South Flanker
c. 1738

Portico Repair, Structural Evaluation and Visitorship Studies at Drayton Hall, Charleston

SC Preservation Conference, Columbia
Thursday, April 23, 2015

Craig M. Bennett, Jr., PE and the whole team at…

Bennett PRESERVATION ENGINEERING PC

West Portico

2009 – 2013 Structural Evaluation

2015 Repair

Main House

2015 Structural Evaluation and Visitorship Study

Drayton Hall's Philosophy

- Site is not restored to a particular period
- Drayton Hall is maintained as received from the Drayton family in 1974

Drayton Hall's Philosophy

- Mission: Research, preserve and interpret Drayton Hall in order to educate the public and to inspire people to embrace historic preservation.

History of Drayton Hall

- 1740-1752 Construction as the first fully executed example of Palladian architecture in America
- Mid 1800s Portico changes
- 1930s Portico floor replacements
- 1974 Transfer from the Draytons to the National Trust

West Portico

2009 – 2013 Structural Evaluation

2015 Repair

Concerns

- Damage to brick and deteriorating concrete on the first floor
- Water intrusion on the second floor
- Structural movement

Process through which we go

- Collaborative effort by a multidisciplinary team: civil engineers, surveyors, architects, conservators, other consulting engineers, historians and most importantly, Drayton Hall Staff.

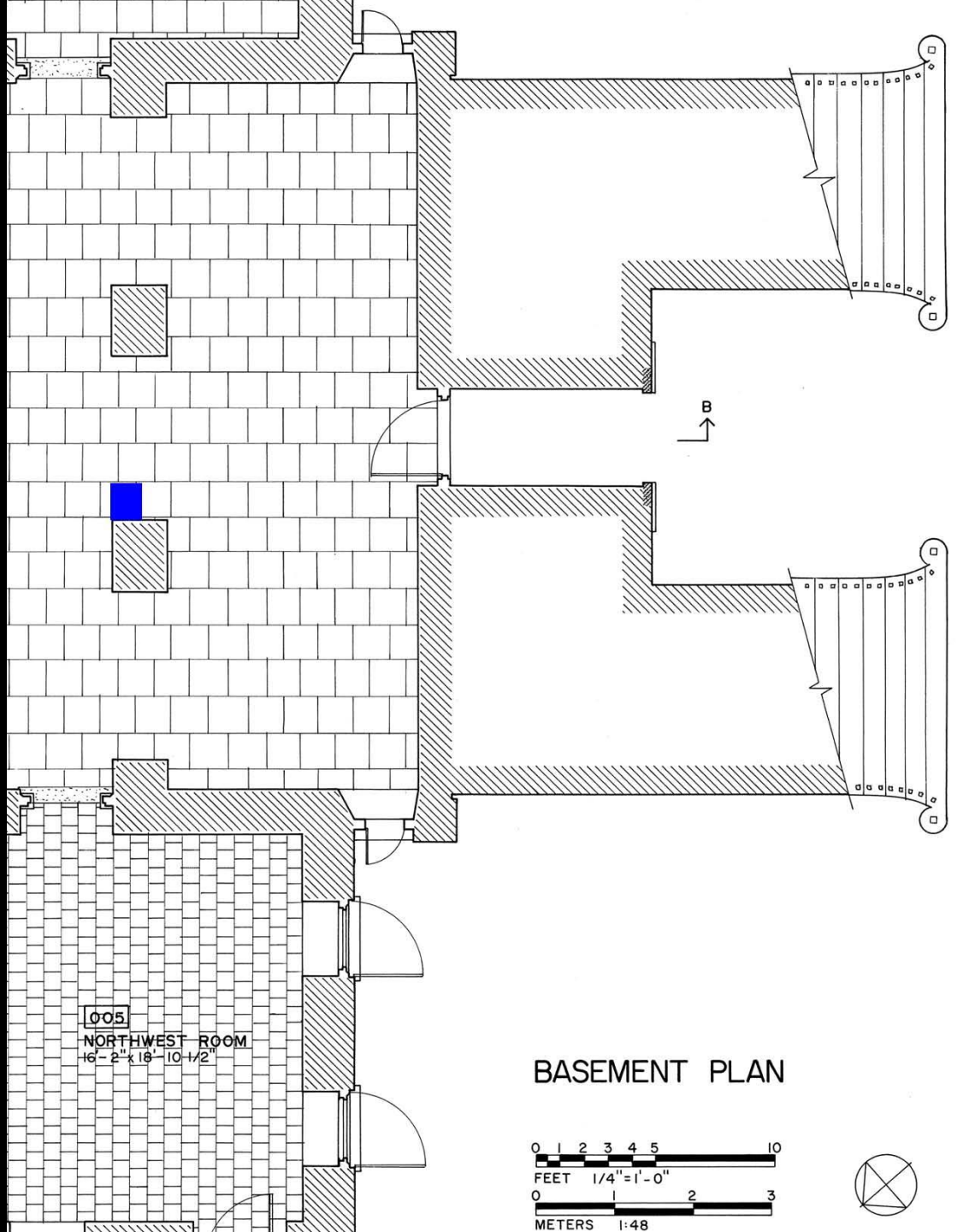
- Consideration of Drayton Hall's philosophy

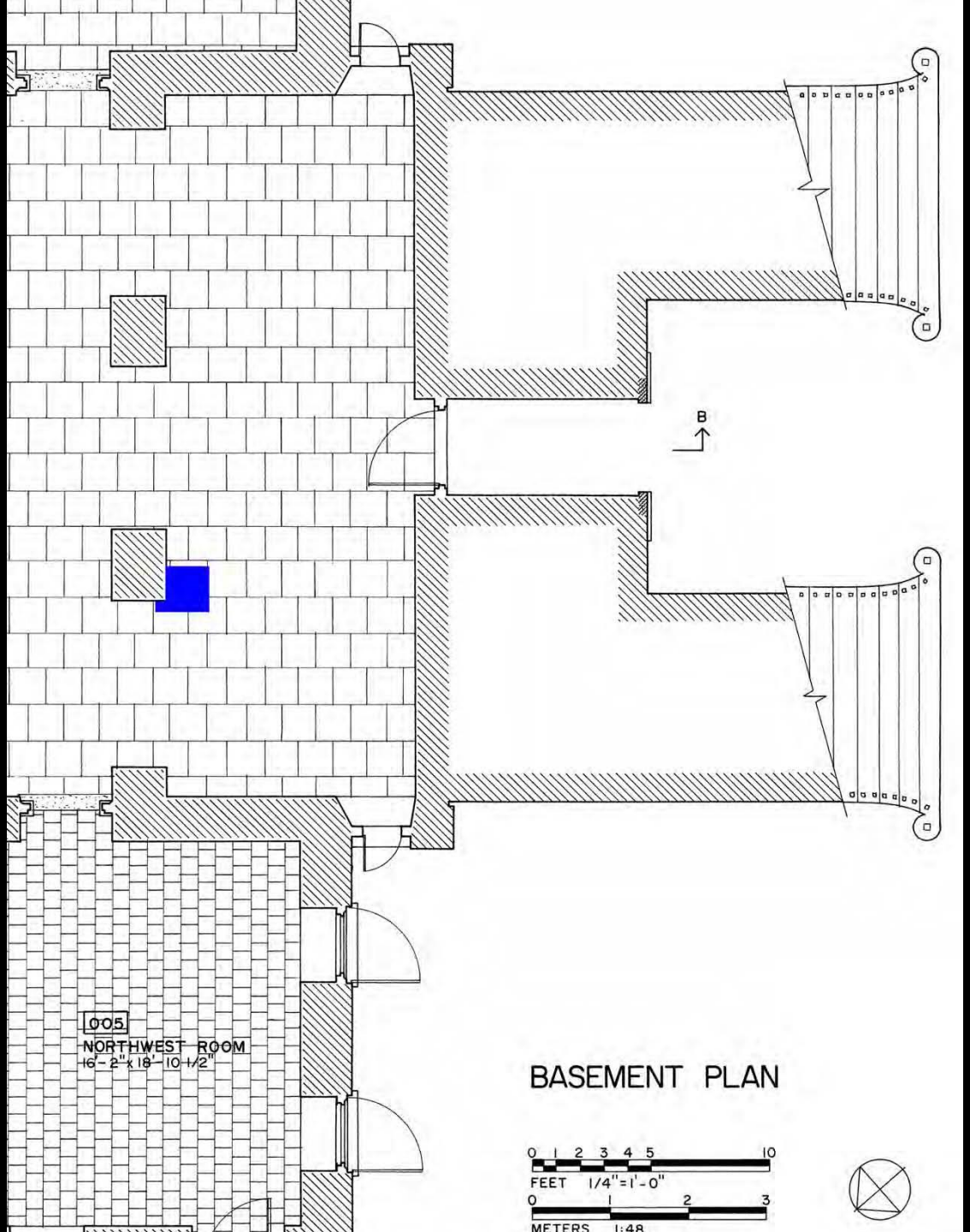
- Findings
- Conclusions
- Discussion of Recommendations

Findings

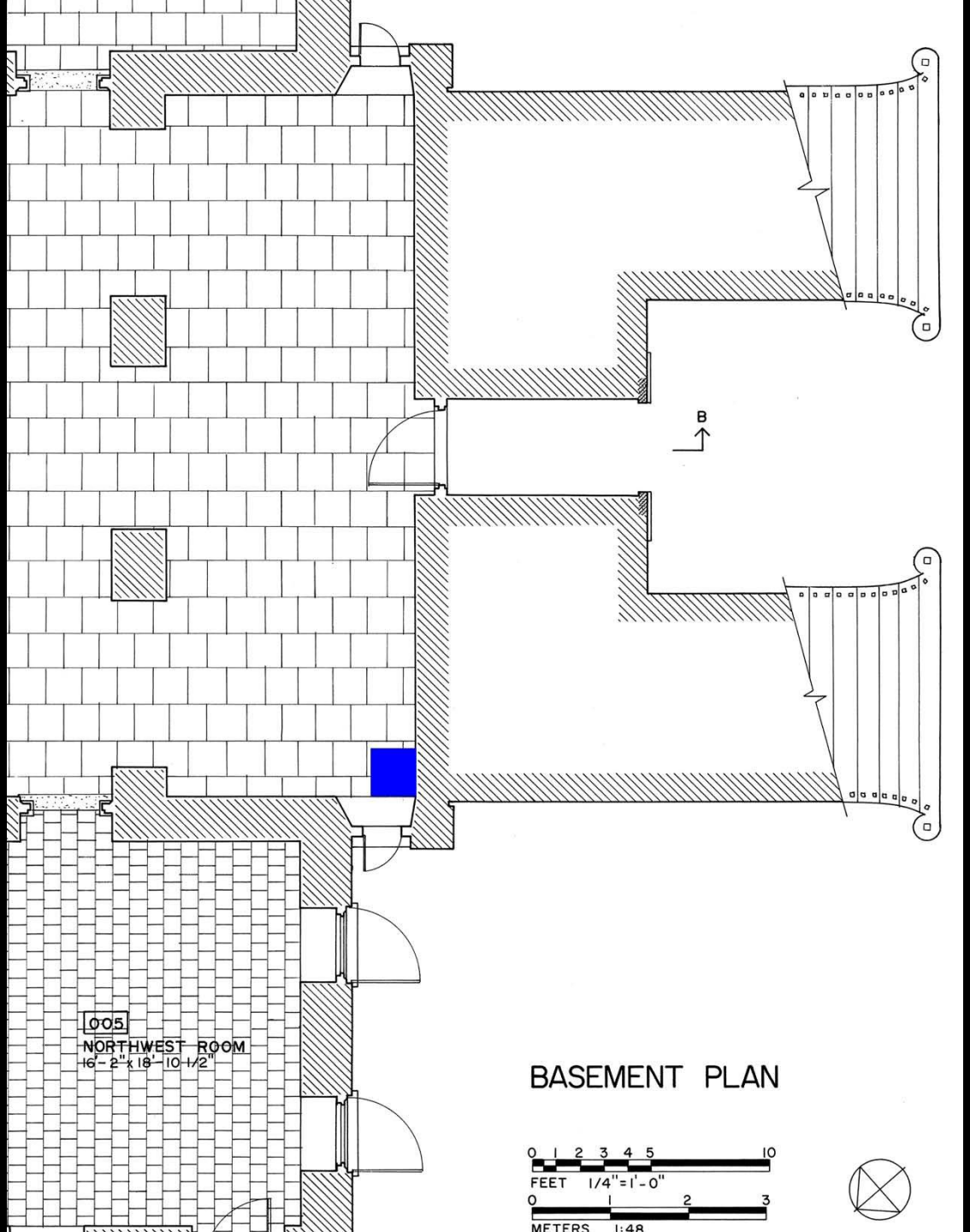
Foundations

- Test pits/excavations
- Revealed only a small step out



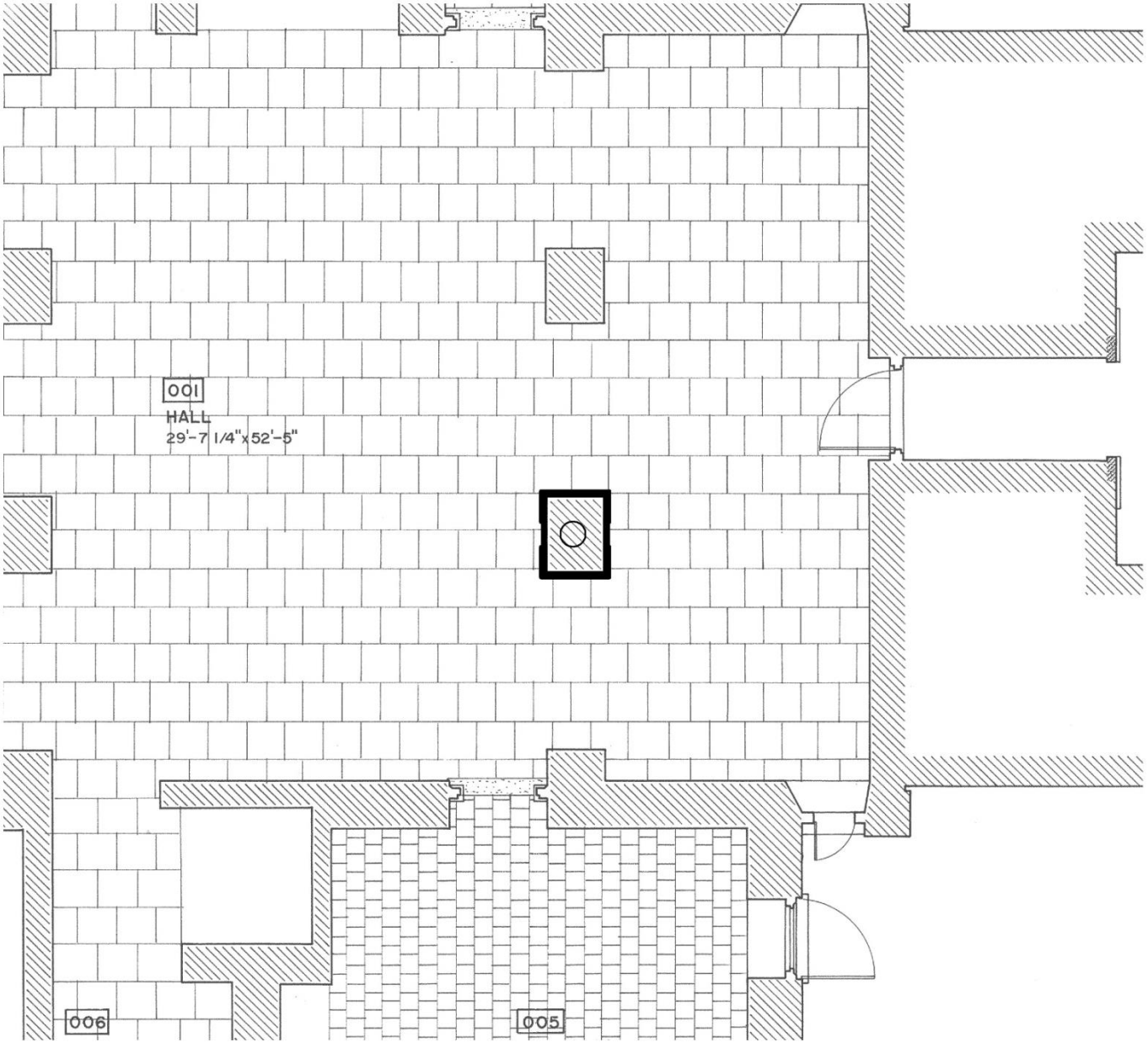


BASEMENT PLAN



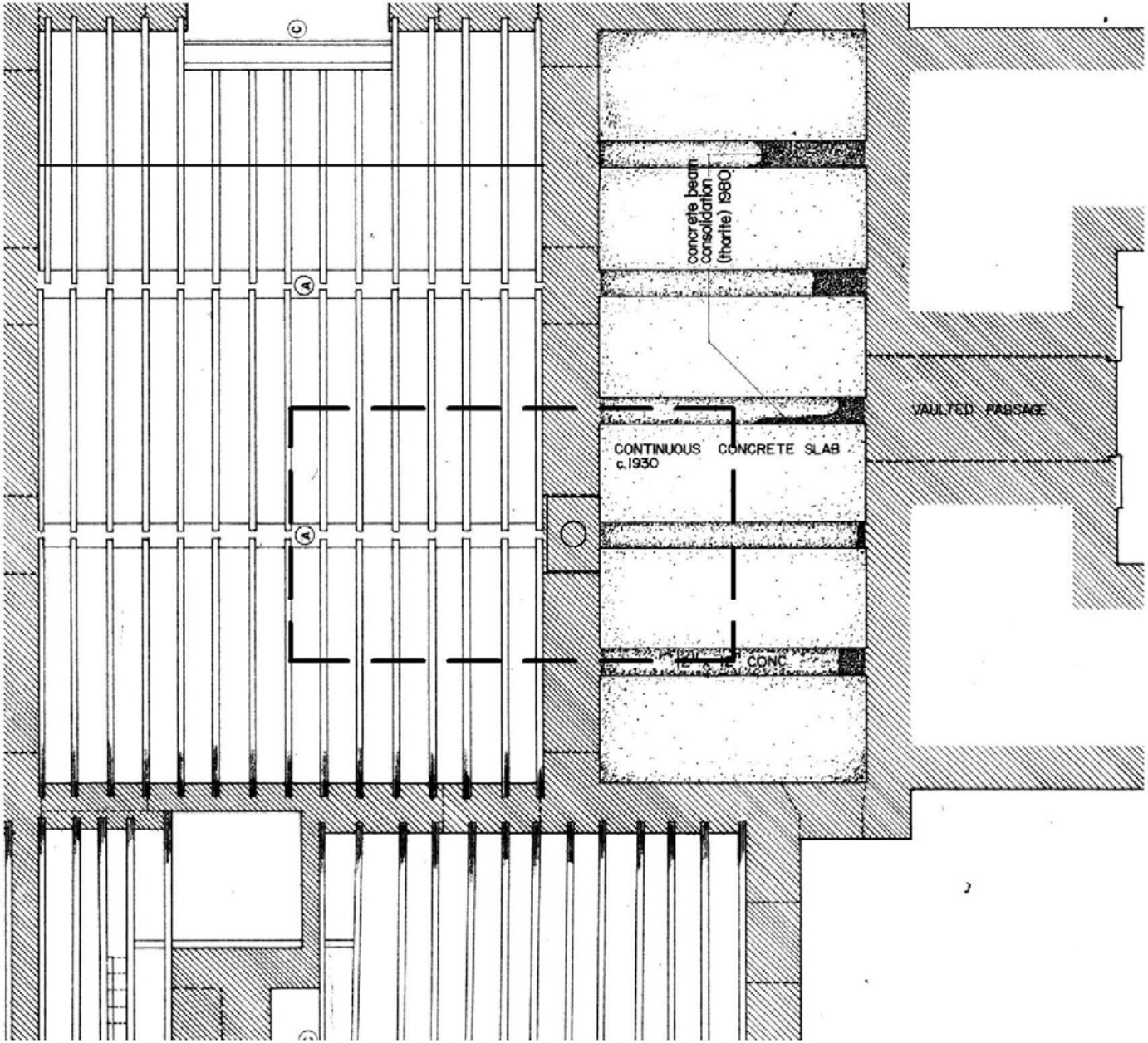
BASEMENT PLAN

Soil Stresses - Calculations



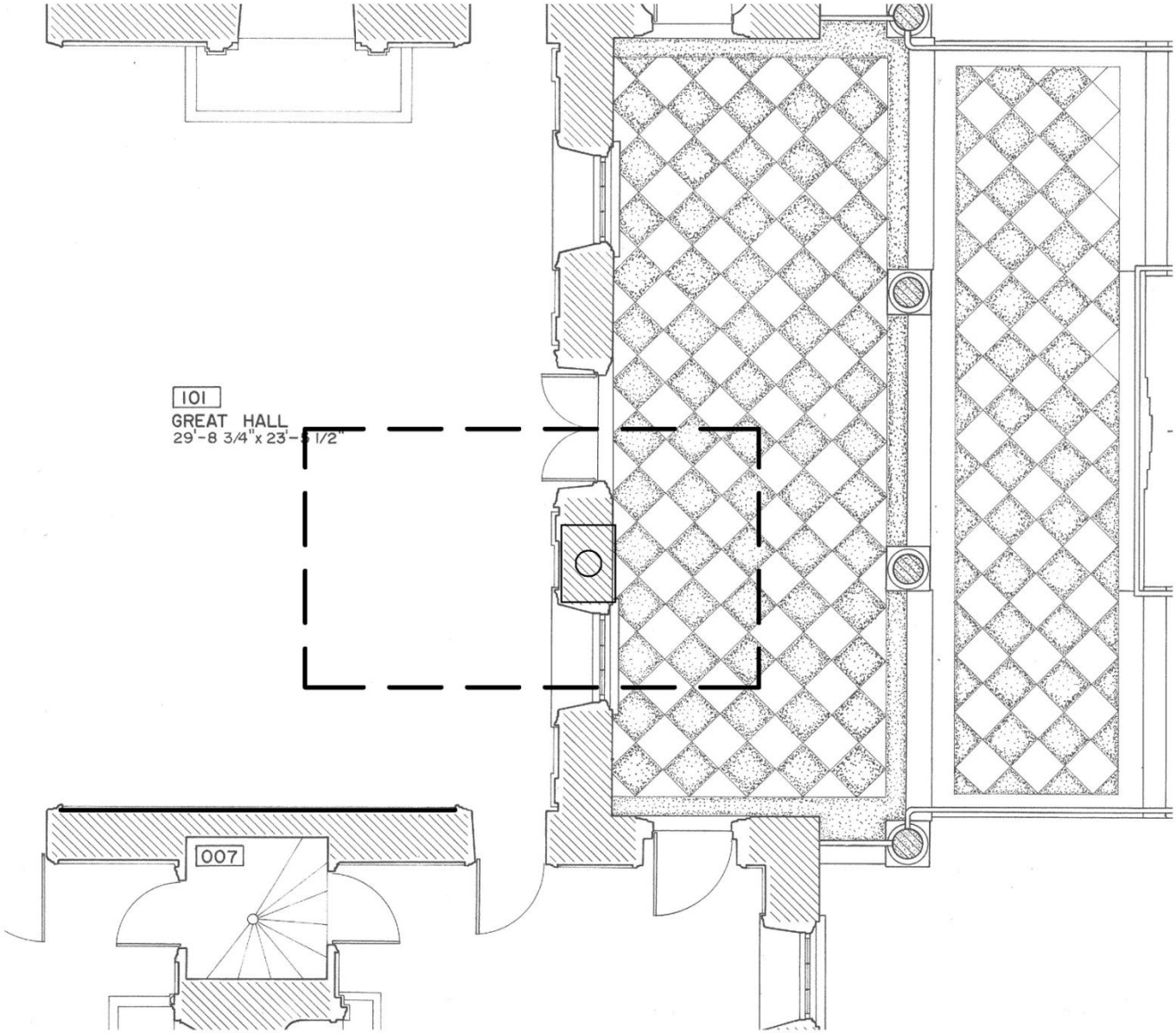
BASEMENT PLAN

1/8" = 1'-0"



