To:		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 08-037
SUPERSEDED BY EI 10-031 EFFECTIVE 5/5/11			

Title: **SECTION 554 – INTERNALLY STABILIZED FILL STRUCTURES**

Distribution:		Approved:
☒ Manufacturers (18)	☐ Surveyors (33)	Robert L. Sack, P.E., Deputy Chief Engineer (Research) — 6-OCT-08 Date
☒ Local Govt. (31)	☒ Consultants (34)	
☒ Agencies (32)	☒ Contractors (39)	
	☐ _____( )	

ADMINISTRATIVE INFORMATION:

- This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of May 7, 2009.
- Superseded issuance(s): This EI does not supersede any previous issuances.
- The information transmitted by this issuance will be incorporated into a future revision to the Standard Specifications.

PURPOSE: The purpose of this EI is to revise Standard Specifications Section 554.

TECHNICAL INFORMATION:

- As outlined in EI 08-005, Standard Specification Section 737 *Geosynthetics* was reserved for the material specifications related to Geosynthetics. Section 554 contains a reference to geogrid reinforcing.

  To reduce the quantity of special specifications to be revised, and to minimize the overall total amount of special specifications as emphasized by SiteManager, some special specifications have been incorporated into the Standard Specifications.

  To address these two issues, Section 554 has been revised entirely. The revisions include:

  1. The title of the specification was changed to the more expansive topic "Internally Stabilized Fill Structures".
  2. The Materials section for geogrid reinforcing refers to §737-07 *Geogrids*.
  3. The Materials section for the backfill material was moved to Standard Specification Section 733-02 *Mechanically Stabilized Earth System Backfill Material.*
  4. The Construction Details section of a Mechanically Stabilized Earth System includes the requirement of a Pre-Operation meeting prior to beginning work.
  5. The Construction Details section, under the Backfill of the MSES Erection, includes the requirement to control and discharge all surface water that will affect the installation of the MSES wall system throughout the construction of the wall.
  6. The requirements of Item 554.05----17 Mechanically Stabilized Segmental Block Retaining Wall System (Extensible Reinforcement) were incorporated into the specification.
  7. The requirements of Item 554.9610—17 & Item 554.9620—17 Geosynthetic Reinforced Earth System (Permanent) & (Temporary) were incorporated into the specification.
  8. The Materials section for the backfill material for a GRES slope was moved to Standard Specification Section 733-03 *Geosynthetic Reinforced Earth System Slope Backfill Material.*

- Additions to Standard Specifications Section 733 *Earthwork Materials* are being issued concurrently via EI 08-038.

- The revision to the Construction Inspection Manual (CIM) MURK Part 1B with the new title Section 554 *Internally Stabilized Fill Structures* will be issued separately at a later date.

IMPLEMENTATION:

- The Main Office Design Quality Assurance Bureau will insert these standard specification shelf notes beginning with projects submitted for the letting of May 7, 2009.

- The following special specifications are disapproved:

Item 554.05----17:	Mechanically Stabilized Segmental Block Retaining Wall System (Extensible Reinforcement)
Item 554.9610--17:	Geosynthetic Reinforced Earth System (Permanent)
Item 554.9620--17:	Geosynthetic Reinforced Earth System (Temporary)

TRANSMITTED MATERIALS:

- Standard Specification shelf notes of revised *Section 554 Internally Stabilized Fill Structures.* Both metric and US Customary shelf notes are attached.

BACKGROUND: The NYS Department of Transportation is implementing Trns·port SiteManager, including both Construction and Materials functionality. Implementation of standard AASHTO software enables SiteManager to allow revising business practices to be more consistent with industry-accepted best practices. The revisions to the Standard Specifications are to conform to SiteManager's methodology in defining its Material Codes and Pay Items.

The Department currently has one Standard Specification section (Section 554) and several special specifications that contain provisions for systems that are essentially the same; that is, a retaining wall system consisting of reinforced fill with a facing. This issuance will combine like elements of the Standard and special specifications, and will establish an Approved List system for tracking acceptable systems.

CONTACT: Questions or comments regarding this issuance should be directed to Randall J. Romer, P.E., of the Geotechnical Engineering Bureau at (518) 457-4714, rromer@dot.state.ny.us.

Make the following changes to the Standard Specifications dated May 4, 2006:

Pages 328 through 334, **Delete** SECTION 554 and **Replace** it with the following:

SECTION 554 – INTERNALLY STABILIZED FILL STRUCTURES

554-1 DESCRIPTION. This work shall consist of furnishing and installing an internally stabilized fill structure at the location(s) and to the elevation(s) shown in the contract documents. Internally stabilized fill structures rely on the internal reinforcing elements to provide tensile forces to resist instability and are categorized in the retaining wall subsections of this specification.

554-1.01 Mechanically Stabilized Earth System. A Mechanically Stabilized Earth System (MSES) is comprised of an unreinforced concrete leveling pad, precast concrete facing units, earth backfill, and reinforcing elements used to stabilize the backfill.

Obtain all necessary materials, except backfill and leveling pad material, from the approved wall system designer-supplier. Approved designers-suppliers, wall systems, and the components of each wall system appear on the Approved List, available on the Department's web site. Designer-suppliers wishing to have their wall systems reviewed for placement on the Approved List shall follow the procedural directives of the Geotechnical Engineering Bureau as contained in Highway Design Manual Appendix 9A.

A. MSES Definitions.

1. Wall System. A combination of a specific precast panel facing unit, a design-specific backfill reinforcing element and characteristic connection method, and the backfill.

2. Leveling Pad. An unreinforced concrete footing which serves as a flat, level surface for placing the initial course of facing units.

3. Facing Unit. A precast concrete panel incorporating a means for attaching the backfill reinforcing element, forming part of the face area of the MSES. A corner unit is a facing unit having two faces.

4. Reinforcing Element. A metal strip, wire mesh, geogrid or other similar material connected to the facing unit and extending into the backfill for the purpose of backfill stabilization.

5. Attaching Devices. Components cast into the facing unit to provide a means for attaching reinforcing elements.

6. Fastener. Hardware used to connect the reinforcing element to the attaching device.

7. Joint Filler. Material used to fill the joints between units.

8. Slip Joint. A vertical joint specific to the wall system used as a stress relief at wall step locations.

9. Identification Markers. Signs or marking tape buried near the finished grade to identify and prohibit excavation of the reinforced backfill.

10. Backfill. Material placed and compacted in conjunction with the reinforcing elements and facing units.

554-1.02 Mechanically Stabilized Segmental Block Retaining Wall System. A Mechanically Stabilized Segmental Block Retaining Wall (MSSBRWS) is comprised of an unreinforced concrete or compacted granular fill leveling pad, facing and cap units, earth backfill, backfill drainage materials, and reinforcing elements used to stabilize the backfill. Only MSSBRWS designer-suppliers (designer-supplier) with facing and cap units appearing on the Approved List for Precast Concrete Retaining Wall Block will be acceptable for use.

Obtain all necessary materials, except backfill, unit infill, leveling pad material, backfill drainage materials, and cast-in-place concrete, from the designer-supplier. Approved facing and cap units from designers-suppliers appear on the Department's Approved List available on the Department's web site. Designer-suppliers wishing to have their facing and cap units reviewed for placement on the Approved List shall follow the procedural directives of the Geotechnical Engineering Bureau as contained in Highway Design Manual Appendix 9A.

A. MSSBRWS Definitions.

1. Wall System. A combination of a specific precast block facing unit, a design-specific backfill reinforcing element and characteristic connection method, and the backfill.

2. Leveling Pad. An unreinforced concrete or compacted granular fill footing or pad which serves as a flat, level surface for placing the initial course of facing units.

3. Facing Unit. A segmental precast concrete block unit, with less than 0.55 m^2 wall face area, that incorporates an alignment and connection device and also forms part of the MSSBRWS face area. A corner unit is a facing unit having two faces.

