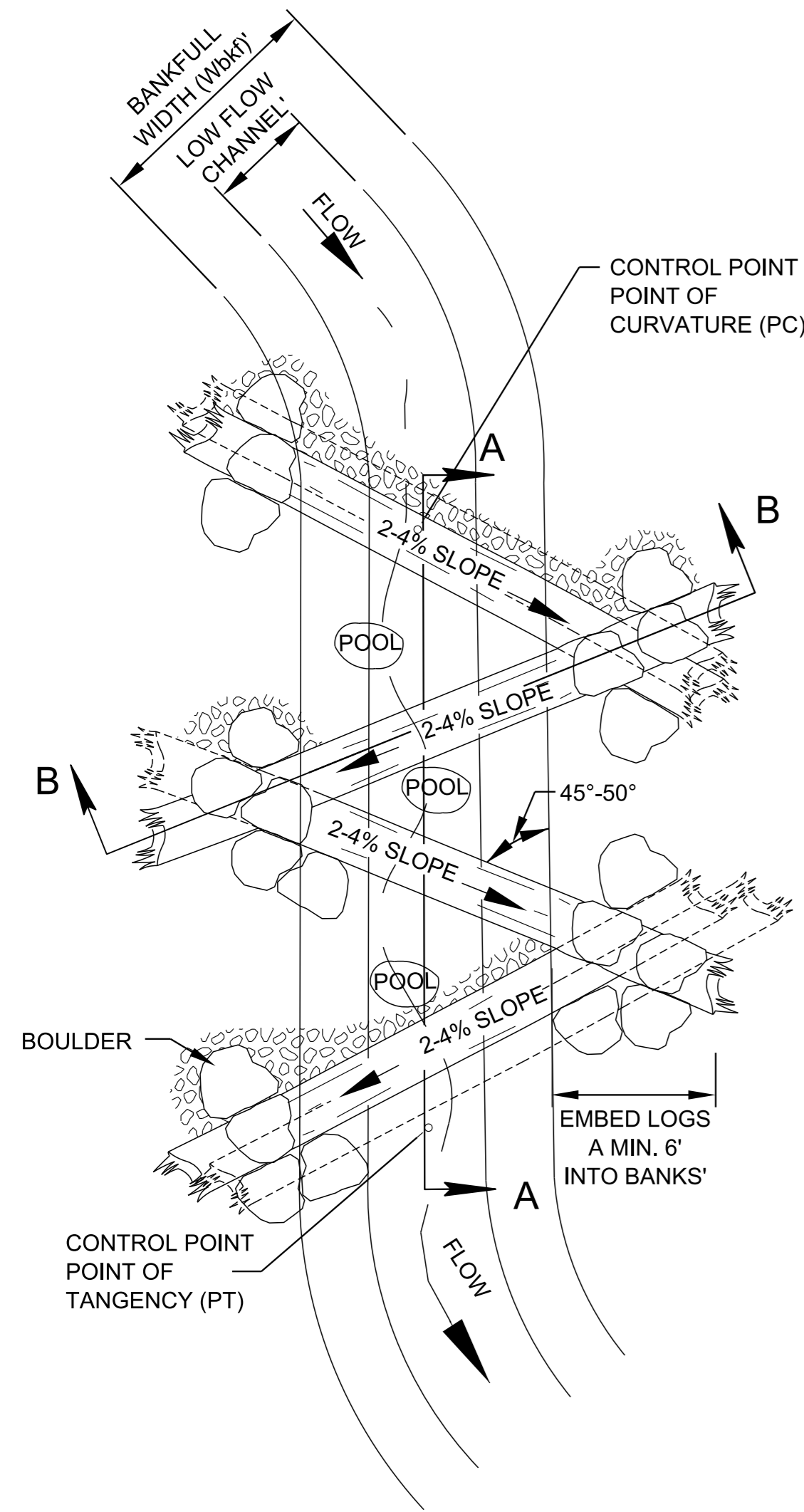
*BOULDER SHOWN ARE A GRAPHICAL REPRESENTATION AND DOES NOT REPRESENT ACTUAL # OF BOULDERS TO BE USED.

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

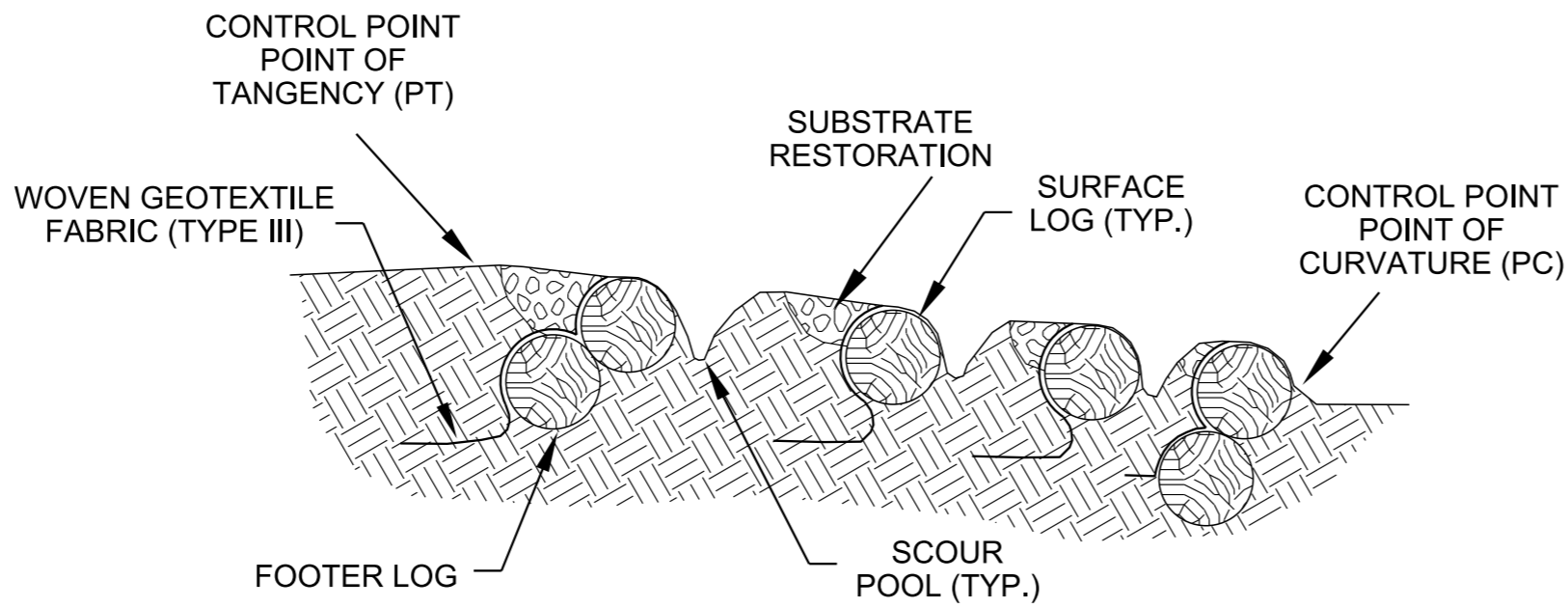
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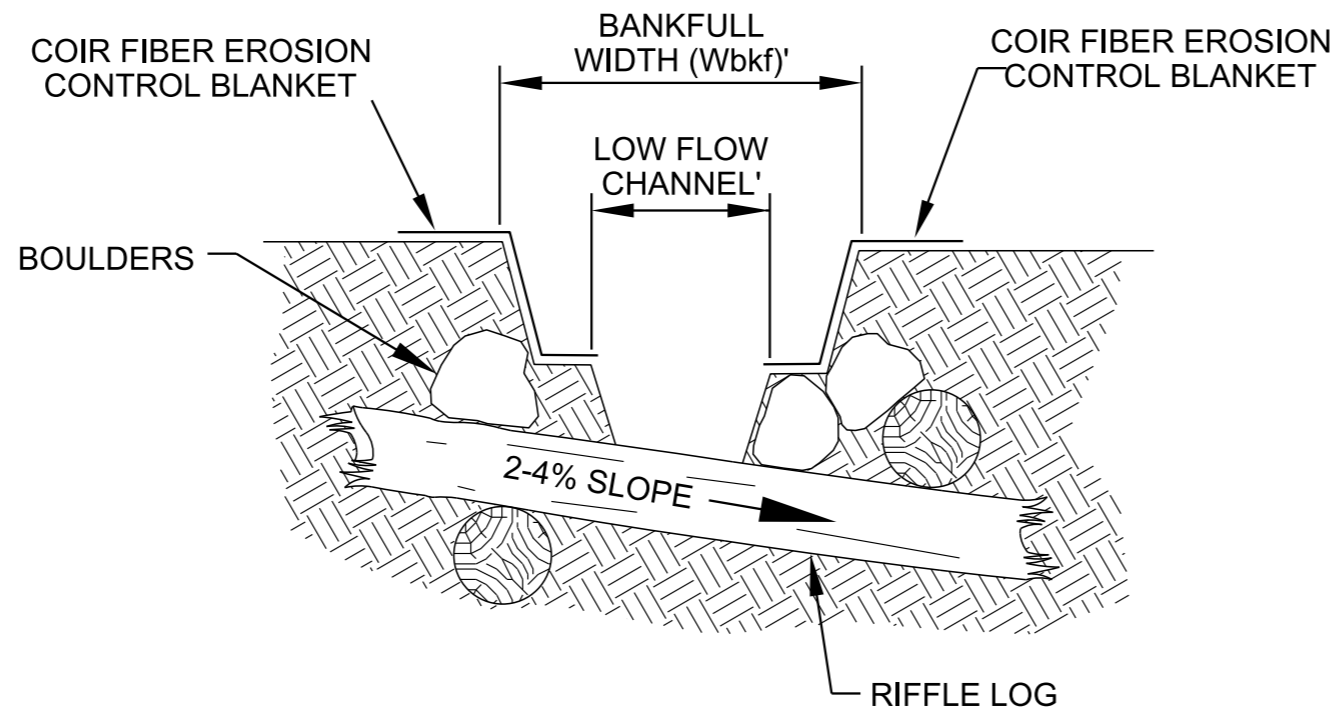
BOULDER
RIFFLES



LOG RIFFLE
PLAN VIEW



SECTION A-A



SECTION B-B

LOG RIFFLES NOTES

- (A) LOG AND BOULDER RIFFLES ARE GRADE CONTROL AND HABITAT ENHANCEMENT MEASURES THAT ARE USED TO MAINTAIN GRADE OF UPSTREAM POOLS, OXYGENATE WATER, AND PROVIDE HABITAT FOR EPIFAUNA AND FISH. THESE STRUCTURES ARE TYPICALLY USED IN LOWER GRADIENT STREAMS WITH SLOPES LESS THAN 3%. THIS DETAIL CAN BE USED FOR CONSTRUCTING RIFFLES USING BOULDERS, LOGS, OR A COMBINATION OF BOULDERS AND LOGS.
- (B) LOG AND BOULDER RIFFLES SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND GEOMORPHIC POSITIONS INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH, MINIMUM LOG AND/OR BOULDER DIMENSIONS, INVERT ELEVATIONS, AND SELECT MATERIAL CLASSIFICATION SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
- (D) LOGS SHALL BE RELATIVELY STRAIGHT, RECENTLY HARVESTED AND DECAY RESISTANT SPECIES SUCH AS CEDAR, WHITE OAK, ETC.
- (E) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
- (F) LOCATE LOG OR BOULDER RIFFLE STRUCTURES (RIFFLE LOGS AND BOULDER MINI-VANES) AT EQUALLY SPACED INTERVALS IN THE STRAIGHT SECTIONS OF THE CHANNEL BETWEEN MEANDER BENDS (I.E., BETWEEN UPSTREAM POINT OF TANGENCY AND DOWNSTREAM POINT OF CURVATURE), AS INDICATED ON THE STREAM MITIGATION PLANS.
- (G) THE MAXIMUM AMOUNT OF DROP IN INVERT FROM ONE RIFFLE LOG OR BOULDER MINI-VANE TO THE NEXT SHALL BE NO GREATER THAN 0.10 FOOT. THE COMBINED AMOUNT OF DROP OVER ALL THE MINI-VANES SHALL NOT EXCEED THE TOTAL AMOUNT OF FALL IN THE RIFFLE SLOPE. THE INVERT IN RIFFLE LOGS AND MINI-VANES SHALL ALTERNATE LEFT AND RIGHT OF CENTERLINE TO PRODUCE A MEANDERING FLOW PATTERN IN THE RIFFLE.
- (H) CONSTRUCT LOG RIFFLE STRUCTURES BY:
- (1) SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
 - (2) LOG RIFFLE STRUCTURES ARE BUILT STARTING WITH THE DOWNSTREAM LOG AND PROCEEDING UPSTREAM. LOGS ARE SLOPED DOWN TWO PERCENT (2%) TO FOUR PERCENT (4%) AT THEIR UPSTREAM END.
 - (3) RIFFLE LOGS SHALL OVERLAP IN THE STREAM BANK, WITH THE DOWNSTREAM END OF THE UPSTREAM LOG PLACED ON TOP OF THE UPSTREAM END OF THE DOWNSTREAM LOG, THEREBY HELPING TO ANCHOR THE DOWNSTREAM LOG. ADDITIONALLY, THE RIFFLE LOGS ARE ANCHORED WITHIN THE BANKS BY PINCHING BOTH SIDES OF THE LOG WITH BOULDERS.
 - (4) EXCAVATE ENOUGH BED AND BANK MATERIAL TO PLACE THE RIFFLE LOGS, ANCHOR BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III), AND ALLUVIUM OR SELECT MATERIAL BACKFILL. SURFACE AND FOOTER LOGS SHOULD EXTEND A MINIMUM OF SIX FEET INTO EACH BANK.
 - (5) THE UPSTREAM RIFFLE LOG IS BUILT WITH A LOG FOOTER. THE DOWNSTREAM RIFFLE LOGS ARE INSTALLED WITHOUT FOOTERS.
 - (6) LOG RIFFLES SHALL ALL BE DESIGNED TO BE SUBMERGED OR COVERED AT LOW FLOWS TO REDUCE THE RATE OF WOOD DECOMPOSITION. INSTALL LOGS AT THE INVERTS SPECIFIED IN THE PLANS AND THEN CHECK THE ELEVATIONS OF THE INVERTS WITH SURVEY EQUIPMENT. PLACE THE FOOTER AND SURFACE LOGS AT THE UPSTREAM END OF THE RIFFLE TO MINIMIZE VOIDS AND TO PRODUCE A SMOOTH COMPACT SURFACE.
 - (7) ONCE THE INVERTS HAVE BEEN ESTABLISHED, FILL THE VOIDS BETWEEN THE UPSTREAM FOOTER AND SURFACE LOG ON THE UPSTREAM SIDE WITH COARSE ALLUVIUM OR SPECIFIED SELECT MATERIAL.
 - (8) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF EACH RIFFLE LOG. THE GEOTEXTILE SHALL EXTEND FROM THE BOTTOM OF THE FOOTER (WHERE PRESENT) TO THE FINISHED GRADE ELEVATION OF THE SURFACE LOG. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED. NAIL GEOTEXTILE FABRIC (TYPE III) TO THE SURFACE LOG APPROXIMATELY ONE QUARTER OF THE CIRCUMFERENCE DOWN FROM THE TOP OF THE SURFACE LOG USING TWO-INCH GALVANIZED ROOFING NAILS ON ONE-FOOT SPACING ALONG THE ENTIRE LENGTH OF THE LOG.
 - (9) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
- (I) THE SURFACE OF LOG AND BOULDER RIFFLES SHALL BE FINISHED TO A NEAT AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE PLANS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS BETWEEN FOOTER AND SURFACE BOULDERS AND LOGS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.
- (J) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
- (K) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS BETWEEN LOGS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (L) COIR FIBER EROSION CONTROL BLANKET SHALL BE INSTALLED ABOVE THE INNER-BERM STAGE AND NOT IN THE LOW-FLOW CHANNEL OF THE RIFFLE. SEE TYPICAL CROSS-SECTION DATA IN STREAM MITIGATION PLANS FOR INNER BERM INFORMATION.
- (M) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (N) LOG RIFFLES SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- 209-03.40 STREAM MITIGATION - LOG RIFFLE PER LINEAR FOOT
- PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR TO CONSTRUCT THE LOG RIFFLE, BOULDER RIFFLE, OR LOG AND BOULDER RIFFLES.
- (O) FOR BOULDER RIFFER DETAIL, SEE N-NSD-26.

