PILOT CONSTRUCTION INC.

RECEIVED 6/6/16

NJ, PB
M. Leach
Sam, file
(T-Group Web Site)

Letter of Transmittal

To: Conor Nagle
VHB, INC.
101 WALNUT STREET
WATERTOWN, MA

Subject: Submittal

Transmittal #: 46
Date: 5/4/2016
Job: 15-512 AMESBURY HEIGHTS

WE ARE SENDING YOU

- ☑ Attached
- ☐ Under separate cover via the following items:
- ☑ Shop drawings
- ☐ Prints
- ☐ Plans
- ☐ Samples
- ☐ Copy of letter
- ☐ Change order
- ☐ Specifications
- ☐ Other

Document Type	Copies	Date	No.	Description
Submittal	1		02 20-26 Rev 0	Segmented Block Retaining Walls - Global Study

THESE ARE TRANSMITTED as checked below:

- ☑ For approval
- ☐ Approved as submitted
- ☐ Resubmit ___ copies for approval
- ☐ For your use
- ☐ Approved as noted
- ☐ Submit ___ copies for distribution
- ☐ As requested
- ☐ Returned for corrections
- ☐ Return ___ corrected prints
- ☐ For review and comment
- ☐ Other
- ☐ FOR BIDS DUE
- ☐ PRINTS RETURNED AFTER LOAN TO US

Remarks: Study associated with five (5) remaining walls.

Copy To: BONFATTI, ANDREW (R.C. MAY & ASSOCIATES), Sean McReynolds (Corcoran Jennison), STEPHEN WOOD (PILOT CONSTRUCTION INC.), STAN FOLTA (PILOT CONSTRUCTION INC.)

From: Bruce Kelly (Pilot Construction)

Signature: Bruce Kelly

If enclosures are not as noted, kindly notify us at once.

PILOT CONSTRUCTION INC.

Submittal

Job: 15-512
AMESBURY HEIGHTS
36 HAVERHILL ROAD
AMESBURY, MA 01913

Spec Section No: 02 20
Submittal No: 26
Revision No: 0
Sent Date: 5/4/2016

Spec Section Title:

Submittal Title: Segmented Block Retaining Walls - Global Study

Contractor:
Pilot Construction, Inc.

REVIEWED

For general compliance with contract documents supplier/subcontractor is responsible for quantities and is not relieved of responsibility to adhere to specifications and design intent.

The Pilot Construction Co.'s

VHB, INC.
Conor Nagle (VHB, INC.)

Architect's Stamp

Engineer's Stamp

SHOP DRAWING REVIEW

☒ 1 REVIEWED AS REQUIRED BY THE CONSTRUCTION CONTRACT DOCUMENTS AND APPROVED, BUT ONLY FOR CONFORMANCE TO THE DESIGN CONCEPT OF THE WORK, AND SUBJECT TO FURTHER LIMITATIONS AND REQUIREMENTS CONTAINED IN THE CONSTRUCTION CONTRACT DOCUMENTS.

☐ 2N FURNISH AS CORRECTED ☐ 2R REVISE AND RESUBMIT ☐ 3 REJECTED

CORRECTIONS OR COMMENTS MADE ON THE SHOP DRAWINGS DURING THIS REVIEW DO NOT RELIEVE THE CONTRACTOR FROM COMPLIANCE WITH REQUIREMENTS OF THE DRAWINGS AND SPECIFICATIONS. THIS CHECK IS ONLY FOR REVIEW OF GENERAL CONFORMANCE WITH THE DESIGN CONCEPT OF THE PROJECT AND GENERAL COMPLIANCE WITH THE INFORMATION GIVEN IN THE CONTRACT DOCUMENTS. THE CONTRACTOR IS RESPONSIBLE FOR: CONFIRMING AND CORRELATING ALL QUANTITIES AND DIMENSIONS; SELECTING FABRICATION PROCESSES AND TECHNIQUES OF CONSTRUCTION; COORDINATING HIS WORK WITH THAT OF ALL OTHER TRADES; AND PERFORMING HIS WORK IN A SAFE AND SATISFACTORY MANNER.

VHB *Vanasse Hangen Brustlin, Inc.*
Transportation, Land Development and Environmental Services 101 Walnut Street, P.O. Box 9151 Watertown, MA 02471 617.924.1770

PROJECT NUMBER: 09407.03
REVIEWED BY: PLH
DATE: 5/5/2016

VHB has reviewed the enclosed retaining wall plan for horizontal and vertical alignment as designed by VHB. VHB has not reviewed the shop drawing for structural purposes and has noted the drawing has been stamped by a structural engineer.

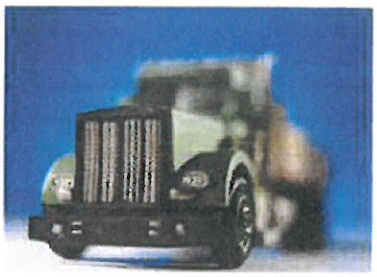
FRANK DeLUCIA & SON INC.

GENERAL CONTRACTORS

119 Newton Road Rear, Plaistow, N.H. 03865

(603) 974-1580 (603) 974-2155

Fax (603) 974-2553



TRANSMITTAL FORM

Date: 05/04/16

To: Pilot Construction
24 Ladd Street
Portsmouth, NH 03801

Attention: Bruce Kelley

Re: Amesbury Heights

We Are Sending You: ☑ Attached ☐ Under Separate Cover

The Following:

☑ Plans ☑ Specifications ☐ Change Order
☐ Letter ☐ Test Results ☐ Product Data
☐ Release ☐ Other _____

(02 00)

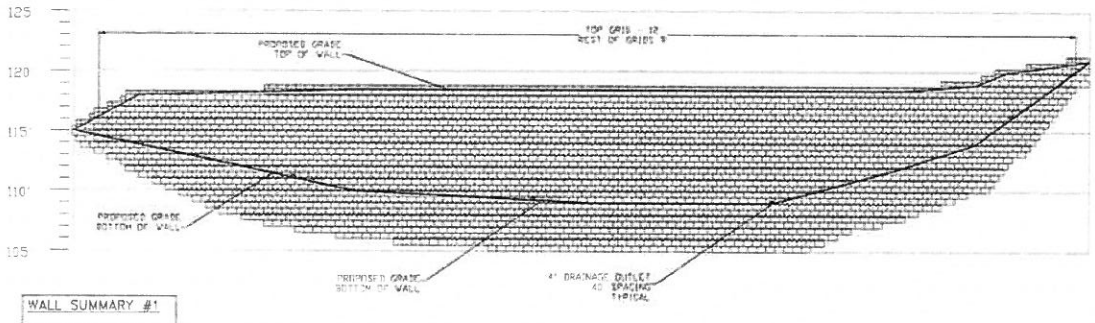
Item	# Copies	Description
		Segmented Block Wall (Remaining 5 walls), Global Stability Study and
		Wall Design
		Plans: Sheets 2 of 2, Titled; Retaining Wall Construction Plan, dated; 5/3/16
		1 Page Drawing Titled: Amesbury.Slope.Slim
		26 pages: Backup Data

These are submitted for:

☑ For Approval ☐ As requested
☐ For Your Use

Signed: Rocci DeLucia Jr.

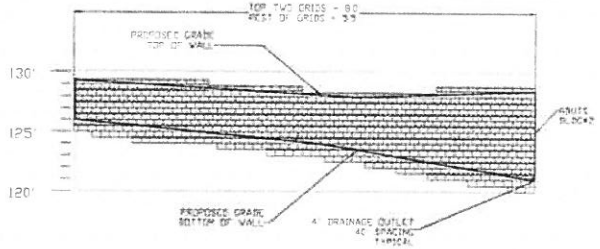
cc: _____



WALL SUMMARY #1

WALL FACE - 1,844 SQ FT
GEOGRID - 1,850 SQ YDS
CAPSTONE - 171 LINEAR FT +/-

PROPOSED RETAINING WALL #1
ELEVATION VIEW
NORTHWEST OF BUILDING #2
FACING FRONT OF WALL
H: 1" = 10'
V: 1" = 5'



PROPOSED RETAINING WALL #3
ELEVATION VIEW
EAST-SOUTH ABUTS BUILDING #2
FACING FRONT OF WALL
H: 1" = 10'
V: 1" = 5'

WALL SUMMARY #3

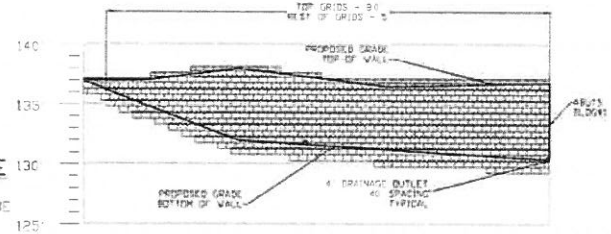
WALL FACE - 451 SQ FT
GEOGRID - 300 SQ YDS
CAPSTONE - 79 LINEAR FT +/-

PROFILE NOTES

1. BEGIN BY CONSTRUCTING LEVELING PAD. PAD SHALL BE COMPACTED TO PROJECT REQUIREMENTS. REFER TO DETAIL FOR TYPICAL GEOMETRY
2. BEGIN BLOCK PLACEMENT AS SHOWN
3. LEVELING PAD STEPS SHALL BE CONSTRUCTED PER DETAIL AS REQUIRED
4. BACKFILL MATERIAL TO MEET GRADATION TO BE COMPACTED IN ACCORDANCE WITH SPECIFICATIONS PROVIDED
5. INSTALL 4" HDPE PERFORATED DRAIN PIPE AS SHOWN - PIPE OUTLET EVERY 40' THROUGH FACE OF WALL OR CONNECT TO ON-SITE STORMWATER SYSTEM
6. FOR TYPICAL SECTION REFER TO DETAIL PROVIDED

REINFORCEMENT SCHEDULE

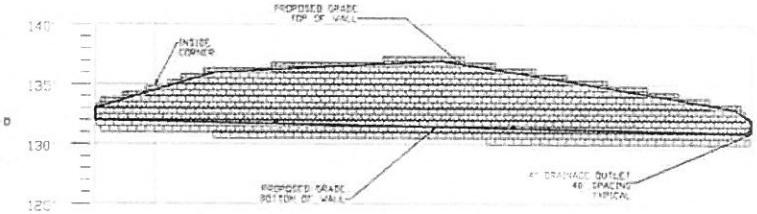
ALL GEOGRID TO BE SYNTEN SF35
GRID LENGTH TO BE MEASURED FROM THE FACE OF THE BLOCK. PLACE GEOGRID ATOP BLOCK AS DEPICTED IN THE ELEVATION VIEW