4. Alignment and Connection Device. Any device that is either built into or specially manufactured for the facing units, such as shear keys, leading/trailing lips, or pins. The device is used to provide alignment and maintain positive location for a facing unit and also provide a means for connecting the reinforcing elements.

5. Reinforcing Element. High density polyethylene, polypropylene or high tenacity polyester geogrid mats for the purpose of backfill stabilization.

6. Unit Infill. Well-graded aggregate fill placed within and/or contiguous to the back of the facing unit.

7. Cap Unit. A segmental precast concrete unit placed on and attached to the top of the finished MSSBRWS.

8. Backfill. Material placed and compacted in conjunction with the reinforcing elements and facing units.

9. Underdrain. A system for removing water from behind the MSSBRWS.

10. Geotextile. A permeable textile material used to separate dissimilar granular materials.

554-1.03 Geosynthetic Reinforced Earth System. A Geosynthetic Reinforced Earth System (GRES) is comprised of earth backfill, geosynthetic reinforcing elements used for internal stabilization and surface protection to resist erosion. For wall applications, the surface protection is replaced by a geotextile face wrap, welded wire forms or permanent facing elements.

A. GRES Definitions.

1. Wall System. A combination of a specific facing system (excluding precast units), a design-specific geosynthetic backfill reinforcing element, and the backfill.

2. Geosynthetic Reinforcing Element. A geogrid or geotextile used for the purpose of backfill stabilization meeting the requirements of §737-07 *Geogrids*.

a. Primary Reinforcing Element. A geogrid or geotextile with sufficient strength and soil compatible modulus, placed horizontally within the slope or wall, to provide tensile forces to resist instability.

b. Secondary Reinforcing Element. A geogrid or geotextile used in a non-wrapped GRES installation typically employed in over steepened slopes, to aid in stability of the slope face between primary reinforcing element layers.

3. Geotextile Face Wrap. A layer of geotextile used to prevent loss of backfill, typically employed in a wall application which incorporates a welded wire facing system. In applications where a geotextile is used as the primary reinforcing element, it may be designed to also function as the face wrap.

4. Facing System. A series of structural elements incorporating a means for attaching the reinforcing elements, which serves to support the front edge of the backfill.

5. Welded Wire Forms. A non-structural facing system used in temporary walls to aid in compaction near the face of the wall.

6. Backfill. Material placed and compacted in conjunction with the reinforcing elements and facing system.

554-2 MATERIALS.

554-2.01. Mechanically Stabilized Earth System. Ensure that the proper materials are supplied for the chosen system design. Not all materials listed below are required for each Mechanically Stabilized Earth System. Provide materials meeting the following requirements:

A. MSES Facing Units. Fabricate precast concrete facing units, coping units, and incidental precast units in accordance with the requirements of §704-14 *Precast Concrete Panel Units.* Architectural treatment of the Precast Concrete Panels may be required by special notes shown in the contract documents.

B. MSES Metal Reinforcing Strips. Provide reinforcing strips of ASTM Designated metal grades and galvanize in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.* The reinforcing strips associated with each approved wall system appear on the Department's approved list under wall system components.

C. MSES Metal Reinforcing Mesh. Fabricate the reinforcing mesh from cold drawn steel wire conforming to the requirements of §709-09 *Cold Drawn Wire for Concrete Reinforcement,* and weld into the finished mesh fabric in accordance with the requirements of §709-02 *Wire Fabric for Concrete Reinforcement.* Galvanize in accordance with §719-01 *Galvanized Coatings and Repair Methods, Type I.* The reinforcing mesh associated with each approved wall system appears on the Department's approved list under wall system components.

D. MSES Geogrid Reinforcing Element. Provide geogrid reinforcing elements meeting the requirements of §737-07 *Geogrids.* The grid(s) associated with each approved wall system appear on the Approved List under wall system components.

E. MSES Fasteners and Attaching Devices. The fasteners and attaching devices are specific to each wall system and provided by the wall system supplier. The fasteners and attaching devices associated with each approved wall system appear on the Approved List under wall system components.

F. MSES Joint Fillers. Fill joints with material approved by D.C.E.S. and approved by the wall system supplier.

G. MSES Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system supplier.

H. MSES Leveling Pad. Provide leveling pad material meeting the requirements of Section 501 *Portland Cement Concrete - General,* Class A concrete.

I. MSES Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

J. MSES Identification Markers

1. Signs. These will be 180 mm x 250 mm (minimum) fiberglass. Include warning information as follows:

WARNING
Internally Stabilized Fill Structure
DO NOT EXCAVATE
Call Regional Office of NYS DOT

2. Marking Tape. This will be polyethylene material 75 mm wide, 100 μm thick. Include warning markings.

554-2.02. Mechanically Stabilized Segmental Block Retaining Wall System. Not all materials listed below are required for each MSSBRWS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. MSSBRWS Leveling Pad. MSSBRWS height is measured from the top of the leveling pad to the top of the cap unit.

1. Wall Heights Taller Than or Equal to 4.6 m. For MSSBRWS taller than or equal to 4.6 m in total height, supply a leveling pad of unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General.*

2. Wall Heights Shorter Than 4.6 m. For MSSBRWS shorter than 4.6 m in total height, supply a leveling pad conforming to one of the following:

a. Unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General*, or

b. Select Granular Fill - §203-2.02 C Select Granular Fill and Select Structure Fill, or

c. Crushed Stone - §501-2.02, B.1.b. Coarse Aggregate Type CA-2 in Table 501-2 Coarse Aggregate Gradations.

B. MSSBRWS Facing and Cap Units. Supply units fabricated and conforming to §704-07 *Segmental Retaining Wall Blocks.*

C. MSSBRWS Alignment and Connection Devices. Supply devices conforming to the designer-supplier's Installation Manual.

D. MSSBRWS Reinforcing Element. Provide geogrid or geotextile reinforcing elements meeting the requirements of §737-07 *Geogrids.*

E. MSSBRWS Unit Infill. Supply unit infill conforming to material and gradation requirements for §501-2.02B.1.b. Coarse Aggregate Type CA-2 in Table 501-2 Coarse Aggregate Gradations.

F. MSSBRWS Cast-In-Place Concrete. Supply concrete conforming to Section 501 *Portland Cement Concrete – General*, Class A concrete.

G. MSSBRWS Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

H. MSSBRWS Separation Geotextile. Supply a geotextile for the separation of dissimilar materials, conforming to the requirements of §737-01 *Geotextiles*, Geotextile Separation, Strength Class 2.

I. MSSBRWS Drainage System. Supply underdrain and geotextile material for a backfill drainage system as shown in the contract documents or conforming to the designer-suppliers Installation Manual:

1. Underdrain Pipe. Supply optional underdrain pipe conforming to Section 605 *Underdrains*.

2. Geotextile Drainage. Supply geotextile conforming to the requirements of §737-01 *Geotextiles*, Geotextile Drainage, Strength Class 2, Drainage Class B.

J. MSSBRWS Identification Markers. Supply identification markers conforming to §554-2.01 J. *MSES Identification Markers.*

554-2.03. Geosynthetic Reinforced Earth System. Ensure that the proper materials are supplied for the chosen system design. Not all materials listed below are required for each GRES. Provide materials meeting the following requirements:

A. GRES Geosynthetic Reinforcing Element. Provide a geogrid or geotextile primary and secondary reinforcing elements meeting the requirements of §737-07 *Geogrids*.

B. GRES Backfill. Provide backfill material conforming to the following:

1. Walls. Provide backfill material meeting the requirements of §203-2.02 C *Select Granular Fill and Select Structural Fill.*

2. Slopes. Provide backfill material meeting the requirements of §733-03 *Geosynthetic Reinforced Earth System Slope Backfill Material.*

C. GRES Facing System. Provide a facing system shown in the contract documents and in accordance with the requirements below.