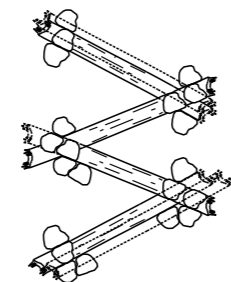
MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

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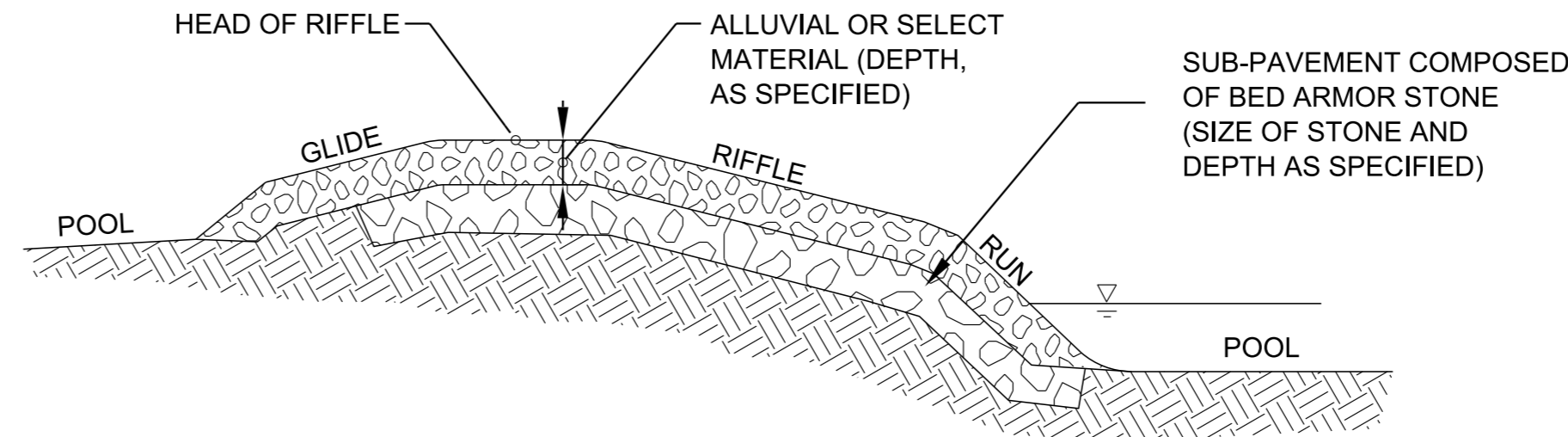
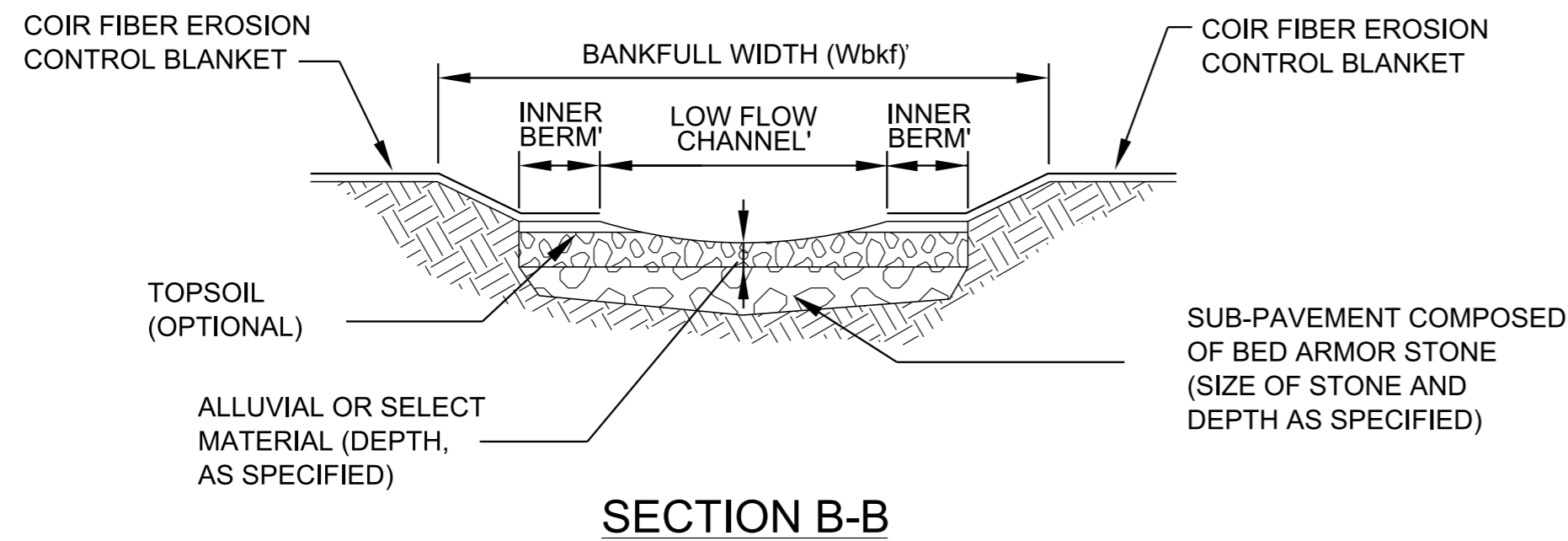
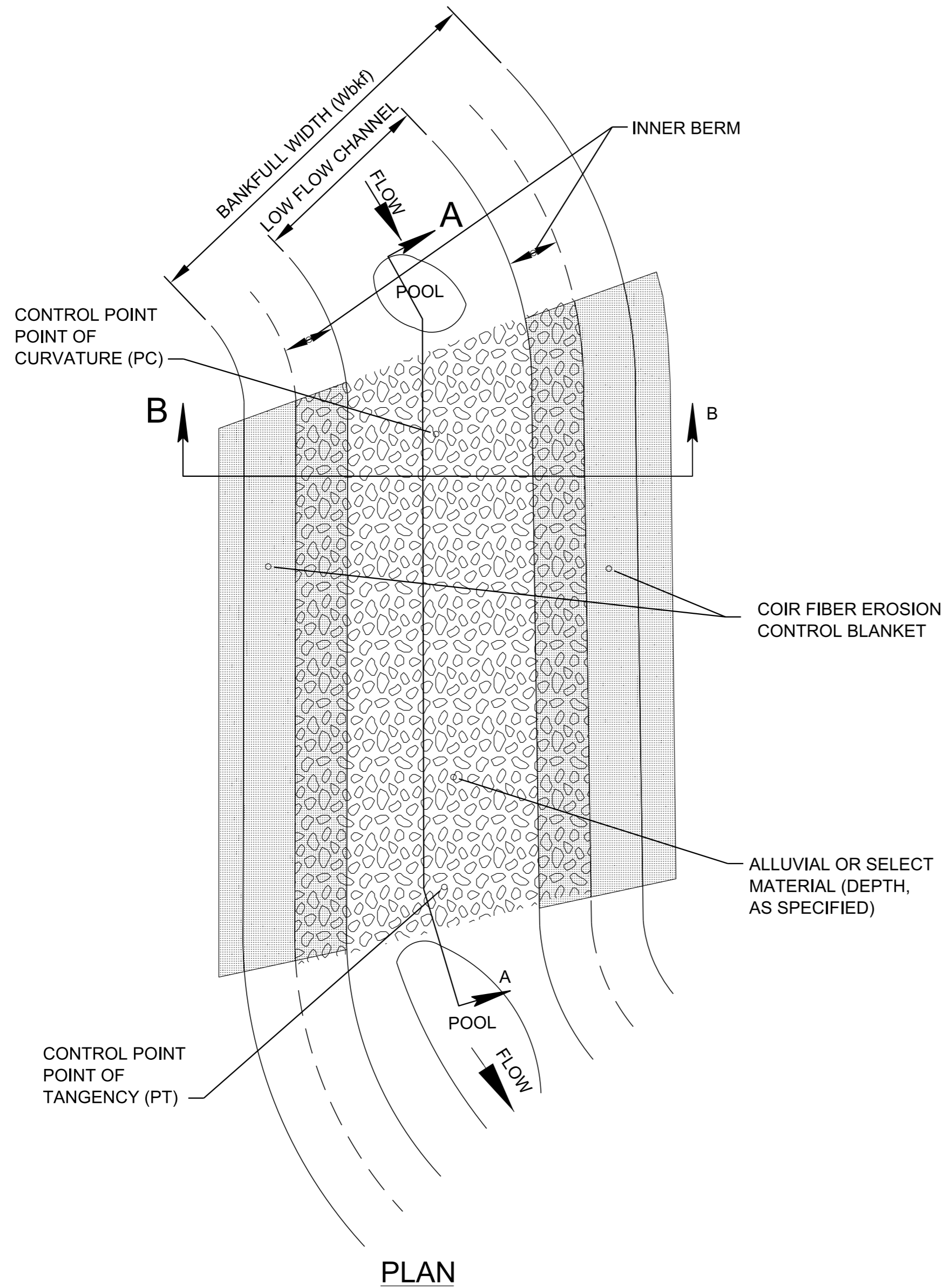
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LOG RIFFLES

STREAM MITIGATION PLAN LEGEND:



LOG RIFFLE



CONSTRUCTED ALLUVIAL RIFFLE NOTES

- (A) CONSTRUCTED ALLUVIAL RIFFLES ARE GRADE CONTROL AND HABITAT ENHANCEMENT MEASURES THAT ARE USED TO MAINTAIN GRADE OF UPSTREAM POOLS, OXYGENATE WATER, AND PROVIDE HABITAT FOR EPIFAUNA AND FISH. THESE STRUCTURES ARE TYPICALLY USED IN LOWER GRADIENT STREAMS WITH OVERALL SLOPES LESS THAN 2% THIS DETAIL CAN BE USED FOR CONSTRUCTING RIFFLES USING NATURAL ALLUVIUM CONSISTING OF BOULDERS, COBBLES, AND GRAVEL OR SPECIFIED SELECT MATERIAL.
- (B) CONSTRUCTED ALLUVIAL RIFFLES SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND GEOMORPHIC POSITIONS INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL, INNER BERM, AND LOW-FLOW CHANNEL WIDTHS; INVERT ELEVATIONS AT HEAD AND BOTTOM OF RIFFLE; ESTIMATED ROCK THRESHOLD SIZE; AND ALLUVIUM OR SELECT MATERIAL CLASSIFICATION AND DEPTH SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR STREAM DESIGN".
- (D) CONSTRUCTED ALLUVIAL RIFFLES ARE PLACED IN THE STRAIGHT SECTIONS OF THE CHANNEL BETWEEN MEANDER BENDS (I.E., BETWEEN UPSTREAM POINT OF TANGENCY AND DOWNSTREAM POINT OF CURVATURE), AS INDICATED ON THE STREAM MITIGATION PLANS.
- (E) ALLUVIUM OR SELECT MATERIAL FOR CONSTRUCTED RIFFLES SHALL CONSIST OF COARSE SUBSTRATE (GRAVEL, COBBLE, AND BOULDER). A MIXTURE OF SIZES OF ALLUVIUM OR SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE IN RIFFLE AND RUN HABITATS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (F) CONSTRUCT ALLUVIAL RIFFLES BY:
- (1) SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
 - (2) EXCAVATE ENOUGH BED MATERIAL TO PLACE SUBPAVEMENT ARMOR STONE, AND COARSE ALLUVIUM OR SELECT MATERIAL FOR THE RIFFLE TO ACHIEVE THE SPECIFIED INVERT ELEVATIONS. IF THE CHANNEL IS DESIGNED WITH AN INNER BERM, KEY THE COARSE ALLUVIUM OR SELECT MATERIAL INTO THE BANKS EXTENDING ENTIRELY UNDER THE INNER BERM. IF THE CHANNEL LACKS AN INNER BERM, KEY THE COARSE ALLUVIUM OR SELECT MATERIAL INTO THE BANKS EXTENDING TO HALF BANKFULL.
 - (3) PLACE THE COARSE ALLUVIUM OR SELECT MATERIAL IN SIX-INCH LIFTS AND COMPACT EACH LIFT WITH THE BUCKET OF THE EXCAVATOR.
 - (4) INSTALL THE ALLUVIAL RIFFLE AT THE INVERTS SPECIFIED IN THE PLANS AND THEN CHECK THE ELEVATIONS OF THE INVERTS WITH SURVEY EQUIPMENT.
 - (5) PLACE SOIL OVER THE TOP OF THE COARSE ALLUVIUM OR SELECT MATERIAL KEYED INTO THE INNER BERM OR STREAM BANK AND GRADE THE INNER BERM/BANKS TO THE SPECIFIED ELEVATIONS.
- (G) THE CONSTRUCTED ALLUVIAL RIFFLE MATERIAL SHALL BE FINISHED TO CREATE A SMOOTH PROFILE, WITHOUT AN ABRUPT JUMP/TRANSITION BETWEEN THE UPSTREAM POOL-GLIDE AND THE RIFFLE, OR AN ABRUPT DROP/TRANSITION BETWEEN THE RIFFLE AND THE DOWNSTREAM RUN-POOL. THE FINISHED CROSS SECTION OF THE RIFFLE MATERIAL SHALL GENERALLY MATCH THE SHAPE AND DIMENSIONS SHOWN ON THE RIFFLE TYPICAL SECTION WITH SOME VARIABILITY OF THE THALWEG LOCATION AS A RESULT OF PLACEMENT OF LARGER SUBSTRATE, SUCH AS BOULDERS.
- (H) THE END OF RIFFLE CONTROL POINT MAY TIE IN TO A DRAINAGE STRUCTURE OR OTHER IN-STREAM STRUCTURE (E.G. - J-HOOK VANE, LOG OR BOULDER SILL, ETC.).
- (I) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
- (J) COIR FIBER EROSION CONTROL BLANKET SHALL BE INSTALLED ABOVE THE INNER-BERM STAGE AND NOT IN THE LOW-FLOW CHANNEL OF THE RIFFLE. SEE TYPICAL CROSS-SECTION DATA IN STREAM MITIGATION PLANS FOR INNER BERM INFORMATION.
- (K) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (L) CONSTRUCTED ALLUVIAL RIFFLES SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

709-05.81 ROCK RIFFLES PER LUMP SUM

PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR TO CONSTRUCT THE ALLUVIAL RIFFLE.

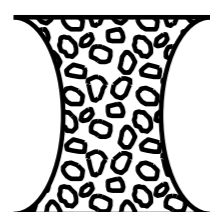
MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

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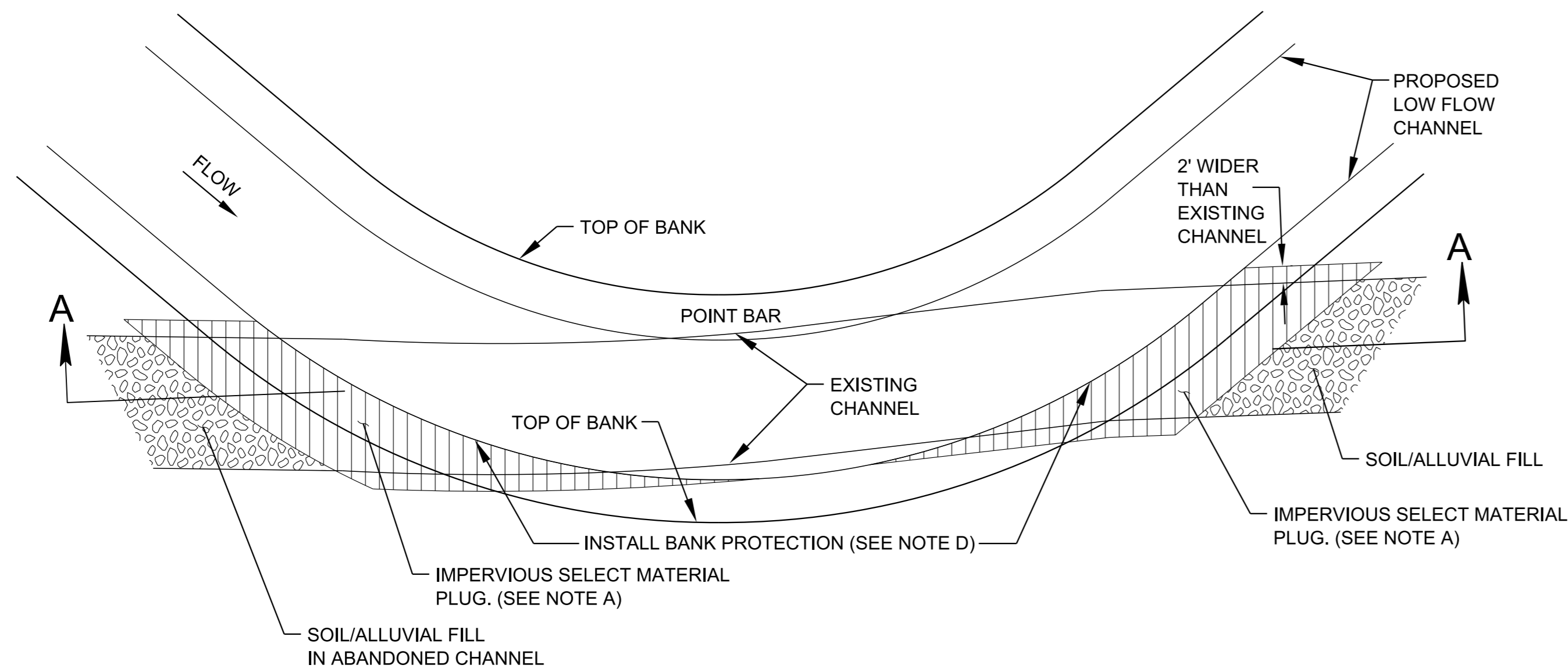
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CONSTRUCTED
ALLUVIAL
RIFFLE

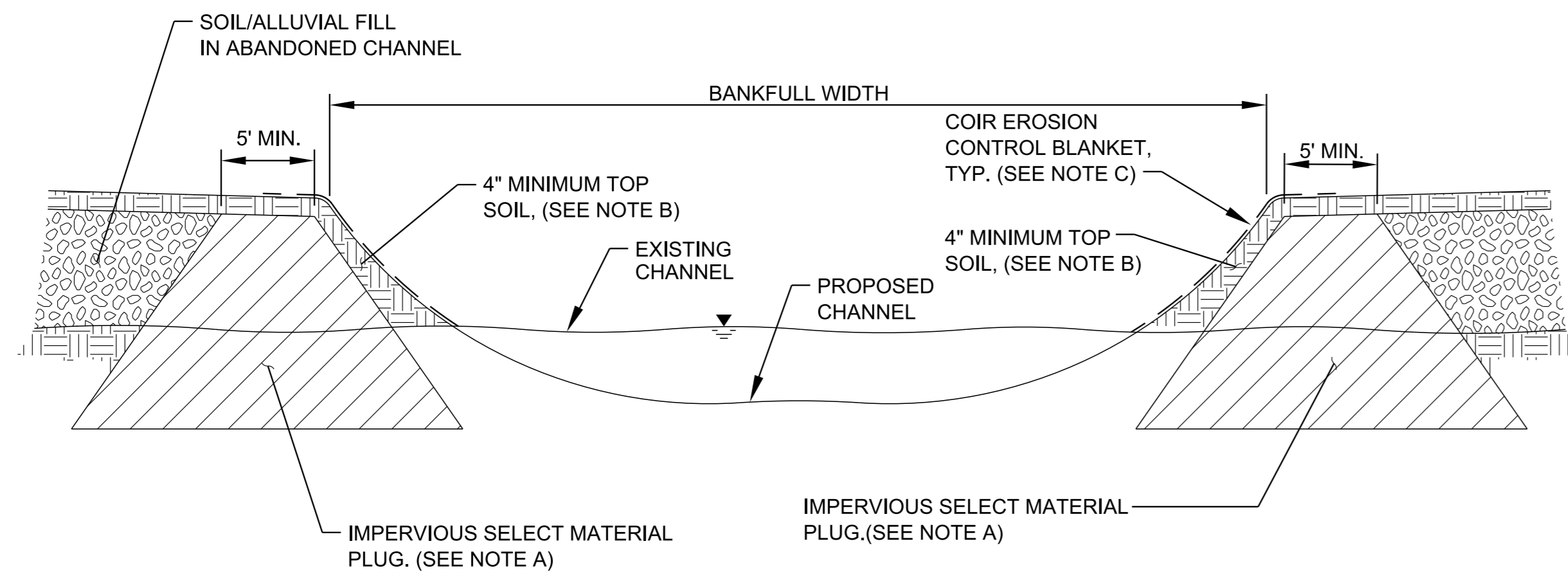
STREAM MITIGATION PLAN LEGEND:



CONSTRUCTED ALLUVIAL RIFFLE



PLAN VIEW



SECTION A-A

CLAY CHANNEL PLUG NOTES

- (A) CLAY CHANNEL PLUGS ARE USED TO BLOCK ABANDONED SECTIONS OF CHANNEL WHEN A STREAM IS RE-ALIGNED AND THE NEW CHANNEL INTERSECTS THE EXISTING CHANNEL. THE CLAY CHANNEL PLUG ALSO PREVENTS SUBSURFACE FLOW LOSS TO THE EXISTING CHANNEL.
- (B) PLACE IMPERVIOUS SELECT MATERIAL PLUG (CLAY, CRUSHED LIMESTONE, ETC., AS SPECIFIED) TO MAXIMUM DEPTH OF PROPOSED CHANNEL AND COMPACT WITH EXCAVATOR BUCKET IN 6-INCH LIFTS.
- (C) PLACE MINIMUM OF 4 INCHES OF TOPSOIL ON STREAM BANKS AND TILL INTO SURFACE OF PLUG, SEED WITH TEMPORARY AND PERMANENT SEED MIXES, AND MULCH LIGHTLY WITH STRAW.
- (D) FOR SHORT-TERM BANK PROTECTION, MULCH SEEDED STREAM BANKS LIGHTLY WITH STRAW AND INSTALL COIR EROSION CONTROL BLANKETS.
- (E) FOR LONG-TERM BANK PROTECTION, INSTALL BANK STABILIZATION (VANE, WOODYTOE, GEOLIFTS, ETC., AS SPECIFIED) AND PLANT WITH WOODY VEGETATION (LIVE STAKES, BRUSH LAYERING, ROOTED PLANTS, ETC., AS SPECIFIED).
- (F) USE THE FOLLOWING PAY ITEM FOR CLAY CHANNEL PLUG:
203-15.03 COMPACTED CLAY PER CY

MATERIAL SHOWN ARE ONLY A GRAPHICAL
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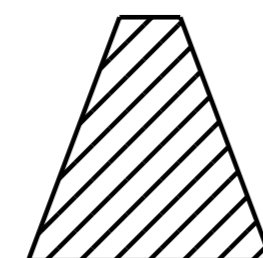
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CLAY CHANNEL
PLUG

8-01-16

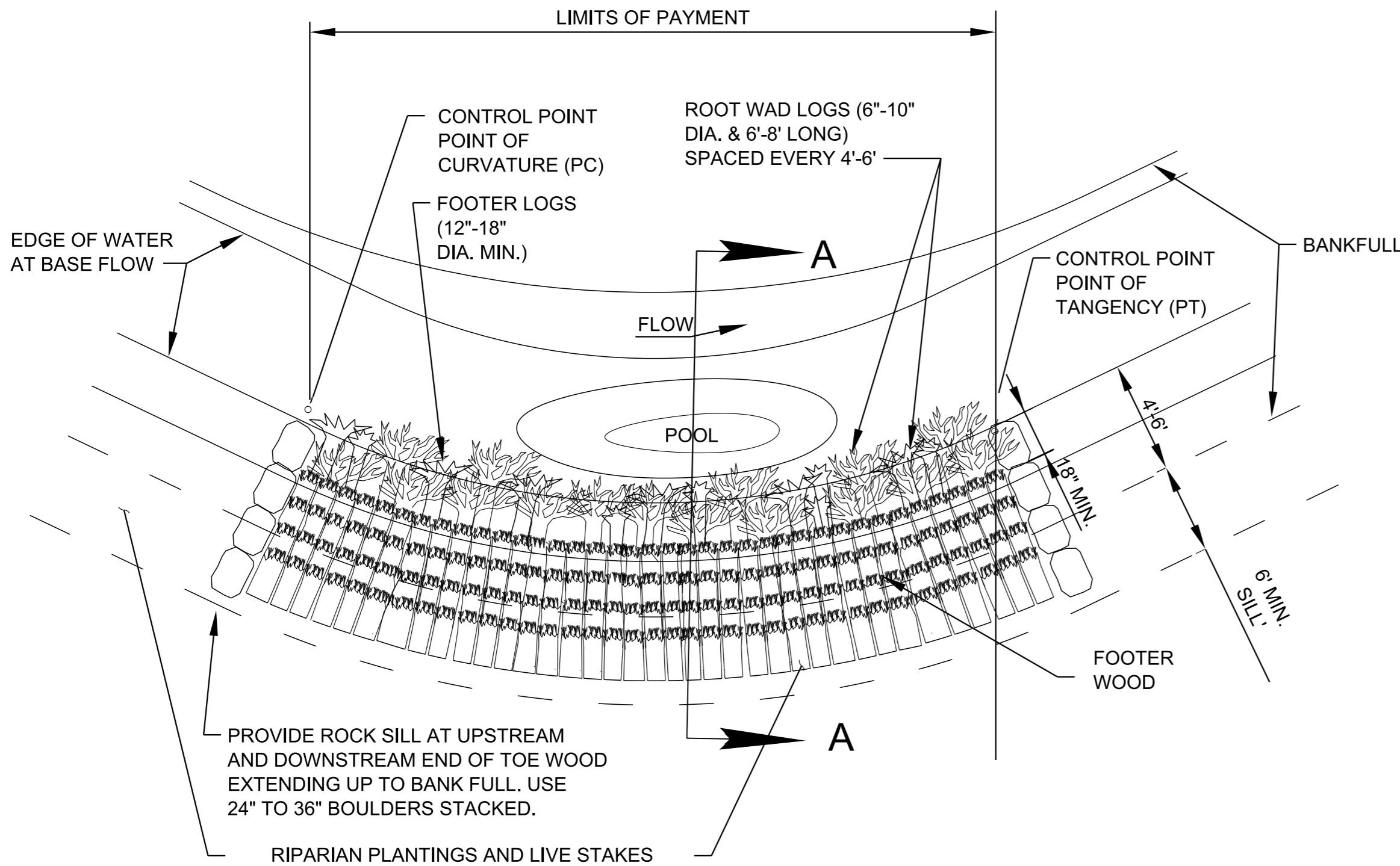
D-NSD-31

STREAM MITIGATION PLAN LEGEND:

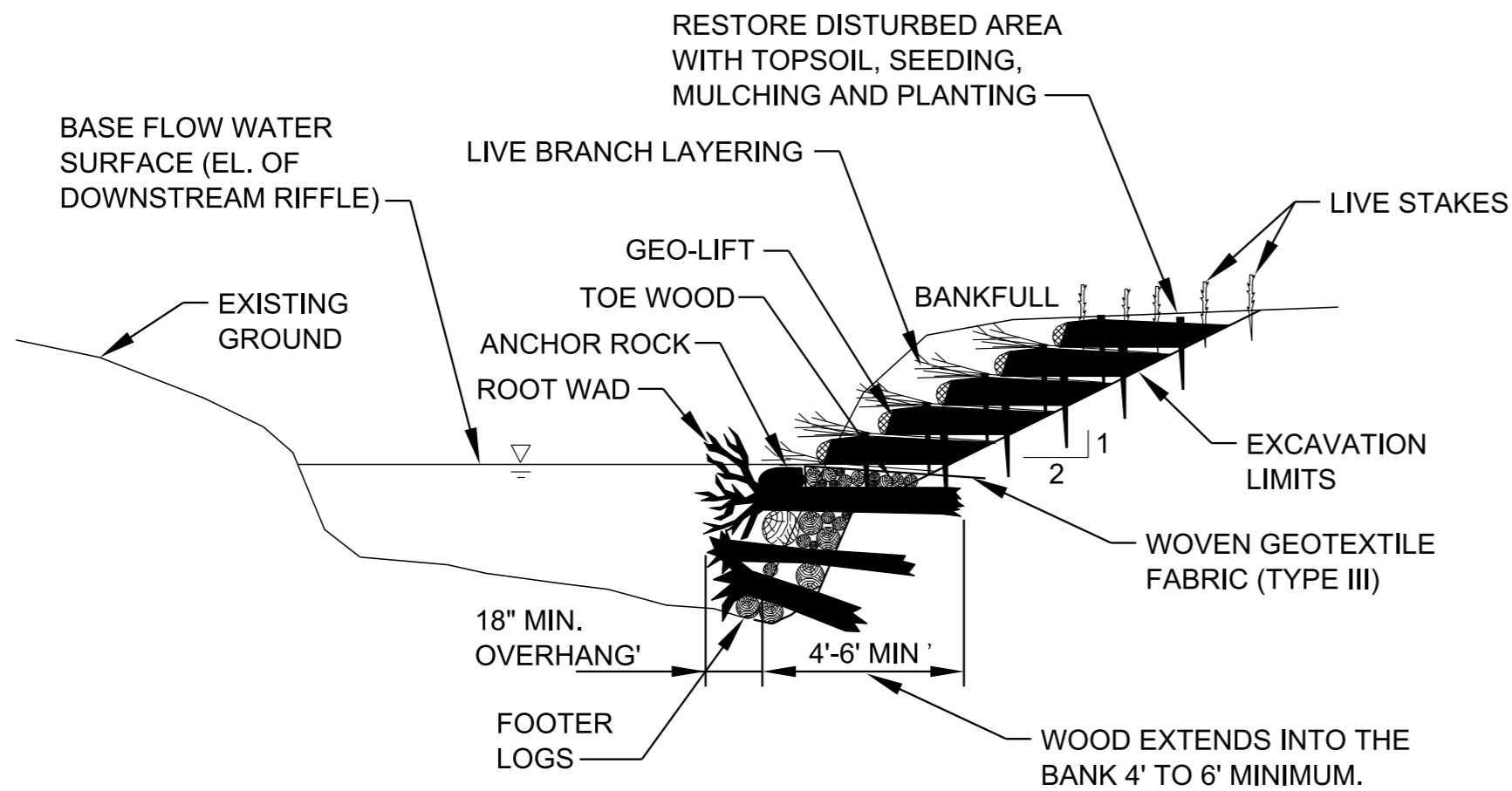


CLAY CHANNEL PLUG

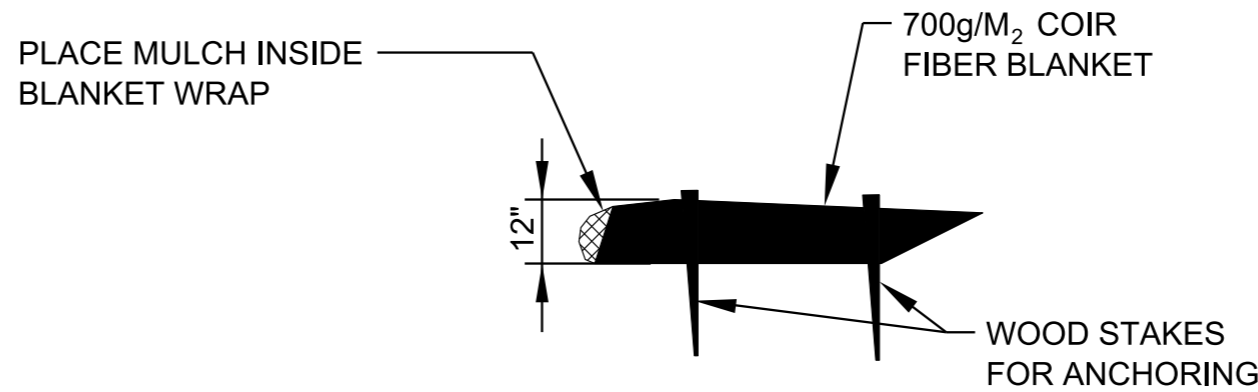
REV. 9-15-17: MODIFIED PAY ITEM DESCRIPTION. MODIFIED THE STREAM MITIGATION PLAN LEGEND SYMBOL. ADDED NOTE (H). MODIFIED WOOD TOE PLAN VIEW. ADDED "GEO-LIFTS" AND "AS DIRECTED BY THE ENGINEER" TO THE REINFORCED EARTH DETAIL. MODIFIED DRAWING NAME. MODIFIED PLAN VIEW AND LEGEND.



WOOD TOE
PLAN VIEW

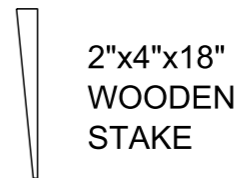


SECTION A-A



REINFORCED EARTH
GEO-LIFTS

(AS DIRECTED BY THE ENGINEER)



WOOD STAKE

NOTE:
STAKES MAY BE MADE BY SAWING
A 2"x4" DIAGONALLY IN HALF.

WOOD TOE WITH GEO-LIFTS NOTES

- (A) WOOD AND BOULDER TOE WITH GEO-LIFTS AND LIVE BRUSH LAYERING ARE BANK STABILIZATION MEASURES THAT PROTECT THE STREAM BANK ALONG OUTSIDE MEANDER BENDS FROM EROSION AND ENHANCE THE ESTABLISHMENT AND GROWTH OF NATIVE VEGETATION USING LIVE BRANCHES AND CUTTINGS. WOOD TOE ALSO PROVIDES HABITAT FOR INVERTEBRATES AND FISH AND HELPS TO MAINTAIN POOL DEPTH BY CREATING TURBULENT FLOW AND SCOUR ALONG THE STREAM BED.
- (B) WOOD AND BOULDER TOE WITH LIVE BRUSH LAYERING SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND GEOMORPHIC POSITIONS INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH, WOOD AND BOULDER DIMENSIONS AND ELEVATIONS, NUMBER AND DIMENSIONS OF GEO-LIFTS, AND LENGTH AND NUMBER OF LIVE BRUSH AND CUTTINGS SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) WOOD TOE SHALL CONSIST OF A MIX OF ROOT WADS, LOGS, BRANCHES, BRUSH, AND OTHER WOODY VEGETATION INSTALLED AT VARIOUS ANGLE, BUT NOT PARALLEL TO THE FLOW.
- (D) A HYDRAULIC EXCAVATOR WITH A HYDRAULIC THUMB SHALL BE USED TO PLACE WOOD AND BOULDERS.
- (E) CONSTRUCT WOOD OR BOULDER TOE, GEO-LIFTS, AND LIVE BRUSH LAYERING BY:
- (1) SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
 - (2) EXCAVATE THE POOL AND GRADE EXISTING BANK SUBGRADE TO 2:1 (MIN).
 - (3) FOR WOOD TOE, LAYER THE WOOD WITH LARGER MATERIAL ON THE BOTTOM AND A MAT OF BRANCHES AS THE TOP LAYER. IF USED, ANGLE ROOT WADS SLIGHTLY UPSTREAM INTO THE FLOW. FILL GAPS BETWEEN LARGER MATERIAL WITH A MIX OF BRANCHES AND WOODY DEBRIS. THE TOP LAYER OF TOE WOOD SHALL BE AT THE ESTABLISHED NORMAL BASE FLOW ELEVATION (I.E., ELEVATION OF THE DOWNSTREAM RIFFLE). PLACE TYPE III WOVEN GEOTEXTILE FABRIC ON TOP OF WOOD TOE.
 - (4) FOR BOULDER TOE, EXCAVATE BANK TO KEY IN BOULDERS AND PLACE TYPE III WOVEN GEOTEXTILE FABRIC ALONG THE EXCAVATED BANK. PLACE BOULDERS IN OVERLAPPING LAYERS AND IMBRICATE EACH LAYER. BACKFILL AREA BEHIND BOULDER WITH SOIL OR ALLUVIUM AND COMPACT WITH EXCAVATOR BUCKET.
 - (5) CONSTRUCT GEO-LIFTS AND LIVE BRUSH LAYERING ABOVE WOOD OR BOULDER TOE, AS FOLLOWS:
 - (a) FOR EACH LIFT, PLACE BRUSH CUTTINGS PERPENDICULAR TO THE BANK AT A DENSITY OF 10-12 STEMS PER FOOT AND COVER WITH TWO INCHES OF SOIL.
 - (b) LAY 700G COIR BLANKETS OVER THE LIVE CUTTINGS PARALLEL TO THE BANK AND SHINGLED IN A DOWNSTREAM DIRECTION.
 - (c) PLACE SPECIFIED SOIL LIFT OVER THE BACK HALF OF THE COIR BLANKET AND COMPACT WITH THE EXCAVATOR BUCKET.
 - (d) PLACE CLEAN STRAW OR MULCH ALONG THE FACE OF THE SOIL LIFT, WRAP THE LIFT WITH THE FRONT HALF OF THE COIR BLANKET AND STAKE IN PLACE WITH A MINIMUM OF TWO ROWS OF 2"x4"x18" WOOD STAKES AT FIVE-FOOT SPACING.
 - (e) REPEAT STEPS (a) THROUGH (d) FOR EACH GEO-LIFT SPECIFIED
 - (f) PLACE LIVE STAKES OR WOODY PLANTINGS, AS SPECIFIED, ON THE TOP LIFT.
- (F) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ONSITE CONSTRUCTION OBSERVER.
- (G) WOOD TOE WITH REINFORCED EARTH AND LIVE BRUSH LAYERING SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- | | |
|-----------|--|
| 209-03.67 | STREAM MITIGATION - WOOD TOE WITH REINFORCED EARTH PER LINEAR FOOT |
| 209-03.42 | STREAM MITIGATION - LIVE BRUSH LAYERING PER LINEAR FOOT |
- PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE WOOD TOE WITH REINFORCED EARTH AND LIVE BRUSH LAYERING.
- (H) FOR BOULDER TOE DETAILS SEE D-NSD-32A.

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DEPTH OR QUANTITY OF
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CHANNEL.

NOT TO SCALE

☐ MINOR REVISION -- FHWA
APPROVAL NOT REQUIRED.