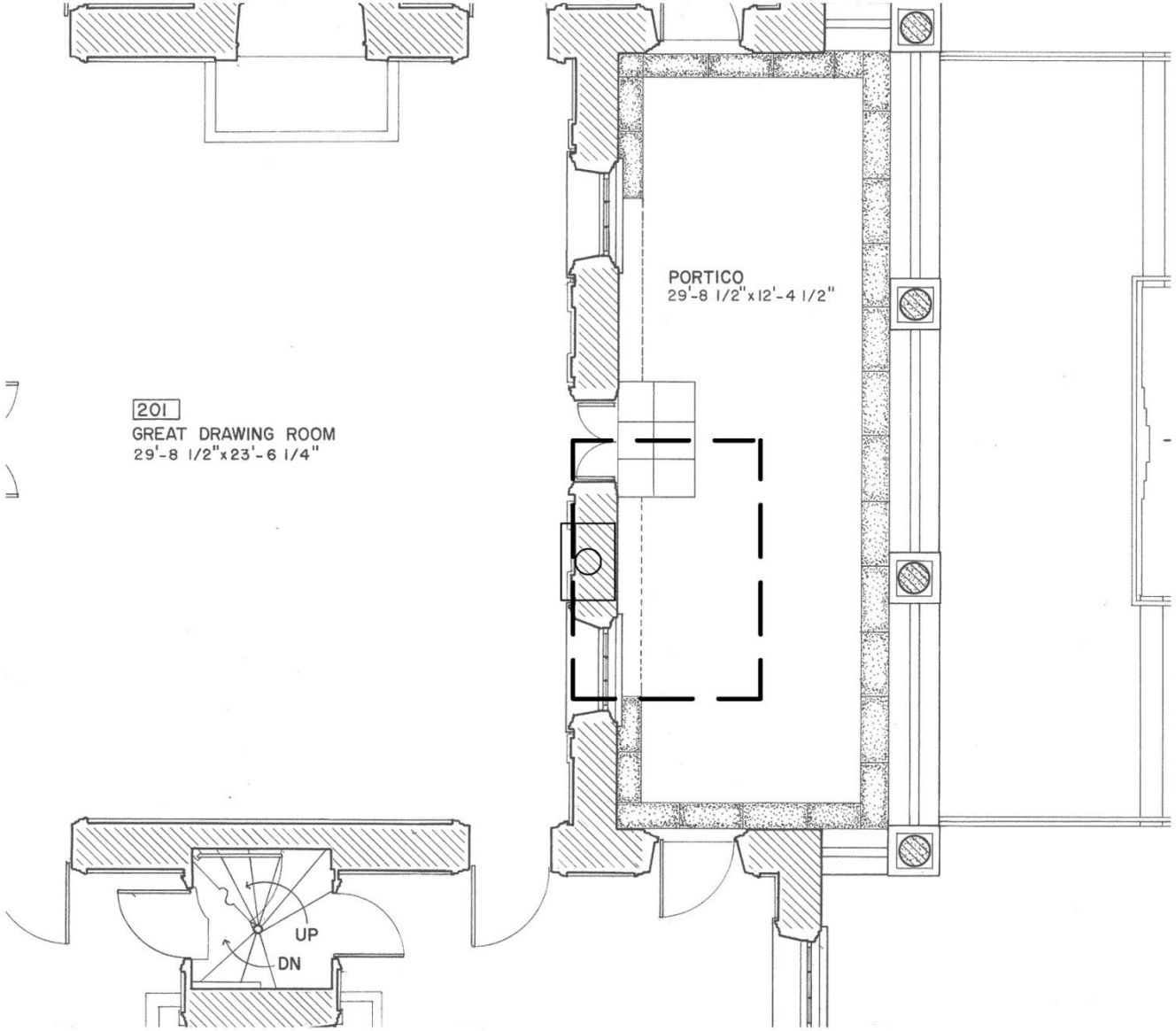
FIRST FLOOR FRAMING PLAN

1/8" = 1'-0"



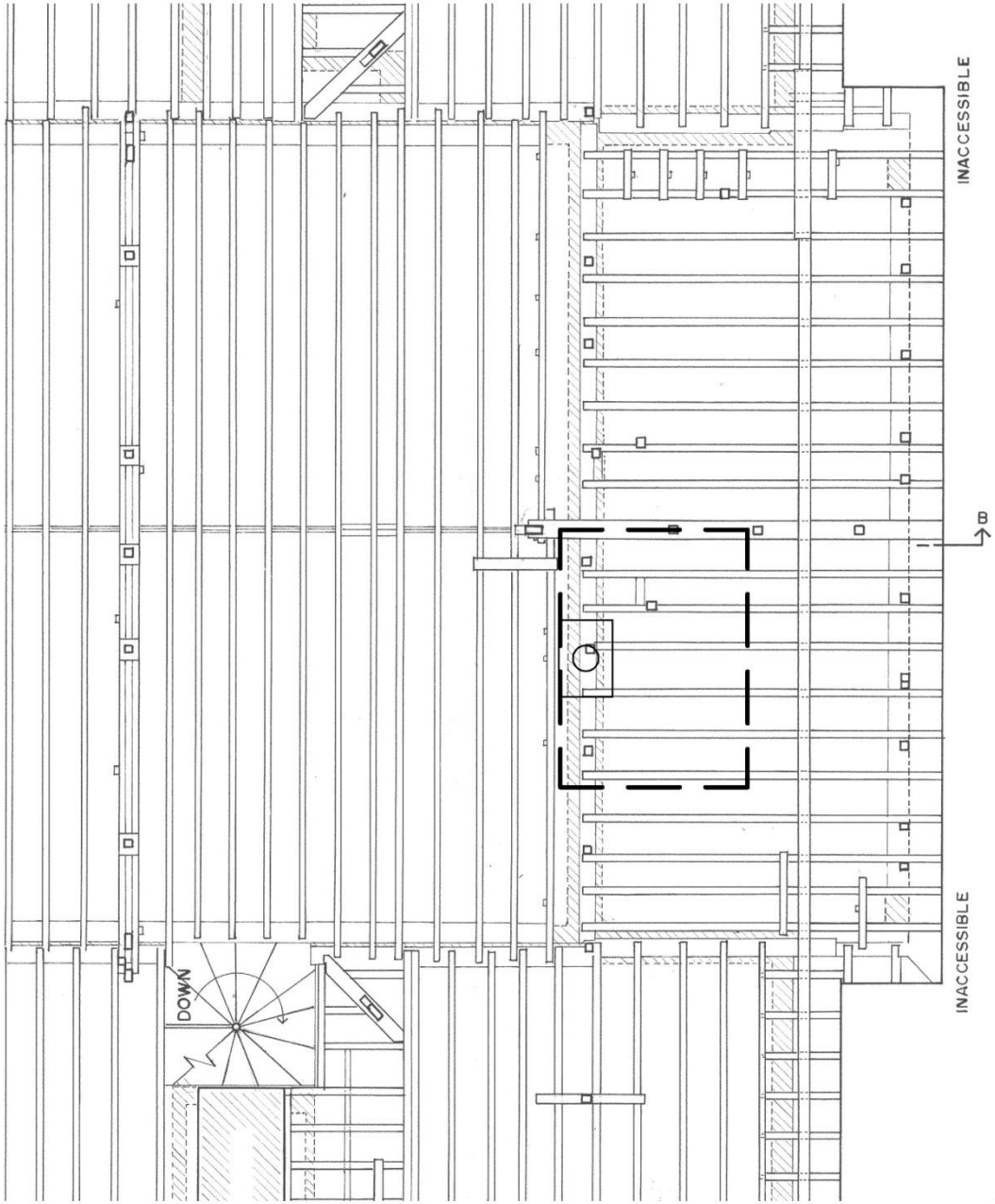
FIRST FLOOR PLAN

1/8" = 1'-0"



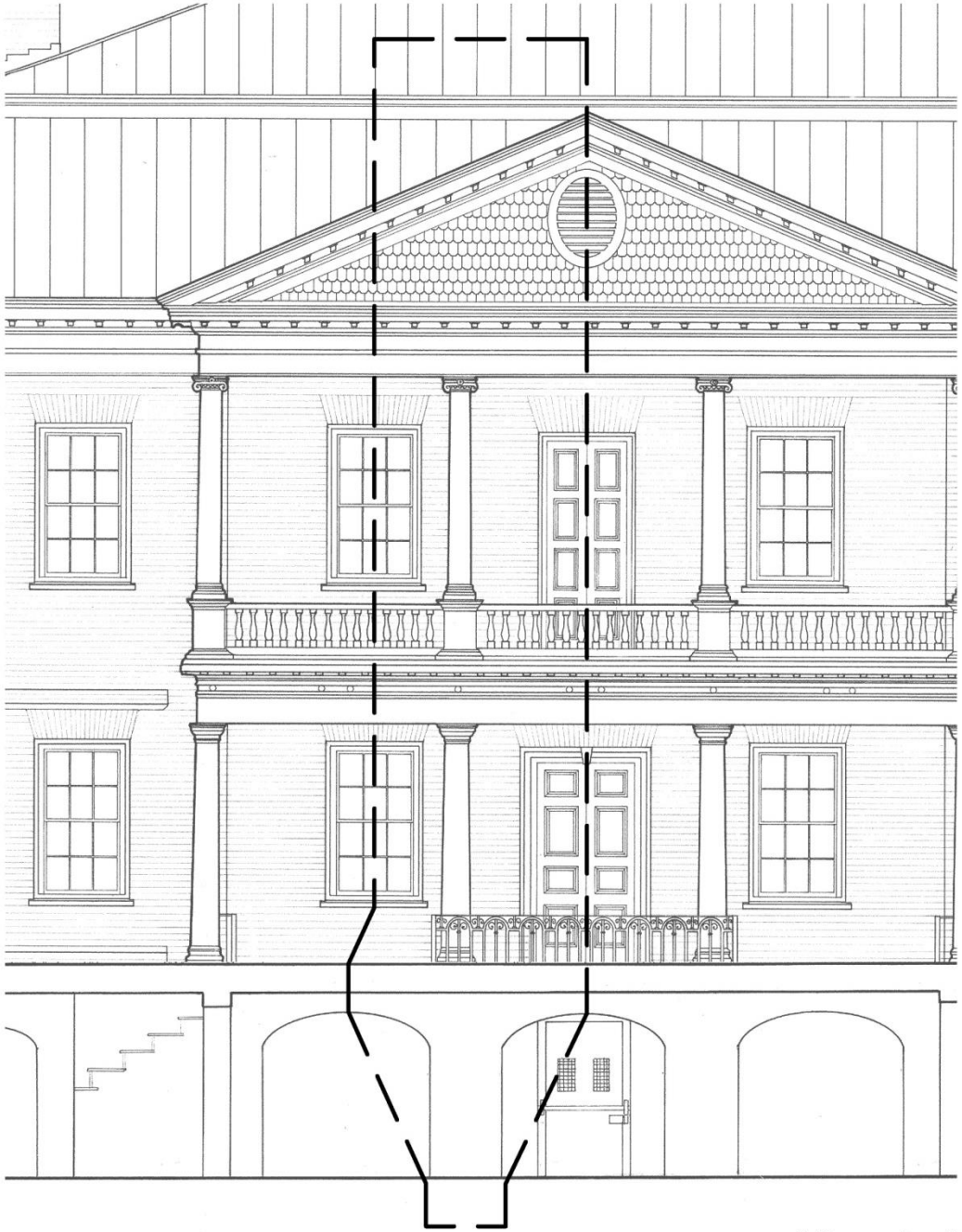
SECOND FLOOR PLAN

1/8" = 1'-0"



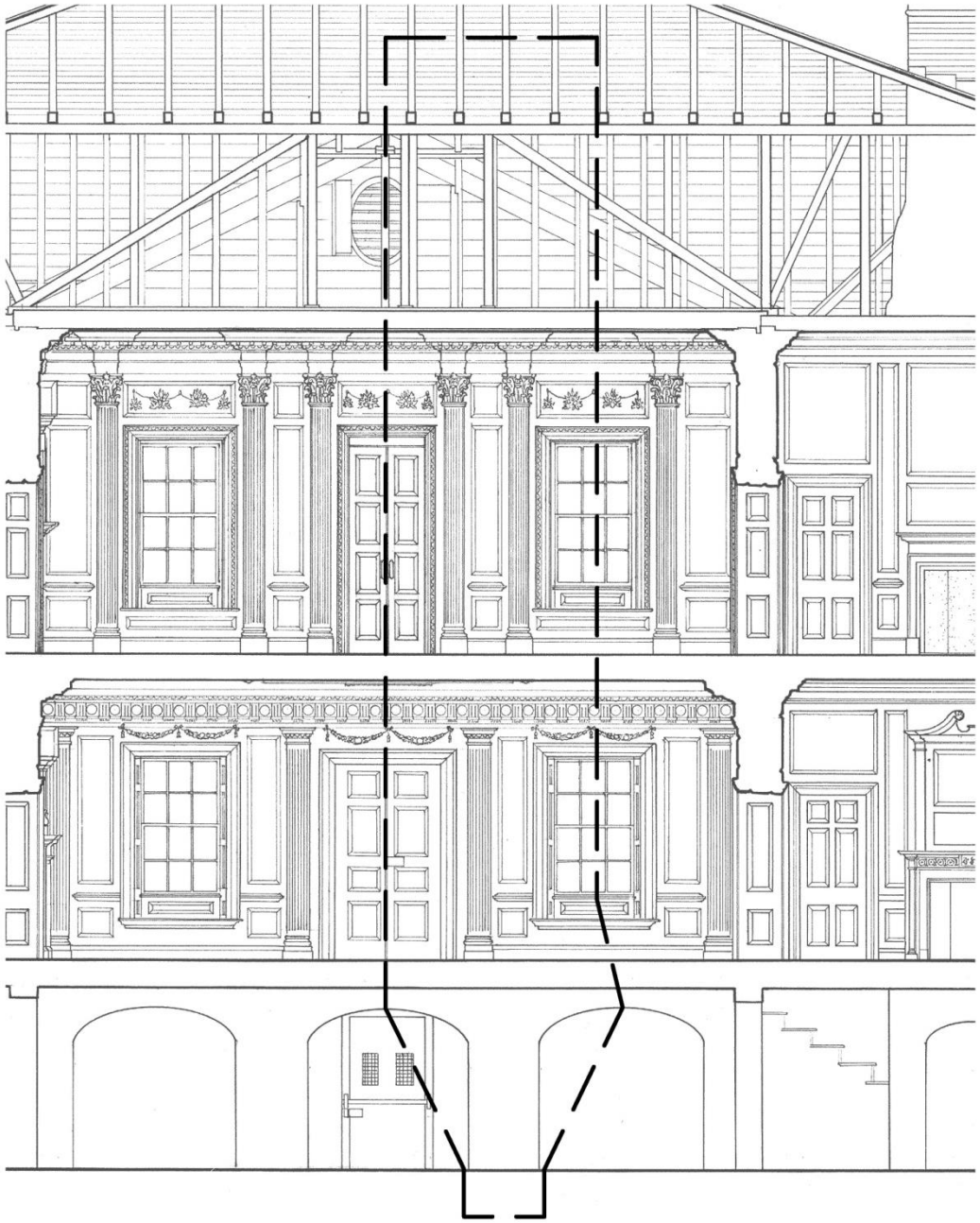
ATTIC FRAMING PLAN

1/8" = 1'-0"



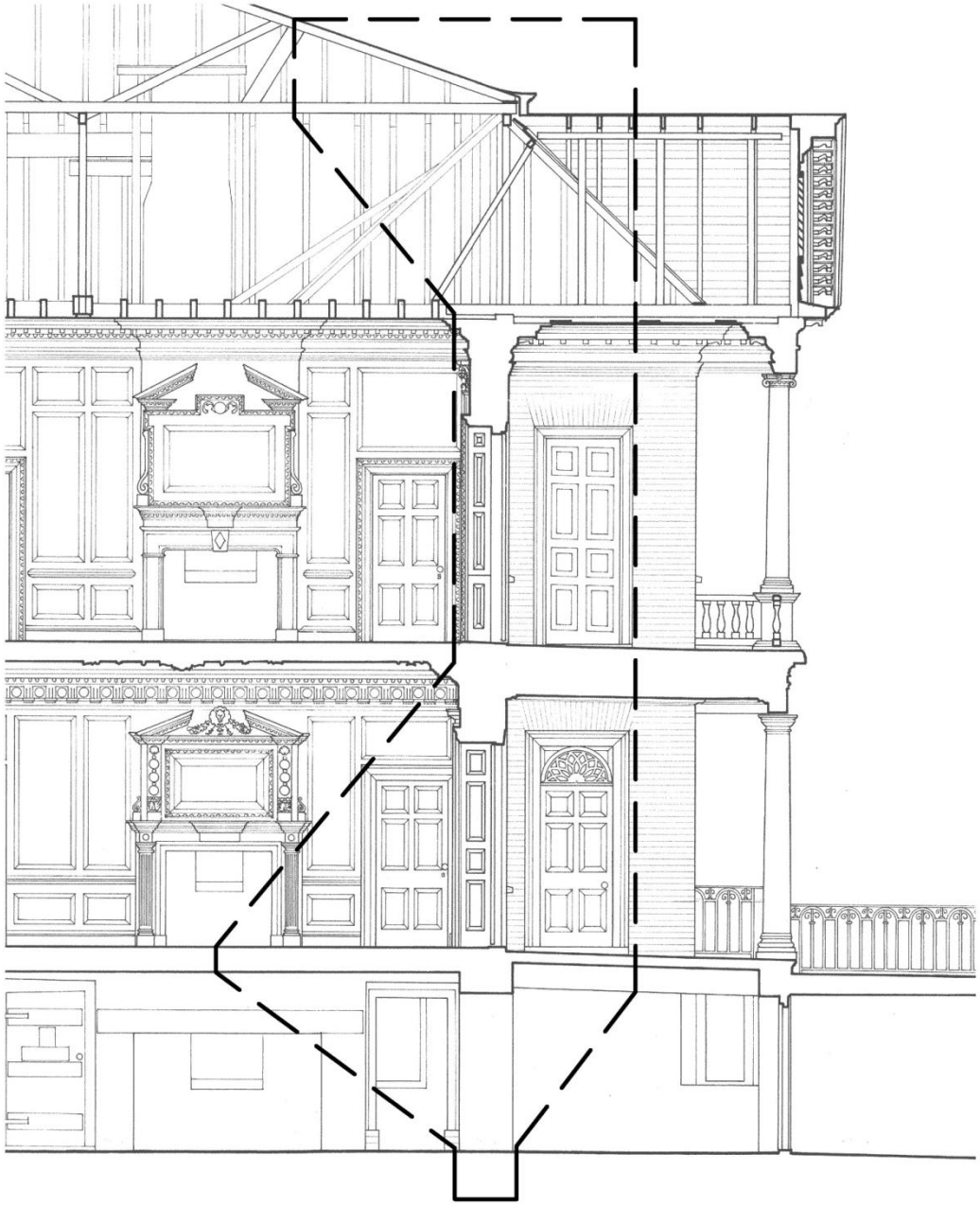
WEST ELEVATION

1/8" = 1'-0"



LONGITUDINAL SECTION

1/8" = 1'-0"



TRANSVERSE SECTION

1/8" = 1'–0"

Drayton Hall - West (landside) Portico									
CMBJr / 4SEinc									
Fri May 18, 2012									
West Portico - Back Pier									
Loads based on square footages									
			trib	trib		wt/sqft	dead	live	total
			width	length			load	load	load
			ft	ft		psf	lbs	lbs	lbs
	Roof								
		Live load - east of wall	10	8.5		20		1700	1700
		Live load - west of wall	10	6.5		20		1300	1300
		Membrane	10	15		1	150		150
		Sheathing	10	15		2	300		300
		Framing	10	15		4	600		600

