


## **APPENDIX A-1**

### **RSMEANS SQUARE FOOT COST ESTIMATE**

# Square Foot Cost Estimate Report

Estimate Name:	U.S. GSA Headquarters Modernization	 <p>Costs are derived from a building model with basic components. Scope differences and market conditions can cause costs to vary significantly. Parameters are not within the ranges recommended by RSMeans.</p>
Building Type:	Office, 5-10 Story with Precast Concrete Panel / R/Conc. Frame	
Location:	WASHINGTON, DC	
Story Count:	9	
Story Height (L.F.):	12	
Floor Area (S.F.):	430000	
Labor Type:	Union	
Basement Included:	Yes	
Data Release:	Year 2012	
Cost Per Square Foot:	\$149.47	
Building Cost:	\$64,270,000	

		% of Total	Cost Per S.F.	Cost
<b>A Substructure</b>		<b>4.80%</b>	<b>\$6.25</b>	<b>\$2,685,500</b>
<b>A1010</b>	<b>Standard Foundations</b> 12" deep x 32" wide 6" square x 30" deep		<b>\$4.39</b>	<b>\$1,889,500</b>
<b>A1030</b>	<b>Slab on Grade</b> Slab on grade, 4" thick, non industrial, reinforced		<b>\$0.57</b>	<b>\$246,500</b>
<b>A2010</b>	<b>Basement Excavation</b> storage		<b>\$0.34</b>	<b>\$146,000</b>
<b>A2020</b>	<b>Basement Walls</b> thick		<b>\$0.94</b>	<b>\$403,500</b>
<b>B Shell</b>		<b>32.20%</b>	<b>\$42.06</b>	<b>\$18,086,000</b>
<b>B1010</b>	<b>Floor Construction</b> 394 lbs/LF, 4000PSI 394 lbs/LF, 6000PSI 394 lbs/LF, 6000PSI load, 10'-14' story height, 375 lbs/LF, 4000PSI bay, 75 PSF superimposed load, 153 PSF total load load, 188 PSF total load		<b>\$21.60</b>	<b>\$9,287,000</b>
<b>B1020</b>	<b>Roof Construction</b> deep beam, 8.5" slab, 146 PSF total load		<b>\$1.58</b>	<b>\$679,000</b>
<b>B2010</b>	<b>Exterior Walls</b> 2" rigid insulation, high rise		<b>\$15.11</b>	<b>\$6,497,000</b>
<b>B2020</b>	<b>Exterior Windows</b> Windows, aluminum, sliding, insulated glass, 5' x 3'		<b>\$2.96</b>	<b>\$1,274,500</b>
<b>B2030</b>	<b>Exterior Doors</b> 6'-0" x 10'-0" opening opening		<b>\$0.25</b>	<b>\$107,000</b>
<b>B3010</b>	<b>Roof Coverings</b> mopped Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite Roof edges, aluminum, duranodic, .050" thick, 6" face Flashing, aluminum, no backing sides, .019"		<b>\$0.56</b>	<b>\$241,500</b>
<b>C Interiors</b>		<b>19.10%</b>	<b>\$24.93</b>	<b>\$10,718,000</b>
<b>C1010</b>	<b>Partitions</b> 5/8" @ 24" OC framing ,same opposite face, no insulation		<b>\$2.48</b>	<b>\$1,068,500</b>



C1020	1/2" fire ratedgypsum board, taped & finished, painted on metal furring <b>Interior Doors</b>	\$3.03	\$1,303,500	
C1030	0" x 7'-0" x 1-3/8" <b>Fittings</b>	\$0.68	\$294,000	
C2010	Toilet partitions, cubicles, ceiling hung, plastic laminate <b>Stair Construction</b>	\$2.97	\$1,276,000	
C3010	Stairs, steel, cement filled metal pan & picket rail, 16 risers, with landing <b>Wall Finishes</b>	\$0.93	\$399,500	
C3020	& 2 coats Vinyl wall covering, fabric back, medium weight <b>Floor Finishes</b>	\$8.46	\$3,639,000	
C3030	Carpet, tufted, nylon, roll goods, 12' wide, 36 oz Carpet, padding, add to above, minimum Vinyl, composition tile, maximum Tile, ceramic natural clay <b>Ceiling Finishes</b>	\$6.37	\$2,737,500	
	channel grid, suspended support			
D Services		43.90%	\$57.32	\$24,646,500
D1010	<b>Elevators and Lifts</b>	\$15.61	\$6,711,000	
	200 FPM			
D2010	<b>Plumbing Fixtures</b>	\$2.56	\$1,100,500	
	Water closet, vitreous china, bowl only with flush valve, wall hung Urinal, vitreous china, wall hung Lavatory w/trim, vanity top, PE on CI, 20" x 18" Service sink w/trim, PE on CI,wall hung w/rim guard, 24" x 20" Water cooler, electric, wall hung, 8.2 GPH Water cooler, electric, wall hung, wheelchair type, 7.5 GPH			
D2020	<b>Domestic Water Distribution</b>	\$0.53	\$229,500	
	Gas fired water heater, commercial, 100< F rise, 200 MBH input, 192 GPH			
D2040	<b>Rain Water Drainage</b>	\$0.27	\$115,000	
	Roof drain, CI, soil,single hub, 5" diam, 10' high Roof drain, CI, soil,single hub, 5" diam, for each additional foot add			
D3050	<b>Terminal &amp; Package Units</b>	\$16.30	\$7,010,500	
	Rooftop, multizone, air conditioner, offices, 25,000 SF, 79.16 ton			
D4010	<b>Sprinklers</b>	\$2.92	\$1,256,500	
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF SF Standard High Rise Accessory Package 8 story			
D4020	<b>Standpipes</b>	\$0.70	\$302,000	
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor floors Fire pump, electric, with controller, 5" pump, 100 HP, 1000 GPM Fire pump, electric, for jockey pump system, add			
D5010	<b>Electrical Service/Distribution</b>	\$0.38	\$163,000	
	4 wire, 120/208 V, 1600 A Feeder installation 600 V, including RGS conduit and XHHW wire, 60 A Feeder installation 600 V, including RGS conduit and XHHW wire, 200 A Feeder installation 600 V, including RGS conduit and XHHW wire, 1600 A Switchgear installation, incl switchboard, panels & circuit breaker, 1600 A			
D5020	<b>Lighting and Branch Wiring</b>	\$12.26	\$5,271,000	
	with transformer			

Miscellaneous power, 1.2 watts  
 Central air conditioning power, 4 watts  
 Motor installation, three phase, 460 V, 15 HP motor size  
 15 HP, 575 V 20 HP  
 Motor connections, three phase, 200/230/460/575 V, up to 5 HP  
 Motor connections, three phase, 200/230/460/575 V, up to 100 HP  
 fixtures @32watt per 1000 SF

<b>D5030</b>	<b>Communications and Security</b>	<b>\$4.64</b>	<b>\$1,997,000</b>
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Telephone wiring for offices & laboratories, 8 jacks/MSF  
 detectors, includes outlets, boxes, conduit and wire  
 Fire alarm command center, addressable with voice, excl. wire & conduit  
 Internet wiring, 8 data/voice outlets per 1000 S.F.

<b>D5090</b>	<b>Other Electrical Systems</b>	<b>\$1.14</b>	<b>\$490,500</b>
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engine with fuel tank, 100 kW  
 Uninterruptible power supply with standard battery pack, 15 kVA/12.75 kW

<b>E Equipment &amp; Furnishings</b>		<b>0.00%</b>	<b>\$0.00</b>	<b>\$0</b>
<b>E1090</b>	<b>Other Equipment</b>		<b>\$0.00</b>	<b>\$0</b>
<b>F Special Construction</b>		<b>0.00%</b>	<b>\$0.00</b>	<b>\$0</b>
<b>G Building Sitework</b>		<b>0.00%</b>	<b>\$0.00</b>	<b>\$0</b>

<b>SubTotal</b>	<b>100%</b>	<b>\$130.55</b>	<b>\$56,136,000</b>
<b>Contractor Fees (General Conditions,Overhead,Profit)</b>	<b>7.00%</b>	<b>\$9.14</b>	<b>\$3,929,500</b>
<b>Architectural Fees</b>	<b>7.00%</b>	<b>\$9.78</b>	<b>\$4,204,500</b>
<b>User Fees</b>	<b>0.00%</b>	<b>\$0.00</b>	<b>\$0</b>
<b>Total Building Cost</b>		<b>\$149.47</b>	<b>\$64,270,000</b>

## APPENDIX A-2

### RSMEANS MEP ASSEMBLIES COST ESTIMATE

MEP Assemblies Cost Estimate									
Assembly Number	Description	Quantity	Unit	Material O&P	Installation O&P	Total O&P	Ext. Material O&P	Ext. Installation O&P	Ext. Total O&P
D20101101920	Water closet, vitreous china, tank type, floor mount, 1 piece	162	Ea.	\$ 1,352.70	\$ 701.79	\$ 2,054.49	\$ 219,137.40	\$ 113,689.98	\$ 332,827.38
D20102102000	Urinal, vitreous china, wall hung	54	Ea.	\$ 641.28	\$ 739.47	\$ 1,380.75	\$ 34,629.12	\$ 39,931.38	\$ 74,560.50
D20103102160	Lavatory w/trim, wall hung, vitreous china, 18" x 15"	162	Ea.	\$ 781.56	\$ 748.89	\$ 1,530.45	\$ 126,612.72	\$ 121,320.18	\$ 247,932.90
D20108102040	Drinking fountain, 1 bubbler, wall mounted, semi-recessed, stainless steel	54	Ea.	\$ 1,477.95	\$ 433.32	\$ 1,911.27	\$ 79,809.30	\$ 23,399.28	\$ 103,208.58
D20202402140	Electric water heater, commercial, 100< F rise, 350 gal, 30 KW 123 GPH	4	Ea.	\$ 27,655.20	\$ 2,260.80	\$ 29,916.00	\$ 110,620.80	\$ 9,043.20	\$ 119,664.00
D20402102200	Roo drain, DWV PVC, 6" diam, 10' high	16	Ea.	\$ 1,177.35	\$ 1,036.20	\$ 2,213.55	\$ 18,837.60	\$ 16,579.20	\$ 35,416.80
D20908101320	Copper tubing, hard temper, solder, type K, 1-1/2" diameter	27900	L.F.	\$ 23.05	\$ 12.43	\$ 35.48	\$ 643,095.00	\$ 346,797.00	\$ 989,892.00
D30105302000	Commercial building heating systems, terminal unit heaters, forced hot water, 1mil SF bldg, 10mil CF, total, 5 floors	430000	S.F.	\$ 1.48	\$ 1.34	\$ 2.82	\$ 636,400.00	\$ 576,200.00	\$ 1,212,600.00
D30203301020	Pump, base mounted with motor, end-suction, 3" size, 5 HP, to 225 GPM	14	Ea.	\$ 13,426.80	\$ 4,074.55	\$ 17,501.35	\$ 187,975.20	\$ 57,043.70	\$ 245,018.90
D30203301030	Pump, base mounted with motor, end-suction, 4" size, 7-1/2 HP, to 350 GPM	2	Ea.	\$ 15,030.00	\$ 4,912.30	\$ 19,942.30	\$ 30,060.00	\$ 9,824.60	\$ 39,884.60
D30203301040	Pump, base mounted with motor, end-suction, 5" size, 15 HP, to 1000 GPM	36	Ea.	\$ 21,543.00	\$ 7,450.65	\$ 28,993.65	\$ 775,548.00	\$ 268,223.40	\$ 1,043,771.40
D30301103520	Packaged chiller, air cooled, with fan coil unit, offices, 40,000 SF, 126.66 ton	430000	S.F.	\$ 7.11	\$ 3.65	\$ 10.76	\$ 3,057,300.00	\$ 1,569,500.00	\$ 4,626,800.00
D30303301050	Cooling tower, stainless steel, packaged unit, draw thru, 1000 ton	3	Ea.	\$ 198,897.00	\$ 34,951.40	\$ 233,848.40	\$ 596,691.00	\$ 104,854.20	\$ 701,545.20
D30401101020	AHU, central station, cool/heat coils, constant volume, filters, 5,000 CFM	10	Ea.	\$ 22,745.40	\$ 8,030.55	\$ 30,775.95	\$ 227,454.00	\$ 80,305.50	\$ 307,759.50
D30401101030	AHU, central station, cool/heat coils, constant volume, filters, 10,000 CFM	7	Ea.	\$ 45,390.60	\$ 11,125.40	\$ 56,516.00	\$ 317,734.20	\$ 77,877.80	\$ 395,612.00
D30401101040	AHU, central station, cool/heat coils, constant volume, filters, 15,000 CFM	3	Ea.	\$ 64,128.00	\$ 15,098.60	\$ 79,226.60	\$ 192,384.00	\$ 45,295.80	\$ 237,679.80
D30401341070	VAV terminal, cooling, hot water reheat, with actuator / controls, 1500 CFM	8	Ea.	\$ 4,383.75	\$ 7,324.05	\$ 11,707.80	\$ 35,070.00	\$ 58,592.40	\$ 93,662.40
D30401381050	VAV terminal, cool, hot water reheat, fan powered, with actuator/controls, 1000 CFM	3	Ea.	\$ 4,108.20	\$ 4,969.05	\$ 9,077.25	\$ 12,324.60	\$ 14,907.15	\$ 27,231.75
D30402201010	Fan system, in-line centrifugal, 500 CFM	4	Ea.	\$ 2,655.30	\$ 3,249.90	\$ 5,905.20	\$ 10,621.20	\$ 12,999.60	\$ 23,620.80
D30402201030	Fan system, in-line centrifugal, 1500 CFM	7	Ea.	\$ 3,607.20	\$ 6,523.35	\$ 10,130.55	\$ 25,250.40	\$ 45,663.45	\$ 70,913.85
D30402201060	Fan system, in-line centrifugal, 5000 CFM	9	Ea.	\$ 9,569.10	\$ 39,752.40	\$ 49,321.50	\$ 86,121.90	\$ 357,771.60	\$ 443,893.50
D30402201080	Fan system, in-line centrifugal, 10,000 CFM	17	Ea.	\$ 13,527.00	\$ 47,571.00	\$ 61,098.00	\$ 229,959.00	\$ 808,707.00	\$ 1,038,666.00
D30402401060	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 5000 CFM	4	Ea.	\$ 5,961.90	\$ 29,296.20	\$ 35,258.10	\$ 23,847.60	\$ 117,184.80	\$ 141,032.40
D30402401070	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 8500 CFM	5	Ea.	\$ 7,915.80	\$ 37,680.00	\$ 45,595.80	\$ 39,579.00	\$ 188,400.00	\$ 227,979.00
D30406101030	Plate heat exchanger, 1200 GPM	2	Ea.	\$ 124,248.00	\$ 24,671.80	\$ 148,919.80	\$ 248,496.00	\$ 49,343.60	\$ 297,839.60
D30501509030	Components of duct pkgs for abv sys, diffusers; al, 24" x 12", one	18		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
D40104101100	Wet pipe sprinkler systems, steel, ordinary hazard, 1 floor, 50,000 SF	50000	S.F.	\$ 1.84	\$ 2.19	\$ 4.03	\$ 92,000.00	\$ 109,500.00	\$ 201,500.00
D40104101240	Wet pipe sprinkler systems, steel, ordinary hazard, each additional floor, 50,000 SF	380000	S.F.	\$ 1.40	\$ 1.91	\$ 3.31	\$ 532,000.00	\$ 725,800.00	\$ 1,257,800.00
D40203100600	Wet standpipe risers, class I, steel, black, sch 40, 6" diam pipe, 1 floor	1	Floor	\$ 7,615.20	\$ 5,401.90	\$ 13,017.10	\$ 7,615.20	\$ 5,401.90	\$ 13,017.10
D40203100620	Wet standpipe risers, class I, steel, black, sch 40, 6" diam pipe, additional floors	8	Floor	\$ 1,978.95	\$ 1,499.85	\$ 3,478.80	\$ 15,831.60	\$ 11,998.80	\$ 27,830.40
D50101200560	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 2000 A	1	Ea.	\$ 31,220.80	\$ 10,706.00	\$ 41,926.80	\$ 31,220.80	\$ 10,706.00	\$ 41,926.80
D50102400280	Switchgear installation, incl switchboard, panels & circuit breaker, 800 A	10	Ea.	\$ 16,993.60	\$ 7,950.00	\$ 24,943.60	\$ 169,936.00	\$ 79,500.00	\$ 249,436.00
D50201200920	Receptacles and wall switches, 1000 SF, 14 receptacles	430000	S.F.	\$ 0.68	\$ 2.75	\$ 3.43	\$ 292,400.00	\$ 1,182,500.00	\$ 1,474,900.00
D50202080600	Fluorescent fixtures, type A, 17 fixtures per 1000 SF	430000	S.F.	\$ 2.69	\$ 5.78	\$ 8.47	\$ 1,156,700.00	\$ 2,485,400.00	\$ 3,642,100.00
D50303100280	Telephone systems, underfloor duct, 7' on center, low density	430000	S.F.	\$ 7.90	\$ 2.78	\$ 10.68	\$ 3,397,000.00	\$ 1,195,400.00	\$ 4,592,400.00
D50303100520	Telephone systems, telepoles, low density	430000	S.F.	\$ 1.21	\$ 0.71	\$ 1.92	\$ 520,300.00	\$ 305,300.00	\$ 825,600.00
D50303101020	Telephone wiring for offices & laboratories, 8 jacks/MSF	430	S.F.	\$ 0.43	\$ 1.80	\$ 2.23	\$ 184.90	\$ 774.00	\$ 958.90
D50309100440	Communication and alarm systems, fire detection, non-addressable, 100 detectors, includes outlets, boxes, conduit and wire	1	Ea.	\$ 23,613.20	\$ 41,764.00	\$ 65,377.20	\$ 23,613.20	\$ 41,764.00	\$ 65,377.20
D50309200110	Internet wiring, 8 data/voice outlets per 1000 S.F.	430	M.S.F.	\$ 637.26	\$ 1,855.00	\$ 2,492.26	\$ 274,021.80	\$ 797,650.00	\$ 1,071,671.80
TOTAL									\$ 26,543,531.00