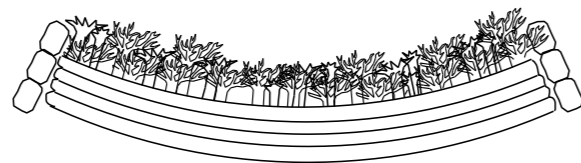
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WOOD TOE WITH
GEO-LIFTS

11-01-16

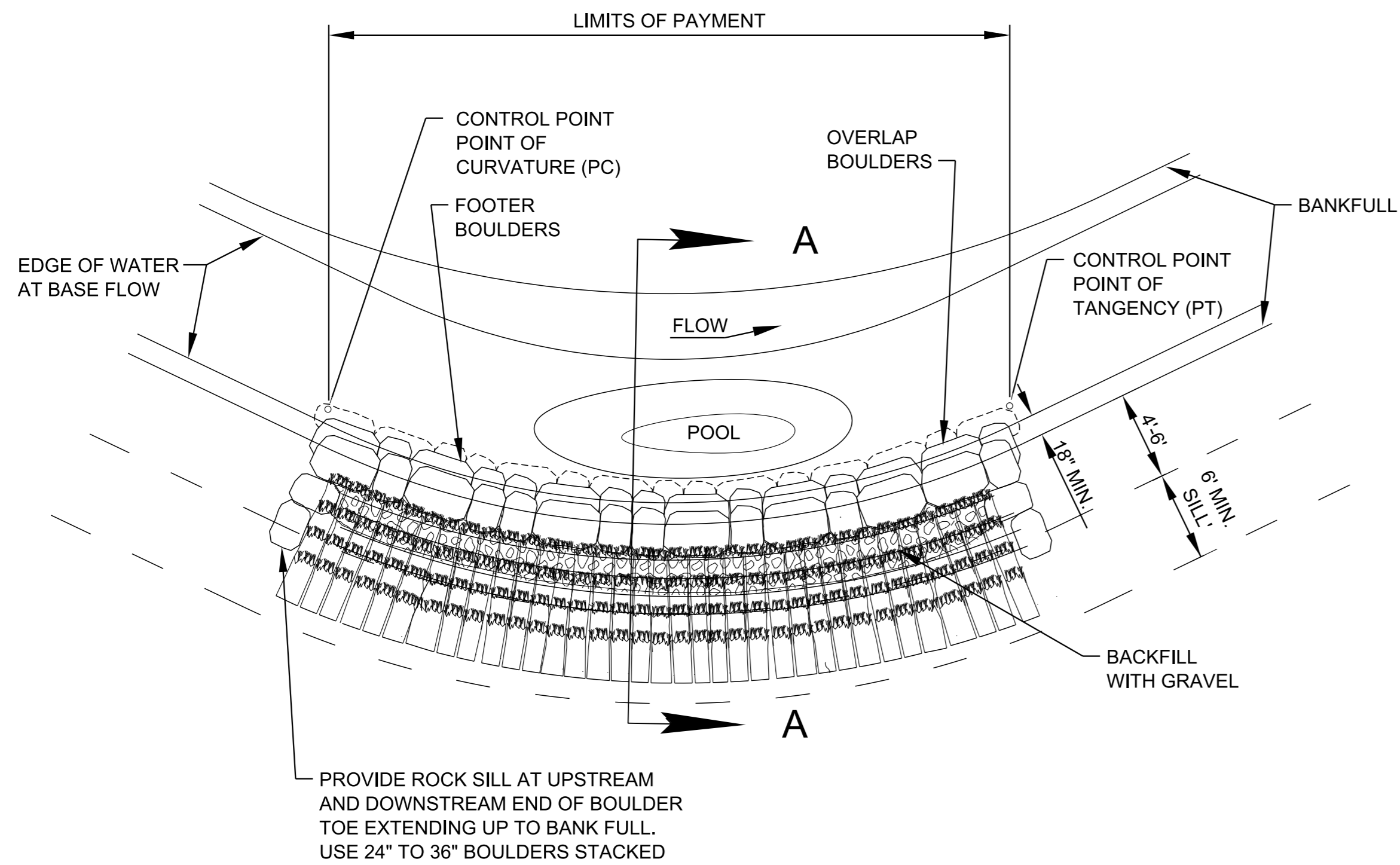
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STREAM MITIGATION PLAN LEGEND:

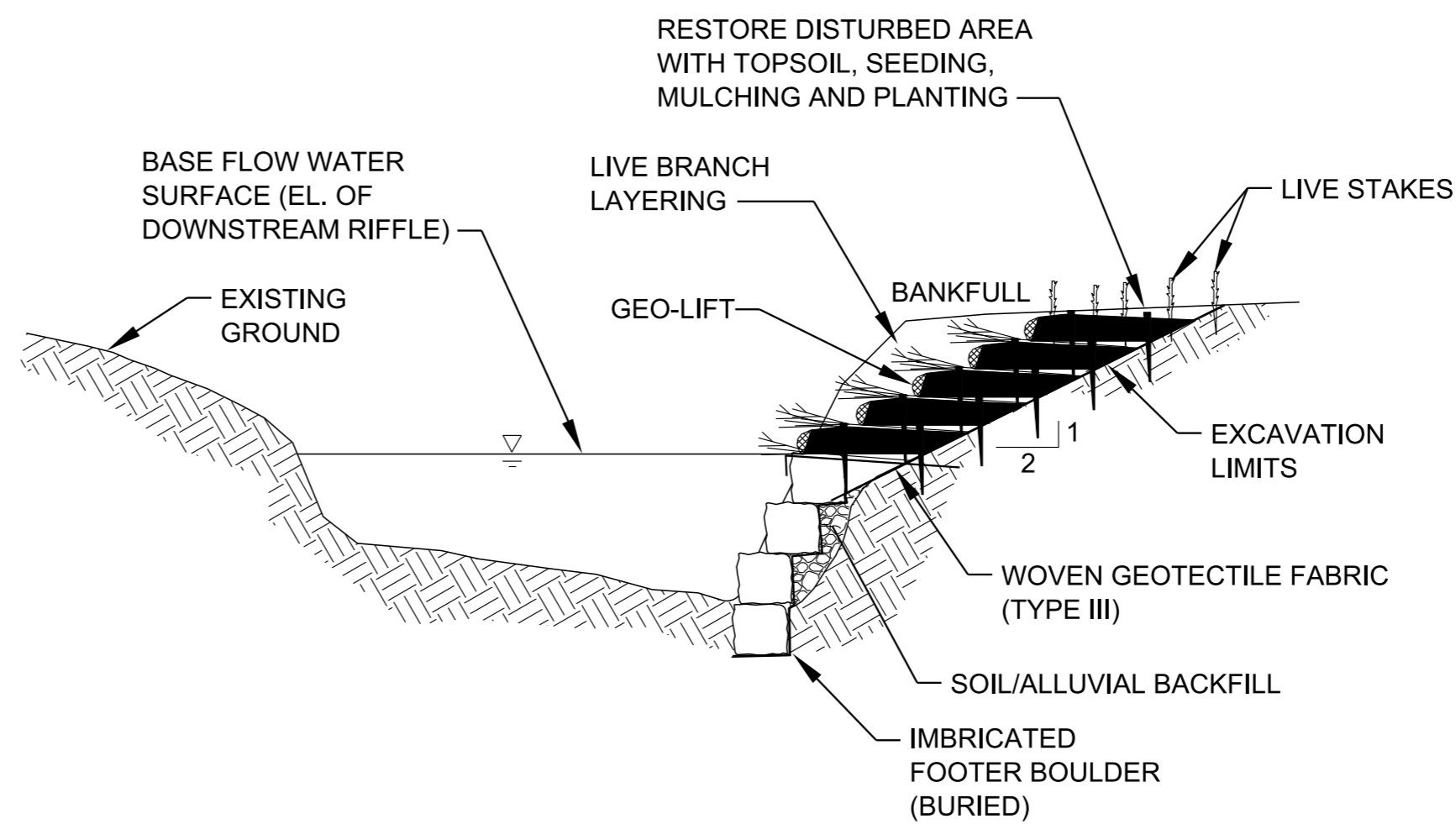


WOOD TOE WITH GEO-LIFTS

REV. 9-15-17; MODIFIED THE STREAM MITIGATION PLAN LEGEND SYMBOL. ADDED PAY ITEM NUMBERS. ADDED WOOD AND BOULDER TOE WITH GEO-LIFTS NOTES, INCLUDING PAY ITEM NUMBER. MODIFIED THE BOULDER TOE PLAN VIEW. DELETED THE PLAN LEGEND. MODIFIED PAGE NAME, LEGEND AND PLAN VIEW. ADDED NOTES.



BOULDER TOE
PLAN VIEW



SECTION A-A

BOULDER TOE WITH GEO-LIFTS NOTES

- (A) BOULDER TOE SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- | | |
|-----------|---|
| 209-03.68 | STREAM MITIGATION - BOULDER TOE PER LINEAR FOOT |
| 209-03.42 | STREAM MITIGATION-LIVE BRUSH LAYERING PER LINEAR FOOT |
| 740-10.03 | GEOTEXTILE (TYPE III) EROSION CONTROL PER SQUARE YARD |
- PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE BOULDER TOE WITH REINFORCED EARTH AND LIVE BRUSH LAYERING.
- (B) BOULDER TOE SHALL BE DURABLE LIMESTONE OF THE SIZE(S) INDICATED ON THE STREAM MITIGATION DATA TABLE, OR AS DIRECTED BY THE ENGINEER.
- (C) FOR WOOD TOE DETAILS SEE D-NSD-32.

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

NOT TO SCALE

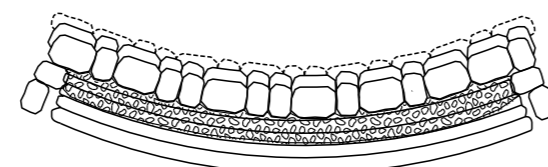
STATE OF TENNESSEE
DEPARTMENT OF
TRANSPORTATION

BOULDER TOE
WITH GEO-LIFTS

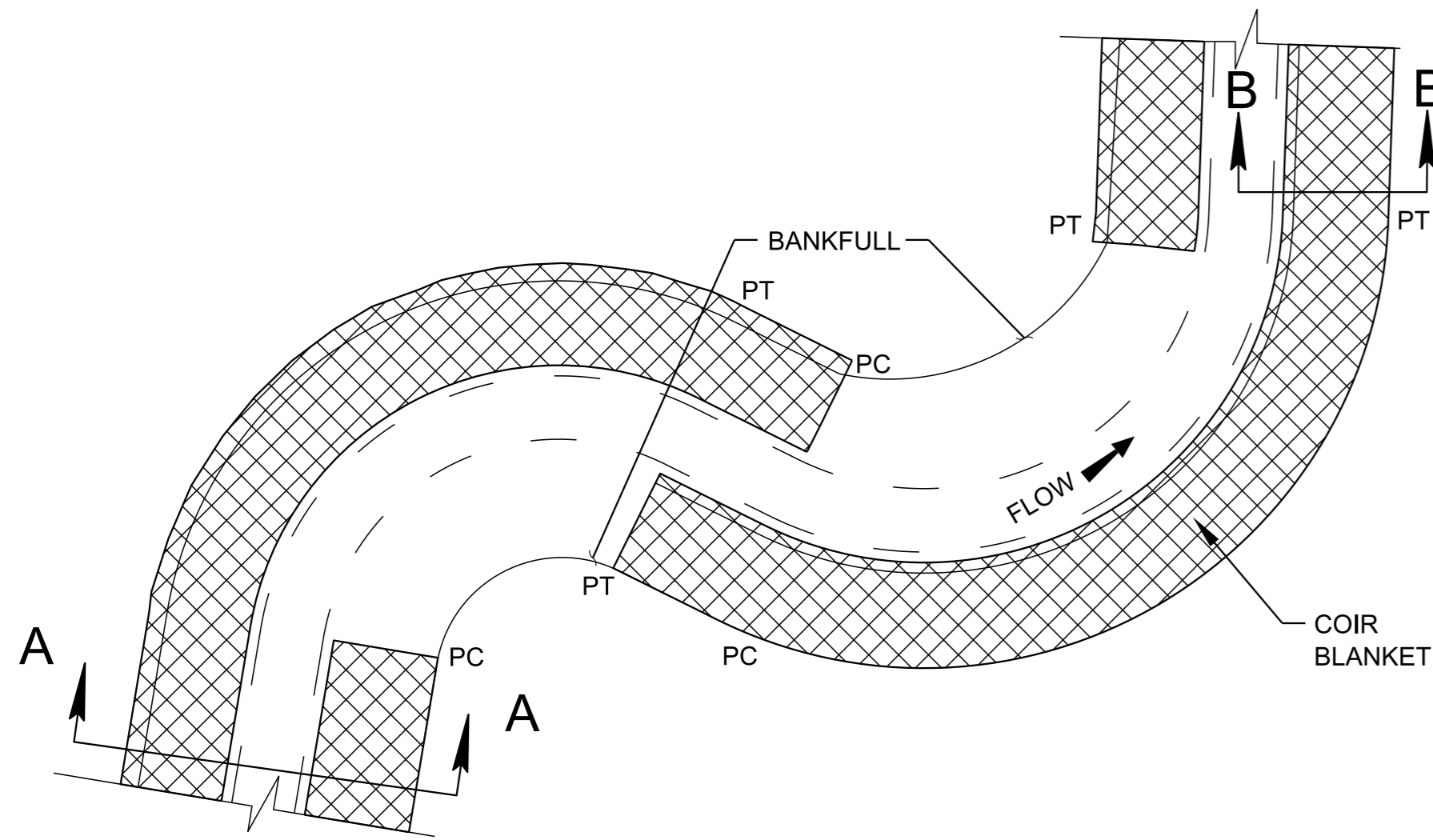
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D-NSD-32A

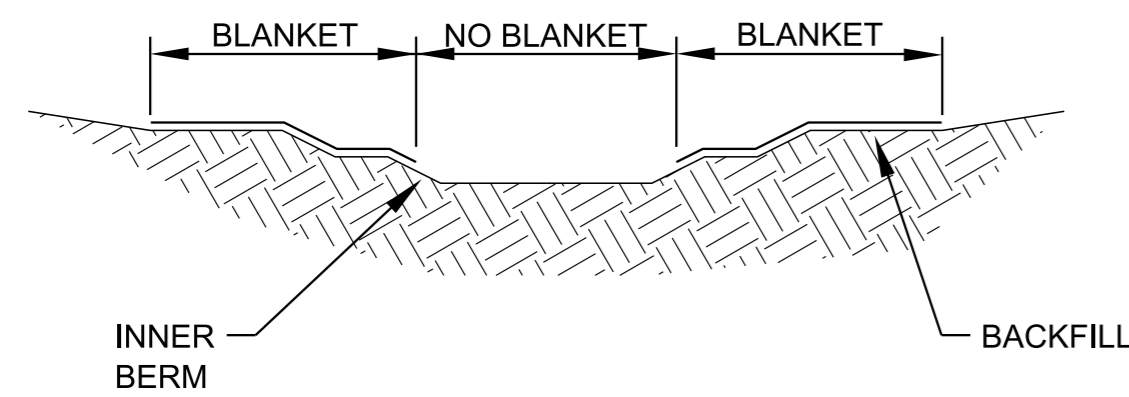
STREAM MITIGATION PLAN LEGEND:



BOULDER TOE WITH GEO-LIFTS

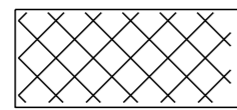


COIR EROSION CONTROL BLANKET
PLAN

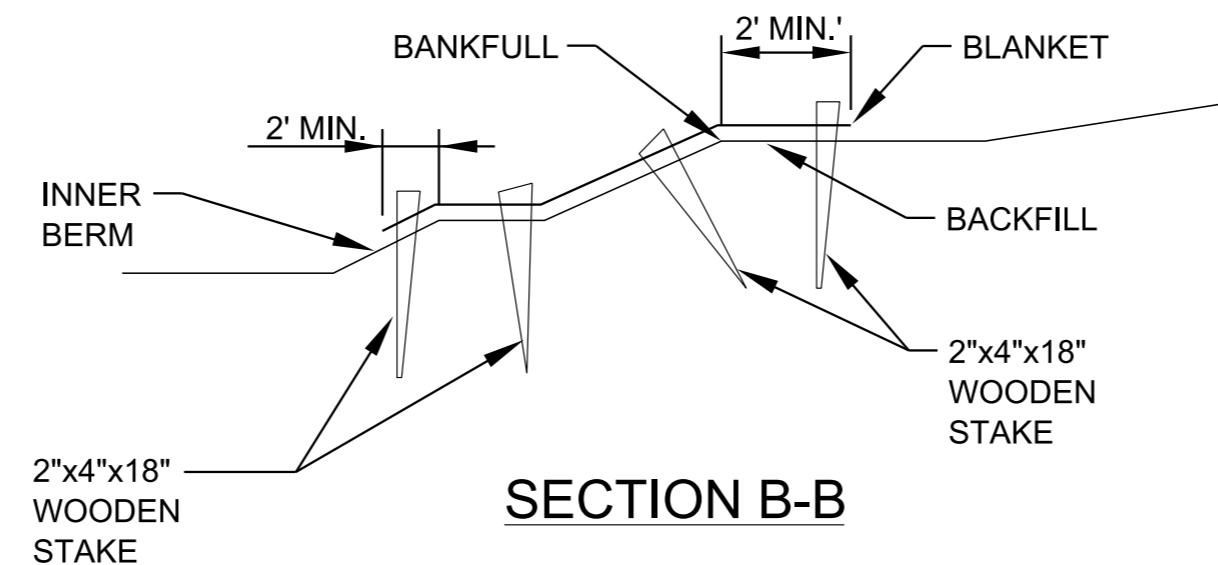


SECTION A-A

STREAM MITIGATION
PLAN LEGEND:



COIR FIBER EROSION
CONTROL BLANKET

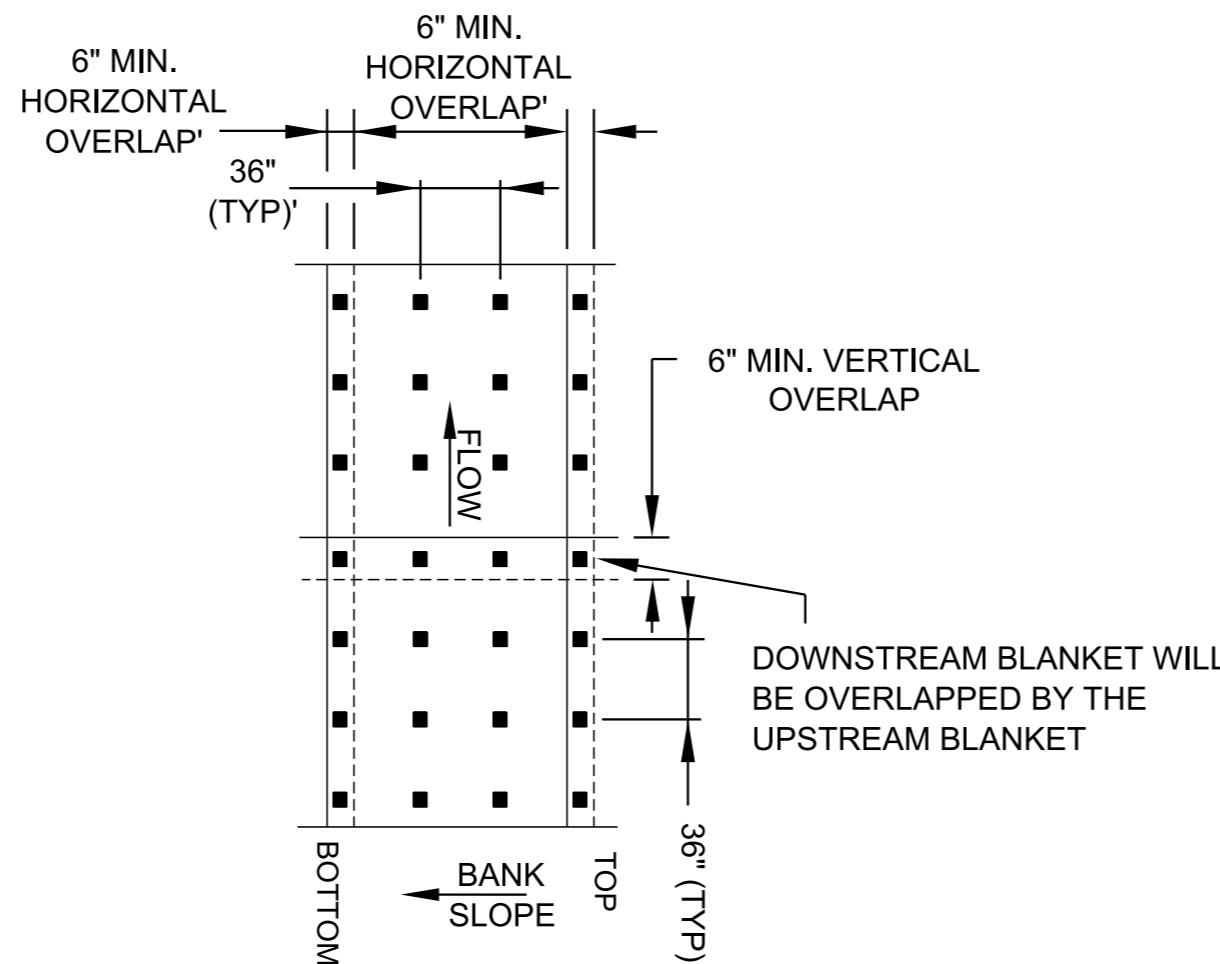


SECTION B-B



NOTE:
STAKES MAY BE MADE BY SAWING
A 2"x4" DIAGONALLY IN HALF.

