49th Annual
MICHIGAN CEW 2015
County Engineers' Workshop
City engineers and consultants are welcome too!
Michigan's Local Technical Assistance Program
Center for Technology & Training

Michigan's First GRS-IBS "Every Day Counts" Bridge Project- Keefer Highway over Sebewa Creek, Ionia County

Site Design and Challenges in Material Acquisition

Williams & Works
engineers . planners . surveyors
a tradition of service

Before

After

Background

What is GRS-IBS?

What is GRS-IBS?

- Instead of conventional bridge support technology, Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS) technology uses alternating layers of compacted granular fill material and fabric sheets of geotextile reinforcement to provide support for the bridge.

- GRS also provides a smooth transition from the bridge onto the roadway, and alleviates the "bump at the bridge" problem caused by uneven settlement between the bridge and approaching roadway.

Source: Federal Highway Administration, U.S. Department of Transportation

What is GRS-IBS cont'd.

- The GRS technique can be applied to many facets of earthwork, such as walls, abutments, culverts, slope stability, rock fall barriers, roadway support, and integrated bridge systems

- IBS is a fast, cost effective method of bridge support that uses GRS technology to blend roadway into superstructure.

Source: Federal Highway Administration, U.S. Department of Transportation

What are the major advantages of GRS IBS?

GRS IBS offers unique advantages, particularly in the construction of small bridges.

- LIGHTER They are easy to maintain because they contain fewer parts: IBS is typically built without many of the elements common to a conventional bridge abutment.
- QUICKER GRS IBS bridges are easy to build with common equipment and materials, so projects can be completed more quickly.
- CHEAPER Construction costs are typically 25-60 percent lower than conventional construction methods.

Source: Federal Highway Administration, U.S. Department of Transportation

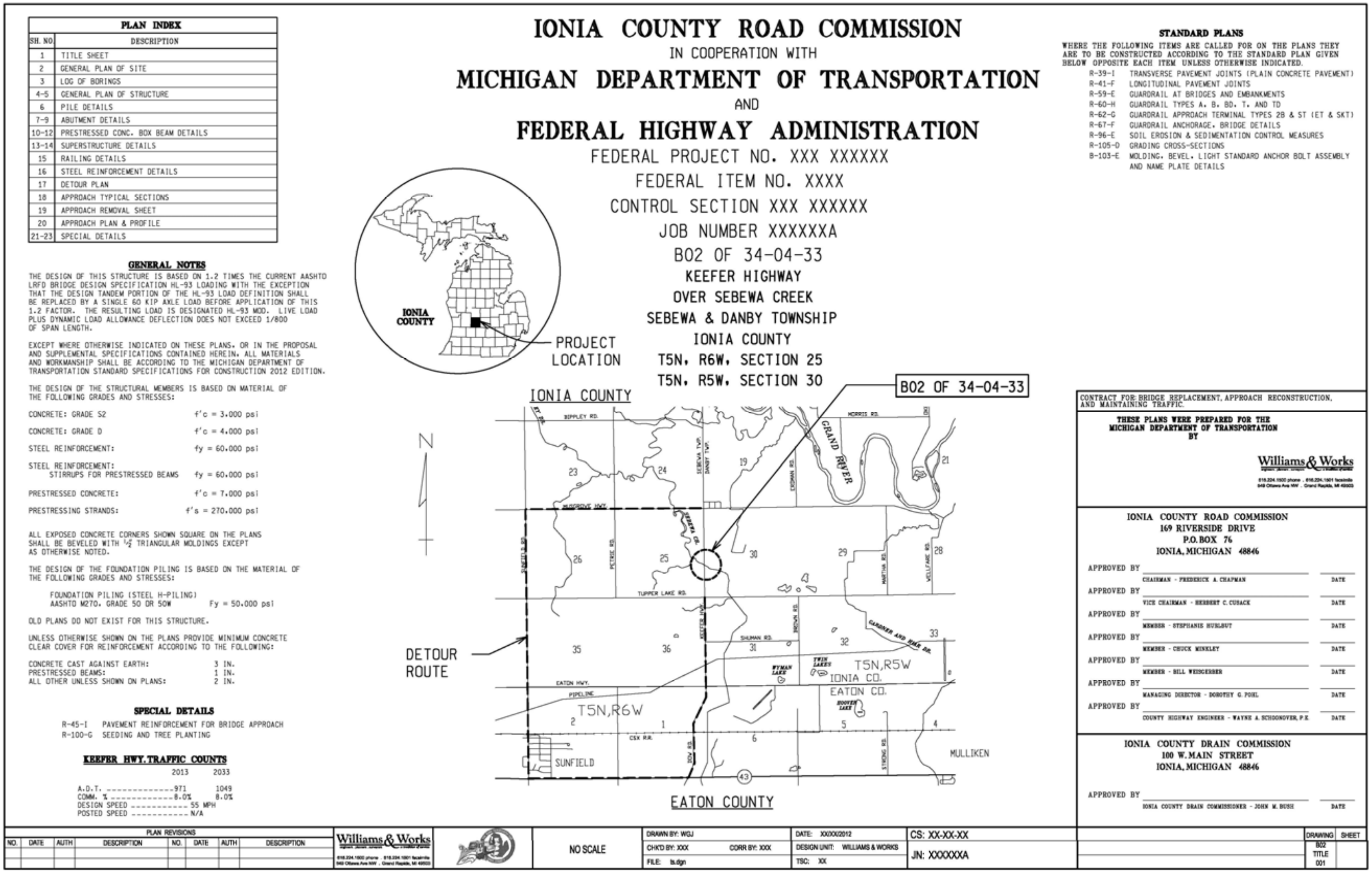
Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide

