Appendix I

Feasibility Study Reports - Mueser Rutledge Consulting Engineers

Mueser Rutledge
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April 28, 2015

PPG Industries, Inc.
EH&S Services
One PPG Place
Pittsburgh, PA 15272

Re: Removal of Boiler Room Structural Slab
Site 156 – Metropolis Towers Boiler Room
270 and 280 Louis Munoz Marin Boulevard
Jersey City, NJ
MRCE File 11857

Gentlemen,

Mueser Rutledge Consulting Engineers (MRCE) has evaluated the structural impacts of remediating sub-slab chromium impacted soils below the boiler room floor. Based on our evaluation, demolition of the concrete slab would compromise the slab integrity both in and around the area of the concern. This letter report was prepared in connection with AECOM's Remedial Investigation and Remedial Action Work Plan (RI/RAWP) and will become an attachment to that document, which will be provided separately.

On April 15, 2015 MRCE, AECOM, CB&I and representatives from Weston Solutions, DEP and the Site Administrator's office met at the site to review and discuss field conditions, available information and this proposed path forward. The discussion focused on an area of concern depicted on the attached AECOM Figure 2, "Sub-Slab Soil Sample Cr+6 Results," which includes a "Proposed Excavation Area" that was marked up by Weston Solutions on behalf of NJDEP. A portion of this area is currently occupied by a concrete pile cap below the column to the south of the area of concern.

Available Structural Drawings and Reinforcing Steel Framing

From a review of available structural drawings from mid-1960's construction, lower reinforcing bar framing consists of #4 bars (1/2" diameter) at 12-inch spacing center to center in each direction continuous throughout with a minimum of 40 bar diameter overlap (20-inches) for use as splices. Upper reinforcing steel configurations interpreted at #5 bars on

approximately 6-inch centers are shown to vary within these limits. All bars are ordered to be placed with ¾-inch clearance of top and bottom.

MRCE Test Pit Investigation

The MRCE test pit investigation confirmed minimum cover with top reinforcing on approximately 6-in centers and bottom reinforcing on approximately 12-in centers each way. The 9-in slab thickness was placed closer to 10 to 12-inches where encountered in the field, underlain by several inches of a void space (generally 3-in or more) as a result of the underlying soil backfill settling away from the underside of the slab. The structural slab supports dead and live loads by spanning between pile caps. The test pit investigation also confirmed the presence of a void space between the underlying soils and the bottom of the concrete slab. During the meeting, NJDEP suggested that this void space would provide a capillary break and prevent the upward migration of chromium. This will be further evaluated as part of AECOM's subsequent RI/RAWP.

Drill Hole Access and Vacuum Option

Consideration was given as to whether the concrete could be core drilled to provide periodic access points, after which soil could be removed by vacuum methods and the slab concrete and structural capacity restored "in-kind". From a constructability perspective, periodic drilled access openings would require a minimum diameter of 8-in to 12-in to provide adequate space to maneuver and angle the vacuum hose to reach and remove soil to full depth throughout the delineated area. Such a large opening is precluded by the existing steel bars in each direction on as close as 6-in spacing providing no greater than a 5.5-inch by 5.5-inch square openings between #4 and #5 bars, less where overlapping splices exist. Further, it is anticipated that a minimum 2-ft by 2-ft slab removal "window" would be required to sufficiently access the impacted material below the slab for removal.

As reinforcing bar locations are unknown and non-destructive type geophysical tests are likely to be inconclusive given the high density of bars at two and in some places three depths within the slab in each direction, reinforcing bars would inadvertently be cut during the core drill process. Cut bars cannot be structurally restored within core drilled holes.

Vacuum Efficiency

Even if the above methodology was successful in obtaining access to the underlying soil without structural damage, the character of the soil encountered in the MRCE test pit suggested that vacuum removal would not be successful without the use of a steel bar or pick to loosen material. This type of removal would be rendered infeasible due to the small work zone access.

Saw Cut and Jack Hammer Option

Consideration was given to mechanical demolition of the concrete leaving the reinforcing steel bars intact. However, the chipping process required to sufficiently remove the concrete would result in irreparable damage to the reinforcing steel, and likely fully cut or sever the steel in multiple locations. Couplers are infeasible due to limited concrete cover over the

bars. Bars could not feasibly be exposed and protected for the design splice length of 20-inches (40 x bar diameter) around the perimeter as the bars would extend into pile caps and columns and beneath the east boiler.

Floor Slab Opening, in General

Regardless of the method, removal of concrete and exposing reinforcing bars in such proximity to column supports and pile caps or existing live loads results in changes in load path and stress distributions within the existing floor slab, footings and column framing system supporting the first floor. This is not recommended for a structural slab.

Conclusion

Based on this evaluation, MRCE has concluded that the remediation of soil to the applicable criteria is technically impracticable from an engineering perspective because demolition of the concrete slab would compromise the slab integrity and affect the long term structural capacity of the boiler room slab.

Please do not hesitate to contact us should you have any questions.

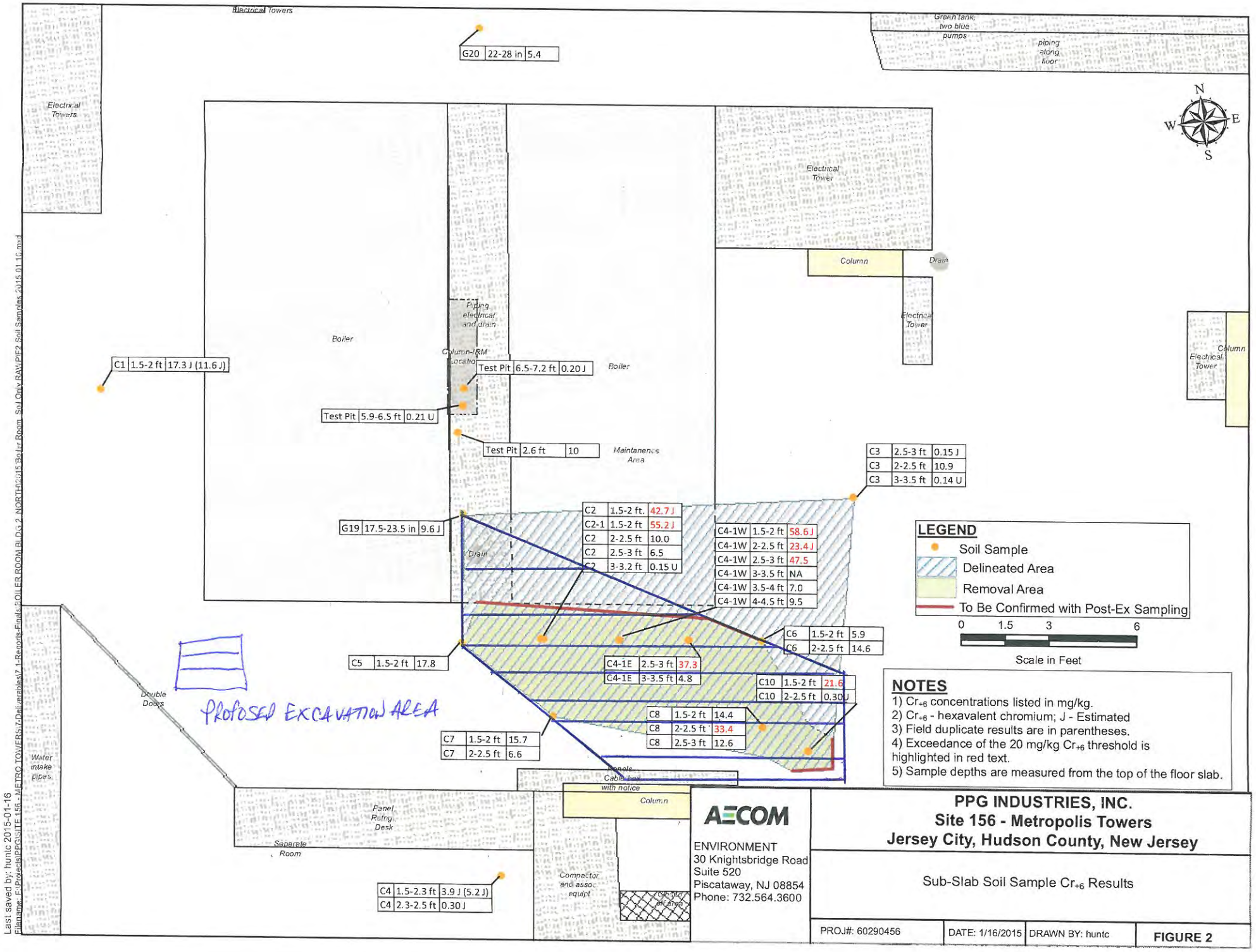
Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS

By: _____
Peter W. Deming, P.E.

Attachments

JLV:EB:SRL:PWD:AL(AECOM):TG(CB&I):F:\118\11857\270 Marin Boiler Room Column Repair\Boiler Room Slab 2015-04-28 tg.docx



NOTES

1) Cr_{+6} concentrations listed in mg/kg.
2) Cr_{+6} - hexavalent chromium; J - Estimated
3) Field duplicate results are in parentheses.
4) Exceedance of the 20 mg/kg Cr_{+6} threshold is highlighted in red text.
5) Sample depths are measured from the top of the floor slab.

AECOM
ENVIRONMENT
30 Knightsbridge Road
Suite 520
Piscataway, NJ 08854
Phone: 732.564.3600

PPG INDUSTRIES, INC.
Site 156 - Metropolis Towers
Jersey City, Hudson County, New Jersey

Sub-Slab Soil Sample Cr_{+6} Results

PROJ#: 60290456	DATE: 1/16/2015	DRAWN BY: huntc	FIGURE 2

Last saved by: huntc 2015-01-16
Filename: F:\Projects\PPG\SITE 156 - METRO TOWERS\7-Deliverables\7.1-Reports-Finals\COILER ROOM BLDG 2 NORTH\2015 Boiler Room Soil Only RAW PIP2 Soil Samples 2015 01 16.mxd

Mueser Rutledge
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December 1, 2014 *(Rev. 1, October 5, 2015)*

CB&I on behalf of,
PPG Industries
EH&S Services
One PPG Place
Pittsburgh, PA 15272

Attention: Mr. Thomas Gibbons (thomas.gibbons@cbi.com)

Re: Feasibility Study for Structural Remediation
of Chromium Contaminated Concrete
Metropolis Towers – Building 2 – Boiler Room
Jersey City, New Jersey
MRCE No. 11857

Gentlemen:

At your request we have prepared this feasibility study for remediation of chromium impacted concrete in the above referenced building. Impacted concrete includes both a column and portions of the slab in the boiler room, located between the two operating boilers that service the building. See attached Figure 11 - Remedial Action Extents by AECOM for plan location of the impacted column and portions of the slab, shaded green.

PROJECT DESCRIPTION

In November 2012, AECOM discovered a potential chromium bloom at the base of a column in the boiler room of Metropolis Towers Building 2. AECOM installed an Intermediate Remedial Measure (IRM) around the base of the column. Subsequent tests were performed on the column and surrounding slab concrete resulting in positive results for chromium contamination. Additional actions were proposed to assess the feasibility of remediating the column to eliminate potential chromium exposure to the building occupants and staff.

MRCE evaluated two concrete remediation alternatives for:

- structural feasibility,
- impact to surrounding structural elements,
- impact on mechanical, electrical, and plumbing (MEP) equipment,
- the duration of construction,
- the construction equipment required,
- inherent risks, and

- relative cost

Our evaluation was based on the available structural drawings, chromium sampling tests provided by AECOM, and site visits to the boiler room (to understand available space restrictions and to observe the MEP equipment adjacent to the column). Based on available information, the column is 1ft x 4ft and is supporting a load of approximately 1400 kips.

The alternatives developed are conceptual. Actual quantities of removed concrete, if any, will be dependent on visual inspection and confirmation testing of concrete during remediation.

EXHIBITS

Figure 11	Remedial Action Extents, by AECOM dated 11/17/2014
Drawings SK-1 to SK-4	Sketches of remediation alternatives
Tables 1 & 2	Cost estimates of remediation alternatives
Appendix A	Photographs
Appendix B	Product literature for structural and vapor barriers
Appendix C	AECOM memorandums dated 7/26/13 and 10/11/13
Appendix D	Site 156 Test Pit Investigation 10/28/14

REMEDIATION ALTERNATIVES

Based on the available information, MRCE developed two conceptual remediation alternatives. For these remediation alternatives we assume the average compressive strength of the structural column meets existing structural design requirements. Coring and laboratory strength testing should be performed to determine the strength of the contaminated concrete left in place. The provided sketches are intended to illustrate general concepts and are not suitable for construction. One alternative involves remediating the column in place, while the other involves temporarily supporting the column structurally to allow removal of contaminated concrete. Description of alternatives, risks, relevant questions and implementation sequence are as follows:

Alternative 1: Seal concrete in place with membrane and armor (concrete left in place)

The deterioration resulting from concrete spalling and other structural degradation can be remediated by providing structural confinement to the concrete through the use of structural fiber wrap technology such as Sikawrap described in Appendix B. We recommend placing structural fiber wrap around the base of the column to a distance of 4 ft (column length) above the observed chromium bloom.

The health hazard resulting from the physical chromium bloom can be remediated by isolating chromium from public and boiler room worker access. A membrane such as Bituthene, described in Appendix B, is recommended for isolation of the concrete column. A spray-on membrane such as Liquid Boot, described in Appendix B, is recommended for isolation of the concrete floor around the column and below the boilers.

The sealed column with membrane remedy can be made permanent by preventing evaporation through use of vapor barriers to maintain moisture within the concrete column and floor. The isolation membranes should perform this vapor barrier function. The vapor barrier, to be effective long term, should be extended throughout the warm boiler room space *to limits determined appropriate by AECOM as the environmental consultant based on a reasonable and conservative range over which it is presumed chromium could wick through concrete should it come in contact again at some point in the future. Areas of the floor where covered, should be lapped and sealed similar to shingling or flashing*.

Mechanical protection and management control should be provided to protect the isolation and vapor barriers. We recommend placing a 3" thick fiber-reinforced concrete floor topping over the floor, and placing metal lath and concrete mortar (trowel-on) around the column. *Any floor penetrations such as drains should be made air-tight with compression fitting gaskets and the floor barrier should seal to the drain cover to the extent practical to minimize surface evaporation which potentially drives chromium salt migration or wicking*. Mechanical protection allows minimal management control, which may entail repair of the barrier only if maintenance work performed the barrier.

We recommend "armoring" the column where impacted concrete is left in place, by affixing diamond steel plate and signage indicating "do not drill or penetrate" to affected areas. We recommend a minimum armor thickness of ¼.

This alternative would have minor impact on MEP equipment immediately adjacent to or attached to the column (see Photos 1 through 5 in Appendix A). There is relatively small risk to adjacent structural elements and the operating boilers would not be impacted. This alternative does not require heavy equipment. We estimate this alternative could be completed in two weeks and the relative cost would be approximately $60,000.

Implementation sequence for Alternative 1 (Refer to SK-1 and SK-2*, replaced by Drawing P-1 and S-1 per Rev. 1*):

1. Remove pipes directly next to column.
2. Relocate electrical box attached to column.
3. Remove IRM (existing encapsulation).
4. Patch spalled section of column with new mortar to square off dimensions of column.
5. Apply structural reinforcement membrane to column.
6. Apply vapor barrier to column.
7. Apply spray on membrane to floor slab.
8. Apply mechanical protection to column and slab.
9. Affix "armor" plating to affected areas of column.
10. Replace piping next to column.
11. Replace electrical box.

Alternative 2: Remove and replace exposed contaminated column and slab concrete (boilers are temporarily supported and jacked or relocated temporarily)

The pile cap concrete and the boilers are left in place. Portions of the CCPW-impacted column and slab concrete are replaced. This alternative includes taking boilers out of service one at a time, and potentially draining and jacking and lifting the boilers off the slab to facilitate complete removal and replacement of the CCPW-impacted slab beneath them. The vapor and mechanical protection of Alternative 1 is recommended to prevent post-contamination similar to current condition.

This alternative would require high impact on MEP equipment immediately adjacent to or attached to the column (See Photos 1 through 5). This alternative requires sequential demolition of the concrete slab to expose the top of the pile cap which remains in place and which will support a transfer frame to temporarily unload the concrete column. A temporary steel jacking frame will transfer load from column to pile cap while contaminated concrete in the column is removed and replaced. The impacted portion of the column cross section would be chipped out with a jackhammer: damaged reinforcement replaced by doweling into the column and pile cap. The column repair would then be formed to place new concrete.

This alternative would require a forklift or portable lifting frame to place the structural steel of the jacking frame, in addition to handheld equipment to demolish concrete and drill cores in the concrete. There are risks of causing structural damage with any temporary support of existing structure and a specialty contractor with adequate experience and insurance is required. We estimate this alternative could be completed in approximately six to eight weeks and cost approximately $225,000 in addition to the $60,000 cost of sealing the column and slab described in Alternative 1. Additional time may be required to allow the slab concrete to cure up to sufficient strength before returning boilers to original position. We have included approximately $60,000 to evaluate and take each boiler out of service temporarily, drain and disconnect them, frame and lift or shift their locations, and return by lowering or shifting them back to their original locations.

Relevant questions and concerns for Alternative 2:

- There is limited access to the boiler room; there are double doors (5’10” wide by 6’10” tall) that lead directly to stairs down to floor level (See photos 8 and 9 in Appendix A). Getting a forklift and structural steel into basement will take planning and possible building modifications.
- Construction activities have to consider space restrictions in the boiler room (See Figure 1 and the provided photographs in Appendix A) as well as being coordinated with routine maintenance operations in the boiler room.

Implementation Sequence Alternative 2 (Refer to SK-3 and SK-4):

1. Determine area of slab to be removed. Design temporary support of boilers after area of slab identified for removal is determined. Design likely to include needle beams and jacking system to transfer load off of existing contact points to area outside of impacted slab areas.
2. Remove/relocate pipes directly adjacent to column.
3. Relocate electrical box from column.

4. Remove IRM.
5. Demolish/remove impacted slab concrete which conflicts with column jacking frame.
6. Prep/level pile cap for steel post base plates.
7. Install steel posts and fill with high early strength concrete.
8. Locate and drill core holes in concrete column (nondestructive testing for location of reinforcement in column).
9. Place steel channels on column.
10. Install thru-bolts and tighten steel channels to column.
11. Setup posts and hydraulic jacks below steel channels. Install frame bracing.
12. Once concrete in steel posts reaches required strength, transfer load from existing column onto the temporary frame to pile cap.
13. Demolish/remove of contaminated column concrete, carefully chipping around column reinforcement.
14. Place forms around column base, coat with bonding agent and pour new concrete.
15. Allow concrete to set then release jacking load and remove jacks.
16. Remove steel channels, thru bolts and temporary support frame.
17. Patch core holes with high strength concrete.
18. Install temporary support frame to shift boilers off of existing supports to expose impacted slab.
19. Sequentially replace concrete slab in strips per Engineer's direction and/or approved Contractor sequence and allow cure to required design strength. Reinforcement to remain intact and be reused where practical.
20. Return boilers to original position on new slab concrete.
21. Carry out Alternative 1 sequence to isolate and armor column.
22. Replace MEP equipment as necessary.

CONCLUSION

This feasibility report for column remediation was prepared to evaluate alternatives in terms of complexity, duration, and costs if three feasible construction alternatives. Table 1 summarizes the comparison of the three remediation alternatives.

Table 1. Remediation Alternative Comparison

Remediation Alternative	Remedy	Approximate Construction Duration	Approximate Construction Cost	Heavy Equipment Required
1. Seal impacted concrete in place with membrane and armor (concrete & boilers left in place)	Corrects mechanical hazard, isolates chromium, and prevents additional pollutant transport. Mechanical protection reduces management control demand.	2 weeks	$60,000	None

2. Remove and replace impacted column and slab concrete (boilers shifted and returned to original position above new concrete)	Removes exposed contaminated concrete and prevents future re-contamination.	6 to 8 weeks	$285,000	Forklifts and lifting frames

Alternative 1 is recommended. Sealing the concrete in place with a membrane accomplishes the goal of protecting human health and the environment while minimizing impact to residents and building operations while reducing the risk to the structure.

Please contact us if you have any questions.