## **APPENDIX B**

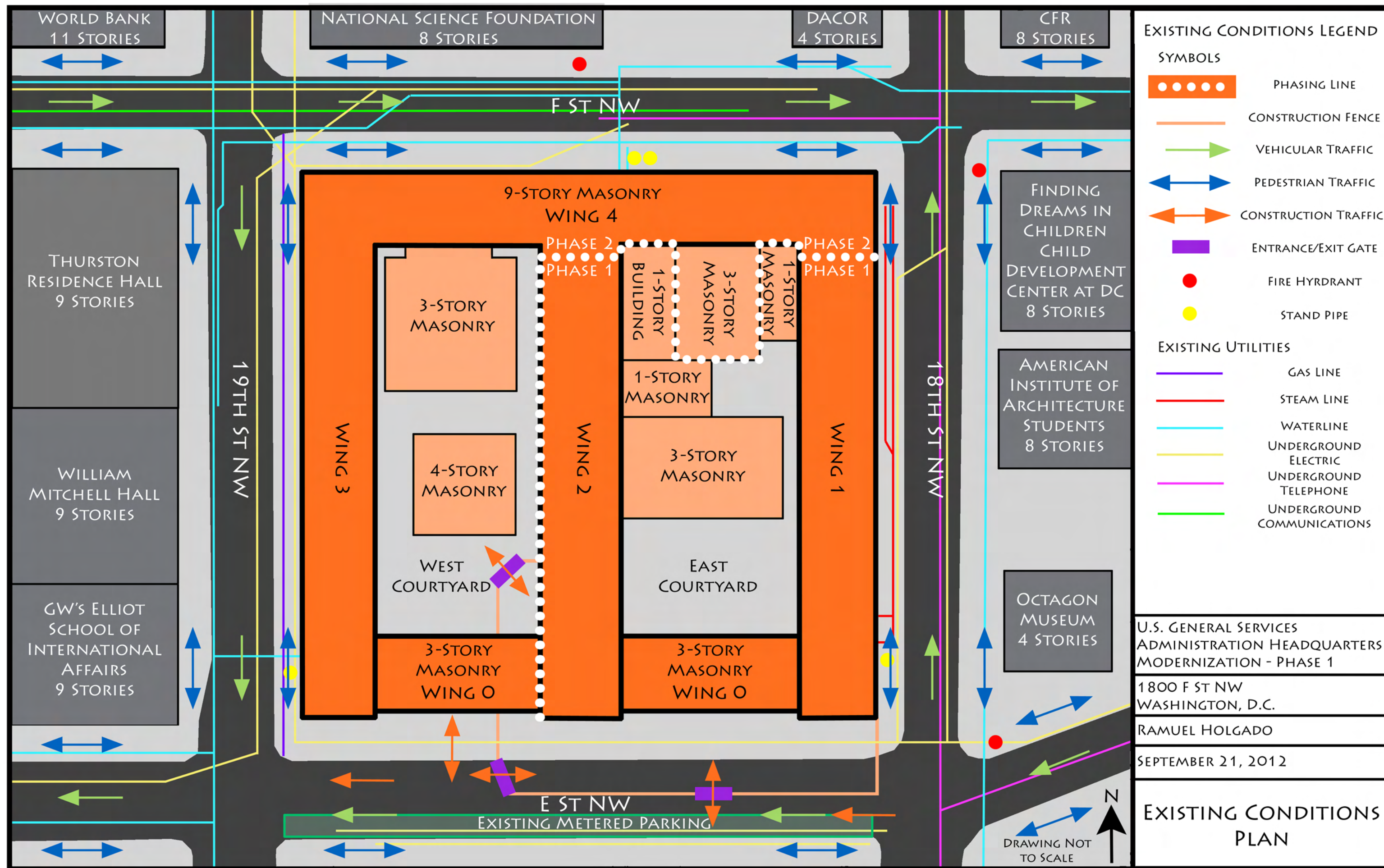
### **GENERAL CONDITIONS ESTIMATE**

Line Item	Quantity	Unit	Rate	Total Cost
<b>Personnel</b>				
Senior Project Manager	100	Week	\$ 3,476.00	\$ 347,600.00
Project Manager	100	Week	\$ 2,821.30	\$ 282,130.00
Quality Control Manager	104	Week	\$ 3,158.78	\$ 328,513.12
Safety Manager	104	Week	\$ 1,689.98	\$ 175,757.92
Senior Superintendent	104	Week	\$ 3,265.23	\$ 339,583.92
Superintendent	104	Week	\$ 3,111.27	\$ 323,572.08
MEP Manager	100	Week	\$ 2,869.74	\$ 286,974.00
Assistant Project Manager	100	Week	\$ 1,640.66	\$ 164,066.00
Project Engineer/Scheduler	104	Week	\$ 1,482.00	\$ 154,128.00
Assistant Project Engineer	104	Week	\$ 1,127.68	\$ 117,278.72
Officer Manager	104	Week	\$ 864.28	\$ 89,885.12
<b>Site Expenses</b>				
Mobilization	1	LS	\$ 23,752.00	\$ 23,752.00
Temporary Buildings	0	Week	\$ -	\$ -
Temporary Utilities	104	Week	\$ 3,684.13	\$ 383,149.52
Temporary Job Construction	104	Week	\$ 2,936.29	\$ 305,374.16
Job Office Expenses	104	Week	\$ 3,784.65	\$ 393,603.60
Job Maintenance	104	Week	\$ 3,517.85	\$ 365,856.40
Demobilization	1	LS	\$ 23,752.00	\$ 23,752.00
<b>Miscellaneous Costs</b>				
Labor Escalation	1	LS	\$ 90,000.00	\$ 90,000.00
General Liability and Builders Risk Insuran	0.59%	Job	\$ 86,412,506.00	\$ 509,833.79
Payment and Performance Bonds	0.89%	Job	\$ 86,412,506.00	\$ 769,071.30
<b>TOTAL</b>				<b>\$ 5,473,881.65</b>

## **APPENDIX C-1**

### **EXISTING CONDITIONS SITE PLAN**

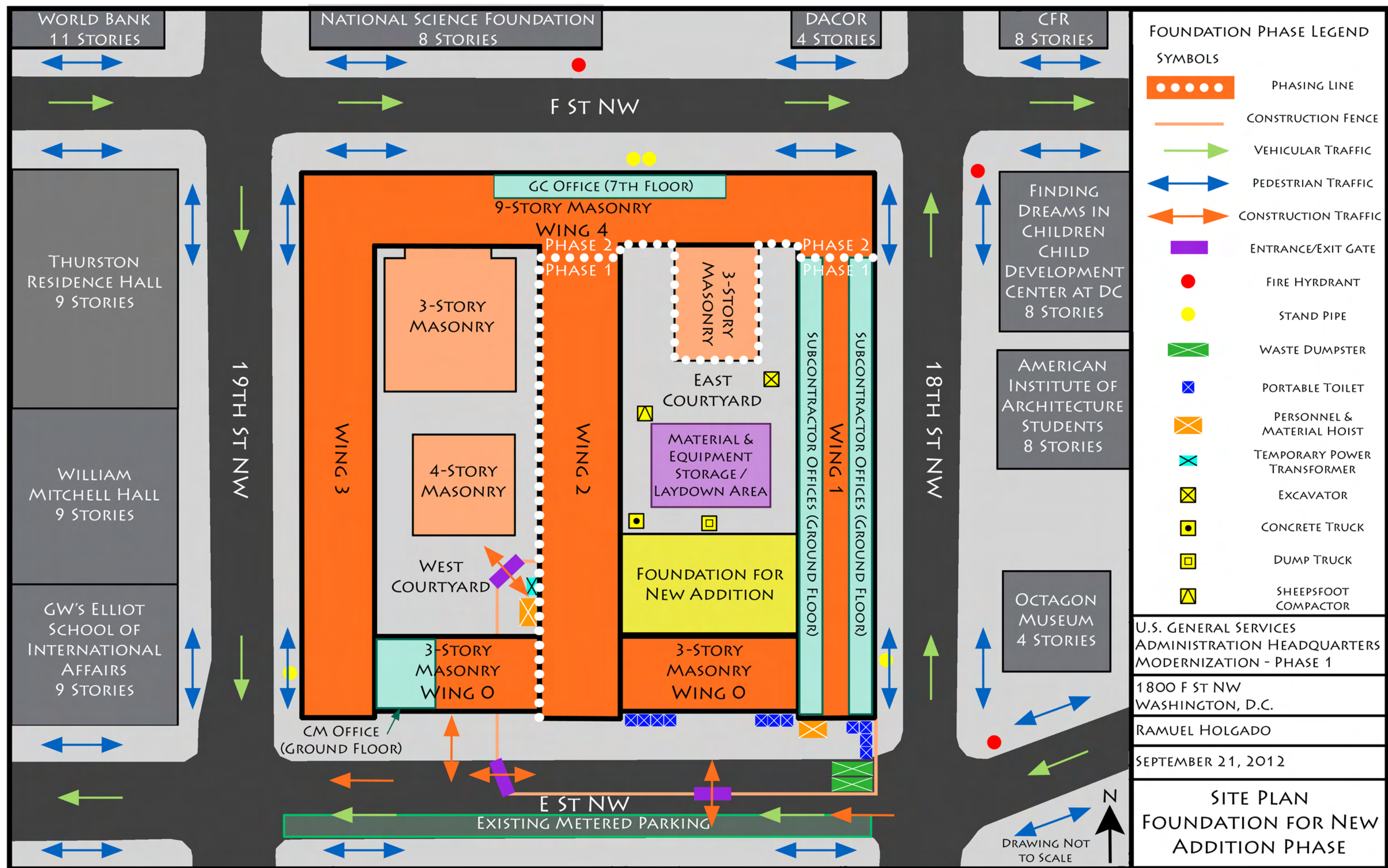






## **APPENDIX C-2**

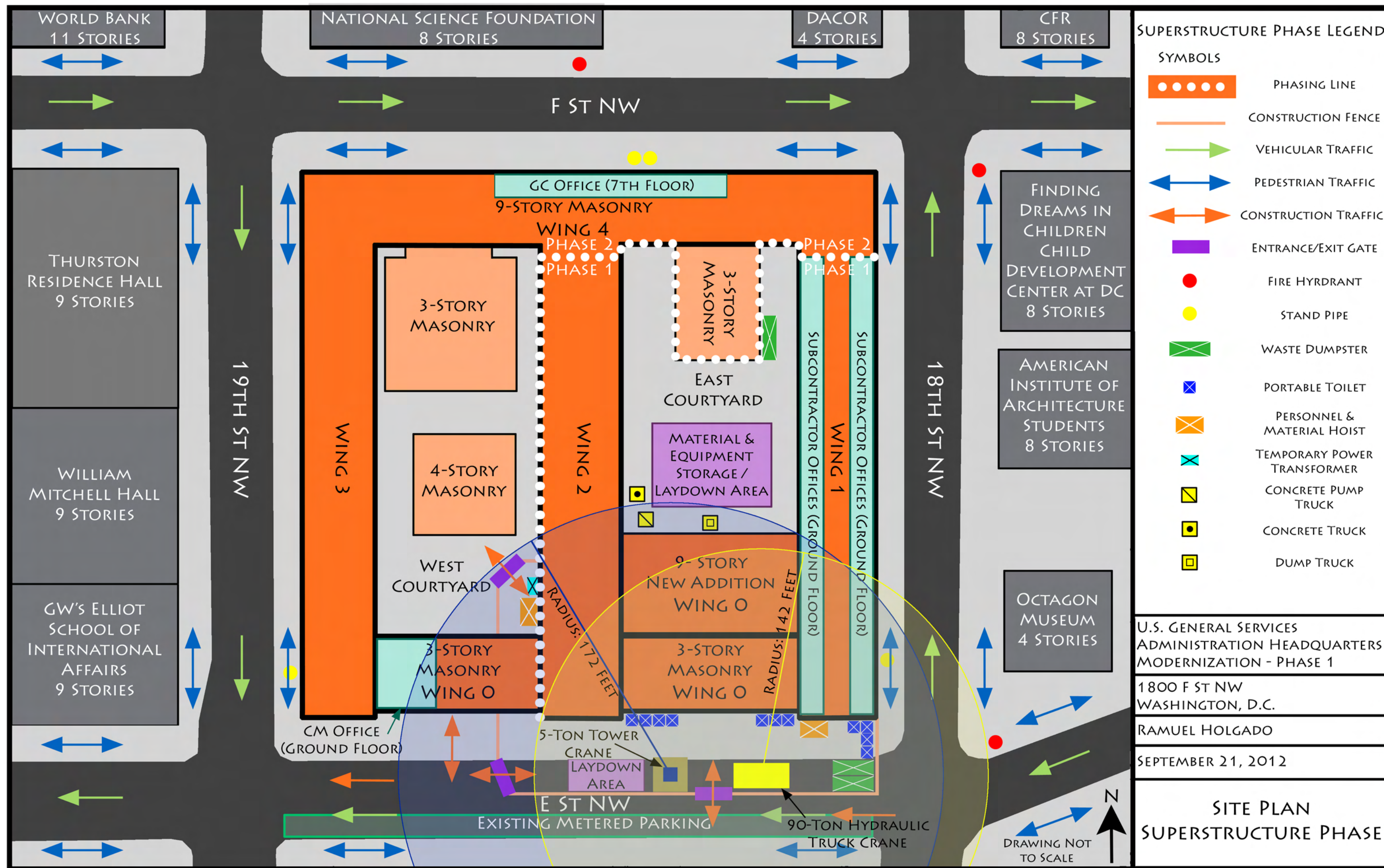
### **FOUNDATION FOR THE NEW ADDITION SITE PLAN**