PUBLICATION NO. FHWA-HRT-11-026 JUNE 2012

U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

Title Sheet



PLAN INDEX
SH. NO. DESCRIPTION
1 TITLE SHEET
2 GENERAL PLAN OF SITE
3 LOG OF BORINGS
4-5 GENERAL PLAN OF STRUCTURE
6 PILE DETAILS
7-9 ABUTMENT DETAILS
10-12 PRESTRESSED CONC. BOX BEAM DETAILS
13-14 SUPERSTRUCTURE DETAILS
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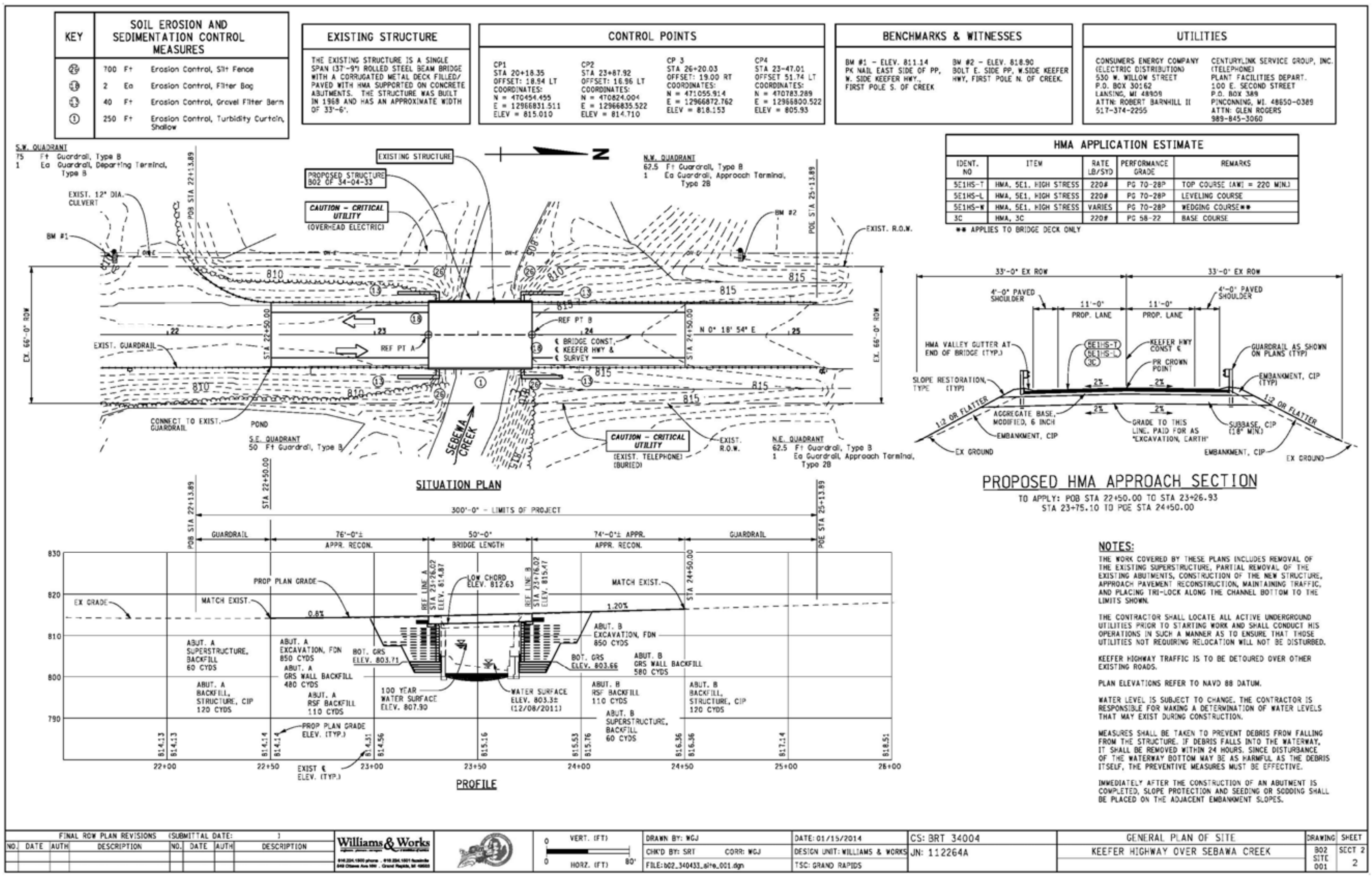
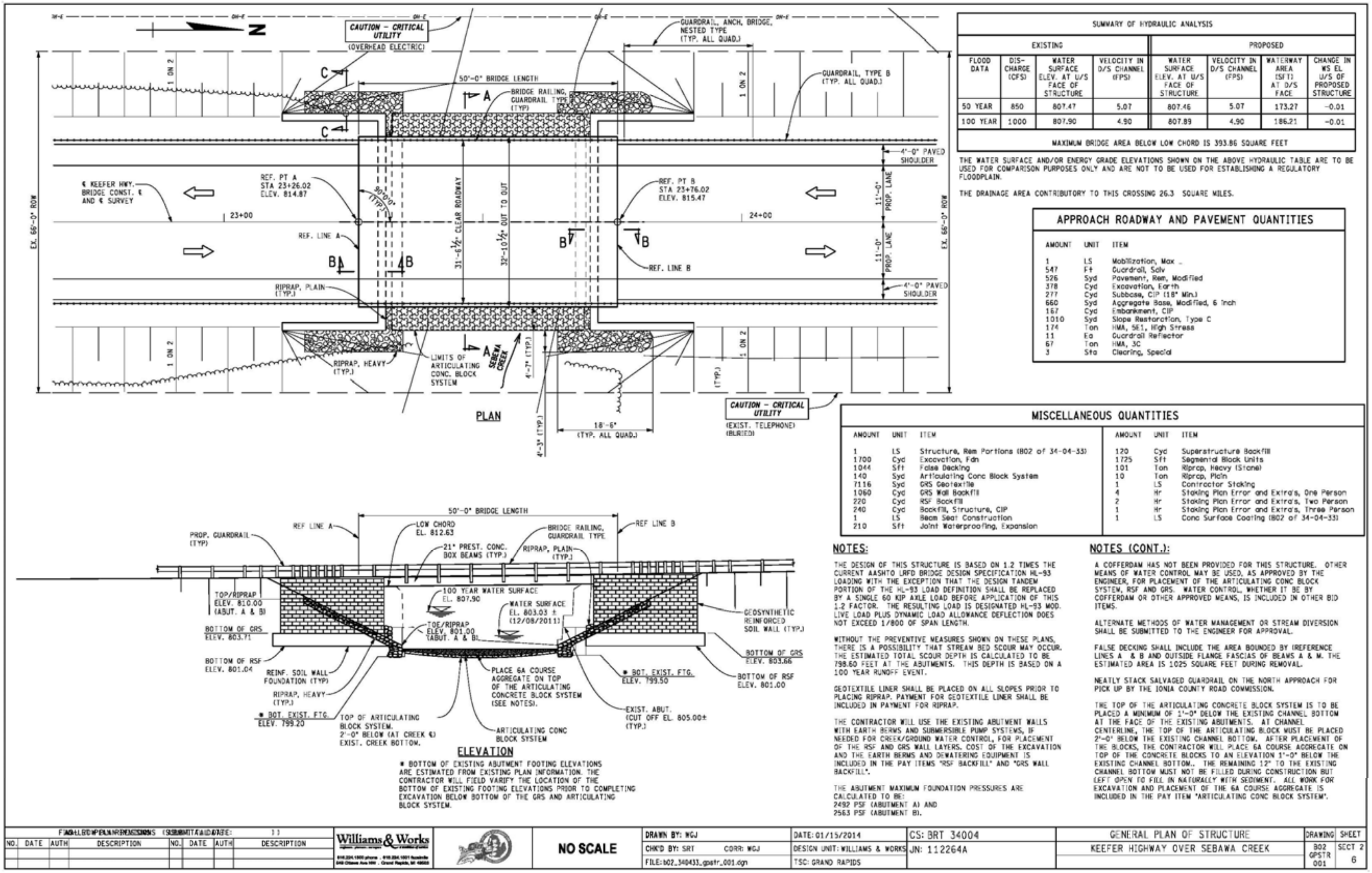
16 STEEL REINFORCEMENT DETAILS
17 DETOUR PLAN
18 APPROACH TYPICAL SECTIONS
19 APPROACH REMOVAL SHEET
20 APPROACH PLAN & PROFILE
21-23 SPECIAL DETAILS
GENERAL NOTES
THE DESIGN OF THIS STRUCTURE IS BASED ON 1.2 TIMES THE CURRENT AASHTO LRFD BRIDGE DESIGN SPECIFICATION HL-93 LOADING WITH THE EXCEPTION THAT THE DESIGN TANDEM PORTION OF THE HL-93 LOAD DEFINITION SHALL BE REPLACED BY A SINGLE 60 KIP AXLE LOAD BEFORE APPLICATION OF THIS 1.2 FACTOR. THE RESULTING LOAD IS DESIGNATED HL-93 MOD. LIVE LOAD PLUS DYNAMIC LOAD ALLOWANCE DEFLECTION DOES NOT EXCEED 1/800 OF SPAN LENGTH.
EXCEPT WHERE OTHERWISE INDICATED ON THESE PLANS, OR IN THE PROPOSAL AND SUPPLEMENTAL SPECIFICATIONS CONTAINED HEREIN, ALL MATERIALS AND WORKMANSHIP SHALL BE ACCORDING TO THE MICHIGAN DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION 2012 EDITION.
THE DESIGN OF THE STRUCTURAL MEMBERS IS BASED ON MATERIAL OF THE FOLLOWING GRADES AND STRESSES:
CONCRETE: GRADE S2 f'c = 3,000 psi
CONCRETE: GRADE D f'c = 4,000 psi
STEEL REINFORCEMENT: fy = 60,000 psi
STEEL REINFORCEMENT: STIRRUPS FOR PRESTRESSED BEAMS fy = 60,000 psi
PRESTRESSED CONCRETE: f'c = 7,000 psi
PRESTRESSING STRANDS: f's = 270,000 psi
ALL EXPOSED CONCRETE CORNERS SHOWN SQUARE ON THE PLANS SHALL BE BEVELED WITH ½" TRIANGULAR MOLDINGS EXCEPT AS OTHERWISE NOTED.
THE DESIGN OF THE FOUNDATION PILING IS BASED ON THE MATERIAL OF THE FOLLOWING GRADES AND STRESSES:
FOUNDATION PILING (STEEL H-PILING) AASHTO M270, GRADE 50 OR 50W Fy = 50,000 psi
OLD PLANS DO NOT EXIST FOR THIS STRUCTURE.
UNLESS OTHERWISE SHOWN ON THE PLANS PROVIDE MINIMUM CONCRETE CLEAR COVER FOR REINFORCEMENT ACCORDING TO THE FOLLOWING:
CONCRETE CAST AGAINST EARTH: 3 IN.
PRESTRESSED BEAMS: 1 IN.
ALL OTHER UNLESS SHOWN ON PLANS: 2 IN.
SPECIAL DETAILS
R-45-I PAVEMENT REINFORCEMENT FOR BRIDGE APPROACH