WOOD STAKE



MATTING STAKING VIEW

COIR FIBER EROSION CONTROL BLANKET NOTES

- (A) COIR FIBER EROSION CONTROL BLANKETS PROVIDE TEMPORARY BANK STABILIZATION FOLLOWING BANK GRADING, UNTIL PERMANENT VEGETATION CAN BE ESTABLISHED.
- (B) COIR FIBER EROSION CONTROL BLANKETS SHALL BE 700 GRAMS PER SQUARE METER.
- (C) BEFORE INSTALLING COIR BLANKETS, RAKE OR TILL THE UPPER THREE TO FOUR INCHES OF THE SOIL ON THE STREAM BANKS, SEED WITH TEMPORARY AND PERMANENT SEED MIXES, RAKE SOIL LEVEL, AND LIGHTLY MULCH WITH CLEAN STRAW.
- (D) COIR BLANKETS SHALL BE INSTALLED ON THE OUTSIDE OF BANKS OF MEANDERS AND ON BOTH BANKS ALONG RIFFLES, FROM THE INNER BERM OF THE CHANNEL TO TWO FEET (MIN.) BEYOND BANKFULL. BLANKET MAY BE ELIMINATED FROM THE INNER BERM AT THE DISCRETION OF THE ENGINEER.
- (E) PLACE COIR BLANKETS PARALLEL TO THE CHANNEL. WHERE MULTIPLE PANELS OF BLANKETS ARE USED, PANELS SHALL BE OVERLAPPED A MINIMUM OF SIX INCHES, IN A DOWNSTREAM AND DOWNSLOPE DIRECTION.
- (F) PULL BLANKETS TIGHT, BUT MAINTAIN CONTACT WITH THE SOIL. USE 2-INCH X 4-INCH X 18-INCH WOODEN STAKES ON THREE-FOOT CENTERS TO SECURE COIR BLANKETS.
- (G) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (H) COIR FIBER EROSION CONTROL BLANKETS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

805-12.08 700 GRAM COIR FIBER EROSION BLANKETS PER SY

SEED AND MULCH SHALL BE PAID FOR ACCORDING TO THEIR RESPECTIVE ITEM NUMBERS. PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR TO INSTALL THE COIR FIBER EROSION CONTROL BLANKETS.

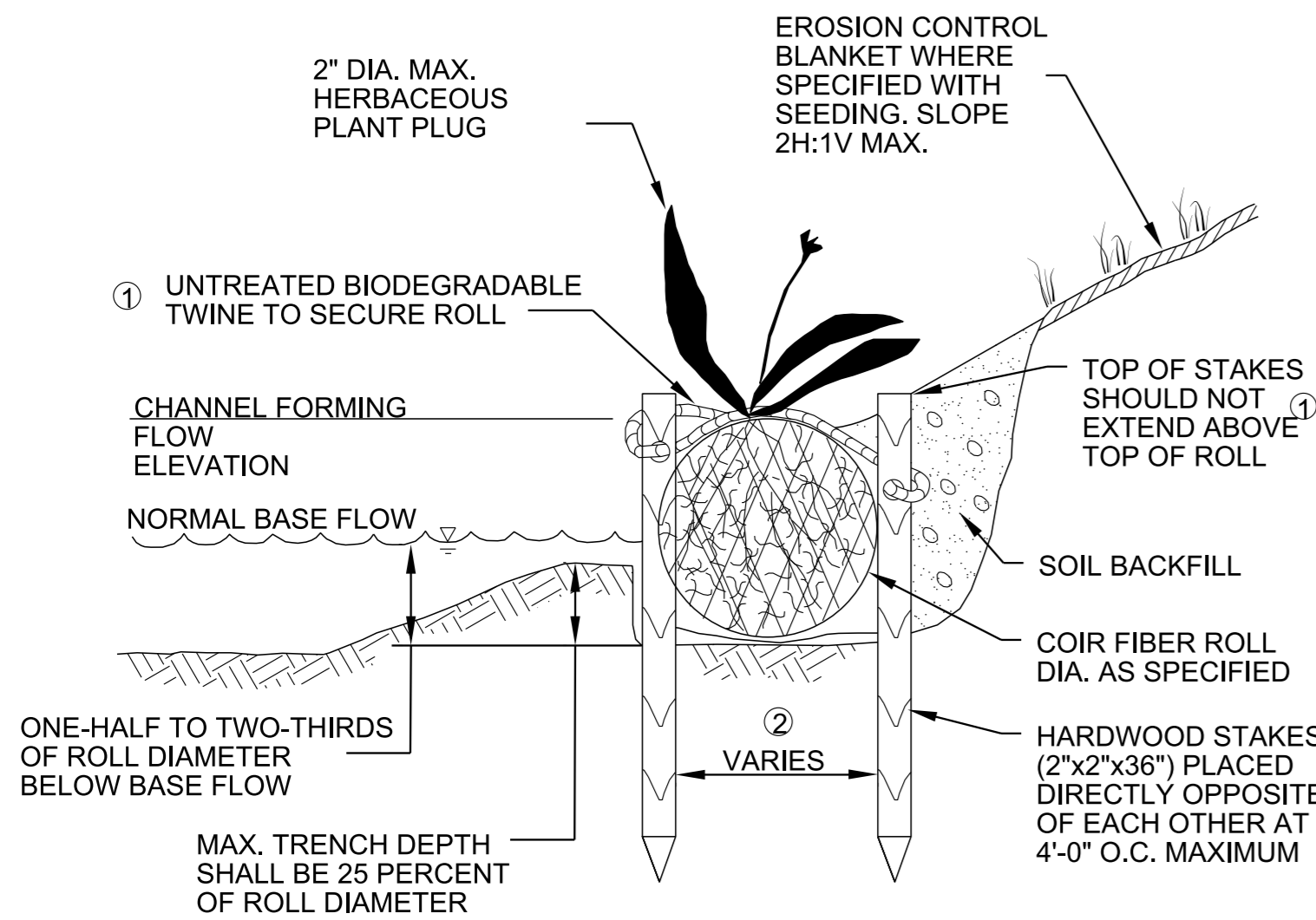
COIR FIBER ROLL NOTES

- (A) COIR FIBER ROLLS ARE A FLEXIBLE BANK STABILIZATION MEASURE CONSISTING OF INTERWOVEN COCONUT HUSK FIBERS THAT CAN BE FITTED TO THE CURVATURE OF A STREAM BANK PROVIDING IMMEDIATE TOE PROTECTION AND BANK STABILIZATION. COIR FIBER ROLLS ARE USED TO ENHANCE THE ESTABLISHMENT AND GROWTH OF NATIVE VEGETATION ALONG THE STREAM BANK BY TRAPPING SEDIMENT BEHIND THE ROLL PROVIDING A SUBSTRATE FOR PLANT GROWTH. EFFECTIVE LIFE 2 TO 3 YEARS.
- (B) COIR FIBER ROLLS ARE AN ACCEPTABLE MITIGATION PRACTICE FOR USE IN STREAMS AND ALONG THE SHORELINE OF PONDS AND WETLANDS.
- (C) COIR FIBER ROLLS MAY BE USED IN COMBINATION WITH LONGITUDINAL STONE TOES, ROOT WADS, LIVE SILTATION, OR OTHER BANK STABILIZATION MEASURES.
- (D) COIR FIBER ROLLS SHOULD NOT BE USED WHEN CHANNEL FLOW VELOCITY EXCEEDS 10 FEET PER SECOND, WHERE CHANNEL SHEAR STRESSES ARE MODERATE TO HIGH ALONG THE BANK, IN BEDROCK CHANNELS, IN CHANNELS WHERE SCOUR IS PRESENT OR EXPECTED, OR IN STREAMS WHERE SIGNIFICANT DEBRIS LOAD IS EXPECTED.
- (E) COIR FIBER ROLLS SHOULD BE CONSTRUCTED AT THE TOE OF A STREAM BANK TO A HEIGHT EQUAL TO THE CHANNEL FORMING FLOW ELEVATION.
- (F) COIR FIBER ROLLS SHALL BE SEATED IN A SHALLOW HAND-CUT TRENCH SLIGHTLY BELOW THE CHANNEL BOTTOM ELEVATION. COIR FIBER ROLL SHALL BE IN CONTACT WITH THE WATER, SUBMERGED FROM ONE-HALF TO TWO-THIRDS OF THE ROLL DIAMETER.
- (G) ENDS OF COIR FIBER ROLLS SHALL BE TURNED IN AND BURIED WITHIN THE BANK TO PREVENT WATER FROM INTRUDING BEHIND THE ROLL.
- (H) VEGETATION (SPECIES) USED FOR HERBACEOUS PLUGS TO BE INSTALLED IN THE TOP OF COIR FIBER ROLLS SHALL BE APPROVED BY THE ENVIRONMENTAL DIVISION. LIVE DORMANT STAKES MAY BE USED FOR PLUGS.
- (I) COIR FIBER ROLLS SHALL BE KEPT DRY PRIOR TO INSTALLATION.
- (J) COIR FIBER ROLLS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

209-03.31 STREAM MITIGATION - COCONUT FIBER ROLLS PER LINEAR FOOT

EROSION CONTROL BLANKETS AND HERBACEOUS PLANT PLUGS SHALL BE PAID FOR ACCORDING TO THEIR RESPECTIVE ITEM NUMBERS.

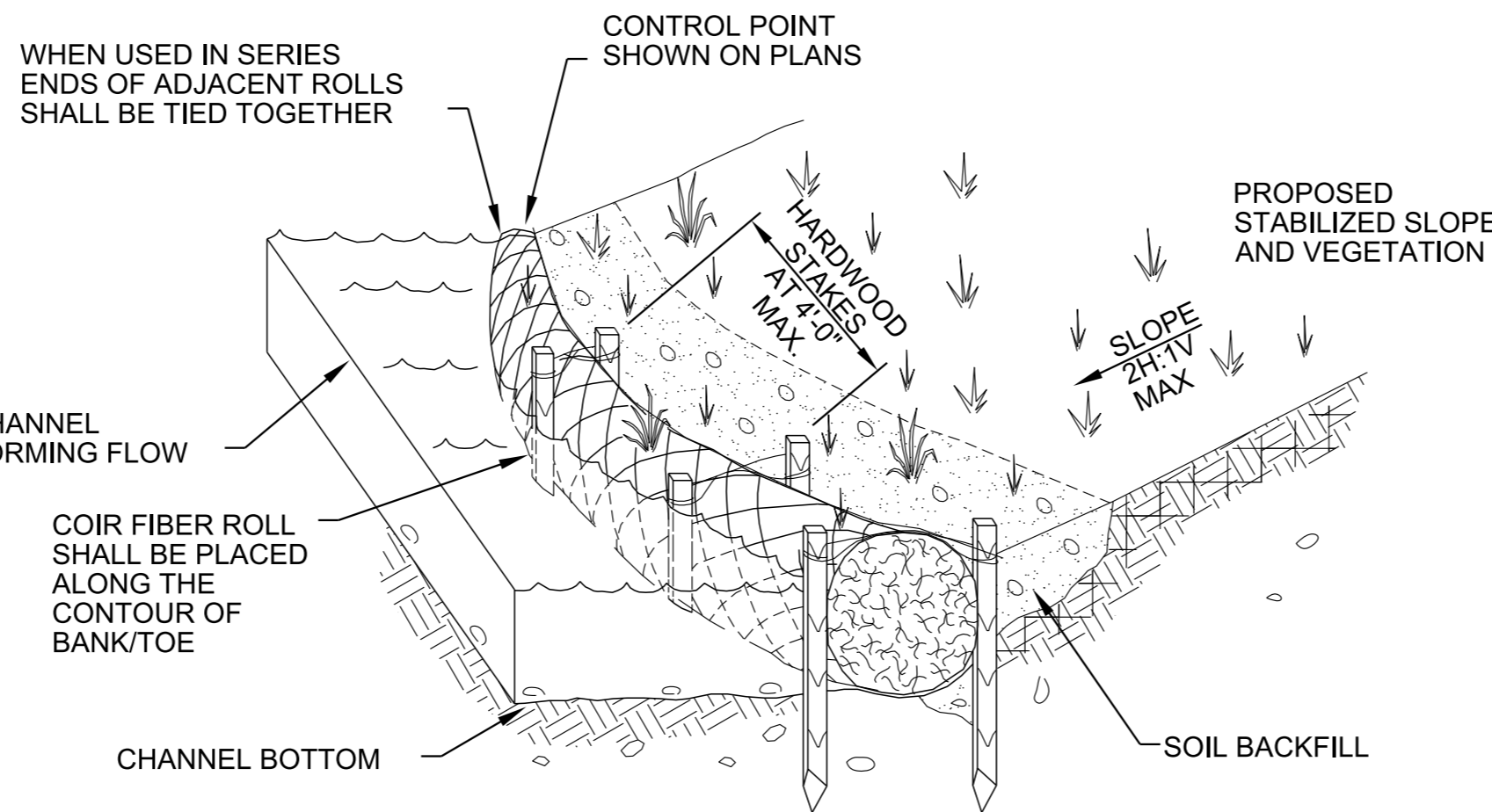
PAYMENT FOR COIR FIBER ROLLS SHALL INCLUDE ALL MATERIALS AND LABOR NECESSARY FOR THE INSTALLATION OF THE COIR FIBER ROLL.



SECTION VIEW
COIR FIBER ROLL

NOTE ①: DRIVE STAKES AS NEEDED SO TWINE IS SECURED AGAINST TOP OF ROLL.

NOTE ②: SPACING VARIES BASED ON ROLL DIAMETER 8, 12, 16, 18, 20-INCH (TYP.)



ISOMETRIC VIEW
COIR FIBER ROLL

STREAM MITIGATION PLAN LEGEND:

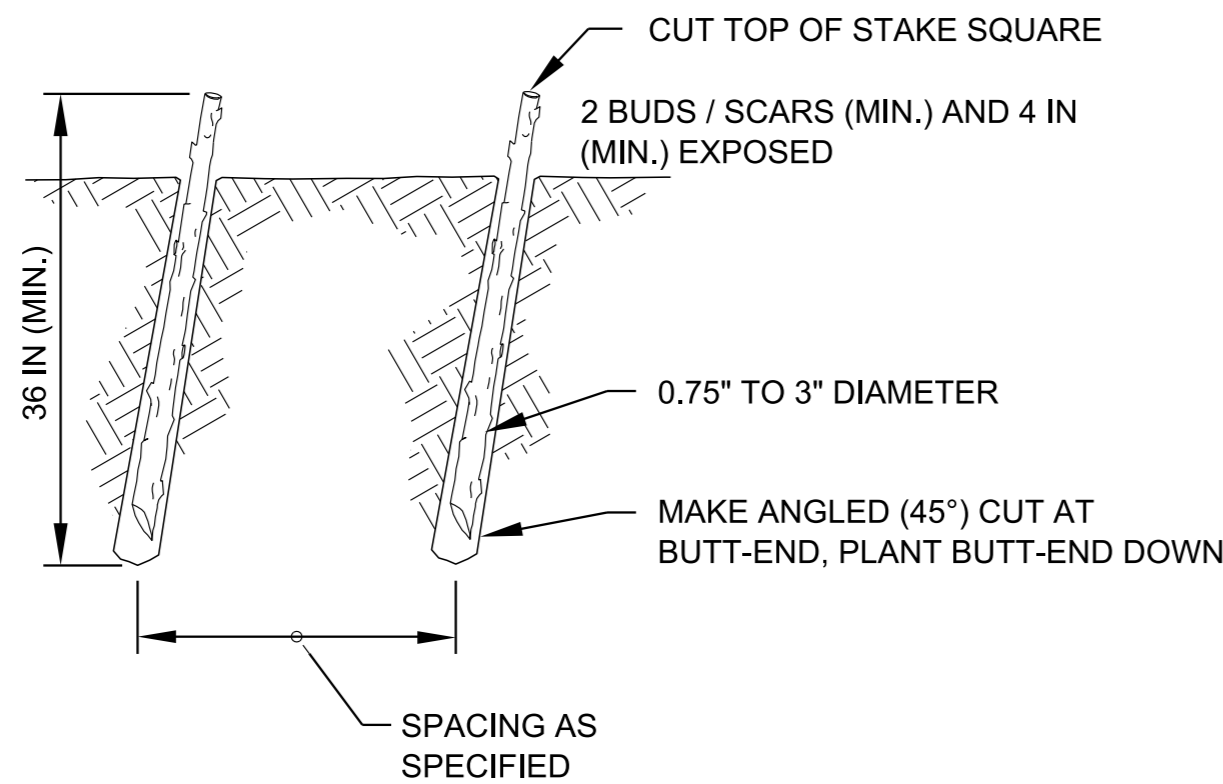
COCONUT FIBER ROLLS

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

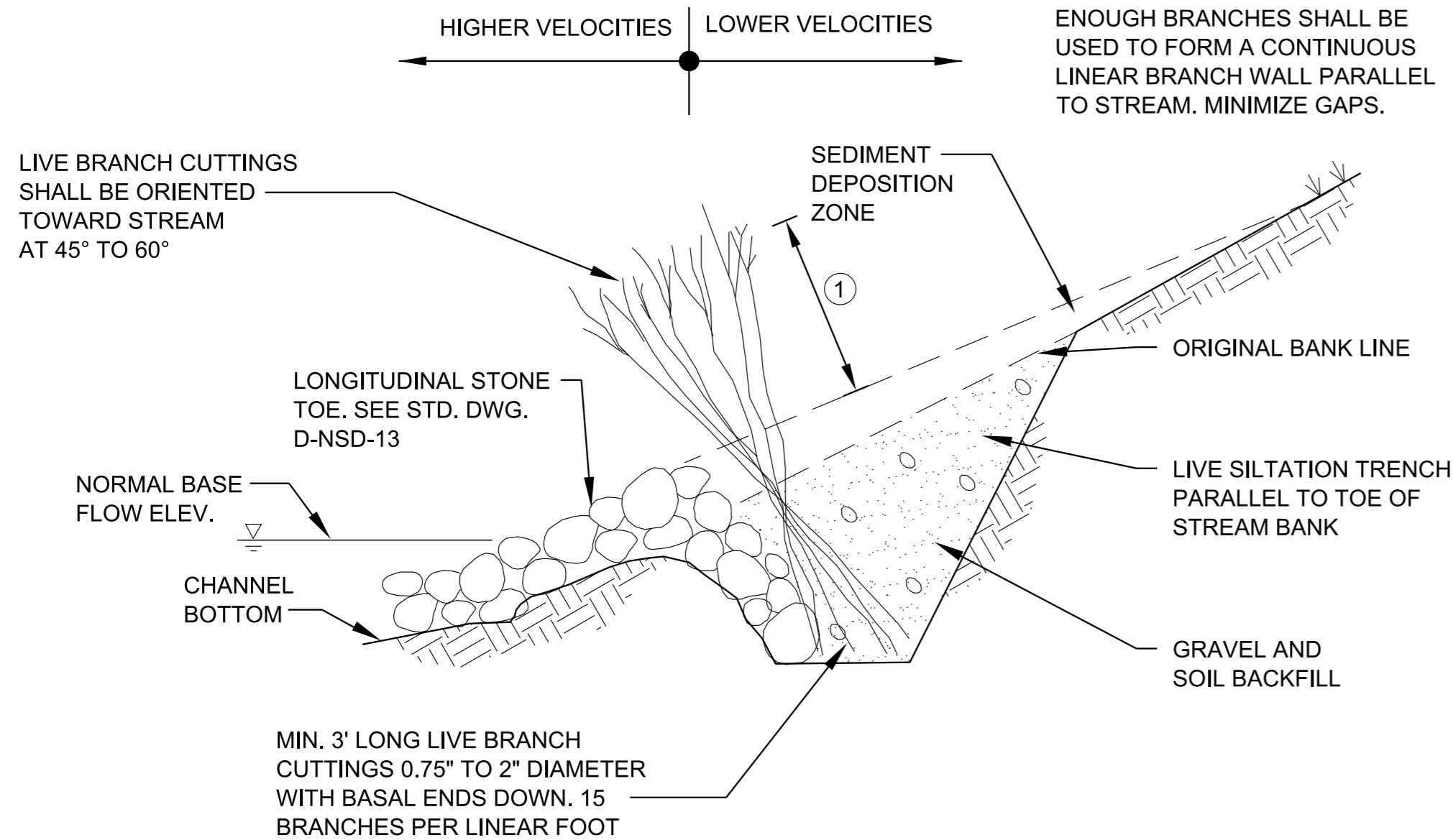
MINOR REVISION -- FHWA
APPROVAL NOT REQUIRED.

STATE OF TENNESSEE
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TRANSPORTATION

COIR FIBER
EROSION CONTROL
BLANKET AND COIR
FIBER ROLLS

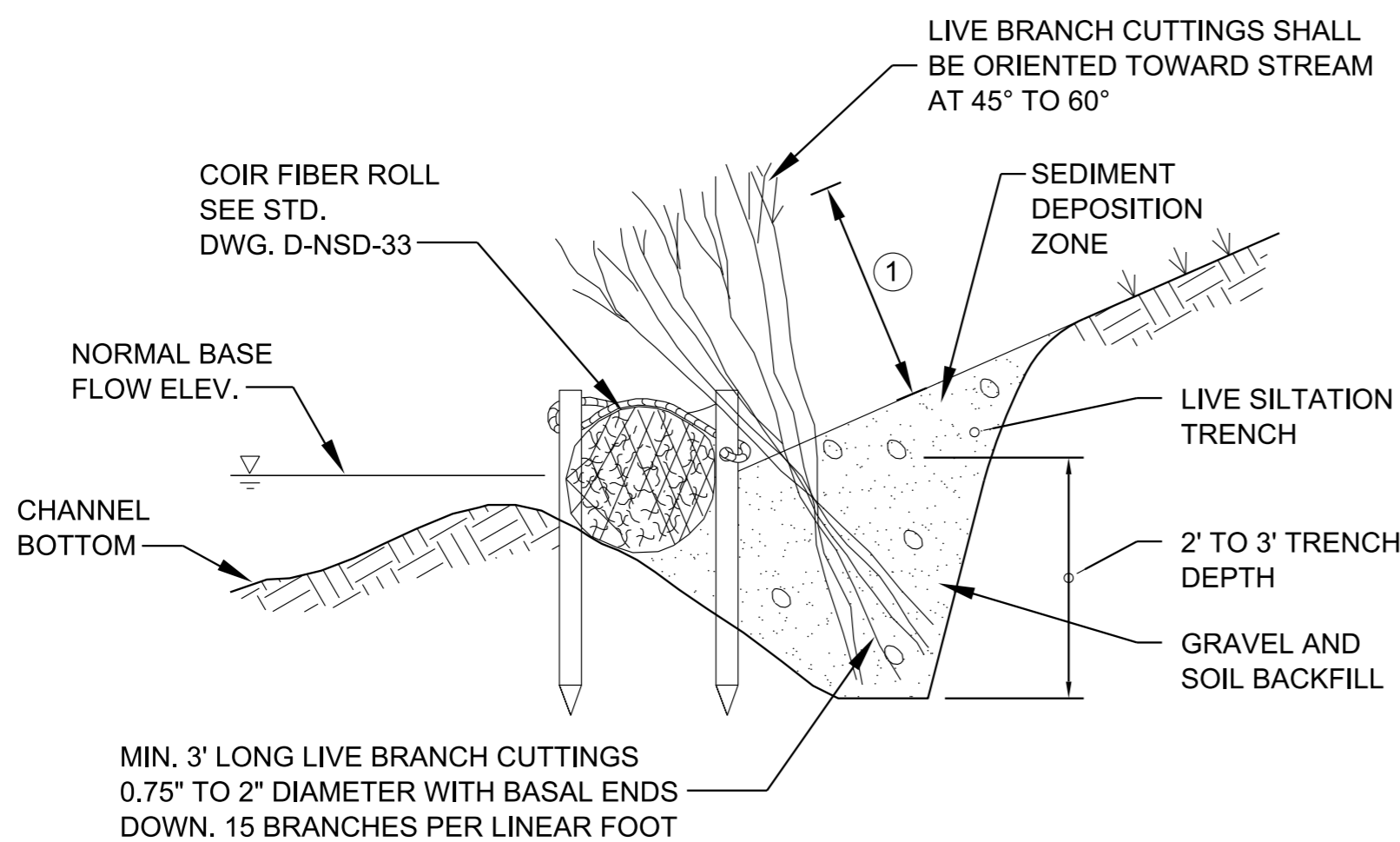


LIVE STAKE



SECTION VIEW - LIVE SILTATION WITH STONE TOE

NOTE ①: 1/3 OF THE BRANCH LENGTH SHALL BE ABOVE TRENCH



SECTION VIEW - LIVE SILTATION WITH COIR FIBER ROLL

NOTE ①: 1/3 OF THE BRANCH LENGTH SHALL BE ABOVE TRENCH

LIVE STAKES NOTES

- (A) LIVE STAKES ARE USED FOR VEGETATIVE STREAM BANK STABILIZATION AND RIPARIAN HABITAT RESTORATION.
- (B) LIVE STAKES SHOULD BE PLACED AT THE STATIONS, OFFSETS, AND ELEVATIONS INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE TYPE (SPECIES), SIZE, SPACING, AND QUANTITY OF LIVE STAKES SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) LIVE STAKES SHALL CONSIST OF WOODY LIVE CUTTINGS OF FAST-GROWING SHRUBS AND TREES (SUCH AS WILLOWS, DOGWOODS, BUTTONBUSH, ETC.), WHICH ARE CAPABLE OF GENERATING ROOTS FROM CUTTINGS WHEN PLACED IN WET OR MOIST SOIL.
- (D) LIVE STAKES SHALL BE AT LEAST ONE YEAR OLD, 0.75 INCH TO 3 INCHES IN DIAMETER, AND A MINIMUM OF 3 FEET LONG, WITH MOIST, GREEN, AND HEALTHY CAMBIUM AND GROWING LEAF BUDS LESS THAN 0.25 INCH. THE MAXIMUM LENGTH OF LIVE STAKES DEPENDS ON THE APPLICATION, AND SHALL BE AS SPECIFIED. WHEN LIVE STAKES ARE INSERTED IN RIP RAP OR STONE FILL, THEY SHALL BE LONG ENOUGH TO EXTEND THROUGH THE SURFACE OF THE RIP RAP OR STONE FILL AND AT LEAST HALF THE LENGTH SHALL BE INSERTED INTO THE SOIL, BELOW THE RIP RAP OR STONE FILL.
- (E) INSTALLING LIVE STAKES:
- (1) LIVE STAKES HARVESTED DURING DORMANCY SHALL BE MAINTAINED IN COLD STORAGE UNDER MOIST CONDITONS. SOAK THE BASE OF DORMANT-HARVESTED LIVE STAKES IN WATER AT LEAST 24 HOURS BEFORE PLANTING.
 - (2) LIVE STAKES HARVESTED ON SITE SHOULD BE INSTALLED THE SAME DAY THEY ARE PREPARED.
 - (3) PRIOR TO PLANTING, LIVE STAKES SHALL BE MAINTAINED IN A CONTINUOUSLY COOL, COVERED, AND MOIST STATE, WITH THE BASES SOAKING IN WATER.
 - (4) CARE SHALL BE TAKEN NOT TO DAMAGE LIVE STAKES DURING INSTALLATION. THOSE DAMAGED SHALL BE LEFT IN PLACE AND SUPPLEMENTED WITH AN INTACT LIVE CUTTING/LIVE STAKE.
 - (5) USE A DIGGING BAR, DIBBLE, OR SIMILAR TOOL TO MAKE A PILOT HOLE IN THE BANK 15 TO 18 INCHES DEEP.
 - (6) PLACE THE LIVE STAKE IN THE PILOT HOLE, SO THAT A MINIMUM OF 4 INCHES AND TWO LIVE BUDS OF THE LIVE STAKE ARE EXPOSED.
 - (7) TAMP THE SOIL AROUND LIVE STAKES.
- (F) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (G) LIVE STAKES SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- | | |
|-----------|--|
| 802-02.40 | CUTTINGS: SALIX NIGRA (24-48IN LENGTH) PER EACH |
| 802-02.41 | CUTTINGS: SALIX SERICEA (24-48IN) PER EACH |
| 802-02.42 | CUTTINGS: CORNUS AMOMUM (24-48IN) PER EACH |
| 802-02.43 | CUTTINGS: SAMBUCUS CANADENSIS (24-48IN) PER EACH |
| 802-02.44 | CUTTINGS: SALIX INTERIOR (24-48IN) PER EACH |
| 802-02.45 | CUTTINGS: CEPHALANTHUS OCCIDENTALIS (24-48IN) PER EACH |
| 802-02.46 | CUTTINGS: CORNUS SERICEA (24-48IN) PER EACH |
| 802-02.47 | CUTTINGS: ALNUS SERRULATA (24-48IN) PER EACH |
- PAYMENT SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR TO INSTALL THE LIVE STAKES.

LIVE SILTATION NOTES

- (A) LIVE SILTATION IS A BANK STABILIZATION MEASURE THAT NATURALLY REBUILDS A STREAM BANK THAT HAS ERODED BY SLOWING THE FLOW VELOCITY RESULTING IN THE DEPOSITION OF SEDIMENT DURING HIGH FLOWS. LIVE SILTATION ALSO ENHANCES THE ESTABLISHMENT AND GROWTH OF NATIVE VEGETATION ALONG THE STREAM BANK BY TRAPPING SEED AND ORGANIC MATERIAL ALONG THE SHORE LINE.
- (B) LIVE SILTATION SHOULD BE CONSTRUCTED AT THE TOE OF A STREAM BANK BEHIND ANY OTHER TOE OF SLOPE PROTECTION AND AT THE NORMAL BASE FLOW ELEVATION.
- (C) LIVE SILTATION SHOULD BE USED IN COMBINATION WITH LONGITUDINAL STONE TOE, ROOT WADS, OR COIR FIBER ROLLS.
- (D) ALLOWABLE VELOCITY OF FLOW FOR USING LIVE SILTATION SHALL BE 0.8 FT/SEC TO A MAXIMUM OF 6.6 FT/SEC WHEN USED WITH OTHER TOE STABILIZATION MEASURES, LIVE SILTATION MAY BE USED FOR FLOWS UP TO 12 FT/SEC MAXIMUM.
- (E) LIVE SILTATION MAY BE USED AT THE INSIDE OF A MEANDER BEND, WITHIN A SIDE CHANNEL, IN AREAS WHERE BANK SCOUR HAS OCCURRED, OR AT LOCATIONS WHERE THE FORMATION OF A NEW BANK IS DESIRED.
- (F) MULTIPLE ROWS OF LIVE SILTATION MAY BE USED PARALLEL TO THE STREAM BANK AND TO EACH OTHER. SPACING OF ROWS SHALL BE 5 TO 10 FEET.
- (G) CONSTRUCTION OF LIVE SILTATION SHOULD BE PERFORMED DURING THE DORMANT SEASON AND DURING LOW FLOW CONDITIONS.
- LIVE SILTATION SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:
- | | |
|-----------|---|
| 209-03.46 | STREAM MITIGATION - LIVE SILTATION (SPECIES) PER CUBIC YARD |
|-----------|---|
- (H) LONGITUDINAL STONE TOE AND COIR FIBER ROLLS SHALL BE PAID FOR ACCORDING TO THEIR RESPECTIVE STANDARD DRAWING.
- PAYMENT FOR LIVE SILTATION SHALL INCLUDE ALL MATERIALS AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE LIVE SILTATION SYSTEM.

MATERIAL SHOWN ARE ONLY A GRAPHICAL
REPRESENTATION AND DO NOT DEPICT
THE ACTUAL DEPTH OR QUANTITY OF
MATERIALS TO APPROPRIATELY
CONSTRUCT OR STABILIZE THE CHANNEL.

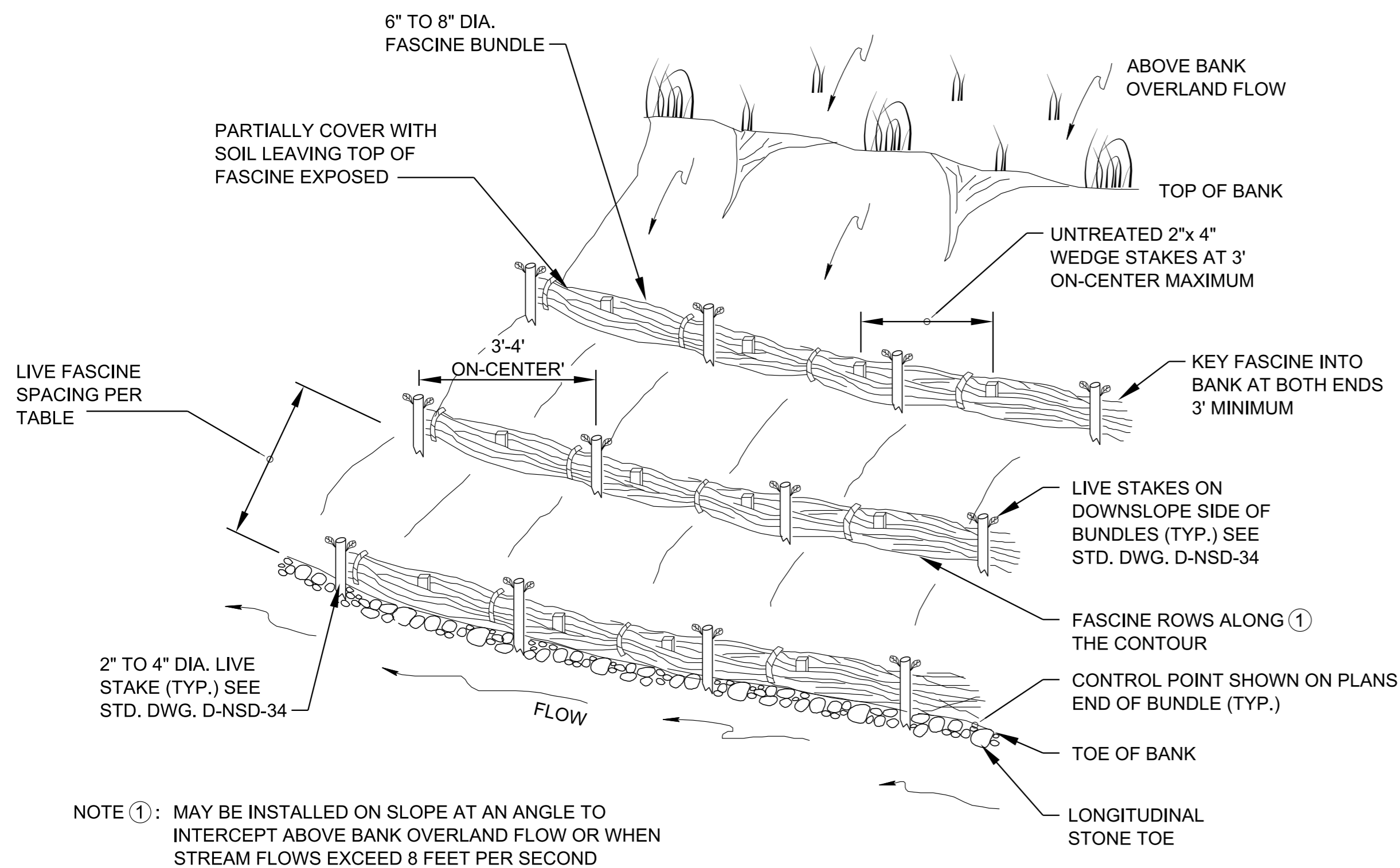
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LIVE STAKES AND
LIVE SILTATION