1. Welded Wire Forms. Provide welded wire forms and wire struts as shown in the contract documents, conforming to the material requirements of §709-02 *Wire Fabric for Concrete Reinforcement.* Provide geotextile face wrap material meeting the requirements of §737-01 *Geotextiles* and as shown in the contract documents.

Proposed alternate, non-structural facing systems used to aid in compaction near the face of the wall shall be included in the submittal outlined in §554-3.03 A. *GRES Submittal.*

2. Geocells. Provide geocells and anchoring devices and staples as shown in the contract documents, conforming to the material requirements of §737-08 *Geocells*.

Provide infill material conforming to §203-2.02 C, *Select Granular Fill and Select Structural Fill*, with the added stipulation that the maximum particle size is 50 mm. Where a vegetated face is called for, the outermost cells are to be filled with topsoil meeting the material requirements of §713-01 *Topsoil.*

3. Timbers. Provide timbers as shown in the contract documents, graded for an extreme fiber stress of at least 6900 kPa conforming to the material requirements of §712-14 *Stress Graded Timber and Lumber.* Treat timbers in accordance with §708-31 *Wood Preservative - Waterborne* and applied in conformance with American Wood Preservers Association (AWPA) Use Category Designation UC4B.

4. Gabions. Provide gabions, tiewire or lacing wire, and gabion backfill as shown in the contract documents, conforming to the material requirements of §712-15 *Gabions*.

5. As Shown in the Contract Documents. Provide materials in accordance with the contract documents. Precast units are excluded as a design-specific GRES facing system,

D. GRES Surface Protection. Provide erosion resistant covering of the finished GRES slope surface meeting the requirements of §713-07 *Rolled Erosion Control Products and Soil Stabilizers* Class III Type C.

E. GRES Identification Markers. Supply identification markers conforming to §554-2.01 J. *MSES Identification Markers.*

554-3 CONSTRUCTION DETAILS

554-3.01. Mechanically Stabilized Earth System.

A. MSES Submittal. Obtain from the designer-supplier a Mechanically Stabilized Earth System design stamped by a Professional Engineer. Submit the MSES design package, including working drawings of the wall design, design calculations, identification of backfill material gradation type(s) (outlined in §733-02B *Gradation*) suitable for the construction of the wall system, and the designer-supplier's Installation Manual to the Deputy Chief Engineer Structures (DCES) at least 30 work days before starting work. The MSES design package must also include working drawings for all contract-specific facing panels not previously approved by the Materials Bureau.

A Pre-Operation Meeting will be held between the Engineer, Contractor, Regional Geotechnical Engineer, Geotechnical Engineering Bureau and other appropriate Department representatives to discuss the Contractors proposed construction methods. Begin work only after receiving the DCES written approval and holding the Pre-Operation Meeting.

Supply on-site technical assistance from a representative of the designated designer-supplier during the beginning of the installation until such time as outside consultation is no longer required.

B. MSES Excavation and Disposal and MSES Area Preparation. Excavate and dispose of all excavated material in accordance with the requirements of Section 203 *Excavation and Embankment*, except as modified herein.

1. Placement Area. Grade the area under the Mechanically Stabilized Earth System, level for a width equal to, or in excess of, the reinforcing element length. Prior to wall system construction, compact this area to a minimum of 90% of Standard Proctor Maximum Density. Treat all soils found to be unsuitable, or incapable of being satisfactorily compacted because of moisture content, in a manner directed by the Engineer, in conjunction with the recommendations of the Regional Geotechnical Engineer.

2. Rock. Remove rock to the limits indicated in the contract documents.

3. Depth of Excavation. The depth of excavation for the leveling pad is indicated in the contract documents. Include the cost of this excavation in a separate excavation item.

C. MSES Facing Unit Inspection, Storage, and Handling

1. Precast Concrete Facing Units. An inspection will be made prior to installation to determine if any damage has occurred to the unit(s). Handle and store the units with care to prevent damage.

2. Damaged Units. Repair damaged units in a manner approved by the Engineer. Replace units that are not repairable at no additional cost to the State.

D. MSES Erection

1. Methods and Equipment. Install units in accordance with the designer-supplier's working drawings and Installation Manual, unless otherwise modified by the contract documents.

Prior to installation of the units, furnish the Engineer with detailed information concerning the proposed construction method, as well as the equipment planned for use.

2. *Unreinforced Concrete Leveling Pad.* Provide an unreinforced concrete leveling pad as required by the contract documents. Place the concrete in accordance with the requirements Section 555 *Structural Concrete.*

3. *Unit Installation*

a. Place units such that, after completion of compaction, the tolerances of Table 554-1 *MSES Facing Unit Alignment and Joint Offset Tolerances* are not exceeded. After placement, maintain each unit in position. If wedges are used, do not allow them to remain in place below three panel unit heights during installation, and compaction. Remove all wedges remaining in the top three panel unit heights upon completion of the MSES. External braces may be required for initial placements. Install joint fillers in the manner indicated by the Installation Manual.

b. Correct all misalignments of installed units in excess of the tolerances allowed by Table 554-1 *MSES Facing Unit Alignment and Joint Offset Tolerances*, at no additional cost to the State.

c. Govern the operations and procedures to prevent misalignment of the installed panel units. Precautionary measures include, but are not limited to, keeping vehicular equipment a minimum of 1.0 m from the panel units. Within 1.0 m of the panel units use compaction equipment meeting the requirements of §203-3.12 B. 6. *Compaction Equipment for Confined Areas.*

TABLE 554-1 MSES FACING UNIT ALIGNMENT AND JOINT OFFSET TOLERANCES	
Horizontal Alignment	± 7 mm/m
Joint Offset per Unit	± 13 mm
Overall Vertical Plumbness (Top to Bottom of Wall System)	± 4 mm/m

4. *Backfill*

a. Do not mix backfill types behind any wall without the written permission of the Director, Geotechnical Engineering Bureau.

b. Place backfill materials, other than Type B and Type D, at a moisture content less than or equal to the Optimum Moisture Content. Rework or replace all backfill material which is at a moisture content in excess of the Optimum Moisture content. Determine the Optimum Moisture Content in accordance with the latest Geotechnical Test Methods for compaction that incorporate moisture content determination. Rework or replace backfill material at no additional cost to the State.

c. Place granular backfill material in uniform layers not exceeding 300 mm loose lift thickness per layer. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

d. Place Type B and Type D backfill in uniform layers not exceeding 400 mm loose lift thickness. Compact in accordance with requirements determined by the Engineer.

e. Prior to placement of the reinforcing element, backfill the area within 1 m of the panel units horizontally to within 25 mm or less, below the required reinforcing element elevation. Roughly grade the backfill beyond the 1 m line to the reinforcing element elevation.

f. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSES throughout the construction of the wall. Maintain

all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

g. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification requirements, the material will be rejected. The Contractor shall remove rejected material and replace it with acceptable material at no additional cost to the State.

5. *Reinforcing Elements*

a. Place reinforcing elements in accordance with the designer-supplier's recommendations or as described in the designer-supplier's Installation Manual.

b. Before attaching the reinforcing elements to the panel units, repair all damage to the zinc coating in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.*

c. Prior to the attachment of the reinforcing elements, as required, fill all openings, or attachment locations, with grease, or other protective material. Obtain the grease or other protective materials from the chosen designer-supplier.

d. Place reinforcing elements normal to the panel units unless indicated otherwise by the contract documents. Take care to avoid breaking, distorting, or disturbing the reinforcing elements. Replace reinforcing elements which are broken, or distorted, as determined by the Engineer.

e. Connect reinforcing elements to the facing before placement of subsequent facing units, or as directed by the approved construction drawings.

f. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 8 kph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 150 mm thick soil layer prior to operating tracked equipment over reinforced areas.

g. Repair or replace damaged reinforcing elements in strict accordance with the designer-supplier's written instructions.