R-100-G SEEDING AND TREE PLANTING
KEEFER HWY. TRAFFIC COUNTS
2013 2033
A.D.T. 971 1049
COMM. % 8.0% 8.0%
DESIGN SPEED 55 MPH
POSTED SPEED N/A
IONIA COUNTY ROAD COMMISSION
IN COOPERATION WITH
MICHIGAN DEPARTMENT OF TRANSPORTATION
AND
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL PROJECT NO. XXX XXXXXX
FEDERAL ITEM NO. XXXX
CONTROL SECTION XXX XXXXXX
JOB NUMBER XXXXXXA
B02 OF 34-04-33
KEEFER HIGHWAY
OVER SEBEWA CREEK
SEBEWA & DANBY TOWNSHIP
IONIA COUNTY
T5N, R6W, SECTION 25
T5N, R5W, SECTION 30
IONIA COUNTY
PROJECT LOCATION
B02 OF 34-04-33
DETOUR ROUTE
GRAND RIVER
T5N,R6W
T5N,R5W
IONIA CO.
EATON CO.
SUNFIELD
MULLIKEN
EATON COUNTY
STANDARD PLANS
WHERE THE FOLLOWING ITEMS ARE CALLED FOR ON THE PLANS THEY ARE TO BE CONSTRUCTED ACCORDING TO THE STANDARD PLAN GIVEN BELOW OPPOSITE EACH ITEM UNLESS OTHERWISE INDICATED.
R-39-I TRANSVERSE PAVEMENT JOINTS (PLAIN CONCRETE PAVEMENT)
R-41-F LONGITUDINAL PAVEMENT JOINTS
R-59-E GUARDRAIL AT BRIDGES AND EMBANKMENTS
R-60-H GUARDRAIL TYPES A, B, BD, T, AND TD
R-62-G GUARDRAIL APPROACH TERMINAL TYPES 2B & ST (ET & SKT)
R-67-F GUARDRAIL ANCHORAGE, BRIDGE DETAILS
R-96-E SOIL EROSION & SEDIMENTATION CONTROL MEASURES
R-105-D GRADING CROSS-SECTIONS
B-103-E MOLDING, BEVEL, LIGHT STANDARD ANCHOR BOLT ASSEMBLY AND NAME PLATE DETAILS
CONTRACT FOR: BRIDGE REPLACEMENT, APPROACH RECONSTRUCTION, AND MAINTAINING TRAFFIC.
THESE PLANS WERE PREPARED FOR THE MICHIGAN DEPARTMENT OF TRANSPORTATION BY
Williams & Works
IONIA COUNTY ROAD COMMISSION
169 RIVERSIDE DRIVE
P.O. BOX 76
IONIA, MICHIGAN 48846
APPROVED BY CHAIRMAN - FREDERICK A. CHAPMAN DATE
APPROVED BY VICE CHAIRMAN - HERBERT C. CUSACK DATE
APPROVED BY MEMBER - STEPHANIE HURLBUT DATE
APPROVED BY MEMBER - CHUCK HINKLEY DATE
APPROVED BY MEMBER - BILL WEISGERBER DATE
APPROVED BY MANAGING DIRECTOR - DOROTHY G. POHL DATE
APPROVED BY COUNTY HIGHWAY ENGINEER - WAYNE A. SCHOONOVER, P.E. DATE
IONIA COUNTY DRAIN COMMISSION
100 W. MAIN STREET
IONIA, MICHIGAN 48846
APPROVED BY IONIA COUNTY DRAIN COMMISSIONER - JOHN M. BUSH DATE
PLAN REVISIONS
NO. DATE AUTH DESCRIPTION NO. DATE AUTH DESCRIPTION
NO SCALE
DRAWN BY: WGJ
CHK'D BY: XXX CORR BY: XXX
FILE: ts.dgn
DATE: XX/XX/2012
DESIGN UNIT: WILLIAMS & WORKS
TSC: XX
CS: XX-XX-XX
JN: XXXXXXA
DRAWING SHEET
B02 TITLE 001

