Appendix A - Breadth Studies

Acoustical Analysis (Analysis I)

As previously discussed, the concept behind Analysis I – Backup Generator Analysis is to utilize the existing backup generator to help offset the electrical load the building imposes on the municipal grid during peak hours. To accompany this analysis, an acoustical analysis was conducted to determine the impact this activity would have on the building's tenants. Included in this analysis are calculations to determine what effect the current construction would have on sound attenuation and what could be done to further reduce the sound that is able to pass through the enclosure and permeate the parking garage.

Structural Analysis (Analysis II)

2175 K Street provides for a challenging arena for the application of an alternate roofing type. The proposed type of roof to be analyzed was a green or vegetated roof. Associated with it are different weight per square foot depending upon thickness and type. Seeing as how 2175 K Street consists of adding three floors onto an existing building, adding loads are critical. To allow for the existing structure to carry the newly imposed loads caused by the new structure, steel reinforcement or carbon fiber, depending on location, was utilized. With this in mind, any additional load imposed by an alternate roofing type would need to be calculated. To ensure the proposed solution is feasible, a structural analysis will need to be conducted.

Mechanical Analysis (Analysis II and Analysis III)

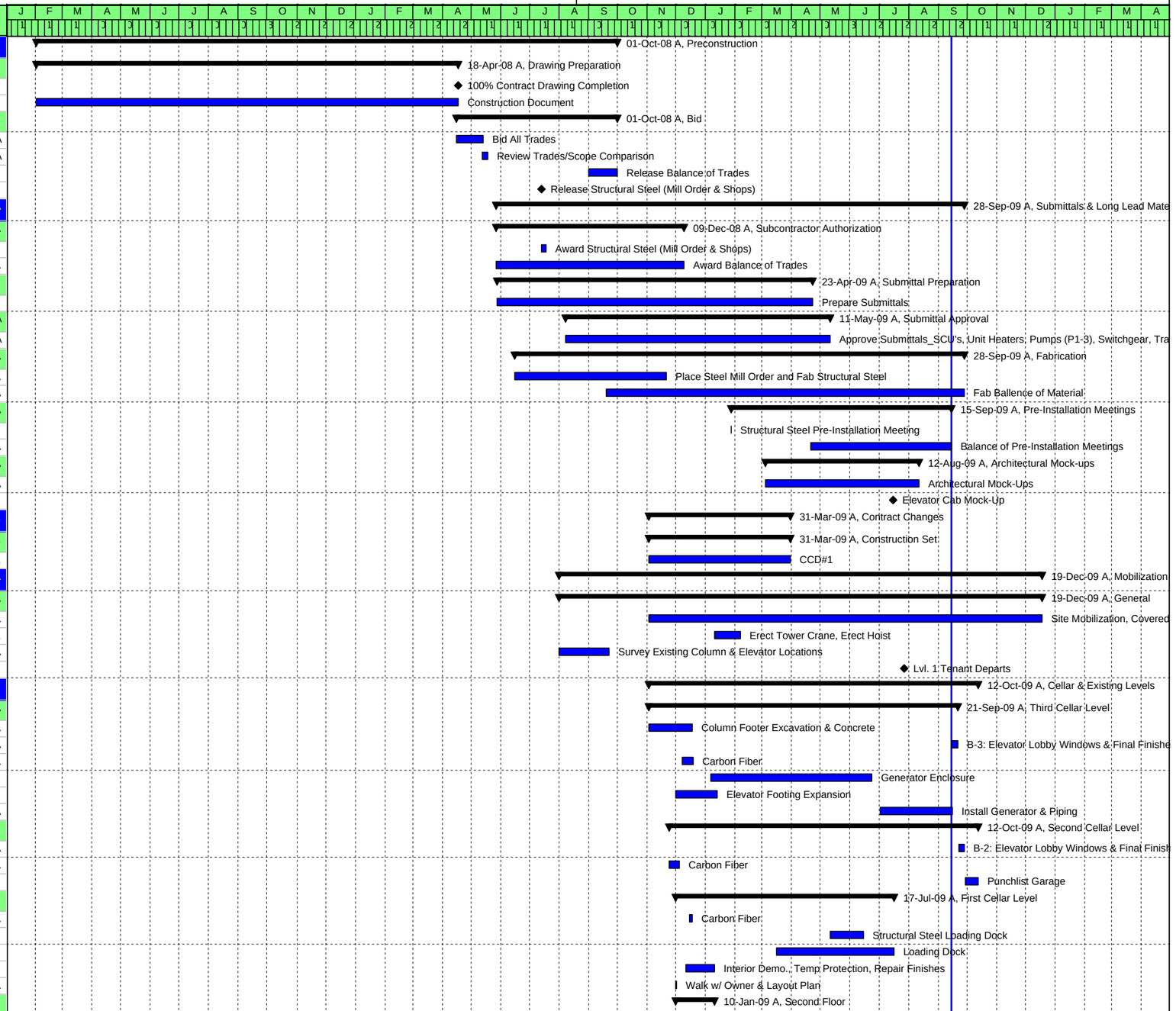
In an attempt to reduce unwanted thermal gain and increase energy efficiency, Analysis II – Green Roof Analysis will look into customizing the building's roofing system based upon the associated materials and sun exposure. The proposed solution to this facet of the analysis is to incorporate the benefits of a green roof in terms of reduced thermal gain. Similarly, within Analysis III – Curtain Wall Redesign Analysis investigated the relative benefit of replacing the existing curtain wall design with a super insulated one. The end results of both analyses had an effect on the electricity usage of the mechanical system. Therefore, a mechanical analysis was conducted to determine the extent of the reduction in electricity usage.

MAE Requirement

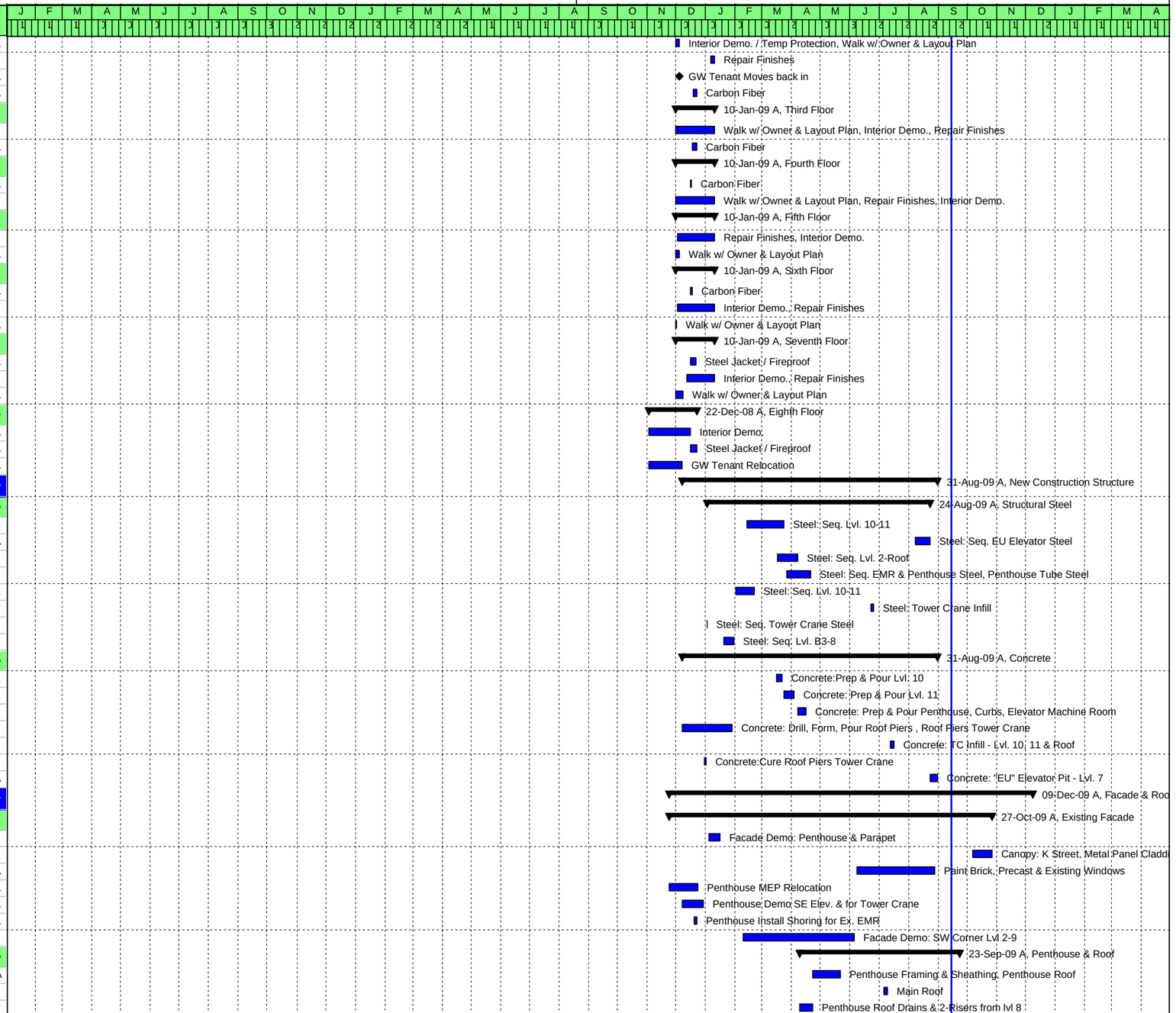
The vocabulary and knowledge attained through a number of graduate level classes were used to enhance the quality of analysis conducted. Additionally, the classes helped to create compelling arguments of the findings of such analyses. Such classes are AE 542 – Building Enclosure Science and Design, AE 572 – Project Development and Delivery Planning, and AE 597D – Sustainable Building Methods. Additionally, AE 572 can be used to create more thorough financial models, which will result in more compelling results. Finally, the knowledge gained in AE 597D will serve as the basis for all of the research involving this proposal.