Very truly yours,

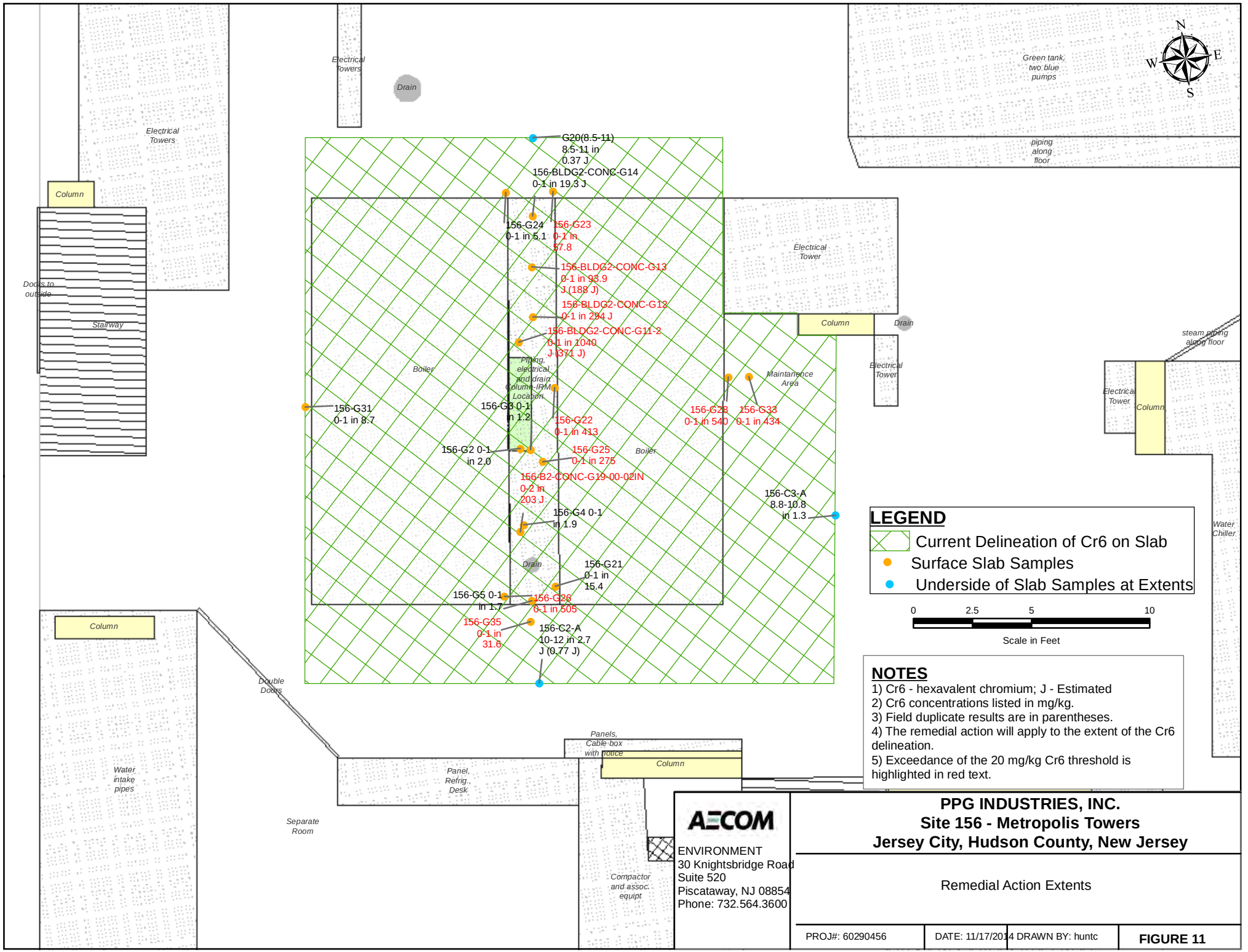
MUESER RUTLEDGE CONSULTING ENGINEERS

By: _____
Peter W. Deming, PE

Attachments

cc: Alfred LoPilato, AECOM (via email)

ELB:SRL:JLV:PWD: TG (CB&I) AL (AECOM) :F:\118\11857\270 Marin Boiler Room Column Repair\MRCE Feasibility Study for Remediation of Contaminated Column 2014-12-01.docx



AECOM
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PPG INDUSTRIES, INC.
Site 156 - Metropolis Towers
Jersey City, Hudson County, New Jersey

Remedial Action Extents

PROJ#: 60290456	DATE: 11/17/2014 DRAWN BY: huntc	FIGURE 11

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Filename: F:\Projects\PPGSITE 156 - METRO TOWERS\7-Deliverables\7.1-Reports-Finals\BOILER ROOM BLDG 2_NORTH\2014_11_RI_RAWP\Figures\F11 Cr6 Extent.mxd

MUESER RUTLEDGE CONSULTING ENGINEERS

SHEET ____ OF ____

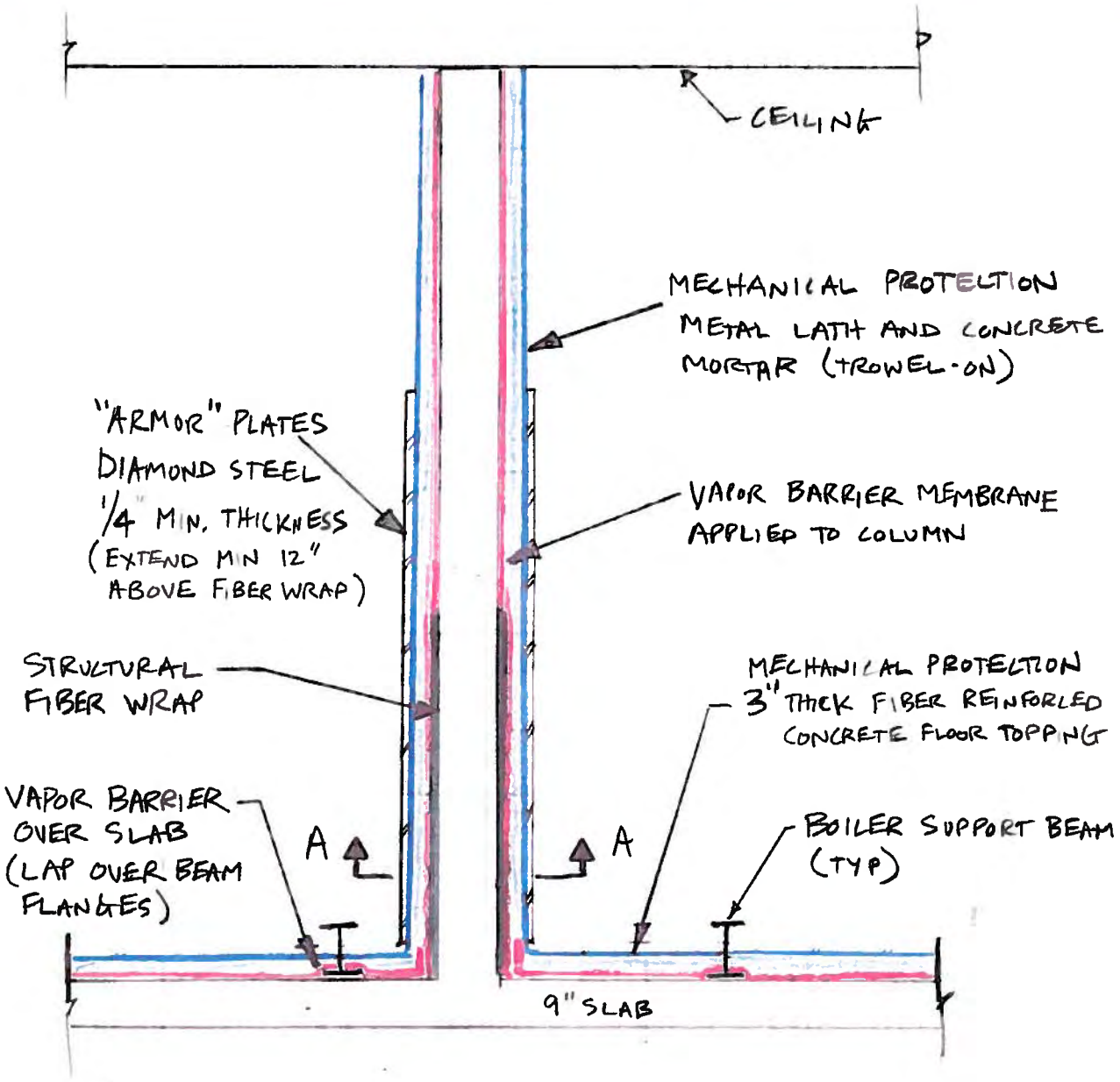
FILE 11857

PROJECT METRO TOWERS

MADE BY ELB DATE 1/6/2014

CHECKED BY ____ DATE REV 10/23/14

SUBJECT Alt. 1: Seal concrete in place with membrane and armor (concrete left in place) SK-1



VERTICAL SECTION

SCALE 3/8" = 1'-0"

MUESER RUTLEDGE CONSULTING ENGINEERS

SHEET ____ OF ____

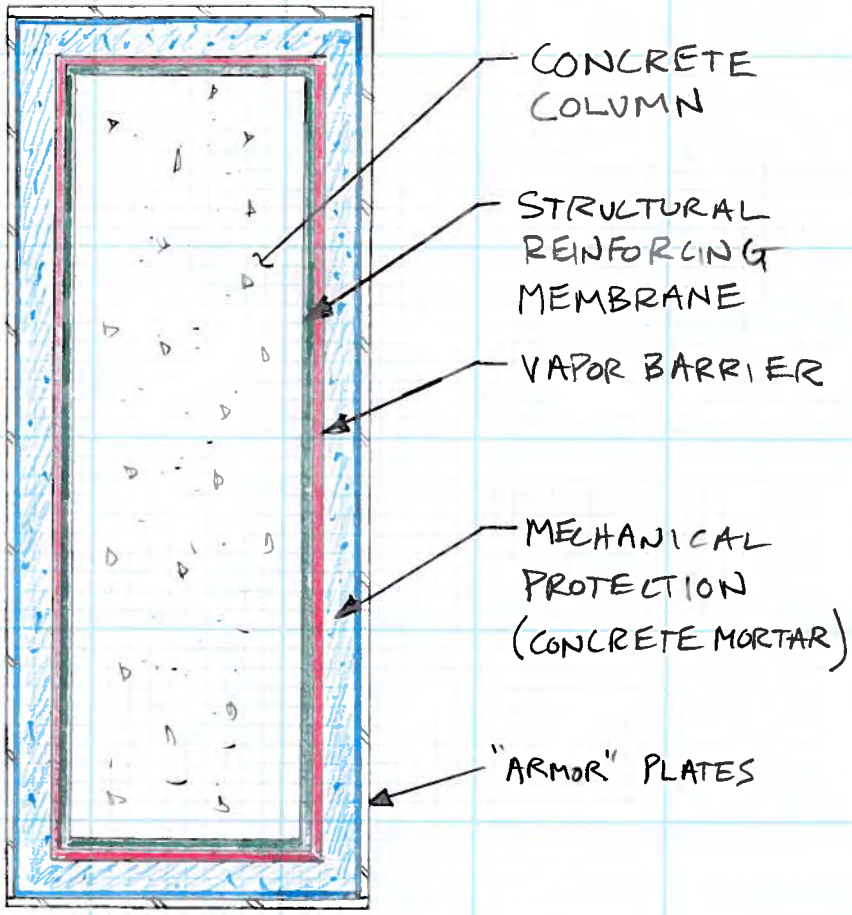
FILE 11857

PROJECT METRO TOWERS

MADE BY ELB DATE 1/6/2014 REV 10/23/14

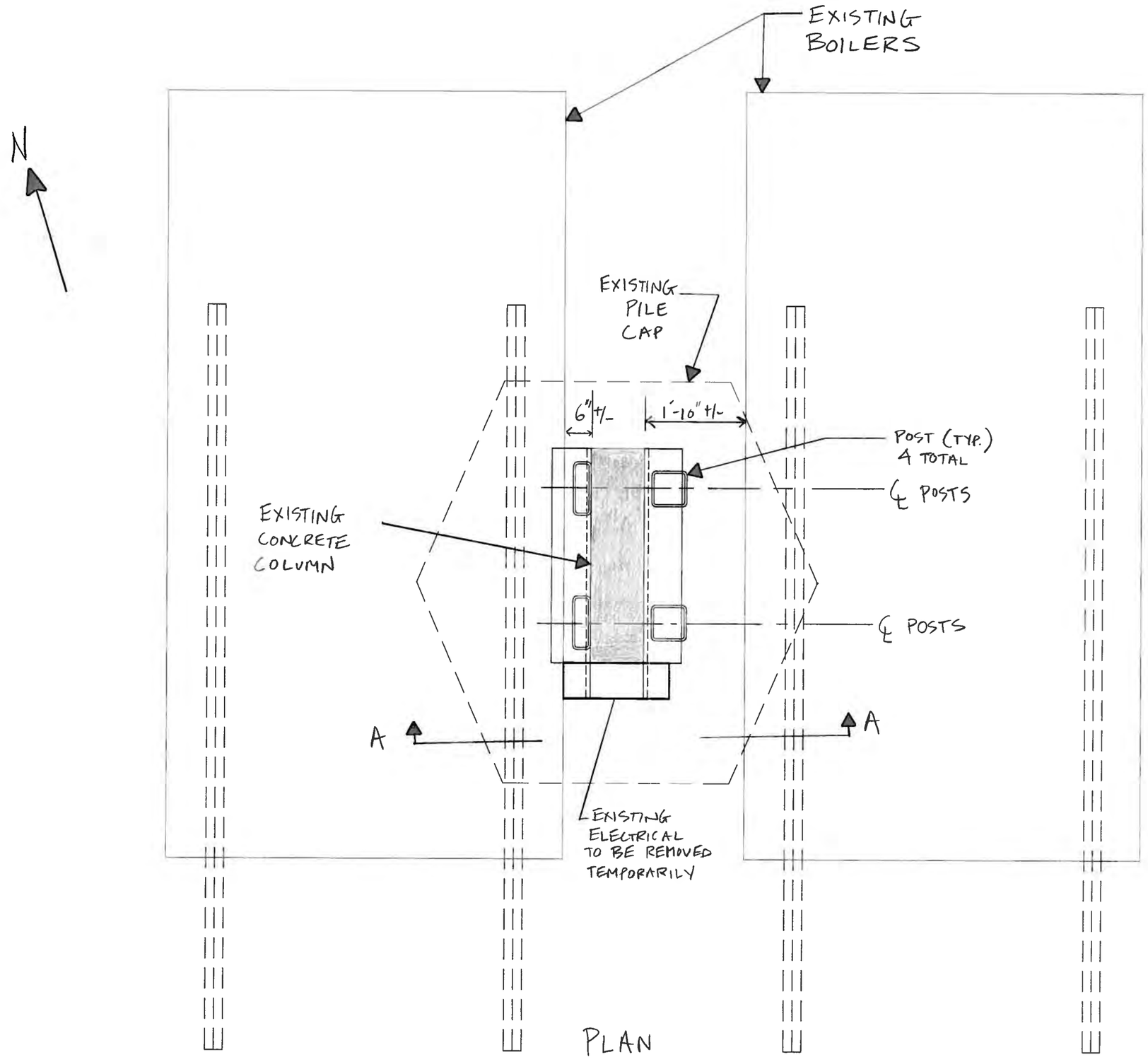
CHECKED BY ____ DATE ____

SUBJECT Alt. 1: Seal concrete in place with membrane and armor (concrete left in place) SK-2



COLUMN SECTION A

SCALE 1" = 1'-0"



PLAN

1/2" = 1'-0"

Not shown: Jack boilers to transfer load away from current framing system and demolish and replace slab in kind per sequence to be determined.

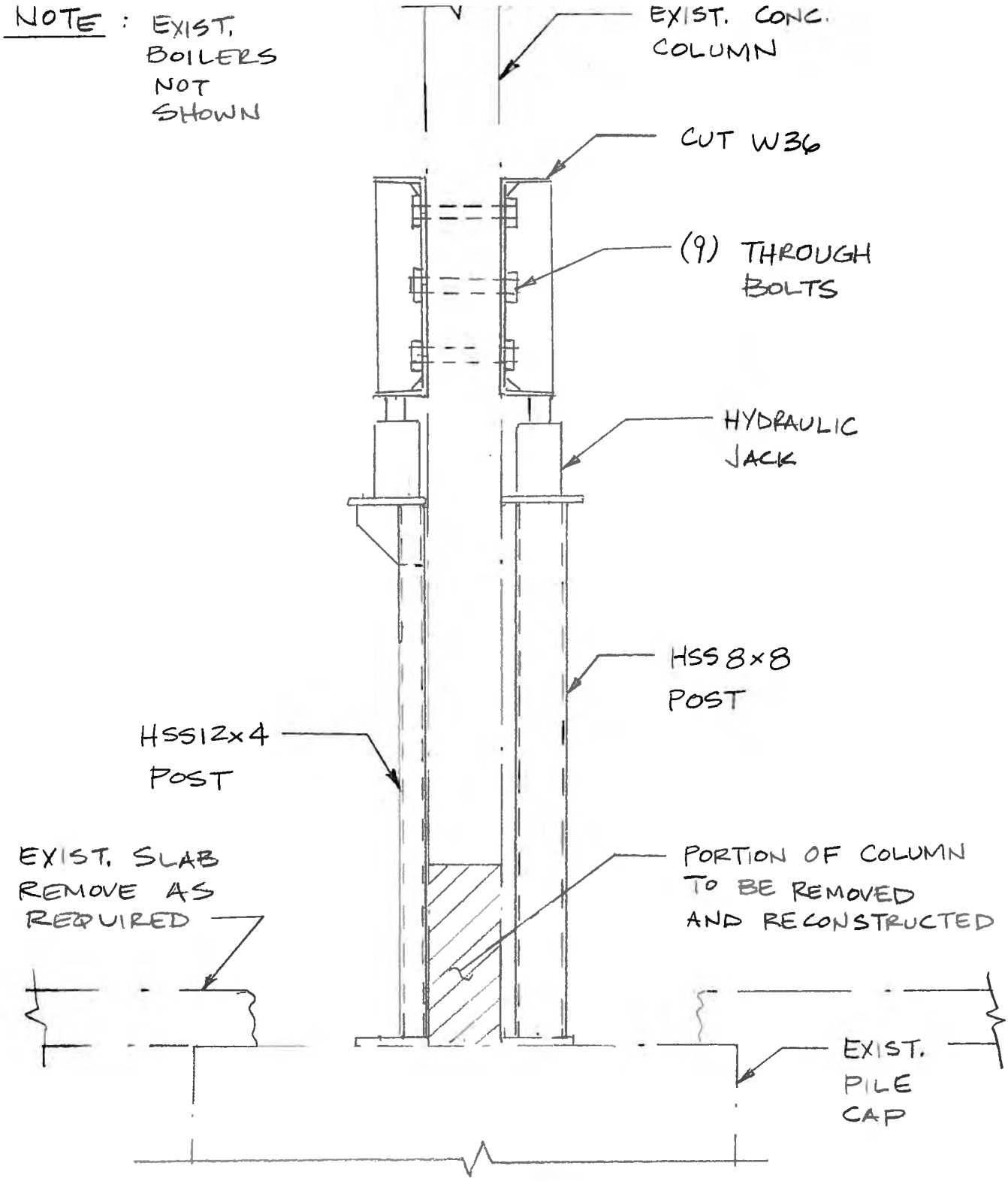
SK-3

Alternative 2: Remove and replace exposed contaminated column and slab concrete (boilers remain in place but are temporarily supported and jacked)

MRCE # 11857

1/6/2014

Alt. 2: Remove and replace exposed contaminated column and slab concrete (boilers remain in place but are temporarily supported and jacked) SK-4



SECTION A-A
½" = 1'-0"

MUESER RUTLEDGE CONSULTING ENGINEERS

File: 11857

10/24/2014

FOR: PPG Industries

Checked By: _____ Date: _____

SUBJECT: **Metro Towers Contaminated Column Remediation**

TABLE 1 - COST ESTIMATE FOR ALTERNATIVE 1

Item	Description	Quantity	Units	Material	Labor	Equipment	Subtotal	Total incl O&P
1	**Dismantling pipes adjacent to column (Plumbers)**	1	Work Days		$1,000	$200	$1,200	$1,526
2	**Remove electrical box (Electricians)**	1	Work Days		$1,600	$200	$1,800	$2,290
3	**Structural Wrap Membrane (50" x 150' roll)**	2	Work Days	$1,400	$1,500		$4,400	$5,597
4	**Bituthene Membrane Vapor barrier column**	2	Work Days	$2,000	$1,500		$5,000	$6,360
5	**Liquid Boot vapor barrier for slab**	2	Work Days	$2,000	$1,500	$1,000	$5,000	$6,360
6	**Mechanical protection (fiber reinforced concrete)**	4	Work Days	$2,000	$1,500	$500	$8,000	$10,176
7	**Re-install pipes adjacent to column (Plumbers)**	1	Work Days		$1,000	$200	$1,200	$1,399
8	**Re-install electrical box (Electricians)**	1	Work Days		$1,600	$200	$1,800	$2,290
9	**Engineer Inspection/Oversight**	4	Work Days				$1,000	$4,240
10	**Diamond Steel Plate Armoring For Concrete**	1	Ea.				$8,000	$8,000
							Subtotal	**$48,238**
							Location adjustment	**$53,061**
							Contingency @ 20%	**$7,236**
							Say	**$60,297**