PROPOSED RETAINING WALL #4
ELEVATION VIEW
EAST OF BUILDING #1
FACING FRONT OF WALL
H: 1" = 10'
V: 1" = 5'

WALL SUMMARY #4

WALL FACE - 467 SQ FT
GEOGRID - 270 SQ YDS
CAPSTONE - 78 LINEAR FT +/-



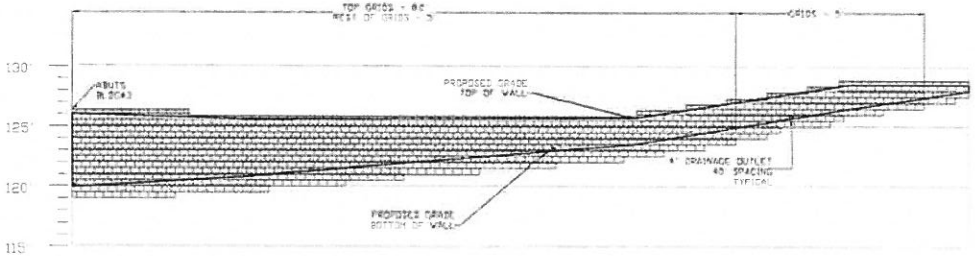
PROPOSED RETAINING WALL #5
ELEVATION VIEW
WEST OF BUILDING #2
FACING FRONT OF WALL
H: 1" = 10'
V: 1" = 5'

WALL SUMMARY #5

WALL FACE - 547 SQ FT
GEOGRID - 300 SQ YDS
CAPSTONE - 118 LINEAR FT +/-

NOTES

1. RETAINING WALL TO BE CONSTRUCTED TO GENERAL LINE AND GRADE SHOWN ON GRADING AND DRAINAGE PLAN PREPARED BY VHB, INC. LATEST REVISION AUGUST 24, 2015.
2. LEVELING PAD TO BE CONSTRUCTED OF A MINIMUM 6" MEETING FOLLOWING GRADATION - 100% PASSING 1", 75-100% PASSING ¾", 0-60% PASSING #4, 0-50% PASSING #40 & 0-5% PASSING #200. ADDITIONALLY, THE DRAINAGE CHIMNEY IS TO CONSIST OF THE SAME CRUSHED STONE.
3. SUBGRADE UNDERLYING LEVELING PAD SHALL CONSIST OF FIRM, DRY, UNDISTURBED NATURAL SOILS OR FREE-DRAINING FILL COMPACTED TO 95% OF MAXIMUMDRY DENSITY DETERMINED IN ACCORDANCE WITH ASTM D1557.
4. IF UNSUITABLE SOIL IS ENCOUNTERED AT SUBGRADE - REMOVE TO SUITABLE SUBGRADE AND REPLACED WITH MATERIAL MEETING FREE-DRAINING FILL SPECIFICATIONS OUTLINED BELOW. IF UNSUITABLE SOIL CAN NOT BE REMOVED, THE DESIGN ENGINEER SHALL BE NOTIFIED PRIOR TO INSTALLATION OF WALL. A SUITABLE FOUNDATION MUST BE IN PLACE PRIOR TO CONSTRUCTION OF THE WALL.
5. RETAINING WALL WAS DESIGNED ASSUMING A COMPETENT BEARING STRATA CAPABLE OF 3,000 PSF.
6. GEOGRID REINFORCEMENT SHALL CONSIST OF SYNTEEN SF35 AND SHOULD BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
7. RETAINING WALL TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
8. GEOGRID TO BE PULLED TAUT PRIOR TO BACKFILLING. BACKFILL IN THE REINFORCED ZONE SHALL CONSIST OF FREE-DRAINING FILL MEETING THE FOLLOWING GRADATION - 100% PASSING 2" SIEVE, 45-60% PASSING No. 4 SIEVE AND MAXIMUM 10% PASSING No. 200 SIEVE. MATERIAL SHOULD BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY DETERMINED IN ACCORDANCE WITH ASTM D1557.
9. GUARDRAIL TO BE INSTALLED WHERE DIRECTED AND REQUIRED BY CODE - DETAIL HEREON.
10. IF CONDITIONS ARE DIFFERENT THAN ASSUMED FOR DESIGN PLEASE CONTACT R&M ENGINEERING CONSULTANTS TO VERIFY DESIGN.



WALL SUMMARY #2

WALL FACE - 836 SQ FT
GEOGRID - 850 SQ YDS
CAPSTONE - 158 LINEAR FT +/-

PROPOSED RETAINING WALL ELEVATION #2
VIEW
ABUTS BUILDING #3
FACING FRONT OF WALL
H: 1" = 10'
V: 1" = 5'

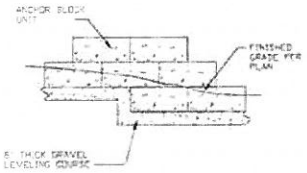
RETAINING WALL CONSTRUCTION PLAN
ANCHOR BLOCK - SITE WALLS
AMESBURY HEIGHTS
AMESBURY, MASSACHUSETTS

DATE	REVISIONS	DATE	REVISIONS	DATE	DRAWN BY
				5/3/16	R. BUSWELL, P.E.
				PROJ. NUMBER 16-144	CHECKED BY R. BUSWELL, P.E.

SHEET 1 OF 2

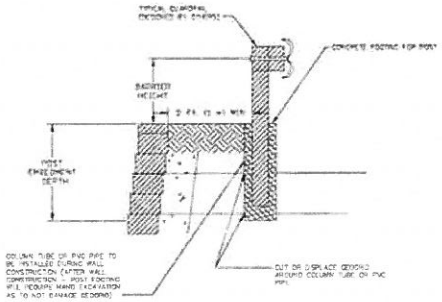
PREPARED FOR: FRANK DeLUCIA & SON, INC. PLAISTOW, NEW HAMPSHIRE

PREPARED BY: R. & M. ENGINEERING CONSULTANTS



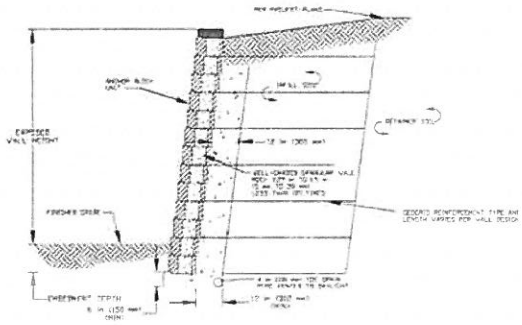
RETAINING WALL DETAIL

BASE COURSE STEP



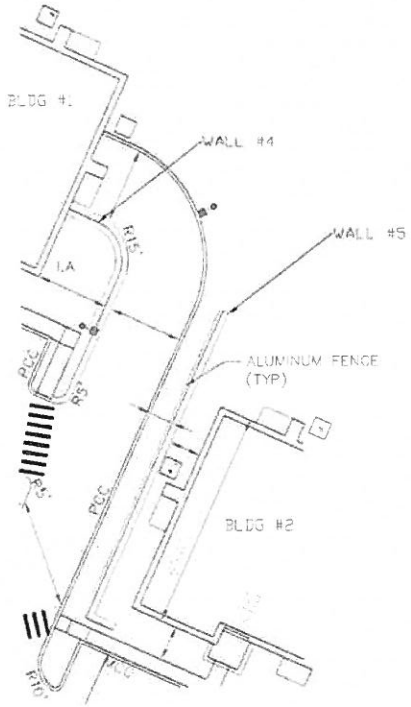
RETAINING WALL DETAIL

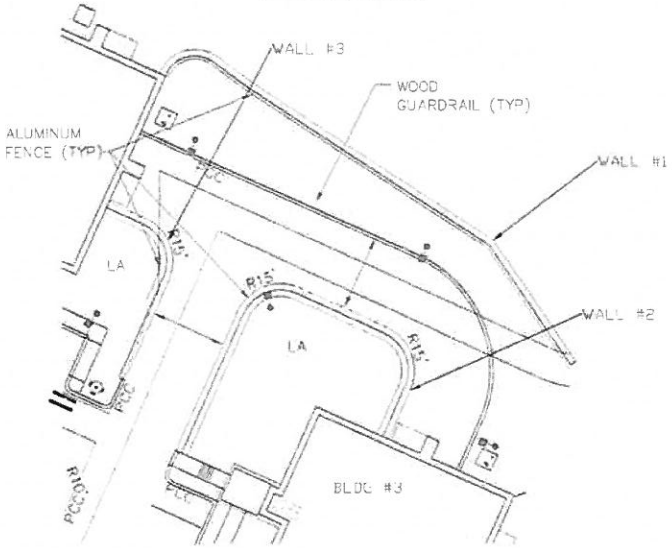
GUARDRAIL DETAIL



RETAINING WALL DETAIL

NTS





VICINITY SKETCH

(REFER TO PROJECT PLANS FOR SCALED LOCATIONS)