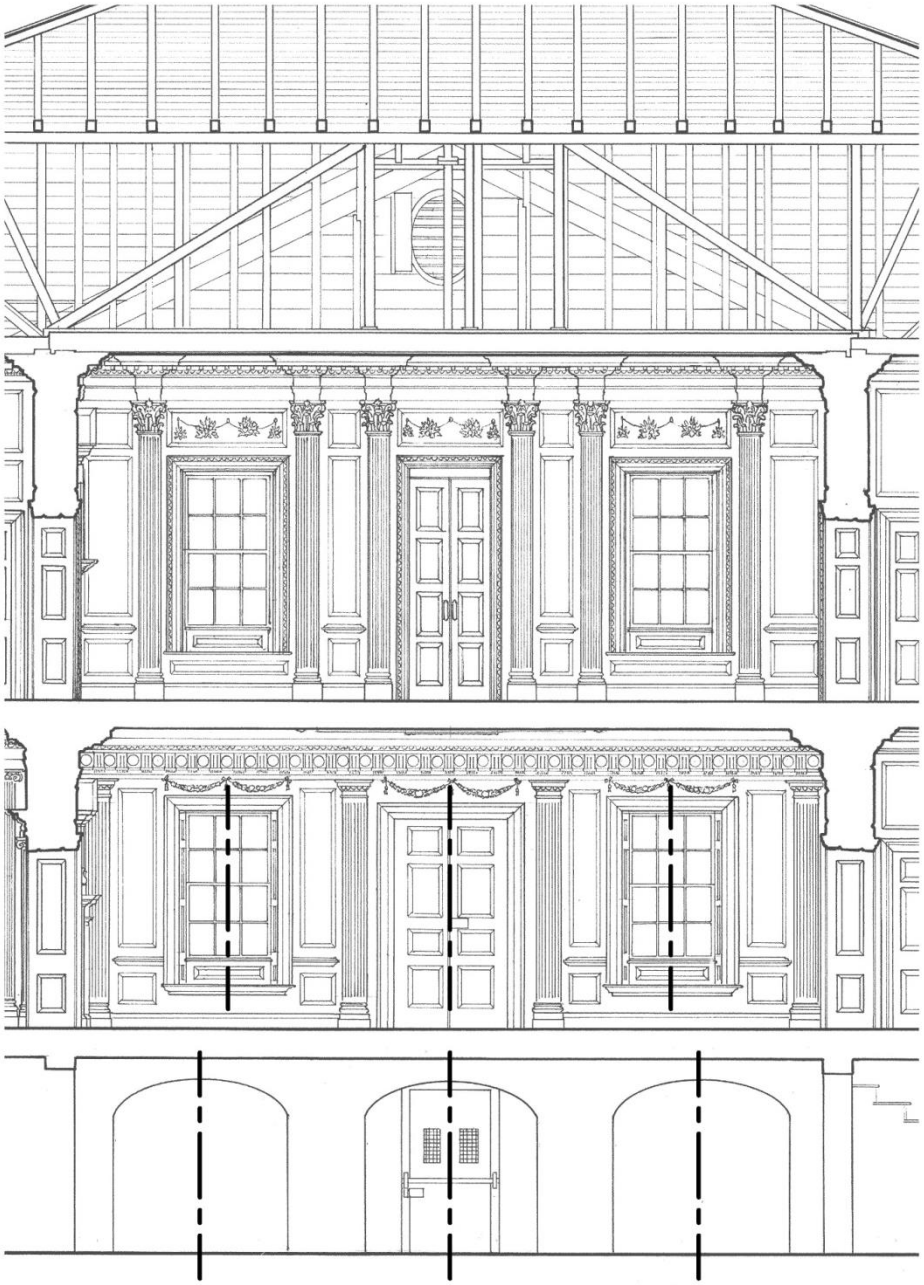
	Second floor								
		Live load - interior	10	2		80		1600	1600
		Live load - exterior	10	6.5		80		5200	5200
		Wooden ceiling - interior	10	2		3	60		60
		Wooden ceiling - exterior	10	6.5		3	195		195
		Floor - interior	10	2		3	60		60
		Floor - Exterior	10	6.5		36	2340		2340
		Floor framing - interior	10	2		4	80		80
		Floor framing - exterior	10	6.5		6	390		390
	First floor								
		Live load - interior	10	11		80		8800	8800
		Live load - exterior	10	6.5		80		5200	5200
		Plaster ceiling - interior	10	2		15	300		300
		Wooden ceiling - exterior	10	6.5		3	195		195
		Floor - interior	10	11		3	330		330
		Floor - Exterior	10	6.5		36	2340		2340
		Floor framing - interior	10	11		6	660		660
		Floor framing - exterior	10	6.5		84	5460		5460

			trib	trib	thickn	unit wt	dead		total
			width	height			load		load
			ft	ft	ft	pcf	lbs		lbs
		Second floor	9	5	1.5	100	6750		6750
			5	7	1.5	100	5250		5250
			7	3	1.5	100	3150		3150
		First floor	9	3.5	1.67	100	5261		5261
			4.5	7	1.67	100	5261		5261
			7	2.5	1.67	100	2923		2923
		Ground floor	10	3	2.25	100	6750		6750
			3	8	2.25	100	5400		5400
Total loads									
							dead	live	total
							load	load	load
							lbs	lbs	lbs
							54,204	23,800	78,004

Bearing stress									
		Column width n-s						approx	40
		Column depth e-w						approx	31
		Bearing area on soil							8.61
		Bearing stress (fa=P/A)					6,295	2,764	9,058
							psf	psf	psf

Basement and First Floor Framing

- Centerline of arches and masonry openings above do not line up
- Geometry of the arches – flat arches
- Concrete beam locations inappropriate
- Concrete reinforcing deterioration

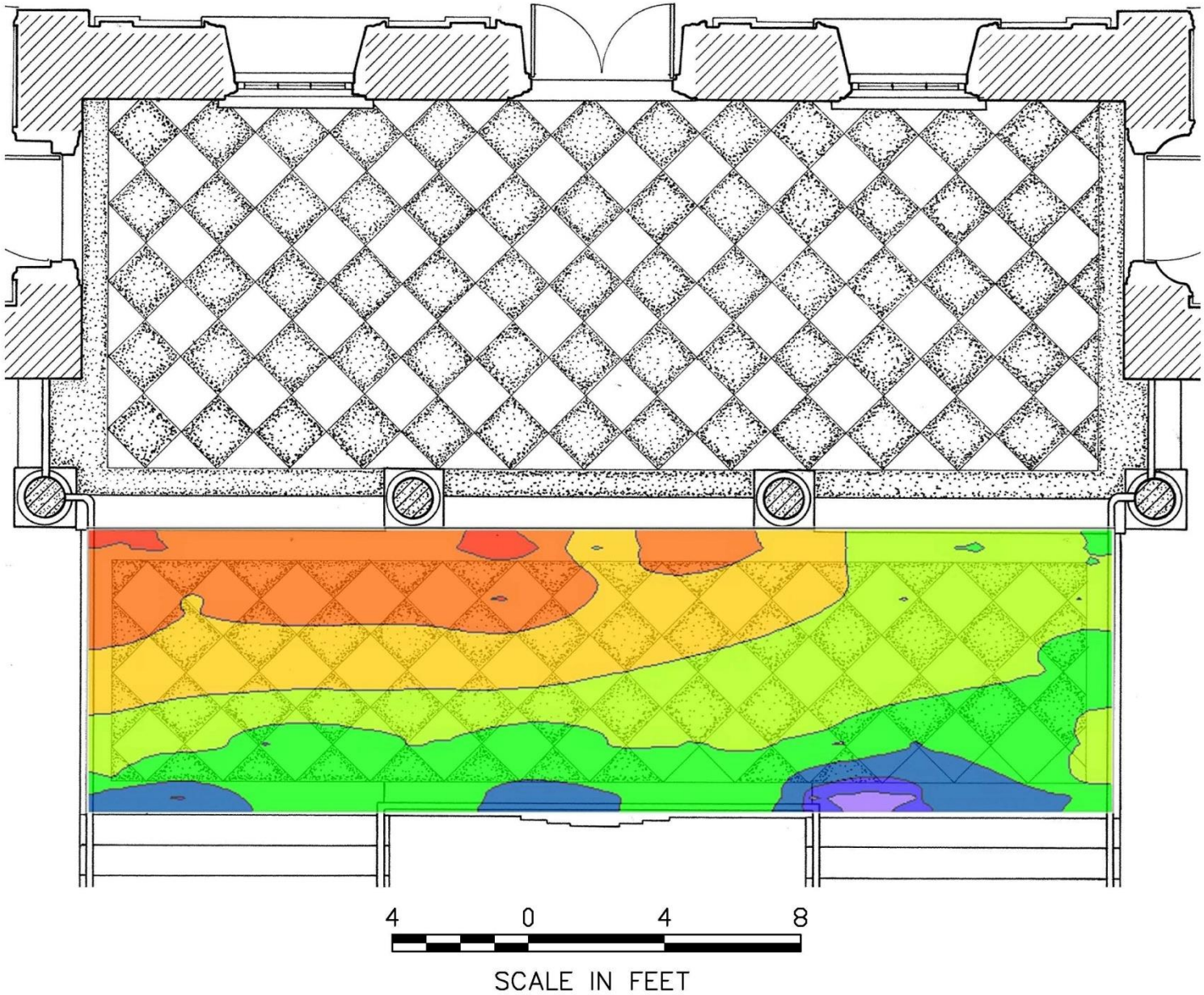


LONGITUDINAL SECTION

1/8" = 1'–0"

First Floor

- Water intrusion
  - Mortar deterioration
  - Concrete deterioration
- Slope of floor
- Measurements of a single mortar joint
- Measurements of corners of masonry openings
- Column movement


4
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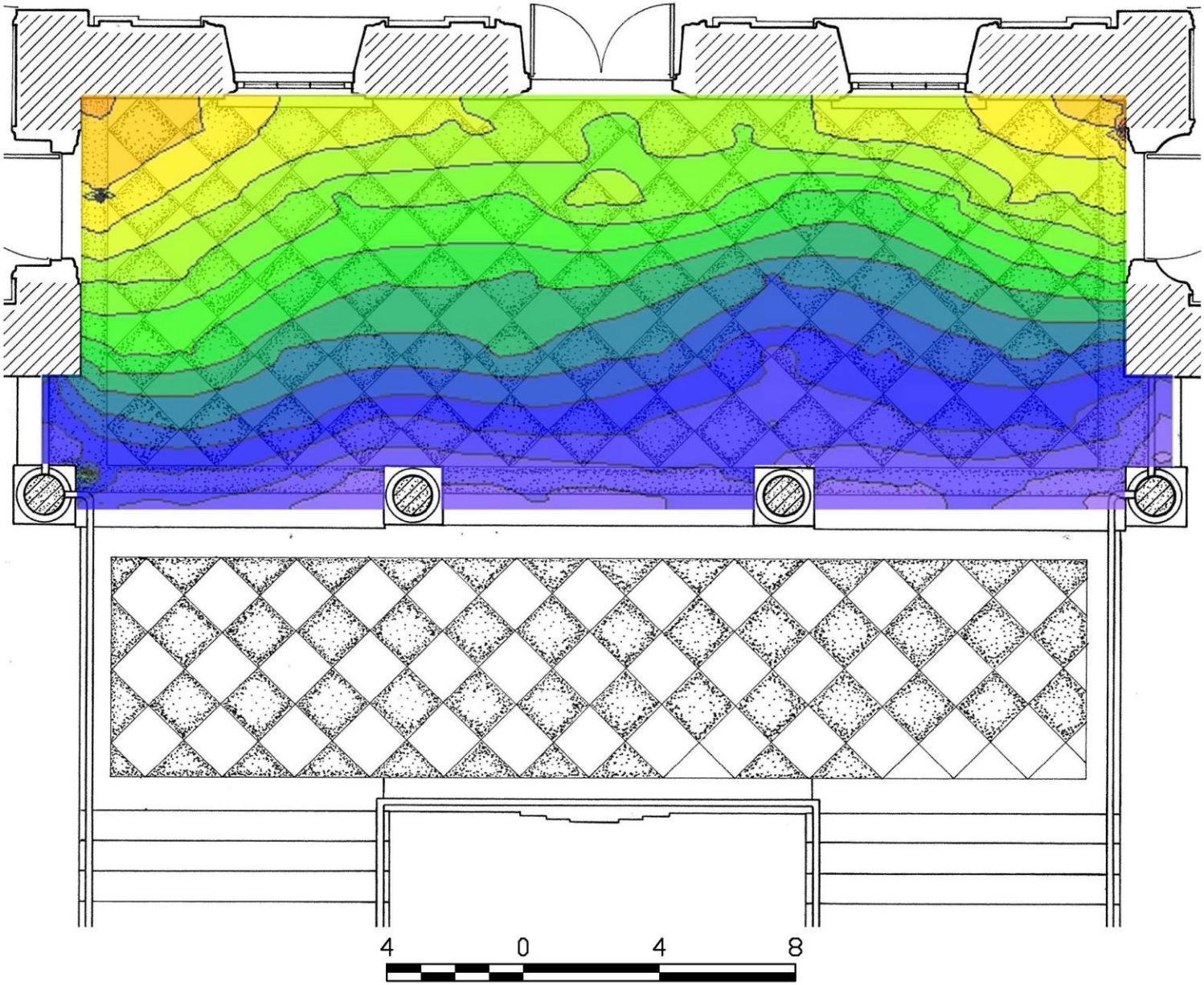
8
SCALE IN FEET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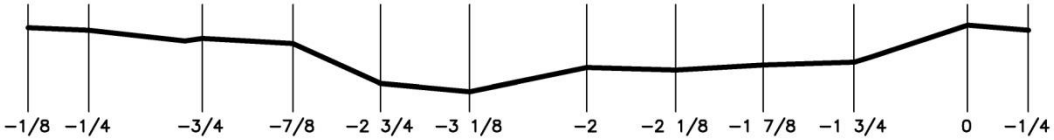
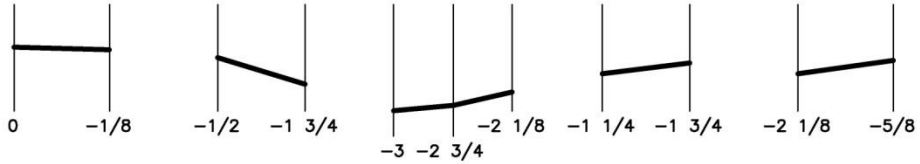
SCALE IN FEET



Horizontal Scale: inches
Vertical Scale: feet



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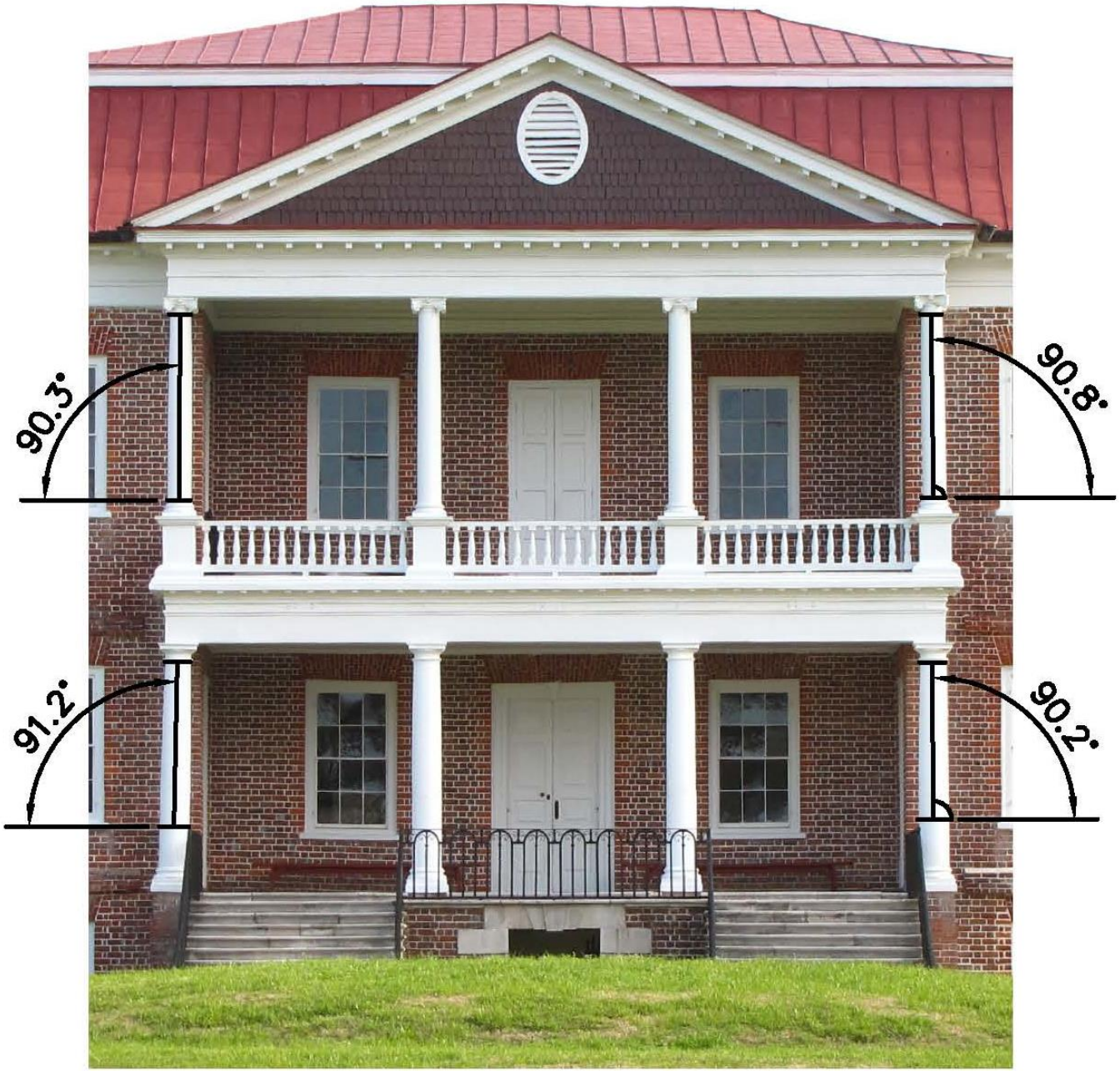


North and South Portico Columns

1/8" = 1'-0"

Second Floor Framing

- Water intrusion
  - Joist and ceiling damage below (2009)
- Lintel condition and stresses

Brownstone lintels

- Stucco cracking
- Brownstone condition
- Measurements
- Calculations

Horizontal Scale: inches
Vertical Scale: feet

Lintels - Calculations

Drayton Hall - West (landside) Portico										
CMBJr / 4SEinc										
Fri May 11, 2012										
West Portico - Second Floor Lintel										
Section properties										
		Width						b	10.25	inches
		Depth						h	13	inches
		Length						l	10.5	feet
									126	inches
		Section modulus							289	in 3
Loading										
				trib leng	width	depth	load	unit wt		
				ft	ft	ft	psf	pcf		
	Dead loads									
		Concrete/stone		6	1.00	0.33		150	300	plf
		Wooden form/ceil		2	1.00	0.17		35	12	plf
		Joists		6	0.25	0.50		35	26	plf
		Woodwork		4	1.00	0.08		35	12	plf
		Brick		1	1.00	0.50		120	60	plf
		Lintel		1	0.98	1.13		120	132	plf
	Live loads									
		Occupant loads		6			80		480	plf

		Total DL + LL							1022	plf

Bending stress										
		Bending moment (M=w*l^2/8)							14,081	ft lb
									168,972	in lb
		Bending stress (fb=M/S)							585	psi

