



To: SUPERSEDED BY EB 21-057 EFFECTIVE 11/24/21		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 02-020
Title: SOIL BIOENGINEERING/BIO TECHNICAL ENGINEERING - SPECIAL SPECIFICATIONS			
Distribution: <input type="checkbox"/> Manufacturers (18) <input type="checkbox"/> Surveyors (33) <input checked="" type="checkbox"/> Main Office (30) <input checked="" type="checkbox"/> Consultants (34) <input type="checkbox"/> Local Govt. (31) <input type="checkbox"/> Contractors (39) <input checked="" type="checkbox"/> Regions/Agencies (32) <input type="checkbox"/> ()	Approved:  P. J. Clark, Deputy Chief Engineer, Design <u>07/15/02</u> Date		

ADMINISTRATIVE INFORMATION:

- This Engineering Instruction (EI) is effective with projects submitted for the letting of 01/16/03.
- This issuance does not supersede any previous issuances. It complements EI 02-019 Soil Bioengineering/Biotechnical Engineering - Design Guidance and EB 02-037 Soil Bioengineering/Biotechnical Engineering - Details
- The contents of this EI ultimately will reside in the NYSDOT Standard Specifications.

PURPOSE: To issue special specifications pertaining to the title subject.

TECHNICAL INFORMATION:

Soil bioengineering/biotechnical erosion control methods are revegetation and stabilization technologies applied on disturbed sites, including slopes and streambanks.

Soil bioengineering is the reliance on plant material for slope protection, rebuilding and stabilization, erosion control, etc.

Soil biotechnical engineering combines the use of plant materials and structural elements to achieve the same goal. The attached transmitted materials; vegetated cribwall, vegetated gabions, and vegetated mats are examples of soil biotechnical engineering.

Policy. Where there is a need for a more natural approach to bank stabilization, soil bioengineering/biotechnical engineering should be considered. However, a thorough assessment of the site should be undertaken to determine the appropriateness of these approaches. This site assessment should include a multidisciplinary consideration of slope geometry, aspect, climate, water regime, soil properties, and surrounding vegetation.

Consult the Regional Geotechnical Engineer, the Regional Hydraulics Engineer and the Regional Landscape Architect about characteristics of specific sites which may warrant hard armor or a combination of hard armor and soil bioengineering erosion control. Additionally the Regional Landscape Architect should be consulted for specific site conditions appropriate for these techniques and plant material recommendations.

The designer should note that with several of the specifications other items are involved which are not being paid for under the Soil Bioengineering item itself. These extra items should be

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taken into consideration when developing the estimate of quantities. See the table below which shows this relationship.

Items Being Specified	Associated Items Which May Be Needed
24616.11 M - Vegetated Gabion 24616.12 M - Vegetated Crib Wall 24616.13 M - Tree Revetment 24616.14 M - Rootwad Revetment 24616.15 M - Live Fascines 24616.17 M - Brushmattressing 24616.19 M - Branchpacking	24616.20 Select Clean Fill
24616.11 M - Vegetated Gabion 24616.12 M - Vegetated Crib Wall	203.02 M Unclassified Excavation and Disposal
24616.12 M - Vegetated Crib Wall	620.03 Stone Filling
24616.07-.09 M - Live Cuttings/live Stakes 24616.10 M - Brushlayering 24616.11 M - Vegetated Gabion 24616.12 M - Vegetated Crib Wall 24616.15 M - Live Fascines 24616.16 M - Fiber Rolls 24616.17 M - Brushmattressing 24616.18 M - Vegetated Mat 24616.19 M - Branchpacking	Misc. erosion control material or methods
24616.15 M - Live Fascines 24616.16 M - Fiber Rolls 24616.17 M - Brushmattressing 24616.18 M - Vegetated Mat	24616.07-.09 M - Live Cuttings/live Stakes
24616.17 M - Brushmattressing	24616.15 M - Live Fascines

TRANSMITTED MATERIALS:

New Specifications:

- ITEM 24616.07-.09 M - LIVE CUTTINGS/LIVE STAKES
- ITEM 24616.10 M - BRUSHLAYERING
- ITEM 24616.11 M - VEGETATED GABION
- ITEM 24616.12 M - VEGETATED CRIB WALL
- ITEM 24616.13 M - TREE REVETMENT
- ITEM 24616.14 M - ROOTWAD REVETMENT
- ITEM 24616.15 M - LIVE FASCINES
- ITEM 24616.16 M - FIBER ROLLS
- ITEM 24616.17 M - BRUSHMATTRESSING

ITEM 24616.18 M - VEGETATED MAT
ITEM 24616.19 M - BRANHPACKING
ITEM 24616.20 M - SELECT CLEAN FILL

REFERENCES:

U.S. Dept. Of Transportation, Publication No. FHWA NHI 01-003, (March 2001)
Hydraulic Engineering Circular No. 23
"Bridge Scour and Stream Instability Countermeasures
Experience, Selection, and Design Guidance, 2nd Edition"
U.S. Dept. Of Transportation, Federal Highway Administration
400 7th Street, S.W.
Washington, D.C. 20590
<http://www.fhwa.dot.gov/>

U.S. Dept. Of Agriculture, Natural Resource Conservation Service, Engineering Field
Handbook, Chapters 16 and 18, "Soil Bioengineering for Upland Slope Protection and Erosion
Reduction." December 1995
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Rd.
Springfield VA 22161
(800) 553-6847 <http://www.nrcs.usda.gov/>

United States Army Corp of Engineers Technical Report EL-97-8, April 1997
"Bioengineering for Stream Bank Erosion Control"
by Allen, Hollis H. and Leech, James R.
Public Affairs Office
U.S. Army Engineer
Waterways Experiment Station
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199
(601) 634-2502
<http://www.wes.army.mil/>

"Biotechnical and Soil Bioengineering Slope Stabilization, a Practical Guide for Erosion
Control"
by Gray, Donald H. and Sotir, Robbin B.
Wiley-Interscience Publication
October 1995

CONTACT:

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ITEM 24616.07 M -- LIVE CUTTING PLANTING

ITEM 24616.08 M -- LIVE STAKE PLANTING (26 to 50 mm)

ITEM 24616.09 M -- LIVE STAKE PLANTING (51 to 100 mm)

DESCRIPTION

Live cuttings and live stakes consist of branch cuttings from freshly cut dormant plants. Under this item the Contractor shall furnish and install live cuttings and/or live stakes in soil, in joint plantings (plantings located in joints in riprap and stone fill), and in other erosion control applications in accordance with the contract documents.

MATERIALS

Live cuttings shall be 12 to 25 mm in diameter and 0.3 to 1.2 m long.

Live stakes shall be 26 to 50 mm or 51 to 100 mm in diameter and 1.5 to 1.8 m long.

No leaf buds shall have initiated growth beyond 6 mm and the cambium layer shall be moist, green, and healthy. All material shall be maintained in a continuously cool, covered, and moist state. All plant material shall be in good condition when installed. Materials harvested on site shall to be installed the same day they are prepared. Nursery grown material shall be soaked for 24 hours prior to installation.

The live cuttings/live stakes shall have side branches cleanly removed and with the bark intact. The basal ends shall be cut at an angle for easy insertion into the soil and the top cut square.

See contract documents for plant species, size, spacing, and planting season specifications.

Plant material substitutions shall be approved by the Engineer prior to delivery to the project site.

Water shall meet the requirements of § 712-01.

CONSTRUCTION DETAILS

Live cutting/live stakes shall be planted with the pointed end in the ground.

Live cuttings shall be inserted by hand into a pilot hole. Use a dead-blow hammer to drive live stakes into the ground. Care shall be taken not to damage live cutting/live stakes during installation. Use of a dibble, a bar, or similar tool for preforming holes and to work an access point through any rock layer is required to prevent damage to plant material during

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installation. Damaged plant material shall be left in place and supplemented with an intact live stake.

Live cuttings/live stakes shall be inserted at least two-thirds their length in soil. In joint plantings, live cuttings/live stakes shall be inserted to one-half their length into soil below stone fill with a minimum 50 mm to 100 mm and two buds exposed above the stone fill. When possible, upon insertion the soil around the live cutting/stake shall be tamped to insure contact with the soil.

Care of Planted Materials During Construction. The Contractor shall care for the planted materials until final acceptance of the contract. Care of planted material shall consist of keeping plant material in a healthy growing condition by watering.

When the Engineer determines that any area within the installation has failed, for any reason, to produce approximately 75% vegetative growth after a suitable period of time the Contractor shall repeat or rectify all the work required by the specification until the growth of vegetation has been established at no additional cost to the State.

METHOD OF MEASUREMENT

The quantity of live cuttings/live stakes will be measured as the number of live cuttings/live stakes of each kind or size as set forth in the contract documents satisfactorily installed and accepted.

BASIS OF PAYMENT

The unit price bid per live cuttings/live stakes shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work including excavation, backfill and watering.

ITEM 24616.10 M – BRUSHLAYERING

DESCRIPTION

The brushlayering system consists of live branch cuttings installed in rows to stabilize cut and fill slope areas. Under this pay item the Contractor shall furnish and install live branch cuttings in accordance with the contract documents.