NOT TO SCALE

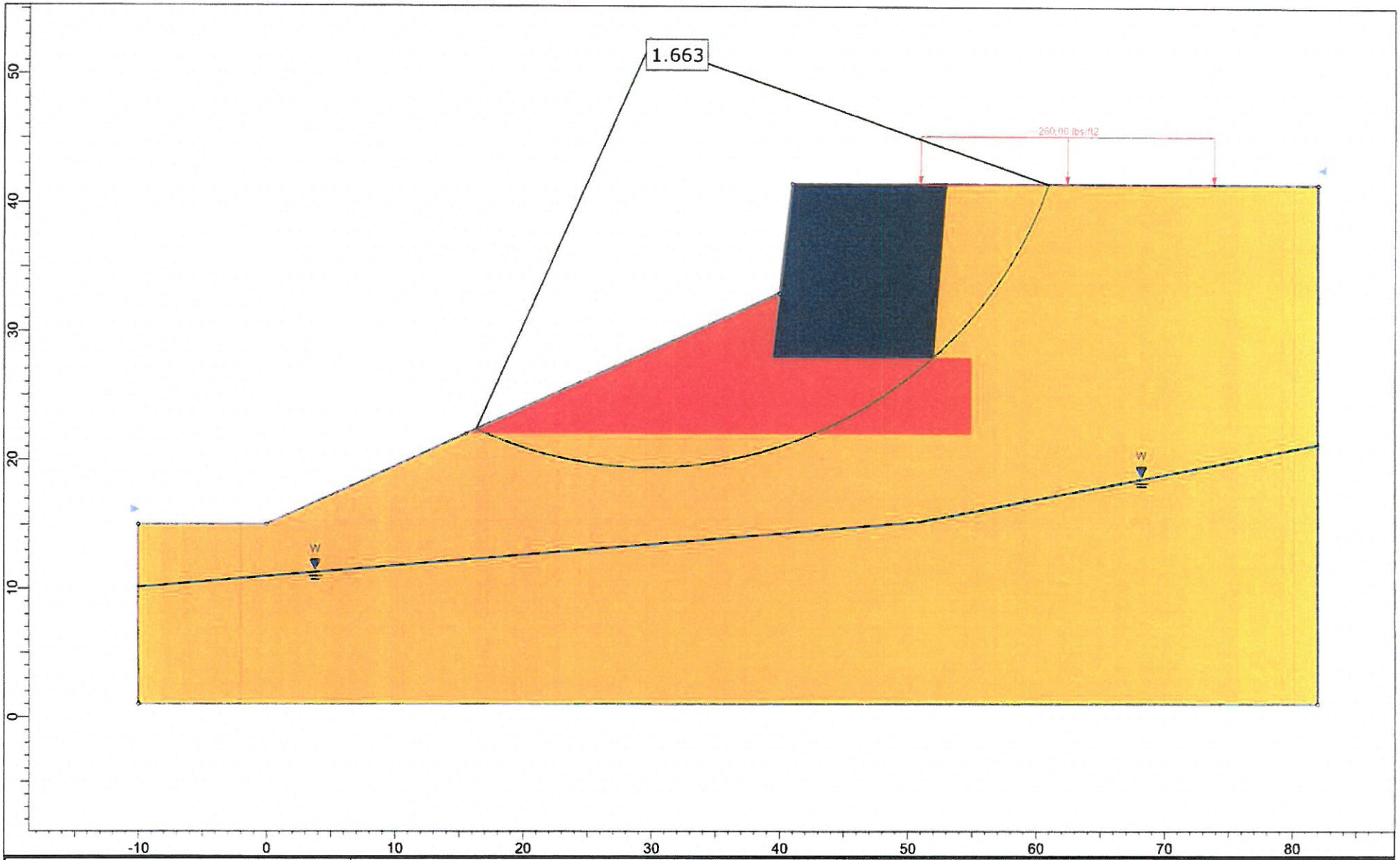
RETAINING WALL CONSTRUCTION PLAN
ANCHOR BLOCK - SITE WALLS
AMESBURY HEIGHTS
AMESBURY, MASSACHUSETTS

DATE	REVISIONS	DATE	REVISIONS	DATE: 5/13/19	DRAWN BY: B. BUSHKELL, P.E.
				PROJ. NUMBER: 5H-144	CHECKED BY: B. BUSHKELL, P.E.

SHEET 2 OF 2

PREPARED FOR: FRANK DOUCLA & SONS, INC. PLAISTOW, NEW HAMPSHIRE

PREPARED BY: B & M ENGINEERING CONSULTANTS



rocscience	Project	Amesbury Heights	
	Analysis Description		
	Drawn By	Scale 1:124	Company R&M Engineering Consultants
SLIDEINTERPRET 7.015	Date		File Name amesbury.slope.slim

LN 0511400

Licensed to: **RICHARD BUSHNELL**
38 EDWARDS DRIVE
GILMANTON IRON WORKS, NH 03837

License Number: **0511400**

Project Identification:

Project Name: **Amesbury Heights**
Section: **NW of BLDG#2**
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.nw bldg2**

Type of Structure: **Geosynthetic-Reinforced Segmental Retaining Wall**
Design Methodology: **NCMA Method A**

Seismic Analysis Details:

Peak Ground Acceleration (PGA) ratio	**0.10**

Wall Geometry:

Design Wall Height (ft)	**13.5**
Embedment Wall Height (ft)	**4.0**
Exposed Design Wall Height (ft)	**9.5**
Vertical Wall Height including Cap Unit (ft)	**13.83**
Exposed Wall Height including Cap Unit (ft)	**9.83**
Minimum Levelling Pad Thickness (ft)	0.5
Number of Segmental Wall Units	**27**
Hinge Height (ft)	**6.0**
Wall Inclination (degrees)	**9.5**

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Slopes:

Front Slope (degrees)	**26.6**
Back Slope (degrees)	**horizontal**

Uniformly Distributed Surcharges:

Live Load Surcharge	**none**
Dead Load Surcharge	**none**

Soil Data:	Soil Description:	Cohesion (psf)	Friction Angle (degrees)	Unit Weight (pcf)
Reinforced Soil	**Gravel**	N/A	**32.0**	**120.0**
Retained Soil	**Sand**	N/A	**32.0**	**120.0**
Levelling Pad Soil	**Crushed Stone**	N/A	**40.0**	**125.0**
Foundation Soil	**Sand**	0.0	**32.0**	**120.0**

Segmental Unit Name:

Segmental Unit Data:

Cap Height (in)	**4.0**
Unit Height (Hu)(in)	**6.0**
Unit Width (Wu)(in)	**12.0**
Unit Length (in)	**18.0**
Setback (in)	**1.0**
Weight (infilled) (lbs)	**120.0**
Unit Weight (infilled) (pcf)	**160.0**
Center of Gravity (in)	**6.0**

COMMONWEALTH OF MASSACHUSETTS
RICHARD E. BUSHNELL
CIVIL
NO 47711
REGISTERED PROFESSIONAL ENGINEER

Segmental Unit Interface Shear Data:

Properties	Ultimate Strength Criteria	Service State Criteria
Minimum (lbs/ft)	**500.0**	**500.0**
Friction Angle (degrees)	**45.0**	**45.0**
Maximum (lbs/ft)	**2000.0**	**2000.0**

Geosynthetic Reinforcement Types and Number:

Type	Number	Name
1	**13**	**SF35**
2	**0**	**SF55**
3	**0**	**PP geosynthetic**

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Geosynthetics Properties:

Strength and Polymer Type:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength (lbs/ft)	3055.0	4200.0	5300.0
Polymer Type	polyester	polyester	HDPE or PP

Reduction Factors:	*Type 1*	*Type 2*	*Type 3*
Creep (=1.00 for seismic analysis)	1.00	1.00	1.00
Durability	1.10	1.10	2.00
Installation Damage	1.05	1.05	3.00
Overall Factor of Safety	1.50	1.50	1.50

(Dynamic) Allowable Strength:	*Type 1*	*Type 2*	*Type 3*
Ta (lbs/ft)	1763.35	2424.24	588.89

Coefficient of Interaction:	*Type 1*	*Type 2*	*Type 3*
Ci	0.7	0.7	0.7

Coefficient of Direct Sliding:	*Type 1*	*Type 2*	*Type 3*
Cds	0.95	0.95	0.95

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REGISTERED PROFESSIONAL ENGINEER

Connection Strength:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0
Service State Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0

Geosynthetic-Segmental Retaining Wall Unit Interface Shear Strength:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0
Service State Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0

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Coefficients of Earth Pressure and Failure Plane Orientations:

Seismic Coefficent (k(int))	0.135
Seismic Coefficent (k(ext))	0.05
Reinforced Soil (static) (Ka)	0.213
Reinforced Soil (static) (Ka horizontal component)	0.208
Reinforced Soil (static + dynamic) (Kae)	0.298
Reinforced Soil (static + dynamic) (Kaeh horizontal component)	0.292
Orientation of failure plane from horizontal (degrees)	53.54
Retained Soil (static) (Ka)	0.21
Retained Soil (static) (Kah horizontal component)	0.194
Retained Soil (static + dynamic) (Kae)	0.241
Retained Soil (static + dynamic) (Kaeh horizontal component)	0.222
Orientation of failure plane from horizontal (degrees)	50.07

Results of External Stability (Seismic) Analyses:

	Calculated	Design Criteria
FOS Sliding	3.31	1.5 OK
FOS Overturning	5.61	1.5 OK
FOS Bearing Capacity	16.25	2.0 OK
Base Reinforcement Length (L) (ft)	9.0	8.1 OK
Base Eccentricity (e)(ft)	0.01	N/A
Base Eccentricity Ratio (e/L-2e)	0.0	N/A
Base Reinforcement Ratio (L/H)	0.67	0.6 OK

Note: calculated values MEET ALL design criteria

Detailed Results of External Stability Analyses:

	Calculated Va
Total Horizontal Force (lbs/ft)	2851.3
Total Vertical Force (lbs/ft)	15120.0
Sliding Resistance (lbs/ft)	9448.0
Driving Moment (lbs-ft/ft)	14668.0
Resisting Moment (lbs-ft/ft)	82287.0
Bearing Capacity (psf)	27388.7
Maximum Bearing Pressure (psf)	1685.4

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RICHARD E. BUSHNELL
CIVIL
NO. 47711
REGISTERED PROFESSIONAL ENGINEER

Results of Internal Stability (Seismic) Analyses:

SRW Unit #	Geosyn Type	Elev (ft)	Length (ft)	Anchor Length (ft) > 1.0	FOS Over-stress > 1.0	FOS Pullout > 1.1	FOS Sliding > 1.5	Layer Spacing (ft) < 3.0
27	1	13.0	12.0	3.56	12.65	1.34	26.19	OK
25	1	12.0	9.0	1.13	11.13	1.13	13.77	OK
23	1	11.0	9.0	1.71	9.94	2.52	10.52	OK
21	1	10.0	9.0	2.28	8.98	4.26	8.77	OK
19	1	9.0	9.0	2.85	8.19	6.25	7.6	OK
17	1	8.0	9.0	3.42	7.52	8.43	6.73	OK
15	1	7.0	9.0	3.99	6.96	10.76	5.97	OK
13	1	6.0	9.0	4.57	6.47	13.2	5.3	OK
11	1	5.0	9.0	5.14	6.05	15.74	4.77	OK
9	1	4.0	9.0	5.71	5.68	18.35	4.34	OK
7	1	3.0	9.0	6.28	5.35	21.03	3.99	OK
5	1	2.0	9.0	6.86	5.06	23.76	3.69	OK
3	1	1.0	9.0	7.43	3.16	17.36	3.43	OK

Note: calculated values MEET ALL design criteria

Note: Seismic analysis may not give the lowest factors of safety for FOS against reinforcement