Appendix B – Detailed Project Schedule

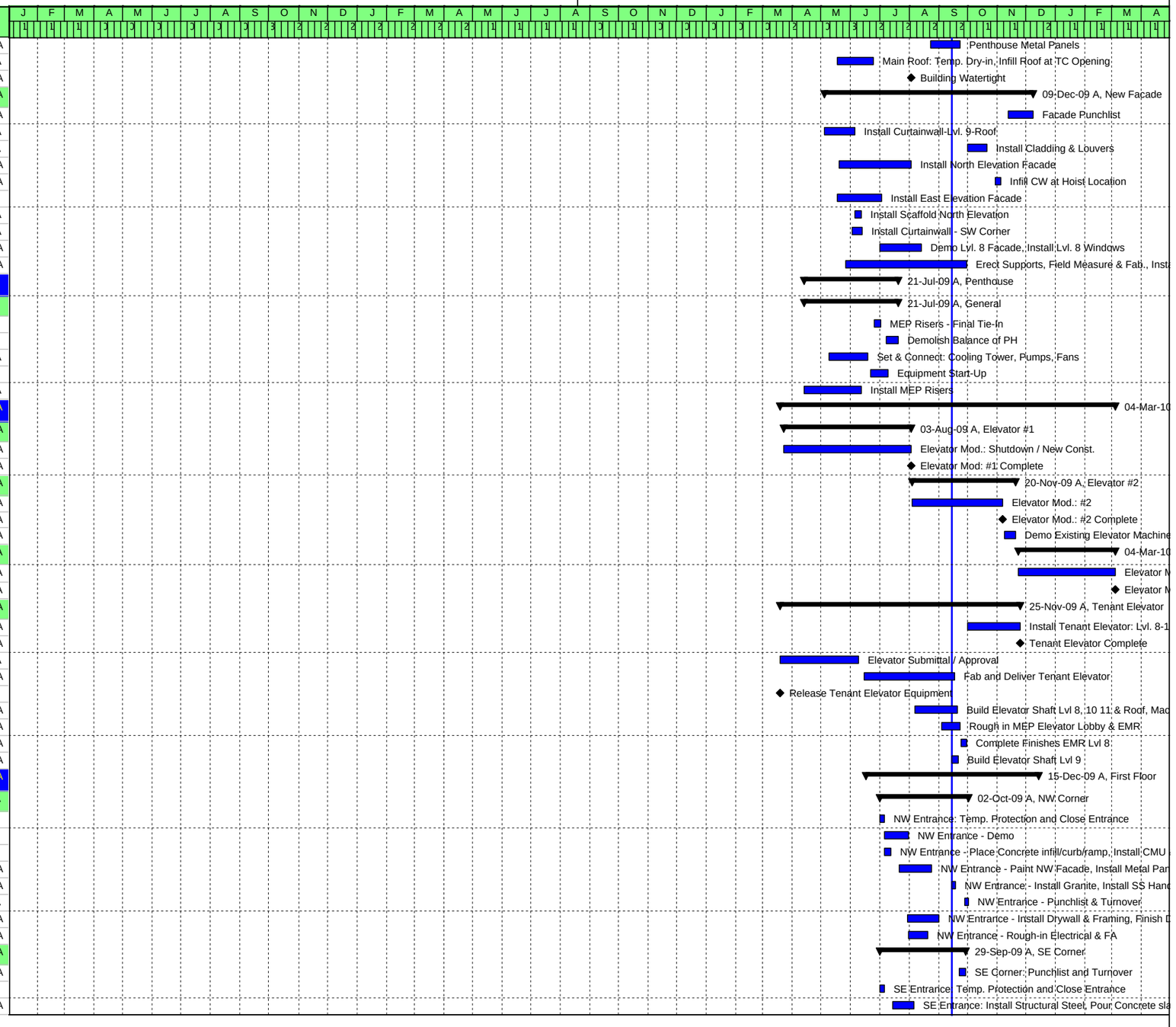
Activity ID	Activity Name	Actual Duration	Start	Finish
Preconstruction		433	02-Feb-07 A	01-Oct-08 A
Drawing Preparation		315	02-Feb-07 A	18-Apr-08 A
PC043	100% Contract Drawing Completion	0		18-Apr-08 A
PC053	Construction Document	308	02-Feb-07 A	18-Apr-08 A
Bid		120	16-Apr-08 A	01-Oct-08 A
B010	Bid All Trades	20	16-Apr-08 A	13-May-08 A
B020	Review Trades/Scope Comparison	4	13-May-08 A	19-May-08 A
B060	Release Balance of Trades	21	01-Sep-08 A	01-Oct-08 A
B050	Release Structural Steel (Mill Order & Shops)	0		14-Jul-08 A
Submittals & Long Lead Material/Equipment		349	27-May-08 A	28-Sep-09 A
Subcontractor Authorization		141	27-May-08 A	09-Dec-08 A
A020	Award Structural Steel (Mill Order & Shops)	5	14-Jul-08 A	18-Jul-08 A
A030	Award Balance of Trades	137	27-May-08 A	09-Dec-08 A
Submittal Preparation		236	28-May-08 A	23-Apr-09 A
SP040	Prepare Submittals	230	28-May-08 A	23-Apr-09 A
Submittal Approval		196	08-Aug-08 A	11-May-09 A
SA060	Approve Submittals_SCU's, Unit Heaters, Pumps (P1-3), Switchgear, ...	191	08-Aug-08 A	11-May-09 A
Fabrication		335	16-Jun-08 A	28-Sep-09 A
F010	Place Steel Mill Order and Fab Structural Steel	112	16-Jun-08 A	21-Nov-08 A
F020	Fab Ballence of Material	259	19-Sep-08 A	28-Sep-09 A
Pre-Installation Meetings		164	28-Jan-09 A	15-Sep-09 A
PM010	Structural Steel Pre-Installation Meeting	0	28-Jan-09 A	28-Jan-09 A
PM020	Balance of Pre-Installation Meetings	102	21-Apr-09 A	15-Sep-09 A
Architectural Mock-ups		114	05-Mar-09 A	12-Aug-09 A
AM010	Architectural Mock-Ups	112	05-Mar-09 A	12-Aug-09 A
AM040	Elevator Cab Mock-Up	0		16-Jul-09 A
Contract Changes		106	03-Nov-08 A	31-Mar-09 A
Construction Set		106	03-Nov-08 A	31-Mar-09 A
CCD1-	CCD#1	102	03-Nov-08 A	31-Mar-09 A
Mobilization		361	01-Aug-08 A	19-Dec-09 A
General		361	01-Aug-08 A	19-Dec-09 A
M020	Site Mobilization, Covered Walkways	286	03-Nov-08 A	19-Dec-09 A
M060	Erect Tower Crane, Erect Hoist	27	10-Jan-09 A	06-Feb-09 A
M010	Survey Existing Column & Elevator Locations	35	01-Aug-08 A	22-Sep-08 A
M070	Lvl. 1 Tenant Departs	0	27-Jul-09 A	
Cellar & Existing Levels		246	03-Nov-08 A	12-Oct-09 A
Third Cellar Level		231	03-Nov-08 A	21-Sep-09 A
B3-020	Column Footer Excavation & Concrete	27	03-Nov-08 A	18-Dec-08 A
B3-200	B-3: Elevator Lobby Windows & Final Finishes	5	15-Sep-09 A	21-Sep-09 A
B3-030	Carbon Fiber	9	08-Dec-08 A	19-Dec-08 A
B3-060	Generator Enclosure	107	07-Jan-09 A	24-Jun-09 A
B3-070	Elevator Footing Expansion	26	01-Dec-08 A	13-Jan-09 A
B3-075	Install Generator & Piping	52	02-Jul-09 A	15-Sep-09 A
Second Cellar Level		231	24-Nov-08 A	12-Oct-09 A
B2-200	B-2: Elevator Lobby Windows & Final Finishes	5	22-Sep-09 A	28-Sep-09 A
B2-020	Carbon Fiber	7	24-Nov-08 A	05-Dec-08 A
B2-210	Punchlist Garage	10	29-Sep-09 A	12-Oct-09 A
First Cellar Level		164	01-Dec-08 A	17-Jul-09 A
B1-020	Carbon Fiber	4	15-Dec-08 A	18-Dec-08 A
B1-080	Structural Steel Loading Dock	24	11-May-09 A	15-Jun-09 A
B1-070	Loading Dock	104	16-Mar-09 A	17-Jul-09 A
B1-010	Interior Demo., Temp Protection, Repair Finishes	20	11-Dec-08 A	10-Jan-09 A
B1-005	Walk w/ Owner & Layout Plan	1	01-Dec-08 A	02-Dec-08 A
Second Floor		30	01-Dec-08 A	10-Jan-09 A