MATERIALS

The branch cuttings shall be from freshly cut dormant plants. No leaf buds shall have initiated growth beyond 6 mm and the cambium layer shall be moist, green, and healthy. All plant material shall be maintained in a continuously cool, covered, and moist state. All plant material shall be in good condition when installed. Live plant material shall be installed within 48 hours of harvesting.

Live branch cuttings shall range from 12 to 50 mm in diameter and be long enough to reach the back of the bench. Side branches shall remain intact for installation. See contract documents for plant species, size, and planting season specifications. Plant material substitutions shall be approved by the Engineer prior to delivery or on-site harvesting.

Water shall meet the requirements of § 712-01.

CONSTRUCTION DETAILS

Care shall be taken not to damage the live branch cuttings during installation. Those that are damaged shall be replaced before backfilling the layer.

Starting at the toe of the slope, excavate benches along the contour of the slope, or as specified in the contract documents. The benches shall range from 600 to 900 mm wide and the surface of the bench shall be angled so that the front edge is higher than the back of the bench. Space the benches as specified in the contract documents.

Live branch cuttings shall be placed on the bench in a crisscross or overlapping configuration in layers 75 to 100 mm thick. Branch cutting shall be aligned with the growing tips slightly protruding out of the slope face and the basal ends to the back of the bench.

Unless otherwise specified, each lower bench shall be filled with the soil excavated from the bench above. The top bench shall be filled with soil from initial excavation. Backfill shall be placed on top of the live branch cuttings and hand tamped in 150 mm lifts. Seed or other erosion control material shall be used between the rows as stated in the contract documents.

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Care of Plant Materials. The Contractor shall care for the planted materials until final acceptance of the contract. Care of planted material shall consist of keeping plant material in a healthy growing condition by watering.

When the Engineer determines that any area within the installation has failed, for any reason, to produce approximately 75% vegetative growth after a suitable period of time, the Contractor shall repeat or rectify all the work required by the specification until the growth of vegetation has been established at no additional cost to the State.

METHOD OF MEASUREMENT

The quantity of brushlayers will be measured as the number of linear meters of vegetated layers, measured along each bench, satisfactorily installed and accepted.

BASIS OF PAYMENT

The unit price bid for brushlayering shall include the cost of furnishing all labor, material, and equipment necessary to satisfactorily complete the work including excavation, backfill and watering.

Seed or other erosion control material shall be paid for under separate items.

ITEM 24616.11 M – VEGETATED ROCK GABIONS

DESCRIPTION

Vegetated rock gabions shall consist of branch cuttings and gabions. The branch cuttings shall be installed in between horizontal layers of gabions. Under this item the Contractor shall furnish and install vegetated rock gabions in accordance with the contract documents.

MATERIALS

Branch cuttings shall be from freshly cut dormant plants harvested from the site or nursery grown. No leaf buds shall have initiated growth beyond 6 mm and the cambium layer shall be moist, green, and healthy. All plant material shall be maintained in a continuously cool, covered, and moist state. All plant material shall be in good condition when installed. Live plant material shall be installed within 48 hours of harvest.

Live branch cuttings shall range from 12 to 25 mm in diameter. Length of the cuttings shall vary according to the size of the gabions and the depth of the cut in the embankment. See contract documents for plant species, size, and planting season specifications. Plant material substitutions shall be approved by the Engineer prior to delivery to the project.

Vegetative plantings, additional soil bioengineering techniques or other erosion control methods, if specified, shall be in accordance with the item specified.

Backfill material used shall meet the requirements of Item "Select Clean Fill".

Water shall meet the requirements of § 712-01.

Gabions shall be as specified in § 712-15 except that the gabions and backfill shall be further specified as follows:

1. Gabions shall meet the requirements of § 712-15.B, P.V.C. Coated Galvanized Gabions.
2. Gabion filling shall consist of approximately 70% stone filling conforming to the provisions of § 712-15, Gabions and 30% Select Clean Fill Material as specified, unless stated elsewhere in the contract documents.
3. All exposed vertical surfaces of the gabions shall be lined with a rolled erosion control product meeting the requirements of § 713-07, Class II, Type B or Type C.

CONSTRUCTION DETAILS

Gabions shall be installed in accordance with § 620-3.07 Gabions and as specified in the contract documents except that the gabions shall be further specified as follows:

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The 70% stone filling shall be placed into the gabion. The remaining 30% of Select Clean Fill Material shall be placed on the stone layer and worked into the layers such that all voids are filled and tamped prior to closing the gabion.

A layer of backfill material shall be spread over the top of the first row of completed gabions to a thickness of 25 mm. This layer shall be raked to remove rocks larger than 15 mm. Live branch cuttings shall be placed on top of the backfill layer in a layers one or two branches thick. An additional 25 mm layer of backfill shall be spread on the live branch cuttings prior to the placement of the successive row of gabions. The cuttings shall be placed perpendicular to the slope and with the growing tips slightly protruding from the front of the gabion wall. A minimum of 300 mm of each cutting shall be in contact with backfill material. Some of the basal ends of the live branch cuttings in each layer shall reach the undisturbed soil at the back of the gabion wall.