Notes:

1 Reference: RS Means Heavy Construction Cost data 2013 for labor/crew costs

2 City cost index For Jersey City, NJ, (City code 073) Weighted Average is 110 compared to national average of 100

3 Pipe removal consider as Pipe repair; Plumbing crew Q-1A: Plumber and 1/4 day for foreman

4 Electrical box relocation crew is R-18: Electrician and 2 helpers

5 Cost of structural membrane based on SIKA HEX 100G

6 Future costs of column inspection/monitoring not included.

MUESER RUTLEDGE CONSULTING ENGINEERS

Sheet No. _____ of _____
File: 11857
Made By: ELB Date: 12/20/2013
Checked By: _____ Date: _____

FOR: PPG Industries

SUBJECT: **Metro Towers Contaminated Column Remediation**

TABLE 2 - COST ESTIMATE FOR ALTERNATIVE 2

Item		Description	Quantity	Units	Material	Labor	Equipment	Subtotal	Total incl O&P	Cost incl 0&P
1	02 41 16.17 2440	**Concrete Slab Removal**	525	S.F.		$11.85	$1.74	$13.59	$20	$13,356
	3 41 16.17 2600	**For average reinforcing add 10%**								$1,336
2	02 41 19.16 1450	**Concrete Column Removal, Cutout**	32	C.F.		$20.50	$2.99	$23.49	$35	$1,404
4	02 41 16.17 4250	**Concrete Disposal Cost**	21	C.Y.		$300.00	$9.70	$309.70	$372	$9,752
5		**Structural Steel**								
	05 12 23.75 7920	**W36x262 (2 beams, 12ft long)**	24	LF	$360.00	$3.77	$1.56	$365.33	$405	$12,364
	05 12 23.17 4600	**HSS 8x8 14ft long (cut in half for two 7ft posts)**	1	Ea.	$730.00	$54.00	$30.00	$814.00	$930	$1,183
	05 12 23.17 5650	**HSS 12x4(use 10"x6" price) 14ft long (cut in half for two 7ft posts)**	1	Ea.	$730.00	$54.00	$30.00	$814.00	$930	$1,183
6		**Hydraulic Jacks Rental for 1 week**	4	Ea./Week	$700.00			$700.00	$840	$3,562
7		**Labor for structural steel installation and jacking**								
		Crew E-4 (similar crew for concrete demo and replacement)	10	Work Days				$1,717.00	$2,986	$37,982
8	03 82 13.10 0300	**Concrete core drilling through 6" wall (9 core holes)**	9	Ea.	$0.41	$40.50	$6.90	$47.81	$70	$935
	03 82 13.10 0350	**Additional 9" drilling for each hole (column is 12" thick)**	6	Additional inch	$0.07	$0.89	$0.15	$1.11	$2	$130
9	01 45 23.50 8000	**Ultrasonic testing for rebar location in column**	1	Ea.	$200.00			$182.00	$200	$254
10		**150ksi Thru Bolts - (9 x 18in long rods)**	9	Ea.	$30.00			$30.00	$42	$401
11		**Mobilization of backhoe loader**	1	Ea.				$3,000.00	$3,600	$3,816
		Rental of forklift to lift steel	20	Day					$500	$10,600
12	03 30 53.40 4840	**Concrete slab replacement**	525	S.F.	$2.59	$0.91	$0.01	$3.51	$4	$2,811
13	03 30 53.40 4260	**Concrete column replacement**	2	C.Y.	$151.00	$136.00	$11.55	$298.55	$390	$992
14	03 21 10.60 0150	**Reinforcement (#4 to #11) for slab, and column**	0.50	Ton		$580.00		$1,560.00	$2,000	$1,378
15	01 54 33.10 1900	**Concrete mixer rental**	4	Week				$425.00	$553	$2,343
16		**Engineer Inspection/Oversight (Not Full time)**	14	Work Days				$1,000.00	$1,000	$14,840
17		**Boiler relocations (design and implementation)**	1	LS				NA	$50,000	$60,000

Subtotal	**$180,621**
Location adjustment	**$198,683**
Contingency @ 15%	**$27,093**
Say	**$225,777**

Notes:

1 Reference: RS Means Heavy Construction Cost data 2013

2 City cost index For Jersey City, NJ, (City code 073) Weighted Average is 110 compared to national average of 100

3 Cost of steel post concrete infill is small volume so it's included in slab and column concrete volume.

APPENDIX A

Photo 1.jpg

Photo 2.jpg

Photo 3.JPG

Photo 4.JPG

Photo 5.JPG

Photo 6.JPG

Photo 7.jpg

Photo 8.JPG

Photo 9.jpg

Photo 10.JPG

Photo 11.JPG

Photo 12.JPG

Photo 13.JPG

Photo 14.JPG

Photo 15.JPG

Photo 16.JPG

Photo 17.jpg

Photo 18.jpg

Photo 19.jpg

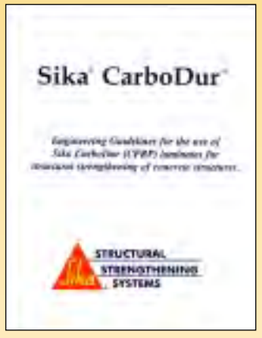
Photo 20.jpg

APPENDIX B

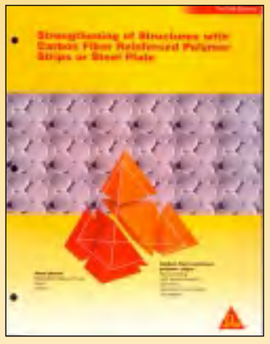
Complete Range Of Composite Materials

		Laminate Properties				
	Description	**Tensile Strength**	**Tensile Modulus**	**Elongation**	**Nominal Thickness**	**Tensile Strength per inch width**
SikaWrap Hex 103C	Carbon fiber fabric (wet lay-up)	139,000 psi (960 N/mm^2)	10.60 msi (73,100 N/mm^2)	1.33%	0.040 in. (1mm)	5,560 lbs./layer (24.7 kN)
SikaWrap Hex 100G	E-Glass Fabric (wet lay-up)	87,000 psi (600 N/mm^2)	3.79 msi (26,100 N/mm^2)	2.24%	0.040 in. (1mm)	3,480 lbs./layer (15.5 kN)
SikaWrap Hex 230C	Carbon fiber fabric (dry lay-up)	139,000 psi (960 N/mm^2)	10.60 msi (73,100 N/mm^2)	1.33%	0.013 in. (0.33mm)	1,807 lbs./layer (8.0 kN)
Sika Wrap Hex 320G	E-Glass Fabric (dry lay-up)	87,000 psi (600 N/mm^2)	3.79 msi (26,100 N/mm^2)	2.24%	0.013 in. (0.33mm)	1,131 lbs./layer (5.0 kN)
Sika CarboDur Strips (Type S)	Pultruded carbon fiber laminate	406,000 psi (2,800 N/mm^2)	23.9 msi (165,000 N/mm^2)	1.9%	0.047 in (1.2mm)	19,082 lbs./layer (84.8 kN)

Also available from Sika



Engineering Guidelines



Strengthening of Structures with Carbon Fiber Reinforced Polymer Strips or Steel Plate

Case Studies

Technology and Concepts for Structural Strengthening

1-800-933-SIKA NATIONWIDE
Regional Information and Sales Centers
For the location of your nearest Sika sales office, contact your regional center.

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Pointe Claire
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Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretara Libre Celaya Km. 8.5
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C.P. 76920 A.P. 136
Phone: 52 42 25 0122
Fax: 52 42 25 0537

For further information:
Visit our website at www.sikausa.com
Or, call our Fax-Back System at: 740-375-0063

SIKA...INNOVATIVE SOLUTIONS FOR A CONCRETE WORLD™

SikaWrap®
Composite Fabrics for Structural and Seismic Strengthening

HEXCEL®

Sika CarboDur® Composite Strengthening Systems
A global alliance between Sika and Hexcel

Sika Worldwide

A recognized world leader in specialty chemicals and products specifically engineered for the construction industry, Sika has been answering the needs of owners, specifiers and contractors with unmatched service since 1910. With an international network of research and development, production and marketing companies in over 50 countries around the world, Sika is able to reach new levels of excellence in finding and implementing innovative solutions that meet the ever-changing demands of our customers.

Hexcel Corporation

The Hexcel Corporation is the leading international developer and manufacturer of advanced, lightweight, high-performance fibers and fabrics, composite materials and structures. Hexcel products are widely used in the aerospace, infrastructure, space and defense, naval transportation, recreation and general industrial markets. Hexcel Civil Engineering and Construction Systems were designed to help provide viable alternatives to traditional methods through the application of composite materials science since 1991.

A Global Partnership

The special alliance formed by the association of Sika and Hexcel offers unique and exclusive advantages to the construction industry in the vital areas of structural strengthening and reinforcement.

The shared expertise of these two industry leaders provides for proven products and techniques that allow for new economy, ease of application and enhanced levels of performance in the field. From product availability to on-the-job know-how, technical support and service, the marriage of Hexcel and Sika brings you exclusive benefits and unparalleled results.

Sika CarboDur®

Comprehensive Composite Strengthening Systems

Sika's systematic approach to structural strengthening incorporates the latest advances in applied technology.

Designed to meet critical requirements for strength and durability, Sika CarboDur composite strengthening systems offer innovative solutions for structural upgrading, repair and protection.

These products include:

* Carbon fiber strips
* Carbon fiber fabrics
* Glass fiber fabrics
* Structural adhesives
* Concrete repair and protection systems
* Corrosion inhibitors

The Case for Structural Strengthening

The reasons for strengthening of reinforced concrete structures are numerous.

* Unsafe conditions for current use
* Increased live and wheel loads
* Installation of heavy machinery
* Modifications such as elimination of walls/columns or openings cut through slabs
* Code changes
* Seismic conditions or vibrations
* Structural damage
* Corrosion of steel reinforcement
* Errors in planning, design or construction

External Reinforcement with Steel Plates

A proven method of strengthening since the 1960's, external reinforcement with steel plates and shells offers many advantages. Sikadur epoxies helped pioneer this strengthening method which is still widely used today. Still, use of steel plates does present a number of drawbacks. These include:

* Heavy weight
* Potential for corrosion
* Limited lengths
* Difficult handling
* High installation costs

Shear strengthening of concrete bridge beam with steel plates and special Sikadur epoxy.

External Reinforcement with Sika CarboDur Composite Systems

Used with increasing effectiveness since their introduction in the aerospace industry in the early 1960's, composite materials offer a number of distinct advantages for structural strengthening.

In addition to their high strength and flexibility, benefits include:

* Lightweight
* Non-corrosive
* Very high tensile strength
* Available in any laminate length

Sikadur structural adhesives are jobsite proven in critical applications like segmental bridge construction.

Sika CarboDur® Composite System Components

Sika CarboDur® Strips

Sika's pioneering research into carbon fiber reinforced pultruded strips began in 1984 with our first product trials at EMPA (the Swiss Federal Laboratories for Materials Testing & Research) in Switzerland. The first commercial application of Sika CFRP strips took place at The Sins Bridge, also in Switzerland, in 1991. Just three years after that, Sika launched its CarboDur System into the global market.

SikaWrap® Fabrics

SikaWrap composite systems have been tested under seismic load conditions at the Charles Lee Powell Structural Research Laboratory at the University of California, San Diego as part of the Caltrans bridge column retrofit program. The first commercial installation of the Hexcel composites was in 1991 for strengthening columns in Los Angeles' Griffith Park. Since then, this remarkable product has gained a rapidly growing acceptance industry-wide for its exceptional properties and capabilities.

Sikadur® Epoxy Resins

At the heart of these systems are the Sikadur epoxy resins. Proven for over 40 years in critical construction applications such as Segmental Bridge construction, these structural adhesives are well recognized as the best in the industry.

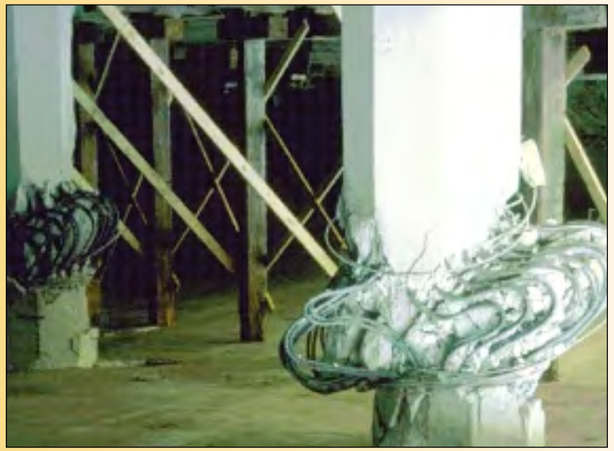
SikaWrap® For Seismic Upgrades of Concrete Columns and Unique Structures

SikaWrap Fabrics

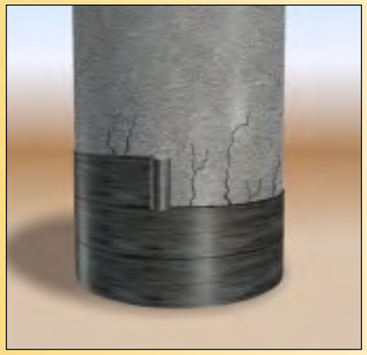
SikaWrap carbon and glass fiber fabrics are high strength materials that are bonded to structures for strengthening purposes. Sharing the attributes of composite strengthening as previously listed, SikaWrap also offers the additional benefits of being able to conform to almost any complex or geometric shape.

The perfect high-tech answer to structural strengthening under these conditions, SikaWrap's unique benefits include:

* Ease of handling
* High strength, lightweight
* Non-corrosive
* Significant gain in load-bearing capacity
* Minimal change to structures weight, shape and appearance
* Minimum structure downtime
* Economical to use
* Effective for both wet and dry lay-up applications
* Conform to irregular shapes and surfaces
* Minimal clearance needed to install



Unstrengthened column buckled from Northridge, CA earthquake of 1994.

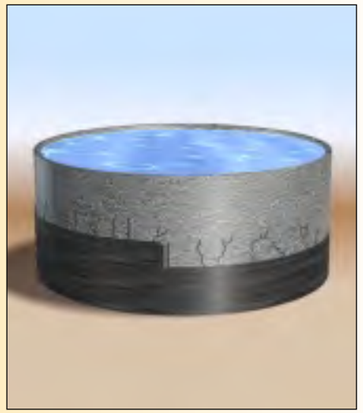


Column Wrapping

* Seismic strengthening
* Confinement
* Flexural Strengthening
* Increased ductility up to tenfold
* Increased axial load carrying capacity
* Shear strengthening

Tank Strengthening

* Confinement (bursting stress)
* Minimizes crack propagation
* Seismic stabilization



Tanks, pipes or chimneys can be strengthened from the inside or outside depending on the jobsite requirements and logistics.

Other Structures

* Chimneys/silos
* Piles
* Pipes
* Tunnels
* Poles

Bridge column tested for ductility at the Charles Lee Powell Structural Research Laboratory - UCSD.

SikaWrap® For Structural Strengthening of Beams, Slabs and Walls

Beam/Slab Strengthening

* Shear
* Flexure
* Provides ductility to structural members
* Reduces deflection in members
* Limits cracking

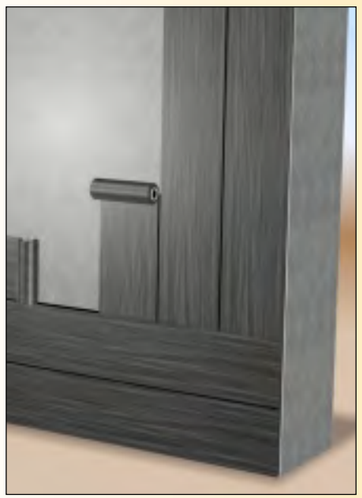
Wall Strengthening

* In-plane shear/flexural retrofit
* Out-of-plane flexural retrofit
* Concrete shear walls
* Unreinforced masonry (URM) walls
* Compressive load increases

Substrates

* Concrete
* Steel
* Masonry
* Timber

Shear strengthening of spandrel beam with CFRP fabric.



Sika's wide range of composite materials can meet all your strengthening needs

APPLICATION PROCEDURE

WET

For Large Projects

1 *Priming the concrete with Sikadur epoxy resin*
- *seals the concrete and promotes adhesion.*

2 *Impregnation of fabric using saturator machine*
- *controls resin distribution and increases productivity on large-scale projects.*

3 *Wet fabric is layed-up onto primed concrete surface*
- *flexible to accomodate the shape of any structure.*

4 *Topcoat applied over fabric*
- *Sika's wide range of coatings can be applied for protective or aesthetic purposes.*

DRY

For Small Projects

1 *Priming and saturating the concrete with Sikadur epoxy resin*
- *seals the concrete and promotes adhesion.*

2 *Dry fabric is layed-up directly onto the saturated concrete surface*
- *quick installation on small-scale projects.*

3 *Fabric smoothed with plastic roller*
- *air voids eliminated and fabric saturated.*

4 *Topcoat applied over fabric*
- *Sika's wide range of coatings can be applied for protective or aesthetic purposes.*

** These two methods of application give the contractor maximum flexibility, quality control, and productivity for large or small jobs.*

Selection Chart for Sika CarboDur® and SikaWrap® Composites

	WET LAY-UP		DRY LAY-UP		
	SikaWrap Hex 103C	SikaWrap Hex 100G	SikaWrap Hex 230C	SikaWrap Hex 320G	CarboDur Strips (Type S)
Beam Strengthening					
Flexure	✔✔	✔	✔	✔	✔✔✔
Shear	✔✔✔	✔✔	✔✔	✔✔	
Limited Access	✔	✔	✔✔	✔✔	✔✔✔
Slab Strengthening					
Small Scale			✔✔✔	✔✔	✔
Large Scale	✔✔✔	✔✔			✔✔
Limited Access	✔	✔	✔✔	✔✔	✔✔✔
Column Wrapping					
Seismic (passive)	✔✔	✔✔✔	✔	✔	
General Strengthening (active)	✔✔✔	✔✔	✔✔	✔✔	
Small Scale	✔	✔✔	✔✔	✔✔✔	
Wall Strengthening					
Seismic (passive)	✔✔	✔✔✔	✔	✔	✔
General Strengthening (active)	✔✔✔	✔✔	✔✔	✔	✔
Small Scale	✔	✔✔	✔✔✔	✔✔	✔
Tanks/Chimneys/Pipes/Silos	✔✔	✔✔✔	✔	✔	✔
Cost Performance					
Tensile strength per inch width per layer	**5,560 lbs. (24.7 kN)**	**3,480 lbs. (15.5 kN)**	**1,807 lbs. (8.0 kN)**	**1,131 lbs. (5.0 kN)**	**16,356 lbs. (72.7 kN)**
Relative Cost	**$ $**	**$**	**$ $**	**$**	**$ $ $**

✔ **better methods available** ✔✔ **acceptable method** ✔✔✔ **best method**

Contractor Training and Quality Control

CarboDur System training includes:

- Objectives of the repair system
- Surface preparation requirements
- Epoxy mixing and application
- Wet and Dry lay-up procedures
- Hands-on applications to structural concrete members
- Quality Control on-site
- Bills of Quantities/Estimating

Make your Specification Complete - Specify Sika-approved CarboDur Composite System Contractors.

As of part of Sika's ongoing commitment to total customer satisfaction, we maintain a national network of Approved Contractors. These carefully-selected professionals are available to ensure that Sika's exclusive CarboDur Composite Systems are properly specified, and applied to meet the critical demands of a challenging marketplace.