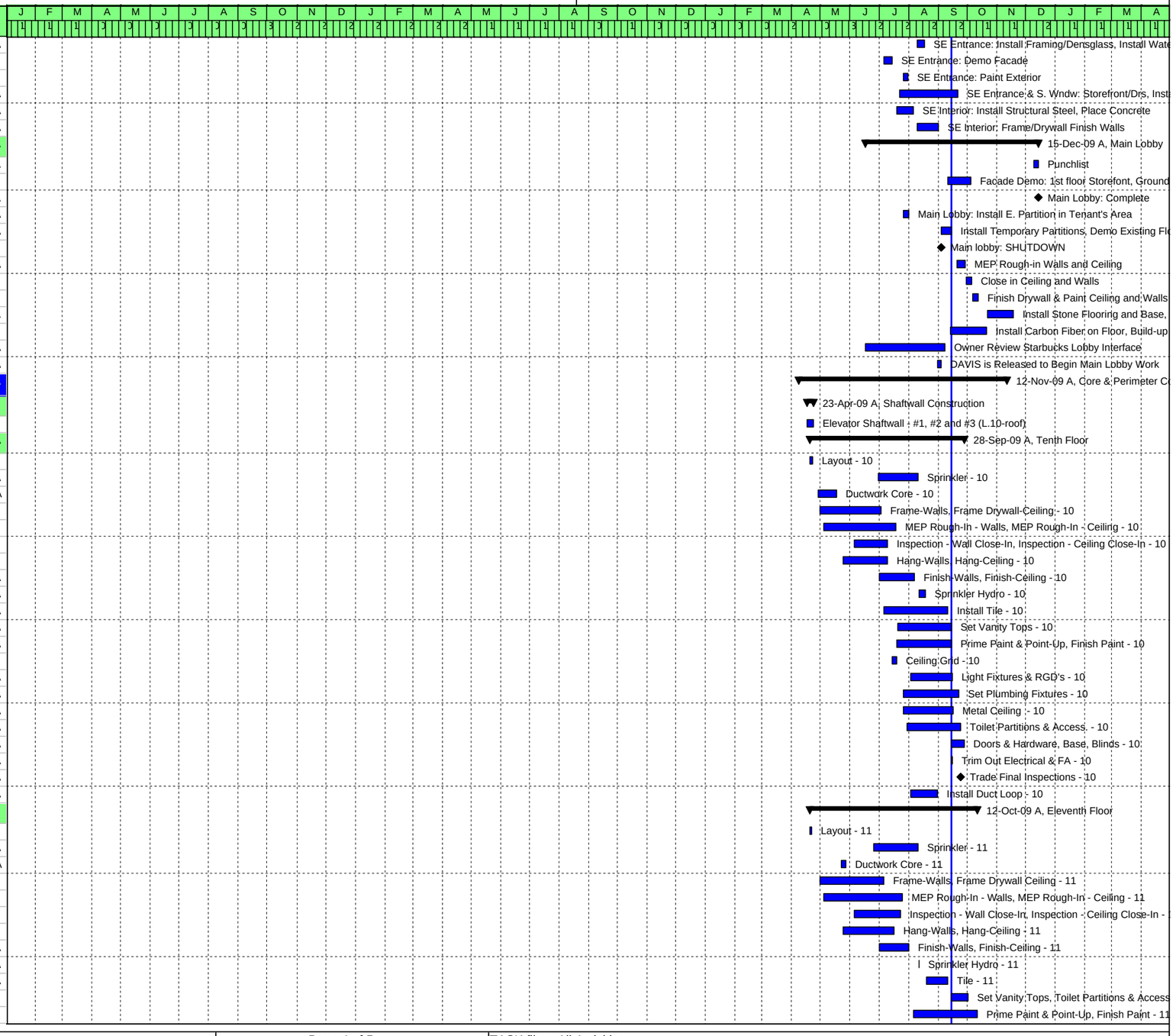
Activity ID	Activity Name	Actual Duration	Start	Finish
E2-030	Interior Demo. / Temp Protection, Walk w/ Owner & Layout Plan	4	01-Dec-08 A	05-Dec-08 A
E2-050	Repair Finishes	3	07-Jan-09 A	10-Jan-09 A
E2-060	GW Tenant Moves back in	0		05-Dec-08 A
E2-040	Carbon Fiber	2	19-Dec-08 A	23-Dec-08 A
Third Floor		30	01-Dec-08 A	10-Jan-09 A
E3-005	Walk w/ Owner & Layout Plan, Interior Demo., Repair Finishes	28	01-Dec-08 A	10-Jan-09 A
E3-030	Carbon Fiber	3	18-Dec-08 A	22-Dec-08 A
Fourth Floor		30	01-Dec-08 A	10-Jan-09 A
E4-015	Carbon Fiber	2	16-Dec-08 A	17-Dec-08 A
E4-005	Walk w/ Owner & Layout Plan, Repair Finishes, Interior Demo.	28	01-Dec-08 A	10-Jan-09 A
Fifth Floor		30	01-Dec-08 A	10-Jan-09 A
E5-030	Repair Finishes, Interior Demo.	26	03-Dec-08 A	10-Jan-09 A
E5-005	Walk w/ Owner & Layout Plan	4	01-Dec-08 A	05-Dec-08 A
Sixth Floor		30	01-Dec-08 A	10-Jan-09 A
E6-040	Carbon Fiber	3	16-Dec-08 A	18-Dec-08 A
E6-020	Interior Demo., Repair Finishes	26	03-Dec-08 A	10-Jan-09 A
E6-010	Walk w/ Owner & Layout Plan	1	01-Dec-08 A	02-Dec-08 A
Seventh Floor		30	01-Dec-08 A	10-Jan-09 A
E7-020	Steel Jacket / Fireproof	4	16-Dec-08 A	22-Dec-08 A
E7-010	Interior Demo., Repair Finishes	19	12-Dec-08 A	10-Jan-09 A
E7-005	Walk w/ Owner & Layout Plan	6	01-Dec-08 A	09-Dec-08 A
Eighth Floor		36	03-Nov-08 A	22-Dec-08 A
E8-005	Interior Demo.	29	03-Nov-08 A	16-Dec-08 A
E8-020	Steel Jacket / Fireproof	5	16-Dec-08 A	22-Dec-08 A
E8-010	GW Tenant Relocation	23	03-Nov-08 A	08-Dec-08 A
New Construction Structure		190	08-Dec-08 A	31-Aug-09 A
Structural Steel		165	03-Jan-09 A	24-Aug-09 A
S020	Steel: Seq. Lvl. 10-11	23	13-Feb-09 A	24-Mar-09 A
S105	Steel: Seq. EU Elevator Steel	9	08-Aug-09 A	24-Aug-09 A
S030	Steel: Seq. Lvl. 2-Roof	15	17-Mar-09 A	07-Apr-09 A
S060	Steel: Seq. EMR & Penthouse Steel, Penthouse Tube Steel	16	27-Mar-09 A	21-Apr-09 A
S010	Steel: Seq. Lvl. 10-11	12	02-Feb-09 A	21-Feb-09 A
S110	Steel: Tower Crane Infill	3	23-Jun-09 A	26-Jun-09 A
S001	Steel: Seq. Tower Crane Steel	0	03-Jan-09 A	03-Jan-09 A
S003	Steel: Seq. Lvl. B3-8	7	20-Jan-09 A	31-Jan-09 A
Concrete		190	08-Dec-08 A	31-Aug-09 A
C025	Concrete:Prep & Pour Lvl. 10	5	16-Mar-09 A	22-Mar-09 A
C040	Concrete: Prep & Pour Lvl. 11	10	24-Mar-09 A	04-Apr-09 A
C080	Concrete: Prep & Pour Penthouse, Curbs, Elevator Machine Room	7	07-Apr-09 A	16-Apr-09 A
C010	Concrete: Drill, Form, Pour Roof Piers , Roof Piers Tower Crane	31	08-Dec-08 A	29-Jan-09 A
C100	Concrete: TC Infill - Lvl. 10, 11 & Roof	4	13-Jul-09 A	17-Jul-09 A
C006	Concrete:Cure Roof Piers Tower Crane	2	31-Dec-08 A	02-Jan-09 A
C090	Concrete: "EU" Elevator Pit - Lvl. 7	5	24-Aug-09 A	31-Aug-09 A
Facade & Roof		272	24-Nov-08 A	09-Dec-09 A
Existing Facade		242	24-Nov-08 A	27-Oct-09 A
EF010	Facade Demo: Penthouse & Parapet	7	05-Jan-09 A	16-Jan-09 A
EF050	Canopy: K Street, Metal Panel Cladding	15	07-Oct-09 A	27-Oct-09 A
EF040	Paint Brick, Precast & Existing Windows	58	08-Jun-09 A	28-Aug-09 A
EF070	Penthouse MEP Relocation	18	24-Nov-08 A	23-Dec-08 A
EF065	Penthouse Demo SE Elev. & for Tower Crane	14	08-Dec-08 A	30-Dec-08 A
EF060	Penthouse Install Shoring for Ex. EMR	1	20-Dec-08 A	23-Dec-08 A
EF015	Facade Demo: SW Corner Lvl 2-9	76	09-Feb-09 A	05-Jun-09 A
Penthouse & Roof		120	09-Apr-09 A	23-Sep-09 A
PH030	Penthouse Framing & Sheathing, Penthouse Roof	20	23-Apr-09 A	22-May-09 A
PH100	Main Roof	4	06-Jul-09 A	10-Jul-09 A
PH005	Penthouse Roof Drains & 2-Risers from lvl 8	9	09-Apr-09 A	22-Apr-09 A