When the Engineer determines that any area within the installation has failed, for any reason, to produce approximately 75% vegetative growth after a suitable period of time, the Contractor shall rectify all work required by the specification until the vegetative growth is established at no additional cost to the State.

METHOD OF MEASUREMENT

The quantity to be measured shall be the number of cubic meters of vegetated gabions satisfactorily installed and accepted in accordance with the contract documents.

BASIS OF PAYMENT

The unit price per cubic meter shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work, including excavation and watering.

Backfill material used shall be paid for under Item "Select Clean Fill".

Vegetative plantings, additional soil bioengineering techniques or other erosion control methods, if specified, shall be paid for under separate items.

Excavation, as required, shall be paid for under Item "Unclassified Excavation and Disposal".

ITEM 24616.12 M -- VEGETATED CRIBWALL

DESCRIPTION

A vegetated cribwall consists of a hollow, box-like interlocking arrangement of untreated logs or timber members on a stone base as indicated on the plans. The structure is filled with soil and layers of live branch cuttings. Under this item the Contractor shall furnish and install the vegetated crib walls, and install the backfill material, in accordance with the contract documents.

MATERIALS

Branch cuttings shall be from freshly cut dormant plants harvested from the site or nursery grown. No leaf buds shall have initiated growth beyond 6 mm and the cambium layer shall be moist, green, and healthy. All plant material shall be maintained in a continuously cool, covered, and moist state. All plant material shall be in good condition when installed. Live plant material shall be installed within 48 hours of harvest.

Live branch cuttings may range from 12 to 50 mm in diameter and long enough to reach from the front of the structure to the undisturbed soil. See contract documents for plant species, size, and planting season specifications. Plant material substitutions shall be approved by the Engineer prior to delivery to the project site.

Only untreated logs or timber shall be used in the crib wall. Logs or timber shall range from 100 to 150 mm in diameter.

Large spikes or #5 rebars are required to secure the logs or timbers together. The minimum length of the securing spikes or rebar shall be 250 mm. See contract documents for specifications.

Water shall meet the requirements of § 712-01.

CONSTRUCTION DETAILS

The Contractor shall excavate a trench 600 to 900 mm deep below the existing grade at the base of the slope, or as indicated in the contract documents. The excavation shall extend into the embankment a minimum of 1.5 to 1.8 m or as indicated in the contract documents to form the foundation for the cribwall. The back of the excavation shall be slightly lower than the front.

The first course of logs or timbers shall be placed parallel to the slope at the front and back of

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the excavated foundation, approximately 1.2 to 1.5 m apart as indicated in the contract documents. The next course of logs or timbers shall be placed on top of and perpendicular to the previous course and fastened with spikes or rebars. The logs or timbers shall overhang the front and back of the previous course by 75 to 150 mm. The vegetated cribwall shall be battered or constructed in a stair-step fashion, as specified in the contract documents. Each course of the vegetated cribwall shall be placed in the same alternating fashion until approximately flush with the existing grade at the base of the slope.

The cribwall structure, and the excavated area behind, shall then be filled with Item stone Filling (light), from the bottom of the excavation up to the existing grade and firmly tamped. Live branch cuttings shall be placed on top of the stone filling in a layer one to two branches thick. The branches shall be orientated perpendicular to the slope with the tips slightly protruding from the front of the wall and the basal ends reaching the undisturbed soil.

Successive courses of logs or timbers and live branch cuttings shall be placed in the similar fashion as the previous courses, except the following: After the layer of light stone filling reaches the existing grade the cribwall, the area behind the structure, shall be backfilled with Select Clean Fill Material as specified elsewhere in the contract documents.

A layer of live branches, one to two branches thick, shall be placed after each transverse log course followed by a layer of hand tamped Select Clean Fill Material. Each face log course (front and rear) shall be backfilled and tamped. This shall be repeated until the wall reaches the height specified in the contract documents.

Care of Plant Materials. The Contractor shall care for the planted materials until final acceptance of the contract. Care of planted material shall consist of keeping plant material in a healthy growing condition by watering.

When the Engineer determines that any area within the installation has failed, for any reason, to produce approximately 75% vegetative growth after a suitable period of time, the Contractor shall repeat or rectify all the work required by the specification until the growth of vegetation has been established at no additional cost to the State.

METHOD OF MEASUREMENT

The quantity of vegetated crib walls shall be measured as the number of square meters of the front wall face area satisfactorily installed and accepted in accordance with the contract documents.