Bituthene® System 4000

Self-adhesive HDPE waterproofing membrane with super tacky compound for use with patented, water-based System 4000 Surface Conditioner

Advantages

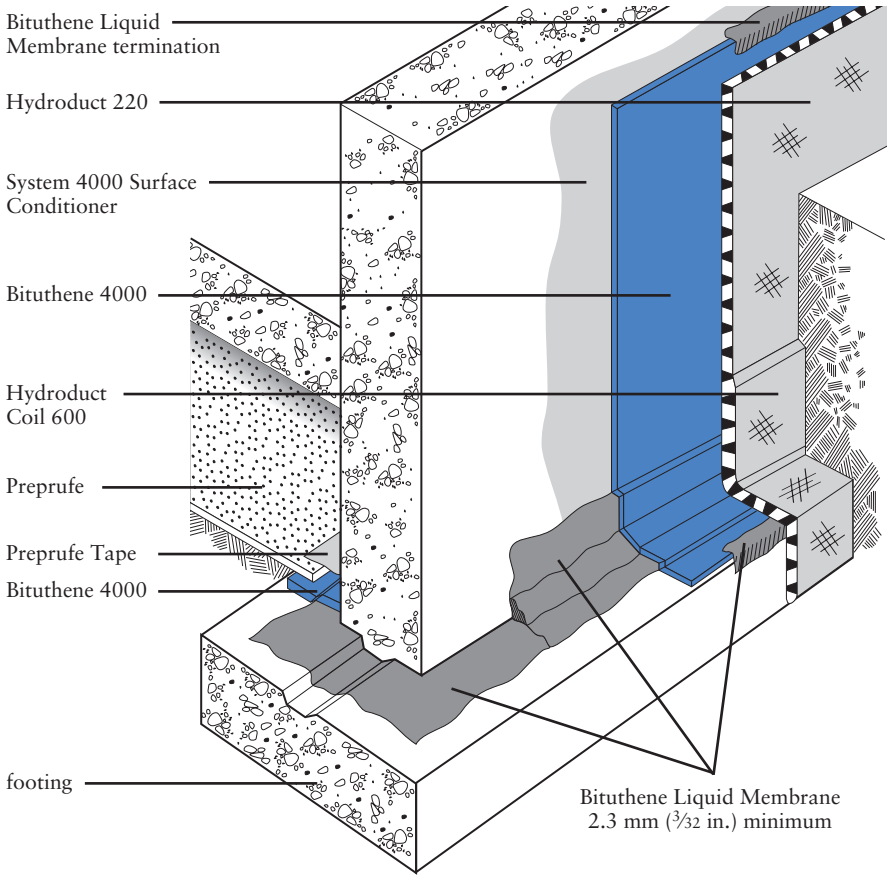
- **Excellent adhesion** – special adhesive compound engineered to work with high tack System 4000 Surface Conditioner
- **Cold applied** – simple application to substrates, especially at low temperatures
- **Reduced inventory and handling costs** – System 4000 Surface Conditioner is included with each roll of membrane
- **Wide application temperature range** – excellent bond to self and substrate from -4°C (25°F) and above
- **Overlap security** – minimizes margin for error under site conditions
- **Cross laminated, high density polyethylene carrier film** – provides high tear strength, puncture and impact resistance
- **Flexible** – accommodates minor structural movements and will bridge shrinkage cracks

Description

Bituthene® System 4000 is a 1.5 mm (1/16 in.) flexible, pre-formed waterproof membrane which combines a high performance, cross laminated, HDPE carrier film with a unique, super tacky, rubberized asphalt compound.

System 4000 Surface Conditioner is a unique, water-based, latex surface treatment which imparts an aggressive, high tack finish to the treated substrate. It is specifically formulated to bind site dust and concrete efflorescence, thereby providing a suitable surface for the Bituthene System 4000 Waterproofing Membrane.

Conveniently packaged in each roll of membrane, System 4000 Surface Conditioner promotes good initial adhesion and, more importantly, excellent permanent adhesion of the Bituthene System 4000 Waterproofing Membrane. The VOC (Volatile Organic Compound) content is 125 g/L.



GRACE Construction Products

Use

Bituthene is ideal for waterproofing concrete, masonry and wood surfaces where in-service temperatures will not exceed 57°C (135°F). It can be applied to foundation walls, tunnels, earth sheltered structures and split slab construction, both above and below grade. (For above grade applications, see "Above Grade Waterproofing Bituthene System 4000.")

Bituthene is 1.5 mm (1/16 in.) thick, 0.9 m (3 ft) wide and 20 m (66.7 ft) long and is supplied in rolls. It is unrolled sticky side down onto concrete slabs or applied onto vertical concrete faces primed with System 4000 Surface Conditioner. Continuity is achieved by overlapping a minimum 50 mm (2 in.) and firmly rolling the joint.

Bituthene is extremely flexible. It is capable of bridging shrinkage cracks in the concrete and will accommodate minor differential movement throughout the service life of the structure.

Application Procedures

Safety, Storage and Handling Information

Bituthene products must be handled properly. Vapors from solvent-based primers and mastic are harmful and flammable. Grace Protection Board Adhesive is extremely flammable. For these products, the best available information on safe handling, storage, personal protection, health and environmental considerations has been gathered. Material Safety Data Sheets (MSDS) are available at www.graceconstruction.com and users should acquaint themselves with this information. Carefully read detailed precaution statements on product labels and the MSDS before use.

Surface Preparation

Surfaces should be structurally sound and free of voids, spalled areas, loose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Concrete must be properly dried (minimum 7 days for normal structural concrete and 14 days for lightweight structural concrete).

If time is critical, Bituthene Primer B2 may be used to allow priming and installation of membrane on damp surfaces or "green" concrete. Priming may begin in this case as soon as the concrete will maintain structural integrity. Use form release agents which will not transfer to the concrete. Remove forms as soon as possible from below horizontal slabs to prevent entrapment of excess moisture. Excess moisture may lead to blistering of the membrane. Cure concrete with clear, resin-based curing compounds which do not contain oil, wax or pigment. Except with Primer B2, allow concrete to thoroughly dry following rain. Do not apply any products to frozen concrete.

Repair defects such as spalled or poorly consolidated areas. Remove sharp protrusions and form match lines. On masonry surfaces, apply a parge coat to rough concrete block and brick walls or trowel cut mortar joints flush to the face of the concrete blocks.

Temperature

- Apply Bituthene System 4000 Membrane and Conditioner only in dry weather and when air and surface temperatures are -4°C (25°F) or above.
- Apply Bituthene Primer B2 in dry weather above -4°C (25°F). (See separate product information sheet.)

Conditioning

Bituthene System 4000 Surface Conditioner is ready to use and can be applied by spray or roller. For best results, use a pump-type air sprayer with fan tip nozzle, like the Bituthene System 4000 Surface Conditioner Sprayer, to apply the surface conditioner.

Apply Bituthene System 4000 Surface Conditioner to clean, dry, frost-free surfaces at a coverage rate of 7.4 m^2/L (300 ft^2/gal). Coverage should be uniform. Surface conditioner should not be applied so heavily that it puddles or runs. **Do not apply conditioner to Bituthene membrane.**

Allow Bituthene System 4000 Surface Conditioner to dry one hour or until substrate returns to its original color. At low temperatures or in high humidity conditions, dry time may be longer.

Bituthene System 4000 Surface Conditioner is clear when dry and may be slightly tacky. In general, conditioning should be limited to what can be covered within 24 hours. In situations where long dry times may prevail, substrates may be conditioned in advance. Substrates should be reconditioned if significant dirt or dust accumulates.

Before surface conditioner dries, tools should be cleaned with water. After surface conditioner dries, tools should be cleaned with mineral spirits. Mineral spirits is a combustible liquid which should be used only in accordance with manufacturer's recommendations. **Do not use solvents to clean hands or skin.**

Corner Details

The treatment of corners varies depending on the location of the corner. For detailed information on Bituthene Liquid Membrane, see separate product information sheet.

- At wall to footing inside corners –
  Option 1:
  Apply membrane to within 25 mm (1 in.) of base of wall. Treat the inside corner by installing a 20 mm (¾ in.) fillet of Bituthene Liquid Membrane. Extend Bituthene Liquid Membrane at least 65 mm (2½ in.) onto footing, and 65 mm (2½ in.) onto wall membrane.
  Option 2:
  Treat the inside corner by installing a 20 mm (¾ in.) fillet of Bituthene Liquid Membrane. Apply 300 mm (12 in.) wide strip of sheet membrane centered over fillet. Apply wall membrane over inside corner and extend 150 mm (6 in.) onto footing. Apply 25 mm (1 in.) wide troweling of Bituthene Liquid Membrane over all terminations and seams within 300 mm (12 in.) of corner.
- At footings where the elevation of the floor slab is 150 mm (6 in.) or more above the footing, treat the inside corner either by the above two methods or terminate the membrane at the base of the wall. Seal the termination with Bituthene Liquid Membrane.

Joints

Properly seal all joints with waterstop, joint filler and sealant as required. Bituthene membranes are not intended to function as the primary joint seal. Allow sealants to fully cure. Pre-strip all slab and wall cracks over 1.5 mm (1/16 in.) wide and all construction and control joints with 230 mm (9 in.) wide sheet membrane strip.

Application on Horizontal Surfaces

(Note: **Preprufe®** pre-applied membranes are strongly recommended for below slab or for any application where the membrane is applied before concreting. See Preprufe product information sheets.)

Apply membrane from the low point to the high point so that laps shed water. Overlap all seams at least 50 mm (2 in.). Stagger all end laps. Roll the entire membrane firmly and completely as soon as possible. Use a linoleum roller or standard water-filled garden roller less than 760 mm (30 in.) wide, weighing a minimum of 34 kg (75 lbs) when filled. Cover the face of the roller with a resilient material such as a 13 mm (½ in.) plastic foam or two wraps of indoor-outdoor carpet to allow the membrane to fully contact the primed substrate. Seal all T-joints and membrane terminations with Bituthene Liquid Membrane at the end of the day.

Protrusions and Drains

Apply membrane to within 25 mm (1 in.) of the base of the protrusion. Apply Bituthene Liquid Membrane 2.5 mm (0.1 in.) thick around protrusion. Bituthene Liquid Membrane should extend over the membrane a minimum of 65 mm (2½ in.) and up the penetration to just below the finished height of the wearing course.

Vertical Surfaces

Apply membrane in lengths up to 2.5 m (8 ft). Overlap all seams at least 50 mm (2 in.). On higher walls apply membrane in two or more sections with the upper overlapping the lower by at least 50 mm (2 in.). Roll all membrane with a hand roller.

Terminate the membrane at grade level. Press the membrane firmly to the wall with the butt end of a hardwood tool such as a hammer handle or secure into a reglet. Failure to use heavy pressure at terminations can result in a poor seal. A termination bar may be used to ensure a tight seal. Terminate the membrane at the base of the wall if the bottom of the interior floor slab is at least 150 mm (6 in.) above the footing. Otherwise, use appropriate inside corner detail where the wall and footing meet.

Membrane Repairs

Patch tears and inadequately lapped seams with membrane. Clean membrane with a damp cloth and dry. Slit fishmouths and repair with a patch extending 150 mm (6 in.) in all directions from the slit and seal edges of the patch with Bituthene Liquid Membrane. Inspect the membrane thoroughly before covering and make any repairs.

Drainage

Hydroduct® drainage composites are recommended for both active drainage and protection of the membrane. See Hydroduct product information sheets.

Protection of Membrane

Protect Bituthene membranes to avoid damage from other trades, construction materials or backfill. Place protection immediately in temperatures above 25°C (77°F) to avoid potential for blisters.

- On vertical applications, use Hydroduct 220 Drainage Composite. Adhere Hydroduct 220 Drainage Composite to membrane with Hydroduct Tape. Alternative methods of protection are to use 25 mm (1 in.) expanded polystyrene or 6 mm (¼ in.) extruded polystyrene that has a minimum compressive strength of 55 kN/m^2 (8 lbs/in.^{2}). Such alternatives do not provide positive drainage to the system.

If 6 mm (¼ in.) extruded polystyrene protection board is used, backfill should not contain sharp rock or aggregate over 50 mm (2 in.) in diameter. Adhere polystyrene protection board with Bituthene® Protection Board Adhesive or Hydroduct Tape.

- In mud slab waterproofing, or other applications where positive drainage is not desired and where reinforced concrete slabs are placed over the membrane, the use of 6 mm (¼ in.) hardboard or 2 layers of 3 mm (⅛ in.) hardboard is recommended.

Insulation

Always apply Bituthene membrane directly to primed or conditioned structural substrates. Insulation, if used, must be applied over the membrane. Do not apply Bituthene membranes over lightweight insulating concrete.

Backfill

Place backfill as soon as possible. Use care during backfill operation to avoid damage to the waterproofing system. Follow generally accepted practices for backfilling and compaction. Backfill should be added and compacted in 150 mm (6 in.) to 300 mm (12 in.) lifts.

For areas which cannot be fully compacted, a termination bar is recommended across the top termination of the membrane.

Placing Steel

When placing steel over properly protected membrane, use concrete bar supports (dobies) or chairs with plastic tips or rolled feet to prevent damage from sharp edges. Use special care when using wire mesh, especially if the mesh is curled.

Approvals

- City of Los Angeles Research Report RR 24386
- U.S. Department of Housing and Urban Development (HUD) HUD Materials Release 628E

Warranty

Five year material warranties covering Bituthene and Hydroduct products are available upon request. Contact your Grace sales representative for details.

Technical Services

Support is provided by full time, technically trained Grace representatives and technical service personnel, backed by a central research and development staff.

System 4000 Surface Conditioner Sprayer

The Bituthene System 4000 Surface Conditioner Sprayer is a professional grade, polyethylene, pump-type, compressed air sprayer with a brass fan tip nozzle. It has a 7.6 L (2 gal) capacity. The nozzle orifice and spray pattern have been specifically engineered for the optimum application of Bituthene System 4000 Surface Conditioner.

Hold nozzle 450 mm (18 in.) from substrate and squeeze handle to spray. Spray in a sweeping motion until substrate is uniformly covered.

Sprayer should be repressurized by pumping as needed. For best results, sprayer should be maintained at high pressure during spraying.

To release pressure, invert the sprayer and spray until all compressed air is released.

Maintenance

The Bituthene System 4000 Surface Conditioner Sprayer should perform without trouble for an extended period if maintained properly.

Sprayer should not be used to store Bituthene System 4000 Surface Conditioner. The sprayer should be flushed with clean water immediately after spraying. For breaks in the spray operation of one hour or less, invert the sprayer and squeeze the spray handle until only air comes from the nozzle. This will avoid clogging.

Should the sprayer need repairs or parts, call the maintenance telephone number on the sprayer tank (800-323-0620).

Supply

Bituthene System 4000	0.9 m x 20 m roll (18.6 m^2) 3 ft x 66.7 ft (200 ft^2)
Roll weight	38 kg (83 lbs) gross
Palletization	25 rolls per pallet
Storage	Store upright in dry conditions below +35°C (95°F).
System 4000 Surface Conditioner	1 x 2.3 L (0.625 gal) bottle in each roll of System 4000 Membrane
Ancillary Products	
Surface Conditioner Sprayer	7.6 L (2 gal) capacity professional grade sprayer with specially engineered nozzle
Bituthene Liquid Membrane	5.7 L (1.5 gal) pail/125 pails per pallet or 15.1 L (4 gal) pail/48 pails per pallet
Hydroduct Tape	2.5 cm x 61.0 m (1 in. x 200 ft) roll/6 rolls per carton
Bituthene Mastic	12 – 0.9 L (30 oz) tubes/carton or 18.9 L (5 gal) pail/36 pails per pallet
Complimentary Materials	
Hydroduct	See separate data sheets.
Protection Board Adhesive	18.9 L (5 gal) pail/36 pails per pallet

Equipment by Others: Soft broom, utility knife, brush or roller for priming

Physical Properties for Bituthene 4000 Membrane

Property	Typical Value	Test Method
Color	Dark gray-black	
Thickness	1.5 mm (1/16 in.) nominal	ASTM D3767 – Method A
Flexibility, 180° bend over 25 mm (1 in.) mandrel at -32°C (-25°F)	Unaffected	ASTM D1970
Tensile Strength, Membrane, Die C	2240 kPa (325 lbs/$in.^2$) minimum	ASTM D412 Modified[1]
Tensile Strength, Film	34.5 MPa (5,000 lbs/$in.^2$) minimum	ASTM D882 Modified[1]
Elongation, Ultimate Failure of Rubberized Asphalt	300% minimum	ASTM D412 Modified[1]
Crack Cycling at -32°C (-25°F), 100 Cycles	Unaffected	ASTM C836
Lap Adhesion at Minimum Application Temperature	880 N/m (5 lbs/in.)	ASTM D1876 Modified[2]
Peel Strength	1576 N/m (9 lbs/in.)	ASTM D903 Modified[3]
Puncture Resistance, Membrane	222 N (50 lbs) minimum	ASTM E154
Resistance to Hydrostatic Head	70 m (210 ft) of water	ASTM D5385
Permeance	2.9 ng/m^2sPa (0.05 perms) maximum	ASTM E96, Section 12 – Water Method
Water Absorption	0.1% maximum	ASTM D570

Footnotes:
1. The test is run at a rate of 50 mm (2 in.) per minute.
2. The test is conducted 15 minutes after the lap is formed and run at a rate of 50 mm (2 in.) per minute at 5°C (40°F).
3. The 180° peel strength is run at a rate of 300 mm (12 in.) per minute.

Physical Properties for System 4000 Surface Conditioner

Property	Typical Value
Solvent Type	Water
Flash Point	>60°C (>140°F)
VOC* Content	125 g/L
Application Temperature	-4°C (25°F) and above
Freeze Thaw Stability	5 cycles (minimum)
Freezing Point (as packaged)	-10°C (14°F)
Dry Time (hours)	1 hour**

* Volatile Organic Compound
** Dry time will vary with weather conditions

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GRACE
Construction Products

TECHNICAL DATA

LIQUID BOOT®

SPRAY-APPLIED GAS VAPOR BARRIER

DESCRIPTION

Liquid Boot® is a seamless, spray-applied, water-based membrane containing no VOCs, which provides a barrier against vapor intrusion into structures. Liquid Boot® is installed under slab and on below grade vertical walls as a gas vapor barrier to minimize vapor and nuisance water migration into buildings. Liquid Boot® spray-application directly to penetrations, footings, grade beams, pile caps and other irregular surfaces, provides for a fully-adhered gas vapor barrier system.

APPLICATIONS

Liquid Boot® is used as an underslab and below-grade vertical wall gas vapor barrier, used to minimize vapor and nuisance water (non-hydrostatic conditions) migration into buildings. Liquid Boot® is ideal for methane migration control. Liquid Boot® is also NSF® certified for use as a potable water liner in concrete water reservoirs and tanks greater than 300,000 gallons to protect the concrete from water seepage.

BENEFITS

- Spray-application provides excellent sealing of penetrations, eliminating the need for mechanical fastening
- Seamless, monolithic membrane eliminates seaming-related membrane failures
- Unique formulation provides superior protection from methane gases and water vapor
- Fully adhered system reduces risk of gas migration
- Protection from methane gas, VOCs, chlorinated solvents and other contaminates

INSTALLATION

Protect all adjacent areas not to receive gas vapor barrier. Ambient temperature shall be within man-ufacturer's specifications. All plumbing, electrical, mechanical and structural items to be under or passing through the gas vapor barrier shall be secured in their proper positions and appropriately protected prior to membrane application. Gas vapor barrier shall be installed before placement of rein-forcing steel. Expansion joints must be filled with a conventional waterproof expansion joint material. Surface preparation shall be per manufacturer's specification. A minimum thickness of 60 dry mils, unless specified otherwise.

LIMITED WARRANTY

CETCO warrants its products to be free of defects. This warranty only applies when the product is applied by Approved Applicators trained by CETCO. As factors which affect the result obtained from this product, including weather, equipment, construction, work-manship and other variables are all beyond CETCO's control, we warrant only that the material herein conforms to our product specifications. Under this warranty we will replace at no charge any product proved to be defective within 12 months of manufacture, provided it has been applied in accordance with our written directions for uses we recommend as suitable for this product. This warranty is in lieu of any and all other warranties expressed or implied (including any implied warranty of merchantability or fitness for a particular use), and the Manufacturer shall have no further liability of any kind including liability for consequential or incidental damages resulting from any defects or any delays caused by replacement or otherwise. This warranty shall become valid only when the product has been paid for in full.

In addition to superior chemical resistance performance, Liquid Boot® spray-application effectively seals penetrations, footings, grade beams and other irregular surfaces that are considered critical vapor intrusion pathways.

EQUIPMENT

- COMPRESSOR: Minimum output of 155-185 cubic feet per minute (CFM)
- PUMPS: For "A" drum, an air-powered piston pump of 4:1 ratio (suggested model: Graco, 4:1 Bulldog). For "B" drum, an air-powered diaphragm pump (0 -100 psi)
- HOSES: For "A" drum, ½" wire hose with a solvent resistant core (for diesel cleaning flush), hose rated for 500 psi minimum. For "B" drum, a 3/8" fluid hose rated at only 300 psi may be used.
- SPRAY WAND: Only the spray wand sold by CETCO is approved for the application of Liquid Boot®.
- SPRAY TIPS: Replacement tips can be purchased separately from CETCO.