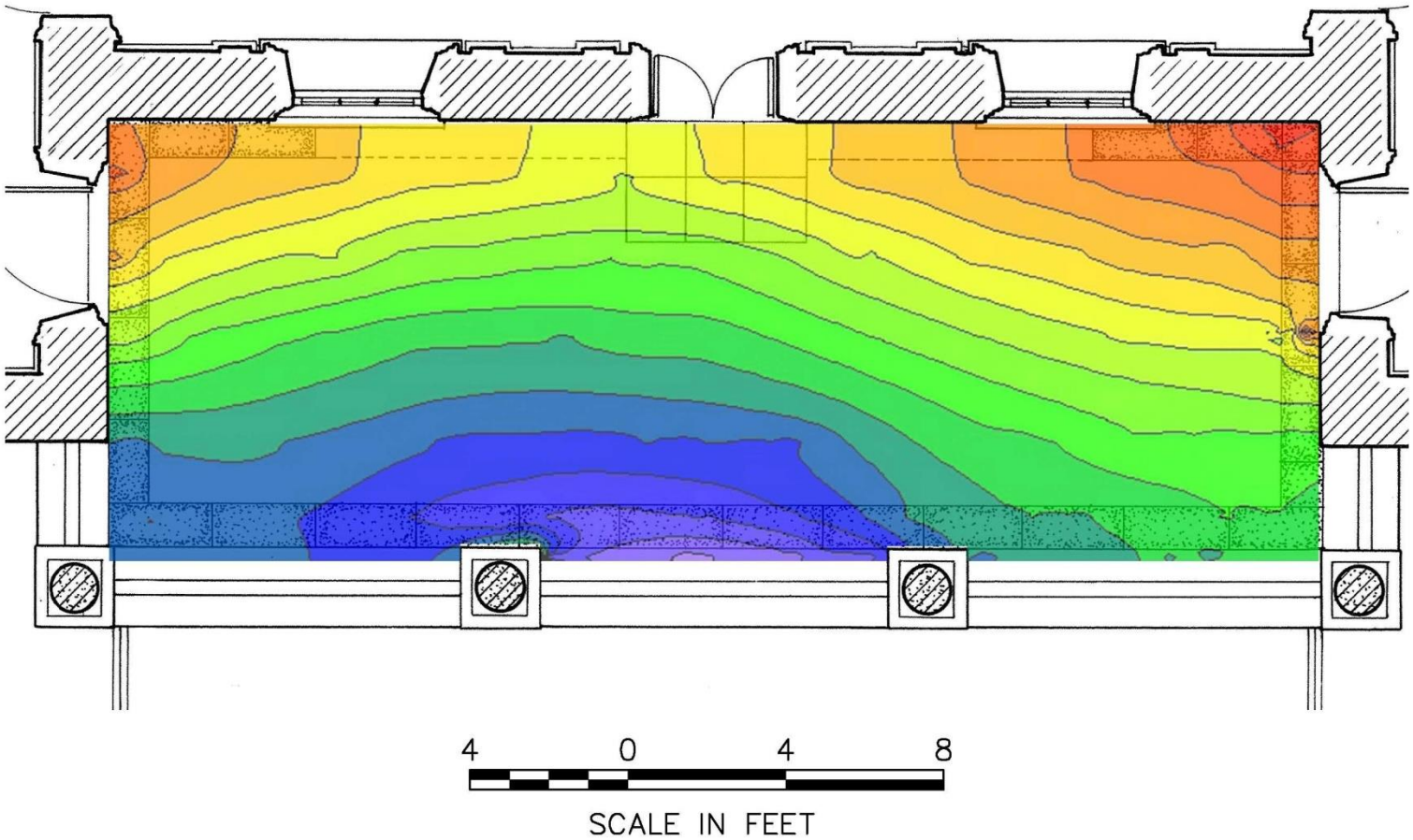
Drayton Hall - West (landside) Portico										
CMBJr / 4SEinc										
Fri May 11, 2012										
West Portico - Second Floor Lintel										
Section properties										
		Width						b	10.25	inches
		Depth						h	13	inches
		Length						l	10.5	feet
									126	inches
		Section modulus							289	in 3
Loading										
				trib leng	width	depth	load	unit wt		
				ft	ft	ft	psf	pcf		
	Dead loads									
		Concrete/stone		6	1.00	0.33		150	300	plf
		Wooden form/ceil		2	1.00	0.17		35	12	plf
		Joists		6	0.25	0.50		35	26	plf
		Woodwork		4	1.00	0.08		35	12	plf
		Brick		1	1.00	0.50		120	60	plf
		Lintel		1	0.98	1.13		120	132	plf
	Live loads									
		Occupant loads		6			25		150	plf

		Total DL + LL							692	plf

Bending stress										
		Bending moment (M=w*l^2/8)							9,533	ft lb
									114,402	in lb
		Bending stress (fb=M/S)							396	psi

Second Floor

- Water intrusion
- Slope of floor
- Measurements of a single mortar joint
- Measurements of corners of masonry openings
- Column movement


4
0
4
8
SCALE IN FEET

Attic

Recommendations

Attic:

- Repair damaged members - later

Second floor portico:

- Minimize loading on lintel
  - 25 PSF live load on deck
  - Keep visitors on back (east) half of porch
- Alternative – Strengthen structure
  - In progress

Second floor portico:

- Minimize water intrusion and damage to structure

First floor portico:

- Remove concrete
- Return to wood
- In progress

First floor portico:

- Monitor movement of columns
  - Yet to be done

Foundations:

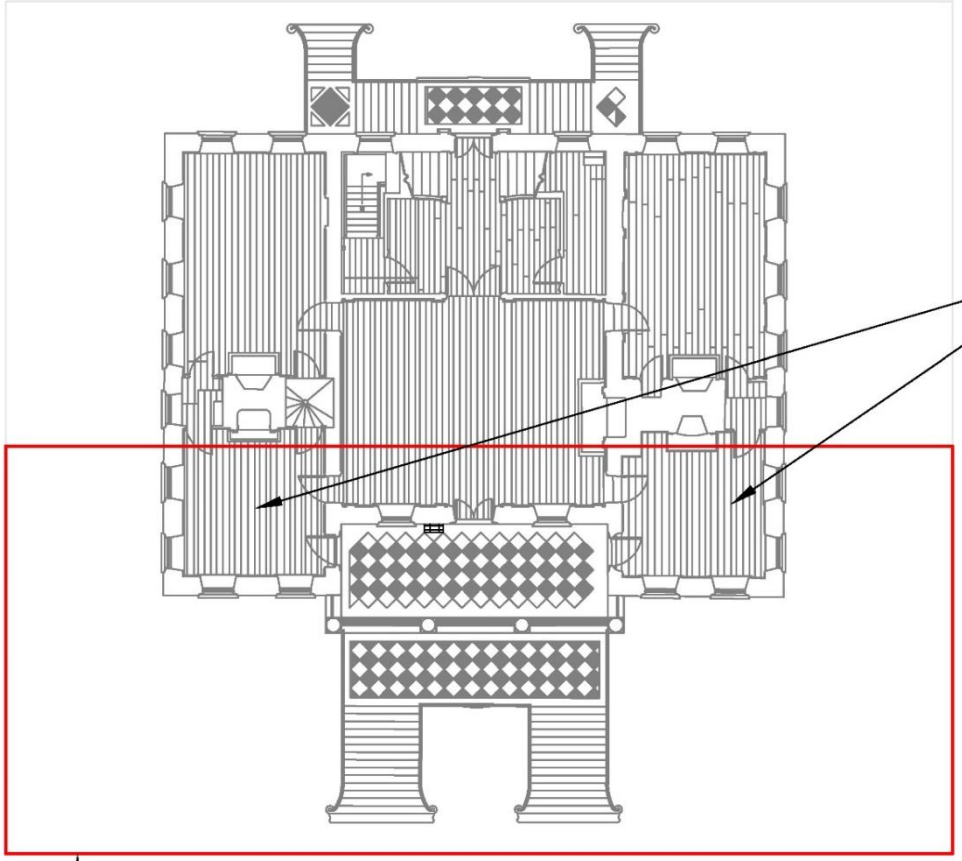
- Monitor movement of pier to north of center
  - In progress

West Portico

2009 – 2013 Structural Evaluation

2015 Repair

So let’s look at a few of the 60 sheets of drawings and see how this portico repair is actually done…



GROUND FLOOR ROOMS AVAILABLE TO USE. INSTALL PROTECTION ON FLOOR BEFORE USE.

AREA OF CONSTRUCTION

1 First Floor Plan of Drayton Hall

Scale: 3/32" = 1'

1 West Elevation

Scale: 3/8" = 1'

SOURCE: HABS

Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK

Checked By: CMB, JR.

Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs

Sheet Title: West Elevation

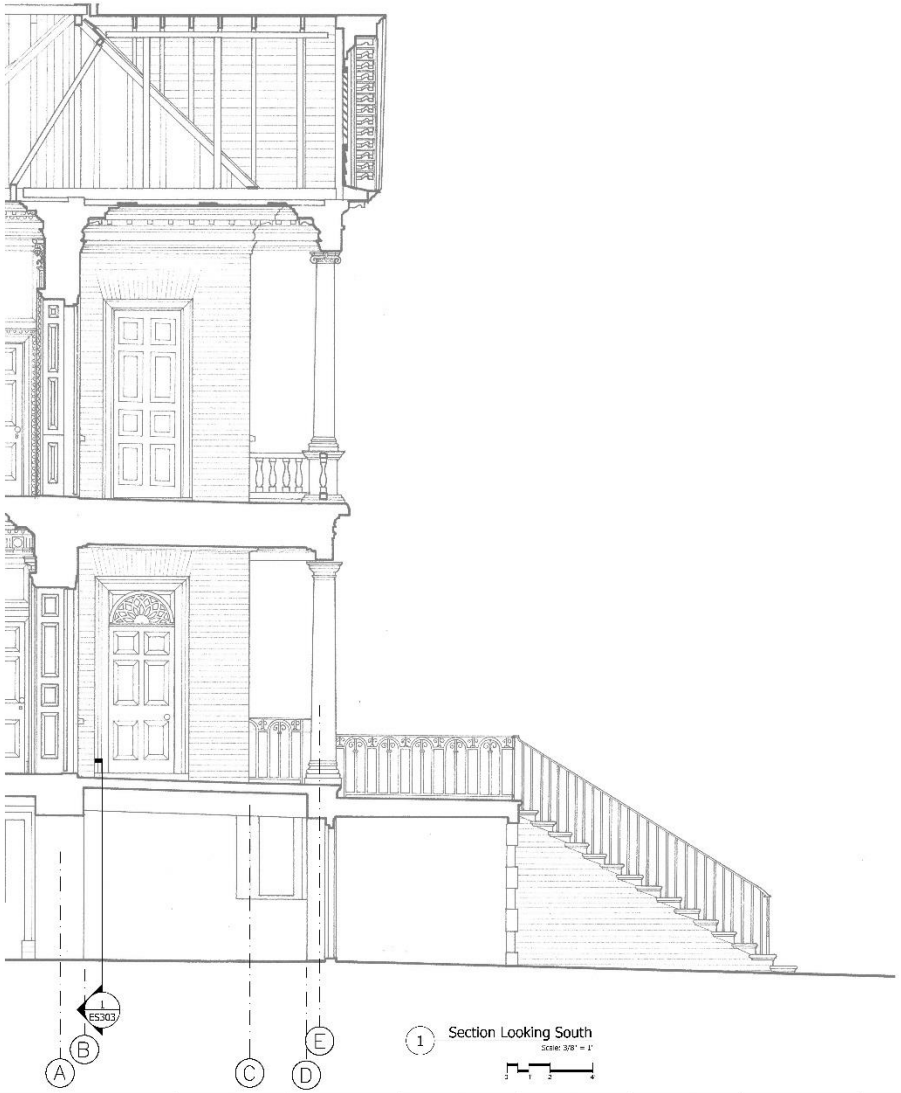
Date of Issue: March 13, 2015

Job Number: 09-071B

Sheet Number: ES201

Sheet 12 of 58

ON A FULL SIZE DRAWING, THIS LINE IS 12 INCHES LONG



1 Section Looking South

Scale: 3/8" = 1'

SOURCE: ~ABS

Bennett PRESERVATION ENGINEERING PC

Drawn By: ZDK

Checked By: CMB JR.

Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs

Sheet Title: Section Looking South

Date of Issue: March 13, 2015

Job Number: 09-071B

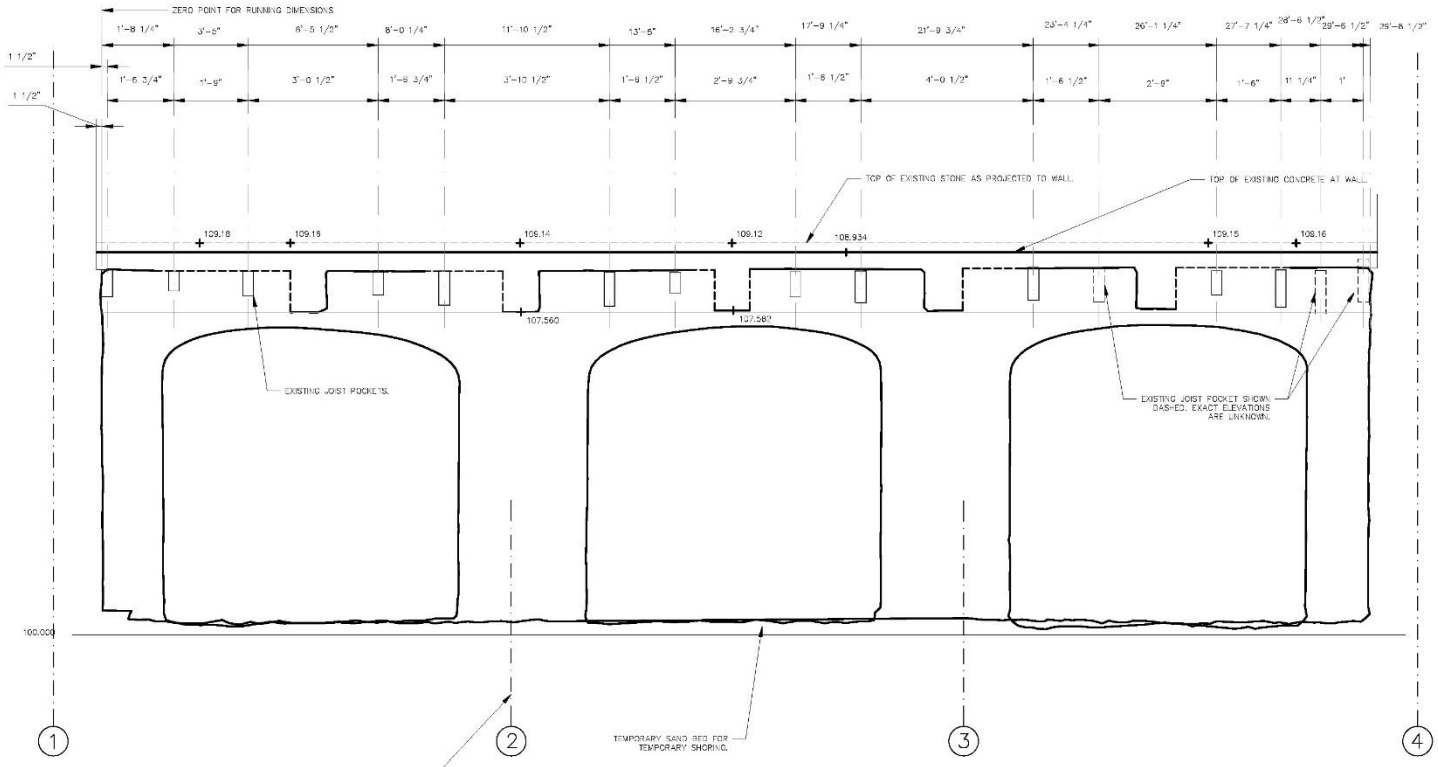
Sheet Number: ES301

Sheet 15 of 58

ON A FULL SIZE DRAWING, THIS LINE IS 12 INCHES LONG

SHEET NOTES:

BOLD LINES INDICATE LASER SCANS.
DASHED LINES INDICATE APPROXIMATE EDGES.



✚ REPRESENTS ELEVATION IN FEET.

DATUM IS FORSBERG ENGINEERING AND SURVEYING INC. DATUM ESTABLISHED BY ELEVATIONS OF THREE BENCHMARKS PLACED APPROXIMATELY 150 FEET NORTHWEST, WEST, AND SOUTHWEST OF SOUTH PORTICO.

1 **Basement Section Looking East**

Scale: 3/4" = 1'

0 6" 1' 2'

SOURCES: DISTO SCANS AND BPE MEASUREMENTS

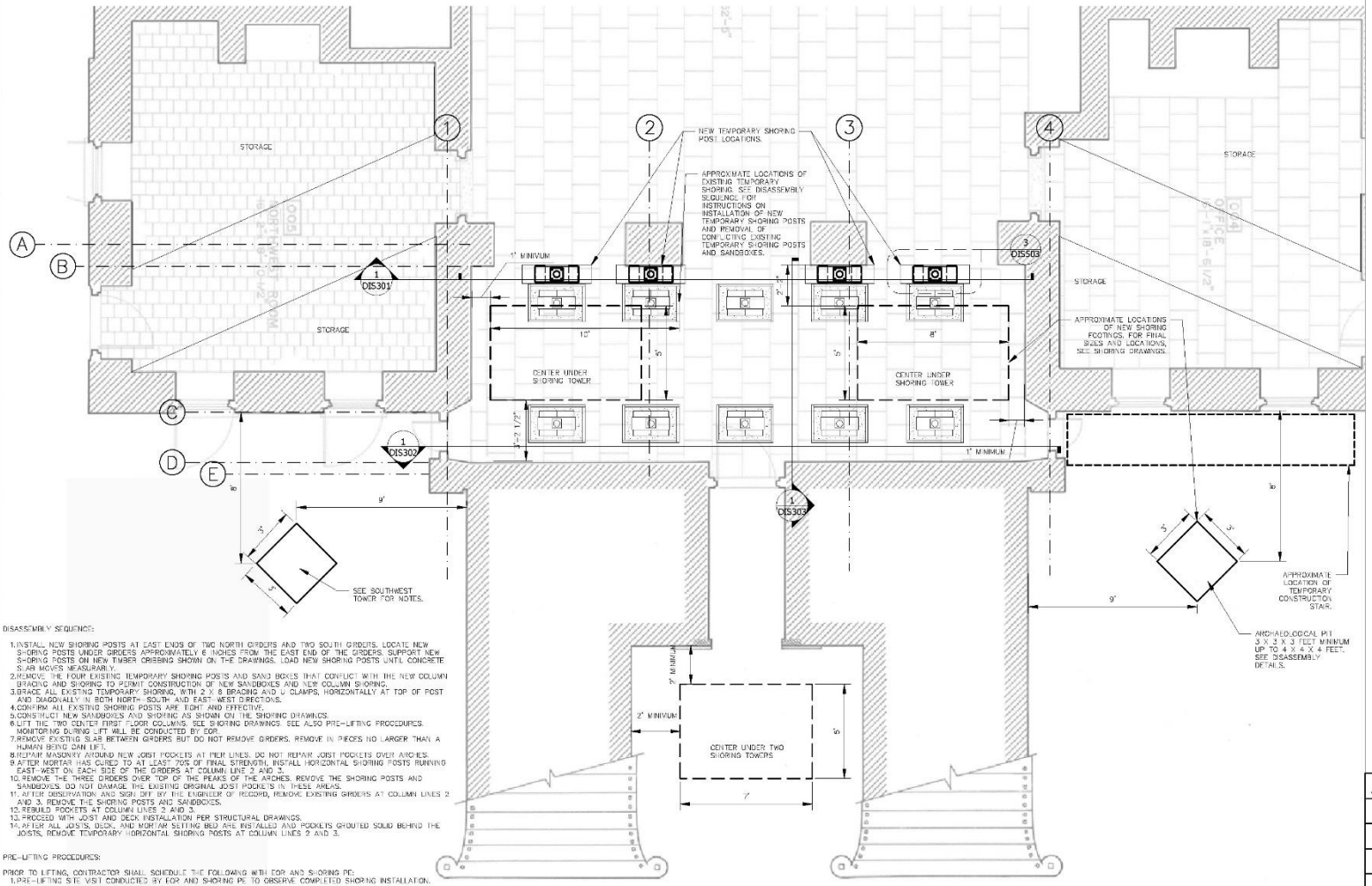
Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK
Checked By: DMB JR
Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs
Sheet Title: Basement Section Looking East

Date of Issue: March 13, 2015
Job Number: 09-071B
Sheet Number: ES303
Sheet 15 of 58

ON A FULL SIZE DRAWING, THIS LINE IS 1/2" LONG



DISASSEMBLY SEQUENCE:

1. INSTALL NEW SHORING POSTS AT EAST ENDS OF TWO NORTH GIRDERS AND TWO SOUTH GIRDERS. LOCATE NEW SHORING POSTS UNDER GIRDERS APPROXIMATELY 6' INCHES FROM THE EAST END OF THE GIRDERS. SUPPORT NEW SHORING POSTS ON NEW TIMBER CRIBBING SHOWN ON THE DRAWINGS. LOAD NEW SHORING POSTS UNTIL CONCRETE SLAB MOVES MEASURABLY.
2. REMOVE THE FOUR EXISTING TEMPORARY SHORING POSTS AND SAND BOXES THAT CONFLICT WITH THE NEW COLUMN BRACING AND SHORING TO PERMIT CONSTRUCTION OF NEW SANDBOXES AND NEW COLUMN SHORING.
3. BRACE ALL EXISTING TEMPORARY SHORING, WITH 2 X 8 BRACING AND U CLAMPS, HORIZONTALLY AT TOP OF POST AND DIAGONALLY IN BOTH NORTH-SOUTH AND EAST-WEST DIRECTIONS.
4. CONFIRM ALL EXISTING SHORING POSTS ARE TIGHT AND EFFECTIVE.
5. CONSTRUCT NEW SANDBOXES AND SHORING AS SHOWN ON THE SHORING DRAWINGS.
6. LIFT THE TWO CENTER FIRST FLOOR COLUMNS. SEE SHORING DRAWINGS. SEE ALSO PRE-LIFTING PROCEDURES. MONITORING DURING LIFT WILL BE CONDUCTED BY EOR.
7. REMOVE EXISTING SLAB BETWEEN GIRDERS BUT DO NOT REMOVE GIRDERS. REMOVE IN PIECES NO LARGER THAN A HUMAN BEING CAN LIFT.
8. REPAIR MASONRY AROUND NEW JOIST POCKETS AT PIER LINES. DO NOT REPAIR JOIST POCKETS OVER ARCHES.
9. AFTER MORTAR HAS CURED TO AT LEAST 70% OF FINAL STRENGTH, INSTALL HORIZONTAL SHORING POSTS RUNNING EAST-WEST ON EACH SIDE OF THE GIRDERS AT COLUMN LINE 2 AND 3.
10. REMOVE THE THREE GIRDERS OVER TOP OF THE PEAKS OF THE ARCHES. REMOVE THE SHORING POSTS AND SANDBOXES. DO NOT DAMAGE THE EXISTING ORIGINAL JOIST POCKETS IN THESE AREAS.
11. AFTER OBSERVATION AND SIGN OFF BY THE ENGINEER OF RECORD, REMOVE EXISTING GIRDERS AT COLUMN LINES 2 AND 3. REMOVE THE SHORING POSTS AND SANDBOXES.
12. REBUILD POCKETS AT COLUMN LINES 2 AND 3.
13. PROCEED WITH JOIST AND DECK INSTALLATION PER STRUCTURAL DRAWINGS.
14. AFTER ALL JOISTS, DECK, AND MORTAR SETTING BED ARE INSTALLED AND POCKETS GROUTED SOLID BEHIND THE JOISTS, REMOVE TEMPORARY HORIZONTAL SHORING POSTS AT COLUMN LINES 2 AND 3.