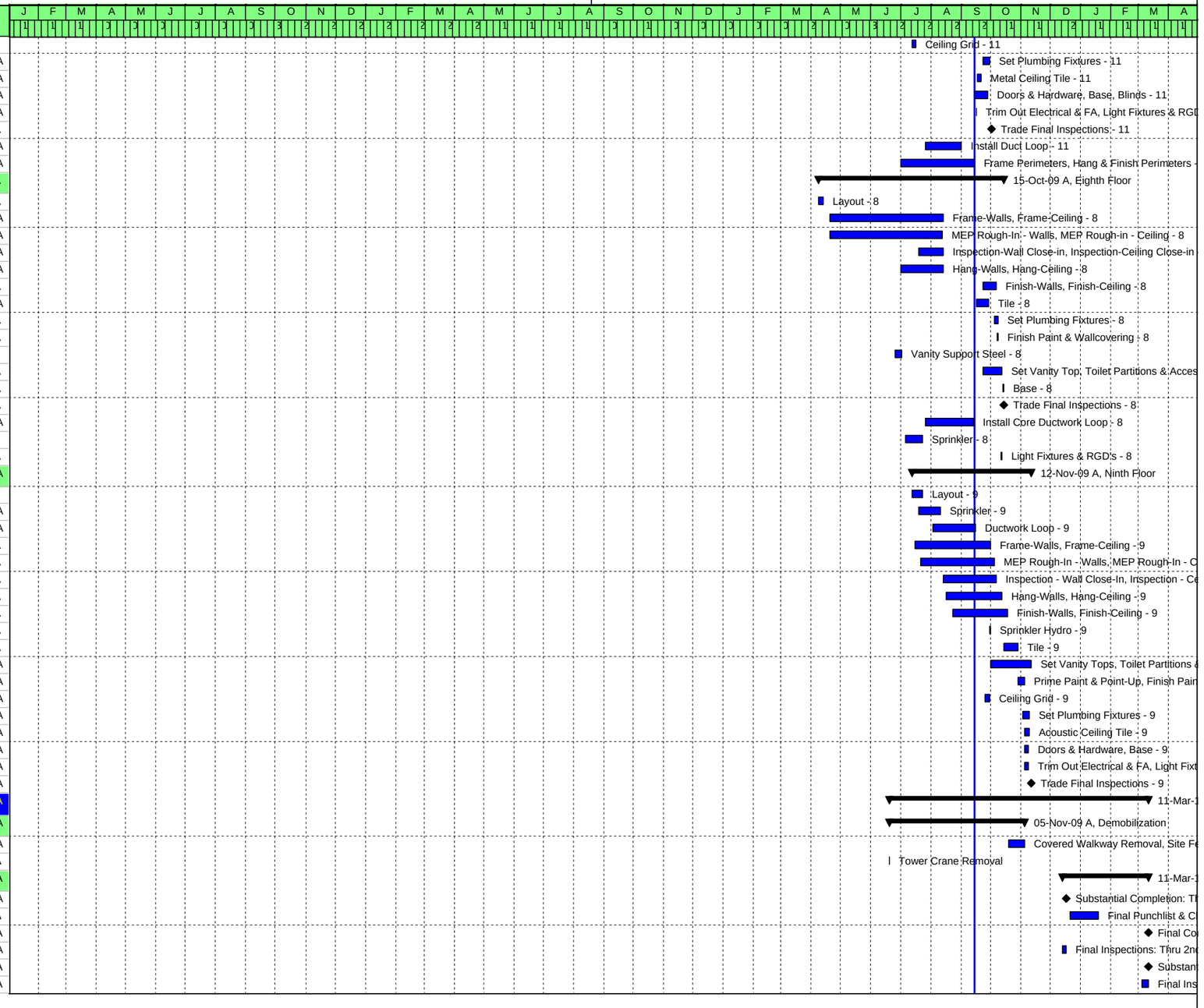
Activity ID	Activity Name	Actual Duration	Start	Finish
PH040	Penthouse Metal Panels	20	24-Aug-09 A	23-Sep-09 A
PH110	Main Roof: Temp. Dry-in, Infill Roof at TC Opening	27	18-May-09 A	25-Jun-09 A
PH140	Building Watertight	0		03-Aug-09 A
New Facade		157	04-May-09 A	09-Dec-09 A
NF050	Facade Punchlist	14	13-Nov-09 A	09-Dec-09 A
NF020	Install Curtainwall-Lvl. 9-Roof	22	04-May-09 A	05-Jun-09 A
NF030	Install Cladding & Louvers	14	01-Oct-09 A	22-Oct-09 A
NF060	Install North Elevation Facade	51	20-May-09 A	03-Aug-09 A
NF070	Infill CW at Hoist Location	4	30-Oct-09 A	05-Nov-09 A
NF110	Install East Elevation Facade	33	18-May-09 A	03-Jul-09 A
NF055	Install Scaffold North Elevation	5	05-Jun-09 A	12-Jun-09 A
NF040	Install Curtainwall - SW Corner	9	02-Jun-09 A	13-Jun-09 A
NF005	Demo Lvl. 8 Facade, Install Lvl. 8 Windows	31	01-Jul-09 A	14-Aug-09 A
NF150	Erect Supports, Field Measure & Fab., Install Vertical Louver	88	27-May-09 A	30-Sep-09 A
Penthouse		71	13-Apr-09 A	21-Jul-09 A
General		71	13-Apr-09 A	21-Jul-09 A
PH070	MEP Risers - Final Tie-In	6	26-Jun-09 A	02-Jul-09 A
PH090	Demolish Balance of PH	9	08-Jul-09 A	21-Jul-09 A
PH050	Set & Connect: Cooling Tower, Pumps, Fans	28	09-May-09 A	19-Jun-09 A
PH060	Equipment Start-Up	13	22-Jun-09 A	10-Jul-09 A
PH130	Install MEP Risers	43	13-Apr-09 A	12-Jun-09 A
Elevators		251	19-Mar-09 A	04-Mar-10 A
Elevator #1		95	23-Mar-09 A	03-Aug-09 A
EL010	Elevator Mod.: Shutdown / New Const.	93	23-Mar-09 A	03-Aug-09 A
EL025	Elevator Mod: #1 Complete	0		03-Aug-09 A
Elevator #2		79	04-Aug-09 A	20-Nov-09 A
EL030	Elevator Mod.: #2	68	04-Aug-09 A	06-Nov-09 A
EL035	Elevator Mod.: #2 Complete	0		06-Nov-09 A
EL055	Demo Existing Elevator Machine Room	10	09-Nov-09 A	20-Nov-09 A
Elevator #3		74	23-Nov-09 A	04-Mar-10 A
EL040	Elevator Mod.: #3	70	23-Nov-09 A	04-Mar-10 A
EL045	Elevator Mod.: #3 Complete	0		04-Mar-10 A
Tenant Elevator		180	19-Mar-09 A	25-Nov-09 A
EL190	Install Tenant Elevator: Lvl. 8-11	40	01-Oct-09 A	25-Nov-09 A
EL200	Tenant Elevator Complete	0		25-Nov-09 A
EL100	Elevator Submittal / Approval	57	19-Mar-09 A	09-Jun-09 A
EL130	Fab and Deliver Tenant Elevator	67	15-Jun-09 A	17-Sep-09 A
EL099	Release Tenant Elevator Equipment	0	19-Mar-09 A	
EL140	Build Elevator Shaft Lvl 8, 10 11 & Roof, Machine Room Lvl. 8	30	07-Aug-09 A	21-Sep-09 A
EL160	Rough in MEP Elevator Lobby & EMR	13	04-Sep-09 A	23-Sep-09 A
EL170	Complete Finishes EMR Lvl 8	5	24-Sep-09 A	30-Sep-09 A
EL180	Build Elevator Shaft Lvl 9	5	15-Sep-09 A	21-Sep-09 A
First Floor		129	17-Jun-09 A	15-Dec-09 A
NW Corner		67	01-Jul-09 A	02-Oct-09 A
L1-001	NW Entrance: Temp. Protection and Close Entrance	2	01-Jul-09 A	06-Jul-09 A
L1-005	NW Entrance - Demo	19	06-Jul-09 A	31-Jul-09 A
L1-015	NW Entrance - Place Concrete infill/curb/ramp, Install CMU & Patch B...	5	06-Jul-09 A	13-Jul-09 A
L1-020	NW Entrance - Paint NW Facade, Install Metal Panels, Storefront Entr...	25	21-Jul-09 A	25-Aug-09 A
L1-060	NW Entrance - Install Granite, Install SS Handrails	4	15-Sep-09 A	18-Sep-09 A
L1-199	NW Entrance - Punchlist & Turnover	4	28-Sep-09 A	02-Oct-09 A
L1-035	NW Entrance - Install Drywall & Framing, Finish Drywall & Paint, Insta...	23	30-Jul-09 A	01-Sep-09 A
L1-030	NW Entrance - Rough-in Electrical & FA	15	31-Jul-09 A	21-Aug-09 A
SE Corner		64	01-Jul-09 A	29-Sep-09 A
L1-299	SE Corner: Punchlist and Turnover	4	23-Sep-09 A	29-Sep-09 A
L1-200	SE Entrance: Temp. Protection and Close Entrance	2	01-Jul-09 A	06-Jul-09 A
L1-210	SE Entrance: Install Structural Steel, Pour Concrete slab/SOD & Curb	16	15-Jul-09 A	06-Aug-09 A