PACKAGING

Liquid Boot® is available in the following packaging options:

- 55 Gallon Drum
- 275 Gallon Tote

2870 Forbs Avenue, Hoffman Estates, IL 60192
800.527.9948 | http://remediation.cetco.com

LIQUID BOOT®

SPRAY-APPLIED GAS VAPOR BARRIER

TESTING DATA

CHEMICAL & PHYSICAL PROPERTIES		
CHEMICAL PROPERTY	**TEST METHOD**	**RESULT**
Acid Exposure (10% H_2SO_4 for 90 days)	ASTM D543	Less than 1% weight change
Benzene Diffusion Test	Tested at 43,000 ppm	2.90 x 10^{-11} m^2/day
Chemical Resistance: VOCs, BTEXs (tested at 20,000 ppm)	ASTM D543	Less than 1% weight change
Chromate Exposure (10% Chromium6+ salt for 31 days)	ASTM E96	Less than 1% weight change
Diesel (1000 mg/l), Ethylbenzene (1000 mg/l), Naphthalene (5000 mg/l) and Acetone (500 mg/l) Exposure for 7 days	ASTM D543	Less than 1% weight change; Less than 1% tensile strength change
Hydrogen Sulfide Gas Permeability	ASTM D1434	None Detected
Methane Permeability	**ASTM 1434-82**	**Passed***
Microorganism Resistance	**ASTM D4068-88**	**Passed***
Oil Resistance	**ASTM D543-87**	**Passed***
PCE Diffusion Coefficient	Tested at 120 mg/L	1.32 x 10^{-13} m^2/sec
Radon Permeability	Tested by US Dept. of Energy	Zero permeability to Radon (222Rn)
TCE Diffusion Coefficient	Tested at 524 mg/L	9.07 x 10^{-13} m^2/sec

PHYSICAL PROPERTY	**TEST METHOD**	**RESULT**
Accelerated Weathering and Ultraviolet Exposure	ASTM D822	No adverse effect after 500 hours
Air Infiltration	ASTM E283-91	0 cfm/sq. ft.
Bonded Seam Strength Tests	ASTM D6392	Passed*
Coefficient of Friction (with geotextile both sides)	ASTM D5321	0.72
Cold Bend Test	ASTM D146	Passed. Ø cracking at -25°F
Dead Load Seam Strength	City of Los Angeles	Passed*
Electric Volume Resistivity	ASTM D257	1.91 x 1010 ohms-cm
Elongation	ASTM D412	1,332% Ø reinforcement, 90% recovery
Elongation w/8 oz. non-woven geotextile both sides	ASTM D751	100% (same as geotextile tested separately)
Environmental Stress-Cracking	ASTM D1693-78	Passed*
Flame Spread	ASTM E108	Class A with top coat (comparable to UL790)
Freeze-Thaw Resistance (100 Cycles)	ASTM A742	Meets criteria. Ø spalling or disbondment
Heat Aging	ASTM D4068-88	Passed*
Hydrostatic Head Resistance	ASTM D751	Tested to 138 feet or 60 psi
Potable Water Containment	ANSI/NSF 61	NSF Certified for tanks >300,000 gal
Puncture Resistance w/8 oz. non-woven geotextile both sides	ASTM D4833	286 lbs. (travel of probe = 0.756 in)
Sodium Sulfate (2% water solution)	ASTM D543, D412, D1434	Less than 1% weight change
Soil Burial	ASTM E154-88	Passed
Tensile Bond Strength to Concrete	ASTM D413	2,556 lbs/ft^2 uplift force
Tensile Strength	ASTM D412	58 psi without reinforcement
Tensile Strength w/8 oz. non-woven geotextile both sides	ASTM D751	196 psi (same as geotextile tested separately)
Toxicity Test	22 CCR 66696	Passed
Water Penetration Rate	ASTM D2434	<7.75 x 10^{-9} cm/sec
Water Vapor Permeance	ASTM E96	0.069 perms

*Passes all Los Angeles City and County Methane Criteria

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APPENDIX C

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845 425 4989 fax

Technical Memorandum

To	Thomas Gibbons (CB&I)	Page	1
CC	Mark Terril (PPG), Keith Prins (PPG) Prabal Amin (Weston), Brian McPeak (Chromium Cleanup Partnership), Scott Mikaelian (AECOM)		
Subject	Site 156 - Metro Towers – Building #2 Boiler Room – Concrete Column and Floor Sampling Results Summary		
From	Alfred LoPilato, AECOM		
Date	October 11, 2013		

Background

On March 29, 2013, AECOM, on behalf of PPG, submitted a Technical Memo to NJDEP which summarized the results of remedial investigation (RI) activities conducted in the boiler room of Site 156 - Metropolis Towers Building No. 2. The RI activities were conducted in November and December 2012, January 2013 and February 2013.

In summary, and as detailed in the above referenced Technical Memo, the RI objectives were to document and investigate conditions surrounding a hexavalent chromium bloom observed in concrete at the base of a building support column located in the boiler room of Building No. 2. The bloom was observed on November 5, 2012, during an inspection subsequent to significant flooding caused by Hurricane Sandy.

On November 13, 2012 a concrete sample was collected from the area of the chrome bloom on the affected column, and analyzed for hexavalent chromium (Cr+6). Results of laboratory analysis indicated a Cr+6 concentration of 645 mg/kg, which exceeds the New Jersey Department of Environmental Protection's (NJDEP) most stringent Chromium Soil Cleanup Criteria (CSCC) of 20 mg/kg for Cr+6.

Based on the detection of elevated levels of Cr+6 at the base of the concrete column, an Interim Remedial Measure (IRM) was installed on November 13, 2012 to prevent disturbance of the area by building maintenance personnel.

Subsequent to installation of the IRM, NJDEP requested that additional investigation be conducted in the boiler room to further characterize and delineate conditions. A *Sampling and Analysis Plan (SAP) (December 2012)* was subsequently prepared and implemented. Activities included additional concrete sampling and sampling of soil below the concrete floor slab. These activities, which are referred to as "Phase 1" of the investigation, were conducted in January 2013.

The Phase 1 soil and concrete sampling resulted in one exceedence (42.7 mg/kg) of the CSCC for Cr+6, associated with one surficial soil sample collected from beneath the concrete floor slab.

Based on the Phase 1 results, and NJDEP's request for additional sampling, a follow-up Phase 2 *Sampling and Analysis Plan (SAP)* was prepared in February 2013 and additional soil and concrete

sampling was conducted to delineate the sub-slab soil Cr+6 exceedence detected in Phase 1. The additional sampling results indicated there were no exceedences of the CSCC criteria in the additional soil boring, surface concrete slab or concrete column samples collected during Phase 2.

Based on these findings, additional actions were proposed, including preparation of a sampling plan and implementation of additional sampling of the concrete column beneath the IRM to verify previously detected Cr+6 concentrations and assess the feasibility of cleaning or repairing (remediating) the column to eliminate the need for a permanent IRM;

On June 25, 2013 additional sampling was conducted on the column beneath the IRM, and the results were presented in a Technical Memorandum dated July 26, 2013 (Attachment 1).

Recent Sampling Events

Subsequent to review of the July 26, 2013 Memo, NJDEP requested additional sampling in the area of the column and IRM as follows:

A) One (1) concrete chip sample collected from each side of the column, just above the currently installed IRM (approximately 3' above the floor), for a total of four (4) samples on the column at this height;

B) One (1) concrete chip sample collected from the north, south and west sides of the column (three samples total), at a height of approximately 5' above the floor. Recall that the east side of the column was already sampled at this height;

C) At least one surficial concrete chip sample collected from the boiler room floor on the north side of the column, as close to the column as possible.

This sampling was implemented on August 15, 2013. As with the previous events, each sample was identified with a unique Sample ID using the following nomenclature: ***156-BLDG2-CONC-EB-1*** indicating the sample is from Site 156 Building 2, is concrete media (CONC), the face of the column that was sampled (e.g. "E" for East, "N" for North, "S" for South), whether the sample was from the "Top" or "Bottom" of the column (e.g. "T" = Top, "B"=Bottom), and the depth designation of the sample (e.g. "1"=1-inch, "4"=4-inch). Floor samples are designated with a "G" for Ground. Field Blanks are designated (FB).

Each sample was analyzed for hexavalent chromium (Cr+6), redox potential, pH and percent solids by Accutest Laboratories of Dayton, NJ (NJDEP Certification #12129). Based on AECOM's review of the analytical data packages from the lab, all data is valid and useable for its intended purpose.

A summary of analytical results is provided in Table 1 below, and Figures 1 & 2 attached:

AECOM

Table 1
Summary of Analytical Results
Hexavalent Chromium
Samples Collected 8/15/2013

Sample ID	Lab ID	Date	Location	Media	Depth (inches)	Cr+6 (mg/kg)	Laboratory Method Detection Limit (MDL) (mg/kg[1])	SAL (mg/kg)
156-BLDG2-CONC-N3ft-0.5	JB44947-2	8/15/13	North Face - 1.7 ft. above grade	Concrete	0-0.5	5.0 J	0.069	20
156-BLDG2-CONC-N5ft-0.5	JB44947-6	8/15/13	North Face - 5.2 ft. above grade	Concrete	0-0.5	2.7 J	0.069	20
156-BLDG2-CONC-5N5ft-0.5 (Field duplicate)	JB44947-8	8/15/13	North Face - 5.2 ft. above grade	Concrete	0-0.5	1.7 J	0.069	20
156-BLDG2-CONC-E3ft-0.5	JB44947-3	8/15/13	East Face - 2.4 ft. above grade	Concrete	0-0.5	5.1 J	0.069	20
156-BLDG2-CONC-S3ft-0.5	JB44947-4	8/15/13	South Face - 2.0 ft. above grade	Concrete	0-0.5	2.2 J	0.069	20
156-BLDG2-CONC-S5ft-0.5	JB44947-7	8/15/13	South Face - 3.2 ft. above grade	Concrete	0-0.5	4.8 J	0.069	20
156-BLDG2-CONC-W3ft-0.5	JB44947-5	8/15/13	West Face - 2.0 ft. above grade	Concrete	0-0.5	5.0 J	0.069	20
156-BLDG2-CONC-G11	JB44947-1	8/15/13	Floor 0.7 ft. North of Column	Concrete	0-0.5	**61.3 J**	0.72	20

Note: Spike recoveries were outside of control limits for 156-BLDG2-CONC-G11 and 156-BLDG2-CONC-W3ft-0.5. There was insufficient sample material to reanalyze. The locations were resampled.

[1] mg/kg = milligrams per kilogram

[2] SAL = State Action Level for Cr+6 is 20 mg/kg

The August 15, 2013 sampling analytical results were compared to the CSCC of 20 mg/kg. No exceedences of CSCC were observed for samples collected above (higher in elevation than) the existing IRM on the column. The concrete floor sample (156-BLDG2-CONC-G11), which was collected approximately 0.7 feet north of the column, did exceed the CSCC, and exhibited a Cr+6 concentration of 61.3 mg/kg.

Based on subsequent data review and data validation reports (see Note to Table 1 above), AECOM requested that the laboratory re-run samples 156-BLDG2-CONC-G11 and 156-BLDG2-CONC-W3ft-0.5; however, the laboratory indicated there was not enough of the original samples left to perform re-analysis, so plans were made to re-collect these samples.

On August 28, 2013, AECOM returned to the boiler room to re-collect 156-BLDG2-CONC-G11 and 156-BLDG2-CONC-W3ft-0.5. In addition, AECOM planned to collect an additional “step-out” sample from the concrete floor (156-BLD2-CONC-G12), approximately 1-foot north of sample 156-BLDG2-CONC-G11.

A summary of analytical results is provided in Table 2 below:

Table 2
Summary of Analytical Results
Hexavalent Chromium
Samples Collected 8/28/2013

Sample ID	Lab ID	Date	Location	Media	Depth (inches)	Cr+6 (mg/kg)	Laboratory Method Detection Limit (MDL) (mg/kg[1])	SAL (mg/kg)
156-BLDG2-CONC-W3ft-2-0.5	JB45884-3	8/28/13	West Face - 2.5 ft. above grade	Concrete	0-0.5	13.6 J	0.059	20
156-BLDG2-CONC-G11-2	JB45884-1	8/28/13	Floor 0.7 ft. North of Column	Concrete	0-0.5	**1040** J	4.5	20
156-BLDG2-CONC-G61-2 (Field duplicate)	JB45884-4	8/28/13	Floor 0.7 ft. North of Column	Concrete	0-0.5	**371** J	2.4	20
156-BLDG2-CONC-G12	JB45884-2	8/28/13	Floor 2 ft. North of Column	Concrete	0-0.5	**294** J	1.8	20

[1] mg/kg = milligrams per kilogram
[2] SAL = State Action Level for Cr+6 is 20 mg/kg

The August 28, 2013 sampling analytical results were compared to the CSCC of 20 mg/kg. Sample 156-BLDG2-CONC-W3ft-0.5, which was re-collected from the column above the IRM, did not exceed the CSCC. Sample 156-BLDG2-CONC-G11-2, which was re-collected from the floor north of the column, confirmed the prior CSCC exceedence and exhibited a Cr+6 concentration of 1,040 mg/kg. The "step-out" out sample, 156-BLDG2-CONC-G12, also exceeded the CSCC and exhibited a Cr+6 concentration of 294 mg/kg.

Based on the findings, NJDEP requested additional "step-out" samples of the concrete floor for delineation purposes. A total of five additional samples were proposed, two samples to be analyzed immediately after collection, and three contingency samples placed on "hold" at the laboratory pending results of initial analysis.

A summary of analytical results is provided in Table 3 below:

Table 3
Summary of Analytical Results
Hexavalent Chromium
Samples Collected 9/11/2013

Sample ID	Lab ID	Date	Location	Media	Depth (inches)	Cr+6 (mg/kg)	Laboratory Method Detection Limit (MDL) (mg/kg[1])	SAL (mg/kg)
156-BLDG2-CONC-G13	JB46992-1	9/11/13	Floor 4 ft. North of Column	Concrete	0-0.5	**93.9**	0.58	20
156-BLDG2-CONC-G63 (Field duplicate)	JB46992-4	9/11/13	Floor 4 ft. North of Column	Concrete	0-0.5	**188**	1.1	20
156-BLDG2-CONC-G14	JB46992-2	9/11/13	Floor 6 ft. North of Column	Concrete	0-0.5	19.3	0.06	20

[1] mg/kg = milligrams per kilogram
[2] SAL = State Action Level for Cr+6 is 20 mg/kg

The September 11, 2013 sampling analytical results were compared to the CSCC of 20 mg/kg. Sample 156-BLDG2-CONC-G13 exceeded the CSCC, but results were significantly lower than the next closes sample to the Column. Sample 156-BLDG2-CONC-G14, did not exceed the CSCC. Based on these results, concentrations of Cr+6 are delineated on the north side of the column.

Results Summary

Based on the analytical results of all concrete sampling conducted to date in the Boiler Room of Building 2, a small area of concrete impacted above CSCC has been identified and delineated, on and near the concrete building support column situated between the two building boilers.

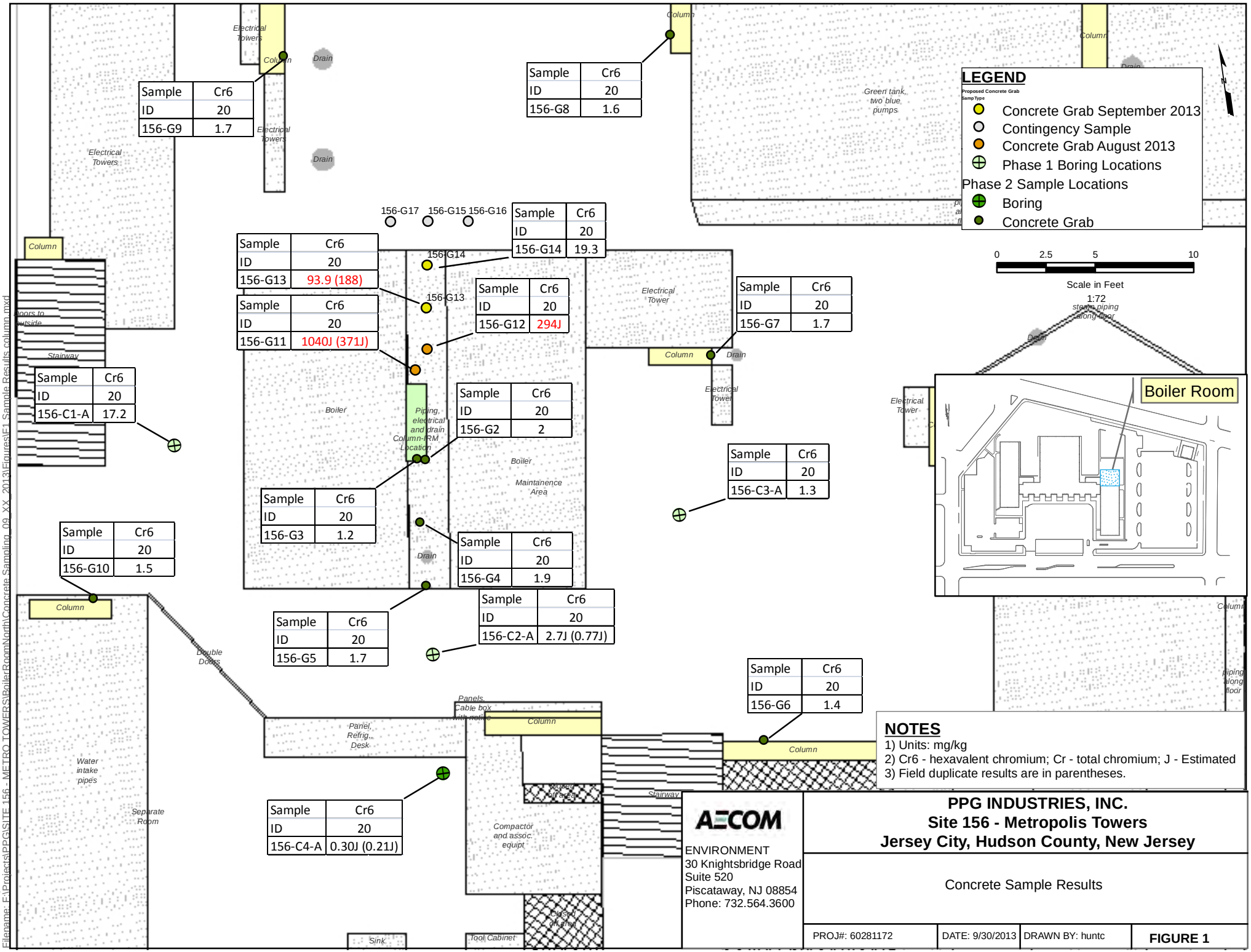
The column itself is impacted on all sides, from ground level to a height of approximately 1.5-feet above the floor. This area of the column is currently covered by an IRM.

The concrete floor is impacted on the north side of the column, between the boilers, to a distance on the floor of approximately 4-feet north of the column. This area is currently marked with caution tape.

Proposed Action

Based on the sampling results, it appears that cleaning or otherwise remediating the column is not feasible, and the current IRM should remain in place.

Pending completion of the site-wide remedial action, an additional IRM, consisting of an epoxy floor coating, is proposed to be installed on the impacted area of concrete floor north of the column between the boilers.