PRE-LIFTING PROCEDURES:

PRIOR TO LIFTING, CONTRACTOR SHALL SCHEDULE THE FOLLOWING WITH EOR AND SHORING PE:
1. PRE-LIFTING SITE VISIT CONDUCTED BY EOR AND SHORING PE TO OBSERVE COMPLETED SHORING INSTALLATION.
2. PRE-LIFTING CONFERENCE WITH EOR AND SHORING PE.

FOLLOWING THE PRE-LIFTING CONFERENCE, CONTRACTOR SHALL OBTAIN WRITTEN APPROVAL TO PROCEED WITH THE LIFTING. ALL SUBMITTALS SHALL BE SUBMITTED AND REVIEWED PRIOR TO APPROVAL TO PROCEED WITH THE LIFTING. THE SHORING PE AND EOR MUST BE ON SITE DURING LIFT. CONTRACTOR SHALL PLAN ON TWO (2) FULL DAYS FOR THE LIFT TO BE COMPLETED.

UPON COMPLETION OF THE LIFT, COLUMNS SHALL BE MAINTAINED WITH LOAD OFF OF THE MASONRY BELOW FOR A PERIOD OF 24 HRS, WITH NO MOVEMENT DETECTED, PRIOR TO DISASSEMBLY OF CONCRETE.

EOR AND SHORING PE ARE REQUIRED ON-SITE DURING LOWERING OF COLUMNS.

MONITORING:

MONITORING DURING LIFT WILL BE CONDUCTED BY EOR. MONITORING SHALL BE LEFT IN PLACE AND UNDISTURBED AFTER LIFT IS COMPLETED TO CONTINUE ELECTRONICALLY MONITORING MOVEMENT OF THE COLUMNS DURING THE PROJECT. AT ANY TIME, EOR RETAINS THE RIGHT TO STOP WORK SHOULD MOVEMENT EXCEED ACCEPTABLE THRESHOLDS.

1 Basement Floor Plan
Scale: 3/8" = 1'

SOURCE: HABS

BUILDING NORTH

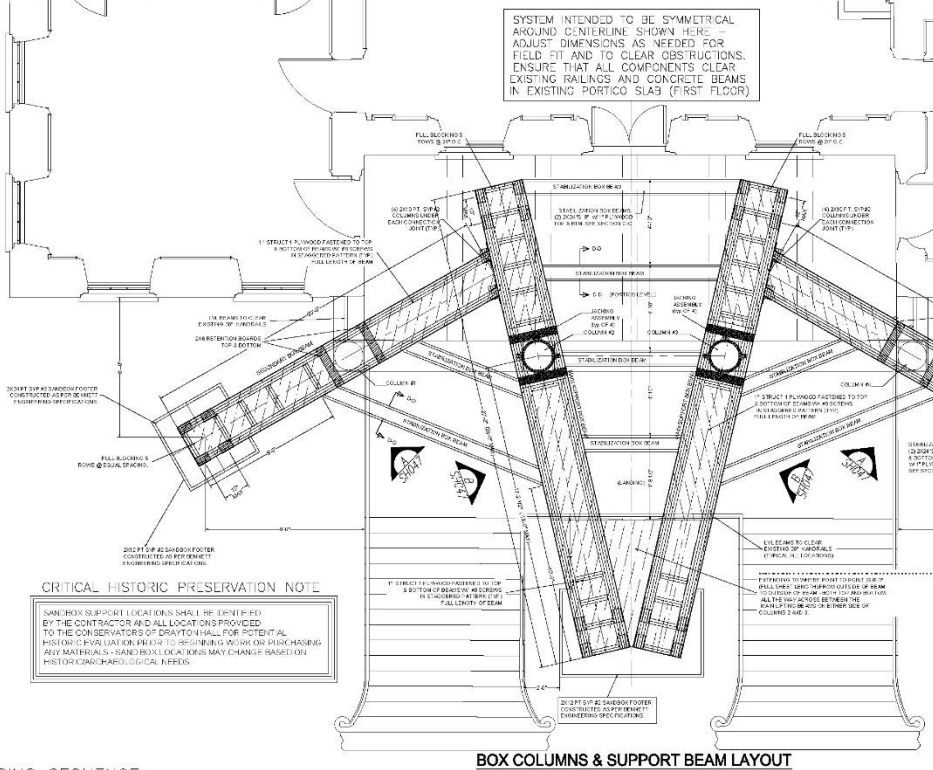
Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK
Checked By: CMB JR
Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs
Sheet Title: Basement Floor Plan

Date of Issue: March 13, 2015
Job Number: 09-071B
Sheet Number: DIS101
Sheet 15 of 58

ON A FULL SIZE DRAWING THIS LINE IS 12 INCHES LONG



BOX COLUMNS & SUPPORT BEAM LAYOUT

NOT TO SCALE - DRAWINGS ARE PROPORTIONAL - FIELD CHECK ALL DIMENSIONS PRIOR TO USE

ALL ASSEMBLIES WILL BE CONSTRUCTED USING #8 SCREWS IN ALL APPLICATIONS SHOWN AND SIZED TO PROVIDE NO LESS THAN 2" OF PENETRATION INTO THE SUPPORTING MEMBER OF THE ASSEMBLY.

CRITICAL HISTORIC PRESERVATION NOTE

SANDBOX SUPPORT LOCATIONS SHALL BE IDENTIFIED BY THE CONTRACTOR AND ALL LOCATIONS PROVIDED TO THE CONSERVATORS OF DRAYTON HALL FOR POTENTIAL HISTORIC EVALUATION PRIOR TO BEGINNING WORK OR PURCHASING ANY MATERIALS - SANDBOX LOCATIONS MAY CHANGE BASED ON HISTORIC/ARCHAEOLOGICAL NEEDS.

CRITICAL NOTE:

NO NAILS TO BE USED IN ASSEMBLIES BOLTS AND SCREWS ONLY

MAXIMUM LIFT TO BE NO GREATER THAN 2mm (ABOUT 1/8")

SHORING SEQUENCE:

1) FIELD VERIFY ALL DIMENSIONS AND CONFIGURATION OF SHORING SYSTEM, NOTIFY ENGINEER OF ANY CONDITIONS WHERE ANY SPANS ARE INCREASED, UNEXPECTED CONDITIONS ARE FOUND, OR OBSTRUCTIONS CANNOT BE AVOIDED AS SHOWN ON THE DRAWINGS.
2) LOCATE AND ASSEMBLE SAND-BOX SUPPORT FOOTINGS PER GUIDANCE FROM BENNETT PRESERVATION ENGINEERING – ENSURE EXCAVATION FOR OUTRIGGERS (COLUMNS 1 AND 4) IS DONE.
3) FABRICATE AND INSTALL WOOD STAVES AND NYLON RETENTION STRAPS ON EACH COLUMN AS SHOWN IN DETAILS AND SECTIONS ON PAGES SH002 AND SH003.
4) PURCHASE AND SHOP FABRICATE MATERIALS FOR SYSTEMS AS SHOWN ON THE DRAWINGS.
5) FABRICATE AND TEST-ASSEMBLE ENTIRE SYSTEM PRIOR TO BRINGING ASSEMBLY TO JOB SITE – SOME FINAL BLOCKING AND BRACING TO BE DONE ON SITE BY MINIMIZED.
6) BRING TESTED ASSEMBLY TO JOB SITE AND ASSEMBLE – ENSURE CARE IS TAKEN TO PROTECT HISTORIC FABRIC – PHOTO DOCUMENT CONDITIONS BEFORE-DURING-AFTER SHORING ASSEMBLY IS INSTALLED.
7) ESTABLISH ELEVATIONS AND MONITORING POINTS TO ALLOW REQUIRED MONITORING OF ELEVATIONS OF ALL FOUR COLUMNS AND END-POINTS OF SECOND FLOOR BEAMS. MONITORING POINTS TO BE SET TO ALLOW MONITORING OF BOTH VERTICAL ELEVATION AND HORIZONTAL PLACEMENT OF ENDS OF COLUMNS AND BEAMS AS REQUIRED IN GENERAL NOTES FOR DURATION OF PROJECT.
8) SNUG ALL CONTACT POINTS TAKING CARE NOT TO EXERT ANY FORCE ON ANY EXISTING COMPONENT OF THE HISTORIC STRUCTURE – ENGAGE ALL LOCK NUTS TO PRECLUDE UNPLANNED MOVEMENT.
9) CONTACT BENNETT PRESERVATION ENGINEERING AND JACKSON ENGINEERING AT LEAST 48 HOURS PRIOR TO COMPLETION OF ASSEMBLY FOR PRE-LOAD INSPECTION.
10) ACCOMPLISH ANY MODIFICATIONS/ITEMS IDENTIFIED IN PRE-LOAD INSPECTION.
11) NOTIFY BENNETT PRESERVATION ENGINEERING AND JACKSON ENGINEERING OF ANY FOLLOW-UP INSPECTIONS REQUIRED – PROVIDE AT LEAST 48 HOURS NOTICE OF PLANNED LIFT DATE.
12) ASSEMBLE LIFTING TEAM AND REQUIRED MEASURING/MONITORING DEVICES ON MORNING OF LIFT – VERIFY SYSTEMS AND MONITORING CAPABILITES – COMMENCE LIFT OF COLUMNS 2 AND 3 ONLY.
13) WHEN CLEARANCE SHOWN ON DRAWINGS (3MM OR 1/8") IS ACHIEVED BENEATH COLUMN BASE – ENGAGE ALL LOCK NUTS IN SYSTEM AND RELEASE PRESSURE FROM ALL JACKS. JACK ELEMENTS TO REMAIN IN SYSTEM LOCKED IN CONTACT WITH SHORING SYSTEM WITH NO PRESSURE BEING APPLIED TO LIFTING ELEMENTS BY THE JACK LOAD CELLS.
14) REMOVE PUMPS FROM JACK LOAD CELLS TO PRECLUDE UNAUTHORIZED/UNCONTROLLED MANIPULATION OF THE SHORING SYSTEM.
15) BEGIN WORK REQUIRED TO REPAIR PORCHES PER BENNETT PRESERVATION ENGINEERING DRAWING AND SPECIFICATIONS.
16) REVERSE ABOVE STEPS TO REMOVE SHORING SYSTEM ELEMENTS.

GENERAL NOTES:

1) ALL DIMENSIONS TO BE FIELD VERIFIED PRIOR TO PURCHASE OF MATERIAL OR BEGINNING FABRICATION
2) ALL DIMENSIONS SHOWN AND OBTAINED IN THE FIELD CAN BE REDUCED AT CONTRACTOR OPTION WITH NO CHANGE IN MEMBERS ELEMENTS, OR DESIGN CRITERIA - ANY INCREASES IN DIMENSIONS FROM THOSE SHOWN ON THESE DRAWINGS SHALL BE EVALUATED AND ADDRESSED BY THE ENGINEER PRIOR TO PROCEEDING WITH THE PROJECT, PURCHASING ANY MATERIALS, OR CONTINUING FABRICATION
3) ALL COMPONENTS TO BE SHOP FABRICATED AND FIELD ASSEMBLED - FIELD FABRICATION TO BE LIMITED TO BRACING AND WOOD ELEMENT ADJUSTMENT ONLY, ALL COMPONENTS TO BE TOTAL ASSEMBLED PRIOR TO BEING BROUGHT ON SITE
4) ALL ENGINEERED WOOD BEAM COMPONENTS TO BE LVL WITH 1E OF 2.0 and 1E x' of 3,100 UNLESS SPECIFIED OTHERWISE
5) ALL PLYWOOD COMPONENTS TO BE STRUCTURAL 1, EXPOSURE 1, 1" THICK OR GREATER
6) ALL STEEL COMPONENTS SHALL BE SHOP PAINTED WITH AN OIL BASED PAINT AND PRIMER SYSTEM PRIOR TO BEING BROUGHT TO THE FIELD.
6) LOCATIONS OF SUPPORT FOOTINGS (SANDBOXES) SHALL BE PROVIDED TO DRAYTON HALL STAFF FOR CHECKING AND BE RESOLVED PRIOR TO PURCHASE OF ANY MATERIALS FOR THE SHORING SYSTEM.
7) STEEL COLLARS SHALL BE SHIMMED USING HARDWOOD SHIMS TO PROVIDE FULL CONTACT BETWEEN THE STEEL AND THE STONE COLUMNS. STEEL COLLARS TO HAVE 1/8" BEAD WELDS ACROSS THE INTERFOR SURFACE ON A 3" SPACING TO PROVIDE GRIP ON THE WOOD SHIMS - SEE DETAILS.
8) ALL BOLTS SHALL BE TIGHTENED TO EMBED AT LEAST 1 WASHER INTO WOOD ELEMENTS AND USING THE A.S.C. TURN-OF-THE-NUT METHOD FOR ALL STEEL ELEMENTS. ALL BOLTS SHALL BE CHECKED FOR TIGHTNESS TWICE A DAY FOR 3 DAYS AFTER ASSEMBLY AND AT LEAST TWICE WEEKLY AFTER THAT FOR THE DURATION OF THE PROJECT.
9) CONTRACTOR SHALL ESTABLISH BENCHMARK ELEVATIONS AND LOCATIONS ON THE SITE AND VERIFY THE POSITION AND ELEVATIONS OF THE SHORING ELEMENTS AND HISTORIC ELEMENTS AT LEAST TWICE A WEEK FOR THE DURATION OF THE PROJECT. NOTIFY THE ENGINEER IF ANY ELEVATIONS REQUIRE ADJUSTMENT DURING THE PROJECT OR IF ELEMENTS MOVE AFTER INITIAL ADJUSTMENT PERIODS.
10) ALL ASSEMBLIES WILL BE CONSTRUCTED USING #8 SCREWS IN ALL APPLICATIONS SHOWN AND SIZED TO PROVIDE NO LESS THAN 2" OF PENETRATION INTO THE SUPPORTING MEMBER OF THE ASSEMBLY.
11) ALL DIMENSIONAL LUMBER SHOWN USED SHALL BE FREE OF CRACKS/CHECKS OR SPLITTING.
12) ALL PRIMARY ELEMENTS SHALL BE FABRICATED FROM TEMPLATES TAKEN FROM DEDICATED FIELD MEASUREMENTS AND LAYOUTS BASED ON THESE DRAWINGS. ALL PRIMARY ELEMENTS AND CONNECTIONS SHALL BE TEST ASSEMBLED PRIOR TO BEING BROUGHT TO THE SITE FOR FINAL ASSEMBLY. MINOR BRACING AND BLOCKING WITH DIMENSIONAL LUMBER ELEMENTS SHALL BE PERMITTED ON SITE BUT MINIMIZED. SEE SHORING ASSEMBLY SEQUENCE AT LEFT THIS PAGE.

Bennett PRESERVATION ENGINEERING PC

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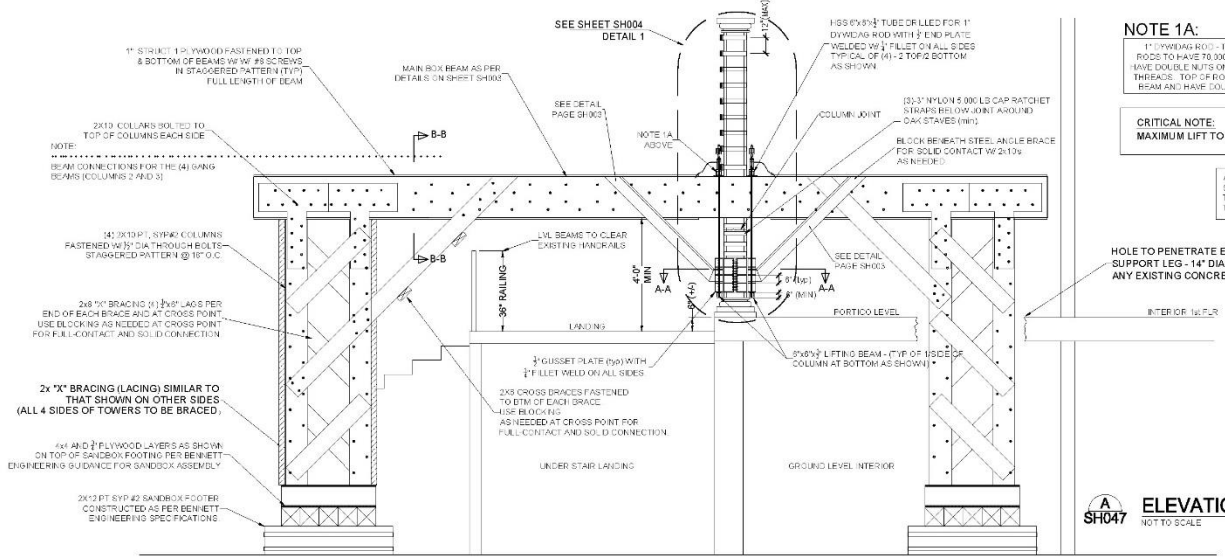
Checked By: WAJ
Phase: FINAL PRICING AND COORDINATION CONSTRUCTION DOCUMENTS

STATE OF SOUTH CAROLINA
REGISTERED PROFESSIONAL ENGINEER
No. 19974
WILLIAM A. JACKSON

STATE OF SOUTH CAROLINA
JACKSON ENGINEERING, LLC
CHARLESTON, SC
No. C-01964
CERTIFICATE OF AUTHORIZATION

Professional Stamp(s)

Job Name: Drayton Hall Portico Repairs
Sheet Title: SHORING PLAN
Date of Issue: MARCH 13, 2015
Job Number: 09-071B
Sheet Number: SH046
Sheet 46 of 58



NOTE 1A:

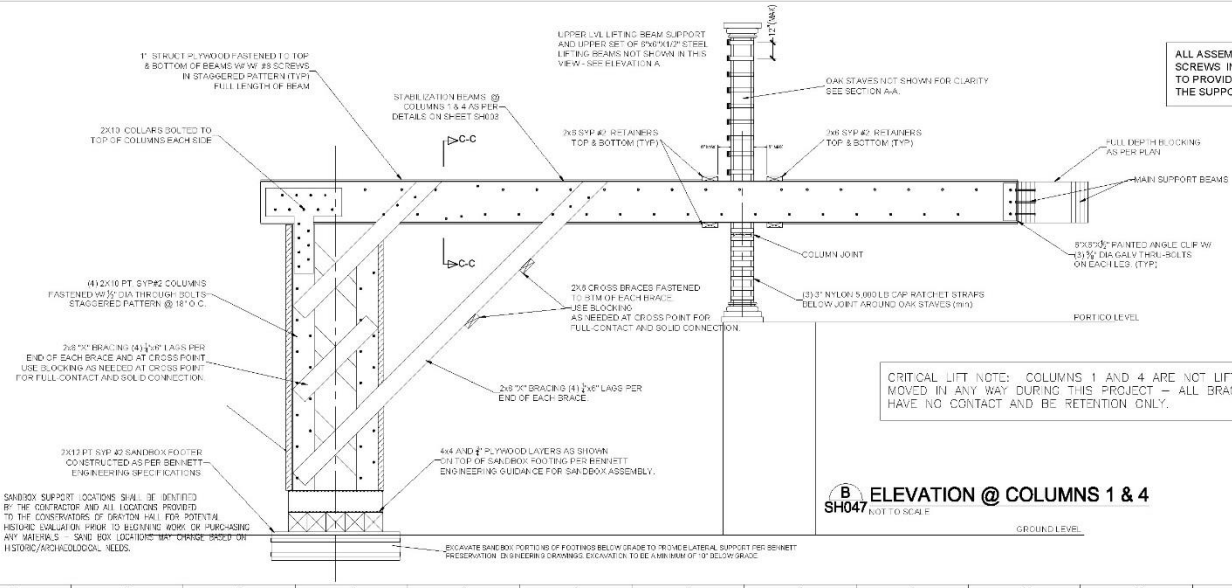
1" DYWIDAG ROD - TYP OF (4)COLUMN (2)PER SIDE/LIFTING BEAM SET RODS TO HAVE 76,000 POUND (MIN) TENSILE WORKING LOAD. RODS TO BE HAVE DOUBLE NUTS ON THE BOTTOM THAT ARE INSTALLED, JAMMED ON THE THREADS. TOP OF RODS TO EXTEND A MINIMUM OF 1" ABOVE UPPER LIFTING BEAM AND HAVE DOUBLE NUTS TO BE JAMMED AFTER LIFT IS COMPLETE.

CRITICAL NOTE:
MAXIMUM LIFT TO BE NO GREATER THAN 3mm (ABOUT ⅛")

ALL ASSEMBLIES WILL BE CONSTRUCTED USING #8 SCREWS IN ALL APPLICATIONS SHOWN AND SIZED TO PROVIDE NO LESS THAN 2" OF PENETRATION INTO THE SUPPORTING MEMBER OF THE ASSEMBLY.

A SH047 ELEVATION @ COLUMNS #2 & #3

NOT TO SCALE



ALL ASSEMBLIES WILL BE CONSTRUCTED USING #8 SCREWS IN ALL APPLICATIONS SHOWN AND SIZED TO PROVIDE NO LESS THAN 2" OF PENETRATION INTO THE SUPPORTING MEMBER OF THE ASSEMBLY.

CRITICAL LIFT NOTE: COLUMNS 1 AND 4 ARE NOT LIFTED OR MOVED IN ANY WAY DURING THIS PROJECT – ALL BRACING TO HAVE NO CONTACT AND BE RETENTION ONLY.