General Plan of Site



General Plan of Structure



SUMMARY OF HYDRAULIC ANALYSIS

EXISTING				PROPOSED			
FLOOD DATA	DIS-CHARGE (CFS)	WATER SURFACE ELEV. AT U/S FACE OF STRUCTURE	VELOCITY IN D/S CHANNEL (FPS)	WATER SURFACE ELEV. AT U/S FACE OF STRUCTURE	VELOCITY IN D/S CHANNEL (FPS)	WATERWAY AREA (SFT) AT D/S FACE	CHANGE IN WS EL U/S OF PROPOSED STRUCTURE
50 YEAR	850	807.47	5.07	807.46	5.07	173.27	-0.01
100 YEAR	1000	807.90	4.90	807.89	4.90	186.21	-0.01

MAXIMUM BRIDGE AREA BELOW LOW CHORD IS 393.86 SQUARE FEET

THE WATER SURFACE AND/OR ENERGY GRADE ELEVATIONS SHOWN ON THE ABOVE HYDRAULIC TABLE ARE TO BE USED FOR COMPARISON PURPOSES ONLY AND ARE NOT TO BE USED FOR ESTABLISHING A REGULATORY FLOODPLAIN.

THE DRAINAGE AREA CONTRIBUTORY TO THIS CROSSING 26.3 SQUARE MILES.

APPROACH ROADWAY AND PAVEMENT QUANTITIES

AMOUNT	UNIT	ITEM
1	LS	Mobilization, Max _
547	Ft	Guardrail, Salv
526	Syd	Pavement, Rem, Modified
378	Cyd	Excavation, Earth
277	Cyd	Subbase, CIP (18" Min.)
660	Syd	Aggregate Base, Modified, 6 Inch
167	Cyd	Embankment, CIP
1010	Syd	Slope Restoration, Type C
174	Ton	HMA, 5E1, High Stress
11	Ea	Guardrail Reflector
67	Ton	HMA, 3C
3	Sta	Clearing, Special

MISCELLANEOUS QUANTITIES

AMOUNT	UNIT	ITEM	AMOUNT	UNIT	ITEM
1	LS	Structure, Rem Portions (802 of 34-04-33)	120	Cyd	Superstructure Backfill
1700	Cyd	Excavation, Fdn	1725	Sft	Segmental Block Units
1044	Sft	False Decking	101	Ton	Riprap, Heavy (Stone)
140	Syd	Articulating Conc Block System	10	Ton	Riprap, Plain
7116	Syd	GRS Geotextile	1	LS	Contractor Staking
1060	Cyd	GRS Wall Backfill	4	Hr	Staking Plan Error and Extra's, One Person
220	Cyd	RSF Backfill	2	Hr	Staking Plan Error and Extra's, Two Person
240	Cyd	Backfill, Structure, CIP	1	Hr	Staking Plan Error and Extra's, Three Person
1	LS	Beam Seat Construction	1	LS	Conc Surface Coating (802 of 34-04-33)
210	Sft	Joint Waterproofing, Expansion			

NOTES:

THE DESIGN OF THIS STRUCTURE IS BASED ON 1.2 TIMES THE CURRENT AASHTO LRFD BRIDGE DESIGN SPECIFICATION HL-93 LOADING WITH THE EXCEPTION THAT THE DESIGN TANDEM PORTION OF THE HL-93 LOAD DEFINITION SHALL BE REPLACED BY A SINGLE 60 KIP AXLE LOAD BEFORE APPLICATION OF THIS 1.2 FACTOR. THE RESULTING LOAD IS DESIGNATED HL-93 MOD. LIVE LOAD PLUS DYNAMIC LOAD ALLOWANCE DEFLECTION DOES NOT EXCEED 1/800 OF SPAN LENGTH.

WITHOUT THE PREVENTIVE MEASURES SHOWN ON THESE PLANS, THERE IS A POSSIBILITY THAT STREAM BED SCOUR MAY OCCUR. THE ESTIMATED TOTAL SCOUR DEPTH IS CALCULATED TO BE 798.60 FEET AT THE ABUTMENTS. THIS DEPTH IS BASED ON A 100 YEAR RUNOFF EVENT.

GEOTEXTILE LINER SHALL BE PLACED ON ALL SLOPES PRIOR TO PLACING RIPRAP. PAYMENT FOR GEOTEXTILE LINER SHALL BE INCLUDED IN PAYMENT FOR RIPRAP.

THE CONTRACTOR WILL USE THE EXISTING ABUTMENT WALLS WITH EARTH BERMS AND SUBMERSIBLE PUMP SYSTEMS, IF NEEDED FOR CREEK/GROUND WATER CONTROL, FOR PLACEMENT OF THE RSF AND GRS WALL LAYERS. COST OF THE EXCAVATION AND THE EARTH BERMS AND DEWATERING EQUIPMENT IS INCLUDED IN THE PAY ITEMS "RSF BACKFILL" AND "GRS WALL BACKFILL".

THE ABUTMENT MAXIMUM FOUNDATION PRESSURES ARE CALCULATED TO BE:
2492 PSF (ABUTMENT A) AND
2563 PSF (ABUTMENT B).

NOTES (CONT.):

A COFFERDAM HAS NOT BEEN PROVIDED FOR THIS STRUCTURE. OTHER MEANS OF WATER CONTROL MAY BE USED, AS APPROVED BY THE ENGINEER, FOR PLACEMENT OF THE ARTICULATING CONC BLOCK SYSTEM, RSF AND GRS. WATER CONTROL, WHETHER IT BE BY COFFERDAM OR OTHER APPROVED MEANS, IS INCLUDED IN OTHER BID ITEMS.

ALTERNATE METHODS OF WATER MANAGEMENT OR STREAM DIVERSION SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.

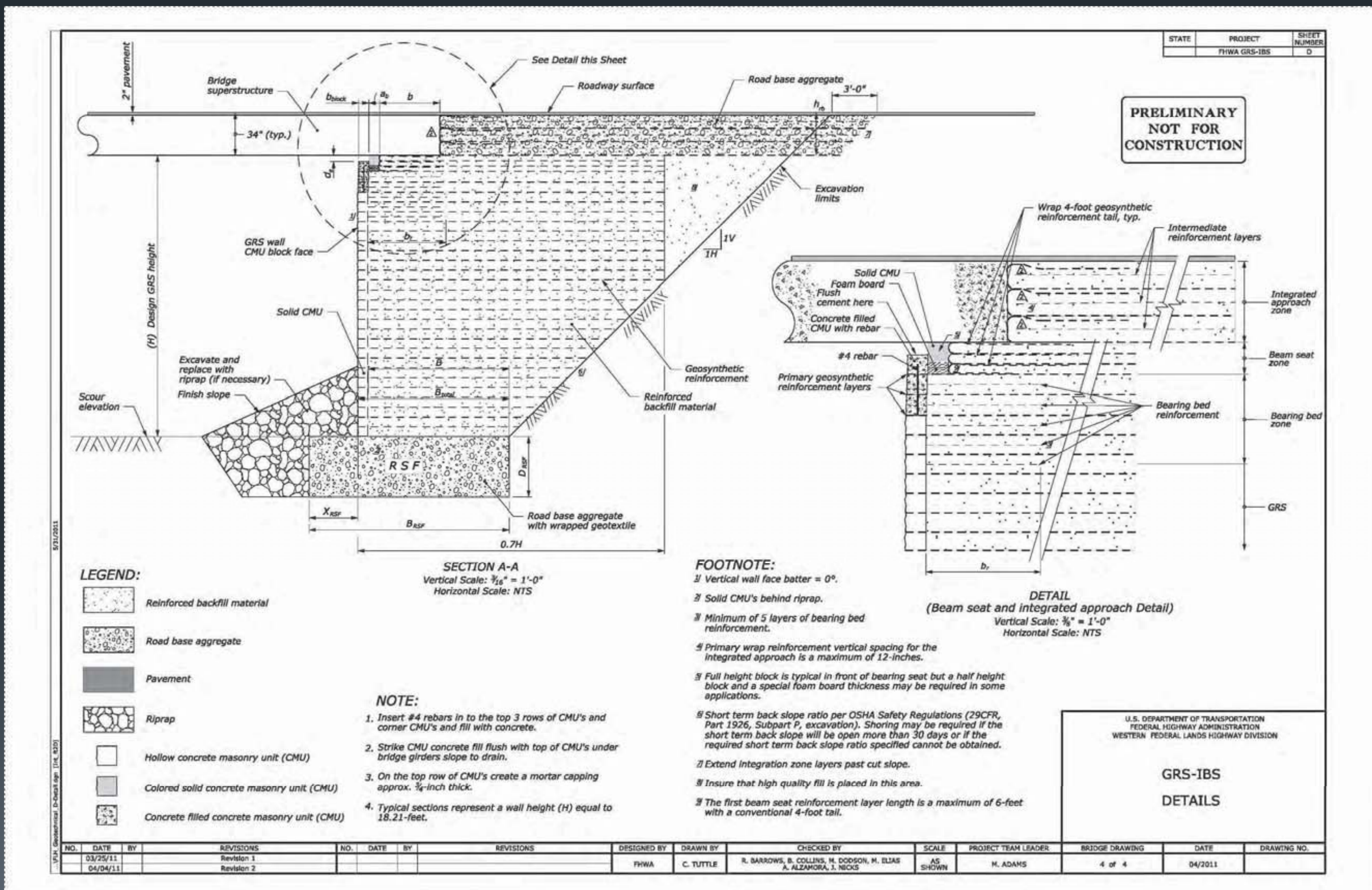
FALSE DECKING SHALL INCLUDE THE AREA BOUNDED BY (REFERENCE LINES A & B AND OUTSIDE FLANGE FASCIAS OF BEAMS A & M. THE ESTIMATED AREA IS 1025 SQUARE FEET DURING REMOVAL.