Sample | Cr6
ID | 20
156-G9 | 1.7
Sample | Cr6
ID | 20
156-G8 | 1.6
Sample | Cr6
ID | 20
156-G14 | 19.3
Sample | Cr6
ID | 20
156-G13 | 93.9 (188)
Sample | Cr6
ID | 20
156-G12 | 294J
Sample | Cr6
ID | 20
156-G11 | 1040J (371J)
Sample | Cr6
ID | 20
156-G7 | 1.7
Sample | Cr6
ID | 20
156-C1-A | 17.2
Sample | Cr6
ID | 20
156-G2 | 2
Sample | Cr6
ID | 20
156-C3-A | 1.3
Sample | Cr6
ID | 20
156-G3 | 1.2
Sample | Cr6
ID | 20
156-G4 | 1.9
Sample | Cr6
ID | 20
156-G10 | 1.5
Sample | Cr6
ID | 20
156-C2-A | 2.7J (0.77J)
Sample | Cr6
ID | 20
156-G5 | 1.7
Sample | Cr6
ID | 20
156-G6 | 1.4
Sample | Cr6
ID | 20
156-C4-A | 0.30J (0.21J)
156-G17
156-G15
156-G16
156-G14
156-G13
LEGEND
Proposed Concrete Grab Samp Type
Concrete Grab September 2013
Contingency Sample
Concrete Grab August 2013
Phase 1 Boring Locations
Phase 2 Sample Locations
Boring
Concrete Grab
0
2.5
5
10
Scale in Feet
1:72
Boiler Room
Column
Drain
Electrical Towers
Electrical Tower
Green tank, two blue pumps
steam piping along floor
Doors to outside
Stairway
Boiler
Piping, electrical and drain Column-RM Location
Maintanence Area
Double Doors
Panels, Cable box with notice
Panel, Refrig., Desk
Water intake pipes
Separate Room
Raised platform area
Compactor and assoc. equipt
Stairway
Sink
Tool Cabinet
piping along floor
NOTES
1) Units: mg/kg
2) Cr6 - hexavalent chromium; Cr - total chromium; J - Estimated
3) Field duplicate results are in parentheses.
AECOM
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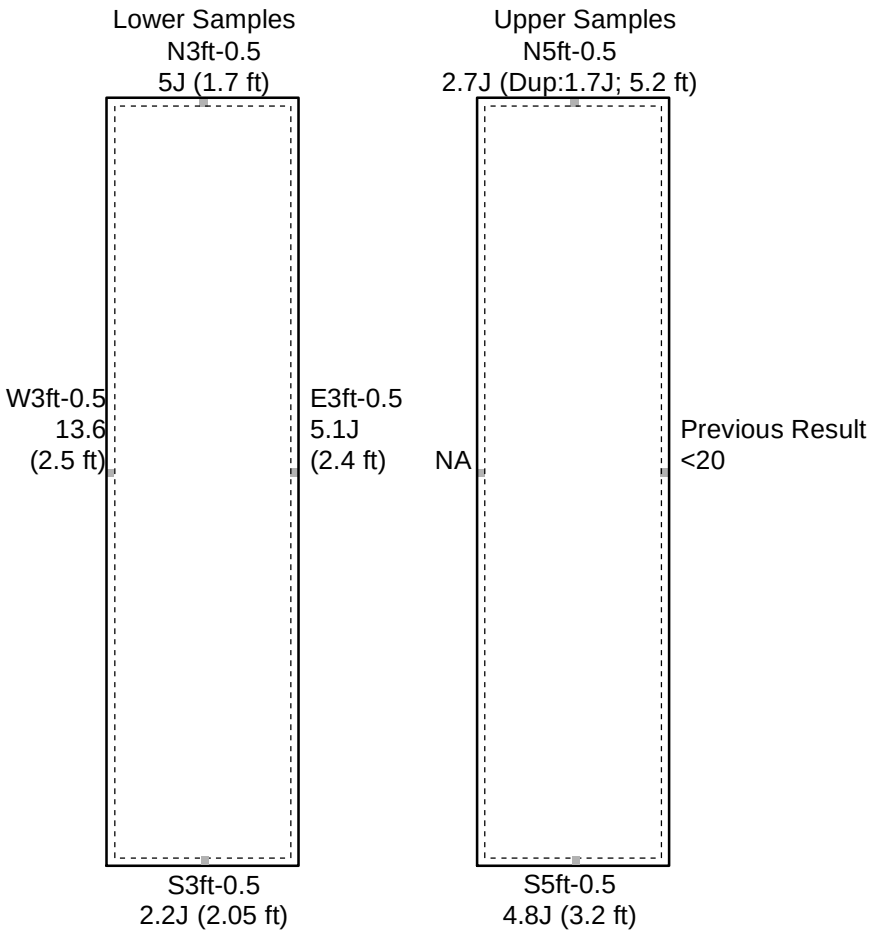
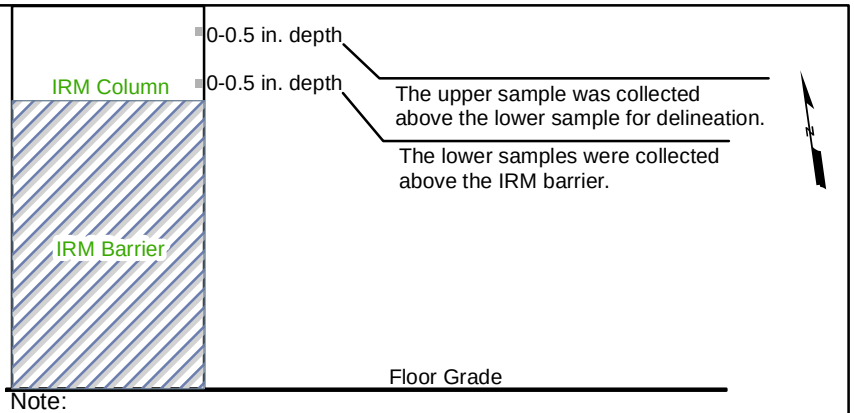
Phone: 732.564.3600
PPG INDUSTRIES, INC.
Site 156 - Metropolis Towers
Jersey City, Hudson County, New Jersey
Concrete Sample Results
PROJ#: 60281172
DATE: 9/30/2013
DRAWN BY: huntc
FIGURE 1
Last saved by: huntc 2013-09-30
Filename: E:\Projects\PPG\SITE 156 - METRO TOWERS\BoilerRoomNorth\Concrete Sampling_09_XX_2013\Figures\F1 Sample Results column.mxd

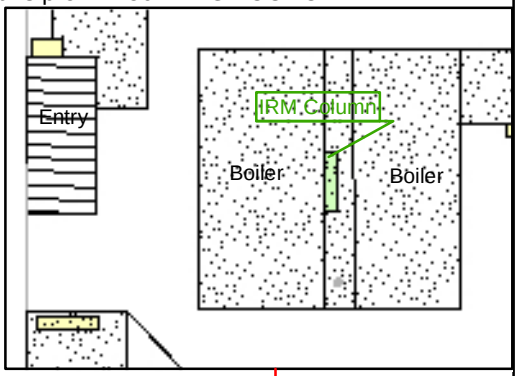
Hexavalent Chromium Results (mg/kg)

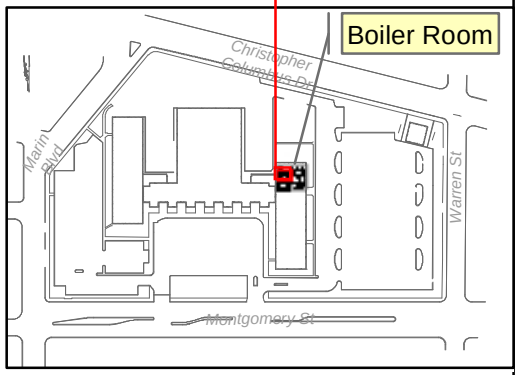


Plan View Cross-Sections of IRM Column



Note:
1. Concentrations in red exceed the 20 mg/kg threshold.
2. The sample height above the floor is shown in parentheses.
3. All sample names start with this prefix: 156-BLDG2-CONC-.





LEGEND

0 5 10 20
Scale in Feet
1:154

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Phone: 732.564.3600

PPG INDUSTRIES, INC.
Site 156 - Metropolis Towers
Jersey City, Hudson County, New Jersey

August 15, 2013 Concrete Column Sample Results -
Boiler Room North at
270 Marin Boulevard

PROJ#: 60281172	DATE: 9/30/2013	DRAWN BY: huntc	**FIGURE 2**

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Technical Memorandum

To	Thomas Gibbons (CB&I)	Page	1
CC	Mark Terril (PPG), Prabal Amin (Weston), Brian McPeak (Chromium Cleanup Partnership), Scott Mikaelian (AECOM)		
Subject	Site 156 - Metro Towers – Building #2 Boiler Room – IRM Concrete Sampling Results		
From	Alfred LoPilato, AECOM		
Date	July 26, 2013		

Background

On March 29, 2013, AECOM, on behalf of PPG, submitted a Technical Memo to NJDEP which summarized the results of remedial investigation (RI) activities conducted in the boiler room of Site 156 - Metropolis Towers Building No. 2. The RI activities were conducted in November and December 2012, January 2013 and February 2013.

In summary, and as detailed in the above referenced Technical Memo, the RI objectives were to document and investigate conditions surrounding a hexavalent chromium bloom observed in concrete at the base of a building support column located in the boiler room of Building No. 2. The bloom was observed on November 5, 2012, during an inspection subsequent to significant flooding caused by Hurricane Sandy.

On November 13, 2012 a concrete sample was collected from the area of the chrome bloom on the affected column, and analyzed for hexavalent chromium (Cr+6). Results of laboratory analysis indicated a Cr+6 concentration of 645 mg/kg, which exceeds the New Jersey Department of Environmental Protection's (NJDEP) most stringent Chromium Soil Cleanup Criteria (CSCC) of 20 mg/kg for Cr+6.

Based on the detection of elevated levels of Cr+6 at the base of the concrete column, an Interim Remedial Measure (IRM) was installed on November 13, 2012 to prevent disturbance of the area by building maintenance personnel.

Subsequent to installation of the IRM, NJDEP requested that additional investigation be conducted in the boiler room to further characterize and delineate conditions. A *Sampling and Analysis Plan (SAP) (December 2012)* was subsequently prepared and implemented. Activities included additional concrete sampling and sampling of soil below the concrete floor slab. These activities, which are referred to as "Phase 1" of the investigation, were conducted in January 2013.

The Phase 1 soil and concrete sampling resulted in one exceedence (42.7 mg/kg) of the CSCC for Cr+6, associated with one surficial soil sample collected from beneath the concrete floor slab.

Based on the Phase 1 results, and NJDEP's request for additional sampling, a follow-up Phase 2 *Sampling and Analysis Plan (SAP)* was prepared in February 2013 and additional soil and concrete

sampling was conducted to delineate the sub-slab soil Cr+6 exceedence detected in Phase 1. The additional sampling results indicated there were no exceedences of the CSCC criteria in the additional soil boring, surface concrete slab or concrete column samples collected during Phase 2.

Based on these findings, additional actions were proposed, including preparation of a sampling plan and implementation of additional sampling of the concrete column beneath the IRM to verify previously detected Cr+6 concentrations and assess the feasibility of cleaning or repairing (remediating) the column to eliminate the need for a permanent IRM;

During a conference call on April 3, 2013, NJDEP requested that PPG/AECOM prepare a brief SAP Addendum, which outlines the additional proposed steps for sampling the concrete column beneath the IRM. The SAP Addendum and proposed additional sampling steps are presented below:

Proposed IRM / Concrete Column Sampling Addendum

- The current IRM was temporarily removed to allow for sampling. The IRM was re-installed upon completion of sampling activities;
- A concrete core drill was used to collect two concrete core samples from each of the four sides of the concrete column, for a total of 8 cores;
- Cores were advanced horizontally into the column at the bottom of the column (flush with floor level) and at a height of approximately one-foot above the floor;
- Cores were approximately 2-inches in diameter and were advanced to a depth of approximately 4-inches;
- Two samples were collected from each concrete core – one from the 0-1 inch depth interval (surface) and one from the 3-4 inch depth interval (total of 16 samples);
- Samples were analyzed for hexavalent chromium;
- All investigation methodologies, quality assurance/quality control procedures, decontamination procedures, investigation derived waste procedures, data evaluation and data validation procedures, etc., as outlined in the Phase 1 and Phase 2 SAP's were incorporated herein, as applicable.

Sampling Results

The concrete column sampling was implemented on June 25, 2013 as outlined above, with the exception that the West side of the column could not be sampled due to its proximity to the adjacent boiler.

A series of concrete cores were drilled on the East, South and North faces of the column, both at floor level and approximately 1-foot above the floor, and concrete samples were collected from the surface to 1-inch, and 3 to 4-inch depth intervals at each core location.

Each sample was identified with a unique Sample ID using the following nomenclature: ***156-BLDG2-CONC-EB-1*** indicating the sample is from Site 156 Building 2, is concrete media (CONC), the face of the column that was sampled (e.g. "E" for East, "N" for North, "S" for South), whether the sample was from the "Top" or "Bottom" of the column (e.g. "T" = Top, "B"=Bottom), and the depth designation of the sample (e.g. "1"=1-inch, "4"=4-inch). A Field Blank (FB) was also collected from the sampling equipment for quality control purposes.

Each sample was analyzed for hexavalent chromium (Cr+6), redox potential, pH and percent solids by Accutest Laboratories of Dayton, NJ (NJDEP Certification #12129). Based on AECOM's review of the analytical data package from the lab, all data is valid and useable for its intended purpose. The data package is included as Attachment 1.

In summary, Cr+6 concentrations ranged from 3.6 mg/kg to 761 mg/kg, and generally confirm the previous result of 645 mg/kg, which initially indicated the presence of an elevated concentration of Cr+6 in the concrete.

The distribution of results depicts generally higher concentrations of Cr+6 in the floor level samples, with generally lower concentrations found 1-foot above the floor. No significant correlation is observed with regard to surface and/or depth within the column. Figure 1 depicts the sample locations and results. A summary of the results is also presented in Table 1 below:

Table 1
Concrete Column Sampling Results
Site 156 – Building 2 – Boiler Room
Samples Collected 6/25/2013

Sample ID	Lab ID	Location	Media	Depth (inches)	Cr+6 (mg/kg[1])	Laboratory Method Detection Limit (MDL) (mg/kg[1])	SAL[2] (mg/kg)
156-BLDG2-CONC-EB-1	JB40573-1	East Face - Bottom	Concrete	0-1	25.2	0.071	20
156-BLDG2-CONC-EB-4	JB40573-2	East Face - Bottom	Concrete	3-4	265	3.5	20
156-BLDG2-CONC-ET-1	JB40573-3	East Face – Top	Concrete	0-1	6	0.07	20
156-BLDG2-CONC-ET-4	JB40573-4	East Face – Top	Concrete	3-4	3.6	0.07	20
156-BLDG20-ONC-NB-4	JB40573-5	North Face - Bottom	Concrete	3-4	553	3.5	20
156-BLDG2-CONC-NB-1	JB40573-6	North Face – Bottom	Concrete	0-1	761	3.5	20
156-BLDG2-CONC-NT-4	JB40573-7	North Face - Top	Concrete	3-4	9.4	0.07	20
156-BLDG2-CONC-NT-1	JB40573-8	North Face – Top	Concrete	0-1	49.3	0.69	20
156-BLDG2-CONC-ST-1	JB40573-9	South Face – Top	Concrete	0-1	375	3.5	20
156-BLDG2-CONC-ST-4	JB40573-10	South Face – Top	Concrete	3-4	71.1	0.7	20
156-BLDG2-CONC-SB-1	JB40573-11	South Face – Bottom	Concrete	0-1	441	3.5	20
156-BLDG2-CONC-SB-4	JB40573-12	South Face – Bottom	Concrete	3-4	373	3.5	20

[1] mg/kg = milligrams per kilogram
[2] SAL = State Action Level for Cr+6 is 20 mg/kg

AECOM

Proposed Action

Based on the sampling results, it appears that cleaning or otherwise remediating the column is not feasible, and the current IRM should remain in place.

Implementation of a Restricted Use Remedy/Deed Notice is already planned with regard to the Cr+6 exceedence in soil below the concrete boiler room floor. An appropriate inspection and maintenance schedule for the concrete column IRM should be prepared as part of the Remedial Action Work Plan (RAWP), and integrated into the overall Monitoring and Reporting Requirements of the Remedial Action Permit and Deed Notice.

Memorandum

To: Mark Terril, PE

From: Al LoPilato

Date: November 14, 2012

CC: Richard Feinberg, PG

Re: Jersey City PPG – Site 156 Metropolis Towers Conditions Assessment Post Hurricane Sandy

The Metropolis Towers (Site 156) along Montgomery Street and Marin Boulevard in Jersey City was initially inspected on November 5th, 2012 by AECOM, accompanied by a representative from Weston Solutions. Photographs collected during the initial inspection are presented below.

The temporary fence surrounding the Interim Remedial Measure (IRM), which is comprised of the concrete paved Plaza area between the buildings, was observed to be down. Exterior flood levels appeared to have exceeded the height of the sidewalk curb in this area, and cars in the parking lot had been visibly moved by the flood waters and had fogging in the windows. No damage to the exterior Plaza concrete IRM, or evidence of migration or release of contaminants at exterior areas of the property, was observed.

The building interior lobbies were observed with a flood line along the wall approximately 10-inches above the floor, and a 4-foot flood line was observed on the basement walls in the buildings.

In the basement boiler room of the eastern building (Building 2), a potential chrome bloom was observed on the base of a concrete column located between two boilers. A concrete chip sample from the suspect bloom area on the column was collected for hexavalent chromium laboratory analysis, and the column was subsequently wrapped and sealed with polyethylene sheeting to prevent potential exposure pending analytical results. Aqueous samples were also collected from a nearby sump which contained approximately 3-feet of water and sent to the laboratory for analysis.

In the western building (Building 1), aqueous samples were collected from a basement sump containing approximately 3-feet of water and sent to the laboratory for hexavalent chromium analysis. No potential chrome blooms were observed in the western building.

Preliminary laboratory analytical results indicated that hexavalent chromium was not detected in the aqueous samples collected from the sumps in either building. Hexavalent chromium was detected in the concrete sample at a preliminary concentration of 939 mg/kg. Final concentrations will be indicated pending data validation.

Based on the detection of elevated levels of hexavalent chromium at the base of the concrete column, a permanent IRM was installed on November 13, 20120 to prevent disturbance of the area by building maintenance personnel. Photographs of the permanent IRM are provided below.

An assessment of potential storm impacts on the status of Receptors was also conducted, and is summarized in the table below. No confirmed change in status of Receptors, as reported in the most recent Receptor Evaluation Form to NJDEP, was observed. However, based on the analytical results of samples collected, additional investigation may be conducted and a subsequent re-evaluation of Receptor status will be performed.

SITE	On-Site / Surrounding Property Use (Sensitive Populations)	Ground Water Use	Vapor Intrusion	Ecological Receptors	Post-Storm Impacts to Potential Receptors
Site 156	Residential / Residential & Commercial	No private potable or irrigation wells within ½-mile of site	No contaminants in groundwater above VI Screening Levels;	None	No change in Receptor Evaluation Status post Sandy – re-evaluation to be conducted as-needed after receipt of any additional investigation and/or analytical results

NOVEMBER 5, 2012 - INITIAL INSPECTION PHOTOS

Water Damaged Vehicles in Parking Lot

Damaged Fence Surrounding IRM Concrete Area

Flood Water in Basement

Basement Sumps

Concrete Column and Potential Chrome Bloom

Concrete Column with Temporary IRM Installed

NOVEMBER 13, 2012 - PERMANENT IRM INSTALLATION PHOTOS

APPENDIX D

TEST PIT INVESTIGATION REPORT
METROPOLIS TOWERS
JERSEY CITY, NEW JERSEY
FILE 11857

MUESER RUTLEDGE CONSULTING ENGINEERS
225 West 34th Street – 14 Penn Plaza
New York, NY 10122

October 28, 2014

Mueser Rutledge
Consulting Engineers
14 Penn Plaza · 225 West 34th Street · New York, NY 10122
Tel: (917) 339-9300 · Fax: (917) 339-9400
www.mrce.com

October 28, 2014

PPG Industries, Inc.
EH&S Services
One PPG Place
Pittsburgh, PA 15272

Attention: Mr. Mark Terril terril@ppg.com

Re: Metropolis Towers: Site 156 Test Pit Investigation
270 Marin Boulevard Tower 2 Boiler Room
Jersey City, New Jersey
MRCE File 11857

Dear Mr. Terril:

At your request, Mueser Rutledge Consulting Engineers (MRCE) designed, coordinated and completed a test pit investigation at the Metropolis Towers site in conjunction with representatives from CB&I on behalf of PPG Industries Inc., Worden Public Relations, AECOM, Entact, Weston representing the DEP, a building representative and a subcontractor Warren George Inc. This report summarizes the test pit investigation which was performed to obtain a soil sample from below the pile cap supporting the impacted column in the Tower 2 boiler room.

EXHIBITS

The following exhibits are attached to illustrate our report:

Drawing LP-1	Test Pit Location Plan
TP-1	Test Pit Logs, Plan and Section
Photographs	

SITE AND PROJECT DESCRIPTION

The Metropolis Towers soil remediation site is located at 270 & 280 Marin Boulevard in Jersey City, NJ. PPG completed remedial construction activities external to the two tower buildings and under directive from third parties was required to conduct this test pit investigation. During site remediation activities,

contractors discovered deterioration and discoloration of a column located in the Tower 2 boiler room at the northwest corner of the building.

The observed conditions of the column had indicated possible contamination of the soil beneath the actual tower. Investigation of the pile cap supporting the contaminated column was performed.

TEST PIT INVESTIGATION

A test pit (TP-1) was excavated between the dates of September 3rd and September 9th, 2014 by Warren George Inc. (WGI) of Jersey City, New Jersey under the continuous inspection of our Resident Engineer, Mr. Jabber Al-Bihani, who prepared sketches and captured photographs of progress. Test pit sketches and photographs are attached. Test pit layout was measured in the field off of the adjacent impacted column. All work was performed in the presence of Mr. James Christopher of AECOM and Mr. Jason Degrosso of Weston on behalf of the DEP.

The objective of excavating TP-1 was to locate the bottom of the pile cap and collect soil and concrete chip samples for testing by AECOM for potential chrome impacts. Sample collection was performed by Mr. James Christopher of AECOM. TP-1 was progressed by jackhammering through the concrete slab and hand excavating the underlying soil alongside the exposed pile cap. Exposed reinforcing bars were cut away as required to provide access into the pit.

At completion of each work day, the test pit was covered with one inch thick plywood and the immediate surrounding area was cordoned off with a safety cone and caution tape. Following receipt of acceptable test results, the test pit was backfilled with approved stone provided by Entact and the concrete slab was restored by WGI on September 23, 2014.