6. *Identification*

a. Install MSES identification markers.

554-3.02. Mechanically Stabilized Segmental Block Retaining Wall System.

A. MSSBRWS Submittal. Obtain from the designer-supplier a Mechanically Stabilized Segmental Block Retaining Wall System design stamped by a Professional Engineer. All MSSBRWS designs shall conform to the requirements of Section 5.8 of the AASHTO Standard Specifications. Submit the MSSBRWS design package, including working drawings of the wall design, design calculations, and the designer-supplier's Installation Manual to the Deputy Chief Engineer Technical Services (DCETS) at least 30 work days before starting work. Begin work only after receiving the DCETS written approval.

Supply on-site technical assistance from a representative of the designated designer-supplier during the beginning of the installation until such time as outside consultation is no longer required.

B. MSSBRWS Excavation and Disposal and MSSBRWS Area Preparation. Excavate, dispose and prepare the area on which the MSSBRWS will rest in conformance with the requirements of §554-3.01 B. *MSES Excavation and Disposal and MSES Area Preparation.*

C. MSSBRWS Facing and Cap Unit Inspection, Storage, and Handling. Handle and store facing and cap units with care to prevent damage. Facing and cap units will be inspected prior to their

installation. Facing and cap units will be considered damaged if they contain any cracks or spalls and/or honeycombed areas with any dimensions greater than 25 mm. Replace rejected units at no additional cost to the State.

D. MSSBRWS Facing Unit Erection

1. Unreinforced Concrete or Compacted Granular Fill Leveling Pad. Provide an unreinforced concrete or compacted granular fill leveling pad as shown in the contract documents.

Place concrete in conformance with Section 555 *Structural Concrete*, or

Place and compact granular fill in conformance with Section 203 *Excavation and Embankment*.

2. Unit Installation. Install by placing, positioning, and aligning facing units in conformance with the designer-supplier's Installation Manual and within the tolerances in Table 554-2 *MSSBRWS Facing Unit Alignment Tolerances*.

3. Corrective Measures. Correct all misalignments of installed facing units that exceed the tolerances allowed in Table 554-2 *MSSBRWS Facing Unit Alignment Tolerances*.

TABLE 554-2 MSSBRWS FACING UNIT ALIGNMENT TOLERANCES	
Vertical Control	± 7 mm over a distance of 3 m
Horizontal Control	± 13 mm over a distance of 3 m
Rotation from established plan wall batter	± 13 mm over a distance of 3 m

4. Control. Control all operations and procedures to prevent misalignment of the facing units. Precautionary measures include (but are not limited to) keeping vehicular equipment at least 1 m behind the back of the facing units. Compaction equipment used within 1.0 m of the back of the facing units must conform to §203-3.12 B.6. *Compaction Equipment for Confined Areas*.

E. MSSBRWS Unit Infill

1. Placement. Place unit infill to the limits indicated in the contract documents. Before installing the next course of facing units, compact the unit infill and brush the tops of the facing units clean to ensure an even placement area.

2. Protection. Protect unit infill from contamination during construction.

F. MSSBRWS Backfill

1. Moisture Content. Place backfill materials (other than Types B and D) at a moisture content less than or equal to the Optimum Moisture Content. Rework or replace all material which is at a moisture content exceeding the Optimum Moisture Content. Determine Optimum Moisture Content in conformance with Geotechnical Test Methods (excluding GTM-6) for compaction that incorporates moisture content determination. Rework or replace backfill material at no additional cost to the State.

2. Backfill Placement. Prior to placement of the reinforcing element, backfill the area within 1 m of the facing units horizontally to within 25 mm or less below the required reinforcing element elevation. Roughly grade the backfill beyond the 1.0 m line to the reinforcing element elevation.

3. Separation Geotextile. Place the geotextile separation, if required, loosely but in intimate contact with the soil so that placement of the overlying material will not stretch or tear the geotextile.

4. Granular Backfill Layers. Place granular backfill material in uniform layers so that the compacted thickness of each layer does not exceed 250 mm or one block height, whichever is less. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

5. Types B and D Backfill Layers. Place Types B and D backfill in uniform layers so that the compacted thickness of each layer does not exceed 250 mm or one block height, whichever is less. Compact each layer in conformance with §203-3.12 Compaction.

6. Drainage System. Lay underdrain pipe at the location shown in the contract documents, at a grade to positively outlet, and having a full, firm and even bearing along the entire length of pipe. Place the geotextile drainage, if required, loosely to the shape of the excavated backslope.

7. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSSBRWS throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

8. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification requirements, the material will be rejected. The Contractor shall remove rejected material and replace it with acceptable material at no additional cost to the State.

G. MSSBRWS Reinforcing Element

1. Reinforcing Element Placement. Place the reinforcing element normal to facing units unless otherwise indicated in the contract documents. Replace all broken, damaged or distorted reinforcing elements at no additional cost to the State.

2. Reinforcing Element Connection. Install the reinforcing element within/between courses of facing units conforming to the designer-supplier's Installation Manual. Pull taut and secure the reinforcing element before placing the backfill.

H. MSSBRWS Identification

1. Identification Markers. Install MSSBRWS identification markers.

554-3.03. Geosynthetic Reinforced Earth System.

A. GRES Submittal. Submit the geogrid or geotextile reinforcing element certifications, verifying that the material meets the requirements of §737-07 *Geogrids* for the specified long term design tensile strength shown in the contract documents, to the Engineer prior to start of work. Begin work only after receiving the Engineer's approval.

Supply on-site technical assistance from a representative of the geosynthetic reinforcing element supplier until such time as outside consultation is no longer required.

B. GRES Storage of Geosynthetic. Store and protect geosynthetic materials in accordance with the manufacturer's recommendations prior to installation.

C. GRES Placement of Materials.

1. Geosynthetic Reinforcing Element. Place and secure the primary and secondary reinforcing element in accordance with the manufacturer's recommendations, in continuous strips without joints, seams or connections throughout the embedment length, to the line, grade and orientation shown in the contract documents. Place reinforcing elements to lay flat with no creases and pull taut to remove any slack prior to placement of backfill.

2. Welded Wire Forms. Place welded wire forms where required, as shown in the contract documents. Position and connect the welded wire forms to overlap 50 mm with adjacent forms and connect with wire ties. Install wire struts as shown in the contract documents and as required to stiffen the welded wire forms.

3. Geotextile Face Wrap. Place geotextile face wrap as shown in the contract documents. If used in conjunction with welded wire forms, place the geotextile face wrap so as to conform closely to the welded wire forms.

4. Backfill. Replace any damaged geosynthetic prior to placement of any overlying material at no cost to the State. Place the backfill onto the geosynthetic reinforcing elements in such a manner that no damage occurs. Progress placement of backfill materials so as to minimize the development of slack in the reinforcing element. The thickness of a compacted lift of backfill is not to exceed 300 mm or the measured vertical distance between geosynthetic layers, whichever is less. Compact the backfill to a minimum of 95% of Standard Proctor Maximum Density in accordance with the requirements contained in §203-3.12 *Compaction*. Only hand operated equipment is allowed within 1.0 m of the face. Lift thickness may have to be reduced to achieve required compaction.

5. Surface Protection. Place and secure erosion control material in accordance with Section 209 *Soil Erosion and Sediment Control* and as shown in the contract documents.

6. Permanent Facing. Place and connect permanent facing as shown in the contract documents.

7. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the GRES throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

D. GRES Construction Monitoring. Monitor the system face during fill placement and compaction. If verticality or the required batter of a system is not being maintained, stop work until compaction equipment and/or operational procedures are modified.