NEATLY STACK SALVAGED GUARDRAIL ON THE NORTH APPROACH FOR PICK UP BY THE IONIA COUNTY ROAD COMMISSION.

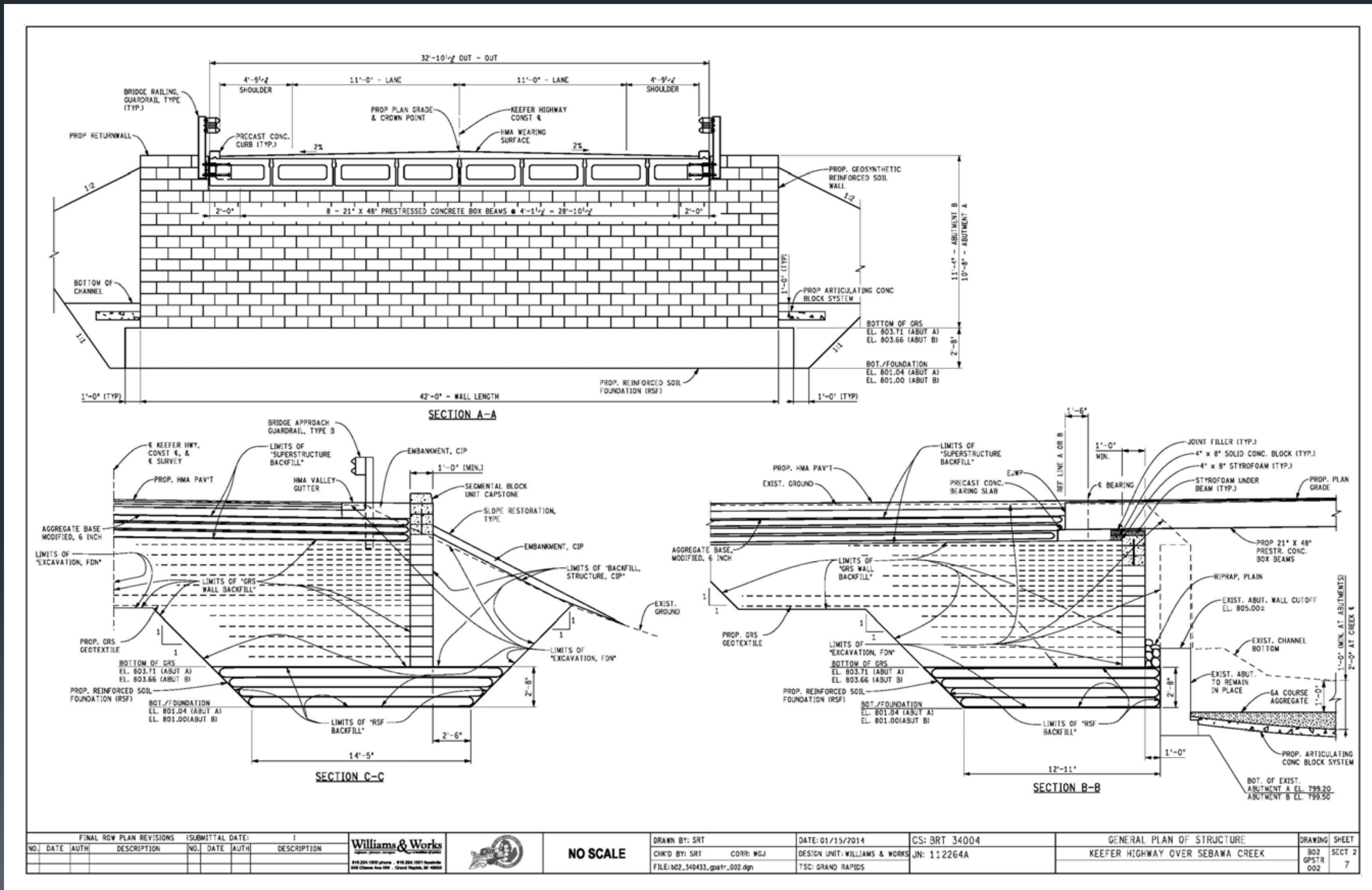
THE TOP OF THE ARTICULATING CONCRETE BLOCK SYSTEM IS TO BE PLACED A MINIMUM OF 1'-0" BELOW THE EXISTING CHANNEL BOTTOM AT THE FACE OF THE EXISTING ABUTMENTS. AT CHANNEL CENTERLINE, THE TOP OF THE ARTICULATING BLOCK MUST BE PLACED 2'-0" BELOW THE EXISTING CHANNEL BOTTOM. AFTER PLACEMENT OF THE BLOCKS, THE CONTRACTOR WILL PLACE 6A COURSE AGGREGATE ON TOP OF THE CONCRETE BLOCKS TO AN ELEVATION 1'-0" BELOW THE EXISTING CHANNEL BOTTOM.. THE REMAINING 12" TO THE EXISTING CHANNEL BOTTOM MUST NOT BE FILLED DURING CONSTRUCTION BUT LEFT OPEN TO FILL IN NATURALLY WITH SEDIMENT. ALL WORK FOR EXCAVATION AND PLACEMENT OF THE 6A COURSE AGGREGATE IS INCLUDED IN THE PAY ITEM "ARTICULATING CONC BLOCK SYSTEM".