Detailed Results of Internal Stability Analyses:
LN 0511400

SRW Unit #	Geosyn Type	Elev (ft)	Allowable Strength (lbs/ft)	Tensile Load (lbs/ft)	Pullout Capacity (lbs/ft)	Sliding Force (lbs/ft)	Sliding Capacity (lbs/ft)
27	1	13.0	1763.3	139.4	186.9	33.0	864.9
25	1	12.0	1763.3	158.4	178.5	115.8	1594.8
23	1	11.0	1763.3	177.4	447.7	221.0	2324.7
21	1	10.0	1763.3	196.4	837.1	348.4	3054.6
19	1	9.0	1763.3	215.4	1346.5	498.2	3784.5
17	1	8.0	1763.3	234.4	1976.1	670.4	4514.3
15	1	7.0	1763.3	253.4	2725.8	864.8	5164.2
13	1	6.0	1763.3	272.4	3595.7	1081.6	5734.1
11	1	5.0	1763.3	291.4	4585.7	1320.8	6304.0
9	1	4.0	1763.3	310.3	5695.8	1582.2	6873.9
7	1	3.0	1763.3	329.3	6926.1	1866.0	7443.7
5	1	2.0	1763.3	348.3	8276.5	2172.1	8013.6
3	1	1.0	1763.3	558.1	9687.1	2500.6	8583.5

Results of Facing Stability (Seismic) Analyses:

SRW Unit #	Heel Elev (ft)	Geosynthetic Type	FOS Over-turning > 1.5	FOS Shear (peak) > 1.5	Shear (deformation) < 0.02 x Hu	FOS Connection (peak) > 1.5	Connection (deformation) < 0.75 in
27	13.0	1	2.4	8.61	OK	9.08	OK
26	12.5	none	10.56	-	-	-	-
25	12.0	1	8.96	9.63	OK	8.4	OK
24	11.5	none	9.69	-	-	-	-
23	11.0	1	9.06	10.43	OK	7.86	OK
22	10.5	none	9.25	-	-	-	-
21	10.0	1	8.88	11.06	OK	7.43	OK
20	9.5	none	8.92	-	-	-	-
19	9.0	1	8.67	11.58	OK	7.08	OK
18	8.5	none	8.66	-	-	-	-
17	8.0	1	8.46	12.02	OK	6.78	OK
16	7.5	none	8.43	-	-	-	-
15	7.0	1	8.23	11.74	OK	6.4	OK
14	6.5	none	8.16	-	-	-	-
13	6.0	1	8.01	10.91	OK	5.95	OK
12	5.5	none	7.93	-	-	-	-
11	5.0	1	7.8	10.19	OK	5.56	OK
10	4.5	none	7.72	-	-	-	-
9	4.0	1	7.6	9.56	OK	5.22	OK
8	3.5	none	7.52	-	-	-	-
7	3.0	1	7.41	9.0	OK	4.92	OK
6	2.5	none	7.34	-	-	-	-
5	2.0	1	7.23	8.5	OK	4.65	OK
4	1.5	none	7.15	-	-	-	-
3	1.0	1	7.05	8.05	OK	2.9	OK
2	0.5	none	6.98	-	-	-	-
1	0.0	none	6.88	-	-	-	-

Note: calculated values MEET ALL design criteria

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Detailed Results of Facing Stability Analyses (Moment and Shear):

SRW Unit #	Heel Elev (ft)	Geo Type	Drive Moment (lbs-ft/ft)	Resist Moment (lbs-ft/ft)	Shear Load (lbs/ft) +out -in	Shear Capacity (lbs/ft) (peak)	Shear Capacity (lbs/ft) (deformation)
27	13.0	1	16.6	40.0	67.3	580.0	580.0
26	12.5	none	68.1	719.5	0.0	660.0	660.0
25	12.0	1	156.9	1405.7	76.8	740.0	740.0
24	11.5	none	285.2	2763.6	0.0	820.0	820.0
23	11.0	1	455.5	4128.3	86.3	900.0	900.0
22	10.5	none	670.1	6197.1	0.0	980.0	980.0
21	10.0	1	931.5	8272.5	95.8	1060.0	1060.0
20	9.5	none	1242.0	11084.4	0.0	1140.0	1140.0
19	9.0	1	1604.0	13903.0	105.3	1220.0	1220.0
18	8.5	none	2019.8	17490.3	0.0	1300.0	1300.0
17	8.0	1	2491.8	21084.4	114.8	1380.0	1380.0
16	7.5	none	3022.4	25479.5	0.0	1460.0	1460.0
15	7.0	1	3614.0	29761.3	124.3	1460.0	1460.0
14	6.5	none	4269.0	34853.7	0.0	1460.0	1460.0
13	6.0	1	4989.6	39946.1	133.8	1460.0	1460.0
12	5.5	none	5778.4	45849.1	0.0	1460.0	1460.0
11	5.0	1	6637.6	51752.1	143.3	1460.0	1460.0
10	4.5	none	7569.6	58465.7	0.0	1460.0	1460.0
9	4.0	1	8576.9	65179.2	152.8	1460.0	1460.0
8	3.5	none	9661.7	72703.5	0.0	1460.0	1460.0
7	3.0	1	10826.5	80227.7	162.3	1460.0	1460.0
6	2.5	none	12073.7	88562.4	0.0	1460.0	1460.0
5	2.0	1	13405.5	96897.3	171.8	1460.0	1460.0
4	1.5	none	14824.4	106042.6	0.0	1460.0	1460.0
3	1.0	1	16332.8	115188.0	181.3	1460.0	1460.0
2	0.5	none	17933.0	125144.1	-190.8	1460.0	1460.0
1	0.0	none	19627.4	135100.0	0.0	1460.0	1460.0

Detailed Results of Facing Stability Analyses (Connections):

SRW Unit #	Heel Elev (ft)	Geo Type	Connection Load (lbs/ft)	Connection Capacity (peak) (lbs/ft)	Connection Capacity (deformation) (lbs/ft)
27	13.0	1	139.4	1265.7	1265.7
25	12.0	1	158.4	1330.3	1330.3
23	11.0	1	177.4	1394.9	1394.9
21	10.0	1	196.4	1459.6	1459.6
19	9.0	1	215.4	1524.2	1524.2
17	8.0	1	234.4	1588.9	1588.9
15	7.0	1	253.4	1621.2	1621.2
13	6.0	1	272.4	1621.2	1621.2
11	5.0	1	291.4	1621.2	1621.2
9	4.0	1	310.3	1621.2	1621.2
7	3.0	1	329.3	1621.2	1621.2
5	2.0	1	348.3	1621.2	1621.2
3	1.0	1	558.1	1621.2	1621.2

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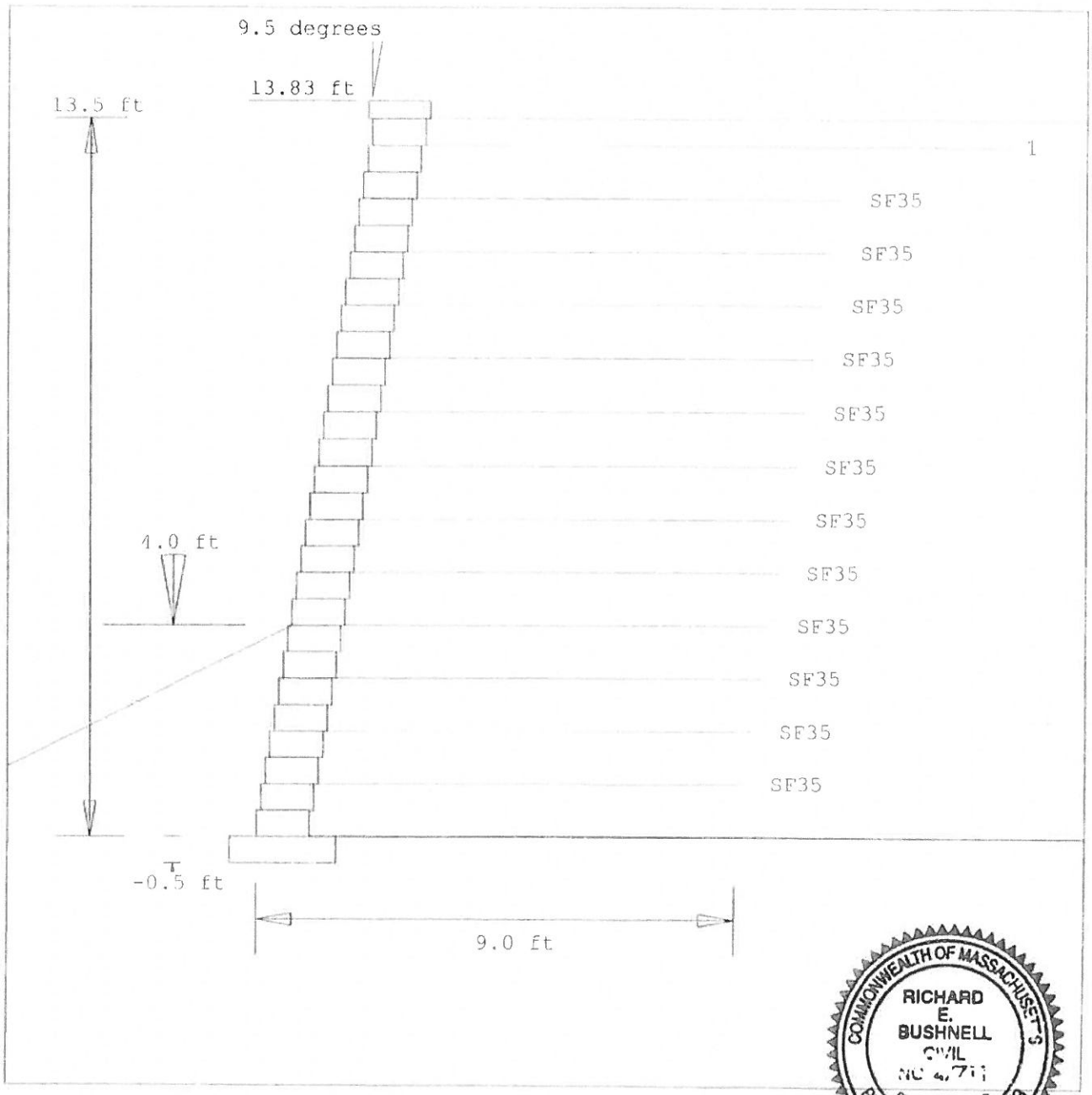

Project Identification:

Project
Name: **Amesbury Heights**
Section: **NW of BLDG#2**
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.nw bldg2**

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License Number: **0511400**

Project Identification:

Project Name: **Amesbury Heights**
Section: **E-S of BLDG#2**
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.e-s bldg 2**