## **APPENDIX C-3**

### **SUPERSTRUCTURE SITE PLAN**

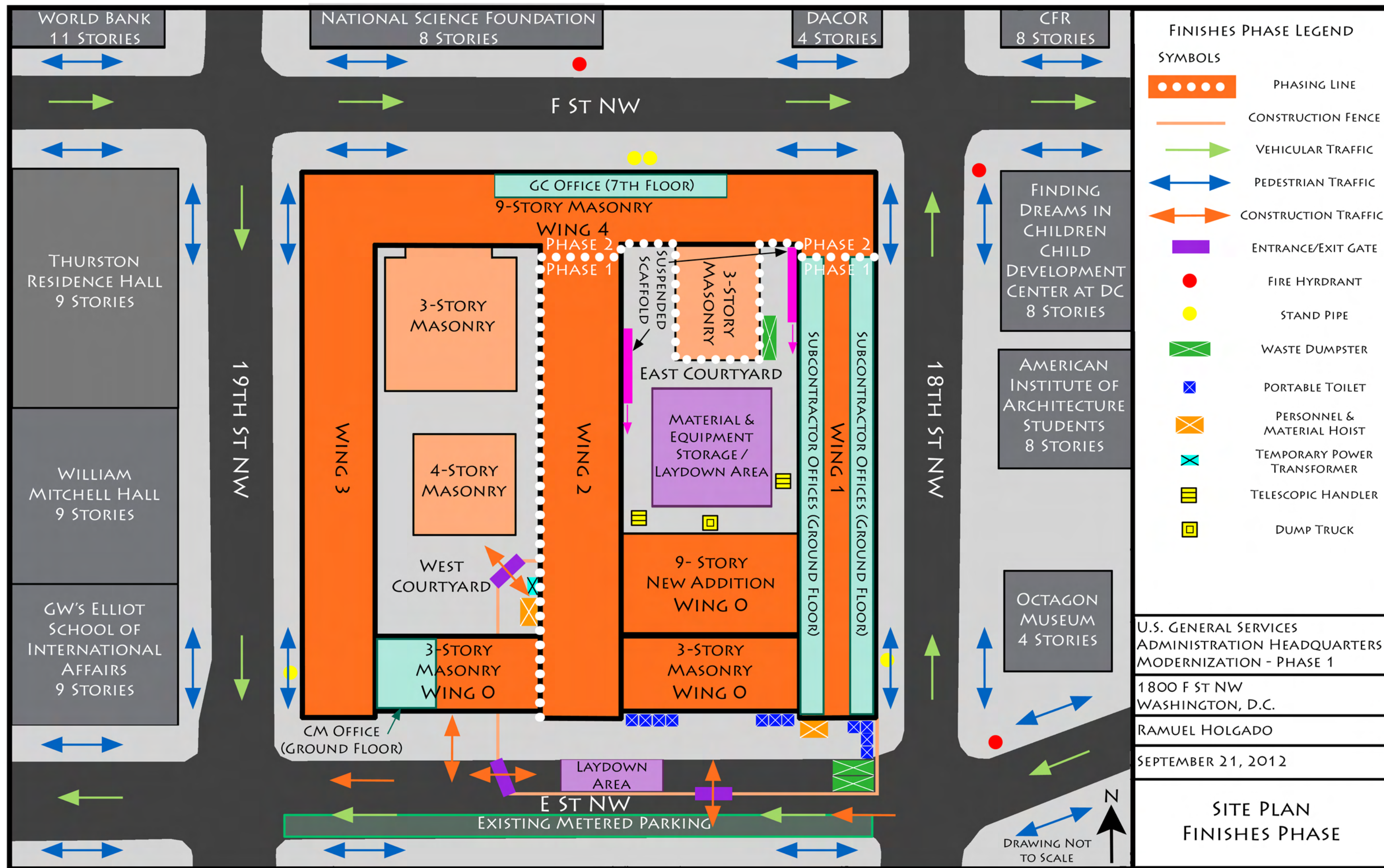




## **APPENDIX C-4**

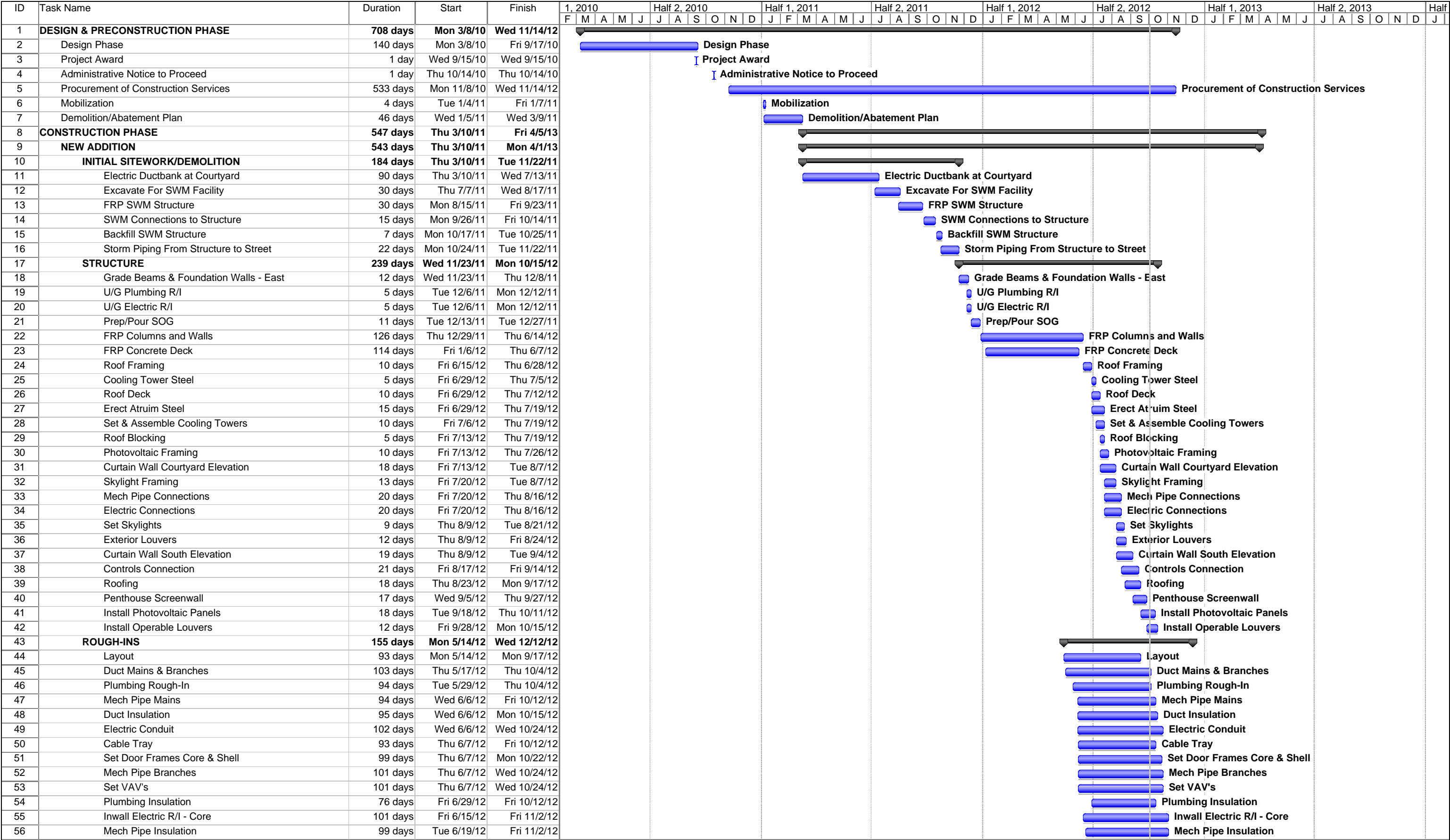
### **FINISHES SITE PLAN**





## **APPENDIX D**

### **DETAILED PROJECT SCHEDULE**







ID	Task Name	Duration	Start	Finish	1, 2010					Half 2, 2010					Half 1, 2011					Half 2, 2011					Half 1, 2012					Half 2, 2012					Half 1, 2013					Half 2, 2013					Half																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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ID	Task Name	Duration	Start	Finish	1, 2010					Half 2, 2010					Half 1, 2011					Half 2, 2011					Half 1, 2012					Half 2, 2012					Half 1, 2013					Half 2, 2013					Half																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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## **APPENDIX E**

### **ATRIUM TAKEOFFS AND CALCULATIONS**

### Original System (60-Foot Tall Curtain Wall)

#### Atrium Steel

- 1) Baltimore Steel Original Contract: **\$2.5M**
- 2) Assume that **\$1M** was used for the truss columns and roof trusses

#### Curtain Wall

- 1) GPR Original Contract: **\$5.35M**
- 2) Assume that **\$2M+** was used for the blast curtain wall

#### Skylights

- 1) Supersky Original Contract: **\$225,000**
- 2) McCoy Original Contract: **\$575,000**
- 3) Total Skylight Contract: **\$800,000**

#### Total

- 1) Total Atrium Cost: **\$8.65M**

### Alternate System (36-Foot Tall Curtain Wall)

Alternate System Cost Estimate							
System	Design	Unit	Quantity	Actual Cost	Actual Cost/Unit	TOTAL Estimated Cost	Estimated Cost/Actual Cost
Curtain Wall	Original	SF	9575.0	\$ 5,350,000.00	\$ 558.75	\$ -	N/A
	Alternate	SF	5400.0	\$ -	\$ -	\$ 3,017,232.38	56.4%
Skylights	Original	SF	3595.7	\$ 800,000.00	\$ 222.49	\$ -	N/A
	Alternate	SF	3595.7	\$ -	\$ -	\$ 800,000.00	100.0%
Atrium Steel	Original	LF	730.3	\$ 2,500,000.00	\$ 3,423.20	\$ -	N/A
	Alternate	LF	535.5	\$ -	\$ -	\$ 1,833,125.66	73.3%
Limestone Wall	Original	SF	0.0	\$ -	\$ -	\$ -	N/A
	Alternate	SF	1890.0	\$ -	\$ 56.18	\$ 106,180.20	N/A
Windows	Original	SF	0.0	\$ -	\$ -	\$ -	N/A
	Alternate	SF	1332.0	\$ -	\$ 28.06	\$ 37,375.92	N/A

Atrium System Cost Comparison						
System	Curtain Wall	Skylights	Atrium Steel	Limestone Wall	Windows	TOTAL
Original	\$ 5,350,000.00	\$ 800,000.00	\$ 2,500,000.00	\$ -	\$ -	\$ 8,650,000.00
Alternate	\$ 3,017,232.38	\$ 800,000.00	\$ 1,833,125.66	\$ 106,180.20	\$ 37,375.92	\$ 5,793,914.15
<b>SAVINGS</b>						<b>\$ 2,856,085.85</b>

#### Notes

Limestone Wall Actual Cost/Unit was taken from Means Costworks

Limestone Wall includes brick masonry backup and 2-1/2" rigin insulation

Window Actual Cost/Unit was calculated from the estimated total taken from Means Costworks

### Original System (60-Foot Tall Curtain Wall)

#### Atrium Steel

- 1) Lead time for truss columns and roof trusses: approximately **4-6 months** due to site measurements, coordination, and painting
- 2) One truss column and one roof truss was delivered and erected each day (**7 days total**)

#### Curtain Wall

- 1) The curtain wall was allotted for 20 days in the schedule
- 2) In reality, it took **30-35 days** because the crane broke and some of the belt courses needed to be notched

#### Skylights

- 1) Skylight framing took **15 days**
- 2) Setting skylights took **10 days**
- 3) Overall, it took **25 days** to install the skylights

### Alternate System (36-Foot Tall Curtain Wall)

Atrium System Schedule Comparison						
System	Curtain Wall	Skylights	Atrium Steel	Limestone Wall	Windows	TOTAL
Original	35	25	7	0	0	67
Alternate	20	25	4	9	6	64
DIFFERENCE						3

#### Notes

Assumed that two truss columns and two roof trusses will be delivered and erected each day (**4 days total**)

Limestone daily output of 275 square feet was taken from Means Costworks (1890 total square feet)

Limestone Wall includes brick masonry backup and 2-1/2" rigid insulation

Window daily output of 3 each was estimated from comparing to the closest line item in Means Costworks (16 total windows)

## **APPENDIX F**

### **ACOUSTICAL ANALYSIS CALCULATIONS**

Construction of Atrium Components	
South Wall (1st Floor)	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
East Wall (1st Floor)	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
West Wall (1st Floor)	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
Windows (1st Floor)	Guardian SN-68 (1" Clear Insulated, Low E)
Interior Atrium Curtain Wall	Viracon V1085 screen #2 (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)
Atrium Curtain Wall	Viracon VNE 1-63#2 (1 3/16" Clear, Insulated, Argon, Laminated, Low-E)
Floor	Stone Paving
Doors	Viracon (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)
Atrium Skylights (Ceiling)	Viracon VE1-2M #2 w/ V175 White Silkscreen #2 (1 5/16" Clear, Insulated Argon, Laminated, Low-E, Fritted)
Atrium Trusses	Steel
Concrete Encased Columns	Concrete
Balcony Floor (2nd Floor)	Greenlite Glasse Systems LITEFLOOR/ R 28/3 (1-1/8" Glass Floor System)
Balcony Floor (Floors 3-6)	Terroxy Resin Systems Terrazzo
Balcony Ceiling	Match Munsell #7.5YR 8/4 (Tan) Paint on Gypsum Wallboard
Balcony Railing	Viracon V1085 screen #2 (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)

	Absorption Coefficient						Total Absorption						
	Coefficients						Area (m <sup>2</sup> )	Room Absorption					
	125 HZ	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		125 HZ	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
South Wall (1st Floor)	0.36	0.44	0.31	0.29	0.39	0.25	105.8	38.08	46.54	32.79	30.67	41.25	26.44
East Wall (1st Floor)	0.36	0.44	0.31	0.29	0.39	0.25	27.3	9.83	12.02	8.47	7.92	10.65	6.83
West Wall (1st Floor)	0.36	0.44	0.31	0.29	0.39	0.25	27.3	9.83	12.02	8.47	7.92	10.65	6.83
Windows (1st Floor)	0.35	0.25	0.18	0.12	0.04	0.04	71.6	25.08	17.91	12.90	8.60	2.87	2.87
Interior Atrium Curtain Wall	0.35	0.25	0.18	0.12	0.04	0.04	826.8	289.38	206.70	148.83	99.22	33.07	33.07
Atrium Curtain Wall	0.35	0.25	0.18	0.12	0.04	0.04	889.5	311.34	222.39	160.12	106.74	35.58	35.58
Floor	0.01	0.01	0.02	0.02	0.02	0.02	334.1	3.34	3.34	6.68	6.68	6.68	6.68
Doors	0.35	0.25	0.18	0.12	0.04	0.04	77.3	27.07	19.34	13.92	9.28	3.09	3.09
Atrium Skylights (Ceiling)	0.35	0.25	0.18	0.12	0.04	0.04	334.1	116.92	83.51	60.13	40.09	13.36	13.36
Atrium Trusses	0.05	0.10	0.10	0.10	0.07	0.02	386.6	19.33	38.66	38.66	38.66	27.06	7.73
Concrete Encased Columns	0.10	0.05	0.06	0.07	0.09	0.08	229.7	22.97	11.49	13.78	16.08	20.68	18.38
Balcony Floor (2nd Floor)	0.35	0.25	0.18	0.12	0.04	0.04	36.3	12.71	9.08	6.54	4.36	1.45	1.45
Balcony Floor (Floors 3-6)	0.01	0.01	0.02	0.02	0.02	0.02	391.3	3.91	3.91	7.83	7.83	7.83	7.83
Balcony Ceiling	0.29	0.10	0.05	0.04	0.07	0.09	427.6	124.01	42.76	21.38	17.11	29.93	38.49
Balcony Railing	0.35	0.25	0.18	0.12	0.04	0.04	143.1	50.07	35.77	25.75	17.17	5.72	5.72
People (40 Adults)	0.25	0.35	0.42	0.46	0.50	0.50	76.0	19.00	26.60	31.92	34.96	38.00	38.00
							Total	1082.89	792.03	598.16	453.28	287.89	252.36



Surface Area of Atrium Components		
	ft <sup>2</sup>	m <sup>2</sup>
South Wall (1st Floor)	1138.5	105.8
East Wall (1st Floor)	294.0	27.3
West Wall (1st Floor)	294.0	27.3
Windows (1st Floor)	771.2	71.6
Interior Atrium Curtain Wall	8899.7	826.8
Atrium Curtain Wall	9575.0	889.5
Floor	3595.7	334.1
Doors	832.5	77.3
Atrium Skylights (Ceiling)	3595.7	334.1
Atrium Trusses	4161.5	386.6
Concrete Encased Columns	2473.0	229.7
Balcony Floor (2nd Floor)	390.9	36.3
Balcony Floor (Floors 3-6)	4212.2	391.3
Balcony Ceiling	4603.1	427.6
Balcony Railing	1540.0	143.1
People (40 Adults)	818.1	76.0
Total Area	47194.8	4384.5

Volume		
	ft <sup>3</sup>	m <sup>3</sup>
Total Volume	283459.8	8026.7

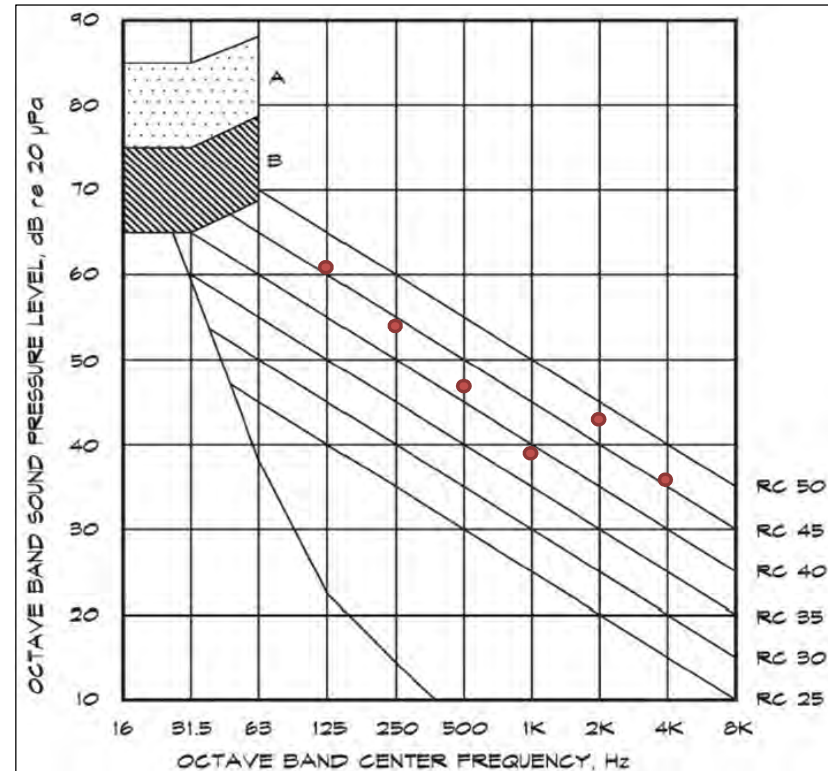
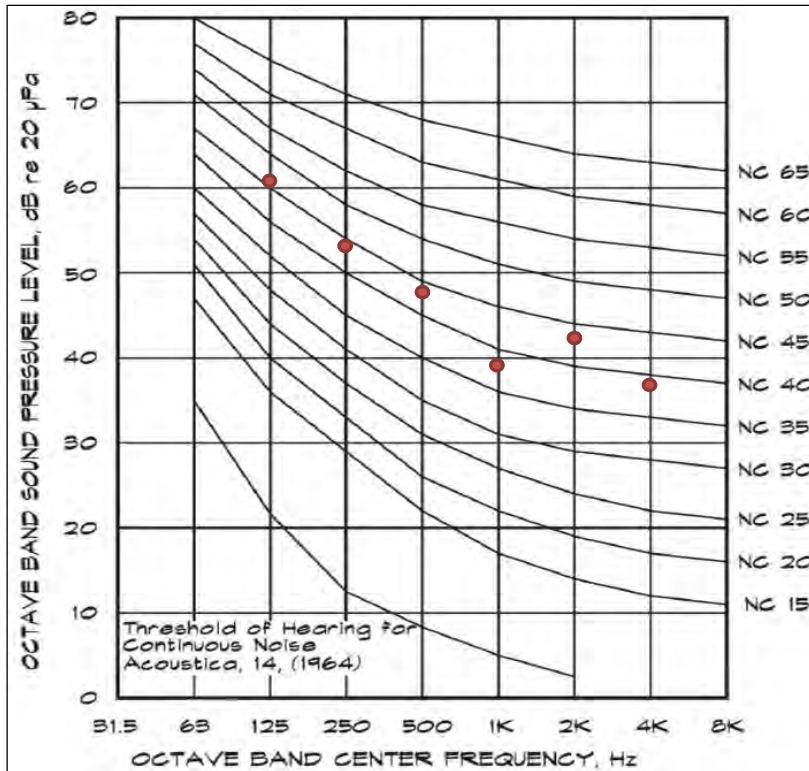
Reverberant Field Level ( $L_{r,f}$ in Source Room)																
Octave Band (Hz)	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Sound Pressure Level (dB)	86	-	-	85	-	-	84	-	-	83	-	-	82	-	-	80
	81	81	80	80	80	79	79	79	78	78	78	77	77	77	75	75

Adjoining Wall																
Wall Type	Salvaged Limestone with Brick Masonry Backup and 2-1/2" Rigid Insulation															
Wall Area (m <sup>2</sup> )	105.8															
Window Type	Guardian SN-68 (1" Clear Insulated, Low E)															
Window Area (m <sup>2</sup> )	65.0															
Door Type	Viracon (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)															
Door Area (m <sup>2</sup> )	6.0															
Atrium Curtain Wall Type	Viracon VNE 1-63#2 Viracon VNE 1-63#2 (1 3/16" Clear, Insulated, Argon, Laminated, Low-E)															
Atrium Curtain Wall Area (m <sup>2</sup> )	889.5															
Octave Band (Hz)	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Wall TL (dB)	38	39	46	47	52	54	57	58	60	61	69	68	71	71	72	74
Window TL (dB)	20	26	26	30	34	34	37	39	40	41	41	40	39	39	46	49
Door TL (dB)	29	30	31	34	32	33	35	35	35	35	34	35	34	38	42	45
Atrium Curtain Wall TL (dB)	23	23	32	31	37	38	41	43	47	50	52	52	48	43	50	46
Wall $\tau$	0.000158	0.000126	2.51E-05	2E-05	6.31E-06	3.98E-06	2E-06	1.58E-06	0.000001	7.94E-07	1.26E-07	1.58E-07	7.94E-08	7.94E-08	6.31E-08	3.98E-08
Window $\tau$	0.01	0.002512	0.002512	0.001	0.000398	0.000398	0.0002	0.000126	0.0001	7.94E-05	7.94E-05	0.0001	0.000126	0.000126	2.51E-05	1.26E-05
Door $\tau$	0.001259	0.001	0.000794	0.000398	0.000631	0.000501	0.000316	0.000316	0.000316	0.000316	0.000398	0.000316	0.000398	0.000158	6.31E-05	3.16E-05
Atrium Curtain Wall $\tau$	0.005012	0.005012	0.000631	0.000794	0.0002	0.000158	7.94E-05	5.01E-05	2E-05	0.00001	6.31E-06	6.31E-06	1.58E-05	5.01E-05	0.00001	2.51E-05
$\tau_{eff}$	0.004818	0.004367	0.000685	0.000729	0.000195	0.00016	8.04E-05	5.14E-05	2.45E-05	1.49E-05	1.22E-05	1.3E-05	2.3E-05	5.04E-05	1.02E-05	2.2E-05
Composite TL (dB)	23	24	32	31	37	38	41	43	46	48	49	49	46	43	50	47
(Source Room $L_{r,f}$ )-TL	58	57	48	49	43	41	38	36	32	30	29	28	31	34	25	28
	61	-	-	53	-	-	44	-	-	35	-	-	37	-	-	30
Absorption (Receiving Room)	1082.89	-	-	792.03	-	-	598.16	-	-	453.28	-	-	287.89	-	-	252.36