DATE: 01/15/2014	CS: BRT 34004	GENERAL PLAN OF STRUCTURE	DRAWING	SHEET
DESIGN UNIT: WILLIAMS & WORKS	JN: 112264A	KEEFER HIGHWAY OVER SEBAWA CREEK	B02 GPSTR 001	SECT 2 6
TSC: GRAND RAPIDS				

Abutment Details



Sections



SECTION A-A
SECTION C-C
SECTION B-B
32'-10 1/2" OUT - OUT
42'-0" - WALL LENGTH
8 - 21" X 48" PRESTRESSED CONCRETE BOX BEAMS @ 4'-1 1/2" = 28'-10 1/2"
PROP. GEOSYNTHETIC REINFORCED SOIL WALL
PROP. REINFORCED SOIL FOUNDATION (RSF)
NO SCALE
Williams & Works
DATE: 01/15/2014
CS: BRT 34004
JN: 112264A
GENERAL PLAN OF STRUCTURE
KEEFER HIGHWAY OVER SEBAWA CREEK
TSC: GRAND RAPIDS

Special Provision for GRS Abutment

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
GEOSYNTHETIC REINFORCED SOIL ABUTMENT

a. Description. The work consists of furnishing and installing a Geosynthetic Reinforced Soil Abutment in accordance with the contract, the FHWA Geosynthetic Reinforced Soil-Integrated Bridge System Interim Implementation Guide, dated June, 2012 (Publication No. FHWA-HRT-11-026), the standard specifications, and as directed by the Engineer.

The following definitions apply when used herein and on the plans:

Geotextile Reinforcement. Biaxial geotextile reinforcement having strength and stiffness that are approximately equal in both the machine and the cross machine directions.

Geosynthetic Reinforced Soil (GRS). Alternating layers of compacted granular fill reinforced with Geotextile Reinforcement. Facing elements are connected to the reinforcement layers to form an outer GRS Wall. Facing elements must consist of segmental block units (SBUs).

GRS Abutment. A GRS retaining wall system designed to support the weight of a bridge superstructure. Usually, GRS abutments have three sides: the abutment face wall and two wing or return walls.

GRS Abutment Face Wall. The vertical or near vertical wall parallel to the center of superstructure bearing seat and designed to support the bridge superstructure.

GRS Wing Wall. A wall attached and adjacent to the GRS abutment face wall. The GRS wing walls are built at the same time as the GRS abutment face wall and at a right or other angle to the GRS abutment face wall.

Reinforced Soil Foundation (RSF). A reinforced soil mass located below the GRS. This mass consists of alternating layers of compacted well-graded aggregate and Geotextile Reinforcement.

Retained Soil. Backfill located behind the GRS wall mass.

Clear Space. The vertical distance between the top of the GRS abutment face wall and bottom of the superstructure above the wall. This distance is 3 inches or 2 percent of the GRS wall height, whichever is greater.

Beam Seat Setback. The lateral distance from the back of the GRS SBU to the front of the superstructure bearing beam seat area. This distance is a minimum of 8 inches or as shown on the plans.

b. Materials. The basis of acceptance for all materials not addressed by the standard specifications and specified herein will be a certification in accordance with the *Materials Quality*

Assurance Procedures Manual and as described herein. Provide all test data certifications by an independent testing laboratory to the Engineer prior to material use.

1. Segmental Block Units (SBU). Use SBUs from an approved segmental block wall manufacturer listed below.

Tensar Mesa Retaining Wall System
5883 Glenridge Drive, Suite 200
Atlanta, Georgia 30328
Ph. 404-250-1290

Keystone Retaining Wall System
4444 West 78th Street
Minneapolis, Minnesota 55435
Ph. 952-897-1040

Allan Block Corporation
7424 West 78th Street
Bloomington, MN 55439
Ph. 952-835-5309

SBUs from these manufacturers or an equal product from another manufacturer approved by the Engineer must meet the following requirements:

A. Lot size may not exceed 10,000 units. Provide test data certifications from a qualified independent testing laboratory for compressive strength, freeze-thaw durability and absorption testing for each lot.

B. Minimum 28 day compressive strength of 5500 psi for individual SBUs and an average of 5800 psi for three SBUs per *ASTM C 140*.

C. The SBUs must have a maximum water absorption of 6 percent when tested according to *ASTM C 140*, with a 24 hour cold water soak.

D. SBUs must meet the freeze-thaw durability requirements of *ASTM C 1262* when tested using a 3 percent NaCl solution for a minimum of 90 cycles. Material loss must not exceed 1 percent for any single sample.

E. SBUs must meet the project aesthetic requirements specified for this site as indicated on the plans.

F. Utilize SBUs with dimensions of 8 inches high by 12 inches deep (minimum) by 18 inches in length (minimum). Supply cap units for the set back block that have minimum dimensions of 4 inches high by 8 inches deep by 16 inches in length.

2. Geotextile Reinforcement. The geotextile reinforcement used within the GRS and RSF must be a woven, high density polyethylene, polypropylene or high-tenacity polyester, biaxial geotextile that is resistant to UV oxidation and degradation caused by chemical and temperature exposures normally encountered in the highway environment. The weatherometer test data certification can be for the product line material type in general and does not have to be tested directly from the batch of geotextile produced for this site.

The ASTM type, class, group, grade, and category of the primary resin used in manufacturing must be identified within the test data certification as applicable.

Provide a test data certification showing that the batch of geotextile reinforcement proposed for this site meets the physical property requirements of Table 1.

Table 1: Woven Geotextile Reinforcement Properties

Property	Test Method	Minimum Value
Ultimate Tensile Strength MD(a) CMD(a)	*ASTM D 4595* Strain Rate of 10% per minute	 4,800 lb/ft 4,800 lb/ft
Tensile Strength @ 2% Strain MD(a) CMD(a)	*ASTM D 4595*	950 lb/ft 950 lb/ft
Apparent Opening Size	*ASTM D 4751*	0.425 mm
Inherent Viscosity (PET (b) only)	*ASTM D 4603*	Minimum Number Average Molecular Weight of 25000
Carboxyl End Group (PET (b) only)	*ASTM D 7409*	Maximum of Carboxyl End Group Content of 30
UV Resistance	*ASTM D 4355*	>70% breaking strength after 500 hr
a. "MD" and "CMD" represent 'machine' and 'cross-machine' directions, referring to the principle directions of the manufacturing process. b. PET - Polyester		

In addition, Certification-Verification samples will be obtained by the Engineer from on-site material. One sample must be obtained for the first 1,200 square yards with subsequent samples every 5,000 square yards. Samples must be a minimum of 5 feet long by the full roll width, with a 6 square yard minimum.

3. GRS Granular Fill. Use either 21AA aggregate or 4G open-graded aggregate as granular fill material within the GRS wall mass as noted on the plans. In addition to the requirements for 4G open-graded aggregates described in the standard specifications, the 4G open-graded aggregate prior to placement and compaction must meet the gradation shown in Table 2. In addition, when compacted to the specified density requirements, the specified material must have a minimum angle of internal friction of 38 degrees per *AASHTO T 236* (large scale direct shear test) or *AASHTO T 296* (large scale triaxial compression test, unconsolidated undrained). Provide a test data certification from an independent testing laboratory for the angle of internal friction for the proposed aggregate source. The testing for angle of internal friction must include at least 5 tests on different samples of the proposed source material.