TEST PIT OBSERVATIONS

Test Pit TP-1. The test pit was excavated in the 270 Marin Boulevard basement boiler room at the impacted column between the existing boilers. The test pit measured 3 feet long by 2 feet wide in plan dimension, and was progressed to approximately 4.9 feet below the top of the basement floor slab. Unless otherwise noted, all depth measurements reference the top of the floor slab. The basement slab varied in thickness from 10 to 12 inches. Approximately 2 foot depth of the pile cap was exposed before groundwater began to seep in, eventually inundating the test pit to that level. Measurements of the total width, length or total thickness of the pile cap were thus not obtained due to the limited work space and groundwater inflow. Accessibility into the test pit was significantly restricted by the presence of piping and the physical location of the boilers which were within a foot east and west of the test pit.

After several days of slow progress attempting to expose the bottom of the pile cap, MRCE, AECOM, Weston and WGI discussed and attempted alternative methods of obtaining soil samples from under the pile cap. Ultimately, a geoprobe driven by a jackhammer obtained a sample at an angle beneath the bottom of the test pit extending under the pile cap. Soil samples were successfully collected at 5.9 and 7.2 feet in depth. Pile cap sidewall concrete chip samples from the exposed portion of the pile cap were obtained at 1.1 and 1.6 feet in depth.

CLOSURE

Soil samples obtained from adjacent to and under the pile cap, and chip concrete pile cap samples were collected by AECOM for testing. During the investigation, no visual staining or other evidence of contaminants was encountered in either the soil, on the concrete surface or in the groundwater.

We trust this data report serves to document the test pit investigation for your records and for archiving purposes. Readers of this report are encouraged to refer to AECOM reports and documentation for environmental and laboratory testing data as they may relate to this investigation.

Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS

By:_____
Jabber Al-Bihani

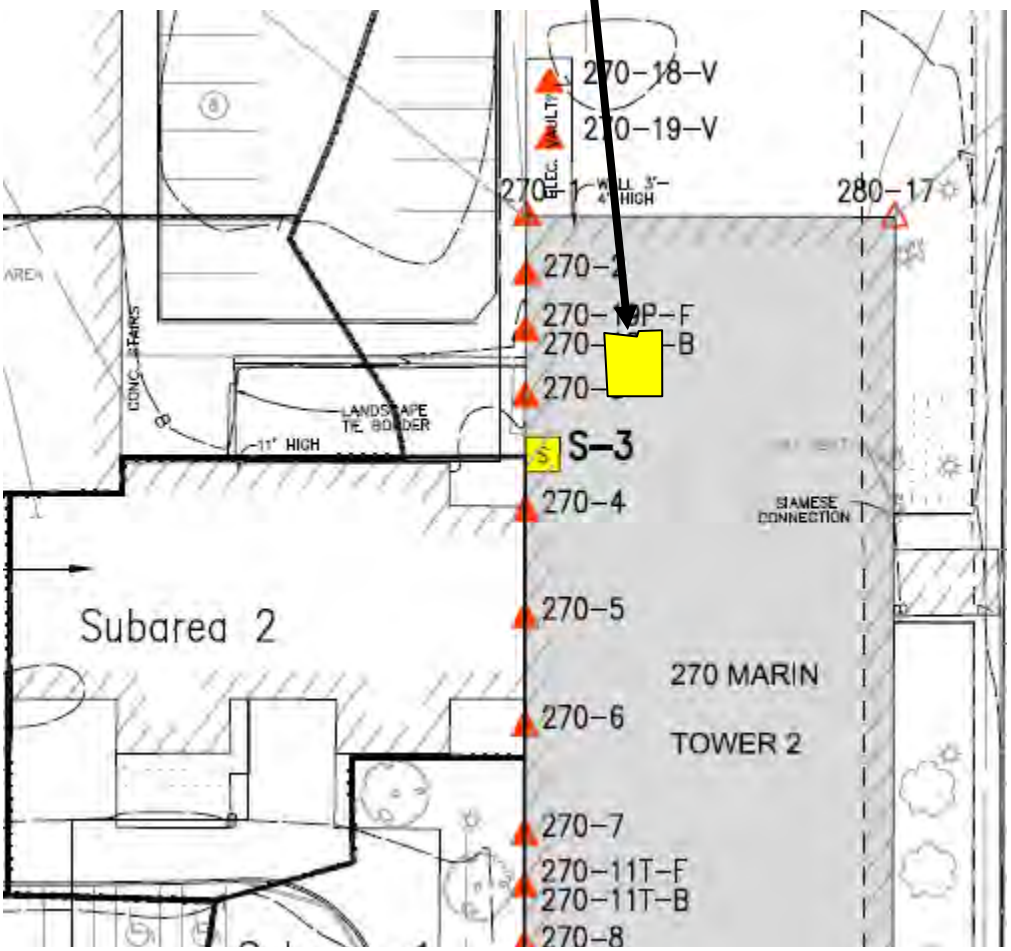
By:_____
Joel L. Volterra

Attachments

JJA:JLV:PWD F:\118\11857\TEST PIT SOIL INVESTIGATION\T P INVESTIGATION REPORT JLV.docx

N

TP-1



NOTES:

1. Yellow area indicates location of the test pit
2. Drawing extracted from MRCE Drawing INST-1

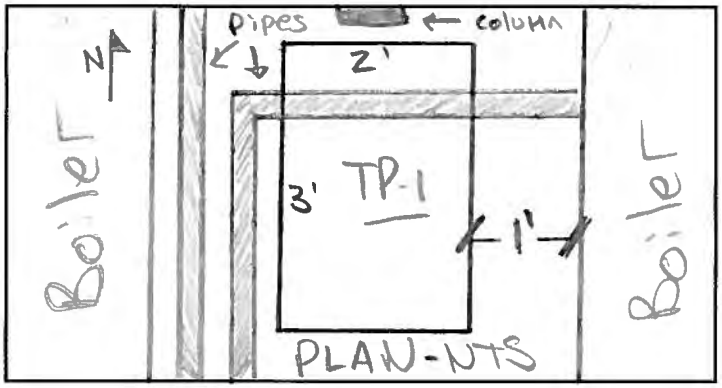
METROPOLIS TOWERS			
JERSEY CITY			NEW JERSEY
MUESER RUTLEDGE CONSULTING ENGINEERS			
14 PENN PLAZA – 225 W 34TH STREET, NEW YORK NY 10122			
SCALE	MADE BY: JJA	DATE: 09-18-2014	FILE No.
NTS	CH'KD BY: JLV	DATE: 09-18-2014	11857
TEST PIT LOCATION PLAN – TOWER 2			Figure No. LP-1

Mueser Rutledge Consulting Engineers
14 Penn Plaza - 225 West 34th Street
New York, NY 10122
T: 917 339-9300 F: 917 339-9400
www.mrce.com

TEST PIT LOG

TEST PIT NO. TP-1.
FILE NO. 11857
DATE 9/3/14
RES ENGR. J. Al-Bihani

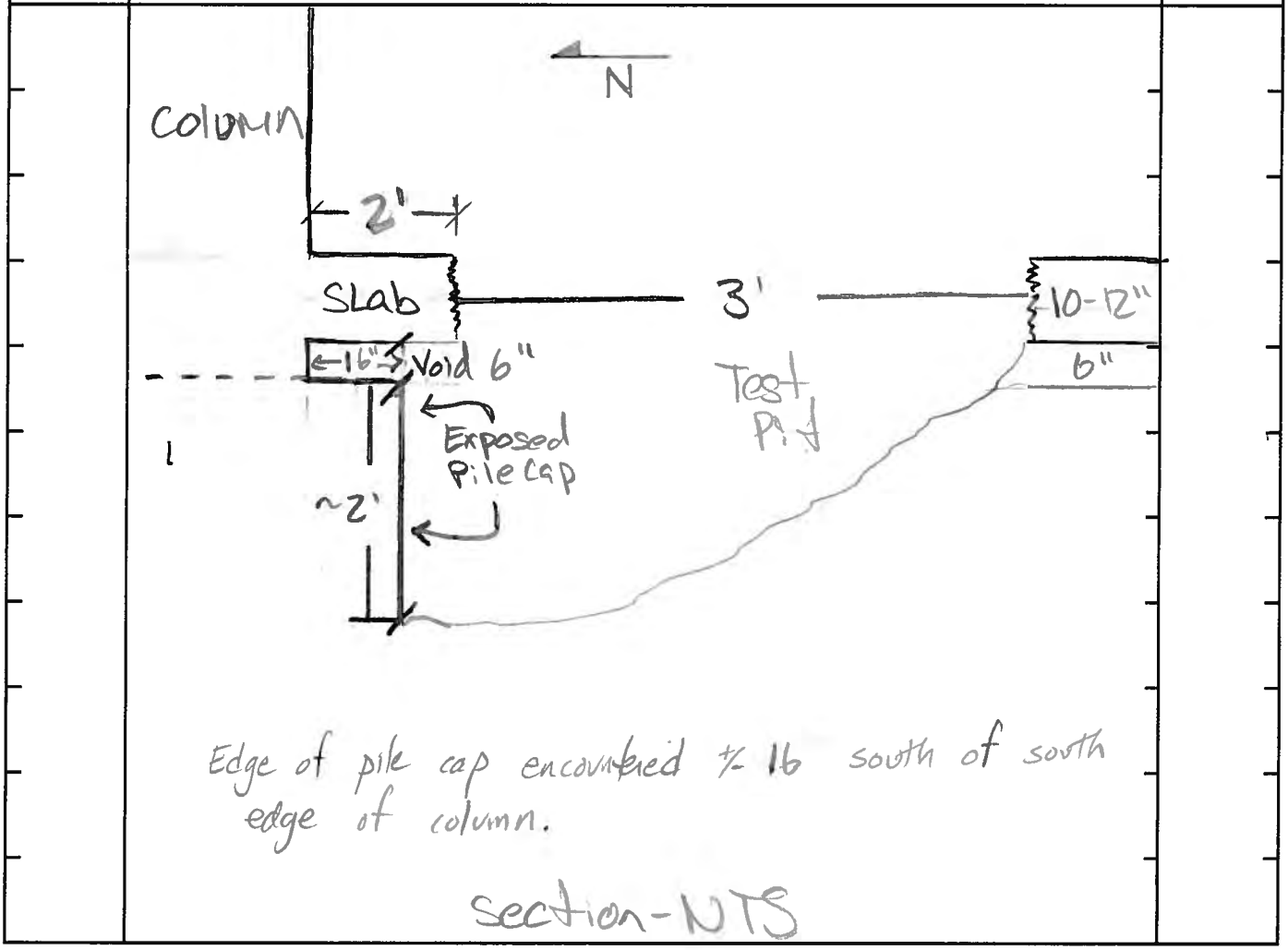
PROJECT: Metropolis Towers
LOCATION: Tower 2. Boiler Room
TEST/INSP. EQUIPMENT Jackhammer (JH) : Hand Tools
REF. CODES/STDS



NOTES
- WGI Drillers began JH conc. slab.
- 3' x 2' TP opened.
- Began shovelling pit material
- Exposed pile cap @ 1.7' from bottom of slab.
- No soil samples collected
- Dark brn fill w/ cobbles & brick.

Ground Surface Elevation

Sample Depth	Description	Depth



TEST PIT NO. 1

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New York, NY 10122
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www.mrce.com

TEST PIT LOG

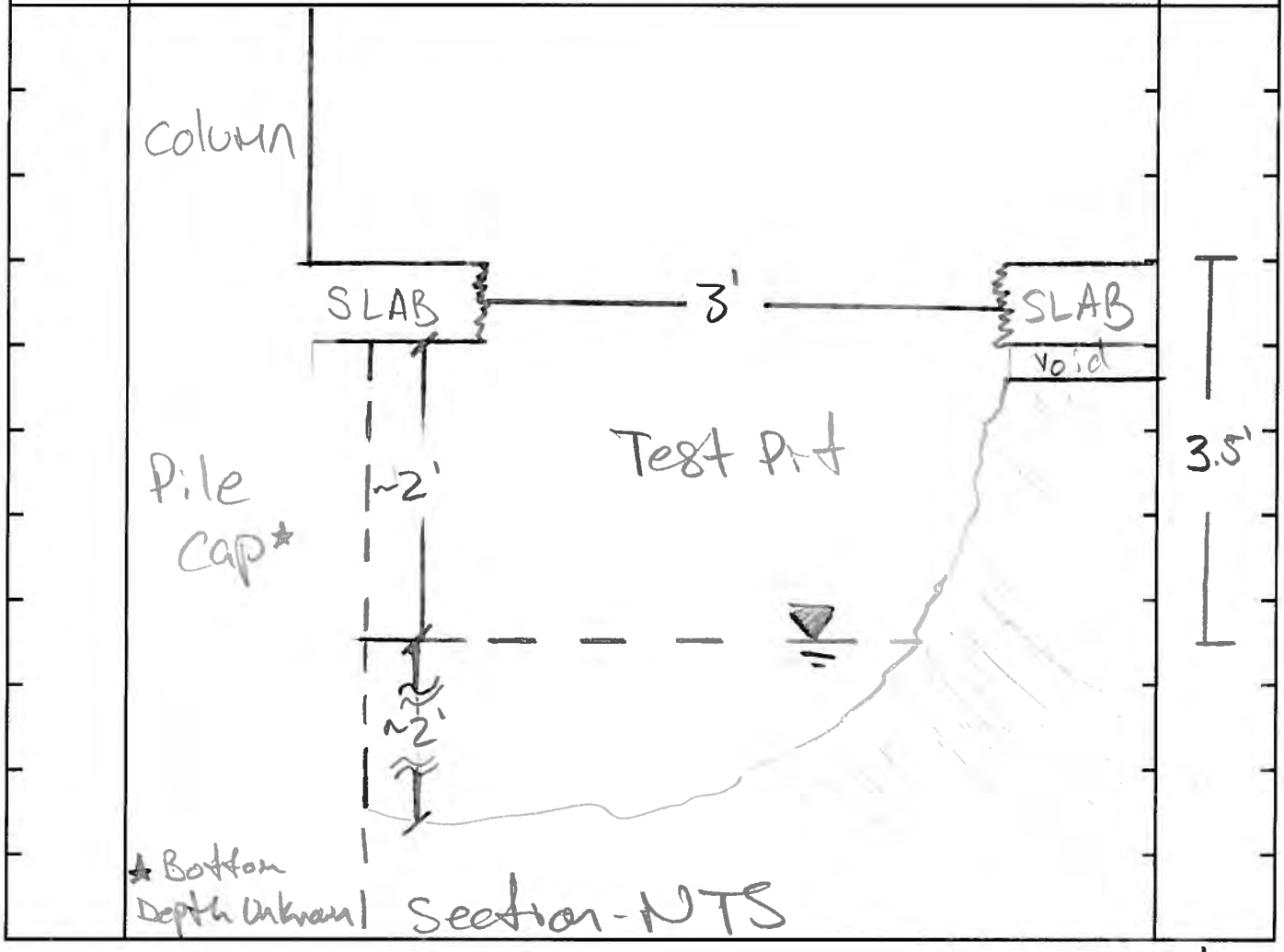
TEST PIT NO. TP-1
FILE NO. 11857
DATE 9/4/14
RES ENGR. J. Al-Bilbeisi

PROJECT: Metropolis Towers
LOCATION: Tower 2, Boiler Room
TEST/INSP. EQUIPMENT Hand tools (shovel, spike, etc)
REF. CODES/STDS

NOTES
- continued digging to expose pile cap bottom.
- reached water table, water began filling hole.
- baling water from hole
-

Ground Surface Elevation

Sample Depth	Description	Depth



TEST PIT NO. 1

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www.mrce.com

TEST PIT LOG

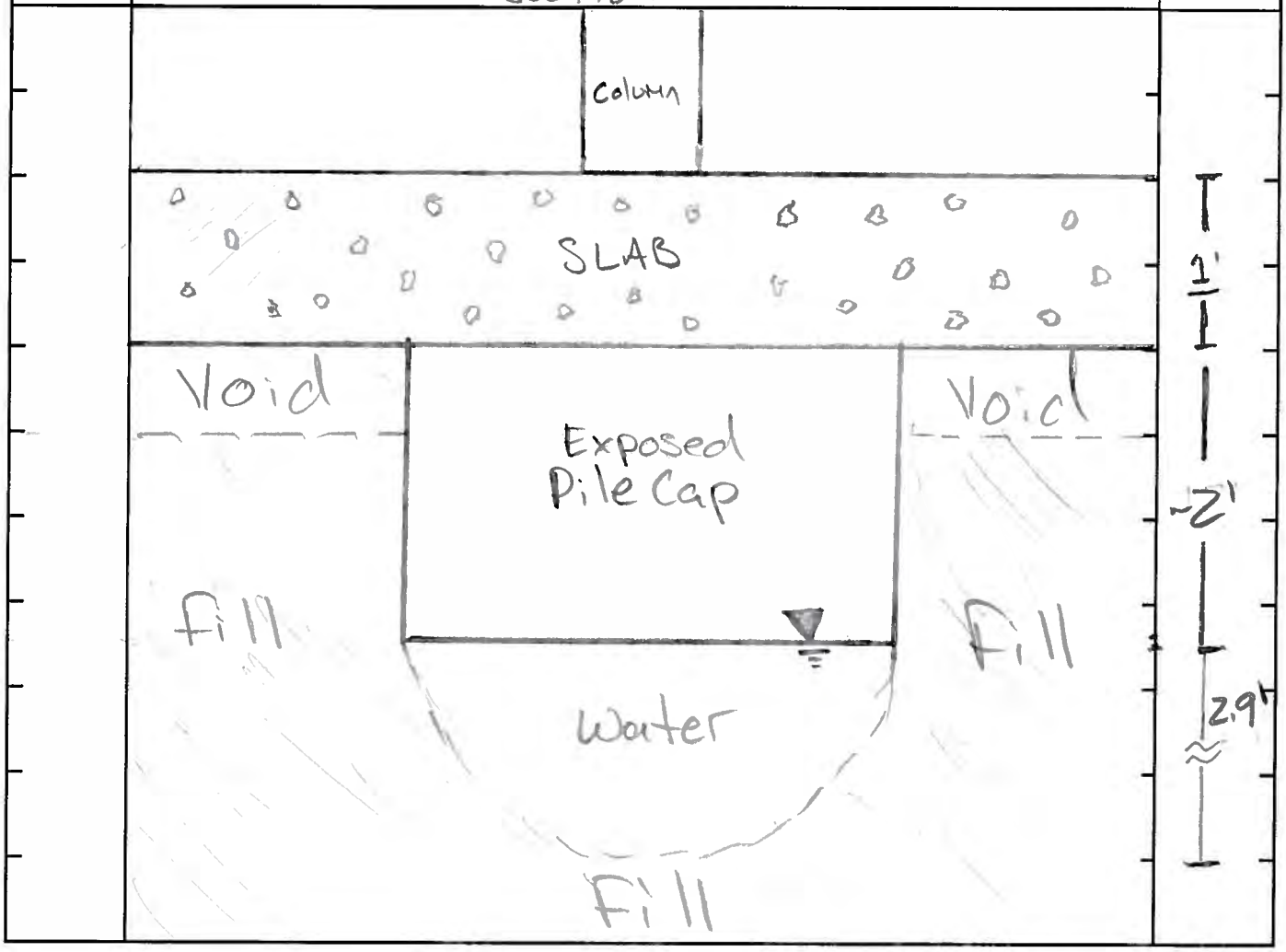
TEST PIT NO. TP-1
FILE NO. 11857
DATE 9/8/14
RES ENGR. J. Al-Bitar

PROJECT: Metropolis Towers
LOCATION: Tower 2 - Boiler Room
TEST/INSP. EQUIPMENT Hand tools
REF. CODES/STDS

NOTES
- locating bottom of pile cap. still in progress.
- water samples obtained by AECOM
- Excavated material moved to drums.