Noise Reduction						
Octave Band (Hz)	125	250	500	1000	2000	4000
Noise Reduction (dB)	0	-1	-3	-4	-6	-6

Reverberant Field Level ( $L_{r,f}$ in Receiving Room)						
Octave Band (Hz)	125	250	500	1000	2000	4000
Reverberant Field Level (dB)	61	54	47	39	43	36

NC Rating (Receiving Room)	
46	
RC Rating (Receiving Room)	
48	



## NC and RC Recommendations

Type of Area		Recommended NC or RC Criteria Range
1	Private Residences	25 to 30
2	Apartments	25 to 30
3	Hotels/motels	
	a Individual rooms or suites	30 to 35
	b Meeting/banquet rooms	25 to 30
	c Halls, corridors, lobbies	35 to 40
	d Service/support areas	40 to 45
4	Offices	
	a Executive	25 to 30
	b Conference room	25 to 30
	c Private	30 to 35
	d Open plan areas	35 to 40
	e Computer equipment rooms	40 to 45
	f Public circulation	40 to 45

Construction of Atrium Components	
South Wall (1st Floor)	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
East Wall (1st Floor)	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
West Wall (1st Floor)	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
Windows (1st Floor)	Guardian SN-68 (1" Clear Insulated, Low E)
Interior Atrium Curtain Wall	Viracon V1085 screen #2 (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)
Atrium Curtain Wall	Viracon VNE 1-63#2 (1 3/16" Clear, Insulated, Argon, Laminated, Low-E)
Floor	Stone Paving
Doors	Viracon (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)
Atrium Skylights (Ceiling)	Viracon VE1-2M #2 w/ V175 White Silkscreen #2 (1 5/16" Clear, Insulated Argon, Laminated, Low-E, Fritted)
Atrium Trusses	Steel
Concrete Encased Columns	Concrete
Balcony Floor (2nd Floor)	Greenlite Glasse Systems LITEFLOOR/ R 28/3 (1-1/8" Glass Floor System)
Balcony Floor (Floors 3-4)	Terroxy Resin Systems Terrazzo
Balcony Ceiling	Match Munsell #7.5YR 8/4 (Tan) Paint on Gypsum Wallboard
Balcony Railing	Viracon V1085 screen #2 (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)

	Absorption Coefficient						Total Absorption						
	Coefficients						Area (m <sup>2</sup> )	Room Absorption					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
South Wall (1st Floor)	0.36	0.44	0.31	0.29	0.39	0.25	105.8	38.08	46.54	32.79	30.67	41.25	26.44
East Wall (1st Floor)	0.36	0.44	0.31	0.29	0.39	0.25	27.3	9.83	12.02	8.47	7.92	10.65	6.83
West Wall (1st Floor)	0.36	0.44	0.31	0.29	0.39	0.25	27.3	9.83	12.02	8.47	7.92	10.65	6.83
Windows (1st Floor)	0.35	0.25	0.18	0.12	0.04	0.04	71.6	25.08	17.91	12.90	8.60	2.87	2.87
Interior Atrium Curtain Wall	0.35	0.25	0.18	0.12	0.04	0.04	427.4	149.60	106.86	76.94	51.29	17.10	17.10
Atrium Curtain Wall	0.35	0.25	0.18	0.12	0.04	0.04	501.7	175.59	125.42	90.30	60.20	20.07	20.07
Floor	0.01	0.01	0.02	0.02	0.02	0.02	334.1	3.34	3.34	6.68	6.68	6.68	6.68
Doors	0.35	0.25	0.18	0.12	0.04	0.04	66.5	23.27	16.62	11.96	7.98	2.66	2.66
Atrium Skylights (Ceiling)	0.35	0.25	0.18	0.12	0.04	0.04	334.1	116.92	83.51	60.13	40.09	13.36	13.36
Atrium Trusses	0.05	0.10	0.10	0.10	0.07	0.02	268.1	13.41	26.81	26.81	26.81	18.77	5.36
Concrete Encased Columns	0.10	0.05	0.06	0.07	0.09	0.08	229.7	22.97	11.49	13.78	16.08	20.68	18.38
Balcony Floor (2nd Floor)	0.35	0.25	0.18	0.12	0.04	0.04	36.3	12.71	9.08	6.54	4.36	1.45	1.45
Balcony Floor (Floors 3-4)	0.01	0.01	0.02	0.02	0.02	0.02	195.7	1.96	1.96	3.91	3.91	3.91	3.91
Balcony Ceiling	0.29	0.10	0.05	0.04	0.07	0.09	231.9	67.25	23.19	11.60	9.28	16.23	20.87
Balcony Railing	0.35	0.25	0.18	0.12	0.04	0.04	81.3	28.45	20.32	14.63	9.75	3.25	3.25
People (34 Adults)	0.25	0.35	0.42	0.46	0.50	0.50	64.6	16.15	22.61	27.13	29.72	32.30	32.30
							Total	714.43	539.69	413.04	321.26	221.88	188.36

Surface Area of Atrium Components		
	ft <sup>2</sup>	m <sup>2</sup>
South Wall (1st Floor)	1138.5	105.8
East Wall (1st Floor)	294.0	27.3
West Wall (1st Floor)	294.0	27.3
Windows (1st Floor)	771.2	71.6
Interior Atrium Curtain Wall	4600.8	427.4
Atrium Curtain Wall	5400.0	501.7
Floor	3595.7	334.1
Doors	715.5	66.5
Atrium Skylights (Ceiling)	3595.7	334.1
Atrium Trusses	2886.3	268.1
Concrete Encased Columns	2473.0	229.7
Balcony Floor (2nd Floor)	390.9	36.3
Balcony Floor (Floors 3-4)	2106.1	195.7
Balcony Ceiling	2496.2	231.9
Balcony Railing	875.0	81.3
People (34 Adults)	695.3	64.6
Total Area	32328.2	3003.4

Volume		
	ft <sup>3</sup>	m <sup>3</sup>
Total Volume	183380.7	5192.8

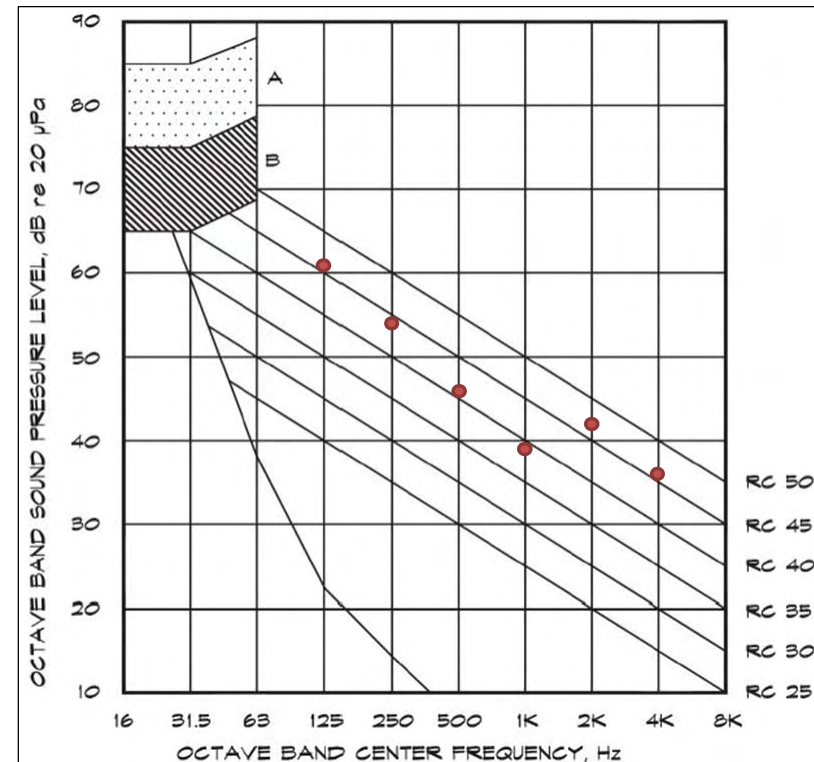
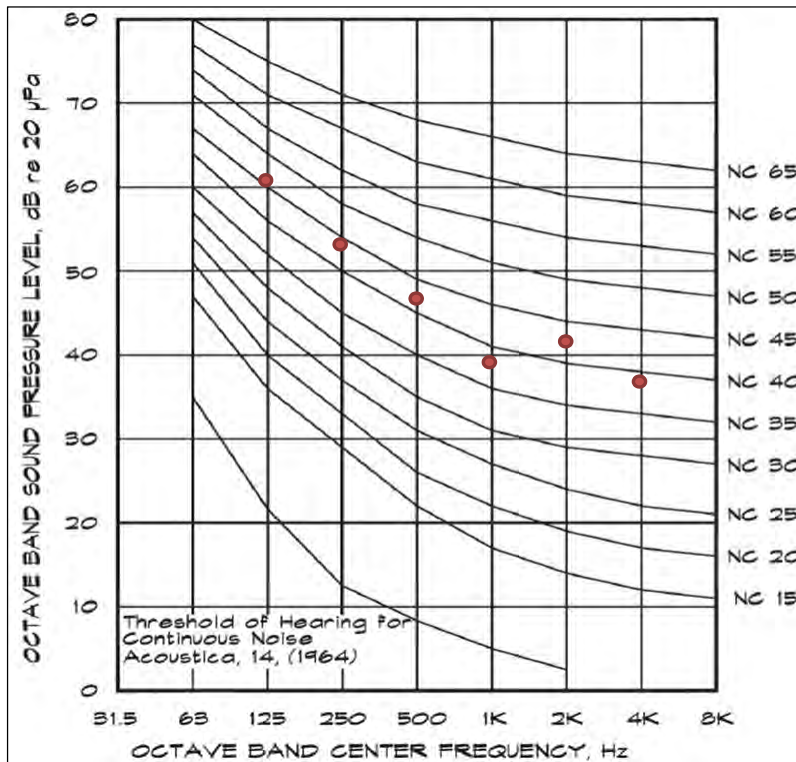
Reverberant Field Level ( $L_{irf}$ in Source Room)																
Octave Band (Hz)	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Sound Pressure Level (dB)	86	-	-	85	-	-	84	-	-	83	-	-	82	-	-	80
	81	81	80	80	80	79	79	79	78	78	78	77	77	77	75	75

Adjoining Wall																
Wall Type	Salvaged Limestone with Brick Masonry Backup and 2-1/2" Rigid Insulation															
Wall Area (m <sup>2</sup> )	105.8															
Window Type	Guardian SN-68 (1" Clear Insulated, Low E)															
Window Area (m <sup>2</sup> )	65.0															
Door Type	Viracon (3/8" total thickness: 2 layers 3/16" laminated glass with a clear interlayer)															
Door Area (m <sup>2</sup> )	6.0															
Atrium Curtain Wall Type	Viracon VNE 1-63#2 Viracon VNE 1-63#2 (1 3/16" Clear, Insulated, Argon, Laminated, Low-E)															
Atrium Curtain Wall Area (m <sup>2</sup> )	501.7															
Octave Band (Hz)	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Wall TL (dB)	38	39	46	47	52	54	57	58	60	61	69	68	71	71	72	74
Window TL (dB)	20	26	26	30	34	34	37	39	40	41	41	40	39	39	46	49
Door TL (dB)	29	30	31	34	32	33	35	35	35	35	34	35	34	38	42	45
Atrium Curtain Wall TL (dB)	23	23	32	31	37	38	41	43	47	50	52	52	48	43	50	46
Wall $\tau$	0.000158	0.000126	2.51E-05	2E-05	6.31E-06	3.98E-06	2E-06	1.58E-06	0.000001	7.94E-07	1.26E-07	1.58E-07	7.94E-08	7.94E-08	6.31E-08	3.98E-08
Window $\tau$	0.01	0.002512	0.002512	0.001	0.000398	0.000398	0.0002	0.000126	0.0001	7.94E-05	7.94E-05	0.0001	0.000126	0.000126	2.51E-05	1.26E-05
Door $\tau$	0.001259	0.001	0.000794	0.000398	0.000631	0.000501	0.000316	0.000316	0.000316	0.000316	0.000398	0.000316	0.000398	0.000398	6.31E-05	3.16E-05
Atrium Curtain Wall $\tau$	0.005012	0.005012	0.000631	0.000794	0.0002	0.000158	7.94E-05	5.01E-05	2E-05	0.00001	6.31E-06	6.31E-06	1.58E-05	5.01E-05	0.00001	2.51E-05
$\tau_{eff}$	0.004699	0.003974	0.000718	0.00069	0.000192	0.00016	8.1E-05	5.22E-05	2.73E-05	1.79E-05	1.58E-05	1.71E-05	2.73E-05	5.05E-05	1.04E-05	2.01E-05
Composite TL (dB)	23	24	31	32	37	38	41	43	46	47	48	48	46	43	50	47
(Source Room $L_{irf}$ )-TL	58	57	49	48	43	41	38	36	32	31	30	29	31	34	25	28
	61	-	-	53	-	-	44	-	-	36	-	-	37	-	-	30
Absorption (Receiving Room)	714.43	-	-	539.69	-	-	413.04	-	-	321.26	-	-	221.88	-	-	188.36

Noise Reduction						
Octave Band (Hz)	125	250	500	1000	2000	4000
Noise Reduction (dB)	0	-1	-2	-3	-5	-6

Reverberant Field Level ( $L_{irf}$ in Receiving Room)						
Octave Band (Hz)	125	250	500	1000	2000	4000
Reverberant Field Level (dB)	61	54	46	39	42	36

NC Rating (Receiving Room)
46
RC Rating (Receiving Room)
47



## NC and RC Recommendations

Type of Area		Recommended NC or RC Criteria Range
1	Private Residences	25 to 30
2	Apartments	25 to 30
3	Hotels/motels	
a	Individual rooms or suites	30 to 35
b	Meeting/banquet rooms	25 to 30
c	Halls, corridors, lobbies	35 to 40
d	Service/support areas	40 to 45
4	Offices	
a	Executive	25 to 30
b	Conference room	25 to 30
c	Private	30 to 35
d	Open plan areas	35 to 40
e	Computer equipment rooms	40 to 45
f	Public circulation	40 to 45

Construction of Office Components	
South Wall	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
South Wall Windows	Guardian SN-68 (1" Clear Insulated, Low E)
East Wall	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
East Wall Windows	Guardian SN-68 (1" Clear Insulated, Low E)
West Wall	Salvaged limestone with brick masonry backup and 2-1/2" rigid insulation
West Wall Windows	Guardian SN-68 (1" Clear Insulated, Low E)
North Glazing Type 1	Viracon VE 1-2M #2 (1" Clear, Insulated, Low-E)
North Glazing Type 2	Viracon V-908#2 (1/4" Spandrel glass, Clear w/ color V-908)
Floor	Carpet, heavy, on concrete
Ceiling	Match Munsell #7.5YR 8/4 (Tan) Paint on Gypsum Wallboard
Columns	Gypsum Board

Absorption Coefficient							Total Absorption						
	Coefficients						Area (m <sup>2</sup> )	Room Absorption					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
South Wall	0.36	0.44	0.31	0.29	0.39	0.25	67.4	24.25	29.64	20.88	19.53	26.27	16.84
South Wall Windows	0.35	0.25	0.18	0.12	0.04	0.04	66.9	23.41	16.72	12.04	8.03	2.68	2.68
East Wall	0.36	0.44	0.31	0.29	0.39	0.25	31.2	11.24	13.73	9.68	9.05	12.17	7.80
East Wall Windows	0.35	0.25	0.18	0.12	0.04	0.04	25.1	8.78	6.27	4.52	3.01	1.00	1.00
West Wall	0.36	0.44	0.31	0.29	0.39	0.25	31.2	11.24	13.73	9.68	9.05	12.17	7.80
West Wall Windows	0.35	0.25	0.18	0.12	0.04	0.04	25.1	8.78	6.27	4.52	3.01	1.00	1.00
North Glazing Type 1	0.35	0.25	0.18	0.12	0.04	0.04	58.8	20.59	14.71	10.59	7.06	2.35	2.35
North Glazing Type 2	0.35	0.25	0.18	0.12	0.04	0.04	73.8	25.84	18.46	13.29	8.86	2.95	2.95
Floor	0.02	0.06	0.14	0.37	0.60	0.65	656.4	13.13	39.39	91.90	242.87	393.85	426.67
Ceiling	0.29	0.10	0.05	0.04	0.07	0.09	656.4	190.36	65.64	32.82	26.26	45.95	59.08
Columns	0.29	0.10	0.05	0.04	0.07	0.09	180.6	52.37	18.06	9.03	7.22	12.64	16.25
People (40 Adults Seated)	0.39	0.57	0.80	0.94	0.92	0.87	76.0	29.64	43.32	60.80	71.44	69.92	66.12
							Total	419.63	285.94	279.73	415.40	582.97	610.56



Surface Area of Office Components		
	ft <sup>2</sup>	m <sup>2</sup>
South Wall	725.0	67.4
South Wall Windows	720.0	66.9
East Wall	336.0	31.2
East Wall Windows	270.0	25.1
West Wall	336.0	31.2
West Wall Windows	270.0	25.1
North Glazing Type 1	633.3	58.8
North Glazing Type 2	794.7	73.8
Floor	7065.6	656.4
Ceiling	7065.6	656.4
Columns	1944.0	180.6
People (40 Adults Seated)	818.1	76.0
Total Area	20978.3	1948.9