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BASIS OF PAYMENT

The unit price bid per square meter shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work including watering.

Backfill material used shall be paid for under Item “Select Clean Fill”.

Vegetative plantings, additional soil bioengineering techniques or other erosion control methods, if specified, shall be paid for under separate items.

Excavation, as required, shall be paid for under Item “Unclassified Excavation and Disposal”.

Stone filling shall be paid for under Item “Stone Filling (light)”.

ITEM 24616.13 M -- TREE REVETMENT

DESCRIPTION

A tree revetment consists of a whole tree, except rootwad, cabled to an earth anchor forming a semipermanent streambank protection. Under this item the Contractor shall furnish and install tree revetments in accordance with the contract documents.

MATERIALS

Trees shall be structurally sound, recently felled conifers with a minimum trunk diameter of 300 mm and a trunk length of 6.0 m or greater. They shall be of a species approved by the Engineer prior to installation.

Anchors shall consist of a commercially manufactured earth anchoring system specified elsewhere in the contract documents. Use of other materials or methods shall be approved by the Engineer prior to installation.

Galvanized cable shall be used to attach trees to the anchor and shall be a thickness stated in the contract documents. The cables shall be clamped together using two galvanized clamps at each connection. Additional cables shall also be used to attach tree revetments together when multiple tree revetments are specified.

CONSTRUCTION DETAILS

Installation shall begin downstream at the farthest point of the work area. An anchor, with galvanized cable attached, shall be installed according to the manufacturers specifications.

The tree shall be laid with the butt end orientated upstream. Branches shall be trimmed on the bank side prior to placement.

Each tree shall be secured to the stream bank by galvanized cable to two anchors. The first attached to the butt end of the tree and the second to the mid-section of the tree. The cable, where attached to the tree, shall be inserted through a drilled hole, wrapped at least one and one-half times around the main trunk, and then clamped using two galvanized clamps at each connection. The cable shall be secured such that the tree is held snug to the embankment.

Where multiple tree revetments are specified they shall overlap each other by 25%. At the point of tree overlap, the trees and shall be secured together with galvanized cable and clamps.

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Minor excavation and backfill may be necessary to fit the tree revetments to some stream banks.

METHOD OF MEASUREMENT

The quantity of tree revetments will be measured as shall be the number of tree revetments satisfactorily installed and accepted.

BASIS OF PAYMENT

The unit price bid per tree revetment shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work including excavation and backfill.

Backfill material used shall be paid for under Item "Select Clean Fill".

ITEM 24616.14 M -- ROOTWAD REVETMENT

DESCRIPTION

Rootwad revetment shall consist of a footer log, rootwad (tree stump), and boulders placed in and on streambanks to stabilize streambanks and create instream structures for improved fish rearing and spawning habitats. Under this item the Contractor shall furnish and install rootwad revetments in accordance with the contract documents.

MATERIALS

Footer logs and rootwads shall be structurally sound conifers or other species approved by the Engineer prior to installation on the site.

The root wad shall have 2.4 to 3.6 m of trunk length, a minimum of 400 mm in diameter and a root bundle with numerous root protrusions attached. Loose soil shall be removed to expose as many roots as possible.

Footer logs shall be the same diameter as the rootwad and a length of 1.2 to 1.6 m.

Anchoring system shall be heavy stone boulders a minimum of 1 to 1.5 times the size of the revetment log diameter, approximately 400 to 600 mm in the greatest dimension weighing from 75 to 300 kg and with an irregular surface. Alternate anchoring systems shall be approved by the Engineer prior to installation.

CONSTRUCTION DETAILS

Excavate for the footer log at the slope or stream base to a depth of one half the footer log diameter. Install the footer log at a slight angle upstream into the direction of the stream flow. Each end of the footer log shall be anchored with at least three boulders. Trench and place rootwads into the stream bank so that the roots are flush with the stream bed and at a slight angle facing upstream and the trunk perpendicular to the footer log. The rootwad shall be placed in between the anchors. Backfill shall be placed around the rootwad, boulders, and to match the existing slope. The backfill shall be tamped sufficiently to secure the rootwad to the stream bank.

METHOD OF MEASUREMENT

The quantity of rootwads will be measured as the number of rootwad revetments satisfactorily installed and accepted.

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BASIS OF PAYMENT

The unit price per rootwad revetment shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work including excavation.

Backfill material used shall be paid for under Item "Select Clean Fill".

ITEM 24616.15 M -- LIVE FASCINES

DESCRIPTION

Live fascines shall consist of long bundles of live branch cuttings bound together into sausage-like structures. Under this item the Contractor shall furnish, install, and backfill live fascines in accordance with the contract documents.