E. GRES Identification

1. Identification Markers. Install GRES identification markers for GRES installations other than welded wire form facing.

554-4 METHOD OF MEASUREMENT.

554-4.01. Mechanically Stabilized Earth System. A MSES will be measured in square meters of face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents.

554-4.02. Mechanically Stabilized Segmental Block Retaining Wall System. A MSSBRWS will be measured in square meters of face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents.

554-4.03. Geosynthetic Reinforced Earth System. A GRES will be measured in square meters of vertical face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents.

554-5 BASIS OF PAYMENT

554-5.01 Mechanically Stabilized Earth System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, reinforcing elements, leveling pad, joint fillers, coping, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the Contract, necessary to satisfactorily complete the work.

554-5.02 Mechanically Stabilized Segmental Block Retaining Wall System. Include in the unit price bid the cost of all labor, material, and equipment, including leveling pad, facing and cap units, backfill, underdrains, geotextiles, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the Contract, necessary to satisfactorily complete the work.

554-5.03 Geosynthetic Reinforced Earth System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, geosynthetic reinforcing elements, geotextile face wrap, welded wire forms and struts necessary to satisfactorily complete the work

Payment will be made under:

Item No.	Item	Pay Unit
554.01XX	Mechanically Stabilized Earth System, No Color	Square Meter
554.02XX	Mechanically Stabilized Earth System, Integral Color	Square Meter
XX	Surface	
01	Plain Concrete Surface	
02	Textured Surface (hand tooled, raked, etc.)	
03	Exposed Aggregate Surface	
04	Architectural Pattern (form liner or stamped)	
05	Other; As Shown in the Contract Documents	
554.20	Mechanically Stabilized Segmental Block Retaining Wall System	Square Meter
554.30XX	Geosynthetic Reinforced Earth System Wall	Square Meter
XX	Facing System	
01	Welded Wire Forms	
02	Geocells	
03	Timbers	
04	Gabions	
05	Other; As Shown in the Contract Documents	
554.31	Geosynthetic Reinforced Earth System Slope	Square Meter

Make the following changes to the Standard Specifications dated May 1, 2008:

Pages 332 through 338, **Delete** SECTION 554 and **Replace** it with the following:

SECTION 554 – INTERNALLY STABILIZED FILL STRUCTURES

554-1 DESCRIPTION. This work shall consist of furnishing and installing an internally stabilized fill structure at the location(s) and to the elevation(s) shown in the contract documents. Internally stabilized fill structures rely on the internal reinforcing elements to provide tensile forces to resist instability and are categorized in the retaining wall subsections of this specification.

554-1.01 Mechanically Stabilized Earth System. A Mechanically Stabilized Earth System (MSES) is comprised of an unreinforced concrete leveling pad, precast concrete facing units, earth backfill, and reinforcing elements used to stabilize the backfill.

Obtain all necessary materials, except backfill and leveling pad material, from the approved wall system designer-supplier. Approved designers-suppliers, wall systems, and the components of each wall system appear on the Approved List, available on the Department's web site. Designer-suppliers wishing to have their wall systems reviewed for placement on the Approved List shall follow the procedural directives of the Geotechnical Engineering Bureau as contained in Highway Design Manual Appendix 9A.

A. MSES Definitions.

1. Wall System. A combination of a specific precast panel facing unit, a design-specific backfill reinforcing element and characteristic connection method, and the backfill.

2. Leveling Pad. An unreinforced concrete footing which serves as a flat, level surface for placing the initial course of facing units.

3. Facing Unit. A precast concrete panel incorporating a means for attaching the backfill reinforcing element, forming part of the face area of the MSES. A corner unit is a facing unit having two faces.

4. Reinforcing Element. A metal strip, wire mesh, geogrid or other similar material connected to the facing unit and extending into the backfill for the purpose of backfill stabilization.

5. Attaching Devices. Components cast into the facing unit to provide a means for attaching reinforcing elements.

6. Fastener. Hardware used to connect the reinforcing element to the attaching device.

7. Joint Filler. Material used to fill the joints between units.

8. Slip Joint. A vertical joint specific to the wall system used as a stress relief at wall step locations.

9. Identification Markers. Signs or marking tape buried near the finished grade to identify and prohibit excavation of the reinforced backfill.

10. Backfill. Material placed and compacted in conjunction with the reinforcing elements and facing units.

554-1.02 Mechanically Stabilized Segmental Block Retaining Wall System. A Mechanically Stabilized Segmental Block Retaining Wall (MSSBRWS) is comprised of an unreinforced concrete or compacted granular fill leveling pad, facing and cap units, earth backfill, backfill drainage materials, and reinforcing elements used to stabilize the backfill. Only MSSBRWS designer-suppliers (designer-supplier) with facing and cap units appearing on the Approved List for Precast Concrete Retaining Wall Block will be acceptable for use.

Obtain all necessary materials, except backfill, unit infill, leveling pad material, backfill drainage materials, and cast-in-place concrete, from the designer-supplier. Approved facing and cap units from

designers-suppliers appear on the Department's Approved List available on the Department's web site. Designer-suppliers wishing to have their facing and cap units reviewed for placement on the Approved List shall follow the procedural directives of the Geotechnical Engineering Bureau as contained in Highway Design Manual Appendix 9A.

A. MSSBRWS Definitions.

1. Wall System. A combination of a specific precast block facing unit, a design-specific backfill reinforcing element and characteristic connection method, and the backfill.

2. Leveling Pad. An unreinforced concrete or compacted granular fill footing or pad which serves as a flat, level surface for placing the initial course of facing units.

3. Facing Unit. A segmental precast concrete block unit, with less than 6 ft^2 wall face area, that incorporates an alignment and connection device and also forms part of the MSSBRWS face area. A corner unit is a facing unit having two faces.

4. Alignment and Connection Device. Any device that is either built into or specially manufactured for the facing units, such as shear keys, leading/trailing lips, or pins. The device is used to provide alignment and maintain positive location for a facing unit and also provide a means for connecting the reinforcing elements.

5. Reinforcing Element. High density polyethylene, polypropylene or high tenacity polyester geogrid mats for the purpose of backfill stabilization.

6. Unit Infill. Well-graded aggregate fill placed within and/or contiguous to the back of the facing unit.

7. Cap Unit. A segmental precast concrete unit placed on and attached to the top of the finished MSSBRWS.

8. Backfill. Material placed and compacted in conjunction with the reinforcing elements and facing units.

9. Underdrain. A system for removing water from behind the MSSBRWS.

10. Geotextile. A permeable textile material used to separate dissimilar granular materials.

554-1.03 Geosynthetic Reinforced Earth System. A Geosynthetic Reinforced Earth System (GRES) is comprised of earth backfill, geosynthetic reinforcing elements used for internal stabilization and surface protection to resist erosion. For wall applications, the surface protection is replaced by a geotextile face wrap, welded wire forms or permanent facing elements.

A. GRES Definitions.

1. Wall System. A combination of a specific facing system (excluding precast units), a design-specific geosynthetic backfill reinforcing element, and the backfill.

2. Geosynthetic Reinforcing Element. A geogrid or geotextile used for the purpose of backfill stabilization meeting the requirements of §737-07 *Geogrids*.

a. Primary Reinforcing Element. A geogrid or geotextile with sufficient strength and soil compatible modulus, placed horizontally within the slope or wall, to provide tensile forces to resist instability.

b. Secondary Reinforcing Element. A geogrid or geotextile used in a non-wrapped GRES installation typically employed in over steepened slopes, to aid in stability of the slope face between primary reinforcing element layers.

3. Geotextile Face Wrap. A layer of geotextile used to prevent loss of backfill, typically employed in a wall application which incorporates a welded wire facing system. In applications where a geotextile is used as the primary reinforcing element, it may be designed to also function as the face wrap.