Volume		
	ft <sup>3</sup>	m <sup>3</sup>
Total Volume	84787.4	2400.9

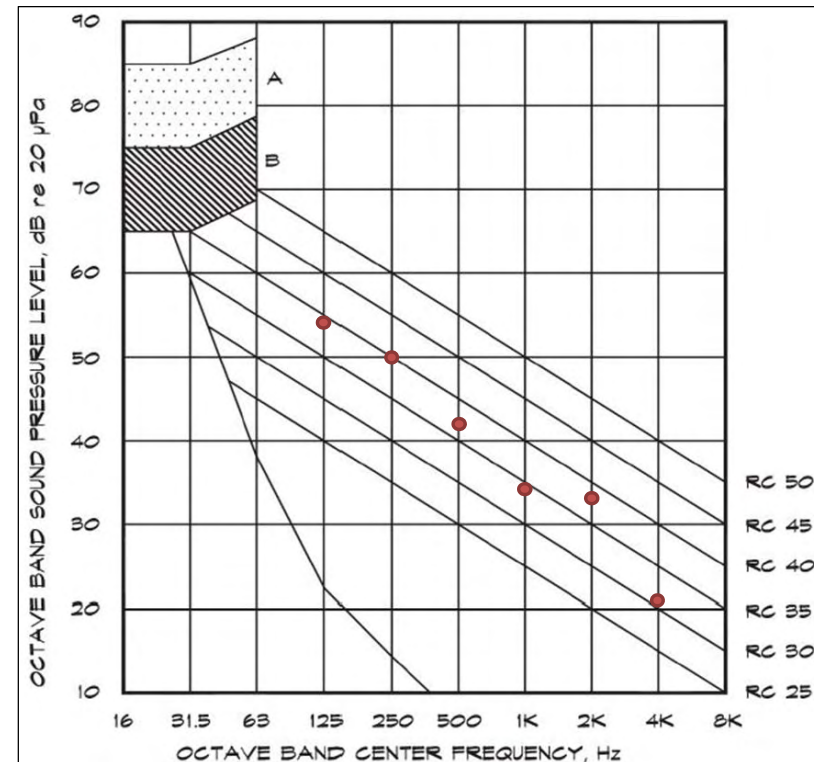
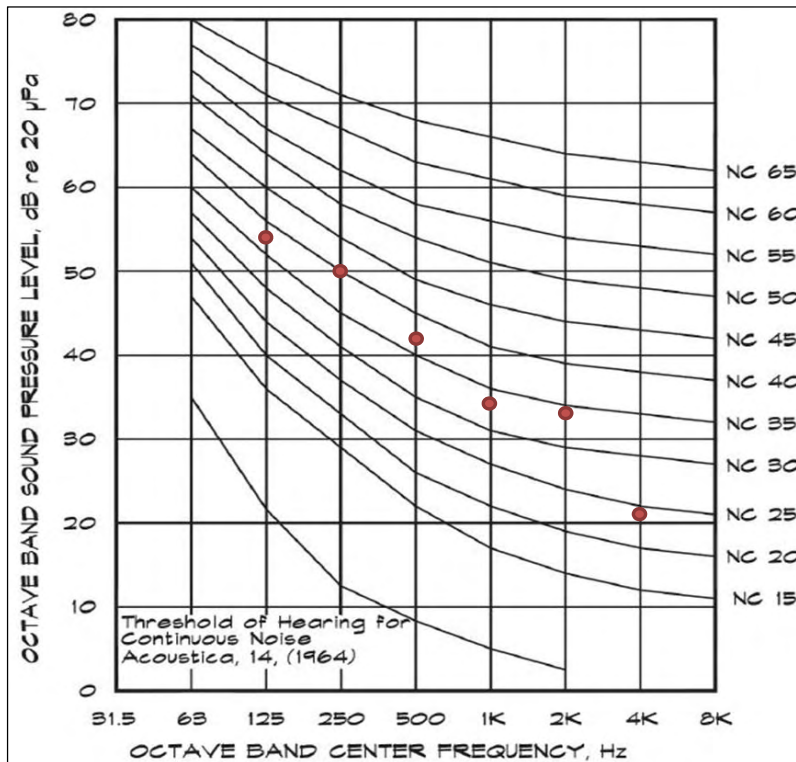
Reverberant Field Level ( $L_{irr}$ in Source Room)																
Octave Band (Hz)	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Sound Pressure Level (dB)	86	-	-	85	-	-	84	-	-	83	-	-	82	-	-	80
	81	81	80	80	80	79	79	79	78	78	78	77	77	77	75	75

Adjoining Wall																
Wall Type	Salvaged Limestone with Brick Masonry Backup and 2-1/2" Rigid Insulation															
Wall Area (m <sup>2</sup> )	67.4															
Window Type	Guardian SN-68 (1" Clear Insulated, Low E)															
Window Area (m <sup>2</sup> )	66.9															
Octave Band (Hz)	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Wall TL (dB)	38	39	46	47	52	54	57	58	60	61	69	68	71	71	72	74
Window TL (dB)	20	26	26	30	34	34	37	39	40	41	41	40	39	39	46	49
Wall $\tau$	0.000158	0.000126	2.51E-05	2E-05	6.31E-06	3.98E-06	2E-06	1.58E-06	0.000001	7.94E-07	1.26E-07	1.58E-07	7.94E-08	7.94E-08	6.31E-08	3.98E-08
Window $\tau$	0.01	0.002512	0.002512	0.001	0.000398	0.000398	0.0002	0.000126	0.0001	7.94E-05	7.94E-05	0.0001	0.000126	0.000126	2.51E-05	1.26E-05
$\tau_{eff}$	0.005061	0.001314	0.001264	0.000508	0.000201	0.0002	0.0001	6.35E-05	5.03E-05	4E-05	3.96E-05	4.99E-05	6.28E-05	6.28E-05	1.25E-05	6.29E-06
Composite TL (dB)	23	29	29	33	37	37	40	42	43	44	44	43	42	42	49	52
(Source Room $L_{irr}$ )-TL	58	52	51	47	43	42	39	37	35	34	34	34	35	35	26	23
	59	-	-	53	-	-	45	-	-	39	-	-	39	-	-	28
Absorption (Receiving Room)	419.63	-	-	285.94	-	-	279.73	-	-	415.40	-	-	582.97	-	-	610.56

Noise Reduction						
Octave Band (Hz)	125	250	500	1000	2000	4000
Noise Reduction (dB)	5	3	3	5	6	7

Reverberant Field Level ( $L_{irr}$ in Receiving Room)						
Octave Band (Hz)	125	250	500	1000	2000	4000
Reverberant Field Level (dB)	54	50	42	34	33	21

NC Rating (Receiving Room)
40
RC Rating (Receiving Room)
40



## NC and RC Recommendations

Type of Area		Recommended NC or RC Criteria Range
1	Private Residences	25 to 30
2	Apartments	25 to 30
3	Hotels/motels	
a	Individual rooms or suites	30 to 35
b	Meeting/banquet rooms	25 to 30
c	Halls, corridors, lobbies	35 to 40
d	Service/support areas	40 to 45
4	Offices	
a	Executive	25 to 30
b	Conference room	25 to 30
c	Private	30 to 35
d	Open plan areas	35 to 40
e	Computer equipment rooms	40 to 45
f	Public circulation	40 to 45

## **APPENDIX G**

### **GEOTECHNICAL REPORT**

## **EXPLORATION PROCEDURES**

### **Subsurface Exploration Procedures**

The soil borings were performed with a truck-mounted auger drill rig, which utilized continuous flight, hollow stem augers to advance the boreholes. Drilling fluid was not used in the boring exploration. The borings were subsequently backfilled with the auger spoils generated during drilling procedures after their completion.

In the soil borings, representative soil samples were obtained by means of the split-barrel sampling procedure in general accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-barrel sampler is driven into the soil a distance of 18 or 24 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through a 12-inch interval is termed the Standard Penetration Test (SPT) N-value and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

A field log of the soils encountered in the borings was maintained by the drill crew. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample was in sealed in glass jars and brought to our laboratory for further visual examination and laboratory testing.

### **Laboratory Testing Program**

Representative soil samples were selected and tested in our laboratory to verify field classifications and to determine pertinent engineering properties. The laboratory testing program included visual classifications of all soil samples recovered during drilling and excavating operations, natural moisture content, Atterberg Limits and grain size analysis of selected soil samples. The data from the laboratory testing program has been included on the applicable boring logs and on separate sheets in the Appendix of this report.

An ECS engineer classified each soil sample on the basis of texture and plasticity in accordance with the Unified Soil Classification System. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. A brief explanation of the Unified System is included with this report. The engineer grouped the various soil types into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs and profiles are approximate; in situ, the transitions may be gradual, rather than distinct.

The soil samples from our most recent exploration will be retained in our laboratory for a period of 60 days, after which they will be discarded unless other instructions are received as to their disposition.

## **Appendix A**

## **EXPLORATION RESULTS**

### **Site Conditions**

The site is currently occupied by an existing nine story building with two centrally located paved courtyards. Several smaller 1-story to 4-story masonry buildings are located within each of these courtyards. The site is accessed from a ramp from E Street down to each of the courtyards, and therefore, the existing building has a partially buried basement. Finished floor elevations range from approximately EL 11.1 to 11.3. Ground surface elevation in the courtyards ranged from approximately EL. 11 to approximately EL. 12 across each of the courtyards.

### **Regional Geology**

The natural soils at the site consist of river terrace deposits consisting of clay, silt, sand and gravel, underlain by residual materials formed from the in-place physical and chemical weathering of the underlying parent bedrock. This rock is believed to be part of the Wissahickon Formation and normally consists of schist, composed of mica, chlorite, quartz, and peltic, and having metagraywacke, gneiss, and quartz veins. The intactness of this type of rock varies dramatically depending upon the frequency, size and orientation of natural joints and fractures, and the presence of quartz veins.

### **Subsurface Conditions**

The natural residual materials encountered at the site are generally consistent with the regional geology and soils information available to us. Asphalt encountered at the site ranged from 4 inches to 9 inches in thickness. The asphalt was underlain by approximately 2 inches to 7 inches of gravel. Existing man-placed fill material was encountered within all of the borings conducted on-site to depths on the order of 2.5± feet to 6.0± feet below the existing ground surface. These existing fill materials generally consisted Silty SAND (SM) and poorly-graded SAND (SP) materials with gravel and cinders.


Beneath the asphalt, gravel, and man-placed fill material, terrace deposit soils underlain by residual soils and hard schist rock were encountered to boring termination depths. The borings were extended to depths on the order of 73.05 feet to 78.8 feet below the existing ground surface, as interpolated using the above-mentioned site plan. Auger refusal was encountered in Boring B-4 at a depth of 73.05 feet below the existing ground surface. The natural soils encountered generally consisted of CLAY (CL), Silty SAND (SM), Clayey SAND (SC), poorly-graded SAND (SP), poorly-graded SAND and GRAVEL (SP/GP) and Clayey SAND and GRAVEL (SC/GC). The residual soils were encountered at EL -55 feet to EL -60 feet and typically became more dense with depth. Standard Penetration Test (SPT) N-values in the natural soils ranged from 10 blows per foot (bpf) to more than 50 blows per one inch of sampler penetration, indicating medium dense to extremely dense relative densities for the natural granular materials encountered at the site. The N-values for the cohesive clay were recorded at 6 bpf indicating a consistency of medium stiff.

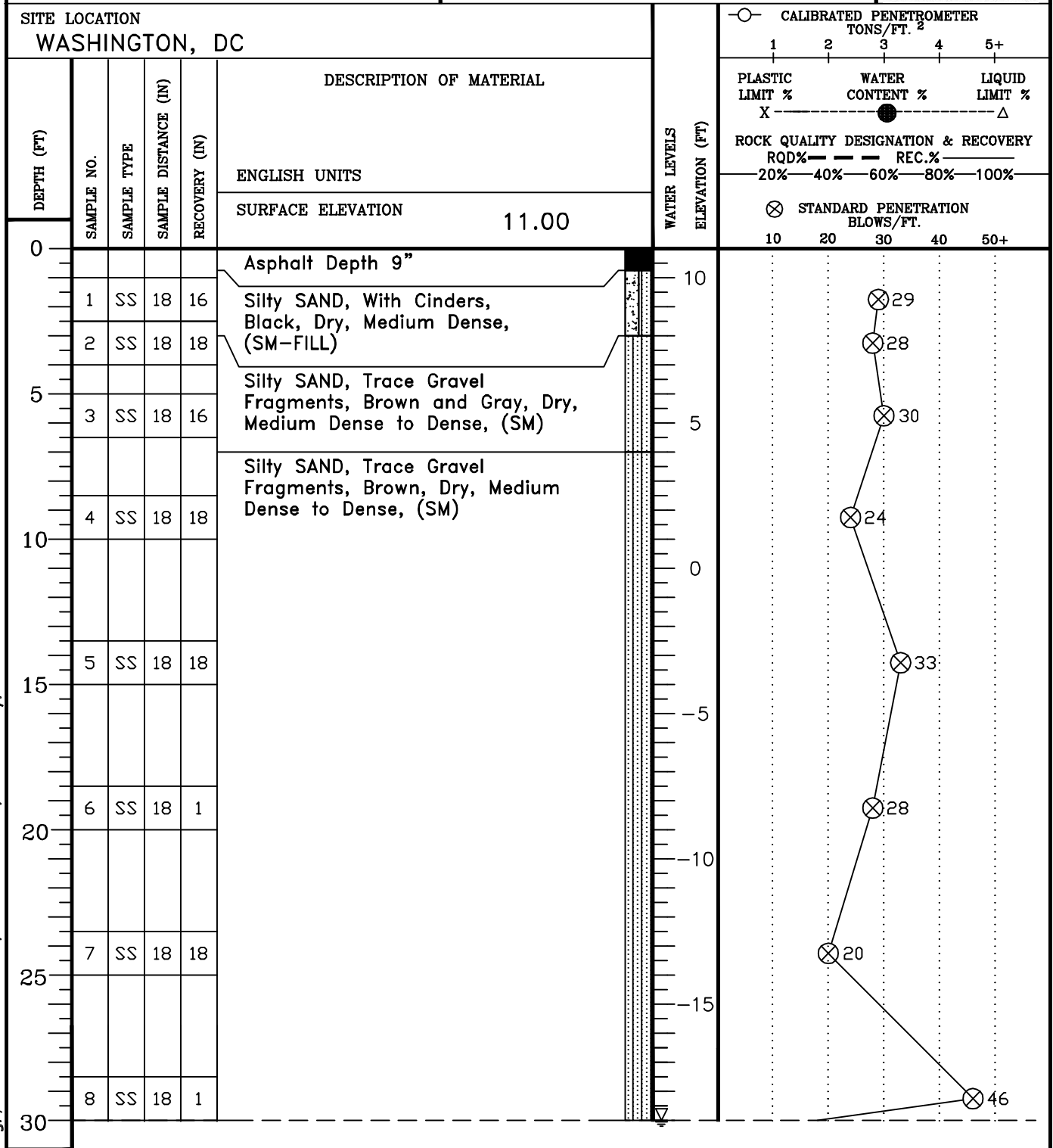
## **Appendix A**

### **Groundwater Observations**


In auger drilling operations, water is not introduced into the boreholes, and the groundwater position can often be determined by observing water flowing into or out of the borings. Furthermore, visual observation of the soil samples retrieved during the auger drilling exploration can often be used in evaluating the groundwater conditions. Groundwater observations were made while drilling, after boring but before the augers were removed, and after the augers were removed prior to backfilling. Groundwater was encountered in all of the borings conducted on site. The groundwater levels recorded in the borings ranged from 28.5 feet to 33.5 feet below the existing ground surface, corresponding to elevations ranging from .

Considering the granular nature of the soils, the recorded groundwater levels are believed to be an accurate representation of the static groundwater table for the times shown. It should be noted that due to the borings being located in a parking area, the boreholes were backfilled after removal of the augers and groundwater readings after 24 hours from completion of the boring were not recorded. The cave-in depths can also be useful in estimating the elevation of the groundwater table and these readings correlate well with corresponding groundwater level measurements. The highest groundwater observations are normally encountered in late winter and early spring and our current groundwater observations are not expected to be at the seasonal maximum water table. Variations in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, and other factors not immediately apparent at the time of this exploration. Free water may also be encountered at the interface of existing man-placed fill materials, or at the interface between soil and weathered rock materials.

CLIENT <b>GSA</b>	JOB # <b>9756</b>	BORING # <b>B-1</b>	SHEET <b>1 OF 3</b>	
PROJECT NAME <b>1800 F STREET - GSA HEADQUARTERS</b>	ARCHITECT-ENGINEER <b>SHALOM BARAMES ASSOCIATES</b>			



CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL			
▽ WL 30.0'	WS OR 	BORING STARTED	7/9/05
▽ WL (AB)	▽ WL (AC) DRY	BORING COMPLETED	7/9/05
▽ WL		RIG CME55 FOREMAN CONNELLY	DRILLING METHOD HSA

Appendix A

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postrowski(08/09/2005)



**ECS**  
MID-ATLANTIC

○ CALIBRATED PENETROMETER  
TONS/FT. <sup>2</sup>

1 2 3 4 5+

PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT %

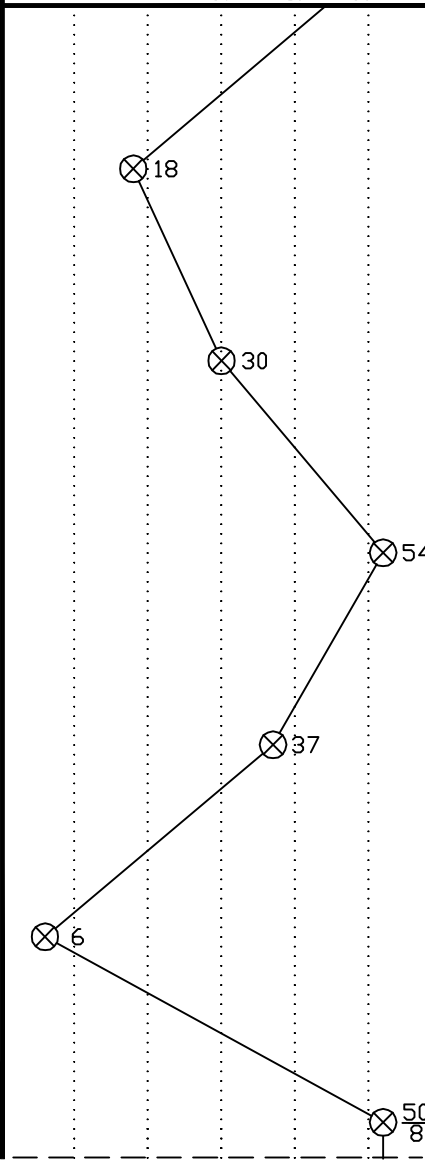
X ————— Δ

ROCK QUALITY DESIGNATION & RECOVERY  
RQD% — — — REC.% — — —  
20% — 40% — 60% — 80% — 100%

⊗ STANDARD PENETRATION  
BLOWS/FT.