Activity ID	Activity Name	Actual Duration	Start	Finish
L1-225	SE Entrance: Install Framing/Densglass, Install Waterproofing/Air bar...	6	10-Aug-09 A	18-Aug-09 A
L1-205	SE Entrance: Demo Facade	7	06-Jul-09 A	15-Jul-09 A
L1-245	SE Entrance: Paint Exterior	4	27-Jul-09 A	31-Jul-09 A
L1-227	SE Entrance & S. Wndw: Storefront/Drs, Install brick, Install Metal Wa...	42	23-Jul-09 A	22-Sep-09 A
L1-255	SE Interior: Install Structural Steel, Place Concrete	13	20-Jul-09 A	06-Aug-09 A
L1-265	SE Interior: Frame/Drywall Finish Walls	17	10-Aug-09 A	01-Sep-09 A
Main Lobby		129	17-Jun-09 A	15-Dec-09 A
L1-595	Punchlist	3	10-Dec-09 A	15-Dec-09 A
L1-520	Facade Demo: 1st floor Storefont, Ground Floor Storefront Entrance ...	15	11-Sep-09 A	05-Oct-09 A
L1-599	Main Lobby: Complete	0		15-Dec-09 A
L1-500	Main Lobby: Install E. Partition in Tenant's Area	5	27-Jul-09 A	01-Aug-09 A
L1-505	Install Temporary Partitions, Demo Existing Floor, Walls & Ceiling	6	04-Sep-09 A	15-Sep-09 A
L1-501	Main lobby: SHUTDOWN	0	04-Sep-09 A	
L1-528	MEP Rough-in Walls and Ceiling	6	21-Sep-09 A	29-Sep-09 A
L1-530	Close in Ceiling and Walls	4	30-Sep-09 A	06-Oct-09 A
L1-535	Finish Drywall & Paint Ceiling and Walls	4	07-Oct-09 A	13-Oct-09 A
L1-545	Install Stone Flooring and Base, Install Millwork, Install Vestibule and ...	20	22-Oct-09 A	18-Nov-09 A
L1-512	Install Carbon Fiber on Floor, Build-up Flooring Insul/Plywood	28	14-Sep-09 A	21-Oct-09 A
DSC-0	Owner Review Starbucks Lobby Interface	57	17-Jun-09 A	08-Sep-09 A
DSC-0	DAVIS is Released to Begin Main Lobby Work	5	31-Aug-09 A	04-Sep-09 A
Core & Perimeter Construction		156	08-Apr-09 A	12-Nov-09 A
Shaftwall Construction		5	17-Apr-09 A	23-Apr-09 A
SF010	Elevator Shaftwall - #1, #2 and #3 (L.10-roof)	5	17-Apr-09 A	23-Apr-09 A
Tenth Floor		115	20-Apr-09 A	28-Sep-09 A
L10-010	Layout - 10	3	20-Apr-09 A	22-Apr-09 A
L10-020	Sprinkler - 10	29	30-Jun-09 A	11-Aug-09 A
L10-030	Ductwork Core - 10	13	29-Apr-09 A	18-May-09 A
L10-040	Frame-Walls, Frame Drywall-Ceiling - 10	44	01-May-09 A	03-Jul-09 A
L10-050	MEP Rough-In - Walls, MEP Rough-In - Ceiling - 10	53	04-May-09 A	19-Jul-09 A
L10-060	Inspection - Wall Close-In, Inspection - Ceiling Close-In - 10	24	05-Jun-09 A	10-Jul-09 A
L10-070	Hang-Walls, Hang-Ceiling - 10	32	25-May-09 A	10-Jul-09 A
L10-080	Finish-Walls, Finish-Ceiling - 10	26	01-Jul-09 A	07-Aug-09 A
L10-110	Sprinkler Hydro - 10	5	12-Aug-09 A	18-Aug-09 A
L10-160	Install Tile - 10	48	06-Jul-09 A	11-Sep-09 A
L10-170	Set Vanity Tops - 10	39	21-Jul-09 A	15-Sep-09 A
L10-180	Prime Paint & Point-Up, Finish Paint - 10	40	20-Jul-09 A	15-Sep-09 A
L10-100	Ceiling Grid - 10	3	15-Jul-09 A	20-Jul-09 A
L10-210	Light Fixtures & RGD's - 10	31	03-Aug-09 A	16-Sep-09 A
L10-200	Set Plumbing Fixtures - 10	41	27-Jul-09 A	23-Sep-09 A
L10-220	Metal Ceiling - 10	37	27-Jul-09 A	17-Sep-09 A
L10-250	Toilet Partitions & Access. - 10	40	30-Jul-09 A	25-Sep-09 A
L10-230	Doors & Hardware, Base, Blinds - 10	9	15-Sep-09 A	28-Sep-09 A
L10-240	Trim Out Electrical & FA - 10	1	15-Sep-09 A	15-Sep-09 A
L10-280	Trade Final Inspections - 10	0		25-Sep-09 A
L10-290	Install Duct Loop - 10	20	03-Aug-09 A	31-Aug-09 A
Eleventh Floor		125	20-Apr-09 A	12-Oct-09 A
L11-010	Layout - 11	2	20-Apr-09 A	22-Apr-09 A
L11-020	Sprinkler - 11	31	26-Jun-09 A	11-Aug-09 A
L11-030	Ductwork Core - 11	2	22-May-09 A	27-May-09 A
L11-040	Frame-Walls, Frame Drywall Ceiling - 11	44	01-May-09 A	06-Jul-09 A
L11-050	MEP Rough-In - Walls, MEP Rough-In - Ceiling - 11	58	04-May-09 A	26-Jul-09 A
L11-060	Inspection - Wall Close-In, Inspection - Ceiling Close-In - 11	34	05-Jun-09 A	24-Jul-09 A
L11-070	Hang-Walls, Hang-Ceiling - 11	37	25-May-09 A	17-Jul-09 A
L11-080	Finish-Walls, Finish-Ceiling - 11	22	01-Jul-09 A	01-Aug-09 A
L11-120	Sprinkler Hydro - 11	0	12-Aug-09 A	12-Aug-09 A
L11-160	Tile - 11	15	20-Aug-09 A	11-Sep-09 A
L11-170	Set Vanity Tops, Toilet Partitions & Accessories - 11	13	15-Sep-09 A	02-Oct-09 A
L11-180	Prime Paint & Point-Up, Finish Paint - 11	46	06-Aug-09 A	12-Oct-09 A



Activity ID	Activity Name	Actual Duration	Start	Finish
L11-105	Ceiling Grid - 11	4	13-Jul-09 A	17-Jul-09 A
L11-200	Set Plumbing Fixtures - 11	4	24-Sep-09 A	30-Sep-09 A
L11-220	Metal Ceiling Tile - 11	2	18-Sep-09 A	22-Sep-09 A
L11-230	Doors & Hardware, Base, Blinds - 11	9	15-Sep-09 A	28-Sep-09 A
L11-240	Trim Out Electrical & FA, Light Fixtures & RGD's - 11	1	16-Sep-09 A	16-Sep-09 A
L11-270	Trade Final Inspections - 11	0		02-Oct-09 A
L11-280	Install Duct Loop - 11	26	27-Jul-09 A	01-Sep-09 A
L11-095	Frame Perimeters, Hang & Finish Perimeters - 11	52	01-Jul-09 A	15-Sep-09 A
Eighth Floor		136	08-Apr-09 A	15-Oct-09 A
L8-010	Layout - 8	3	08-Apr-09 A	13-Apr-09 A
L8-050	Frame-Walls, Frame-Ceiling - 8	82	20-Apr-09 A	14-Aug-09 A
L8-020	MEP Rough-In - Walls, MEP Rough-in - Ceiling - 8	81	20-Apr-09 A	13-Aug-09 A
L8-060	Inspection-Wall Close-in, Inspection-Ceiling Close-in - 8	19	20-Jul-09 A	14-Aug-09 A
L8-080	Hang-Walls, Hang-Ceiling - 8	31	01-Jul-09 A	14-Aug-09 A
L8-090	Finish-Walls, Finish-Ceiling - 8	9	24-Sep-09 A	07-Oct-09 A
L8-150	Tile - 8	10	16-Sep-09 A	29-Sep-09 A
L8-170	Set Plumbing Fixtures - 8	4	05-Oct-09 A	09-Oct-09 A
L8-180	Finish Paint & Wallcovering - 8	1	08-Oct-09 A	09-Oct-09 A
L8-070	Vanity Support Steel - 8	4	26-Jun-09 A	02-Jul-09 A
L8-160	Set Vanity Top, Toilet Partitions & Accessories - 8	13	24-Sep-09 A	13-Oct-09 A
L8-210	Base - 8	1	14-Oct-09 A	15-Oct-09 A
L8-230	Trade Final Inspections - 8	0		15-Oct-09 A
L8-030	Install Core Ductwork Loop - 8	34	27-Jul-09 A	14-Sep-09 A
L8-040	Sprinkler - 8	14	06-Jul-09 A	24-Jul-09 A
L8-200	Light Fixtures & RGD's - 8	1	12-Oct-09 A	13-Oct-09 A
Ninth Floor		88	13-Jul-09 A	12-Nov-09 A
L9-010	Layout - 9	9	13-Jul-09 A	24-Jul-09 A
L9-020	Sprinkler - 9	16	20-Jul-09 A	11-Aug-09 A
L9-030	Ductwork Loop - 9	31	03-Aug-09 A	15-Sep-09 A
L9-040	Frame-Walls, Frame-Ceiling - 9	54	16-Jul-09 A	01-Oct-09 A
L9-050	MEP Rough-In - Walls, MEP Rough-In - Ceiling - 9	52	22-Jul-09 A	05-Oct-09 A
L9-060	Inspection - Wall Close-In, Inspection - Ceiling Close-In - 9	37	14-Aug-09 A	07-Oct-09 A
L9-070	Hang-Walls, Hang-Ceiling - 9	40	17-Aug-09 A	13-Oct-09 A
L9-080	Finish-Walls, Finish-Ceiling - 9	39	24-Aug-09 A	19-Oct-09 A
L9-110	Sprinkler Hydro - 9	1	30-Sep-09 A	01-Oct-09 A
L9-160	Tile - 9	10	15-Oct-09 A	29-Oct-09 A
L9-170	Set Vanity Tops, Toilet Partitions & Accessories - 9	29	01-Oct-09 A	12-Nov-09 A
L9-180	Prime Paint & Point-Up, Finish Paint & Wallcovering - 9	5	29-Oct-09 A	05-Nov-09 A
L9-100	Ceiling Grid - 9	3	25-Sep-09 A	30-Sep-09 A
L9-200	Set Plumbing Fixtures - 9	5	03-Nov-09 A	10-Nov-09 A
L9-220	Acoustic Ceiling Tile - 9	3	05-Nov-09 A	10-Nov-09 A
L9-230	Doors & Hardware, Base - 9	2	05-Nov-09 A	09-Nov-09 A
L9-240	Trim Out Electrical & FA, Light Fixtures & RGD's - 9	2	05-Nov-09 A	09-Nov-09 A
L9-280	Trade Final Inspections - 9	0		12-Nov-09 A
Project Completion		189	20-Jun-09 A	11-Mar-10 A
Demobilization		98	20-Jun-09 A	05-Nov-09 A
PC020	Covered Walkway Removal, Site Fence Removal, Personnel/Material...	12	20-Oct-09 A	05-Nov-09 A
PC010	Tower Crane Removal	0	20-Jun-09 A	20-Jun-09 A
Closeout		64	14-Dec-09 A	11-Mar-10 A
PC060	Substantial Completion: Thru 2nd Elev. Mod.	0		18-Dec-09 A
PC070	Final Punchlist & Close-out Documents	19	21-Dec-09 A	19-Jan-10 A
PC100	Final Completion	0		11-Mar-10 A
PC090	Final Inspections: Thru 2nd Elev. Mod.	4	14-Dec-09 A	18-Dec-09 A
PC095	Substantial Completion: Through Final Elev. Mod.	0		11-Mar-10 A
PC085	Final Inspections: Thru Final Elev. Mod. (Letter of Core & Shell Compl...	5	05-Mar-10 A	11-Mar-10 A