B SH047 ELEVATION @ COLUMNS 1 & 4

NOT TO SCALE

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Job Name: Drayton Hall Portico Repairs

Sheet Title: ELEVATIONS @ SHORING

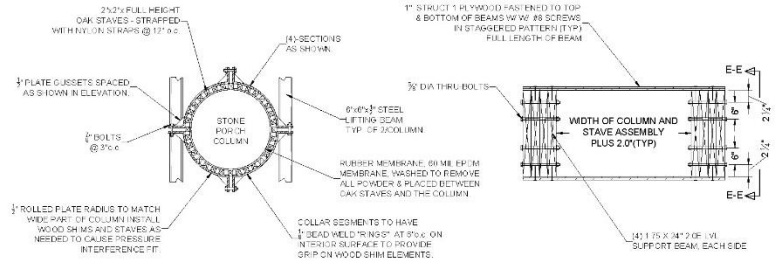
Date of Issue: MARCH 13, 2015

Job Number: 09-071B

Sheet Number: SH047

Sheet 47 of 59

Professional Stamp(s)

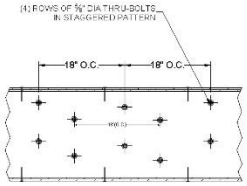


SECTION A-A @ COLUMN COLLAR

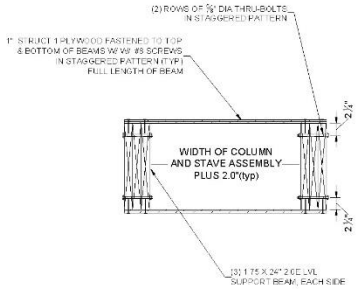
SCALE: N.T.S.

SECTION B-B @ MAIN BOX BEAMS

SCALE: N.T.S.



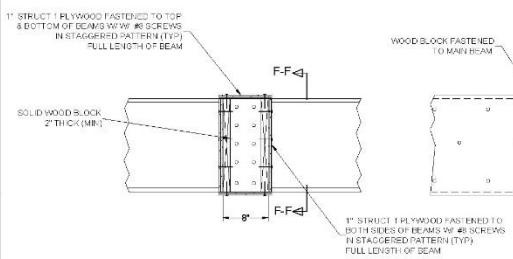
SECTION E-E



SECTION C-C @ STABILIZATION BEAMS

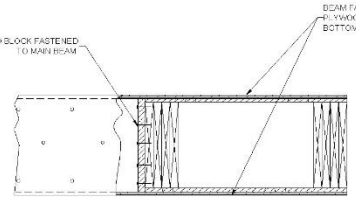
SCALE: N.T.S.

ALL ASSEMBLIES WILL BE CONSTRUCTED USING #8 SCREWS IN ALL APPLICATIONS SHOWN AND SIZED TO PROVIDE NO LESS THAN 2" OF PENETRATION INTO THE SUPPORTING MEMBER OF THE ASSEMBLY.



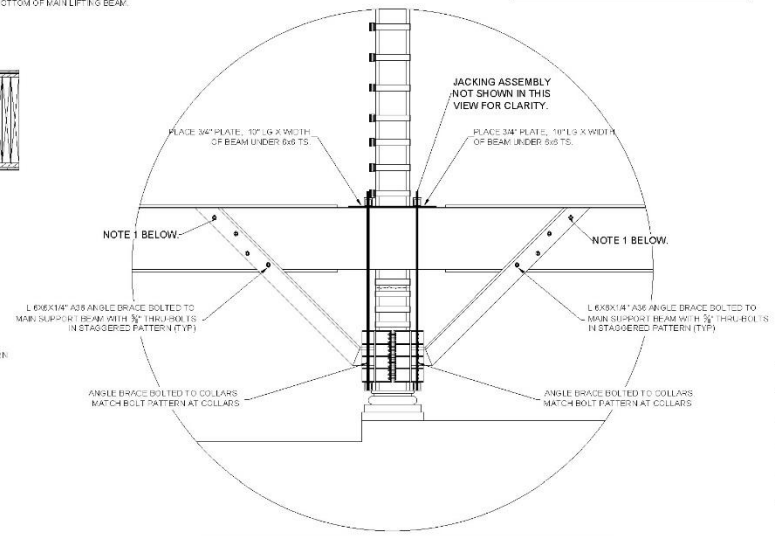
SECTION D-D @ STABILIZATION BEAMS

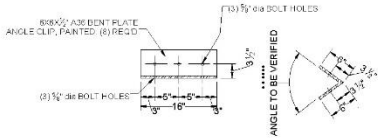
SCALE: N.T.S.



SECTION F-F

ALL ASSEMBLIES WILL BE CONSTRUCTED USING #8 SCREWS IN ALL APPLICATIONS SHOWN AND SIZED TO PROVIDE NO LESS THAN 2" OF PENETRATION INTO THE SUPPORTING MEMBER OF THE ASSEMBLY.

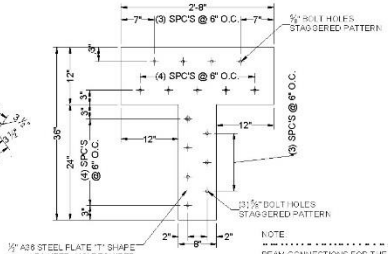




ALL CONNECTION PLATES AND CLIPS QUANTITIES TO BE VERIFIED BY CONTRACTOR PRIOR TO FABRICATION

ANGLE CLIP DETAIL

SCALE: N.T.S.



"T" PLATE DETAIL

SCALE: N.T.S.

NOTE

BEAM CONNECTIONS FOR THE (4) GANG BEAMS (COLUMNS 2 AND 3)

NOTE 1: ALL HOLES IN 8"x6"x1/4" ANGLE BRACING TO HAVE SLOTTED HOLES FOR LAG BOLTS INTO BEAMS TO ALLOW NO MORE THAN 1/2" OF VERTICAL MOVEMENT

DIAGONAL BRACING @ COLUMN BASE

SCALE: N.T.S.

Professional Stamp(s)

STATE OF SOUTH CAROLINA — REGISTERED PROFESSIONAL ENGINEER — CHARLESTON, SC — No. 13516 — JOHN M. JACKSON

STATE OF SOUTH CAROLINA — JACKSON ENGINEERING, L.L.C. — CHARLESTON, SC — No. C-01964 — CERTIFICATE OF AUTHORIZATION

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Checked By: XXX
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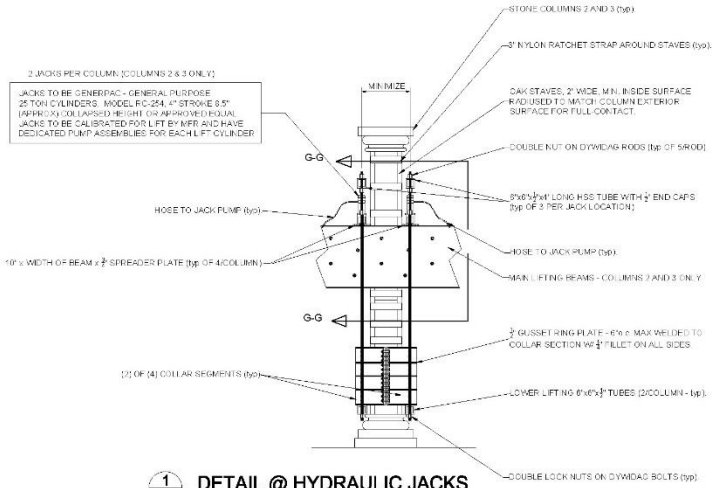
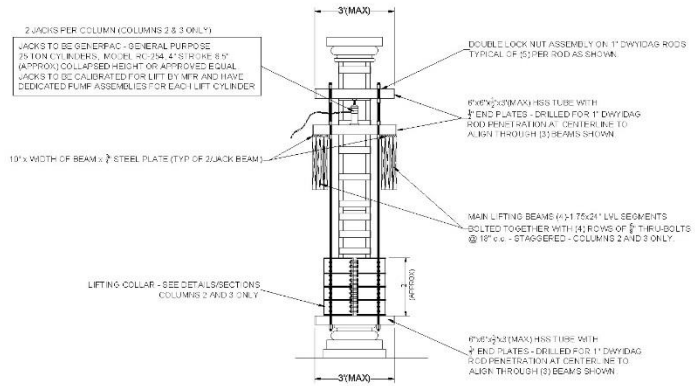
Job Name: Drayton Hall Portico Repairs
Sheet Title: DETAIL SHEET #1

Date of Issue: MARCH 13, 2015
Job Number: 09-071B
Sheet Number: SH048
Sheet 48 of 59



1 SH004 **DETAIL @ HYDRAULIC JACKS**

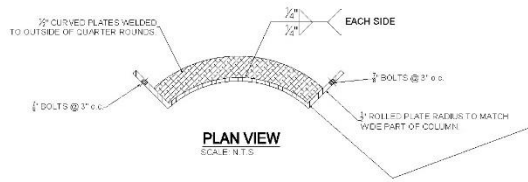
SCALE: N.T.S.



G-G @ HYDRAULIC JACKS

SCALE: N.T.S.

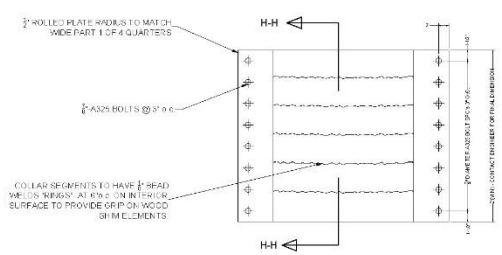
CRITICAL COLLAR ASSEMBLY NOTE:
LIMIT BOLT TORQUE TO 210 FOOT-POUNDS TO PROVIDE 300 PSI MAX PRESSURE ON STONE COLUMN.



PLAN VIEW

SCALE: N.T.S.

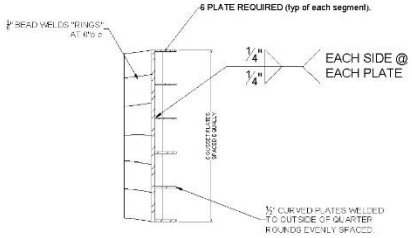
IF BOLT PLATES (EARS) ARE WELDED TO RADIUSED SEGMENT PLATES - USE 1/4" FILLET ON ALL SIDES



NOTE:
WOOD SHIMS CUT AND SHAPED AS NEEDED TO FILL GAP BETWEEN STEEL AND RUBBER

STEEL COLLAR DETAIL

SCALE: N.T.S.



SECTION H-H

SCALE: N.T.S.

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Checked By: WAJ
Phase: FINAL PRICING AND COORDINATION CONSTRUCTION DOCUMENTS

Job Name: Drayton Hall Portico Repairs
Sheet Title: DETAIL SHEET #2

Date of Issue: MARCH 13, 2015
Job Number: 09-071B
Sheet Number: SH049
Sheet 45 of 58

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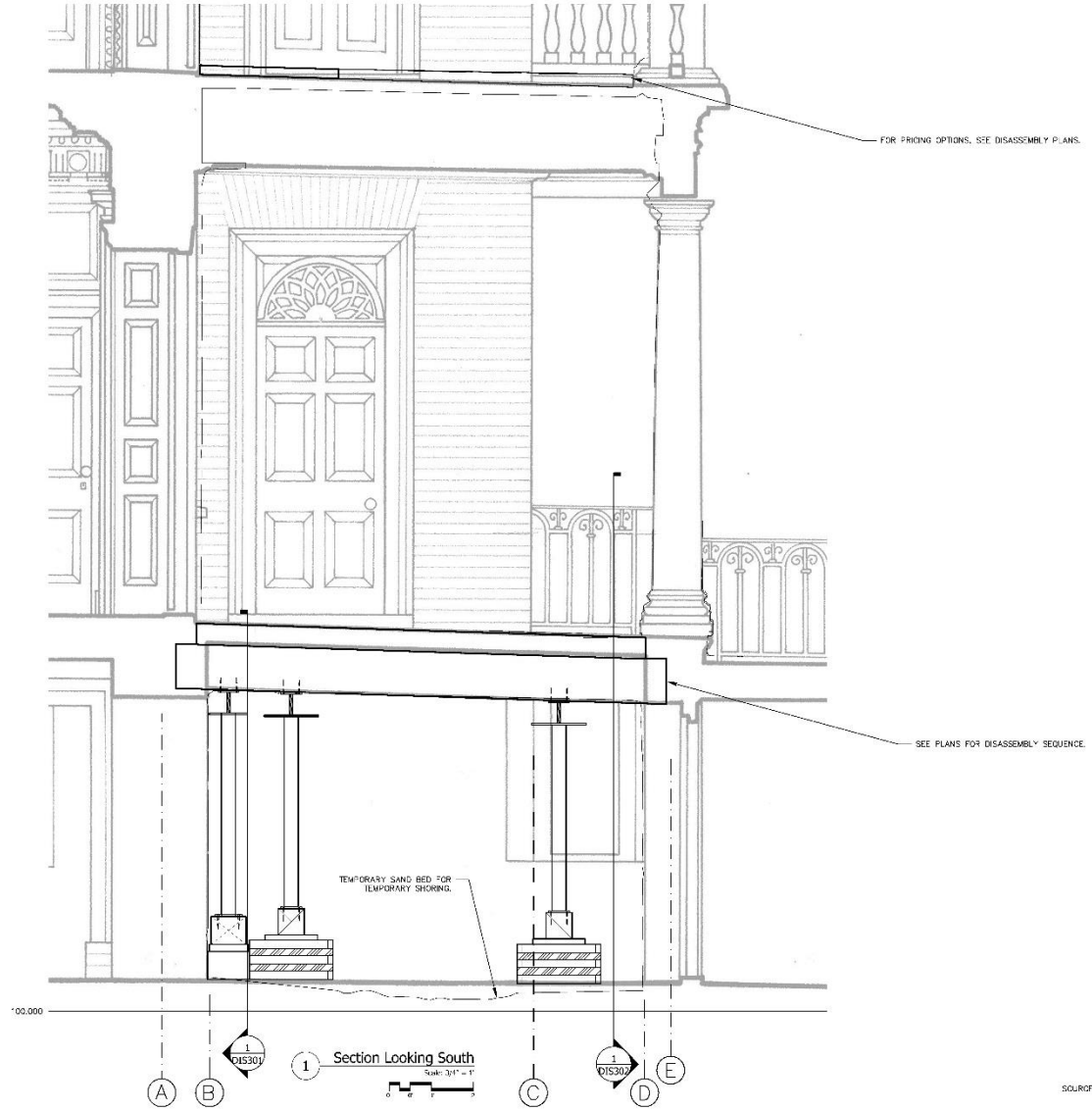


SOURCES: HABS AND DISTO SCANS

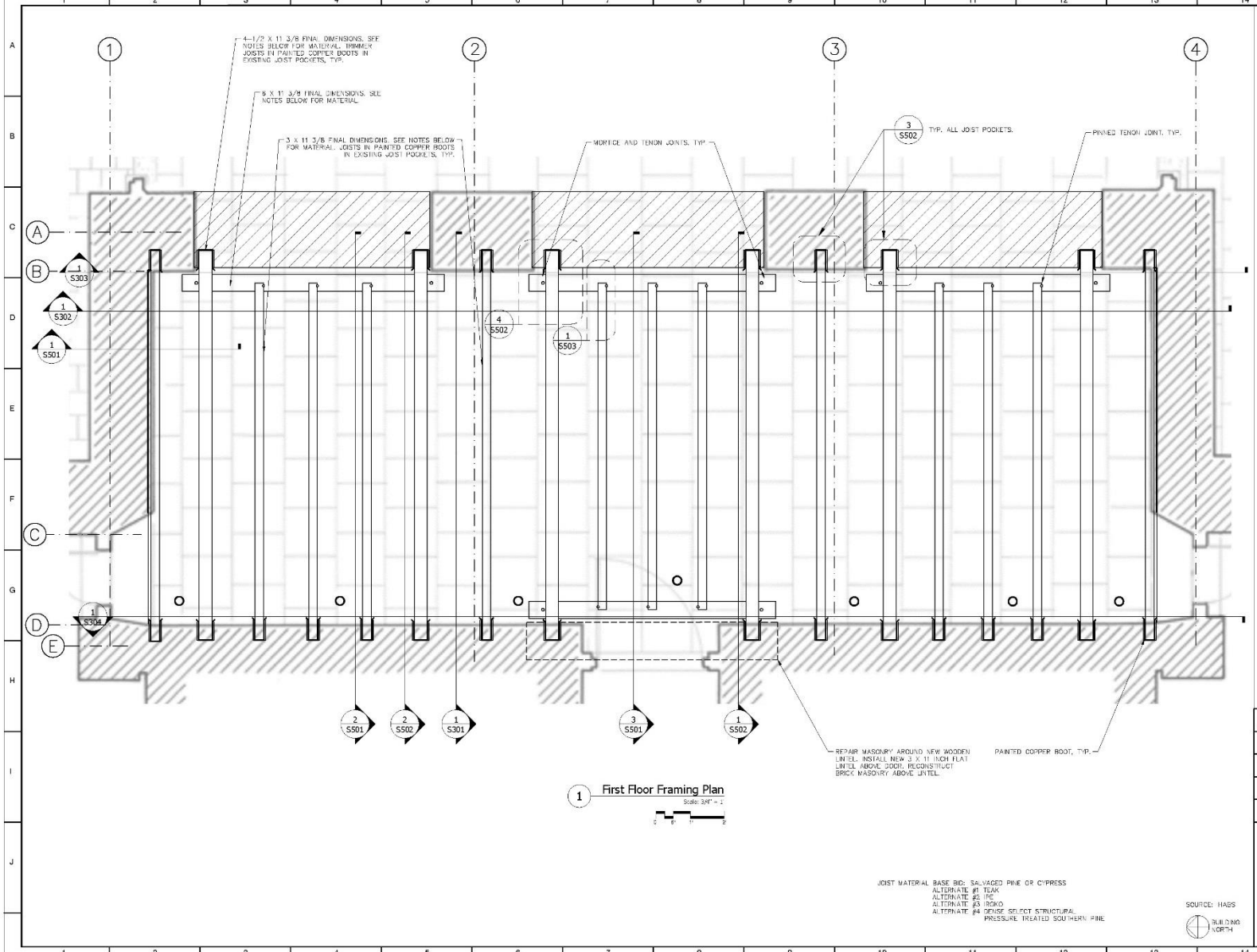
Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK
Checked By: Date: JH.
Issue: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs
Sheet Title: Section Looking South

Date of Issue: March 13, 2015
Job Number: 09-071B
Sheet Number: DIS303
Sheet 25 of 58

ON A FULL SIZE DRAWING, THIS LINE IS 12 INCHES LONG



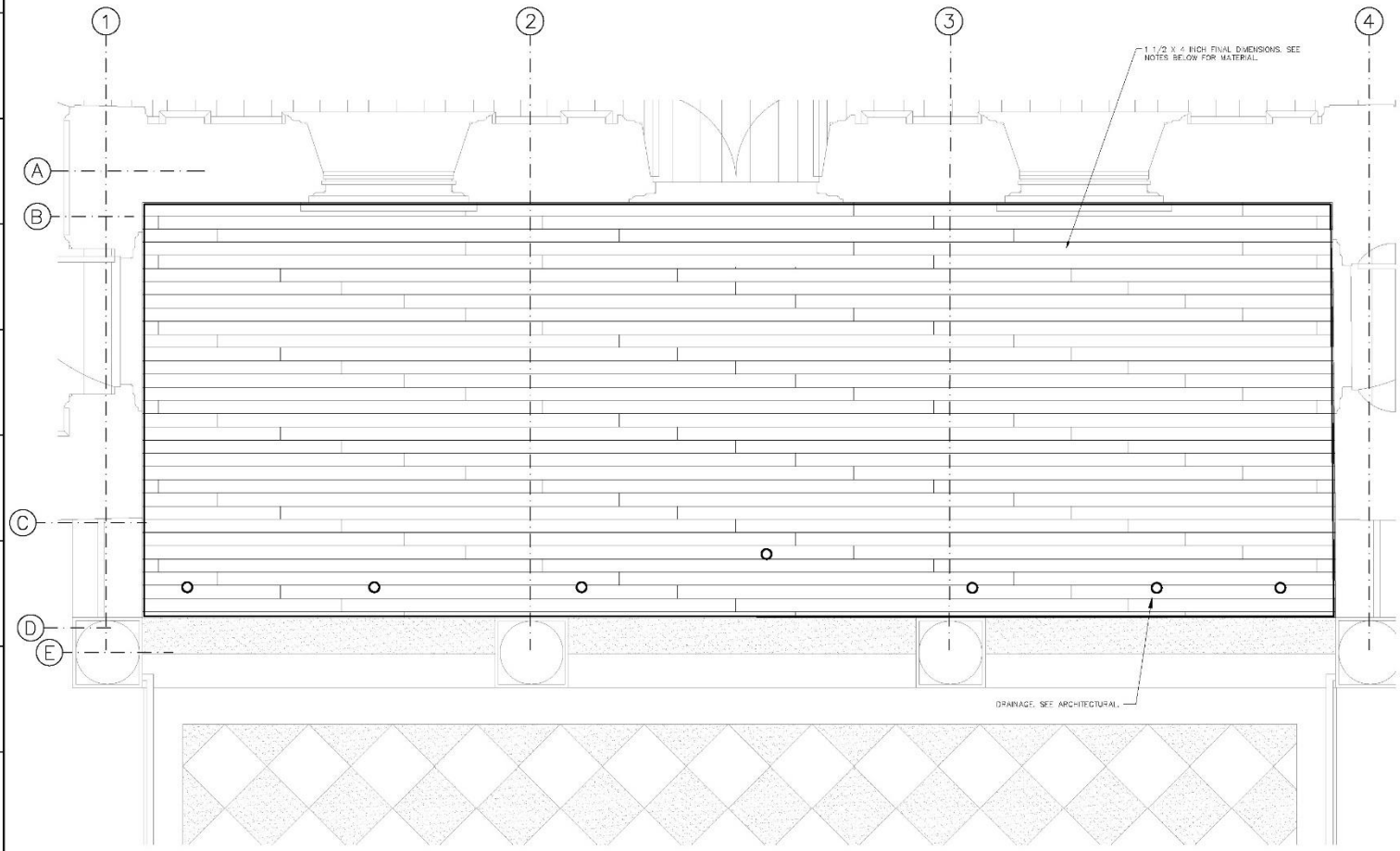
Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK
Checked By: CMB-JR
Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs
Sheet Title: First Floor Framing Plan

Date of Issue: March 13, 2015
Job Number: 09-071B
Sheet Number: S102
Sheet 20 of 58

ON A FULL SIZE DRAWING THIS LINE IS 12 INCHES LONG



1 First Floor Subfloor Plan

Scale: 3/4" = 1'

0 6" 1' 2'

JOIST MATERIAL BASE BID: SALVAGED PINE OR CYPRESS
ALTERNATE #1 TEAK
ALTERNATE #2 IPE
ALTERNATE #3 IROKO
ALTERNATE #4 DENSE SELECT STRUCTURAL
PRESSURE TREATED SOUTHERN PINE

SOURCE: DRAYTON HALL HABS

BUILDING NORTH

Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK
Checked By: CMB/JR
Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs
Sheet Title: First Floor Subfloor Plan

Date of Issue: March 13, 2015
Job Number: 09-071B
Sheet Number: S103
Sheet 31 of 58

ON A FULL SIZE DRAWING, THIS LINE IS 12 INCHES LONG

BASE BID: REINSTALL EXISTING STONES. SEE SALVAGE RATES ON DISASSEMBLY DRAWINGS. CONTRACTOR TO VERIFY CONDITION OF ALREADY REMOVED STONES FOR REINSTALLATION AND BID QUANTITY. SEE SPECIFICATIONS FOR UNIT PRICES.