10 20 30 40 50+

WATER LEVELS  
ELEVATION (FT)


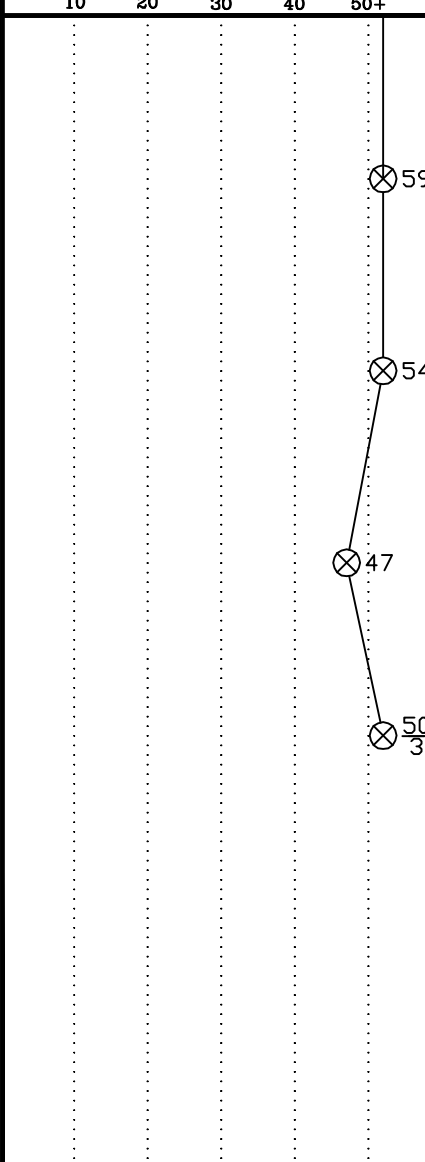


THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽ WL 30.0'	WS OR <b>WD</b>	BORING STARTED	7/9/05	
▽ WL(AB)	▽ WL(AC) DRY	BORING COMPLETED	7/9/05	CAVE IN DEPTH @ 27.0'
▽ WL		RIG CME55	FOREMAN CONNELLY	DRILLING METHOD HSA

## Appendix A

Postrowski(08/09/2005)

CLIENT <b>GSA</b>				JOB # <b>9756</b>		BORING # <b>B-1</b>		SHEET <b>3 OF 3</b>		
PROJECT NAME <b>1800 F STREET - GSA HEADQUARTERS</b>				ARCHITECT-ENGINEER <b>SHALOM BARAMES ASSOCIATES</b>						
SITE LOCATION <b>WASHINGTON, DC</b>										
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL		WATER LEVELS ELEVATION (FT)	○ CALIBRATED PENETROMETER TONS/FT. <sup>2</sup> 1      2      3      4      5+ PLASTIC      WATER      LIQUID LIMIT %      CONTENT %      LIMIT % X ————— ● ————— Δ ROCK QUALITY DESIGNATION & RECOVERY RQD% ——— REC.% ——— 20% — 40% — 60% — 80% — 100% ⊗ STANDARD PENETRATION BLOWS/FT. 10      20      30      40      50+		
					ENGLISH UNITS					
					SURFACE ELEVATION <b>11.00</b>					
60					Clayey Coarse SAND, Trace Gravel Fragments, Grayish Brown, Moist, Very Dense to Extremely Dense, (SC/GC)	-50				
65	15	SS	18	18		-55				
70	16	SS	18	3		Coarse SAND, With SCHIST Fragments, Gray and Brown, Wet, Dense, (SP/GP)				-60
75	17	SS	18	3						-65
80	18	SS	3	3	Weathered SCHIST, Sampled as Medium SAND, With SCHIST Fragments, Gray, Moist, Extremely Dense	-65				
END OF BORING @ 78.80'						-70				
85						-75				
90										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽ WL 30.0'	WS OR <b>WD</b>	BORING STARTED <b>7/9/05</b>	
▽ WL (AB)	▽ WL (AC) DRY	BORING COMPLETED <b>7/9/05</b>	CAVE IN DEPTH @ 27.0'
▽ WL		RIG CME55      FOREMAN CONNELLY	DRILLING METHOD HSA

**Appendix A**

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postrowski(08/09/2005)

**ECS**  
MID-ATLANTIC

**CALIBRATED PENETROMETER**  
TONS/FT. <sup>2</sup>

1 2 3 4 5+

**PLASTIC LIMIT %**      **WATER CONTENT %**      **LIQUID LIMIT %**

X ————— ● ————— Δ

**ROCK QUALITY DESIGNATION & RECOVERY**  
RQD% — — — REC.% — — —

20% — 40% — 60% — 80% — 100%

⊗ **STANDARD PENETRATION BLOWS/FT.**

10 20 30 40 50+

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

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**ECS**  
MID-ATLANTIC

○ CALIBRATED PENETROMETER  
TONS/FT. <sup>2</sup>

1 2 3 4 5+

PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT %

X ————— Δ

ROCK QUALITY DESIGNATION & RECOVERY

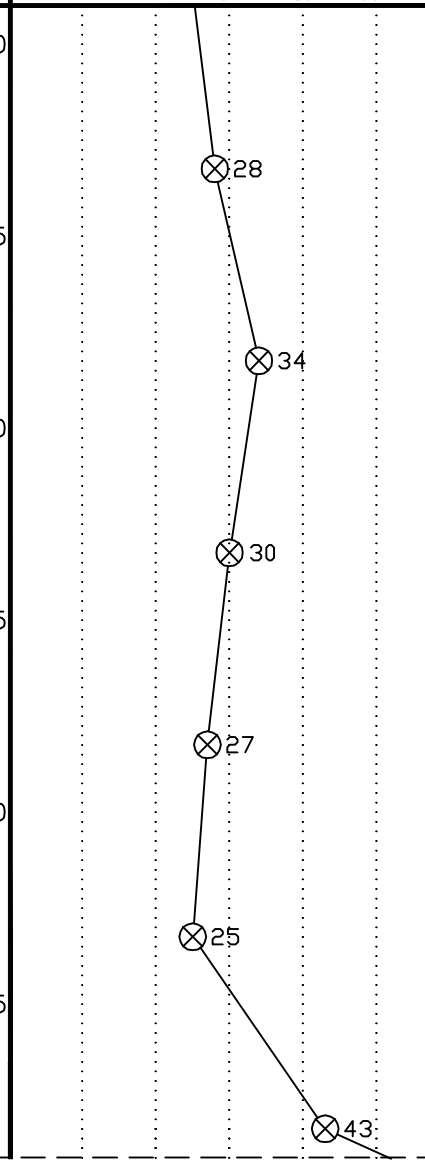
RQD% — — — REC.% — — —

20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.

10 20 30 40 50+

WATER LEVELS  
ELEVATION (FT)



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽ WL 29.0'	WS OR <b>WD</b>	BORING STARTED	7/9/05	
▽ WL(AB)	▽ WL(AC) DRY	BORING COMPLETED	7/9/05	CAVE IN DEPTH @ 22.0'
▽ WL		RIG CME55	FOREMAN CONNELLY	DRILLING METHOD HSA

## Appendix A

Postrowski(08/09/2005)


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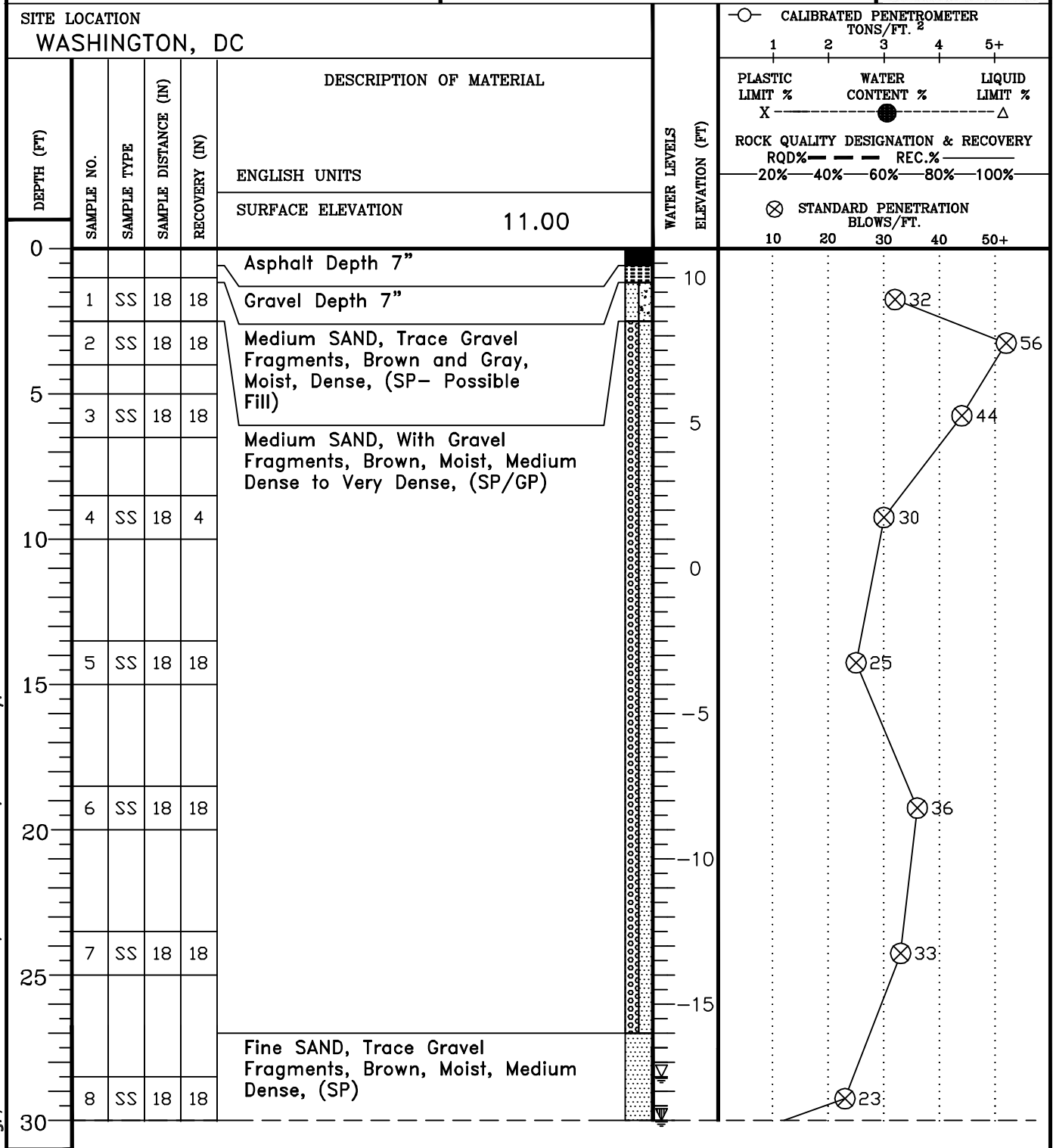


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CLIENT <b>GSA</b>	JOB # <b>9756</b>	BORING # <b>B-4</b>	SHEET <b>1 OF 3</b>	
PROJECT NAME <b>1800 F STREET - GSA HEADQUARTERS</b>	ARCHITECT-ENGINEER <b>SHALOM BARAMES ASSOCIATES</b>			




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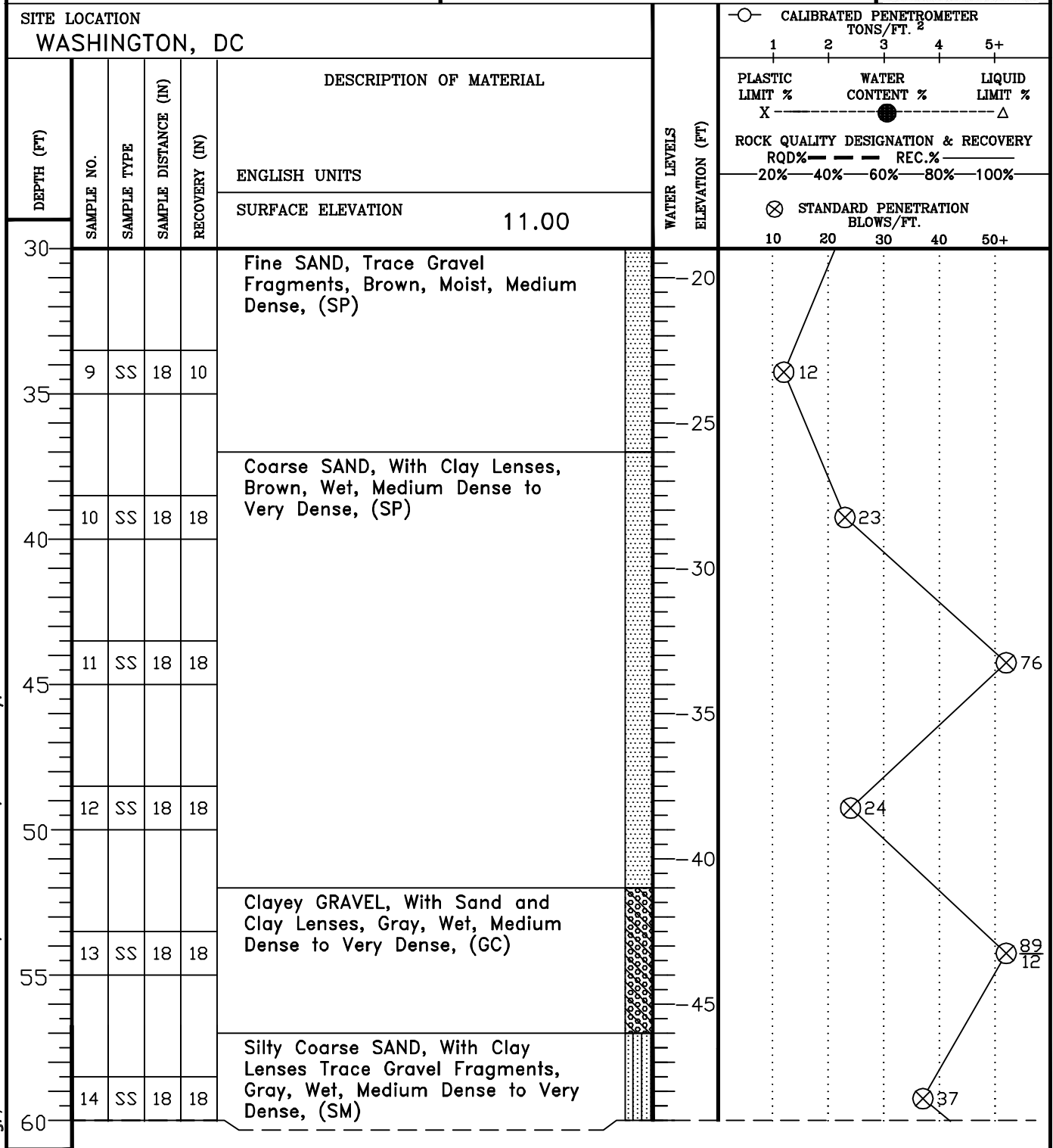
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL			
▽ WL 28.5'	WS OR 	BORING STARTED <b>7/30/05</b>	
▽ WL(AB) 30.0'    ▽ WL(AC) DRY		BORING COMPLETED <b>7/30/05</b>	CAVE IN DEPTH @ 27.5'
▽ WL	RIG CME55    FOREMAN CONNELLY	DRILLING METHOD HSA	

Appendix A


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postrowski(08/09/2005)

CLIENT <b>GSA</b>	JOB # <b>9756</b>	BORING # <b>B-4</b>	SHEET <b>2 OF 3</b>	
PROJECT NAME <b>1800 F STREET - GSA HEADQUARTERS</b>	ARCHITECT-ENGINEER <b>SHALOM BARAMES ASSOCIATES</b>			



CONTINUED ON NEXT PAGE.




THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL			
▽ WL 28.5'	WS OR 	BORING STARTED <b>7/30/05</b>	
▽ WL(AB) 30.0'    ▽ WL(AC) DRY		BORING COMPLETED <b>7/30/05</b>	CAVE IN DEPTH @ 27.5'
▽ WL	RIG CME55    FOREMAN CONNELLY	DRILLING METHOD HSA	

Appendix A

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postrowski(08/09/2005)

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CLIENT <b>GSA</b>				JOB # <b>9756</b>	BORING # <b>B-4</b>	SHEET <b>3 OF 3</b>	
PROJECT NAME <b>1800 F STREET - GSA HEADQUARTERS</b>				ARCHITECT-ENGINEER <b>SHALOM BARAMES ASSOCIATES</b>			
SITE LOCATION <b>WASHINGTON, DC</b>						<div style="text-align: center;">  CALIBRATED PENETROMETER TONS/FT.<sup>2</sup>  1    2    3    4    5+  PLASTIC LIMIT %    WATER CONTENT %    LIQUID LIMIT %  X ----- ● ----- Δ  ROCK QUALITY DESIGNATION &amp; RECOVERY  RQD% --- REC.% ---  20% --- 40% --- 60% --- 80% --- 100%   STANDARD PENETRATION BLOWS/FT.  10    20    30    40    50+ </div>	
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL		
ENGLISH UNITS SURFACE ELEVATION <span style="float: right;">11.00</span>							
60					Silty Coarse SAND, With Clay Lenses Trace Gravel Fragments, Gray, Wet, Medium Dense to Very Dense, (SM)	10	
65	15	SS	18	18	Medium SAND, Brown, Wet, Dense, (SP)	5	
70	16	SS	18	18		0	
75	17	SS	5	5	Weathered SCHIST, Sampled as Medium SAND, With SCHIST Fragments, Gray, Wet, Extremely Dense	-5	
80	AUGER REFUSAL @ 73.05'					-10	
85						-15	
90							

## **APPENDIX H**

### **FOUNDATION TAKEOFFS AND CALCULATIONS**

Given:  $P = 285\text{ k}$  (from Thornton-Tomasetti Calculations)  
 Allowable Soil Bearing Capacity:  $q_u = 5000\text{ psf}$  (from Thornton-Tomasetti Calculations)  
 Local Frost Depth: 30 inches (from Washington, D.C. Construction Codes)

Assume:  $P_D = 140\text{ k}$   
 $P_L = 145\text{ k}$   
 $f'_c = 3000\text{ psi}$   
 36" x 36" square concrete pier

Find: Design and detail the footing for this condition

Solution:  $P = P_D + P_L$   
 $= 140\text{ k} + 145\text{ k}$   
 $= 285\text{ k}$

$$q_a \geq \frac{P}{B^2} \geq \frac{285\text{ k}}{7.55^2}$$

Use  $B = 8\text{ ft}$

$$P_u = 1.2 P_D + 1.6 P_L$$

$$= 1.2(140\text{ k}) + 1.6(145\text{ k})$$

$$= 400\text{ k}$$

$$q = \frac{P_u}{B^2}$$

$$= \frac{400\text{ k}}{8^2}$$

$$= 6.25\text{ ksf}$$

$$= 43.4\text{ psi}$$

$$V_c = \phi \left( \frac{4}{3} \right) \sqrt{f'_c}$$

$$= 0.75 \left( \frac{4}{3} \right) \sqrt{3000\text{ psi}}$$

$$= 164.3\text{ psi}$$

This equation for the 2-way shear stress controls by inspection

$$\frac{d^2}{175.2} \left( \frac{V_c}{164.3} + \frac{q}{6697} \right) \leq \frac{d}{85938} \left( \frac{V_c}{164.3} + \frac{q}{43.4} \right) \quad \text{or} \quad \frac{d}{10.1} \leq \frac{q}{43.4} \left( \frac{B}{4} \right) \left( \frac{L}{96} - \frac{w^2}{36} \right) \quad (26)$$

$$h = d + 3\text{ in} + d_b$$

$$= 10.1\text{ in} + 3\text{ in} + 0.625\text{ in}$$

$$= 13.725\text{ in}$$

Use  $h = 16\text{ in}$

$$d = 16\text{ in} - 3\text{ in} - 0.625\text{ in} = 12.375\text{ in}$$

$$l = \left( 8\text{ ft} - 2\text{ ft} \right) / 2 = 3\text{ ft}$$

$$M_u = q \left( \frac{l^2}{3} \right) \left( \frac{2}{3} \right)$$

$$= 6.25 \left( \frac{3^2}{3} \right) \left( \frac{2}{3} \right)$$

$$= 28.13\text{ ft-k}$$

$$a = \left( \frac{A_s}{A_s} \right) \left( \frac{f_y}{60\text{ ksi}} \right) \left( \frac{0.85 f'_c}{0.85} \right) \left( \frac{b}{3\text{ ksi}} \right) \quad (12\text{ in})$$

$$= 1.961 A_s$$

$$M_u = \phi \left( \frac{M_n}{A_s} \right) \left( \frac{60\text{ ksi}}{60\text{ ksi}} \right) \left( \frac{d - a}{2} \right)$$

$$A_s = \frac{28.13 \text{ ft-k} \cdot 12 \text{ in/in}}{0.527 \text{ in}^2} = 0.9 A_s \cdot 60 \text{ ksi} \left( 12.375 \text{ in} - 1.961 A_s / 2 \right)$$

$$\text{Use } \#5 @ 6 \text{ in o.c. } A_s = 0.62 \text{ in}^2$$

$$\begin{aligned} \rho &= A_s / b \cdot h \\ &= 0.62 / 12 \cdot 16 \\ &= 0.0032 \geq 0.0018 \end{aligned}$$

$$a = 1.961 A_s = 1.961 \cdot 0.62 \text{ in}^2 = 1.216 \text{ in}$$

$$c = a / 0.85 = 1.216 \text{ in} / 0.85 = 1.43 \text{ in}$$

$$\begin{aligned} \epsilon_s &= 0.003 / c \left( d - c \right) \\ &= 0.003 / 1.43 \text{ in} \left( 12.375 \text{ in} - 1.43 \text{ in} \right) \\ &= 0.023 \text{ in/in} \geq 0.005 \text{ in/in} \end{aligned}$$

$$\text{Therefore } \phi = 0.9$$

Spacing is OK by inspection

Use 16 #5 each way

$$\begin{aligned} \phi B_n &= \phi \cdot 0.85 \cdot f'_c \cdot A_1 \\ &= 0.65 \cdot 0.85 \cdot 3 \text{ ksi} \cdot 36 \text{ in} \cdot 36 \text{ in} \\ &= 2148 \text{ k} \geq P_u = 400 \text{ k} \end{aligned}$$

$$\begin{aligned} A_{smin} &= 0.005 A_{col} \\ &= 0.005 \cdot 36 \text{ in} \cdot 36 \text{ in} \\ &= 6.48 \text{ in}^2 \geq A_s = 9.92 \text{ in}^2 \end{aligned}$$

OK!

8' x 8' x 1.33' Spread Footing with (16) #5 each way



Given:  $P = 225\text{ k}$  (from Thornton-Tomasetti Calculations)  
 Allowable Soil Bearing Capacity:  $q_a = 5000\text{ psf}$  (from Thornton-Tomasetti Calculations)  
 Local Frost Depth: 30 inches (from Washington, D.C. Construction Codes)

Assume:  $P_D = 110\text{ k}$   
 $P_L = 115\text{ k}$   
 $f'_c = 3000\text{ psi}$   
 36" x 36" square concrete pier

Find: Design and detail the footing for this condition

Solution:  $P = P_D + P_L$   
 $= 110\text{ k} + 115\text{ k}$   
 $= 225\text{ k}$

$q_a \geq \frac{P}{A}$   
 $5\text{ ksf} \geq \frac{225\text{ k}}{B^2}$   
 $B \geq 6.708$

Use  $B = 7\text{ ft}$

$P_u = 1.2 P_D + 1.6 P_L$   
 $= 1.2(110\text{ k}) + 1.6(115\text{ k})$   
 $= 316\text{ k}$

$q = \frac{P_u}{A}$   
 $= \frac{316\text{ k}}{7^2}$   
 $= 6.449\text{ ksf}$   
 $= 44.78\text{ psi}$

$V_c = \phi * 4 * \text{sqrt}(f'_c)$   
 $= 0.75 * 4 * \text{sqrt}(3000\text{ psi})$   
 $= 164.3\text{ psi}$

This equation for the 2-way shear stress controls by inspection

$$\frac{d^2}{175.5} \left( \frac{V_c}{d^2} + \frac{q}{6722} \right) + \frac{d}{d} \left( \frac{V_c}{164.3} + \frac{q}{44.78} \right) = \frac{w}{36} = \frac{q}{44.78} \left( \frac{B}{84} * L - \frac{w^2}{36} \right) \quad (26)$$

$h = \frac{d}{7.95} + \frac{3\text{ in}}{3\text{ in}} + \frac{d_b}{0.625}$   
 $= 11.575\text{ in}$

Use  $h = 12\text{ in}$

$d = 12\text{ in} - 3\text{ in} - 0.625\text{ in} = 8.375\text{ in}$

$l = (7\text{ ft} - 2\text{ ft}) / 2 = 2.5\text{ ft}$

$M_u = q * l^2 / 2$   
 $= 6.449 * 2.5^2 / 2$   
 $= 20.15\text{ ft-k}$

$a = \left( \frac{A_s}{A_s} * f_y \right) / \left( 0.85 * f'_c * \frac{b}{3\text{ ksi}} \right) * 12\text{ in}$   
 $= \left( \frac{A_s}{A_s} * 60\text{ ksi} \right) / \left( 0.85 * 3000\text{ psi} * \frac{b}{3\text{ ksi}} \right) * 12\text{ in}$   
 $= 1.961 A_s$

$M_u = \phi M_n$

$$\phi = \frac{20.15 \text{ ft-k}}{A_s} = \frac{\phi A_s}{12 \text{ in/in}} = \frac{60 \text{ ksi}}{0.9 A_s} \left( \frac{d}{a} - \frac{1}{60 \text{ ksi}} \right) \left( \frac{8.375 \text{ in}}{2} - \frac{1.961 A_s}{2} \right)$$

$$\text{Use } \#5 @ 6 \text{ in o.c. } A_s = 0.62 \text{ in}^2$$

$$\rho = \frac{A_s}{b h} = \frac{0.62}{12} = 0.0043 \geq 0.0018$$

$$a = \frac{1.961 A_s}{\phi} = \frac{1.961 * 0.62 \text{ in}^2}{0.9} = 1.216 \text{ in}$$

$$c = \frac{a}{0.85} = \frac{1.216 \text{ in}}{0.85} = 1.43 \text{ in}$$

$$\epsilon_s = \frac{0.003}{c} \left( \frac{d}{c} - \frac{c}{d} \right) = \frac{0.003}{1.43 \text{ in}} \left( \frac{8.375 \text{ in}}{1.43 \text{ in}} - 1 \right) = 0.015 \text{ in/in} \geq 0.005 \text{ in/in}$$

$$\text{Therefore } \phi = 0.9$$

Spacing is OK by inspection

Use 14 #5 each way

$$\phi B_n = \phi \left( \frac{0.65 * 0.85 * f'_c}{2148 \text{ k}} \right) A_1 = \frac{0.85 * 3 \text{ ksi}}{316 \text{ k}} (36 \text{ in})^2 = 36 \text{ in}$$

$$A_{smin} = 0.005 A_{col} = 0.005 * 36 \text{ in}^2 = 0.18 \text{ in}^2 \geq A_s = 8.68 \text{ in}^2$$

OK!

7' x 7' x 1' Spread Footing with (14) #5 each way

	Concrete						Reinforcement			
Location	Size			Cubic Feet	Cubic Yards	Formwork (SFCA)	Bottom Bars	Top Bars	Weight (lbs)	Total Weight (tons)
	W (ft)	L (ft)	H (ft)							
D-4.3	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-5	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-9	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-11	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
D-11.7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
F-4.3	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
F-5	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	233.63	0.12
F-7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
F-9	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
F-11	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
F-11.7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-4.3	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-5	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-9	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-11	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
H-11.7	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
J-4.3	8.0	8.0	1.3	85.33	3.16	42.67	16 - #5	16 - #5	311.51	0.16
J-5	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-9	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-10	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-11	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
J-11.7	7.0	7.0	1.0	49.00	1.81	28.00	14 - #5	14 - #5	233.63	0.12
TOTAL					61.52	876.00	3.35			
TOTAL + WASTE FACTOR					64.59	919.80	3.52			

Original System (Caissons + Grade Beams)

Caissons

1) Brayman Original Contract: \$1.56M

Grade Beams

1) Perrin Enterprises Original Contract: \$195,000

Total

1) Total Foundation System Cost: \$1,755,000

Alternate System (Spread Footings)

Detailed Foundation System Estimate															
Line Number	Item	Unit	Crew	Daily Output	Labor Hours	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total Incl O&P	Quantity	Project Total	Project Total Incl O&P		
Division 03 - Concrete															
03 11 13.05 1000	C.I.P. concrete forms, aluminum, average cost, buy, includes accessories, exludes ties	SFCA	C2	315.00	0.152	23.90	5.33		29.23	34.50	919.80	\$	26,885.75	\$	31,731.44
03 30 53.40 0740	Cast-In-Place Concrete, Columns, square (4000 psi), 12" x 12", Over 3% reinforcing	CY	C14A	9.03	22.148	1055.22	894.00	86.98	2036.20	2641.11	64.59	\$	131,527.21	\$	170,601.03
TOTAL												\$	158,412.96	\$	202,332.48
Division 31 - Earthwork															
31 23 16.13 0050	Excavation common earth with no sheeting or dewatering included, 1' to 4' deep, 1/2 CY Excavator	BCY	B11M	200.00	0.080		3.10	2.07	5.17	7.00	217.90	\$	1,126.54	\$	1,525.30
TOTAL												\$	1,126.54	\$	1,525.30
DETAILED STRUCTURAL SYSTEM ESTIMATE TOTAL												\$	159,539.50	\$	203,857.78

Notes

All items were chosen to closest possible match  
Used labor totals from Line Number 03 11 13.20 1150 for Line Number 03 11 13.05 1000  
Frost Depth = 30"  
Excavation per interior spread footing = approximately 10.25 CY  
Excavation per exterior spread footing = approximately 7.3 CY

Foundation System Cost Comparison				
System	Caissons	Grade Beams	Spread Footings	TOTAL
Original	\$ 1,560,000.00	\$ 195,000.00	\$ -	\$ 1,755,000.00
Alternate	\$ -	\$ -	\$ 203,857.78	\$ 203,857.78
SAVINGS				\$ 1,551,142.22

## Original System (Caissons + Grade Beams)

### Caissons

- 1) Work was delayed since Whiting-Turner/Walsh couldn't obtain the Erosion and Sediment Control (E & S) Permit
  - a) The Owner (GSA) never applied for a building permit
- 2) No schedule impacts due to good weather
- 3) Duration for mobilizing caisson rig is **2 days**
- 4) Duration for caissons is **25 days**

### Grade Beams

- 1) Duration for grade beams and foundation walls is **20 days**

## Alternate System (Spread Footings)

Activity	Units	Daily Output	Quantity	TOTAL DAYS
Excavation	BCY	200.00	217.90	2
Concrete Forms	SFCA	315.00	919.80	3
Cast-In-Place Spread Footing with Reinforcing	CY	10.25	64.59	7
<b>TOTAL</b>				<b>12</b>

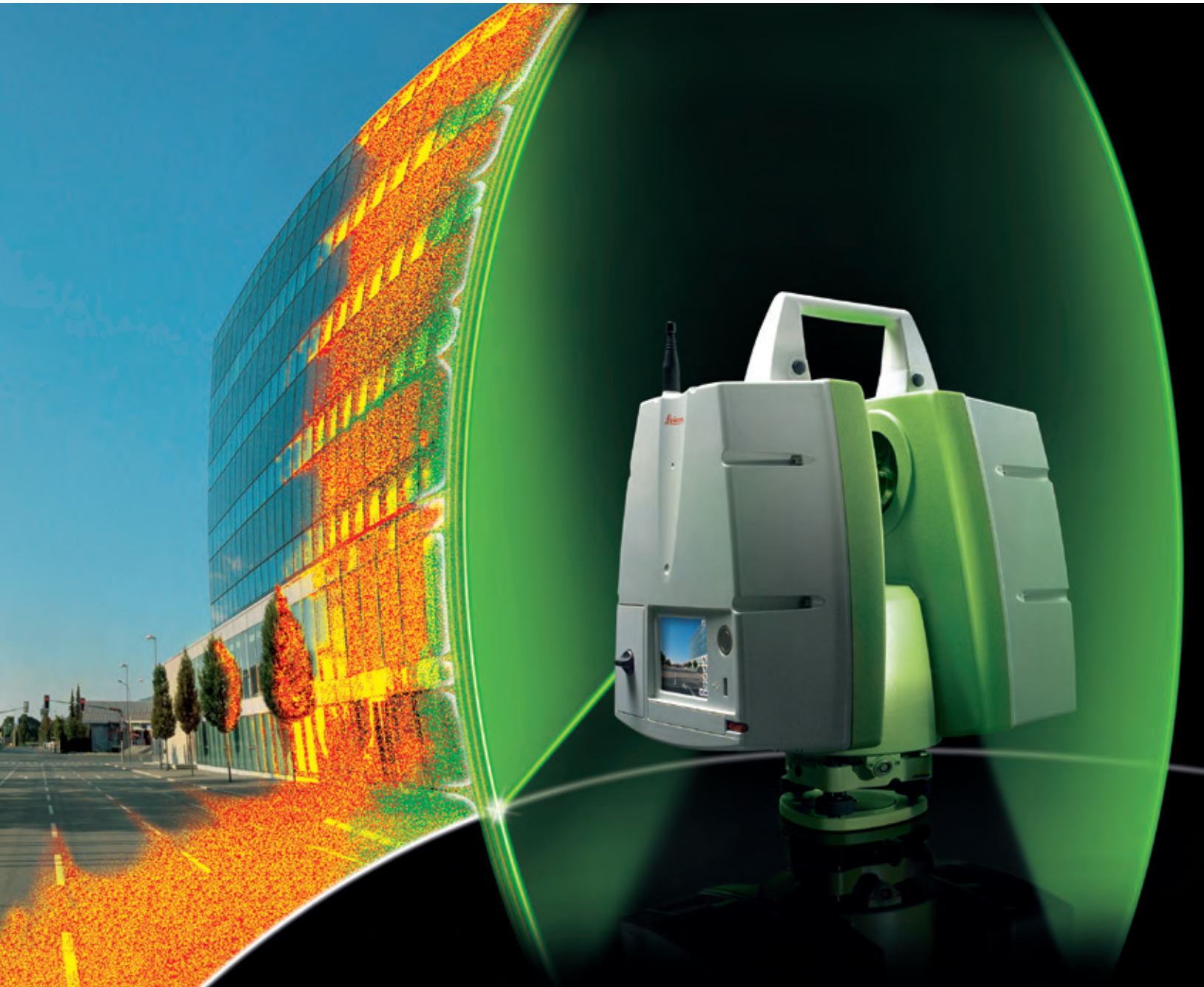
Foundation System Schedule Comparison				
System	Caissons	Grade Beams	Spread Footings	TOTAL
Original	27	20	0	47
Alternate	0	0	12	12
<b>DIFFERENCE</b>				<b>35</b>

## **APPENDIX I**

### **LEICA SCANSTATION C10 BROCHURE AND DATASHEET**

# Leica ScanStation C10

The All-in-One Laser Scanner  
for Any Application



- when it has to be **right**

**Leica**  
Geosystems

# Leica ScanStation C10

## Versatility, Productivity, Value

Many organizations interested in laser scanning – to diversify and/or improve current business – have been waiting for a scanner with greater versatility, a lower cost of ownership, and even higher productivity for as-built and topographic surveys. Your wait is over.

The “All-in-One” ScanStation C10 delivers a faster payback for your investment in High-Definition Surveying™ (HDS™) at many levels:

- All critical components in one, portable survey instrument: full field-of-view, high-speed, high-accuracy, long range scanner; rich, graphic controller; powerful camera/video; data storage; hot-swap battery; tilt compensator, and more.
- All-in-One versatility in applications and sites where scanning is profitable.
- One-stop-shopping via the industry’s leading vendor: the most comprehensive scanning software, scanner selection, and customer support.

### Next Generation of the Most Popular Laser Scanner

No one has packed more laser scanning capability and value into a single unit.