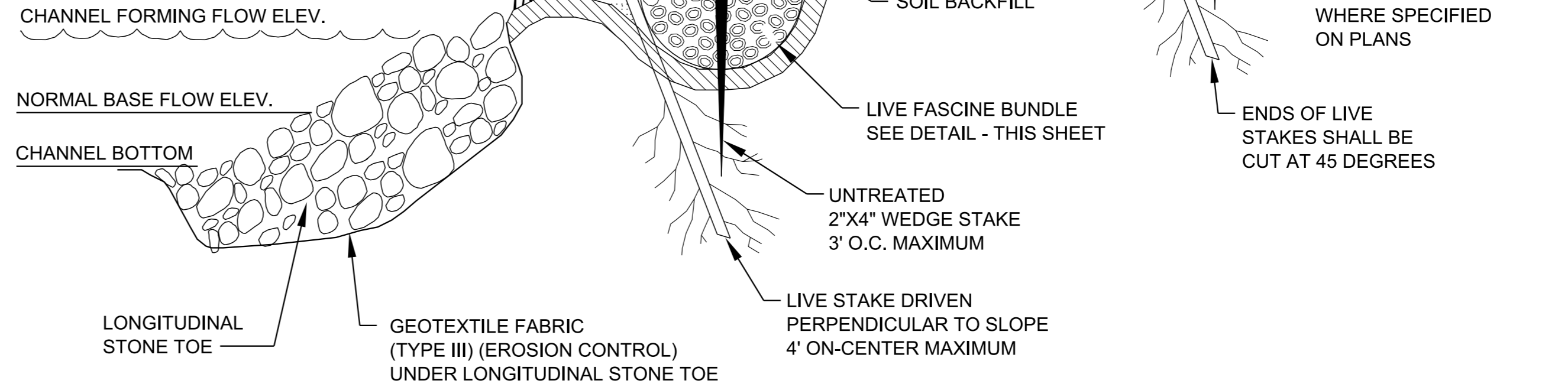
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ISOMETRIC VIEW

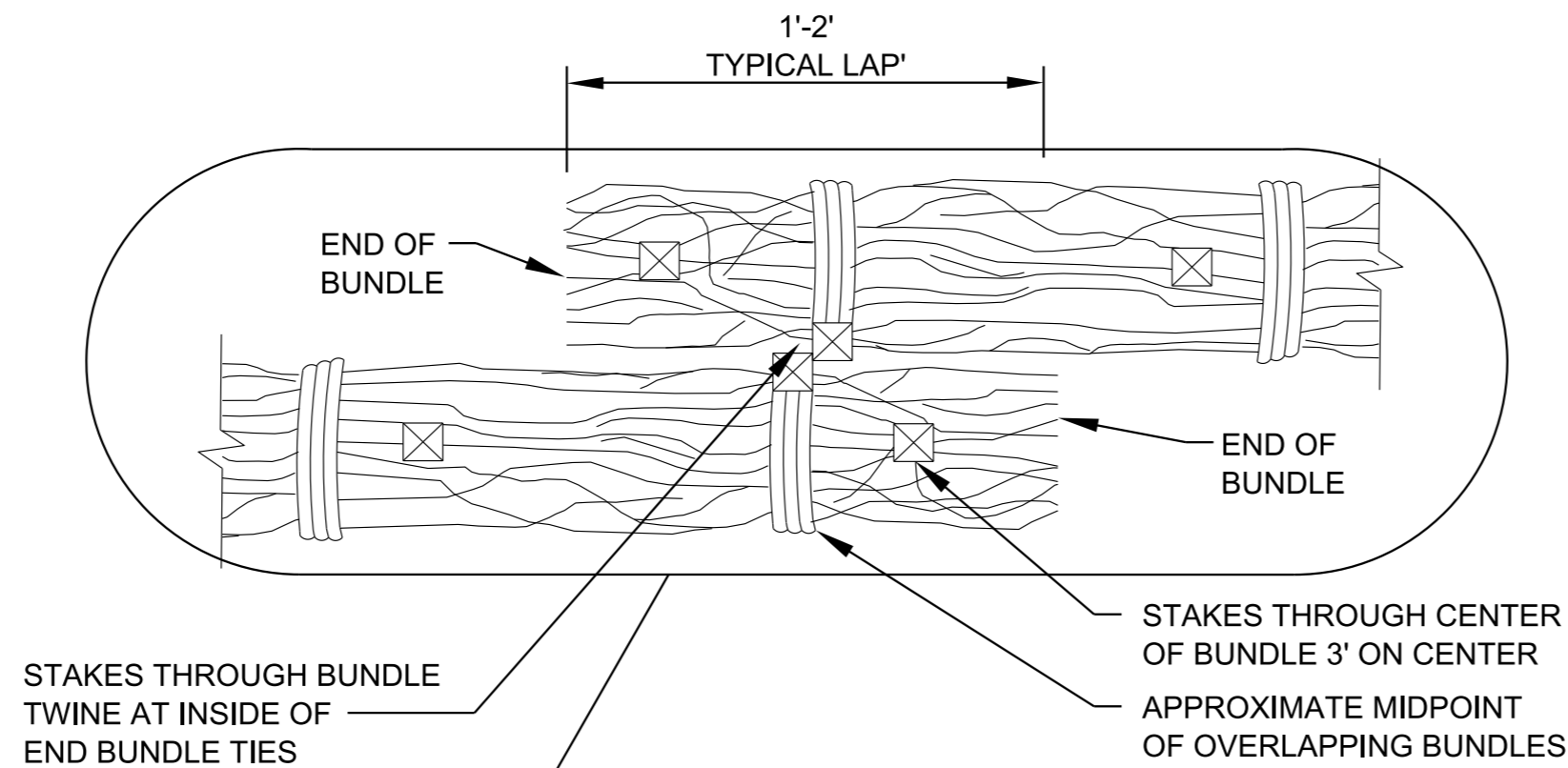
SHOWN ON SURFACE FOR CLARITY FASCINES SHALL BE TRENCHED IN AS SHOWN IN SECTION VIEW



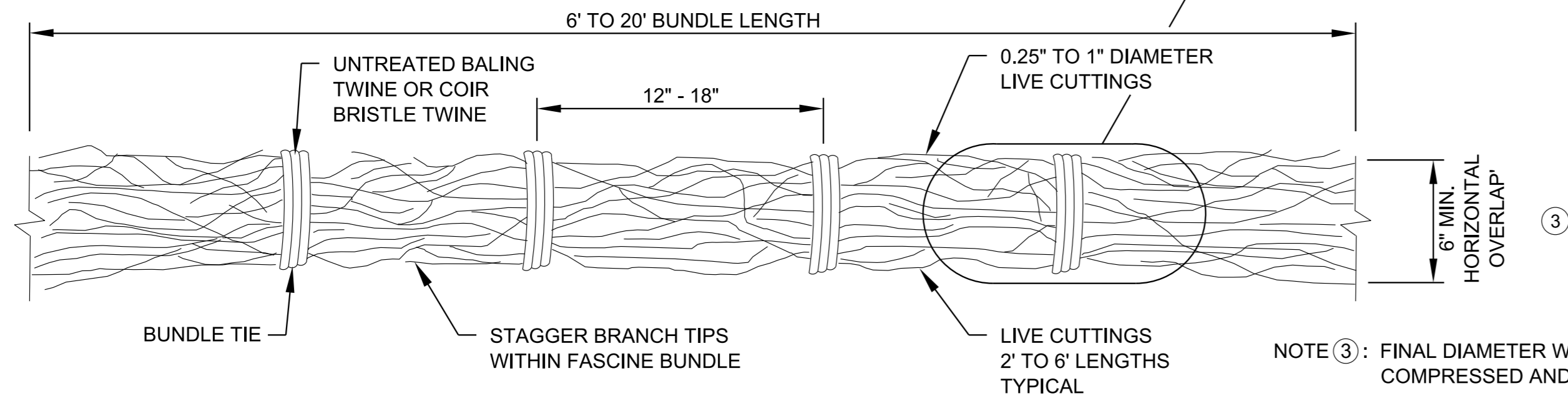
SECTION VIEW

LIVE FASCINE SPACING (FEET)		
SLOPE	SOIL TYPE	
	COHESIVE	NON-COHESIVE
1H:1V	3*	NA
1H:1V-2H:1V	3-4*	NA
2H:1V-3H:1V	4-5*	3-4*
3H:1V-4H:1V	5-6	4-5*
4:1 OR FLATTER	6-8	5-7

* USE OF AN EROSION CONTROL BLANKET BETWEEN THE LIVE FASCINE AND BANK RECOMMENDED



OVERLAP DETAIL



LIVE FASCINES DETAIL

LIVE FASCINES NOTES

- (A) LIVE FASCINES ARE CYLINDRICAL BUNDLES OF LIVE BRANCH CUTTINGS USED AS A BANK STABILIZATION MEASURE TO PROTECT A BANK AND TOE FROM SURFACE EROSION, TRAP SEDIMENTS, AND INCREASE SLOPE STABILITY WITH A DEVELOPED ROOT SYSTEM. FASCINES ARE USED ABOVE THE BASE FLOW ELEVATION OF A SLOPE TO TRAP SEED AND SEDIMENT AND TO ENHANCE CONDITIONS FOR COLONIZATION OF NATIVE VEGETATION USED IN THE BUNDLES.
- (B) CONSTRUCTION OF FASCINES ON SLOPES SHALL CONFORM TO ASTM D6599.
- (C) THIS MEASURE MAY BE COMBINED WITH OTHER SLOPE STABILIZATION MEASURES INCLUDING LIVE STAKES, EROSION CONTROL BLANKET, TURF REINFORCED MAT, BRUSH MATTRESSES, AND LONGITUDINAL STONE TOE.
- (D) NOT SUITABLE FOR USE ON SLOPES COMPRISED OF SAND, GRAVEL, OR ROCK, OR ON SLOPES THAT ARE NOT IN FULL SUNLIGHT. FASCINES SHALL NOT BE USED WHERE THEY WILL BE SUBJECTED TO CONCENTRATED FLOW FROM ABOVE THE STREAMBANK OR WHERE CHANNEL FLOW VELOCITIES EXCEED 12 FEET PER SECOND.
- (E) FASCINES SHALL BE PLACED ON A SLOPE ALONG THE CONTOUR AND SHALL BE KEYED INTO BANK AT BOTH ENDS OF THE FASCINE ROW A MINIMUM OF 3 FEET.
- (F) FASCINE BUNDLES SHALL BE CONSTRUCTED OF LIVE DORMANT BRANCH CUTTINGS RANDOMLY BOUND TOGETHER WITH UNTREATED TWINE EVERY 12 TO 18 INCHES. BASAL (CUT) ENDS OF BRANCHES SHALL BE ALTERNATING WITHIN THE FASCINE BUNDLE.
- (G) FASCINES SHALL BE OVERLAPPED AT THE ENDS A MINIMUM OF ONE FOOT WITH THE UPSTREAM FASCINE OVERLAPPING BELOW THE DOWNSTREAM FASCINE.
- (H) UNTREATED 2"x4" WEDGE STAKES SHALL BE INSTALLED FLUSH WITH THE TOP OF THE FASCINE BUNDLES AND SHALL BE SPACED AT 3 FEET ON-CENTER MAXIMUM.
- (I) LIVE DORMANT BRANCH CUTTINGS SHALL BE OBTAINED FROM LOCAL SOURCES APPROVED BY THE ENGINEER.
- (J) LIVE FASCINES SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

209-03.45 STREAM MITIGATION - LIVE FASCINES (SPECIES) PER LINEAR FOOT

LIVE STAKES, LONGITUDINAL STONE TOE, EROSION CONTROL BLANKETS AND TURF REINFORCED MATS SHALL BE PAID FOR ACCORDING TO THEIR RESPECTIVE ITEM NUMBERS.

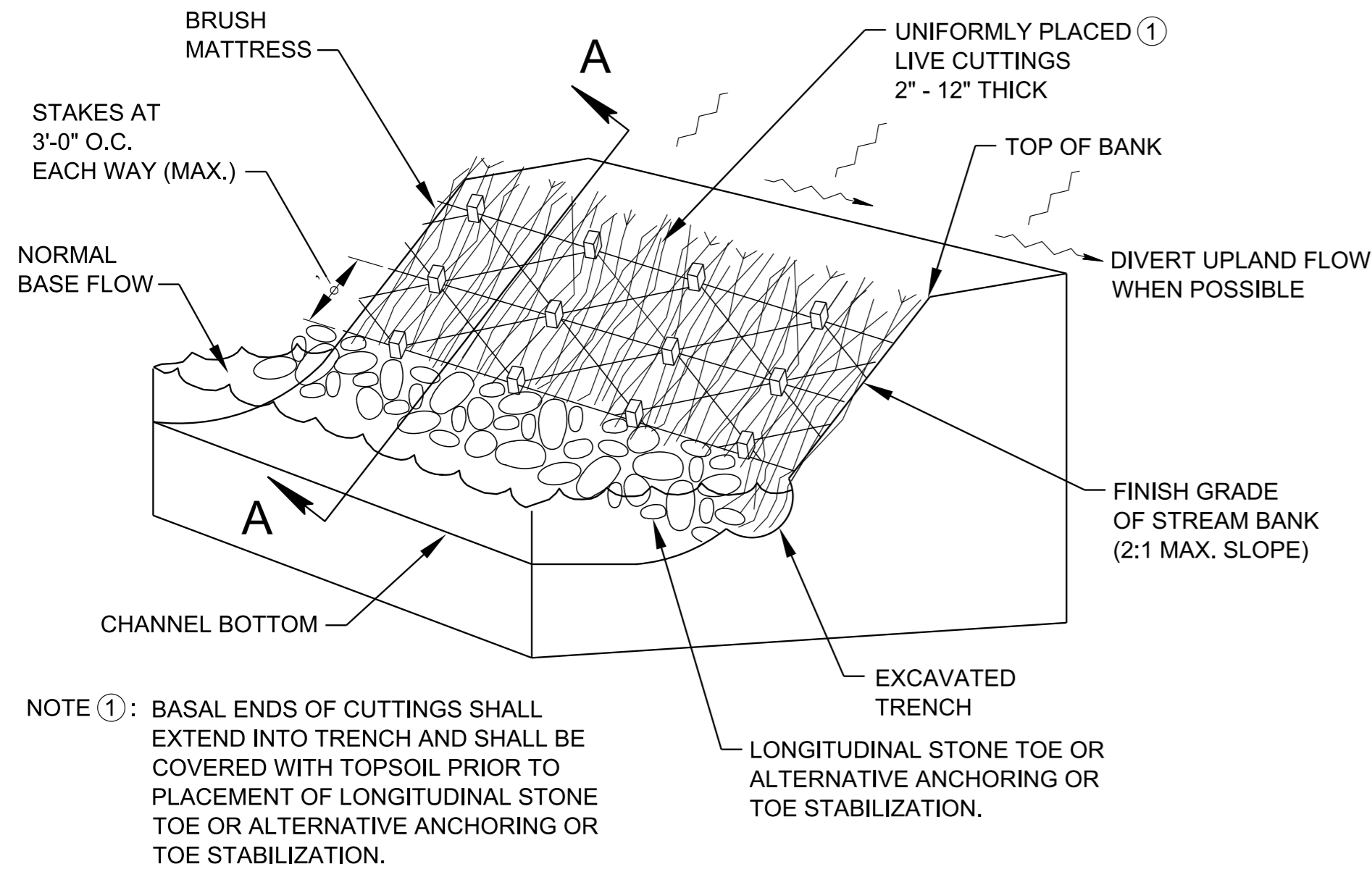
PAYMENT FOR LIVE FASCINES SHALL INCLUDE ALL MATERIALS AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE LIVE FASCINE.