MATERIALS

Live fascines shall be prepared from freshly cut dormant plants. No leaf buds shall have initiated growth beyond 6 mm and the cambium layer of each cutting shall be moist, green, and healthy. All plant material shall be maintained in a continuously cool, covered, and moist state. All plant material shall be in good condition when installed.

Live fascines shall be obtained from sources approved by the Engineer. Live fascines shall be prepared and installed within 48 hours of the time the plant material is harvested. See contract documents for plant species, size, and planting season specifications. Plant material substitutions shall be approved by the Engineer prior to delivery or on site harvesting.

Wooden posts shall be prepared from new, sound, and untreated 38 by 89 mm lumber sawn diagonally. See contract documents for length. Where specified live stakes shall be substituted for posts.

Water shall meet the requirements of § 712-01.

CONSTRUCTION DETAILS

Live fascines shall be prepared in bundles 150 to 200 mm in diameter and a minimum length of 1.2 m. The bundle lengths will vary to suit the installation conditions. The tips of the branches within the live fascine shall be staggered. All growing tips shall be oriented in the same direction. Untreated natural fiber twine shall be used to tie the bundles together. The twine shall be wrapped at least twice around the bundle and tied securely at intervals not less than every 400mm along the length of the bundle and where bundles overlap.

Care shall be taken not to damage the live fascines during assembly or installation. Those damaged shall be replaced before installation is completed.

Trenches shall be dug along the slope as indicated in contract documents. The trenches shall be dug just large enough to contain the live fascines. Live fascines shall be placed in the prepared trenches. The fascines shall overlap by 10% of the bundle length and tied where two

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live fascines come together in a trench. Wooden posts shall be driven every 610 to 900 mm along length of the bundles, as shown on the plans. Any post that shatters upon installation shall be left in place and supplemented with an intact post. Extra posts shall be used at connections or bundle overlaps. The tops of the posts shall be left flush with the installed bundle.

Trenches shall be backfilled with the excavated soil, unless specified elsewhere in the contract documents. The backfill shall be tamped to minimize air voids and to insure contact with the fascine. The tops of the live fascines shall be slightly visible when the installation is complete.

Seed or other erosion control material shall be used between the fascine rows, as specified in the contract documents and paid for under separate items.

Care of Plant Materials. The Contractor shall care for the planted materials until final acceptance of the contract. Care of planted material shall consist of keeping plant material in a healthy growing condition by watering.

When the Engineer determines that any area within the installation has failed, for any reason, to produce approximately 75% vegetative growth after a suitable period of time, the Contractor shall repeat or rectify all the work required by the specification until the growth of vegetation has been established at no additional cost to the State.

METHOD OF MEASUREMENT

The quantity of live fascines will be measured as the number of linear meters of live fascines satisfactorily installed and accepted.

BASIS OF PAYMENTS

The unit price bid per linear meter of live fascines shall include the cost of furnishing all labor, material, and equipment necessary to satisfactorily complete the work including excavation and watering.

Backfill material used shall be paid for under Item "Select Clean Fill".

Seed or other erosion control materials and techniques, if specified, shall be paid for under separate items.

ITEM 24616.16 M -- FIBER ROLLS

DESCRIPTION

A fiber roll is a coir, straw or excelsior woven roll encased in webbing. The tube material may be burlap unless otherwise specified in the Contract Documents. Fiber rolls are used to dissipate energy along banks of streams, channels, bodies of water or on slope contours. It must demonstrate the ability to conform to terrain details and reduce water velocity.

MATERIALS

The fiber roll shall be of the size and type specified elsewhere in the Contract Documents. The following minimum performance requirements shall be met as verified by the manufacturer's written certification:

- Sediment retention capacity of 40 kg/m under a minimum of three simulated 10 year predicted storm events on a 3:1 slope with clayey sand soil.
- Soil loss effectiveness shall not be less than 50% (minimum sediment yield reduction value) under the simulated rainfall event specified above.
- The maximum destabilizing moisture content of the fiber rolls shall not exceed 10% under the simulated rainfall event described above.

Wooden posts shall be prepared from new, sound, and untreated 50 by 50 mm lumber a minimum of 900 mm long.

Wire used to secure fiber rolls shall be 16 gauge nongalvanized wire.

CONSTRUCTION DETAILS

The fiber roll manufacturer and the product proposed for use shall be approved by the Engineer prior to delivery to the project site based on the manufacturer's certification indicating compliance with the material requirements.

Under this item the Contractor shall furnish and install fiber rolls in accordance with the contract documents.

Installation includes, all excavation and backfill necessary to embed and fit the material to the proposed site.

Install vegetative plantings and use other erosion control methods and techniques were specified in the Contract documents.

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METHOD OF MEASUREMENT

The quantity of fiber rolls will be measured as the number of linear meters of fiber rolls satisfactorily installed and accepted.