ALT 1: REINSTALL EXISTING BROWNSTONE AND LIMESTONE. REPLACE EXISTING MARBLE WITH NEW LIMESTONE. DO NOT DISCARD MARBLE.

ON WEST EDGE OF FIRST FLOOR PORTICO MATCH NEW ELEVATION OF FINISHED FLOOR TO EXISTING ELEVATION OF STONES.

FINAL ELEVATION OF FINISHED FLOOR TYP. NOTE THAT UPPER EAST EDGE VARIES AND LOWER WEST EDGE DOES NOT VARY.

109.18

109.12

109.18

FOR DRAINAGE MAT, SEE ARCHITECTURAL.

108.94

108.94

108.94

108.94

REMOVE AND REINSTALL RAIL ONLY AS NEEDED FOR STEP REMOVAL, TYP.

REPOINT, SEE ARCHITECTURAL.

FILL CRACKS IN LIMSTONE WITH BEDDING MORTAR, SEE ARCHITECTURAL SPECIFICATIONS FOR BEDDING MORTAR FOR STONES. EOR/CONSERVATOR TO EXAMINE PREVIOUS LOSS COMPENSATION REPAIRS FOR POSSIBLE REPLACEMENT WITH DUTCHMEN.

SOURCE: DRAYTON HALL HABS

BUILDING NORTH

1 First Floor Plan

Scale: 3/4" = 1'

0 6" 1' 2'

Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK

Checked By: CMB/JR

Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs

Sheet Title: First Floor Plan

Date of Issue: March 13, 2015

Job Number: 09-071B

Sheet Number: S104

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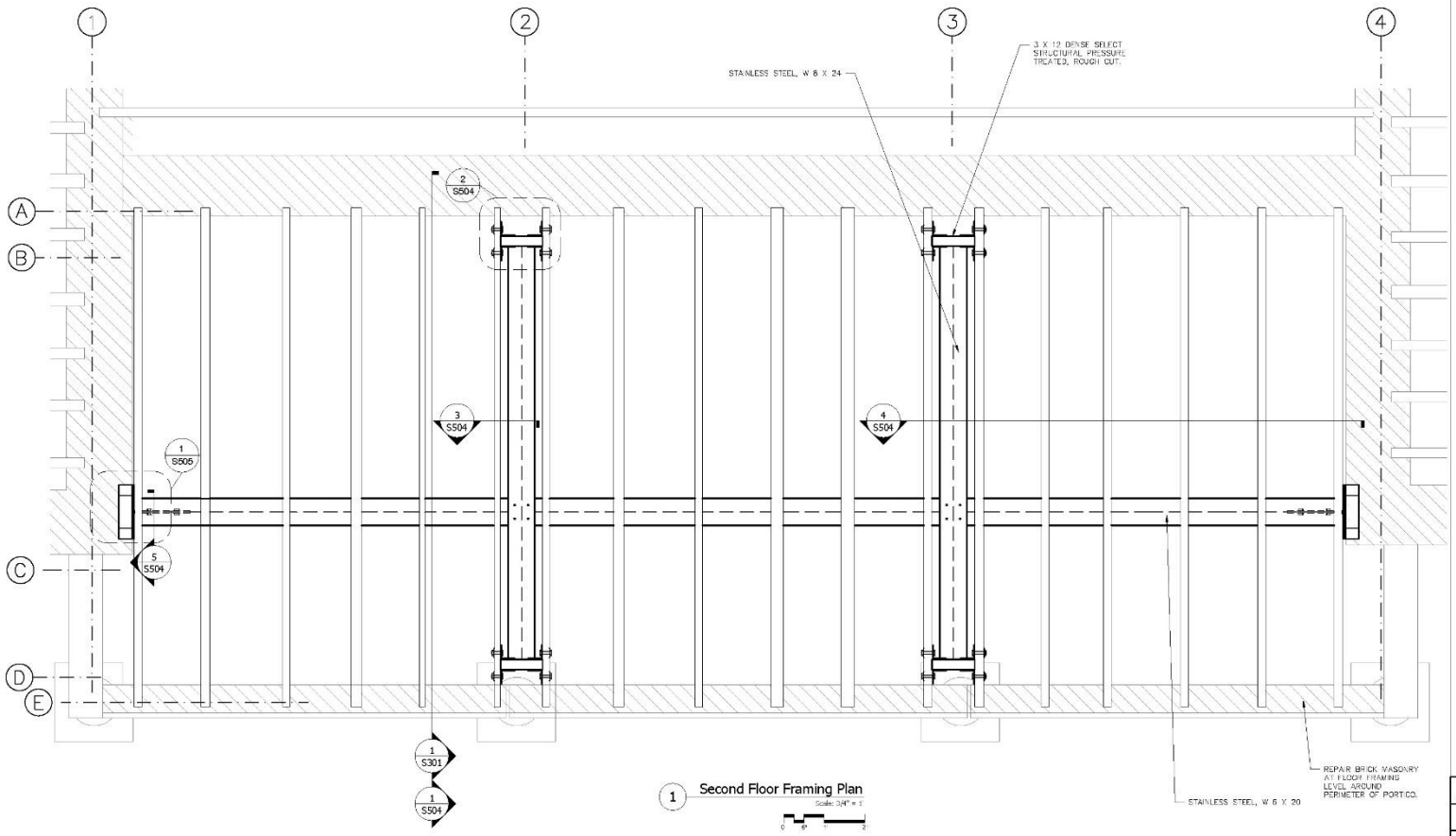


1 Second Floor Framing Plan

Scale: 3/4" = 1'

SOURCE: DRAYTON HALL HABS

BUILDING NORTH

Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK

Checked By: CMR,JR

Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs

Sheet Title: Second Floor Framing Plan

Date of Issue: March 13, 2015

Job Number: 09-071B

Sheet Number: S105

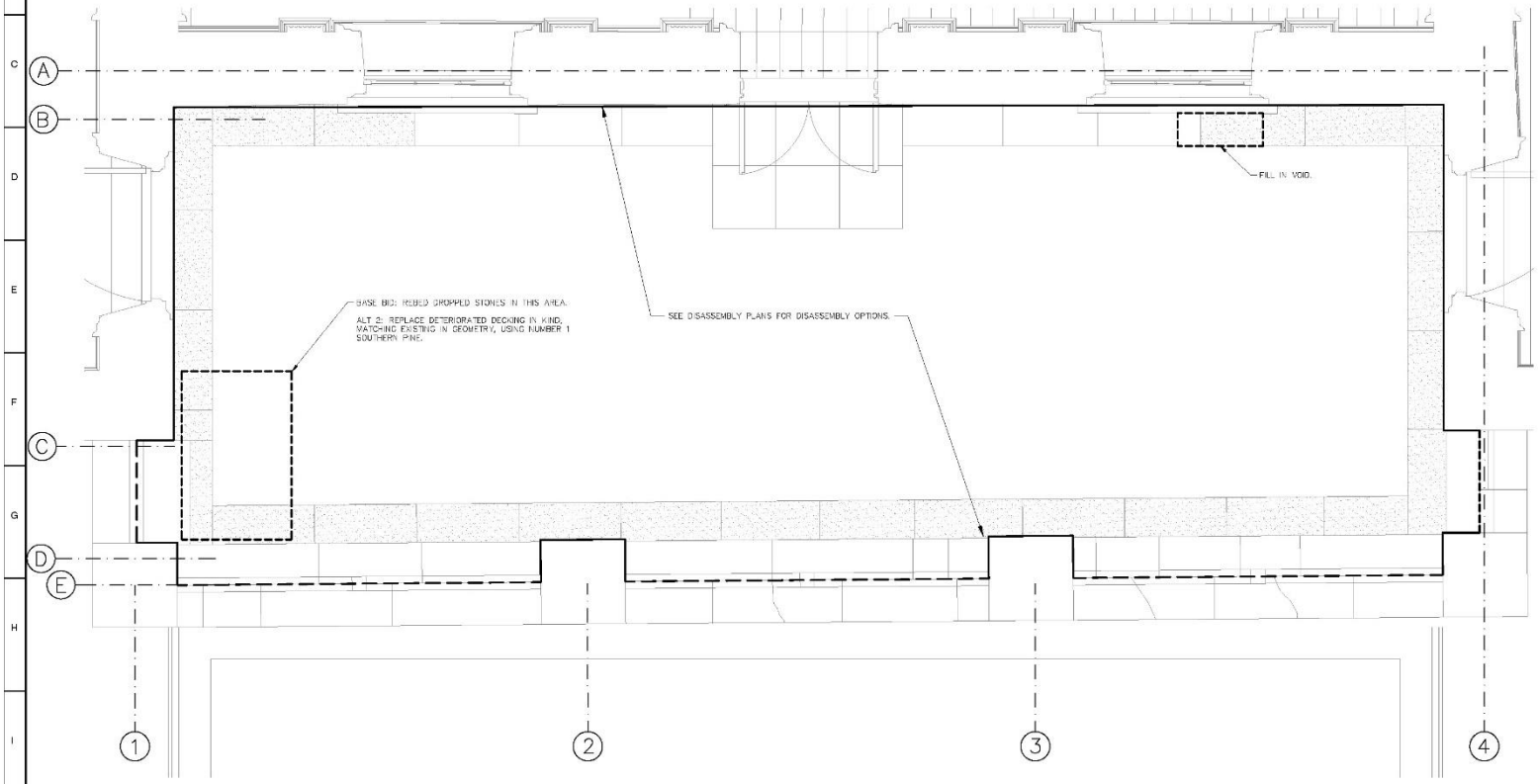
Sheet 33of 58

ON A FULL SIZE DRAWING THIS LINE IS 12 INCHES LONG

BASE BID: FILL IN VOID WHERE CONCRETE WAS REMOVED FOR EXPLORATORY MEASURES. REBED DROPPED STONES ON NORTH. SEE ARCHITECTURAL FOR WATERPROOFING MEMBRANE.

ALT 1: REMOVE SIX STONE PAVERS. FILL ALL VOIDS AS PER NOTES FOR ALT 2. DROP TOP OF PLYWOOD ELEVATION 1/4 INCH AND SHAVE SURROUNDING CONCRETE TO ALLOW DOORS TO SWING OPEN. SEE ARCHITECTURAL FOR WATERPROOFING MEMBRANE.

ALT 2: AFTER REMOVAL OF CONCRETE, REPAIR TIMBER AND MASONRY EDGES OF PORTICO. REPAIR DETERIORATED DECKING. LAY DOWN 3 1/2 INCH WIDE FURRING STRIPS AT PERIMETER THEN AT 16 INCH SPACING WITHIN FIELD OF PORCH RUNNING NORTH/SOUTH WITH 16 INCH O.C. EAST/WEST SPACING. BLOCK WITH ADDITIONAL FURRING STRIPS BETWEEN NORTH/SOUTH STRIPS AT 48 INCHES O.C. NEW FURRING STRIPS SHALL BE NUMBER 1 SOUTHERN PINE, PRESSURE TREATED AND KILN DRIED AFTER TREATMENT. DEPTH OF FURRING STRIPS IS APPROX. 2 7/8 INCHES BUT SHOULD BE ADJUSTED SO THAT 3/4 INCH PLYWOOD ON TOP OF FURRING STRIPS IS FLUSH WITH WEST EDGE AND SHOULD MATCH CURRENT ELEVATION OF EXISTING PAVERS ALONG EAST EDGE. DROP 1/4 INCHES IN MIDDLE EAST SIDE TO ALLOW FOR DOORS TO SWING OPEN. ATTACH 3/4 INCH (NOMINAL) STRUCTURAL 1 PLYWOOD TO FURRING STRIPS WITH 2 INCH NUMBER 8 STAINLESS STEEL WOOD SCREWS AT 6 INCHES O.C. PERIMETER AND 12 INCHES O.C. INTERIOR. SEE ARCHITECTURAL FOR WATERPROOFING MEMBRANE.



1 Second Floor Plan
Scale: 3/4" = 1'

SOURCE: DRAYTON HALL -ASS

BUILDING NORTH

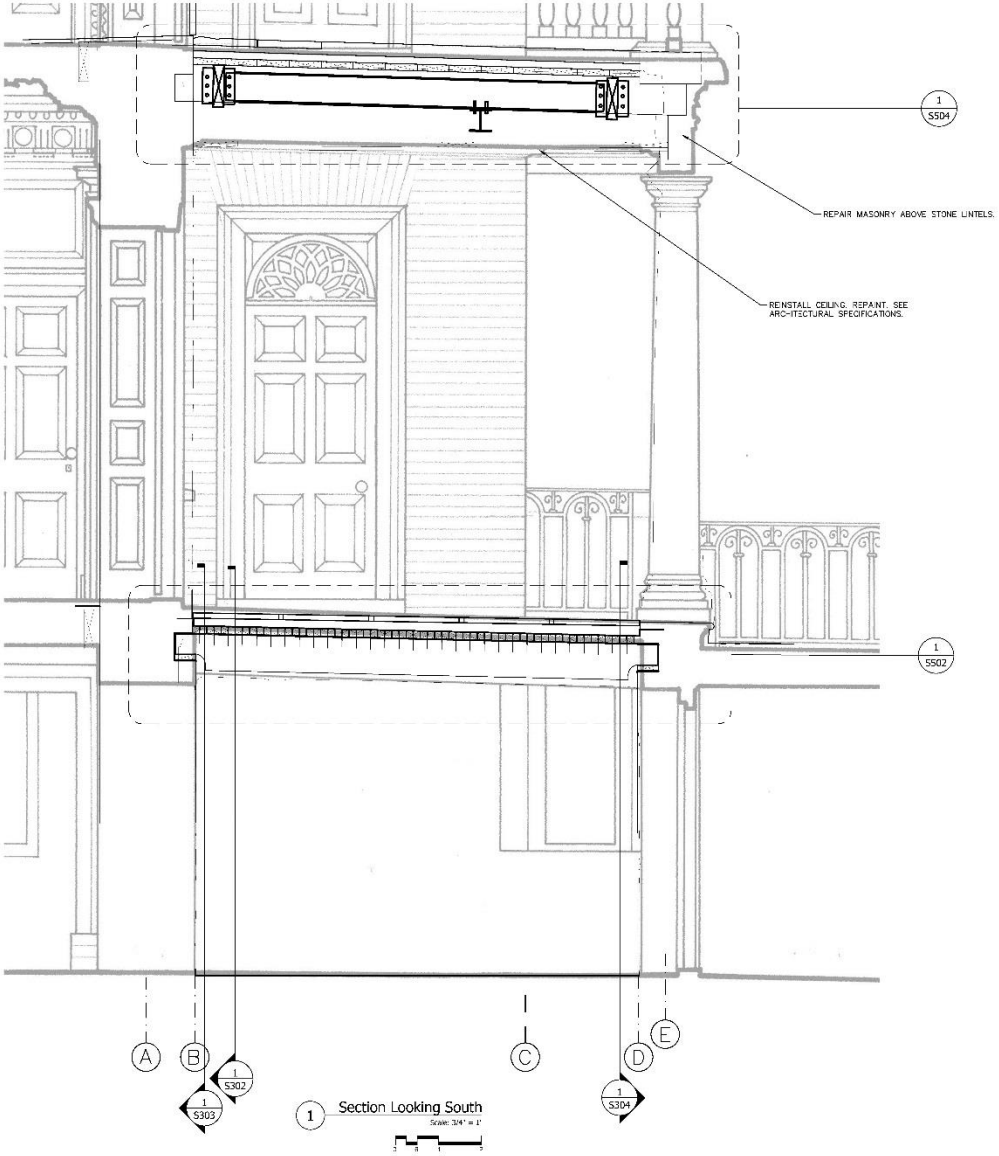
Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK
Checked By: CMB,JR
Phase: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs
Sheet Title: Second Floor Plan

Date of Issue: March 13, 2015
Job Number: 09-071B
Sheet Number: S106
Sheet 34 of 58

ON A FULL SIZE DRAWING, THIS LINE IS 12 INCHES LONG



1 Section Looking South
Scale: 3/4" = 1'

SOURCES: HABS
DISTO SCANS

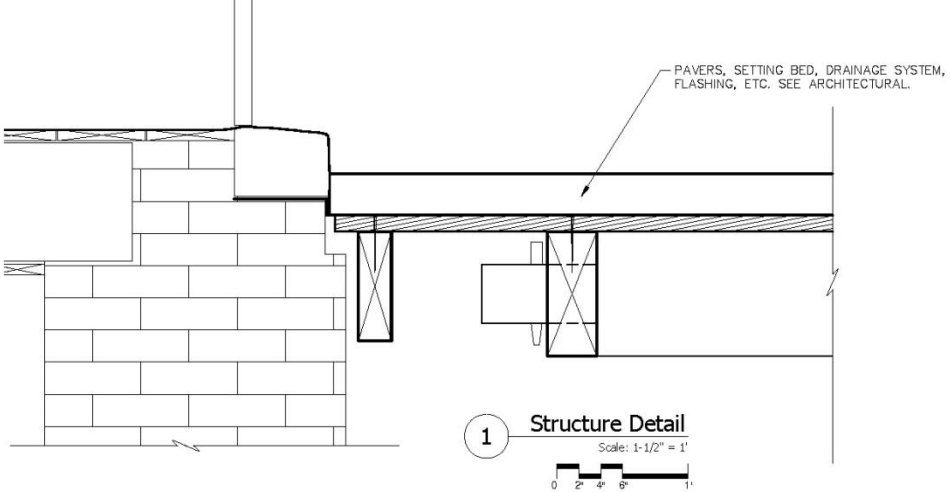
Bennett PRESERVATION ENGINEERING PC

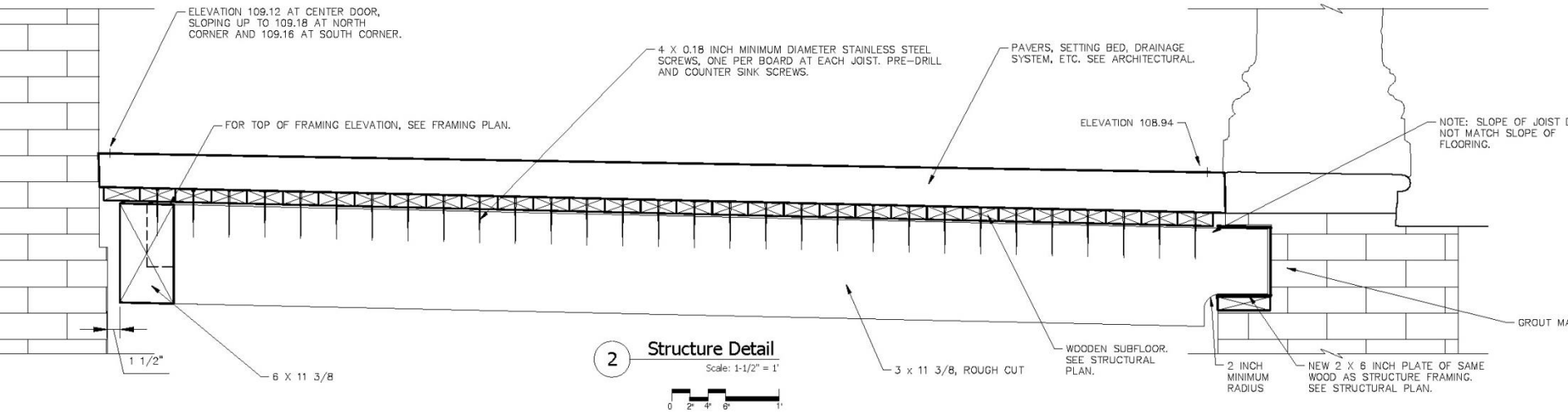
Drawn By: ESK
Checked By: CMB JR
Issue: Final Pricing and Coordination Construction Documents

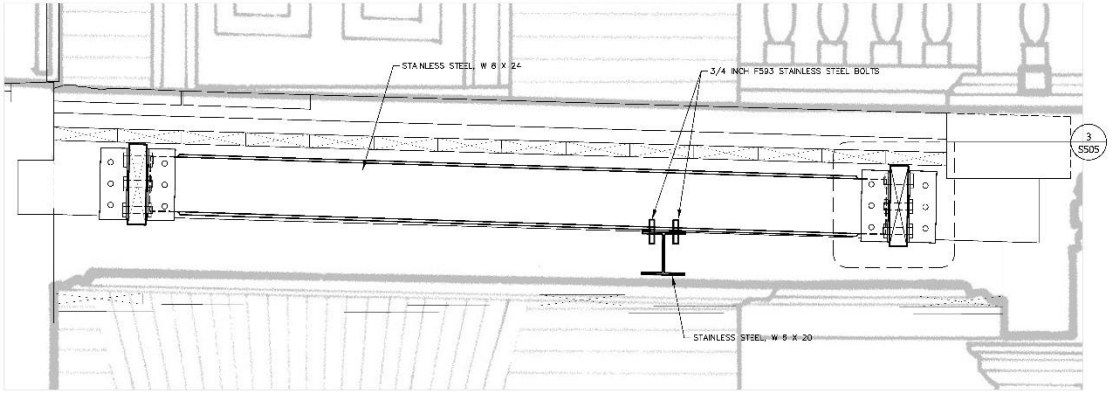
Job Name: Drayton Hall Portico Repairs
Sheet Title: Section Looking South

Date of Issue: March 13, 2015
Job Number: 09-071B
Sheet Number: S301
Sheet 53 of 58

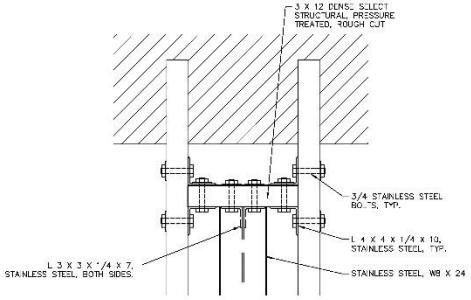
ON A FULL SIZE DRAWING, THIS LINE IS 12 INCHES LONG


PAVERS, SETTING BED, DRAINAGE SYSTEM, FLASHING, ETC. SEE ARCHITECTURAL.
1
Structure Detail
Scale: 1-1/2" = 1'
0 2" 4" 6" 1'

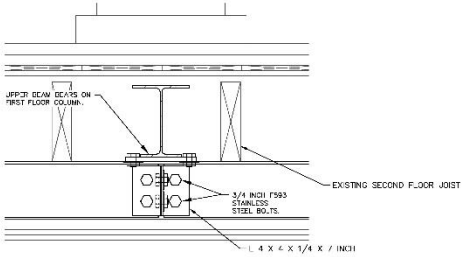

ELEVATION 109.12 AT CENTER DOOR, SLOPING UP TO 109.18 AT NORTH CORNER AND 109.16 AT SOUTH CORNER.
FOR TOP OF FRAMING ELEVATION, SEE FRAMING PLAN.
4 X 0.18 INCH MINIMUM DIAMETER STAINLESS STEEL SCREWS, ONE PER BOARD AT EACH JOIST. PRE-DRILL AND COUNTER SINK SCREWS.
PAVERS, SETTING BED, DRAINAGE SYSTEM, ETC. SEE ARCHITECTURAL.
ELEVATION 108.94
NOTE: SLOPE OF JOIST D
NOT MATCH SLOPE OF
FLOORING.
GROUT MA
1 1/2"
6 X 11 3/8
2
Structure Detail
Scale: 1-1/2" = 1'
0 2" 4" 6" 1'
3 x 11 3/8, ROUGH CUT
WOODEN SUBFLOOR. SEE STRUCTURAL PLAN.
2 INCH MINIMUM RADIUS
NEW 2 X 6 INCH PLATE OF SAME WOOD AS STRUCTURE FRAMING. SEE STRUCTURAL PLAN.