Type of Structure: **Geosynthetic-Reinforced Segmental Retaining Wall**
Design Methodology: **NCMA Method A**

Seismic Analysis Details:

Peak Ground Acceleration (PGA) ratio	**0.10**

Wall Geometry:

Design Wall Height (ft)	**8.5**
Embedment Wall Height (ft)	**1.0**
Exposed Design Wall Height (ft)	**7.5**
Vertical Wall Height including Cap Unit (ft)	**8.83**
Exposed Wall Height including Cap Unit (ft)	**7.83**
Minimum Levelling Pad Thickness (ft)	0.5

Number of Segmental Wall Units	**17**
Hinge Height (ft)	**6.0**
Wall Inclination (degrees)	**9.5**

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Slopes:

Front Slope (degrees)	**horizontal**
Back Slope (degrees)	**horizontal**

Uniformly Distributed Surcharges:

Live Load Surcharge	**none**
Dead Load Surcharge	**none**

Soil Data:	*Soil Description:*	*Cohesion (psf)*	*Friction Angle (degrees)*	*Unit Weight (pcf)*
Reinforced Soil	**Gravel**	N/A	**32.0**	**120.0**
Retained Soil	**Sand**	N/A	**32.0**	**120.0**
Levelling Pad Soil	**Crushed Stone**	N/A	**40.0**	**125.0**
Foundation Soil	**Sand**	0.0	**32.0**	**120.0**

Segmental Unit Name:

Segmental Unit Data:

Cap Height (in)	**4.0**
Unit Height (Hu)(in)	**6.0**
Unit Width (Wu)(in)	**12.0**
Unit Length (in)	**18.0**
Setback (in)	**1.0**
Weight (infilled) (lbs)	**120.0**
Unit Weight (infilled) (pcf)	**160.0**
Center of Gravity (in)	**6.0**

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Segmental Unit Interface Shear Data:

Properties	*Ultimate Strength Criteria*	*Service State Criteria*
Minimum (lbs/ft)	**500.0**	**500.0**
Friction Angle (degrees)	**45.0**	**45.0**
Maximum (lbs/ft)	**2000.0**	**2000.0**

Geosynthetic Reinforcement Types and Number:

Type	*Number*	*Name*
1	**8**	**SF35**
2	**0**	**SF55**
3	**0**	**PP geosynthetic**

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Geosynthetics Properties:

Strength and Polymer Type:	Type 1	Type 2	Type 3
Ultimate Strength (lbs/ft)	3055.0	4200.0	5300.0
Polymer Type	polyester	polyester	HDPE or PP

Reduction Factors:	Type 1	Type 2	Type 3
Creep (=1.00 for seismic analysis)	1.00	1.00	1.00
Durability	1.10	1.10	2.00
Installation Damage	1.05	1.05	3.00
Overall Factor of Safety	1.50	1.50	1.50

(Dynamic) Allowable Strength:	Type 1	Type 2	Type 3
Ta (lbs/ft)	1763.35	2424.24	588.89

Coefficient of Interaction:	Type 1	Type 2	Type 3
Ci	0.7	0.7	0.7

Coefficient of Direct Sliding:	Type 1	Type 2	Type 3
Cds	0.95	0.95	0.95

Connection Strength:	Type 1	Type 2	Type 3
Ultimate Strength Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0
Service State Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0

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Geosynthetic-Segmental Retaining Wall Unit Interface Shear Strength:	Type 1	Type 2	Type 3
Ultimate Strength Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0
Service State Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0

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Coefficients of Earth Pressure and Failure Plane Orientations:

Seismic Coefficent (k(int))	0.135
Seismic Coefficent (k(ext))	0.05
Reinforced Soil (static) (Ka)	0.213
Reinforced Soil (static) (Ka horizontal component)	0.208
Reinforced Soil (static + dynamic) (Kae)	0.298
Reinforced Soil (static + dynamic) (Kaeh horizontal component)	0.292
Orientation of failure plane from horizontal (degrees)	53.54
Retained Soil (static) (Ka)	0.21
Retained Soil (static) (Kah horizontal component)	0.194
Retained Soil (static + dynamic) (Kae)	0.241
Retained Soil (static + dynamic) (Kaeh horizontal component)	0.222
Orientation of failure plane from horizontal (degrees)	50.07

Results of External Stability (Seismic) Analyses:

	Calculated	Design Criteria
FOS Sliding	3.27	1.5 OK
FOS Overturning	5.31	1.5 OK
FOS Bearing Capacity	11.26	2.0 OK
Base Reinforcement Length (L) (ft)	5.5	5.1 OK
Base Eccentricity (e)(ft)	0.07	N/A
Base Eccentricity Ratio (e/L-2e)	0.01	N/A
Base Reinforcement Ratio (L/H)	0.65	0.6 OK

Note: calculated values MEET ALL design criteria

Detailed Results of External Stability Analyses:

	Calculated Values:
Total Horizontal Force (lbs/ft)	1136.7
Total Vertical Force (lbs/ft)	5950.0
Sliding Resistance (lbs/ft)	3718.0
Driving Moment (lbs-ft/ft)	3688.0
Resisting Moment (lbs-ft/ft)	19581.2
Bearing Capacity (psf)	12497.1
Maximum Bearing Pressure (psf)	1110.2

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Results of Internal Stability (Seismic) Analyses:

SRW Unit #	Geosyn Type	Elev (ft)	Length (ft)	Anchor Length (ft) > 1.0	FOS Over-stress > 1.0	FOS Pullout > 1.1	FOS Sliding > 1.5	Layer Spacing (ft) < 3.0
17	1	8.0	8.0	2.42	17.76	1.28	33.34	OK
15	1	7.0	8.0	2.99	14.91	3.99	14.65	OK
13	1	6.0	5.5	1.07	12.84	2.04	10.2	OK
11	1	5.0	5.5	1.64	11.28	3.85	8.0	OK
9	1	4.0	5.5	2.21	10.06	5.96	6.64	OK
7	1	3.0	5.5	2.78	9.08	8.27	5.7	OK
5	1	2.0	5.5	3.36	8.27	10.74	4.89	OK
3	1	1.0	5.5	3.93	4.96	8.7	4.2	OK

Note: calculated values MEET ALL design criteria

Note: Seismic analysis may not give the lowest factors of safety for FOS against reinforcement over-stress in internal stabilty calculations. Be sure to check current design using static analysis option.

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Detailed Results of Internal Stability Analyses:

SRW Unit #	Geosyn Type	Elev (ft)	Allowable Strength (lbs/ft)	Tensile Load (lbs/ft)	Pullout Capacity (lbs/ft)	Sliding Force (lbs/ft)	Sliding Capacity (lbs/ft)
17	1	8.0	1763.3	99.3	127.2	22.2	740.3
15	1	7.0	1763.3	118.3	471.6	83.4	1220.8
13	1	6.0	1763.3	137.3	280.0	166.8	1701.4
11	1	5.0	1763.3	156.3	602.2	272.6	2182.0
9	1	4.0	1763.3	175.3	1044.6	400.8	2662.5
7	1	3.0	1763.3	194.3	1607.1	551.3	3143.1
5	1	2.0	1763.3	213.2	2289.7	724.1	3543.6
3	1	1.0	1763.3	355.5	3092.5	919.2	3864.2

Results of Facing Stability (Seismic) Analyses:

SRW Unit #	Heel Elev (ft)	Geosynthetic Type	FOS Over-turning > 1.5	FOS Shear (peak) > 1.5	Shear (deformation) < 0.02 x Hu	FOS Connection (peak) > 1.5	Connection (deformation) < 0.75 in
17	8.0	1	3.44	12.27	OK	12.75	OK
16	7.5	none	14.97	-	-	-	-
15	7.0	1	12.58	13.03	OK	11.25	OK
14	6.5	none	13.49	-	-	-	-
13	6.0	1	12.51	13.58	OK	10.16	OK
12	5.5	none	12.66	-	-	-	-
11	5.0	1	12.06	13.99	OK	9.34	OK
10	4.5	none	12.03	-	-	-	-
9	4.0	1	11.61	14.31	OK	8.7	OK
8	3.5	none	11.52	-	-	-	-
7	3.0	1	11.19	14.56	OK	8.18	OK
6	2.5	none	11.08	-	-	-	-
5	2.0	1	10.76	14.0	OK	7.6	OK
4	1.5	none	10.61	-	-	-	-
3	1.0	1	10.35	12.84	OK	4.56	OK
2	0.5	none	10.2	-	-	-	-
1	0.0	none	9.98	-	-	-	-

Note: calculated values MEET ALL design criteria

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Detailed Results of Facing Stability Analyses (Moment and Shear):

SRW Unit #	Heel Elev (ft)	Geo Type	Drive Moment (lbs-ft/ft)	Resist Moment (lbs-ft/ft)	Shear Load (lbs/ft) Hout -in	Shear Capacity (lbs/ft) (peak)	Shear Capacity (lbs/ft) (deformation)
17	8.0	1	11.6	40.0	47.3	580.0	580.0
16	7.5	none	48.1	719.5	0.0	660.0	660.0
15	7.0	1	111.7	1405.6	56.8	740.0	740.0
14	6.5	none	204.9	2763.6	0.0	820.0	820.0
13	6.0	1	330.1	4128.3	66.3	900.0	900.0
12	5.5	none	489.6	6197.0	0.0	980.0	980.0
11	5.0	1	685.8	8272.5	75.8	1060.0	1060.0
10	4.5	none	921.0	11084.4	0.0	1140.0	1140.0
9	4.0	1	1197.7	13903.0	85.3	1220.0	1220.0
8	3.5	none	1518.2	17490.4	0.0	1300.0	1300.0
7	3.0	1	1885.0	21084.4	94.8	1380.0	1380.0
6	2.5	none	2300.2	25479.5	0.0	1460.0	1460.0
5	2.0	1	2766.4	29761.3	104.3	1460.0	1460.0
4	1.5	none	3286.0	34853.7	0.0	1460.0	1460.0
3	1.0	1	3861.2	39946.1	113.7	1460.0	1460.0
2	0.5	none	4494.4	45849.1	-123.2	1460.0	1460.0
1	0.0	none	5188.1	51752.1	0.0	1460.0	1460.0

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Detailed Results of Facing Stability Analyses (Connections):