Table 2. 4G Open-Graded GRS Granular Fill

U.S. Sieve Size	Gradation Limits, Percent Passing
1½ inch	100
1 inch	85-100
½ inch	45-65
# 8	15-30
# 30	6-18
Loss by Wash	6.0 max

4. Retained Soil. If additional bridge approach embankment fill is required behind the GRS wall mass, provide Structure Backfill, CIP extending to at least 10 feet behind the back edges of the GRS wall reinforcement materials. Backfill, Structure, CIP will be paid for separately.

5. Reinforced Soil Foundation (RSF). Provide 21AA aggregate within the wrapped geotextile reinforcement layers for the RSF volume.

6. Reinforced Superstructure Backfill. Provide 21AA aggregate within the wrapped geotextile layers for the bridge abutment backfill material situated above the GRS wall mass and below the design pavement section for the bridge approach.

7. Concrete. Use Portland cement concrete meeting the requirements for Grade S1 concrete according to section 701 of the Standard Specifications for Construction, except as modified herein. Use coarse aggregate originating only from geologically natural sources meeting physical requirements of Class 26A.

8. Flashings. Provide grade 304 stainless steel flashings as shown on the plans. Provide long-life all-weather butyl sealants/adhesives for flashing overlaps.

c. **Submittals.** Provide an electronic pdf copy of all submittals to the Engineer at least 45 days prior to the start of RSF or GRS abutment construction. The Engineer will approve or reject the submittals within 14 calendar days after receipt of a complete submission. Additional time required due to incomplete or unacceptable submittals will not be justification for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals will be borne by the Contractor.

1. Submit test data certifications for the proposed aggregates.

2. Submit test data certifications for geotextile reinforcement.

3. Submit test data certifications for the proposed SBUs.

4. Submit detailed GRS installation plan. Within the plan, indicate construction sequence for the GRS elements including width and directional placement of geotextile reinforcement layers throughout the various RSF and GRS zones.

5. Submit a sketch illustrating crane locations, including outrigger pads, in relation to

the edge of GRS walls during positioning of the bridge beams. The edge of the crane's outrigger pad mat must remain a minimum distance of 4 feet from the back of the SBUs. Crane outrigger pad sizes must result in less than a 4,000 psf bearing pressure being applied to reinforced soil areas near the GRS walls. Calculations must accompany the crane sketches indicating the resulting outrigger and load bearing system (crane, mats, beams, etc.) pressure on the underlying soil.

d. Construction. Construction procedures must adhere to the design plans, this special provision and Chapter 7 of the FHWA Geosynthetic Reinforced Soil-Integrated Bridge System Interim Implementation Guide, dated June, 2012 (Publication No. FHWA-HRT-11-026).

1. Subgrade Preparation. Excavate to the necessary elevations and dimensions shown on the plans. Provide run-off water controls to prevent excessive flow into the excavation. Provide groundwater control for the excavation. Prior to wall construction, inspect the RSF subgrade and compact, if necessary, according to subsection 205.03.I.1 of the Standard Specifications for Construction, or prepare as required in the contract. Undercut unsuitable material as directed by the Engineer. Undercutting of unsuitable material will be paid for separately as Excavation, Fdn. Unless otherwise directed by the Engineer, replace undercut soils with Backfill, Structure, CIP compacted to 95 percent of the material maximum unit weight according to section 205 of the Standard Specifications for Construction. Structure Backfill, CIP will be paid for separately.

If the base of the excavation is left open, grade the base to one end to facilitate the removal of any water intrusion with a pump. If the excavation is flooded, all water must be removed along with any unsuitable soils, as directed by the Engineer. Final subgrade must be smooth, uniform and free from irregular surface shape or protruding objects that would obstruct placement of geotextile wrapped reinforced aggregate fills for the RSF.

2. Reinforced Soil Foundation (RSF). Construct the RSF according to the plans. Place backfill in lifts measuring not more than 8 inches in thickness. Compact backfill within this zone to 98 percent of its maximum unit weight in accordance with *AASHTO T 99*. Decrease the maximum lift thickness if necessary to obtain the specified density.

The entire RSF must be completely encapsulated with Geotextile Reinforcement. The wrapped corners of the RSF must be tight and without exposed soil. Minimum shingle overlaps of 2 feet are required regardless of structure location. For GRS abutments adjacent to waterways, overlap the RSF geotextile reinforcement a minimum of 3 feet. For proper shingle flow of water over the overlaps, start with the outer layer of the overlap situated on the upstream side of the RSF. Orient overlapped sections of geotextile reinforcement to prevent water from penetrating the layers of reinforcement.

Pull the Geotextile Reinforcement taut to remove all wrinkles prior to placing and compacting the backfill. Place fill starting at the river side front face and proceeding towards the back to push out folds or wrinkles towards the free end of the reinforcement layer. The end of the overlap must be located at least 3 feet from the RSF edge.

3. Geosynthetic Reinforced Soil (GRS) Abutment. Place courses of SBUs, and GRS systematically per the contract and the approved installation procedures.

A. SBU Placement. Place each course of SBU level, even, and within plan tolerance. Adjacent blocks must be placed tightly against each other to prevent backfill from escaping between gaps. Offset subsequent courses of block by half a block width so that vertical joints are not continuous.

Check the vertical alignment of the GRS Abutment Face Wall at least every other block layer. Correct any deviations greater than 0.25 inches. In addition, check every other row of block alignment with a string line referenced off the back of the facing block from wall corner to corner. Correct deficiencies as required.

At right-angle wall corners, stagger face wall and wing wall block courses to form a tight, interlocking, stable corner. For walls with angles larger than 90 degrees, a vertical seam or joint is formed. At these locations, install rebar and concrete as indicated on the design plans.

B. GRS Wall Granular Fill. Follow the placement of each course of block closely with granular fill. Carefully place granular fill so as to avoid any damage or disturbance of the wall materials or any misalignment of the block units or soil reinforcement. Remove and replace any wall SBUs and Geotextile Reinforcement that become damaged or misaligned during granular fill placement at no cost to the Department. Any depressions present behind the SBUs must be filled level to the top of the SBU prior to placing the Geotextile Reinforcement.

Compact the GRS Wall Granular Fill to a minimum 95 percent of its maximum unit weight per *AASHTO T 99* or to the minimum density required to achieve the minimum angle of internal friction of 38 degrees for the GRS if higher than 95 percent. For aggregate placed within the RSF, Beam Seat Zone, and Integrated Wrapped Approach Zone, compact the soil to 98 percent of its maximum unit weight per *AASHTO T 99*. Do not use sheep's foot or grid-type rollers for compaction within the reinforced soil mass.

Since the SBUs are not rigidly connected to the geotextile reinforcement, perform compaction within 3 feet of the back face of the SBU utilizing lightweight, hand operated compaction equipment (e.g., a lightweight mechanical tamper, plate, or roller). Adjust granular fill lift heights in order to achieve the compaction requirements. Check the position of the SBUs after compaction. Any elements that have been displaced should be removed and reset into their proper location and position.