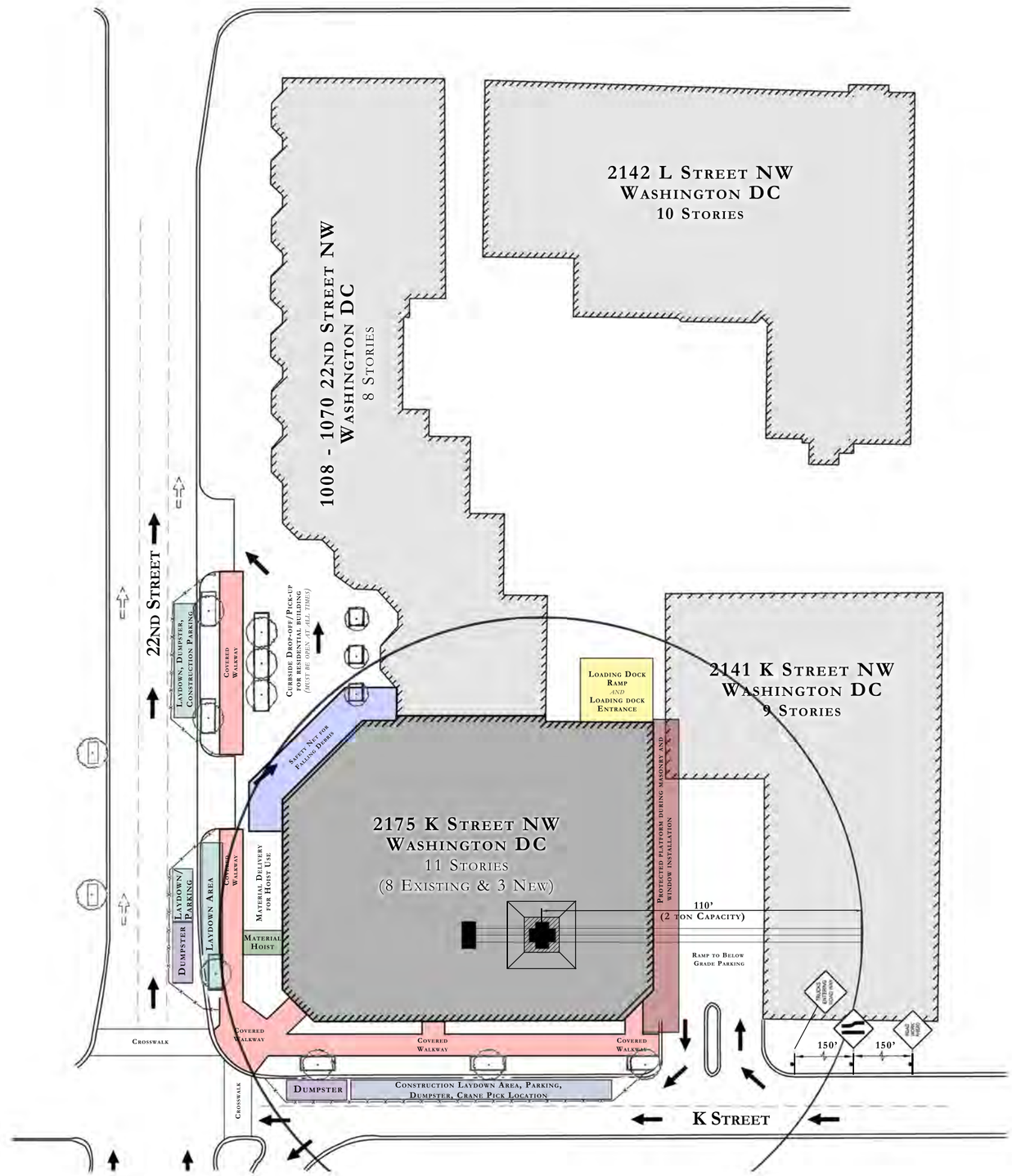
Appendix C – Site Layout Plan

Sheet Notes:

1. All existing utilities are to remain
2. Project contains no new utilities
3. Construction activities are to use existing service
4. Telecommunication was not shown on utilities plan
5. No temporary lighting
6. All temporary facilities are located on level 8 unless otherwise noted
7. DAVIS office is to be located on level 8 until demolition is scheduled to begin, at which time the office is to relocate to the B1 level
8. All subcontractor offices are to be located on level 8 until demolition is scheduled to begin, at which time the offices are to relocate to the B1 level to a location designated by DAVIS
9. Tool trailers are to remain on level 8 until new levels are completed
10. Existing transformer is to remain
11. Temporary Toilets will be located one on each floor (Levels 8, 9, 10, 11, and roof)
12. Roof of covered walkways will be utilized for staging and material storage
13. Loading dock entrance from north side of 2141 K Street and down east side of building to K Street

Drawing Key

- Site Fence
- Normal Traffic
- Restricted Traffic (4:00 PM - 9:00 AM)



Site Utilization Plan (All Phases of Construction)

Scale: NTS

Drawing By:
Timothy Conroy

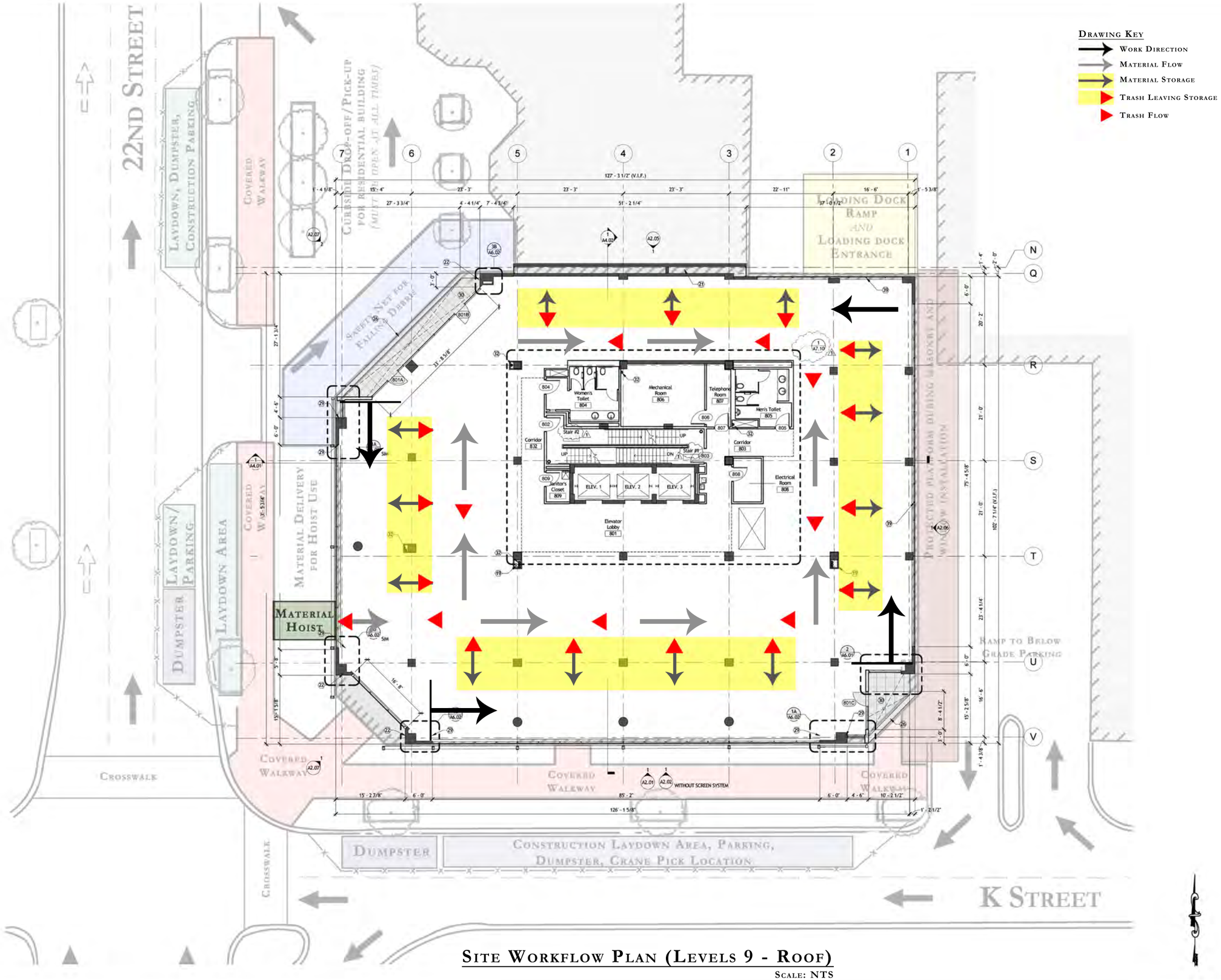
Date:
21 October 2009

Project:
2175 K Street, NW
Washington, DC 20037

Drawn By: Timothy Conroy
Date: 1 October 2009
Drawing Title:
Site Utilization Plan