SRW Unit #	Heel Elev (ft)	Geo Type	Connection Load (lbs/ft)	Connection Capacity (peak) (lbs/ft)	Connection Capacity (deformation) (lbs/ft)
17	8.0	1	99.3	1265.7	1265.7
15	7.0	1	118.3	1330.3	1330.3
13	6.0	1	137.3	1394.9	1394.9
11	5.0	1	156.3	1459.6	1459.6
9	4.0	1	175.3	1524.2	1524.2
7	3.0	1	194.3	1588.9	1588.9
5	2.0	1	213.2	1621.2	1621.2
3	1.0	1	355.5	1621.2	1621.2

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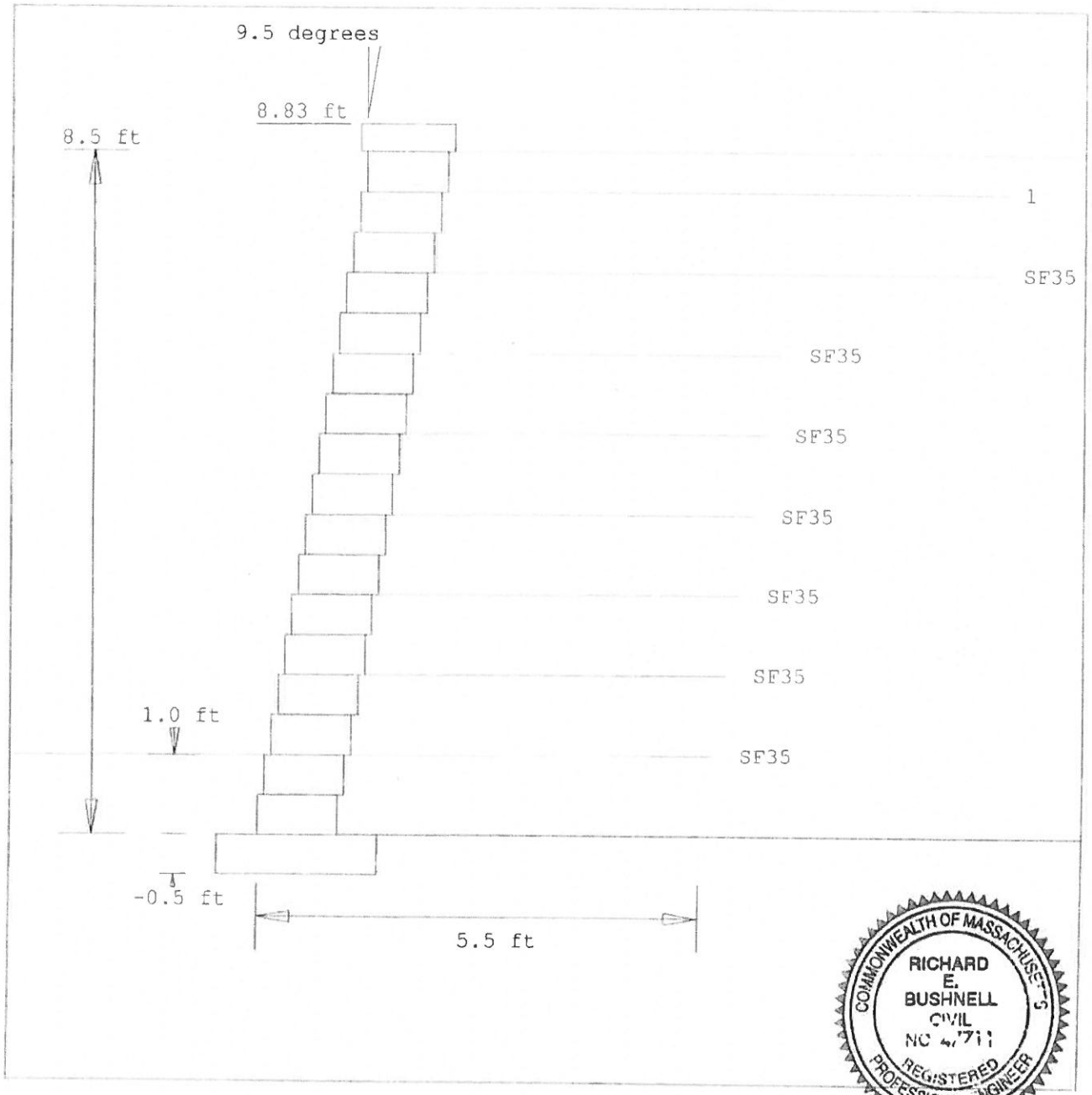

Project Identification:

Project
Name: **Amesbury Heights**
Section: **E-S of BLDG#2**
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.e-s bldg 2**

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License Number: **0511400**

Project Identification:

Project Name: **Amesbury Heights**
Section: **Abuts Bldg #3**
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.abuts bldg 3.shorter**

Type of Structure: **Geosynthetic-Reinforced Segmental Retaining Wall**
Design Methodology: **NCMA Method A**

Seismic Analysis Details:

Peak Ground Acceleration (PGA) ratio	0.10

Wall Geometry:

Design Wall Height (ft)	3.0
Embedment Wall Height (ft)	1.0
Exposed Design Wall Height (ft)	2.0
Vertical Wall Height including Cap Unit (ft)	3.33
Exposed Wall Height including Cap Unit (ft)	2.33
Minimum Levelling Pad Thickness (ft)	0.5
Number of Segmental Wall Units	6
Hinge Height (ft)	3.0
Wall Inclination (degrees)	9.5

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Slopes:

Front Slope (degrees)	**horizontal**
Back Slope (degrees)	**horizontal**

Uniformly Distributed Surcharges:

Live Load Surcharge	**none**
Dead Load Surcharge	**none**

Soil Data:	*Soil Description:*	*Cohesion (psf)*	*Friction Angle (degrees)*	*Unit Weight (pcf)*
Reinforced Soil	**Gravel**	N/A	**32.0**	**120.0**
Retained Soil	**Sand**	N/A	**32.0**	**120.0**
Levelling Pad Soil	**Crushed Stone**	N/A	**40.0**	**125.0**
Foundation Soil	**Sand**	**0.0**	**32.0**	**120.0**

Segmental Unit Name:

Segmental Unit Data:

Cap Height (in)	**4.0**
Unit Height (Hu)(in)	**6.0**
Unit Width (Wu)(in)	**12.0**
Unit Length (in)	**18.0**
Setback (in)	**1.0**
Weight (infilled) (lbs)	**120.0**
Unit Weight (infilled) (pcf)	**160.0**
Center of Gravity (in)	**6.0**

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Segmental Unit Interface Shear Data:

Properties	*Ultimate Strength Criteria*	*Service State Criteria*
Minimum (lbs/ft)	**500.0**	**500.0**
Friction Angle (degrees)	**45.0**	**45.0**
Maximum (lbs/ft)	**2000.0**	**2000.0**

Geosynthetic Reinforcement Types and Number:

Type	*Number*	*Name*
1	**2**	**SF35**
2	**0**	**SF55**
3	**0**	**PP geosynthetic**

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Geosynthetics Properties:

Strength and Polymer Type:	Type 1	Type 2	Type 3
Ultimate Strength (lbs/ft)	3055.0	4200.0	5300.0
Polymer Type	polyester	polyester	HDPE or PP

Reduction Factors:	Type 1	Type 2	Type 3
Creep (=1.00 for seismic analysis)	1.00	1.00	1.00
Durability	1.10	1.10	2.00
Installation Damage	1.05	1.05	3.00
Overall Factor of Safety	1.50	1.50	1.50

(Dynamic) Allowable Strength:	Type 1	Type 2	Type 3
Ta (lbs/ft)	1763.35	2424.24	588.89

Coefficient of Interaction:	Type 1	Type 2	Type 3
Ci	0.7	0.7	0.7

Coefficient of Direct Sliding:	Type 1	Type 2	Type 3
Cds	0.95	0.95	0.95

Connection Strength:	Type 1	Type 2	Type 3
Ultimate Strength Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0
Service State Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0

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Geosynthetic-Segmental Retaining Wall Unit Interface Shear Strength:	Type 1	Type 2	Type 3
Ultimate Strength Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0
Service State Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0

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Coefficients of Earth Pressure and Failure Plane Orientations:

Seismic Coefficent (k(int))	0.135
Seismic Coefficent (k(ext))	0.05
Reinforced Soil (static) (Ka)	0.213
Reinforced Soil (static) (Ka horizontal component)	0.208
Reinforced Soil (static + dynamic) (Kae)	0.298
Reinforced Soil (static + dynamic) (Kaeh horizontal component)	0.292
Orientation of failure plane from horizontal (degrees)	53.54
Retained Soil (static) (Ka)	0.21
Retained Soil (static) (Kah horizontal component)	0.194
Retained Soil (static + dynamic) (Kae)	0.241
Retained Soil (static + dynamic) (Kaeh horizontal component)	0.222
Orientation of failure plane from horizontal (degrees)	50.07

Results of External Stability (Seismic) Analyses:

	Calculated	*Design Criteria*
FOS Sliding	5.15	1.5 OK
FOS Overturning	11.53	1.5 OK
FOS Bearing Capacity	19.99	2.0 OK
Base Reinforcement Length (L) (ft)	3.0	1.8 OK
Base Eccentricity (e)(ft)	0.02	N/A
Base Eccentricity Ratio (e/L-2e)	0.01	N/A
Base Reinforcement Ratio (L/H)	1.0	0.6 OK

Note: calculated values MEET ALL design criteria

Detailed Results of External Stability Analyses:	*Calculated Values:*
Total Horizontal Force (lbs/ft)	145.5
Total Vertical Force (lbs/ft)	1200.0
Sliding Resistance (lbs/ft)	749.8
Driving Moment (lbs-ft/ft)	168.0
Resisting Moment (lbs-ft/ft)	1936.0
Bearing Capacity (psf)	8130.0
Maximum Bearing Pressure (psf)	406.7

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Results of Internal Stability (Seismic) Analyses:

SRW Unit #	*Geosyn Type*	*Elev (ft)*	*Length (ft)*	*Anchor Length (ft)* > 1.0	*FOS Over-stress* > 1.0	*FOS Pullout* > 1.1	*FOS Sliding* > 1.5	*Layer Spacing (ft)* < 3.0
5	1	2.0	5.0	2.86	19.62	3.34	30.68	OK
3	1	1.0	5.0	3.43	13.3	5.43	14.8	OK

Note: calculated values MEET ALL design criteria

Note: Seismic analysis may not give the lowest factors of safety for FOS against reinforcement over-stress in internal stabilty calculations. Be sure to check current design using static analysis option.