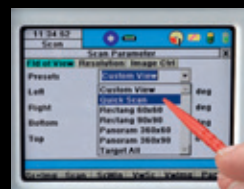
#### Unprecedented Versatility

- Compact, full dome, accurate, excellent range - take advantage of scanning on more sites for more applications
- Use targets, traverse, resection or free-station registration and “geo-referencing” methods as site logistics dictate
- Even faster scanning makes HDS cost effective for more projects: exteriors and interiors, short and long range
- Onboard or PC control
- GPS and prism options



#### Major Productivity Advances

- Up to 10x faster full dome scans: now, just minutes
- Several times faster area scans
- Move, setup and tear-down faster
- Locate targets easier and faster
- Register and geo-reference faster
- Check scan results in the field easier
- Up to 90% field labor savings vs traditional methods



#### Valuable Cost Savings

- Reduced ownership cost
- Platform designed for incremental upgradeability
- Easy-to-learn, total station-like interface
- Cable-less, with reduced accessory and maintenance costs
- Reduced site re-visits

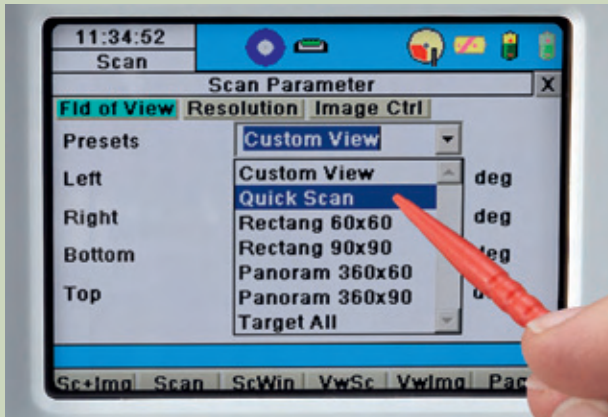






# Leica ScanStation C10

## All-in-One



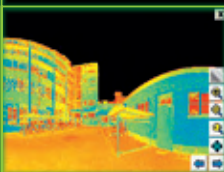
### Familiar, Total Station-like Interface

Leica ScanStation C10 supports standard field workflows with a rich, familiar total station interface. Easy to learn touch screen operation.



### Integrated real-time streaming video with zoom

Fast, accurate selection of scene and targets to be scanned



### Onboard controller and color, graphic display

Convenient control and on-site QA, including onboard review of scans



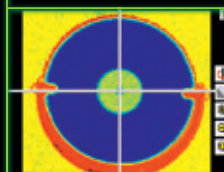
### High-resolution digital image display

Auto-adjusting, internal, high resolution digital camera for "photo-realistic" color mapping of point clouds



### Graphical icons make learning the instrument easy

Leica firmware makes onboard management fast and efficient for instrument setup, operation and monitoring with rigorous field QA



### 3D viewing of target scans

Helps ensure Leica Geosystems-quality registration and geo-referencing





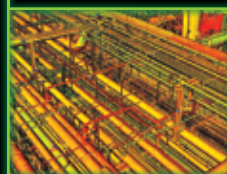
#### **Compatibility with standard surveying equipment**

Attach handles with Leica GPS SmartAntenna or prism holder, or use without handle for unobstructed overhead scans



#### **Smart X-Mirror™ design**

The mirror automatically spins for fast 360° and full dome scans and oscillates for efficient, targeted scans



#### **Very-high speed, low noise pulsed laser**

Reduces field time while providing excellent range and survey-grade accuracy for each point



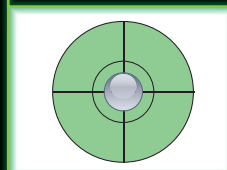
#### **Wireless Remote Access**

Transfers onboard control screen to handheld controller for safe distance, remote control



#### **Integrated data storage**

Avoids the need for a laptop or separate handheld device; easy data transfer via USB or Ethernet interface



#### **Integrated, dual-axis level compensator**

For convenient survey-grade traversing and resection, plus tighter registration



#### **Integrated battery**

Hot-swappable, standard total station battery



#### **Laser plummet and tribrach mount**

Standard procedures make ScanStation C10 easy to use



# Leica ScanStation C10

## One Scanner for Any Application

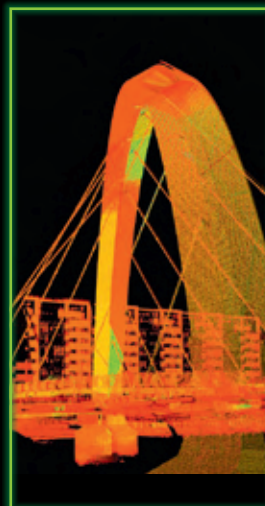
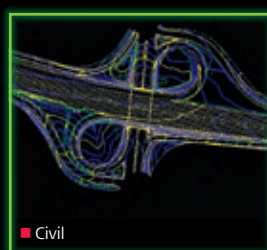
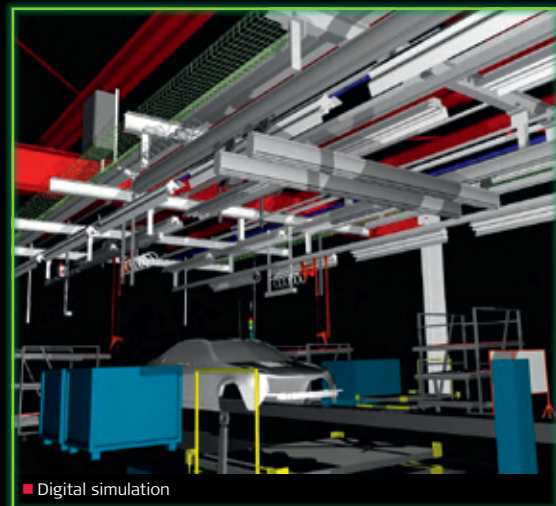
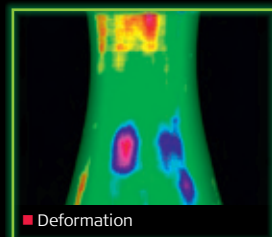
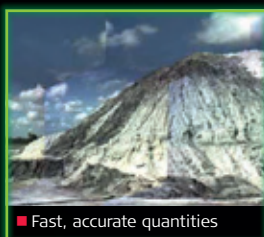
Reap all of the benefits of High-Definition Surveying™ (HDS™) for more as-built, topographic and mapping surveys.

### Benefits

- Lower cost
- Faster
- More accurate & complete
- Safer
- Less intrusive
- More informative

### Applications

- Design & engineering
- Construction & fabrication QA
- Asset management & archive
- Forensics & security planning
- Marketing proposals
- Research & education



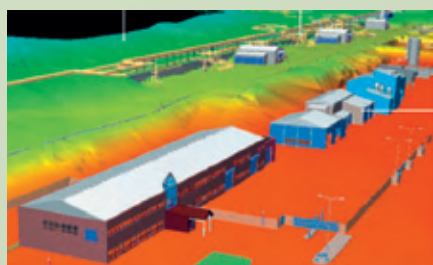
# Leica Geosystems

## The All-in-One Vendor

Organizations that enter into laser scanning need more than just hardware. You also need software, training and support, and at some point you may even want more than one type

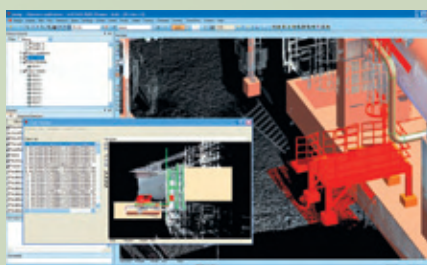
of laser scanner. For meeting your complete needs in High-Definition Surveying, no organization measures up to Leica Geosystems – the acknowledged industry leader.

### Software: Comprehensive, Powerful, Versatile



#### Leica Cyclone & Cyclone II

This comprehensive, industry-standard suite includes powerful, stand alone modules for scanning, registration & geo-referencing, viewing, modeling & data management, and creating a wide range of deliverables & QA reports.



#### Leica CloudWorx

This popular suite of affordable CAD plug-ins makes it easy to learn and work efficiently with rich scan data directly in leading CAD applications for civil/survey, architectural, and plant projects.



#### More Software

Leica Geosystems also offers specialized scanning software solutions to meet the full range of user needs. These include free, web-based view/measure/markup software (Leica TruView); forensic mapping; mining; and efficient 3D meshing.

### Worldclass Training and Support

From on-site and factory-based classroom and field training to a global network of experienced HDS support specialists, no organization can help you succeed in High-Definition Surveying better than Leica Geosystems.

Moreover, Leica Geosystems actively cultivates a HDS user community network that supports itself – through idea exchange, training, backup hardware and backup staff.

The user network includes a world-wide HDS user group conference and many local HDS user group meetings, where Leica Geosystems staff and experienced users share their latest insights.

#### Active Customer Care

Working with the best maintained equipment and most up-to-date firmware and software ensures the best results for your business. That's what Leica Geosystems Customer Care Packages (CCP) offer. They protect your initial investment and keep your tools up-to-date for additional gains.



Whether you're designing a modification to a complex refinery piping system, surveying a site or documenting a historic building, you need reliable measurements. High-Definition Surveying scanning systems and software by Leica Geosystems provide you with exact data of what's there. When your as-built information has to be right, rely on Leica Geosystems.

Leica Geosystems is best known for its pioneering scanning technology and trustworthy, total solutions: versatile, accurate laser scanners, industry standard point cloud software, and a full complement of accessories, training and support.

Precision, quality and service from Leica Geosystems.

**When it has to be right.**

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**Total Quality Management –**  
our commitment to total  
customer satisfaction.

Ask your local Leica Geosystems  
dealer for more information  
about our TQM program.

**Laser plummet:**  
Laser class 2 in accordance  
with IEC 60825-1 resp.  
EN 60825-1

**Scanner:**  
Laser class 3R in accordance  
with IEC 60825-1 resp.  
EN 60825-1



**Leica ScanStation C5**  
Product information  
and specifications



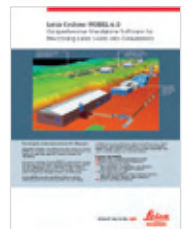
**HDS7000**  
Product information  
and specifications



**HDS8800**  
Product information  
and specifications



**Leica Cyclone  
REGISTER**  
Product information



**Leica Cyclone  
MODEL**  
Product information



# Leica ScanStation C10

## The All-in-One Laser Scanner for Any Application

See also  
ScanStation  
C10  
brochure!



### New platform represents the most capabilities and best value packed into a single instrument

#### Leica ScanStation C10: new standard for pulsed scanners

The industry's most popular class of laser scanner – ScanStation – is now in a compact, all-in-one ScanStation C10 platform: scanner, battery, controller, data storage, and video camera. In addition, ScanStation C10 also features major advances in productivity, versatility, and ease-of-use for as-built and topographic High-Definition Surveying™ (HDS™).

#### All-in-one scanner capabilities for higher value

ScanStation C10 gives users the advantage of high-accuracy, long range scanning plus the advantage of fast, full-dome interior scanning – all in one instrument. The key is the new Smart X-Mirror™ design that automatically spins or oscillates

the mirror for optimum productivity. Smart X-Mirror also automatically aligns the embedded, high-resolution video camera with the laser for fast targeting and fast, accurate texture mapping of scans.

#### Full field-of-view + traverse + high accuracy + excellent range = Versatility

ScanStation C10 includes the hallmark versatility features that have made the ScanStation class so popular. These capabilities let users take advantage of scanning for more applications and more sites, while minimizing field labor.

#### Easy to learn

ScanStation C10 includes surveyor-friendly, total station-like onboard graphic control, including the ability to view target scans in 3D. Users can also take advantage of laptop control for more comprehensive scan viewing.

- when it has to be **right**

**Leica**  
Geosystems

# Leica ScanStation C10

## Product Specifications

General	
<b>Instrument type</b>	Compact, pulsed, dual-axis compensated, very high speed laser scanner, with survey-grade accuracy, range, and field-of-view; integrated camera and laser plummet
<b>User interface</b>	Onboard control, notebook, tablet PC or remote controller
<b>Data storage</b>	Integrated solid-state drive (SSD), external PC or external USB device
<b>Camera</b>	Auto-adjusting, integrated high-resolution digital camera with zoom video

System Performance	
<b>Accuracy of single measurement</b>	
Position*	6 mm
Distance*	4 mm
Angle (horizontal/vertical)	60 µrad / 60 µrad (12" / 12")
<b>Modeled surface precision**/noise</b>	2 mm
<b>Target acquisition***</b>	2 mm std. deviation
<b>Dual-axis compensator</b>	Selectable on/off, resolution 1", dynamic range +/- 5', accuracy 1.5"

Laser Scanning System	
<b>Type</b>	Pulsed; proprietary microchip
<b>Color</b>	Green, wavelength = 532 nm visible
<b>Laser Class</b>	3R (IEC 60825-1)
<b>Range</b>	300 m @ 90%; 134 m @ 18% albedo (minimum range 0.1 m)
<b>Scan rate</b>	Up to 50,000 points/sec, maximum instantaneous rate
<b>Scan resolution</b>	
Spot size	From 0 – 50 m: 4.5 mm (FWHH-based); 7 mm (Gaussian-based)
Point spacing	Fully selectable horizontal and vertical; < 1 mm minimum spacing, through full range; single point dwell capacity
<b>Field-of-View</b>	
Horizontal	360° (maximum)
Vertical	270° (maximum)
Aiming/Sighting	Parallax-free, integrated zoom video
<b>Scanning Optics</b>	Vertically rotating mirror on horizontally rotating base; Smart X-Mirror™ automatically spins or oscillates for minimum scan time
<b>Data storage capacity</b>	80 GB onboard solid-state drive (SSD) or external USB device
<b>Communications</b>	Dynamic Internet Protocol (IP) Address, Ethernet or wireless LAN (WLAN) with external adapter
<b>Integrated color digital camera with zoom video</b>	Single 17° x 17° image: 1920 x 1920 pixels (4 megapixels) Full 360° x 270° dome: 260 images; streaming video with zoom; auto-adjusts to ambient lighting
<b>Onboard display</b>	Touchscreen control with stylus, full color graphic display, QVGA (320 x 240 pixels)
<b>Level indicator</b>	External bubble, electronic bubble in onboard control and Cyclone software
<b>Data transfer</b>	Ethernet, WLAN or USB 2.0 device
<b>Laser plummet</b>	Laser class: 2 (IEC 60825-1) Centering accuracy: 1.5 mm @ 1.5 m Laser dot diameter: 2.5 mm @ 1.5 m Selectable ON/OFF

Electrical	
<b>Power supply</b>	15 V DC, 90 – 260 V AC
<b>Power Consumption</b>	< 50 W avg.
<b>Battery Type</b>	Internal: Li-Ion; External: Li-Ion
<b>Power Ports</b>	Internal: 2, External: 1 (simultaneous use, hot swappable)
<b>Duration</b>	Internal: >3.5 h (2 batteries), External: >6 h (room temp)

Environmental	
<b>Operating temp.</b>	0° C to 40° C / 32° F to 104° F
<b>Storage temp.</b>	-25° C to +65° C / -13° F to 149° F
<b>Lighting</b>	Fully operational between bright sunlight and complete darkness
<b>Humidity</b>	Non-condensing
<b>Dust/humidity</b>	IP54 (IEC 60529)

Physical	
<b>Scanner</b>	
Dimensions (D x W x H)	238 mm x 358 mm x 395 mm / 9.4" x 14.1" x 15.6"
Weight	13 kg / 28.7 lbs, nominal (w/o batteries)
<b>Battery (internal)</b>	
Dimensions (D x W x H)	40 mm x 72 mm x 77 mm / 1.6" x 2.8" x 3.0"
Weight	0.4 kg / 0.9 lbs
<b>Battery (external)</b>	
Dimensions (D x W x H)	95 mm x 248 mm x 60 mm / 3.7" x 9.8" x 2.4"
Weight	1.9 kg / 4.2 lbs
<b>AC Power Supply</b>	
Dimensions (D x W x H)	85 mm x 170 mm x 41 mm / 3.4" x 6.7" x 1.6"
Weight	0.9 kg / 1.9 lbs

Standard Accessories Included	
Scanner transport case	
Tribrach (Leica Professional Series)	
4x Internal batteries	
Battery charger/AC power cable, Car adapter, Daisy chain cable	
Data cable	
Height meter and distance holder for height meter	
Cleaning kit	
Cyclone™ SCAN software	
1year CCP Basic support agreement	

Additional Accessories	
HDS scan targets and target accessories	
Service agreement for Leica ScanStation C10	
Extended warranty for Leica ScanStation C10	
External battery with charging station, AC power supply and power cable	
Professional charger for internal batteries	
AC power supply for scanner	
Tripod, tripod star, rolling base, external wireless LAN adapter (third-party)	

Notebook PC for scanning with Cyclone software Δ	
Component	required (minimum)
Processor	1.7 GHz Pentium M or higher
RAM	1 GB (2 GB for Windows Vista)
Network card	Ethernet
Display	SVGA or OpenGL accelerated graphics card (with latest drivers)
Operating system	Windows XP Professional (SP2 or higher) (32 or 64) Windows Vista (32 or 64), Windows 7 (32 or 64)

Control Options	
Full color touch screen for onboard scan control	
Leica Cyclone SCAN software for laptop PC (see Leica Cyclone SCAN data sheet for full list of features)	
Remote controller (Leica CS10/15 or any other remote desktop capable device)	

Ordering Information	
Contact Leica Geosystems or authorized representatives	

All specifications are subject to change without notice.

All ± accuracy specifications are one sigma unless otherwise noted.

\* At 1 m – 50 m range, one sigma

\*\* Subject to modeling methodology for modeled surface

\*\*\* Algorithmic fit to planar HDS targets

Δ Minimum requirements for modeling operations are different. Refer to Cyclone data sheet specifications

Scanner: Laser class 3R in accordance with IEC 60825-1 resp. EN 60825-1

Laser plummet: Laser class 2 in accordance with IEC 60825-1 resp. EN 60825-1

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## **APPENDIX J**

### **DATA COLLECTION TOOL**

## INTERVIEW QUESTIONS

- 1) What are the benefits of using energy management software during the operational phase of a building?
- 2) What are the initial costs of implementing energy management software and what is the typical payback period?
- 3) What are the difficulties of monitoring a web-based energy reporting tool?
- 4) What is the importance of balancing energy efficiency and occupant comfort?
- 5) How can you integrate methods that allow occupants to physically see the impact of their behavior (e.g. leaving a window open when the heating system is operating)?