4. Facing System. A series of structural elements incorporating a means for attaching the reinforcing elements, which serves to support the front edge of the backfill.

5. Welded Wire Forms. A non-structural facing system used in temporary walls to aid in compaction near the face of the wall.

6. Backfill. Material placed and compacted in conjunction with the reinforcing elements and facing system.

554-2 MATERIALS.

554-2.01. Mechanically Stabilized Earth System. Ensure that the proper materials are supplied for the chosen system design. Not all materials listed below are required for each Mechanically Stabilized Earth System. Provide materials meeting the following requirements:

A. MSES Facing Units. Fabricate precast concrete facing units, coping units, and other precast units in accordance with the requirements of §704-14 *Precast Concrete Panel Units*. Architectural treatment of the Precast Concrete Panels may be required by special notes shown in the contract documents.

B. MSES Metal Reinforcing Strips. Provide reinforcing strips of ASTM Designated metal grades and galvanize in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I*. The reinforcing strips associated with each approved wall system appear on the Department's approved list under wall system components.

C. MSES Metal Reinforcing Mesh. Fabricate the reinforcing mesh from cold drawn steel wire conforming to the requirements of §709-09 *Cold Drawn Wire for Concrete Reinforcement*, and weld into the finished mesh fabric in accordance with the requirements of §709-02 *Wire Fabric for Concrete Reinforcement*. Galvanize in accordance with §719-01 *Galvanized Coatings and Repair Methods, Type I*. The reinforcing mesh associated with each approved wall system appears on the Department's approved list under wall system components.

D. MSES Geogrid Reinforcing Element. Provide geogrid reinforcing elements meeting the requirements of §737-07 *Geogrids*. The grid(s) associated with each approved wall system appear on the Approved List under wall system components.

E. MSES Fasteners and Attaching Devices. The fasteners and attaching devices are specific to each wall system and provided by the wall system supplier. The fasteners and attaching devices associated with each approved wall system appear on the Approved List under wall system components.

F. MSES Joint Fillers. Fill joints with material approved by D.C.E.S. and approved by the wall system supplier.

G. MSES Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system supplier.

H. MSES Leveling Pad. Provide leveling pad material meeting the requirements of Section 501 *Portland Cement Concrete - General*, Class A concrete.

I. MSES Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material*.

J. MSES Identification Markers

1. Signs. These will be 7 in. x 10 in. (minimum) fiberglass. Include warning information as follows:

WARNING
Internally Stabilized Fill Structure
DO NOT EXCAVATE
Call Regional Office of NYS DOT

2. Marking Tape. This will be polyethylene material 3 in. wide, 4 mil thick. Include warning markings.

554-2.02. Mechanically Stabilized Segmental Block Retaining Wall System. Not all materials listed below are required for each MSSBRWS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. MSSBRWS Leveling Pad. MSSBRWS height is measured from the top of the leveling pad to the top of the cap unit.

1. Wall Heights Taller Than or Equal to 15 ft. For MSSBRWS taller than or equal to 15 ft. in total height, supply a leveling pad of unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General.*

2. Wall Heights Shorter Than 15 ft. For MSSBRWS shorter than 15 ft. in total height, supply a leveling pad conforming to one of the following:

a. Unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General*, or

b. Select Granular Fill - §203-2.02 C Select Granular Fill and Select Structure Fill, or

c. Crushed Stone - §501-2.02, B.1.b. Coarse Aggregate Type CA-2 in Table 501-2 Coarse Aggregate Gradations.

B. MSSBRWS Facing and Cap Units. Supply units fabricated and conforming to §704-07 *Segmental Retaining Wall Blocks.*

C. MSSBRWS Alignment and Connection Devices. Supply devices conforming to the designer-supplier's Installation Manual.

D. MSSBRWS Reinforcing Element. Provide geogrid or geotextile reinforcing elements meeting the requirements of §737-07 *Geogrids.*

E. MSSBRWS Unit Infill. Supply unit infill conforming to material and gradation requirements for §501-2.02B.1.b. Coarse Aggregate Type CA-2 in Table 501-2 Coarse Aggregate Gradations.

F. MSSBRWS Cast-In-Place Concrete. Supply concrete conforming to Section 501 *Portland Cement Concrete – General*, Class A concrete.

G. MSSBRWS Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

H. MSSBRWS Separation Geotextile. Supply a geotextile for the separation of dissimilar materials, conforming to the requirements of §737-01 *Geotextiles*, Geotextile Separation, Strength Class 2.

I. MSSBRWS Drainage System. Supply underdrain and geotextile material for a backfill drainage system as shown in the contract documents or conforming to the designer-suppliers Installation Manual:

1. Underdrain Pipe. Supply optional underdrain pipe conforming to Section 605 *Underdrains*.

2. Geotextile Drainage. Supply geotextile conforming to the requirements of §737-01 *Geotextiles*, Geotextile Drainage, Strength Class 2, Drainage Class B.

J. MSSBRWS Identification Markers. Supply identification markers conforming to §554-2.01 J. *MSES Identification Markers.*

554-2.03. Geosynthetic Reinforced Earth System. Ensure that the proper materials are supplied for the chosen system design. Not all materials listed below are required for each GRES. Provide materials meeting the following requirements:

A. GRES Geosynthetic Reinforcing Element. Provide a geogrid or geotextile primary and secondary reinforcing elements meeting the requirements of §737-07 *Geogrids*.

B. GRES Backfill. Provide backfill material conforming to the following:

1. Walls. Provide backfill material meeting the requirements of §203-2.02 C *Select Granular Fill and Select Structural Fill.*

2. Slopes. Provide backfill material meeting the requirements of §733-03 *Geosynthetic Reinforced Earth System Slope Backfill Material.*

C. GRES Facing System. Provide a facing system shown in the contract documents and in accordance with the requirements below.

1. Welded Wire Forms. Provide welded wire forms and wire struts as shown in the contract documents, conforming to the material requirements of §709-02 *Wire Fabric for Concrete Reinforcement.* Provide geotextile face wrap material meeting the requirements of §737-01 *Geotextiles* and as shown in the contract documents.

Proposed alternate, non-structural facing systems used to aid in compaction near the face of the wall shall be included in the submittal outlined in §554-3.03 A. *GRES Submittal.*

2. Geocells. Provide geocells and anchoring devices and staples as shown in the contract documents, conforming to the material requirements of §737-08 *Geocells*.

Provide infill material conforming to §203-2.02 C, *Select Granular Fill and Select Structural Fill*, with the added stipulation that the maximum particle size is 2 in. Where a vegetated face is called for, the outermost cells are to be filled with topsoil meeting the material requirements of §713-01 *Topsoil*.

3. Timbers. Provide timbers as shown in the contract documents, graded for an extreme fiber stress of at least 1000 psi conforming to the material requirements of §712-14 *Stress Graded Timber and Lumber*. Treat timbers in accordance with §708-31 *Wood Preservative - Waterborne* and applied in conformance with American Wood Preservers Association (AWPA) Use Category Designation UC4B.

4. Gabions. Provide gabions, tiewire or lacing wire, and gabion backfill as shown in the contract documents, conforming to the material requirements of §712-15 *Gabions*.

5. As Shown in the Contract Documents. Provide materials in accordance with the contract documents. Precast units are excluded as a design-specific GRES facing system,

D. GRES Surface Protection. Provide erosion resistant covering of the finished GRES slope surface meeting the requirements of §713-07 *Rolled Erosion Control Products and Soil Stabilizers* Class III Type C.

E. GRES Identification Markers. Supply identification markers conforming to §554-2.01 J. *MSES Identification Markers.*

554-3 CONSTRUCTION DETAILS

554-3.01. Mechanically Stabilized Earth System.