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Detailed Results of Internal Stability Analyses:

SRW Unit #	Geosyn Type	Elev (ft)	Allowable Strength (lbs/ft)	Tensile Load (lbs/ft)	Pullout Capacity (lbs/ft)	Sliding Force (lbs/ft)	Sliding Capacity (lbs/ft)
5	1	2.0	1763.3	89.9	299.8	26.2	802.5
3	1	1.0	1763.3	132.6	719.7	74.7	1104.9

Results of Facing Stability (Seismic) Analyses:

SRW Unit #	Heel Elev (ft)	Geosynthetic Type	FOS Over-turning > 1.5	FOS Shear (peak) > 1.5	Shear (deformation) < 0.02 x Hu	FOS Connection (peak) > 1.5	Connection (deformation) < 0.75 in
6	2.5	none	6.55	23.01	OK	-	-
5	2.0	1	3.33	11.96	OK	14.44	OK
4	1.5	none	12.71	-	-	-	-
3	1.0	1	12.84	20.78	OK	10.28	OK
2	0.5	none	15.06	-	-	-	-
1	0.0	none	14.77	-	-	-	-

Note: calculated values MEET ALL design criteria

Detailed Results of Facing Stability Analyses (Moment and Shear):

SRW Unit #	Heel Elev (ft)	Geo Type	Drive Moment (lbs-ft/ft)	Resist Moment (lbs-ft/ft)	Shear Load (lbs/ft) +out -in	Shear Capacity (lbs/ft) (peak)	Shear Capacity (lbs/ft) (deformation)
6	2.5	none	6.1	40.0	25.2	580.0	580.0
5	2.0	1	26.0	86.7	55.2	660.0	660.0
4	1.5	none	62.1	789.0	0.0	740.0	740.0
3	1.0	1	116.7	1498.0	39.5	820.0	820.0
2	0.5	none	192.2	2895.0	-48.9	900.0	900.0
1	0.0	none	291.0	4298.6	0.0	980.0	980.0

Detailed Results of Facing Stability Analyses (Connections):

SRW Unit #	Heel Elev (ft)	Geo Type	Connection Load (lbs/ft)	Connection Capacity (peak) (lbs/ft)	Connection Capacity (deformation) (lbs/ft)
5	2.0	1	89.9	1298.0	1298.0
3	1.0	1	132.6	1362.6	1362.6

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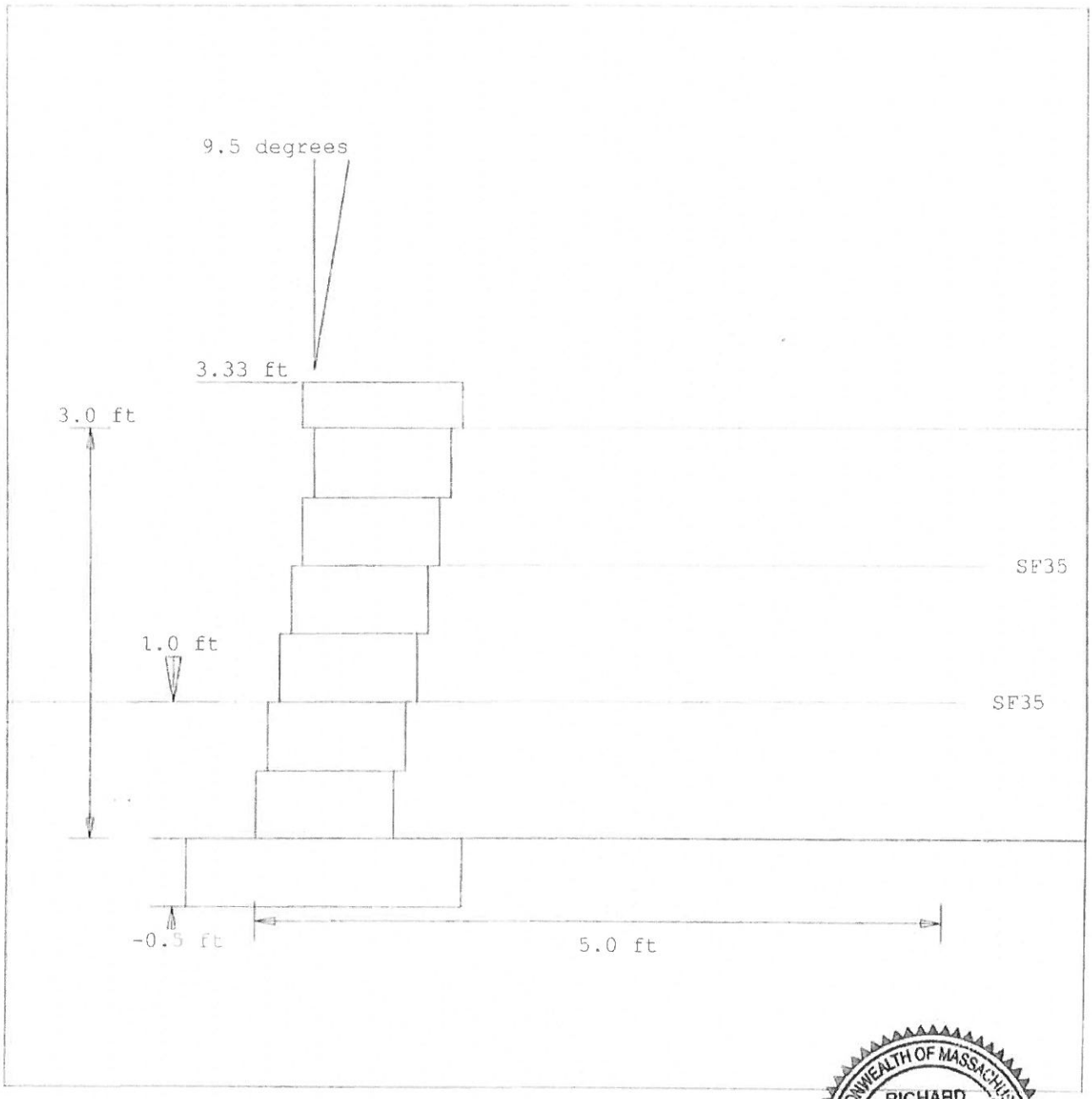

Project Identification:

Project
Name: **Amesbury Heights**
Section: **Abuts Bldg #3**
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.abuts bldg 3.shorter**

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Licensed to: **RICHARD BUSHNELL**
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GILMANTON IRON WORKS, NH 03837

License Number: **0511400**

Project Identification:

Project Name: **Amesbury Heights**
Section: **Abuts Bldg #3** { WEST BLDG #2 } EAST OF BLDG #1
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.abuts bldg 3**

Type of Structure: **Geosynthetic-Reinforced Segmental Retaining Wall**
Design Methodology: **NCMA Method A**

Seismic Analysis Details:

Peak Ground Acceleration (PGA) ratio **0.10**

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Wall Geometry:

Design Wall Height (ft)	**7.0**
Embedment Wall Height (ft)	**1.0**
Exposed Design Wall Height (ft)	**6.0**
Vertical Wall Height including Cap Unit (ft)	**7.33**
Exposed Wall Height including Cap Unit (ft)	**6.33**
Minimum Levelling Pad Thickness (ft)	0.5
Number of Segmental Wall Units	**14**
Hinge Height (ft)	**6.0**
Wall Inclination (degrees)	**9.5**

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Slopes:

Front Slope (degrees)	**horizontal**
Back Slope (degrees)	**horizontal**

Uniformly Distributed Surcharges:

Live Load Surcharge	**none**
Dead Load Surcharge	**none**

Soil Data:	*Soil Description:*	*Cohesion (psf)*	*Friction Angle (degrees)*	*Unit Weight (pcf)*
Reinforced Soil	**Gravel**	N/A	**32.0**	**120.0**
Retained Soil	**Sand**	N/A	**32.0**	**120.0**
Levelling Pad Soil	**Crushed Stone**	N/A	**40.0**	**125.0**
Foundation Soil	**Sand**	0.0	**32.0**	**120.0**

Segmental Unit Name:

Segmental Unit Data:

Cap Height (in)	**4.0**
Unit Height (Hu)(in)	**6.0**
Unit Width (Wu)(in)	**12.0**
Unit Length (in)	**18.0**
Setback (in)	**1.0**
Weight (infilled) (lbs)	**120.0**
Unit Weight (infilled) (pcf)	**160.0**
Center of Gravity (in)	**6.0**

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Segmental Unit Interface Shear Data:

Properties	*Ultimate Strength Criteria*	*Service State Criteria*
Minimum (lbs/ft)	**500.0**	500.0
Friction Angle (degrees)	**45.0**	45.0
Maximum (lbs/ft)	**2000.0**	2000.0

Geosynthetic Reinforcement Types and Number:

Type	*Number*	*Name*
1	**6**	**SF35**
2	**0**	**SF55**
3	**0**	**PP geosynthetic**

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Geosynthetics Properties:			
Strength and Polymer Type:	Type 1	Type 2	Type 3
Ultimate Strength (lbs/ft)	3055.0	4200.0	5300.0
Polymer Type	polyester	polyester	HDPE or PP

Reduction Factors:	Type 1	Type 2	Type 3
Creep (=1.00 for seismic analysis)	1.00	1.00	1.00
Durability	1.10	1.10	2.00
Installation Damage	1.05	1.05	3.00
Overall Factor of Safety	1.50	1.50	1.50

(Dynamic) Allowable Strength:	Type 1	Type 2	Type 3
Ta (lbs/ft)	1763.35	2424.24	588.89

Coefficient of Interaction:	Type 1	Type 2	Type 3
Ci	0.7	0.7	0.7

Coefficient of Direct Sliding:	Type 1	Type 2	Type 3
Cds	0.95	0.95	0.95

Connection Strength:	Type 1	Type 2	Type 3
Ultimate Strength Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0
Service State Criterion:			
Minimum (lbs/ft)	1233.3	875.0	1766.7
Friction Angle (degrees)	22.0	22.0	22.0
Maximum (lbs/ft)	1850.0	1312.5	2650.0

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Geosynthetic Segmental Retaining Wall Unit Interface Shear Strength:	Type 1	Type 2	Type 3
Ultimate Strength Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0
Service State Criterion:			
Minimum (lbs/ft)	500.0	500.0	500.0
Friction Angle (degrees)	45.0	45.0	45.0
Maximum (lbs/ft)	2000.0	2000.0	2000.0

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Coefficients of Earth Pressure and Failure Plane Orientations:

Seismic Coefficent (k(int))	0.135
Seismic Coefficent (k(ext))	0.05
Reinforced Soil (static) (Ka)	0.213
Reinforced Soil (static) (Ka horizontal component)	0.208
Reinforced Soil (static + dynamic) (Kae)	0.298
Reinforced Soil (static + dynamic) (Kaeh horizontal component)	0.292
Orientation of failure plane from horizontal (degrees)	53.54
Retained Soil (static) (Ka)	0.21
Retained Soil (static) (Kah horizontal component)	0.194
Retained Soil (static + dynamic) (Kae)	0.241
Retained Soil (static + dynamic) (Kaeh horizontal component)	0.222
Orientation of failure plane from horizontal (degrees)	50.07

Results of External Stability (Seismic) Analyses:

	Calculated	Design Criteria
FOS Sliding	3.62	1.5 OK
FOS Overturning	6.32	1.5 OK
FOS Bearing Capacity	12.89	2.0 OK
Base Reinforcement Length (L) (ft)	5.0	4.2 OK
Base Eccentricity (e)(ft)	0.04	N/A
Base Eccentricity Ratio (e/L-2e)	0.01	N/A
Base Reinforcement Ratio (L/H)	0.71	0.6 OK

Note: calculated values MEET ALL design criteria

Detailed Results of External Stability Analyses: Calculated Values:

Total Horizontal Force (lbs/ft)	773.4
Total Vertical Force (lbs/ft)	4480.0
Sliding Resistance (lbs/ft)	2799.4
Driving Moment (lbs-ft/ft)	2068.5
Resisting Moment (lbs-ft/ft)	13080.7
Bearing Capacity (psf)	11716.6
Maximum Bearing Pressure (psf)	908.9

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Results of Internal Stability (Seismic) Analyses:

SRW Unit #	Geosyn Type	Elev (ft)	Length (ft)	Anchor Length (ft) > 1.0	FOS Over-stress > 1.0	FOS Pullout > 1.1	FOS Sliding > 1.5	Layer Spacing (ft) < 3.0
13	1	6.0	8.0	3.57	12.78	2.71	21.73	OK
11	1	5.0	5.0	1.14	15.23	2.07	12.72	OK
9	1	4.0	5.0	1.71	13.09	4.0	9.29	OK
7	1	3.0	5.0	2.28	11.47	6.24	7.4	OK
5	1	2.0	5.0	2.86	10.21	8.68	6.18	OK
3	1	1.0	5.0	3.43	5.98	7.33	5.32	OK

Note: calculated values MEET ALL design criteria

Note: Seismic analysis may not give the lowest factors of safety for FOS against reinforcement over-stress in internal stability calculations. Be sure to check current design using static analysis option.

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Detailed Results of Internal Stability Analyses:

SRW Unit #	Geosyn Type	Elev (ft)	Allowable Strength (lbs/ft)	Tensile Load (lbs/ft)	Pullout Capacity (lbs/ft)	Sliding Force (lbs/ft)	Sliding Capacity (lbs/ft)
13	1	6.0	1763.3	138.0	374.4	43.5	944.9
11	1	5.0	1763.3	115.8	239.2	109.3	1389.9
9	1	4.0	1763.3	134.7	538.9	197.5	1834.8
7	1	3.0	1763.3	153.7	958.9	307.9	2279.8
5	1	2.0	1763.3	172.7	1498.9	440.7	2724.7
3	1	1.0	1763.3	294.7	2159.1	595.9	3169.6

Results of Facing Stability (Seismic) Analyses:

SRW Unit #	Heel Elev (ft)	Geosynthetic Type	FOS Over-turning > 1.5	FOS Shear (peak) > 1.5	Shear (deformation) < 0.02 x Hu	FOS Connection (peak) > 1.5	Connection (deformation) < 0.75 in
14	6.5	none	3.95	14.06	OK	-	-
13	6.0	1	2.06	7.56	OK	9.4	OK
12	5.5	none	8.04	-	-	-	-
11	5.0	1	8.28	14.77	OK	11.77	OK
10	4.5	none	9.9	-	-	-	-
9	4.0	1	9.87	15.08	OK	10.59	OK
8	3.5	none	10.49	-	-	-	-
7	3.0	1	10.37	15.3	OK	9.7	OK
6	2.5	none	10.63	-	-	-	-
5	2.0	1	10.47	15.48	OK	9.01	OK
4	1.5	none	10.57	-	-	-	-
3	1.0	1	10.41	15.62	OK	5.5	OK
2	0.5	none	10.37	-	-	-	-
1	0.0	none	10.18	-	-	-	-

Note: calculated values MEET ALL design criteria

Detailed Results of Facing Stability Analyses (Moment and Shear):

SRW Unit #	Heel Elev (ft)	Geo Type	Drive Moment (lbs-ft/ft)	Resist Moment (lbs-ft/ft)	Shear Load (lbs/ft) +out -in	Shear Capacity (lbs/ft) (peak)	Shear Capacity (lbs/ft) (deformation)
14	6.5	none	10.1	40.0	41.3	580.0	580.0
13	6.0	1	42.1	86.7	87.3	660.0	660.0
12	5.5	none	98.2	789.0	0.0	740.0	740.0
11	5.0	1	180.9	1498.0	55.5	820.0	820.0
10	4.5	none	292.5	2894.9	0.0	900.0	900.0
9	4.0	1	435.4	4298.6	65.0	980.0	980.0
8	3.5	none	612.1	6422.5	0.0	1060.0	1060.0
7	3.0	1	824.7	8553.1	74.5	1140.0	1140.0
6	2.5	none	1075.9	11436.3	0.0	1220.0	1220.0
5	2.0	1	1367.8	14326.2	84.0	1300.0	1300.0
4	1.5	none	1702.9	18001.0	0.0	1380.0	1380.0
3	1.0	1	2083.6	21682.5	93.5	1460.0	1460.0
2	0.5	none	2512.2	26061.3	-103.0	1460.0	1460.0
1	0.0	none	2991.1	30440.1	0.0	1460.0	1460.0

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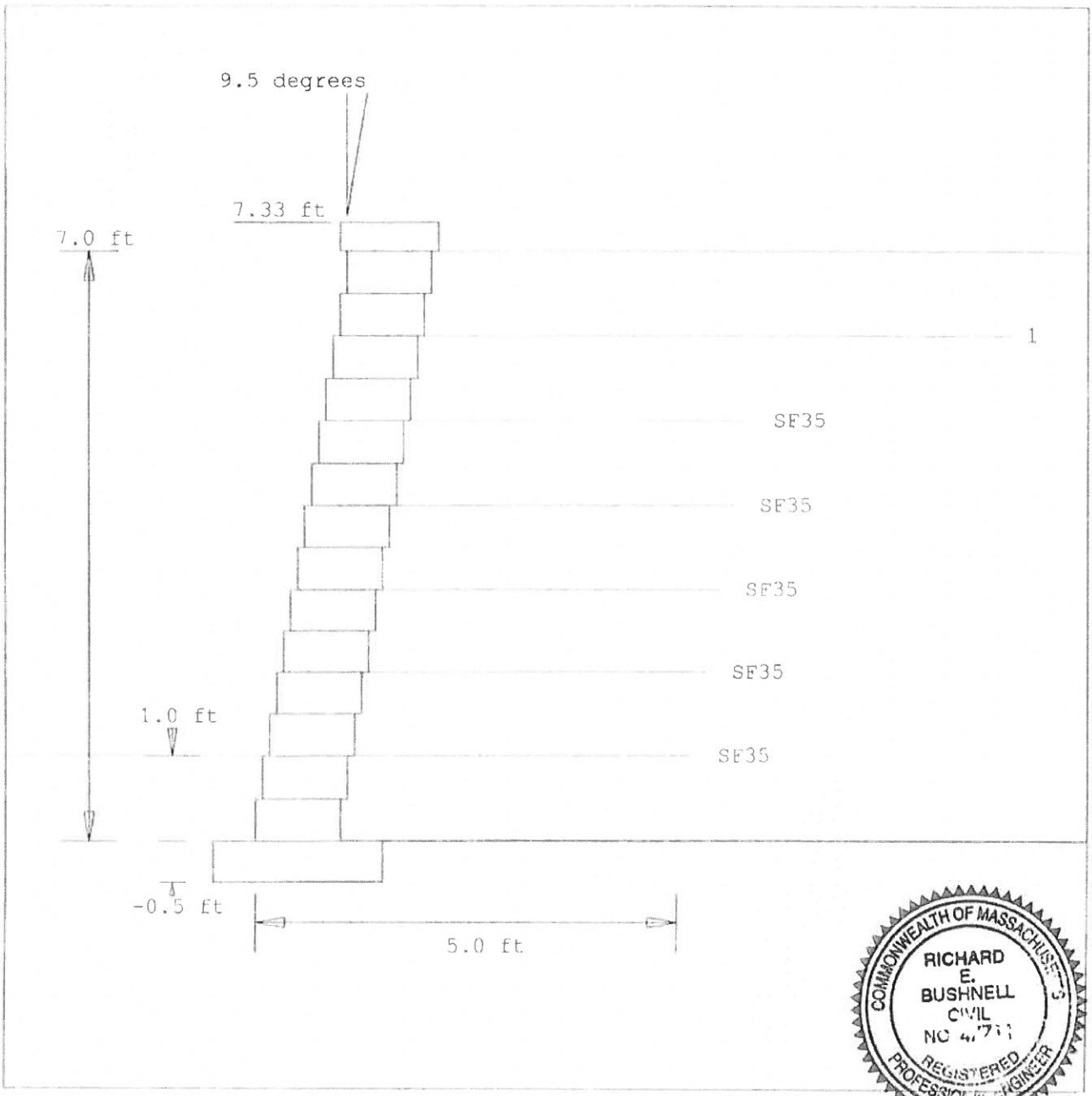
Detailed Results of Facing Stability Analyses (Connections):

SRW Unit #	Heel Elev (ft)	Geo Type	Connection Load (lbs/ft)	Connection Capacity (peak) (lbs/ft)	Connection Capacity (deformation) (lbs/ft)
13	6.0	1	138.0	1298.0	1298.0
11	5.0	1	115.8	1362.6	1362.6
9	4.0	1	134.7	1427.3	1427.3
7	3.0	1	153.7	1491.9	1491.9
5	2.0	1	172.7	1556.6	1556.6
3	1.0	1	294.7	1621.2	1621.2



Project Identification:

Project
Name: **Amesbury Heights**
Section: **Abuts Bldg #3**
Data Sheet:

Owner:
Client:

Prepared by: **R & M Engineering Consultants**
Date:
Time:

Data file: **c:\program files (x86)\srwall32\amesbury heights.abuts bldg 3**