BASIS OF PAYMENT

The unit price bid per linear meter shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work.

Vegetative plantings, additional soil bioengineering techniques or other erosion control methods, if specified, shall be paid for under separate items.

ITEM 24616.17 M -- BRUSHMATTRESS

DESCRIPTION

Brushmattressing consists of a combination of branch cuttings, posts, wire and backfill installed to cover and stabilize stream banks. Under this item the Contractor shall furnish and install select vegetative material and place select clean fill material in accordance with the contract documents.

MATERIALS

Live branch cuttings shall be from freshly cut dormant plants harvested from the site or nursery grown. No leaf buds shall have initiated growth beyond 6 mm and the cambium layer shall be moist, green, and healthy. All plant material shall be maintained in a continuously cool, covered, and moist state. All plant material shall be in good condition when installed. Live plant material shall be installed within 48 hours of harvest.

Live branch cuttings shall range from 25 mm and smaller diameters and from 1.8 to 2.7 m long. Live stakes, if specified in the contract documents, shall be 26 to 100 mm in diameter and 0.9 to 1.2 m long. See contract documents for plant species, size, and planting season specifications. Plant material substitutions shall be approved by the Engineer prior to delivery to the project site or on-site harvesting.

Wooden posts shall be used to secure the material in place. Wooden posts shall be prepared from new, sound, untreated 38 by 89 mm lumber sawn diagonally and 0.9 to 1.2 m long.

Wire used for securing brush and fascines shall be 16 gauge nongalvanized wire.

Water shall meet the requirements of § 712-01.

Backfill shall meet the requirements of Item "Select Clean Fill".

CONSTRUCTION DETAILS

Installation shall begin at base of the slope as specified in the contract documents. If specified, a trench for live fascine and branch ends shall be excavated. Branch cuttings shall be placed in a layer two or three branches thick on the prepared slope with basal ends facing down slope. Posts shall be installed to a minimum depth of 500 mm over the face of the graded area using 600 mm spacing. Live stakes, if specified, shall be used in place of every other post.

Wire shall be stretched diagonally from one post to another, **excluding live stakes** if

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specified. The wire shall be wrapped tightly around each post no closer than 150 mm from its top. The posts shall be driven into the ground until branches are tightly secured to the slope. The entire area of installation shall be covered with approximately 100 mm of backfill and tamped to work soil into the branch layer. The top surface of the brush mattress shall be left slightly exposed.

If specified, the live fascines shall be constructed as stated elsewhere in the contract documents.

The fascines shall be placed in a prepared trench, over the basal ends of the branches at the base of the brushmattress. The fascine shall be staked with posts as specified and fastened to the posts with wire. The trench shall be backfilled and any voids between brushmattresses and fascine shall be filled with soil. The backfill shall be tamped to insure contact with fascine and branches.

Care of Plant Materials. The Contractor shall care for the planted materials until final acceptance of the contract. Care of planted material shall consist of keeping plant material in a healthy growing condition by watering.

When the Engineer determines that any area within the installation has failed, for any reason, to produce approximately 75% vegetative growth after a suitable period of time, the Contractor shall repeat or rectify all the work required by the specification until the growth of vegetation has been established at no additional cost to the State.

METHOD OF MEASUREMENT

The quantity of brushmattress will be measured as the number of square meters of surface area satisfactorily installed and accepted.

BASIS OF PAYMENT

The unit price bid per square meter shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work including excavation and watering.

Live stakes and live fascines, if specified in the contract documents, shall be paid under separate items.

Seed or other erosion control material shall be paid for under separate items.

Backfill material used shall be paid for under Item "Select Clean Fill".

ITEM 24616.18 M -- VEGETATED MAT

DESCRIPTION

A vegetative mat consists of a reinforced coir-woven blanket used along banks of streams, channels, or bodies of water to control erosion and provide a suitable planting medium for selected plants. Under this item the Contractor shall furnish and install vegetative mats in accordance with the contract documents.

MATERIALS

The mat shall meet the minimum requirements of § 713-07 Class 1, Type C erosion control material or as specified otherwise in the contract documents. In addition, the matrix shall be no less than 70% coconut fiber and 30% straw, excelsior, rice straw or other approved material and be manufacturer-certified 100% weed free. The matrix shall be encased in a net material which shall be an open mesh, photodegradable or biodegradable material with a grid size of between 5 and 10 mm. The netting material shall be attached on both sides of the matrix and stitched together. The netting shall have a minimum effective life span of no less than one year.

CONSTRUCTION DETAILS

Vegetative mats shall be installed according to manufacturers recommendations, except when otherwise specified in the contract documents.