G-01

Appendix D – Site Workflow Plan



Drawing Key

- Work Direction
- Material Flow
- Material Storage
- Trash Leaving Storage
- Trash Flow

Site Workflow Plan (Levels 9 - Roof)

Scale: NTS

Drawing By:
Timothy Conroy

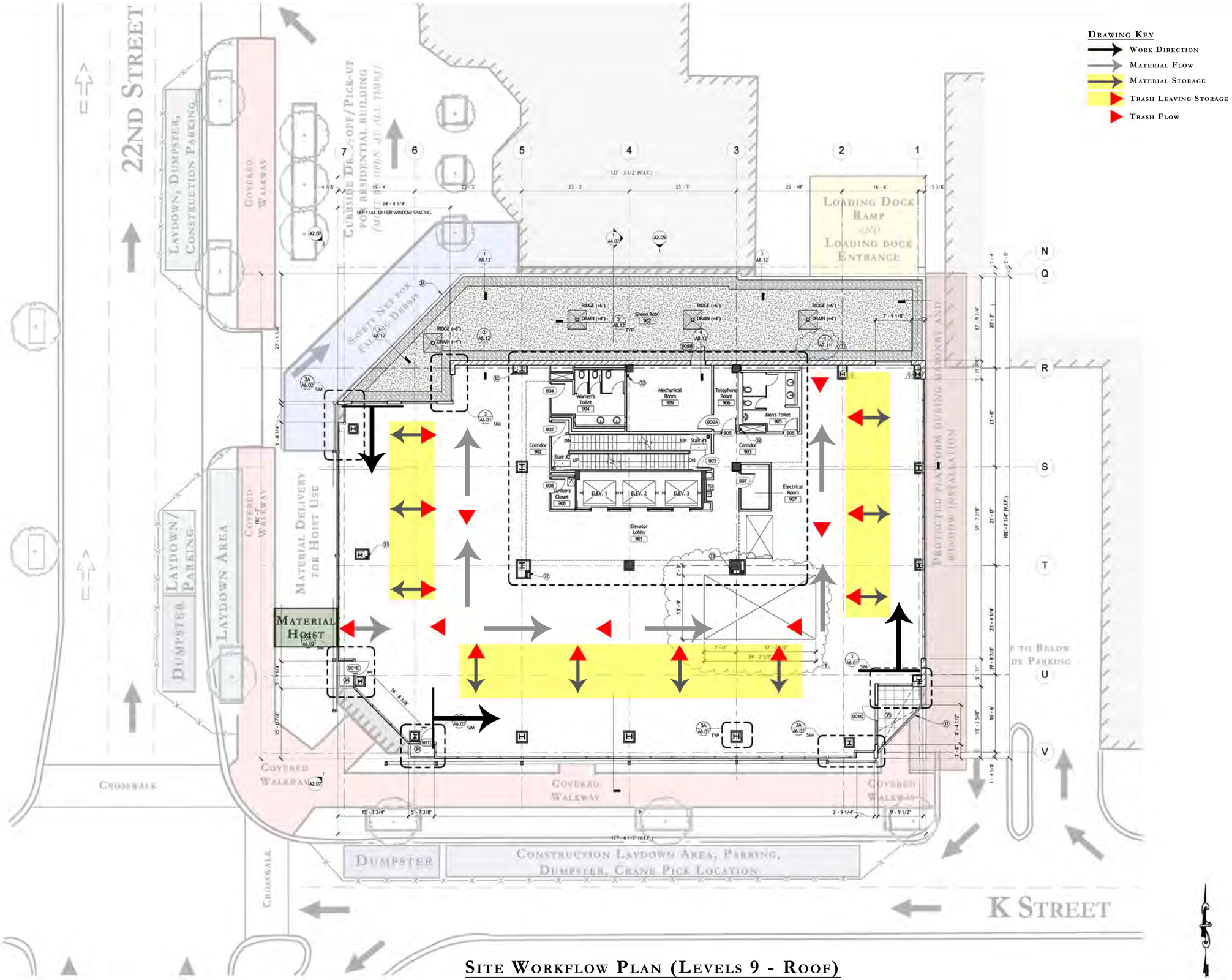
Date:
21 October 2009

Project:
2175 K Street, NW
Washington, DC 20037

Drawn By: Timothy Conroy
Date: 1 October 2009

Drawing Title:
Site Workflow Plan

G-02



Site Workflow Plan (Levels 9 - Roof)

Scale: NTS

Drawing By:
Timothy Conroy

Date:
21 October 2009

Project:
2175 K Street, NW
Washington, DC 20037

Drawn By: Timothy Conroy
Date: 1 October 2009

Drawing Title:
Site Workflow Plan

G-03

Appendix E – General Conditions Estimate

			Material		Labor		Total Material Cost	Total Labor Cost
Category/Activity	Quantity	Unit	Rate	Cost	Rate	Cost		
Rentals (DAVIS)								
Pickup truck (sup't)	65	Wks	$ 325	$ 21,125	$ -	$ -		
Courier vehicle	178	Hrs	$ 26	$ 4,628	$ -	$ -		
Dump truck	178	Hrs	$ 28	$ 4,984	$ -	$ -		
Field office trailer	16	Mos	$ 425	$ 6,800	$ -	$ -		
Storage/change house trailer	16	Mos	$ 200	$ 3,200	$ -	$ -		
Industrial vacuum	2	Ls	$ 400	$ 800	$ -	$ -		
Surveying instruments	2	Mos	$ 162	$ 374	$ -	$ -		
Two way radios	7	Mos	$ 445	$ 3,115	$ -	$ -		
Gang box	16	Mos	$ 150	$ 2,400	$ -	$ -		
Vehicle (Sr. PM)	89	Wks	$ 163	$ 14,463	$ -	$ -		
Vehicle (Proj. Manager)	89	Wks	$ 325	$ 28,925	$ -	$ -		
Pickup truck (Layout Engineer)	10	Wks	$ 81	$ 813	$ -	$ -		
Vehicle Allowance	1	Ls	$ 2,500	$ 2,500	$ -	$ -		
Cell Phone	14,854	Hrs	$ 2	$ 34,164	$ -	$ -		
Computer/Supporting Systems	16	Mos	$ 2,000	$ 32,000	$ -	$ -		
Copier/Fax	16	Mos	$ 469	$ 7,504	$ -	$ -		
Subtotal			$	167,794	$	-		
Sales tax	5.75	%	$	9,648	$	-		
			$	177,442	$	-	**$ 177,442**	**$ -**
Temporary Facilities								
Field telephone								
Equipment Hookup	1	Ls	$ 1,000	$ 1,000	$ -	$ -		
Calling Plan	16	Mos	$ 450	$ 7,200	$ -	$ -		
Temporary protection	JOB COST		$ -	JOB COST	$ -	$ -		
Parking Meter Rental	JOB COST		$ 60	JOB COST	$ -	$ -		
Field Office Set-up	1	Ls	$ 8,000	$ 8,000	$ -	$ -		
Field office expense	65	Wks	$ 125	$ 8,125	$ -	$ -		
Subtotal			$	24,325	$	-		
Sales tax	5.75	%	$	1,399	$	-		
			$	25,724	$	-	**$ 25,724**	**$ -**
Safety								
Health and Environment Controls	16	Mos	$ 528.75	$ 8,460	$ -	$ -		
Protection and Life Safety Equip.	10	Ctns	$ 618.64	$ 6,186	$ -	$ -		
Fire Protection and Prevention	20	Ea	$ 60.81	$ 1,216	$ -	$ -		
Sign, Signals and Barricades	JOB COST		$ -	$ -	$ -	$ -		
Material Storage and Disposal	65	Wks	$ -	$ -	$ 261.19	$ 16,978		
Temporary Heat	JOB COST		$ -	$ -	$ -	$ -		
Personal Protection - Site	JOB COST		$ -	$ -	$ -	$ -		
Personal Protection - Building	2,400	Lf	$ 3.29	$ 7,900	$ 3.04	$ 7,300		
Scaffolding	JOB COST		$ -	$ -	$ -	$ -		
Excavation and Trenching	N/A		$ -	$ -	$ -	$ -		
Subtotal			$	23,762	$	24,278		
Sales tax	5.75	%	$	1,366	$	1,396		
			$	25,128	$	24,278	**$ 25,128**	**$ 24,278**
Punch List / Warrantee	100	Hrs	$ 10	$ 1,000	$ 25	$ 2,457	**$ 1,000**	**$ 2,457**
Page Two Subtotal							**$ 229,294**	**$ 26,735**