A. MSES Submittal. Obtain from the designer-supplier a Mechanically Stabilized Earth System design stamped by a Professional Engineer. Submit the MSES design package, including working drawings of the wall design, design calculations, identification of backfill material gradation type(s) (outlined in §733-02B *Gradation*) suitable for the construction of the wall system, and the designer-supplier's Installation Manual to the Deputy Chief Engineer Structures (DCES) at least 30 work days before starting work. The MSES design package must also include working drawings for all contract-specific facing panels not previously approved by the Materials Bureau.

A Pre-Operation Meeting will be held between the Engineer, Contractor, Regional Geotechnical Engineer, Geotechnical Engineering Bureau and other appropriate Department representatives to discuss the Contractors proposed construction methods. Begin work only after receiving the DCES written approval and holding the Pre-Operation Meeting.

Supply on-site technical assistance from a representative of the designated designer-supplier during the beginning of the installation until such time as outside consultation is no longer required.

B. MSES Excavation and Disposal and MSES Area Preparation. Excavate and dispose of all excavated material in accordance with the requirements of Section 203 *Excavation and Embankment*, except as modified herein.

1. Placement Area. Grade the area under the Mechanically Stabilized Earth System, level for a width equal to, or in excess of, the reinforcing element length. Prior to wall system construction, compact this area to a minimum of 90% of Standard Proctor Maximum Density. Treat all soils found to be unsuitable, or incapable of being satisfactorily compacted because of moisture content, in a manner directed by the Engineer, in conjunction with the recommendations of the Regional Geotechnical Engineer.

2. Rock. Remove rock to the limits indicated in the contract documents.

3. Depth of Excavation. The depth of excavation for the leveling pad is indicated in the contract documents. Include the cost of this excavation in a separate excavation item.

C. MSES Facing Unit Inspection, Storage, and Handling

1. Precast Concrete Facing Units. An inspection will be made prior to installation to determine if any damage has occurred to the unit(s). Handle and store the units with care to prevent damage.

2. Damaged Units. Repair damaged units in a manner approved by the Engineer. Replace units that are not repairable at no additional cost to the State.

D. MSES Erection

1. Methods and Equipment. Install units in accordance with the designer-supplier's working drawings and Installation Manual, unless otherwise modified by the contract documents. Prior to installation of the units, furnish the Engineer with detailed information concerning the proposed construction method, as well as the equipment planned for use.

2. *Unreinforced Concrete Leveling Pad.* Provide an unreinforced concrete leveling pad as required by the contract documents. Place the concrete in accordance with the requirements Section 555 *Structural Concrete*.

3. *Unit Installation*

a. Place units such that, after completion of compaction, the tolerances of Table 554-1 *MSES Facing Unit Alignment and Joint Offset Tolerances* are not exceeded. After placement, maintain each unit in position. If wedges are used, do not allow them to remain in place below three panel unit heights during installation, and compaction. Remove all wedges remaining in the top three panel unit heights upon completion of the MSES. External braces may be required for initial placements. Install joint fillers in the manner indicated by the Installation Manual.

b. Correct all misalignments of installed units in excess of the tolerances allowed by Table 554-1 *MSES Facing Unit Alignment and Joint Offset Tolerances*, at no additional cost to the State.

c. Govern the operations and procedures to prevent misalignment of the installed panel units. Precautionary measures include, but are not limited to, keeping vehicular equipment a minimum of 3 ft. from the panel units. Within 3 ft. of the panel units use compaction equipment meeting the requirements of §203-3.12 B. 6. *Compaction Equipment for Confined Areas.*

TABLE 554-1 MSES FACING UNIT ALIGNMENT AND JOINT OFFSET TOLERANCES	
Horizontal Alignment	± ¾ in./ 10 ft.
Joint Offset per Unit	± ½ in.
Overall Vertical Plumbness (Top to Bottom of Wall System)	± ½ in./ 10 ft.

4. *Backfill*

a. Do not mix backfill types behind any wall without the written permission of the Director, Geotechnical Engineering Bureau.

b. Place backfill materials, other than Type B and Type D, at a moisture content less than or equal to the Optimum Moisture Content. Rework or replace all backfill material which is at a moisture content in excess of the Optimum Moisture content. Determine the Optimum Moisture Content in accordance with the latest Geotechnical Test Methods for compaction that incorporate moisture content determination. Rework or replace backfill material at no additional cost to the State.

c. Place granular backfill material in uniform layers not exceeding 12 in. loose lift thickness per layer. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

d. Place Type B and Type D backfill in uniform layers not exceeding 16 in. loose lift thickness. Compact in accordance with requirements determined by the Engineer.

e. Prior to placement of the reinforcing element, backfill the area within 3 ft. of the panel units horizontally to within 1 in. or less, below the required reinforcing element elevation. Roughly grade the backfill beyond the 3 ft. line to the reinforcing element elevation.

f. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSES throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

g. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification

requirements, the material will be rejected. The Contractor shall remove rejected material and replace it with acceptable material at no additional cost to the State.

5. *Reinforcing Elements*

a. Place reinforcing elements in accordance with the designer-supplier's recommendations or as described in the designer-supplier's Installation Manual.

b. Before attaching the reinforcing elements to the panel units, repair all damage to the zinc coating in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.*

c. Prior to the attachment of the reinforcing elements, as required, fill all openings, or attachment locations, with grease, or other protective material. Obtain the grease or other protective materials from the chosen designer-supplier.

d. Place reinforcing elements normal to the panel units unless indicated otherwise by the contract documents. Take care to avoid breaking, distorting, or disturbing the reinforcing elements. Replace reinforcing elements which are broken, or distorted, as determined by the Engineer.

e. Connect reinforcing elements to the facing before placement of subsequent facing units, or as directed by the approved construction drawings.

f. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 5 mph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 6 in. thick soil layer prior to operating tracked equipment over reinforced areas.

g. Repair or replace damaged reinforcing elements in strict accordance with the designer-supplier's written instructions.

6. *Identification*

a. Install MSES identification markers.

554-3.02. Mechanically Stabilized Segmental Block Retaining Wall System.

A. MSSBRWS Submittal. Obtain from the designer-supplier a Mechanically Stabilized Segmental Block Retaining Wall System design stamped by a Professional Engineer. All MSSBRWS designs shall conform to the requirements of Section 5.8 of the AASHTO Standard Specifications. Submit the MSSBRWS design package, including working drawings of the wall design, design calculations, and the designer-supplier's Installation Manual to the Deputy Chief Engineer Technical Services (DCETS) at least 30 work days before starting work. Begin work only after receiving the DCETS written approval.

Supply on-site technical assistance from a representative of the designated designer-supplier during the beginning of the installation until such time as outside consultation is no longer required.

B. MSSBRWS Excavation and Disposal and MSSBRWS Area Preparation. Excavate, dispose and prepare the area on which the MSSBRWS will rest in conformance with the requirements of §554-3.01 B. *MSES Excavation and Disposal and MSES Area Preparation.*

C. MSSBRWS Facing and Cap Unit Inspection, Storage, and Handling. Handle and store facing and cap units with care to prevent damage. Facing and cap units will be inspected prior to their installation. Facing and cap units will be considered damaged if they contain any cracks or spalls and/or honeycombed areas with any dimensions greater than 1 in. Replace rejected units at no additional cost to the State.

D. MSSBRWS Facing Unit Erection

1. Unreinforced Concrete or Compacted Granular Fill Leveling Pad. Provide an unreinforced concrete or compacted granular fill leveling pad as shown in the contract documents.

Place concrete in conformance with Section 555 *Structural Concrete*, or

Place and compact granular fill in conformance with Section 203 *Excavation and Embankment* .