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

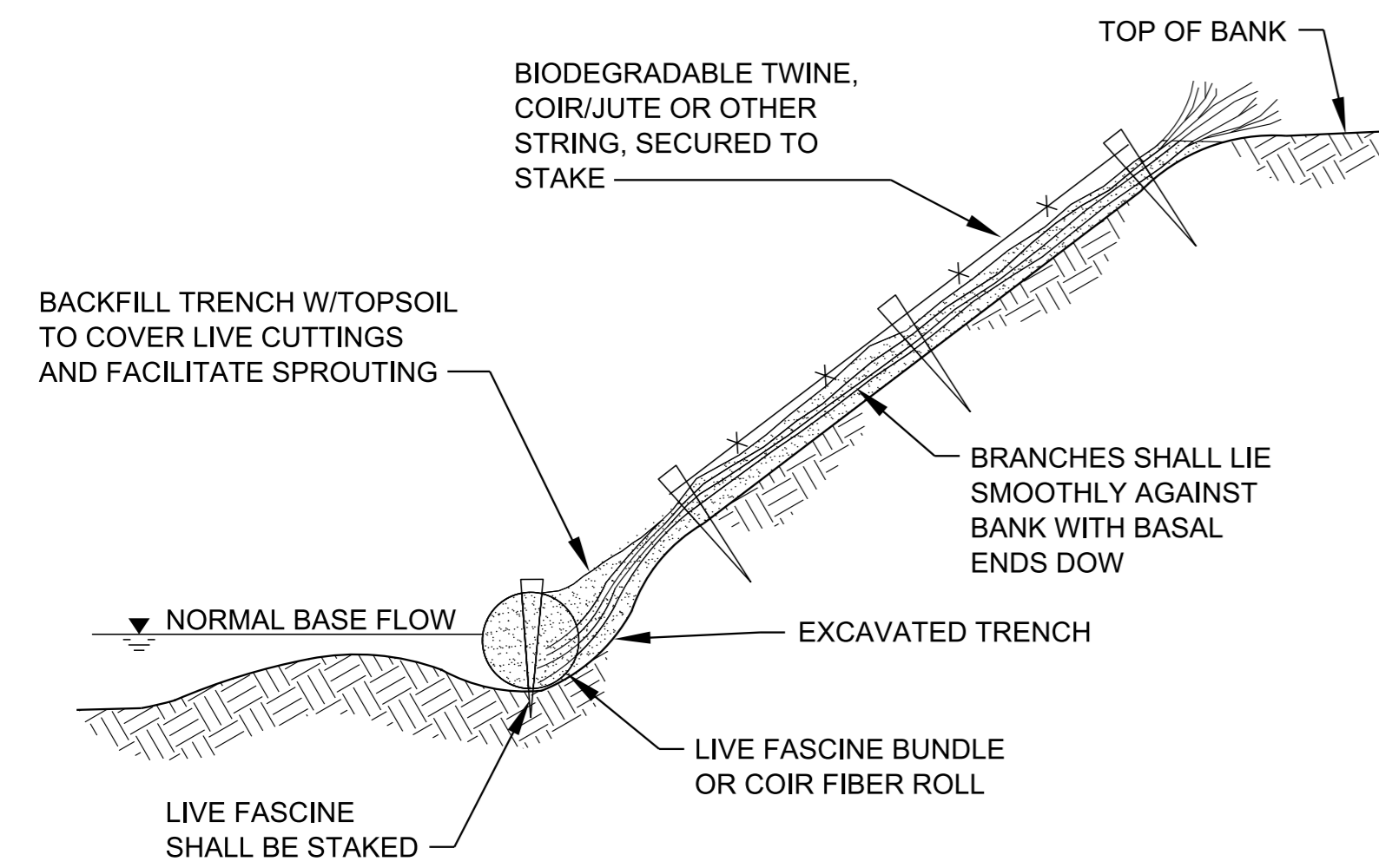
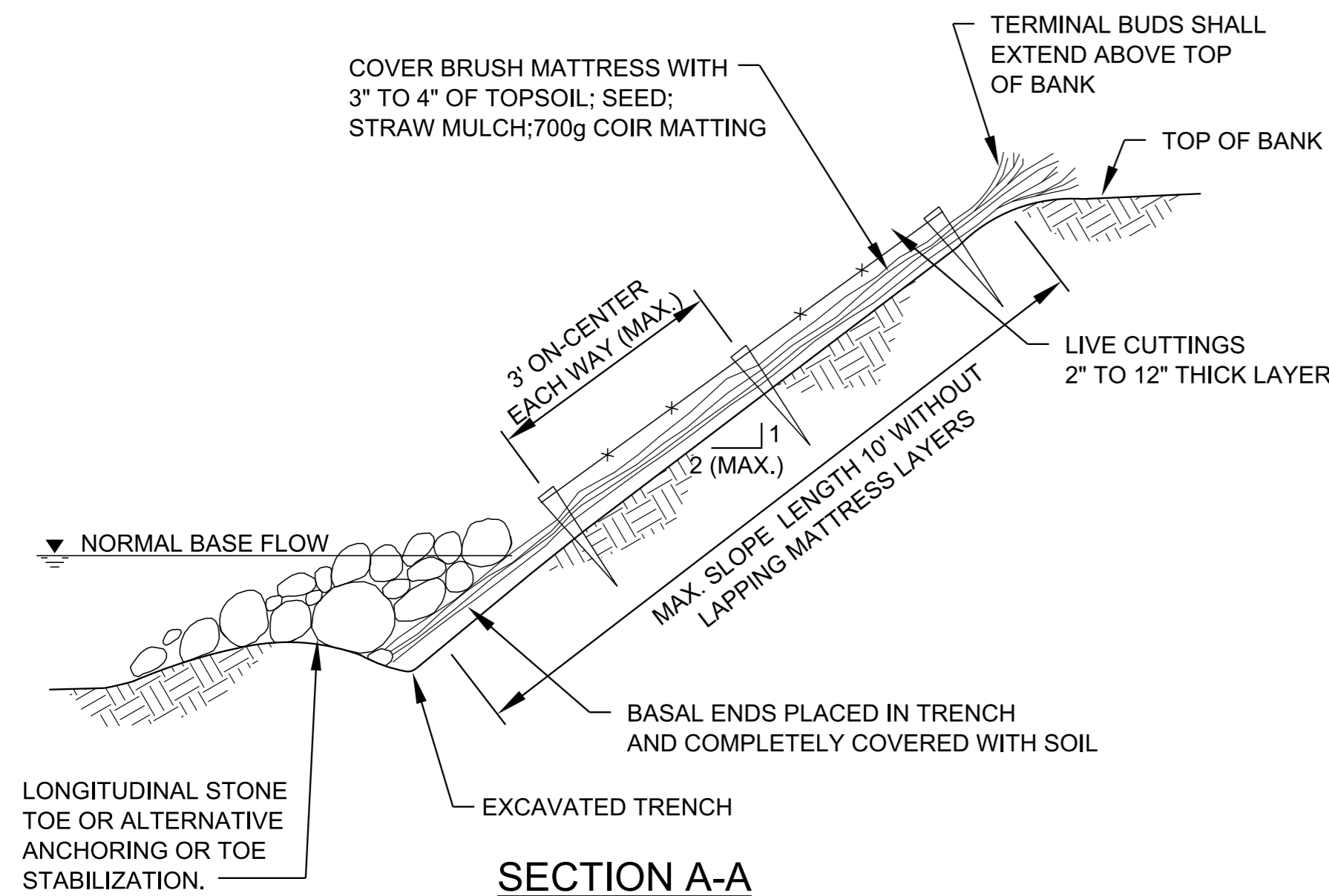
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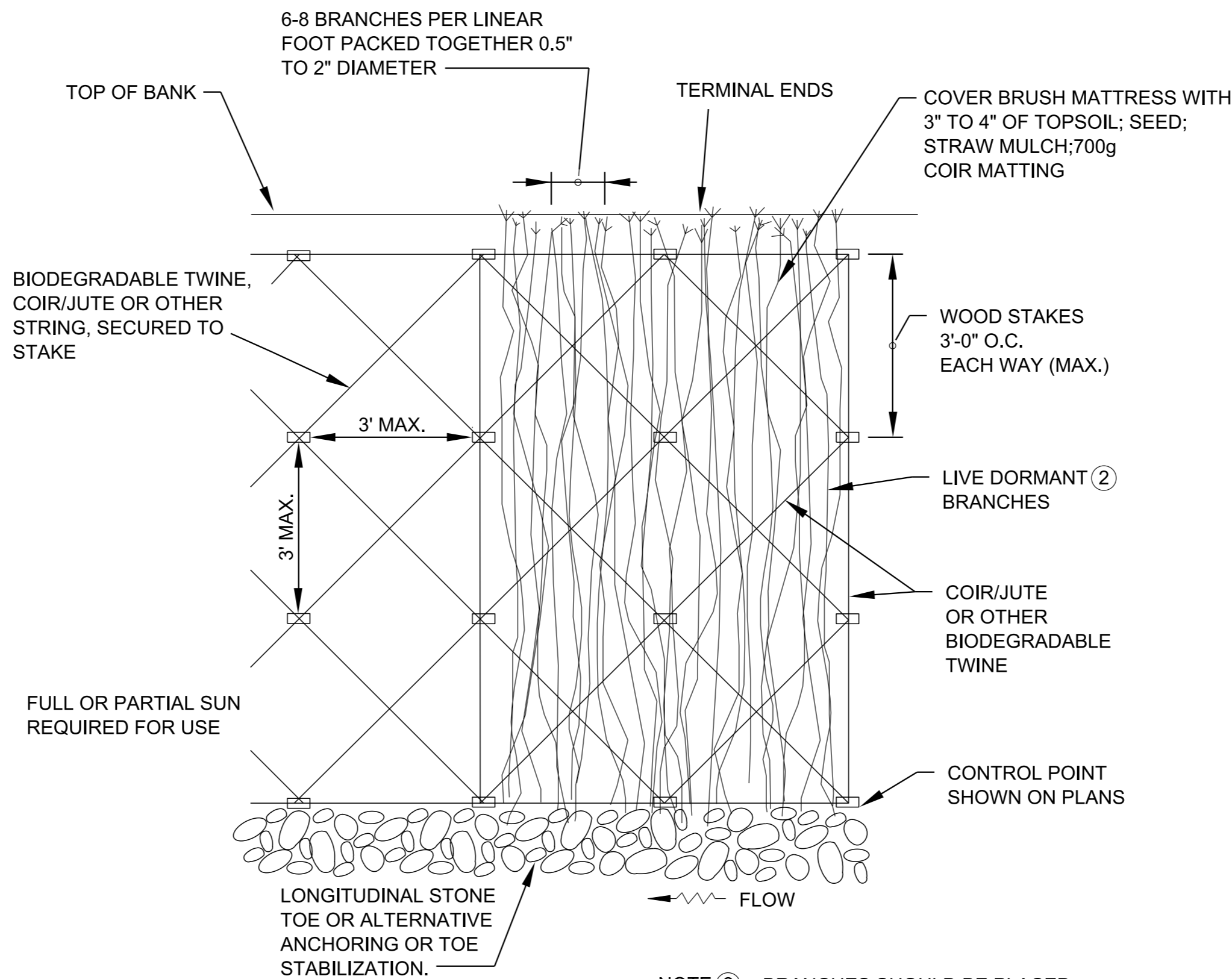
LIVE FASCINES



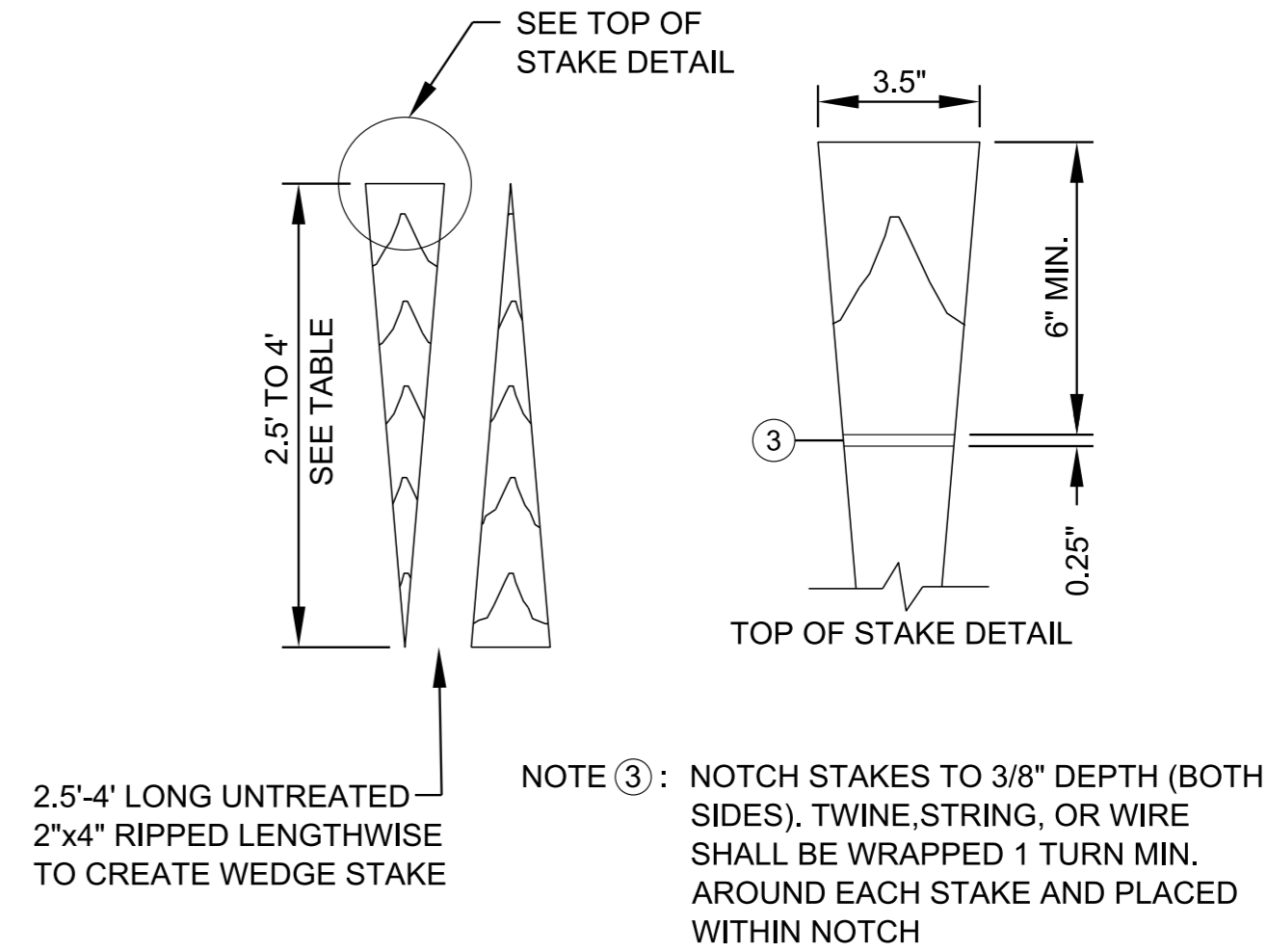
ISOMETRIC VIEW



EXAMPLE OF ALTERNATIVE
STABILIZATION AT TOE OF SLOPE



PLAN VIEW



BRUSH MATTRESS
STAKE DETAIL

STAKE LENGTH	
SOIL TYPE	LENGTH (FEET)
CLAY	2.5
SILT	3.0
SAND	4.0
LOAM	2.5

BRUSH MATTRESS NOTES

A	BRUSH MATTRESS IS A BANK STABILIZATION PRACTICE THAT PROTECTS A STREAMBANK FROM EROSION, CAPTURES SEDIMENT DURING HIGH FLOWS, AND ENHANCES THE ESTABLISHMENT AND GROWTH OF NATIVE VEGETATION USING LIVE BRANCHES AND CUTTINGS ANCHORED TO THE STREAM BANK.	I	TYPICAL INSTALLATION SEQUENCE:
			(1) COLLECT AND SOAK LIVE BRANCHES A MINIMUM OF 24 HOURS. 5-7 DAYS PREFERRED. LEAVE SIDE BRANCHES INTACT. (2) EXCAVATE BANK TO DESIRED GRADE CLEARING AWAY LARGE DEBRIS. (3) EXCAVATE AN 8 TO 12-INCH DEEP HORIZONTAL TRENCH AT THE TOE OF SLOPE. (4) LAY CUTTINGS FLAT AGAINST THE SLOPE WITH BASAL ENDS PLACED DEEPLY IN THE TRENCH EXPOSED TO MOIST SOIL. (5) INSTALL WEDGE STAKES OR LIVE STAKES LEAVING APPROXIMATELY 12 INCHES OF THE TOP OF STAKE EXPOSED. DISCARD AND REPLACE SHATTERED STAKES. (6) TIE TWINE, STRING, OR OTHER BIODEGRADABLE WIRE AROUND STAKES IN A DIAGONAL PATTERN BETWEEN EACH ROW OF STAKES. (7) DRIVE THE STAKES IN FURTHER TO COMPRESS THE MATTRESS AGAINST THE SLOPE LEAVING A MINIMUM OF 6 INCHES OF THE STAKE ABOVE THE MATTRESS. (8) INSTALL LONGITUDINAL STONE TOE OR OTHER APPROVED ALTERNATE IN TRENCH. (9) BACKFILL IN AND BETWEEN THE BRANCHES WITH LOOSE MATERIAL UNTIL APPROXIMATELY HALF THE MATTRESS REMAINS EXPOSED. WET THE SURFACE TO WASH SOIL DOWN BETWEEN THE BRANCHES. (10) COVER BRUSH MATTRESS WITH 3-4 INCHES OF TOPSOIL TO PROVIDE ROOTING MEDIUM. SPREAD TEMPORARY AND PERMANENT SEED MIX, STRAW MUCH AND MEDIUN. INSTALL COIR MATTING OVER BRUSH MATTRESS.
B	BRUSH MATTRESSES SHOULD NOT BE USED WHERE PERENNIAL (YEAR ROUND) STREAM FLOW IS NOT PRESENT OR ALONG STREAMS WITH ANTICIPATED HIGH SEDIMENT LOADS.	J	ALL TWINE, STRING, WIRE OR OTHER MEASURES USED FOR SECURING MATTRESS TO STAKES SHALL BE BIODEGRADABLE. WHERE COIR TWINE IS USED, IT SHALL BE MACHINE SPUN BRISTLE COIR OF 0.2 TO 0.25-INCH THICKNESS WITH BREAK STRENGTH OF 70 TO 100 POUNDS. JUTE OR OTHER BIODEGRADABLE MATERIAL IS ACCEPTABLE. BRANCHES SHALL BE FLEXIBLE ENOUGH TO CONFORM TO ANY SLOPE SURFACE IRREGULARITIES AND SHOULD BE INSTALLED DURING DORMANT SEASON.
C	LIVE DORMANT CUTTINGS SHALL BE PLACED ON THE SLOPE PERPENDICULAR TO THE STREAM AND THE MATTRESS SHALL BE BETWEEN 2 INCHES AND 12 INCHES THICK. CUTTINGS SHALL BE STRAIGHT, FLEXIBLE BRANCHES OF WILLOW, SHRUB DOGWOOD, OR OTHER APPROVED SPECIES.	K	BRUSH MATTRESS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER: 209-03.59 STREAM MITIGATION - BRUSH MATTRESS PER SQUARE YARD
D	LIVE DORMANT CUTTINGS OR BRANCHES SHALL BE A MINIMUM OF 0.5-INCHES IN DIAMETER AT THE BASAL END AND NO GREATER THAN 2 INCHES. BASAL ENDS OF THE BRANCHES SHOULD BE CUT AT A 30 TO 45 DEGREE ANGLE AND SHALL BE INSTALLED BELOW THE NORMAL BASE FLOW ELEVATION IN THE TRENCH.		LONGITUDINAL STONE TOE, COIR FIBER ROLL, AND LIVE FASCINE BUNDLES SHALL BE PAID FOR ACCORDING TO THEIR RESPECTIVE STANDARD DRAWINGS.
E	MAXIMUM GRADE OF SLOPE FOR BRUSH MATTRESS SHALL BE 2H:1V OR FLATTER AND SHALL BE UNIFORMLY GRADED AND SHAPED TO PROVIDE ADEQUATE SOIL TO STEM CONTACT. MAXIMUM FACE LENGTH OF SLOPE SHALL BE 10 FEET. WHERE LONGER SLOPES ARE PRESENT, USE MULTIPLE ROWS OF BRUSH MATTRESS WITH MINIMUM 1 FOOT OVERLAP. TERMINAL ENDS OF LOWER ROW SHALL LAP OVER THE BASAL ENDS OF UPPER ROW.		PAYMENT FOR BRUSH MATTRESS SHALL INCLUDE ALL MATERIALS AND LABOR NECESSARY FOR THE CONSTRUCTION OF THE MATTRESS.
F	CARE SHOULD BE TAKEN WHEN INSTALLING LONGITUDINAL STONE TOE, COIR FIBER ROLLS OR LIVE FASCINES IN TRENCH TO AVOID PUTTING THE BRANCHES IN TENSION AND LIFTING THEM FROM THE STREAMBANK.		
G	ROCK FOR LONGITUDINAL STONE TOE OR ALTERNATIVE TOE STABILIZATION SHALL BE SIZED ACCORDING TO COMPUTED FLOW VELOCITY AND SHEAR STRESS ALONG THE BANK. FOR ADDITIONAL DETAILS OF LONGITUDINAL STONE TOE SEE STANDARD DRAWING D-NSD-13. FOR DETAILS OF LIVE FASCINES SEE STANDARD DRAWING D-NSD-35.		
H	WOOD STAKES MAY BE STANDARD COMMERCIAL GRADE UNTREATED LUMBER CUT TO LENGTH, RIPPED LENGTHWISE TO PRODUCE TWO WEDGE SHAPED STAKES, AND NOTCHED AT THE TOP TO ACCEPT 1 TURN OF THE TWINE, STRING, OR BIODEGRADABLE WIRE WITHIN THE NOTCH. WHERE DORMANT LIVE STAKES ARE USED INSTEAD OF DEAD STAKES, NOTCH FOR TWINE SHALL BE OMITTED. NON-BIODEGRADABLE STAKES ARE NOT PERMITTED FOR USE WITH BRUSH MATTRESS.		

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

NOT TO SCALE

STATE OF TENNESSEE
DEPARTMENT OF
TRANSPORTATION

BRUSH
MATTRESS