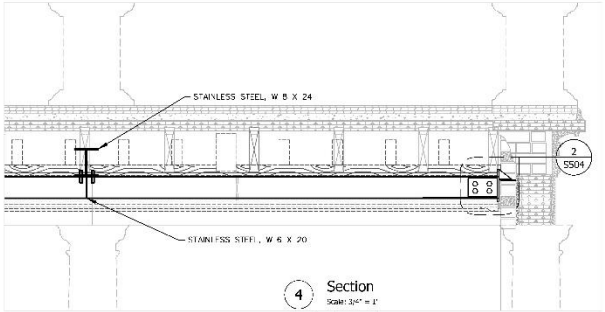
1 Section
Scale: 1-1/2" = 1'



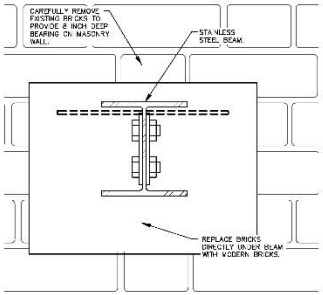
2 Typical Header Detail
Scale: 1 1/2" = 1'



3 Steel Beam Connection
Scale: 1-1/2" = 1'



4 Section
Scale: 3/4" = 1'



5 Steel Beam at Walls
Scale: 1" = 1'

SOURCE: RICHARD MARKS RESTORATIONS AND FABS

Bennett PRESERVATION ENGINEERING PC

Drawn By: EDK
Checked By: CKB JR
Issue: Final Pricing and Coordination Construction Documents

Job Name: Drayton Hall Portico Repairs
Sheet Title: Second Floor Details

Date of Issue: March 4, 2015
Job Number: 09-071B
Sheet Number: S504
Sheet 38 of 58

ON A FULL SIZE DRAWING, THIS LINE IS 12 INCHES LONG

Main House

2015 Structural Evaluation and Visitorship Study

Findings and Conclusions

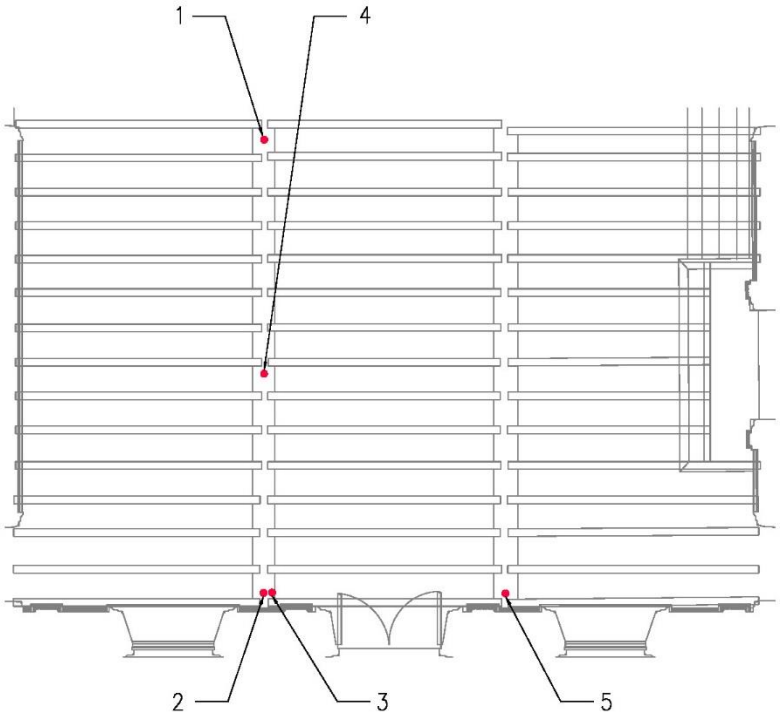
Visitorship

- Live loads
- Lateral loads

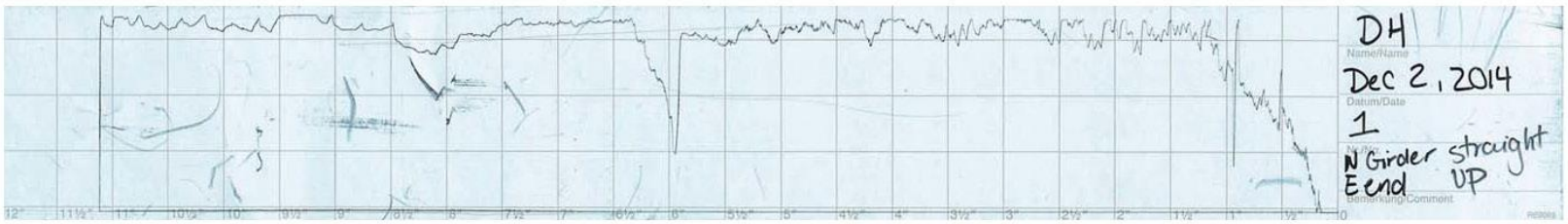
Findings and Conclusions

Wooden Framing

- Rot
- Termite damage



Resistance Drill Key - First Flooring Framing of Great Hall

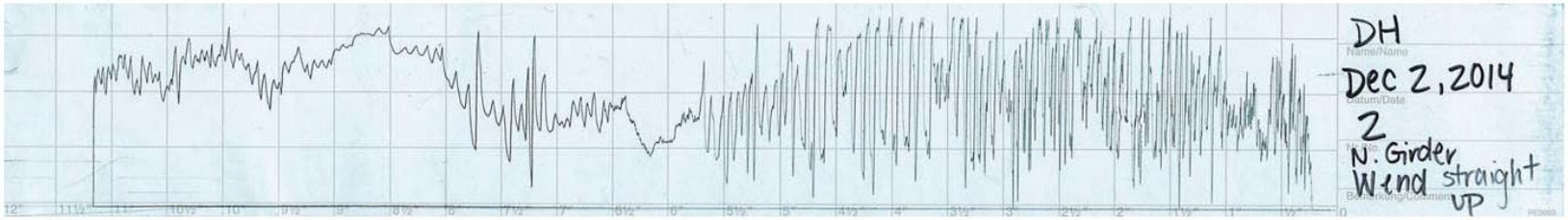


Top of Girder

Maximum extent of resistance drill approximately 11"

Bottom of Girder

Figure G1: Drilled at the east end of the north girder, straight up from bottom. The girder at this end is in good condition. There appears to be a check or split at mid-depth of the member.

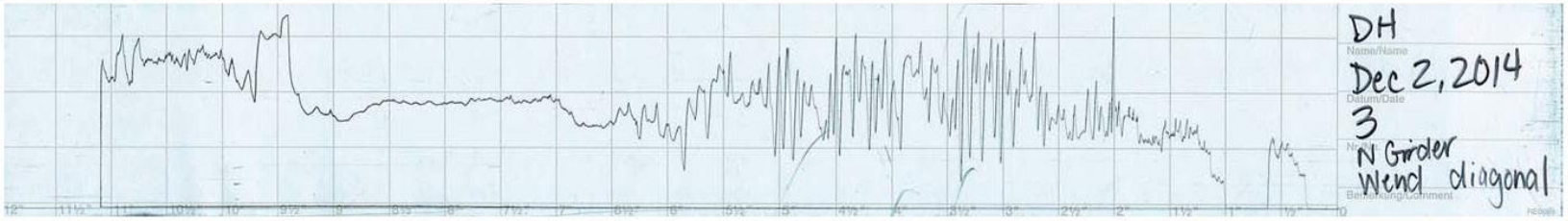


Top of Girder

Maximum extent of resistance drill approximately 11"

Bottom of Girder

Figure G2: Drilled at the west end of the north girder, straight up from bottom.
The results show termite damage (termite galleries) in the bottom 5 1/2 inches.

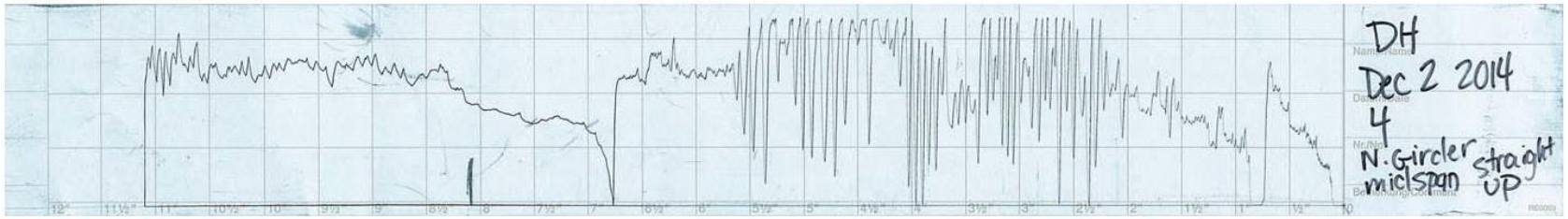


Top of Girder

Maximum extent of resistance drill approximately 11"

Bottom of Girder

Figure G3: Drilled at the west of the north girder, diagonally from the bottom south corner of the member upward. The results show termite damage (termite galleries) in the bottom of the member.

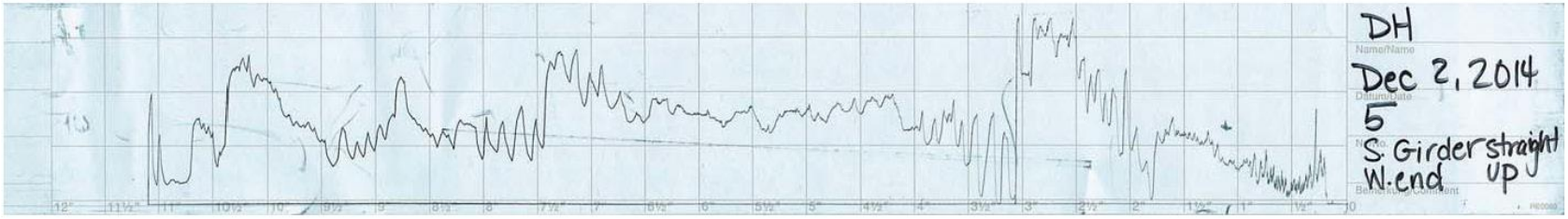


Top of Girder

Maximum extent of resistance drill approximately 11"

Bottom of Girder

Figure G4: Drilled at the middle of the north girder, straight up from bottom.
The results show termite damage (termite galleries) in the bottom 5 1/2 inches. Damage is similar to the damage at the west end.



Top of Girder

Maximum extent of resistance drill approximately 11"

Bottom of Girder

Figure G5: Drilled at the west end of the south girder, straight up from bottom.
The girder at this end is in relatively good condition.

DRAYTON
N. Girder
E. end 1
STANLEY
THE STANLEY WORKS © 1986
P.R. APP'D NO. 339 TC

E A PARTNER IN PRESERVATION
JOINT MEMBERSHIP IN THE FRIENDS OF DRAYTON HALL
THE NATIONAL TRUST FOR HISTORIC PRESERVATION
BENEFITS
MEMBERSHIP DUES SUPPORT
EXPOSÉ
EXCLUSIVE MEMBER EVENTS

5L

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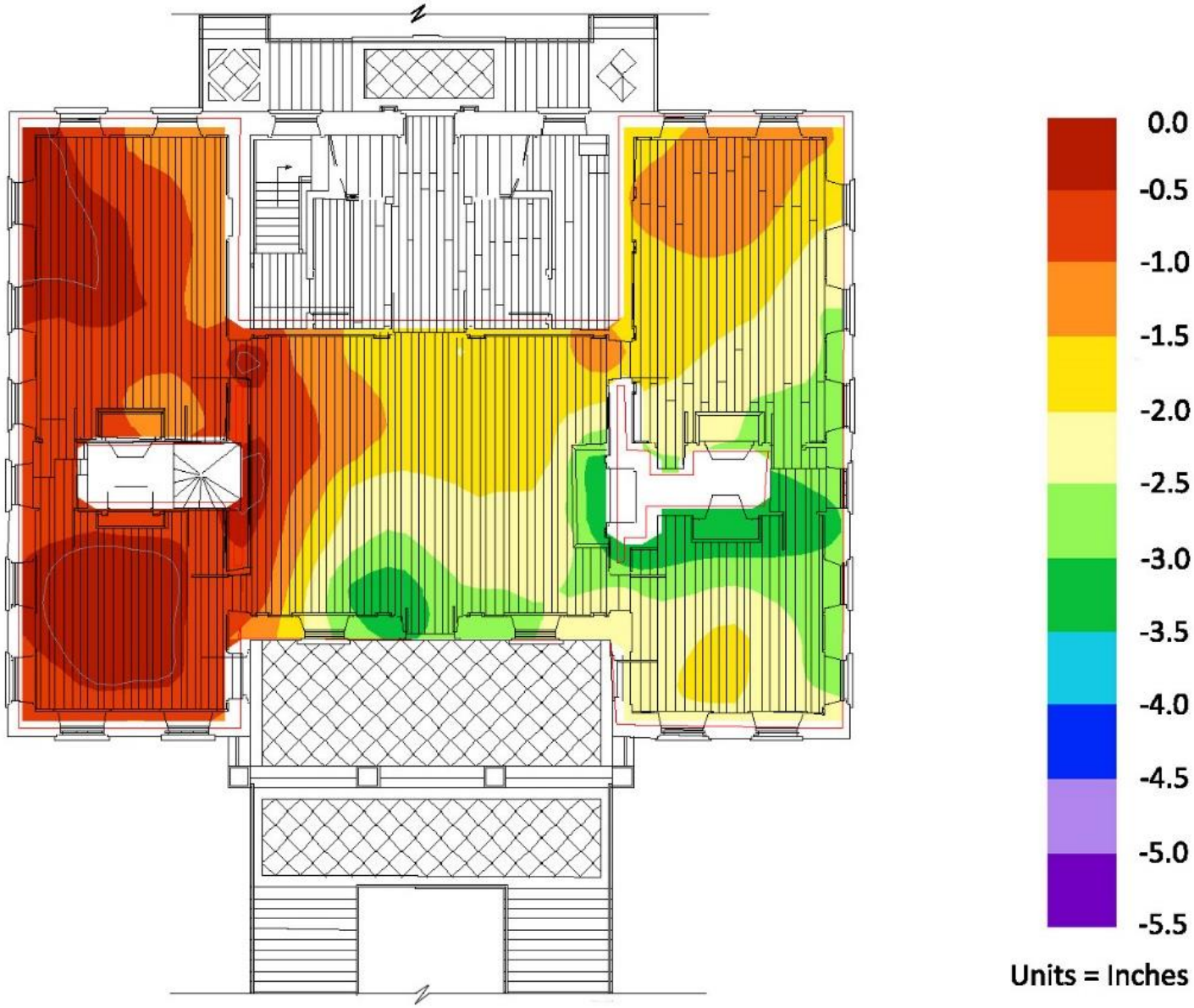
BECO

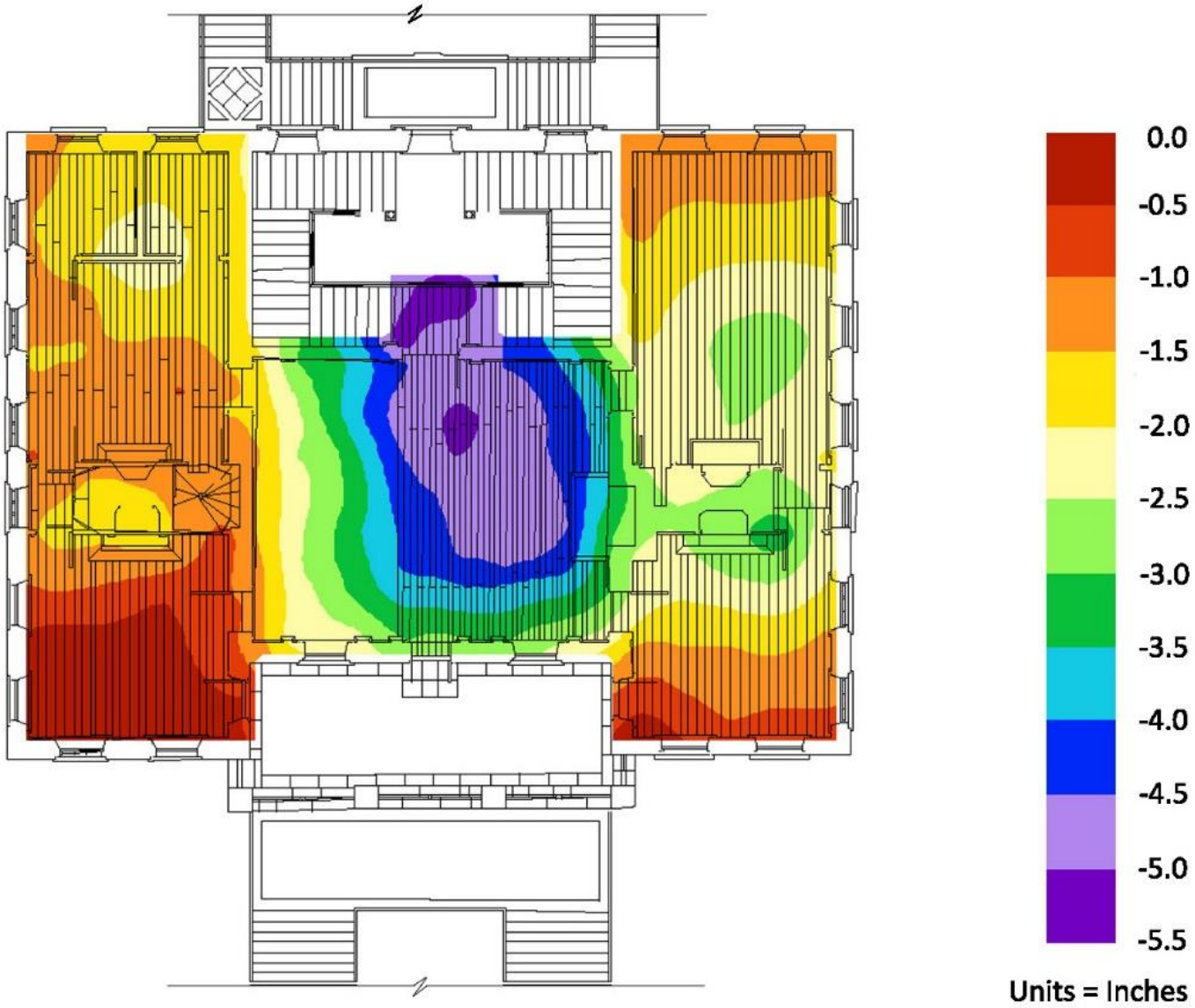
Findings and Conclusions

Wooden Framing

- Undersized members
- Large deflections



Drayton Hall - First Floor Deformations (Contour Map) 2014



Drayton Hall - Second Floor Deformations (Contour Map) 2014

in
8m/26'
cm

11-3

Findings and Conclusions

Roof Framing

- Not original
- North, south, and portico ridge lines are sloped.
- Outward thrust is affecting the north and south masonry walls.

Findings and Conclusions

Wall Framing

- First and second floor east wall of the Great Hall has dropped.
- Bow in wooden crown molding.

Findings and Conclusions

Stairs

- Undersized stringers
- Handrail connections