2. Unit Installation. Install by placing, positioning, and aligning facing units in conformance with the designer-supplier's Installation Manual and within the tolerances in Table 554-2 *MSSBRWS Facing Unit Alignment Tolerances.*

3. Corrective Measures. Correct all misalignments of installed facing units that exceed the tolerances allowed in Table 554-2 *MSSBRWS Facing Unit Alignment Tolerances.*

TABLE 554-2 MSSBRWS FACING UNIT ALIGNMENT TOLERANCES	
Vertical Control	± ¼ in. over a distance of 10 ft.
Horizontal Control	± ½ in. over a distance of 10 ft.
Rotation from established plan wall batter	± ½ in. over a distance of 10 ft.

4. Control. Control all operations and procedures to prevent misalignment of the facing units. Precautionary measures include (but are not limited to) keeping vehicular equipment at least 3 ft. behind the back of the facing units. Compaction equipment used within 3 ft. of the back of the facing units must conform to §203-3.12 B.6. *Compaction Equipment for Confined Areas.*

E. MSSBRWS Unit Infill

1. Placement. Place unit infill to the limits indicated in the contract documents. Before installing the next course of facing units, compact the unit infill and brush the tops of the facing units clean to ensure an even placement area.

2. Protection. Protect unit infill from contamination during construction.

F. MSSBRWS Backfill

1. Moisture Content. Place backfill materials (other than Types B and D) at a moisture content less than or equal to the Optimum Moisture Content. Rework or replace all material which is at a moisture content exceeding the Optimum Moisture Content. Determine Optimum Moisture Content in conformance with Geotechnical Test Methods (excluding GTM-6) for compaction that incorporates moisture content determination. Rework or replace backfill material at no additional cost to the State.

2. Backfill Placement. Prior to placement of the reinforcing element, backfill the area within 3 ft. of the facing units horizontally to within 1 in. or less below the required reinforcing element elevation. Roughly grade the backfill beyond the 3 ft. line to the reinforcing element elevation.

3. Separation Geotextile. Place the geotextile separation, if required, loosely but in intimate contact with the soil so that placement of the overlying material will not stretch or tear the geotextile.

4. Granular Backfill Layers. Place granular backfill material in uniform layers so that the compacted thickness of each layer does not exceed 10 in. or one block height, whichever is less. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

5. Types B and D Backfill Layers. Place Types B and D backfill in uniform layers so that the compacted thickness of each layer does not exceed 10 in. or one block height, whichever is less. Compact each layer in conformance with §203-3.12 Compaction.

6. Drainage System. Lay underdrain pipe at the location shown in the contract documents, at a grade to positively outlet, and having a full, firm and even bearing along the entire length of pipe. Place the geotextile drainage, if required, loosely to the shape of the excavated backslope.

7. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSSBRWS throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

8. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification requirements, the material will be rejected. The Contractor shall remove rejected material and replace it with acceptable material at no additional cost to the State.

G. MSSBRWS Reinforcing Element

1. Reinforcing Element Placement. Place the reinforcing element normal to facing units unless otherwise indicated in the contract documents. Replace all broken, damaged or distorted reinforcing elements at no additional cost to the State.

2. Reinforcing Element Connection. Install the reinforcing element within/between courses of facing units conforming to the designer-supplier's Installation Manual. Pull taut and secure the reinforcing element before placing the backfill.

H. MSSBRWS Identification

1. Identification Markers. Install MSSBRWS identification markers.

554-3.03. Geosynthetic Reinforced Earth System.

A. GRES Submittal. Submit the geogrid or geotextile reinforcing element certifications, verifying that the material meets the requirements of §737-07 *Geogrids* for the specified long term design tensile strength shown in the contract documents, to the Engineer prior to start of work. Begin work only after receiving the Engineer's approval.

Supply on-site technical assistance from a representative of the geosynthetic reinforcing element supplier until such time as outside consultation is no longer required.

B. GRES Storage of Geosynthetic. Store and protect geosynthetic materials in accordance with the manufacturer's recommendations prior to installation.

C. GRES Placement of Materials.

1. Geosynthetic Reinforcing Element. Place and secure the primary and secondary reinforcing element in accordance with the manufacturer's recommendations, in continuous strips without joints, seams or connections throughout the embedment length, to the line, grade and orientation shown in the contract documents. Place reinforcing elements to lay flat with no creases and pull taut to remove any slack prior to placement of backfill.

2. Welded Wire Forms. Place welded wire forms where required, as shown in the contract documents. Position and connect the welded wire forms to overlap 2 in. with adjacent forms and connect with wire ties. Install wire struts as shown in the contract documents and as required to stiffen the welded wire forms.

3. Geotextile Face Wrap. Place geotextile face wrap as shown in the contract documents. If used in conjunction with welded wire forms, place the geotextile face wrap so as to conform closely to the welded wire forms.

4. Backfill. Replace any damaged geosynthetic prior to placement of any overlying material at no cost to the State. Place the backfill onto the geosynthetic reinforcing elements in such a manner that no damage occurs. Progress placement of backfill materials so as to minimize the development of slack in the reinforcing element. The thickness of a compacted lift of backfill is not to exceed 12 in. or the measured vertical distance between geosynthetic layers, whichever is less. Compact the backfill to a minimum of 95% of Standard Proctor Maximum Density in accordance with the requirements contained in §203-3.12 *Compaction*. Only hand operated equipment is allowed within 3 ft. of the face. Lift thickness may have to be reduced to achieve required compaction.

5. Surface Protection. Place and secure erosion control material in accordance with Section 209 *Soil Erosion and Sediment Control* and as shown in the contract documents.

6. Permanent Facing. Place and connect permanent facing as shown in the contract documents.

7. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the GRES throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

D. GRES Construction Monitoring. Monitor the system face during fill placement and compaction. If verticality or the required batter of a system is not being maintained, stop work until compaction equipment and/or operational procedures are modified.

E. GRES Identification

1. Identification Markers. Install GRES identification markers for GRES installations other than welded wire form facing.

554-4 METHOD OF MEASUREMENT.

554-4.01. Mechanically Stabilized Earth System. A MSES will be measured in square feet of face area, measured to the nearest square foot from the payment lines shown in the contract documents.

554-4.02. Mechanically Stabilized Segmental Block Retaining Wall System. A MSSBRWS will be measured in square feet of face area, measured to the nearest square foot from the payment lines shown in the contract documents.

554-4.03. Geosynthetic Reinforced Earth System. A GRES will be measured in square feet of vertical face area, measured to the nearest square foot from the payment lines shown in the contract documents.

554-5 BASIS OF PAYMENT

554-5.01 Mechanically Stabilized Earth System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, reinforcing elements, leveling pad, joint fillers, coping, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the Contract, necessary to satisfactorily complete the work.

554-5.02 Mechanically Stabilized Segmental Block Retaining Wall System. Include in the unit price bid the cost of all labor, material, and equipment, including leveling pad, facing and cap units, backfill, underdrains, geotextiles, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the Contract, necessary to satisfactorily complete the work.

554-5.03 Geosynthetic Reinforced Earth System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, geosynthetic reinforcing elements, geotextile face wrap, welded wire forms and struts necessary to satisfactorily complete the work

Payment will be made under:

Item No.	Item	Pay Unit
554.01XX	Mechanically Stabilized Earth System, No Color	Square Feet
554.02XX	Mechanically Stabilized Earth System, Integral Color	Square Feet
XX	Surface	
01	Plain Concrete Surface	
02	Textured Surface (hand tooled, raked, etc.)	
03	Exposed Aggregate Surface	
04	Architectural Pattern (form liner or stamped)	
05	Other; As Shown in the Contract Documents	
554.20	Mechanically Stabilized Segmental Block Retaining Wall System	Square Feet
554.30XX	Geosynthetic Reinforced Earth System Wall	Square Feet
XX	Facing System	
01	Welded Wire Forms	
02	Geocells	
03	Timbers	
04	Gabions	
05	Other; As Shown in the Contract Documents	
554.31	Geosynthetic Reinforced Earth System Slope	Square Feet