Ensure uniform moisture content throughout each layer of the granular fill prior to and during compaction. Place the granular fill at a moisture content that is within two percentage points of the optimum moisture content percentage, or at a moisture content and density that is uniform and acceptable to the Engineer, throughout the entire lift.

At the end of each day's operation, slope the last layer of the granular fill away from the wall face and cover with a suitable water-resistant tarp, to rapidly direct runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

C. Geotextile Reinforcement. Place geotextile reinforcement in continuous full-length strips from the wall face to the design strip lengths without use of overlap or factory seam splices in the critical load bearing dimensions. Place the strong direction (typically the machine direction) of the geosynthetic perpendicular to the GRS abutment and wing/return wall faces, unless otherwise directed by the Engineer. Extend the geotextile reinforcement so that it is situated between layers of SBU to provide a frictional connection. The geotextile reinforcement must extend to within 1 inch of the wall face. Remove all excess geotextile reinforcement extending beyond the wall face by cutting with a razor knife or other means approved by the Engineer.

Uniformly tension geotextile reinforcements to remove any slack in the connections or materials, so that geotextile reinforcements are taut, free of wrinkles, and flat. Where overlaps exist on top of the SBU, trim as necessary to prevent varying geotextile reinforcement thickness or excessive gaps between adjacent blocks.

Place granular fill starting at the wall face and moving backwards to remove and prevent the formation of wrinkles in the geotextile reinforcement. Correct any misalignment or distortion of the wall face in excess of the tolerances specified herein at no additional cost to the Department.

Driving equipment directly on the geotextile reinforcement is prohibited. Place a minimum 6 inch layer of granular fill prior to operating any vehicles or equipment over the geotextile reinforcement. Tracked vehicles are not allowed above the geotextile reinforcement.

D. Superstructure Backfill and Approach Integration. Construct reinforced superstructure backfill approach zone per the plans. Wrap the superstructure approach fill with geotextile reinforcement on three sides. Multiple sheets are allowed along the width of the approach, as long as all seams are kept perpendicular to the wall face. Wrap geotextile reinforcement on the roadway sides to prevent lateral spreading of the backfills. The superstructure backfill geotextile reinforcement must be placed so that the strong direction is parallel to the roadway.

E. The Engineer is responsible for performing field density tests.

For each layer of granular fill placed behind an GRS abutment, the Engineer must perform at least three field density tests. Do not penetrate the geotextile reinforcement with field density equipment. If the granular fill is such that it cannot be tested accurately with a nuclear gauge, then a procedural specification will be developed by the Engineer at the time of construction. The procedural specification will develop a certain number of passes required based on the Contractor's compaction equipment and visual movement of the aggregate. The developed specification will address a procedure near the wall surface (within 3 feet) for smaller hand operated equipment and larger ride-on rollers further away from the wall, as necessary.

e. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Items	**Pay Unit**
Geotextile Reinforcement	Square Yard
Geosynthetic Reinforced Soil Granular Fill	Cubic Yard
Reinforced Soil Foundation Aggregate	Cubic Yard
Beam Seat Construction	Lump Sum
Superstructure Backfill	Cubic Yard
Segmental Block Units	Square Foot

1. **Geotextile Reinforcement** will be paid for by the square yard for material placed. Overlaps are included when determining the final as placed quantity. Payment for **Geotextile Reinforcement** includes furnishing all material, providing submittals, and all equipment, labor, testing and miscellaneous hardware required for placing all types of geotextile reinforcement used in the GRS Abutments.

2. **Geosynthetic Reinforced Soil Granular Fill** will be paid for by the cubic yard for material placed. Payment for **Geosynthetic Reinforced Soil Granular Fill** includes furnishing all of the aggregates, conducting angle of friction testing, providing submittals, and equipment, labor and miscellaneous hardware necessary for placing this material at the GRS Abutments.

3. **Reinforced Soil Foundation Aggregate** will be paid for by the cubic yard for material placed. Payment for **Reinforced Soil Foundation Aggregate** includes furnishing all of the 21AA aggregate used in the RSF, testing, providing submittals, and all equipment, labor, and miscellaneous hardware necessary for placing the material. Payment for **Reinforced Soil Foundation Aggregate** also includes any dewatering materials equipment and labor necessary to place the RSF for the GRS Abutments.

4. **Beam Seat Construction** is paid as a lump sum pay item for the entire project and includes furnishing all materials not included in other pay items including but not limited to foam, concrete, stainless steel flashing, sealant, rebar and joint filler, needed to complete the beam seat detailed on the plans. Payment for **Beam Seat Construction** also includes providing submittals and all labor and equipment for constructing these items as indicated on the plans.

5. **Superstructure Backfill** will be paid for by the cubic yard for material placed. Payment for **Superstructure Backfill** includes furnishing the 21AA aggregate used in the reinforced backfills placed immediately behind the ends of the superstructure, and below the typical pavement section. The pay item also includes providing submittals and all equipment, labor, testing, and miscellaneous hardware necessary for placing this material.

6. **Segmental Block Units** will be paid for by the square foot of finished wall face area, based on material placed. Payment includes all compensation for furnishing the SBUs and all equipment, labor, testing, and miscellaneous hardware necessary for placing the blocks. Payment for **Segmental Block Units** also includes any wasted or rejected blocks, providing submittals, and incorporation of aesthetic details (block style and color) required in the contract.

Underdrains, if required on the plans or by the Engineer, will be paid for separately according to the standard specifications.

Excavation, Fdn and **Structure Backfill, CIP** required for undercutting unsuitable subgrade soils below the plan RSF elevation will be paid for separately according to the standard specifications. The bottom of the RSF reinforced soil mass shown on the plans will be considered the bottom of footing for measurement purposes.

If the Engineer determines that a sheet pile type **Cofferdam** or use of **Temporary Sheeting** is necessary to adequately complete construction of the RSF, and these items are not shown on the construction plans, these items will be paid for separately as extra work and according to the standard specifications. The Contractor should expect that shallow earth berm type cofferdams will be necessary for RSF construction. The costs associated with establishing earth berm type groundwater control and use of submersible pumps and other dewatering equipment for RSF construction will be included in the items covering the general foundation excavation of the GRS abutment volume and in the item **Reinforced Soil Foundation Aggregate.**

References

- FHWA: www.fhwa.dot.gov/everydaycounts/technology/grs_ibs/
- WisDOT: www.dot.state.wi.us
- WisDot Video: www.youtube.com/watch?v=frxx9j7qiWU
- FDOT: www.dot.state.fl.us

Design Challenges

Costs

Preliminary Estimates for Structural Alternatives

- Three-Sided Precast Arch Structure: $516,000
- Side by Side Pre-Stressed Concrete Box Beam Structure: $670,000
- Spread Pre-Stressed Concrete Box Beam Structure: $668,000
- GRS-IBS with Side by Side Pre-Stressed Concrete Box Beams Structure: $403,000

As Bid Prices

- GRS- IBS with Side by Side Pre-Stressed Concrete Box Beams Structure: $504,000

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20,000 LBS CAP


CAT
330B L
CAT
DANGER

Material Acquisition


158760601
AB CLASSIC LFT CORNER
HICKORY BLEND
Cube Count
36
READINGROCK
BUILDING MATERIALS & SERVICES

GIVE 'EM A
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SAFETY
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READINGROCK


WACKER
NEUSON