The Contractor shall supply vegetative mats as specified in the contract documents. The vegetated mat manufacturer and the product proposed for use shall be approved by the Engineer prior to delivery to the site. Herbaceous plugs and other erosion control methods and techniques may be specified in the Contact Documents.

METHOD OF MEASUREMENT

The quantity of vegetated mat will be measured as the number of square meters of surface area satisfactorily installed and accepted in accordance with the plans.

BASIS OF PAYMENT

The unit price per square meter shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work.

Herbaceous plugs, live cuttings, live stakes, fiber rolls, live fascines or other erosion control items shall be paid for under the item specified, if used in conjunction with vegetative mats.

ITEM 24616.19 M -- BRANCKPACKING

DESCRIPTION

Branchpacking consists of alternate layers of live branch cuttings and tamped backfill to repair small localized slumps and holes in slopes. Under this item the Contractor shall furnish and install select vegetative material and place select clean fill material, in accordance with the contract documents.

MATERIALS

Branchpackings shall consist of branch cuttings from freshly cut dormant plants. On branches no leaf buds shall have initiated growth beyond 6 mm and the cambium layer shall be moist, green, and healthy. All plant material shall be maintained in a continuously cool, covered, and moist state. All material shall be in good condition when installed. Live plant material shall be installed within 48 hours of harvesting.

Live branch cuttings may range from 12 to 50 mm in diameter. They shall be long enough to touch the undisturbed soil at the back of the trench and extend slightly from the rebuilt slope face. See contract documents for plant species, size, and planting season specifications. Plant material substitutions shall be approved by the Engineer prior to delivery to the project site.

Wooden posts shall be used to secure the material in place. These posts shall be 1.5 to 2.4 m long and made from 75 to 100 mm diameter poles or 38 by 89 mm lumber, depending upon the depth of the particular slump or hole. Where specified, live stakes shall be used in place of posts.

Water shall meet the requirements of § 712-01.

Backfill shall meet the requirements of Item "Select Clean Fill".

CONSTRUCTION DETAILS

Installation shall begin at the lowest point of the work area. Wooden posts shall be spaced in a grid pattern, throughout slump or hole, 300 to 450 mm apart and driven vertically into the ground to a depth of 0.9 to 1.2 m.

A layer of live branch cuttings 100 to 150 mm thick is to be placed between the posts and perpendicular to the slope face. They shall be placed in a crisscross configuration with the basal ends lower than the growing tips. Some of the basal ends of the branches shall touch the back of the hole or slope and the growing tips shall be generally oriented toward and protruding

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from the slope face.

Each layer of branches shall be covered by a layer of moistened backfill 450 to 900 mm thick. The soil layer shall be hand tamped in 175 mm lifts to minimize air voids and insure contact with the branches.

The final grade installation shall match the existing slope.

Care of Plant Materials. The Contractor shall care for the planted materials until final acceptance of the contract. Care of planted material shall consist of keeping plant material in a healthy growing condition by watering.

When the Engineer determines that any area within the installation has failed, for any reason, to produce approximately 75% vegetative growth after a suitable period of time, the Contractor shall repeat or rectify all the work required by the specification until the growth of vegetation has been established at no additional cost to the State.

METHOD OF MEASUREMENT

The quantity of branchpacking will be measured as the total number of square meters of surface area satisfactorily installed and accepted, as measured along the slope face.

BASIS OF PAYMENT

The unit price bid per square meter shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work including watering.

Excavation shall be paid for separately.

Seed or other erosion control material shall be paid for under separate items.

Backfill material used shall be paid for under Item "Select Clean Fill".

ITEM 24616.20 M -- SELECT CLEAN FILL

DESCRIPTION

Select clean fill material is a naturally occurring soil having characteristics making it suitable for promoting plant growth. Under this item the Contractor shall furnish this backfill material for installation between the payment lines shown on the plans or as otherwise specified.

MATERIAL

Place the material in a storage pile in a manner that ensures uniformity throughout the pile.

Backfill shall be a reasonably well graded naturally occurring soil meeting the following requirements:

A. Gradation:

Sieve Designation	Percent Passing by Weight
75 mm	100
2 mm	50
0.075 mm	20

B. Organic Content: Not less than 1% or greater than 5%.

C. pH: Between 5.5 and 7.6.

Material acceptance will be based on visual inspection by the Engineer, or his/her representative, unless the State elects to test the material for the criteria listed previously.

CONSTRUCTION DETAILS

The material shall be hand tamped into place as required in the applicable specifications.

METHOD OF MEASUREMENT

The quantity of Select Clean Fill will be measured as the number of cubic meters of fill satisfactorily installed and accepted within the payment lines shown in the Contract Documents.

BASIS OF PAYMENT

The unit price bid per cubic meter shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work.