Ground Surface Elevation

Sample Depth	Description	Depth
	Section	



TEST PIT NO. 1

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TEST PIT LOG

TEST PIT NO. TP-1
FILE NO. 11857
DATE 9/9/14
RES ENGR. J. Al-Bihani
REF. CODES/STDS

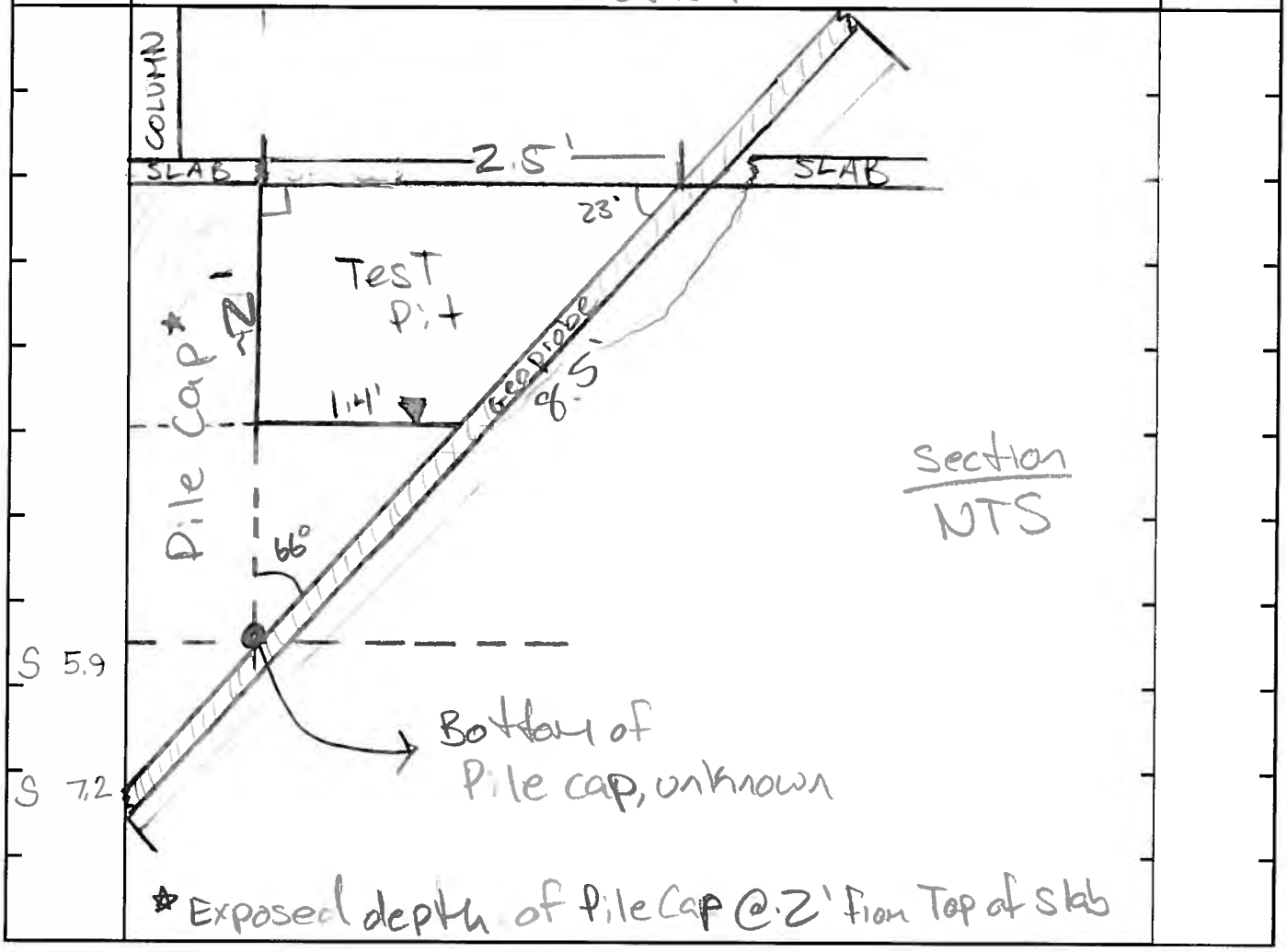
PROJECT: Metropolis Towers.
LOCATION: Tower 2 - Boiler Room
TEST/INSP. EQUIPMENT Elec Jack Hammer

NOTES

- Jack hammer a geoprobe to penetrate the soil / Fill to obtain a soil sample @ known depths
- samples obtained @ 5.9' & 7.2' depth below slab.

Ground Surface Elevation

Sample Depth	Description	Depth
	Section	



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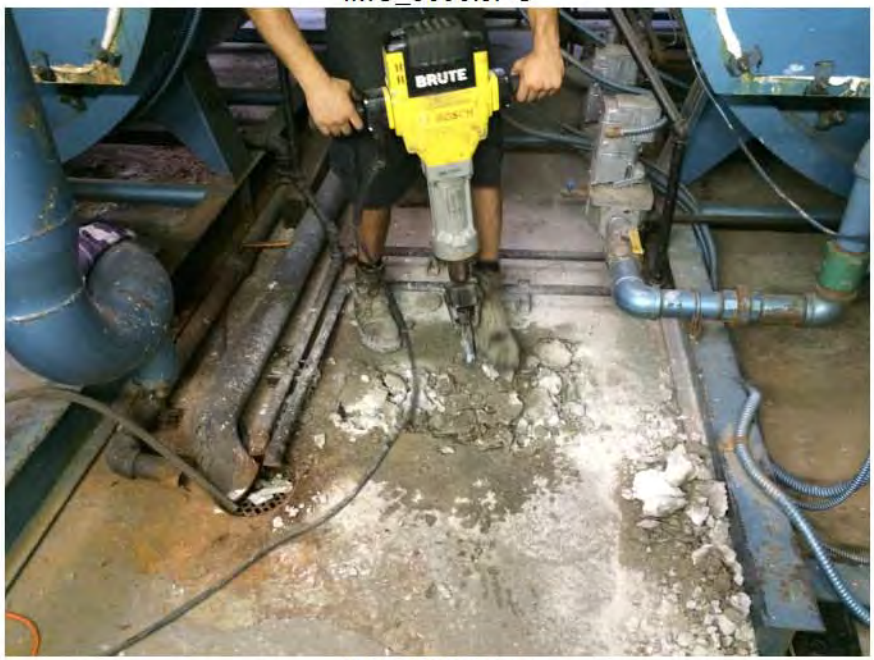

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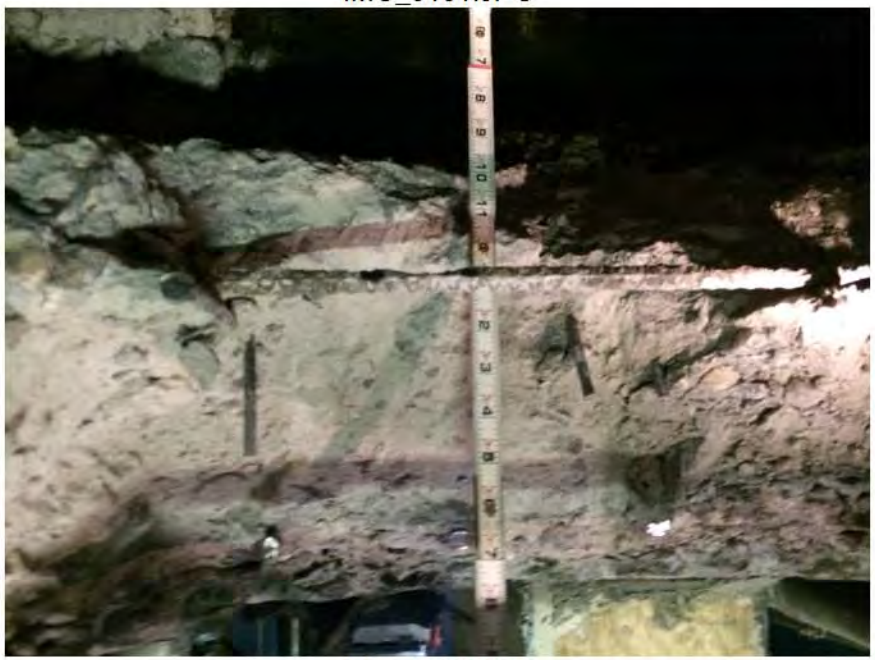

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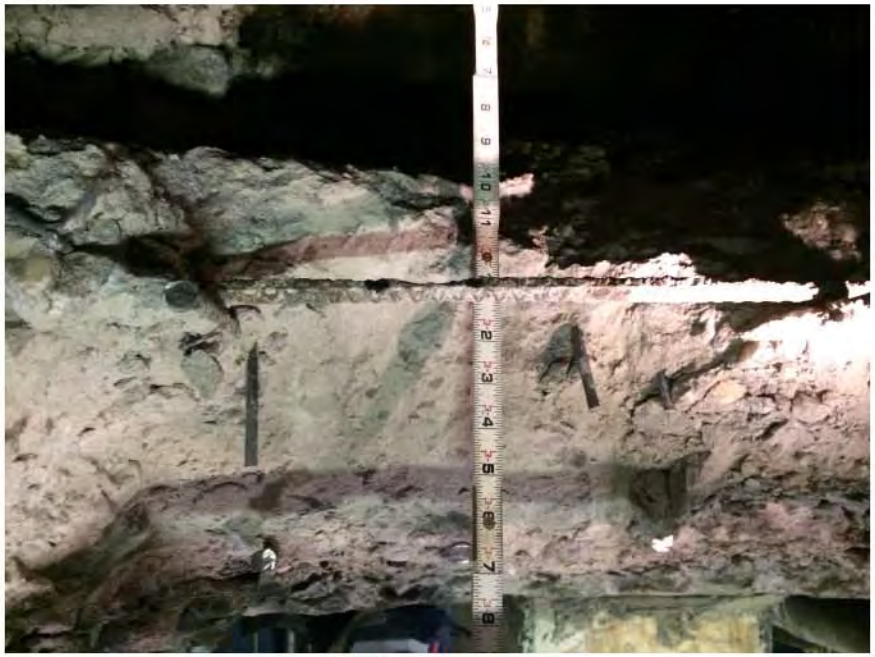

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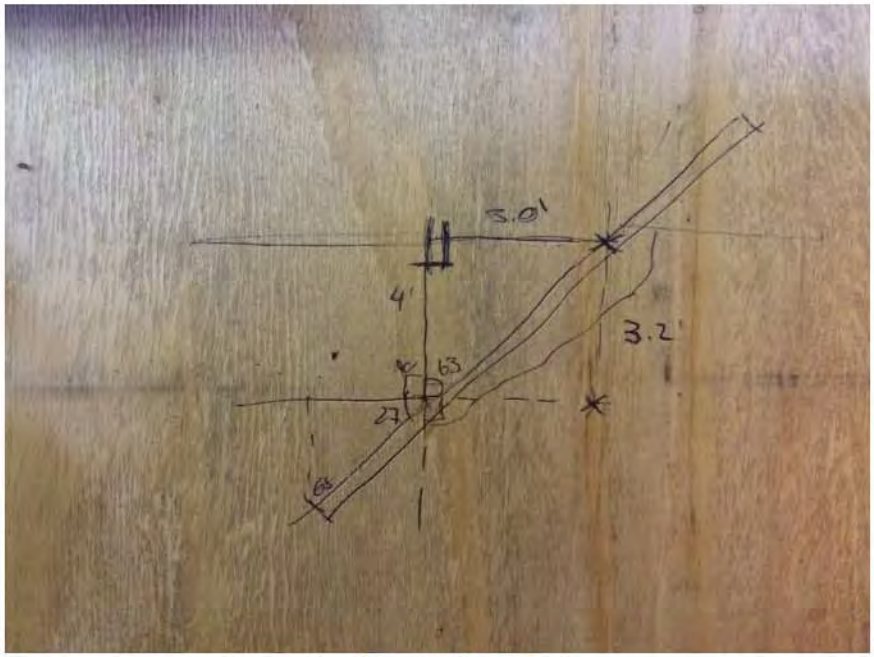

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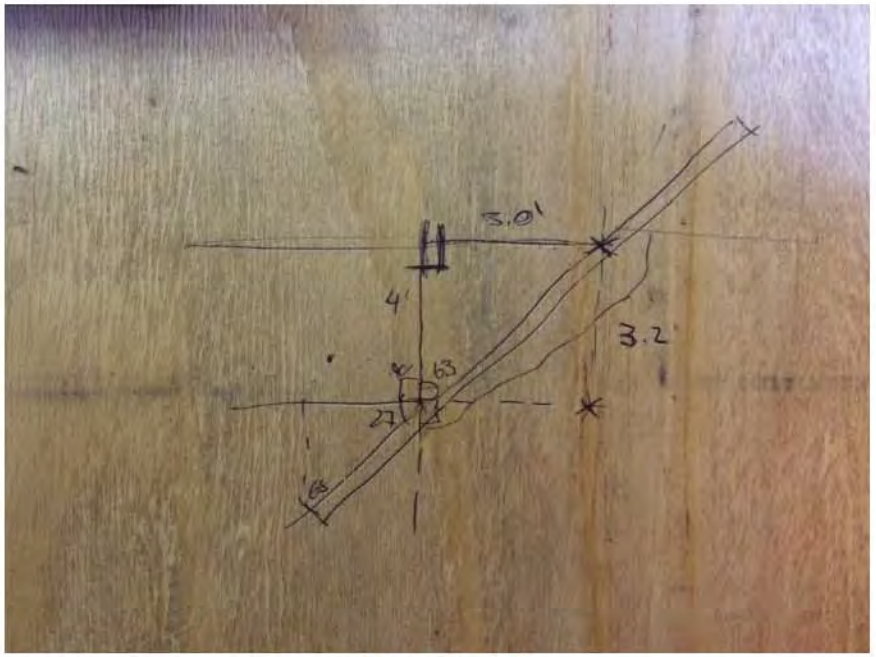

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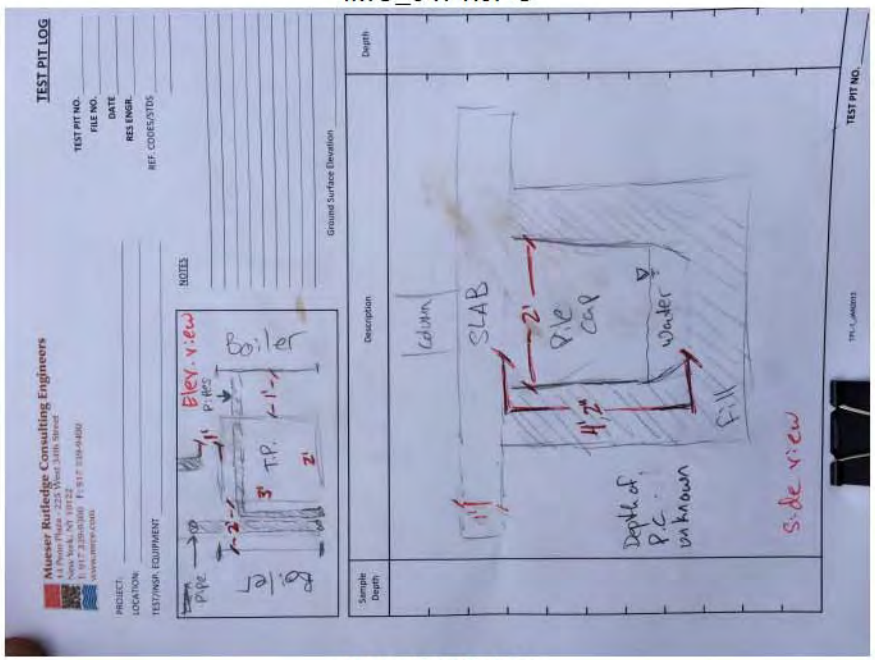

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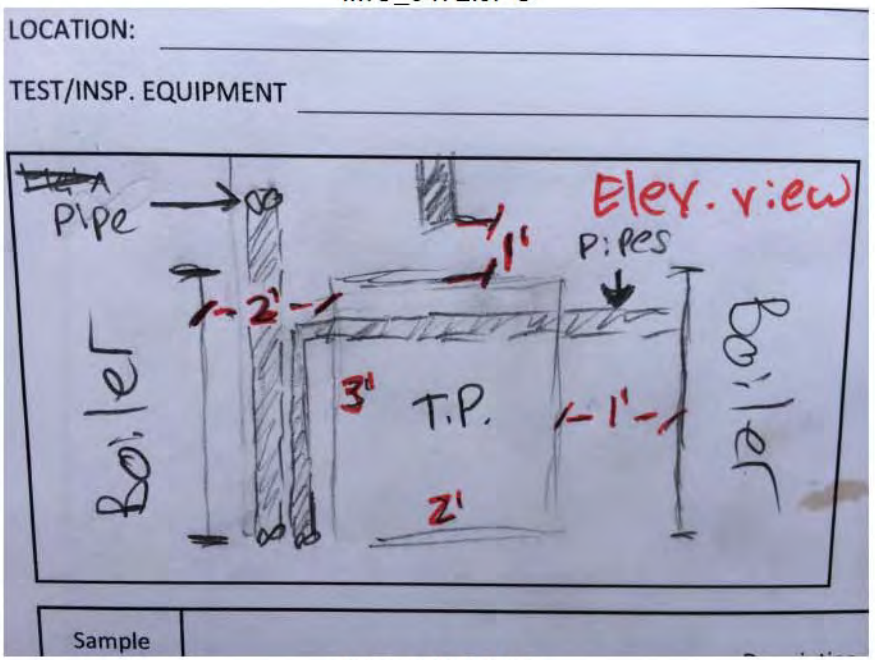

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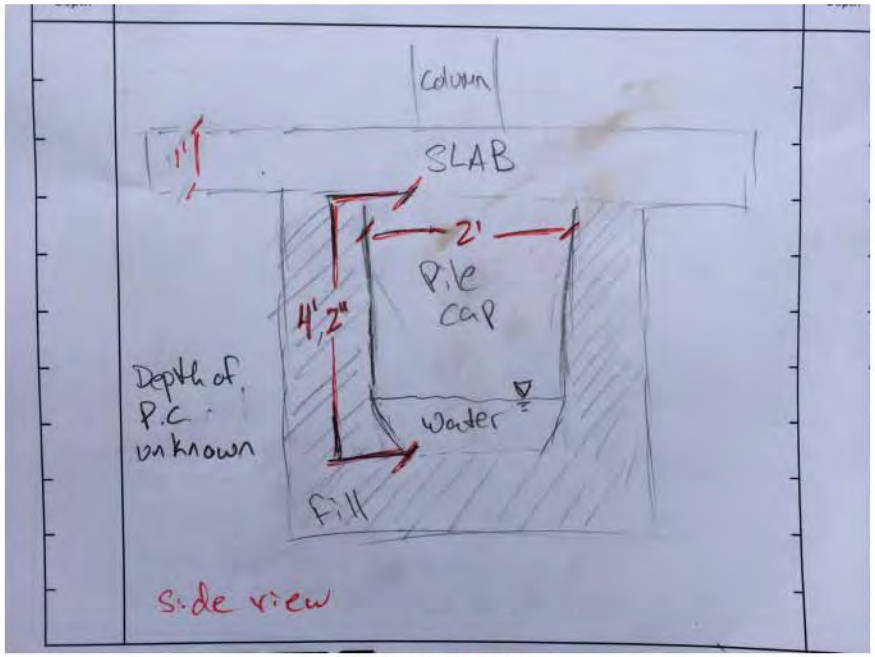

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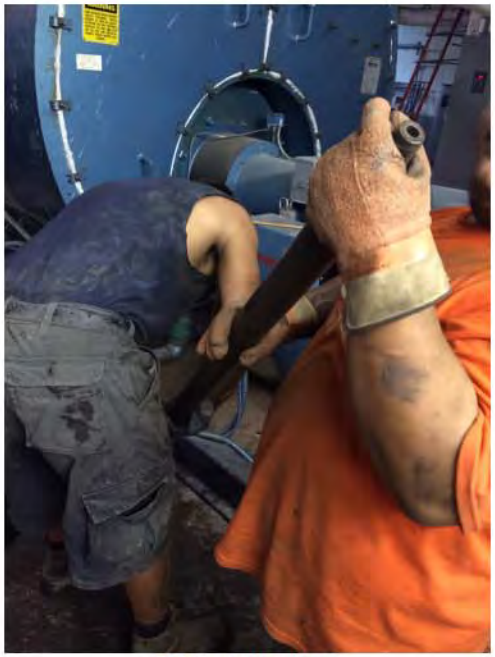

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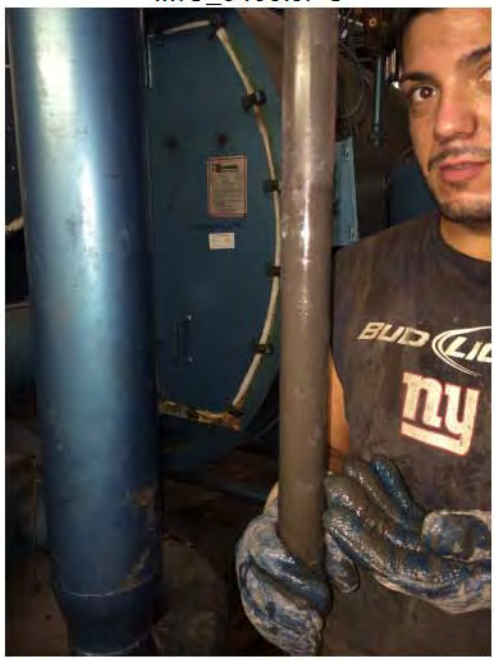

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