Category/Activity	Quantity	Unit	Material Rate	Material Cost	Labor Rate	Labor Cost	Total Material Cost	Total Labor Cost
Rentals (DAVIS)								
Pickup truck (sup't)	65	Wks	$ 325	$ 21,125	$ -	$ -		
Courier vehicle	178	Hrs	$ 26	$ 4,628	$ -	$ -		
Dump truck	178	Hrs	$ 28	$ 4,984	$ -	$ -		
Field office trailer	16	Mos	$ 425	$ 6,800	$ -	$ -		
Storage/change house trailer	16	Mos	$ 200	$ 3,200	$ -	$ -		
Industrial vacuum	2	Ls	$ 400	$ 800	$ -	$ -		
Surveying instruments	2	Mos	$ 162	$ 374	$ -	$ -		
Two way radios	7	Mos	$ 445	$ 3,115	$ -	$ -		
Gang box	16	Mos	$ 150	$ 2,400	$ -	$ -		
Vehicle (Sr. PM)	89	Wks	$ 163	$ 14,463	$ -	$ -		
Vehicle (Proj. Manager)	89	Wks	$ 325	$ 28,925	$ -	$ -		
Pickup truck (Layout Engineer)	10	Wks	$ 81	$ 813	$ -	$ -		
Vehicle Allowance	1	Ls	$ 2,500	$ 2,500	$ -	$ -		
Cell Phone	14,854	Hrs	$ 2	$ 34,164	$ -	$ -		
Computer/Supporting Systems	16	Mos	$ 2,000	$ 32,000	$ -	$ -		
Copier/Fax	16	Mos	$ 469	$ 7,504	$ -	$ -		
Subtotal			$	167,794	$	-		
Sales tax	5.75	%	$	9,648	$	-		
			$	177,442	$	-	**$ 177,442**	**$ -**
Temporary Facilities								
Field telephone								
Equipment Hookup	1	Ls	$ 1,000	$ 1,000	$ -	$ -		
Calling Plan	16	Mos	$ 450	$ 7,200	$ -	$ -		
Temporary protection	JOB COST		$ -	JOB COST	$ -	$ -		
Parking Meter Rental	JOB COST		$ 60	JOB COST	$ -	$ -		
Field Office Set-up	1	Ls	$ 8,000	$ 8,000	$ -	$ -		
Field office expense	65	Wks	$ 125	$ 8,125	$ -	$ -		
Subtotal			$	24,325	$	-		
Sales tax	5.75	%	$	1,399	$	-		
			$	25,724	$	-	**$ 25,724**	**$ -**
Safety								
Health and Environment Controls	16	Mos	$ 528.75	$ 8,460	$ -	$ -		
Protection and Life Safety Equip.	10	Ctns	$ 618.64	$ 6,186	$ -	$ -		
Fire Protection and Prevention	20	Ea	$ 60.81	$ 1,216	$ -	$ -		
Sign, Signals and Barricades	JOB COST		$ -	$ -	$ -	$ -		
Material Storage and Disposal	65	Wks	$ -	$ -	$ 261.19	$ 16,978		
Temporary Heat	JOB COST		$ -	$ -	$ -	$ -		
Personal Protection - Site	JOB COST		$ -	$ -	$ -	$ -		
Personal Protection - Building	2,400	Lf	$ 3.29	$ 7,900	$ 3.04	$ 7,300		
Scaffolding	JOB COST		$ -	$ -	$ -	$ -		
Excavation and Trenching	N/A		$ -	$ -	$ -	$ -		
Subtotal			$	23,762	$	24,278		
Sales tax	5.75	%	$	1,366	$	1,396		
			$	25,128	$	24,278	**$ 25,128**	**$ 24,278**
Punch List / Warrantee	100	Hrs	$ 10	$ 1,000	$ 25	$ 2,457	**$ 1,000**	**$ 2,457**
Page Two Subtotal							**$ 229,294**	**$ 26,735**

2175 K STREET, NW

Contractor General Conditions

(Estimate Summary)

CATEGORY/ACTIVITY	QUANTITY	UNIT	MATERIAL RATE	MATERIAL COST	LABOR RATE	LABOR COST	TOTAL MATERIAL COST	TOTAL LABOR COST
Page One Subtotal (Permit, Management Team, General Conditions, Misc. Labor, Courier, Dump Truck)							$ 8,582	$ 766,321
Page Two Subtotal (DAVIS Rentals, Temporary Facilities, Punch List / Warrantee)							$ 229,294	$ 26,735
SUBTOTAL							$ 237,876	$ 793,056
Insurances & employee benefits	55	%					$ -	$ 436,181
Total general conditions							$ 237,876	$ 1,229,236
GENERAL CONDITIONS GRAND TOTAL							$	1,467,112

2175 K STREET, NW

Contractor General Conditions

(Price Comparison - Percentage)

CATEGORY/ACTIVITY	TOTAL MATERIAL COST	PERCENT OF SUBTOTAL	PERCENT OF TOTAL	TOTAL LABOR COST	PERCENT OF SUBTOTAL	PERCENT OF TOTAL
Permit	$ -	-	-	$ -	-	-
Supervision & Project Management	$ -	-	-	$ 712,625.72	**89.86%**	**57.97%**
General Conditions	$ 8,581.61	3.61%	3.61%	$ -	-	-
Miscellaneous Labor	$ -	-	-	$ 43,206.00	5.45%	3.51%
Courier	$ -	-	-	$ 6,992.92	0.88%	0.57%
Dump Truck - Driver	$ -	-	-	$ 3,496.46	0.44%	0.28%
Rentals (DAVIS)	$ 177,441.96	**74.59%**	**74.59%**	$ -	-	-
Temporary Facilities	$ 25,723.69	10.81%	10.81%	$ -	-	-
Safety	$ 25,128.34	10.56%	10.56%	$ 24,277.50	3.06%	1.98%
Punch List / Warrantee	$ 1,000.00	0.42%	0.42%	$ 2,457.00	0.31%	0.20%
SUBTOTAL	$ 237,875.60		16.21%	$ 793,055.60		54.06%
TOTALS	$ 237,875.60		16.21%	$ 1,229,236.18		83.79%
GENERAL CONDITIONS GRAND TOTAL	**$1,467,112**					

2175 K STREET, NW

Contractor General Conditions

(Price Comparison - Cost per Week)

CATEGORY/ACTIVITY	QUANTITY	TOTAL MATERIAL COST	COST PER WEEK	TOTAL LABOR COST	COST PER WEEK
Permit	0	$ -	-	$ -	-
Supervision & Project Management	89	$ -	-	$ 712,625.72	**$ 8,007**
General Conditions	89	$ 8,581.61	$ 96	$ -	-
Miscellaneous Labor	69	$ -	-	$ 43,206.00	$ 626
Courier	56	$ -	-	$ 6,992.92	$ 125
Dump Truck - Driver	3	$ -	-	$ 3,496.46	$ 1,249
Rentals (DAVIS)	89	$ 177,441.96	**$ 1,994**	$ -	-
Temporary Facilities	69	$ 25,723.69	$ 371	$ -	-
Safety	69	$ 25,128.34	$ 362	$ 24,277.50	$ 350
Punch List / Warrantee	3	$ 1,000.00	$ 400	$ 2,457.00	$ 983
SUBTOTAL	89	$ 237,875.60	$ 2,673	$ 793,055.60	$ 8,911
TOTALS	89	$ 237,875.60	$ 2,673	$ 1,229,236.18	$ 13,812
GENERAL CONDITIONS GRAND TOTAL		**$1,467,112**			***$16,484***

Appendix F – Acoustic Analysis (Backup Generator Analysis)

Thesis

Timothy Conroy | Analysis I - Acoustic Calcs. | Date: 3/1/2010 Revised

Existing Conditions (Location: Parking Level 3)

Wall Construction: 7-5/8" Masonry (CMU)

Concrete Wall up to 4'-0" above slab

Door: 2" Thick Hollow Metal (6'-0" x 4'-0")

Room Dimensions: 18'-0" by 14'-6" (sheet A1.02)

Length of Walls:

Interior = 18 + 14.5 = 32'-6"

Exterior = 32'-6"

Height:

Parking Level 3: 29'-6½" TOS

Parking Level 2: 38'-6½" TOS

Slab Thickness: 8" Concrete

Total Height = (38'-6½") - (29'-6½") - (0'-8")

= 8'-4"

Concrete Wall = ~~8'-9"~~ 4'-0"

CMU Wall = (8'-4") - (4'-0") = 4'-4"

Areas

Concrete Wall = 4'-0" (32'-6") - (~~6'-0"~~ 6'-0" x 4'-0") = ~~106 ft²~~ 106 ft²

CMU Wall = ~~4'-8"~~ 4'-4" (32'-6") - (~~2'-0"~~ 6'-0" x 4'-0") = ~~132.83 ft²~~ 116.82 ft²

Door = 6'-0" x 8'-0" = 48 ft²

Transmission Losses (Architectural Acoustics M. David Egan pp. 204-205)

	125	250	500	1000	2000	4000	STC
Concrete	38	43	52	59	67	72	53
CMU	34	40	44	49	59	64	49
Door	23	28	36	41	39	44	38

½

Analysis I - Acoustic Calcs. Timothy Conroy

Sample Calculation (@ 125 Hz)

$TL = 10 \log \frac{1}{\tau}$

Concrete: $38 = 10 \log \frac{1}{\tau}$, $\tau = 1.58 \times 10^{-4}$

CMU: $34 = 10 \log \frac{1}{\tau}$, $\tau = 3.98 \times 10^{-4}$

Door: $24 = 10 \log \frac{1}{\tau}$, $\tau = 5.01 \times 10^{-3}$

Composite $TL = 10 \log (\Sigma S / \Sigma \tau S)$

$$= 10 \log \left[\frac{(106 + 116.83 + 48)}{(106 \times 1.58 \times 10^{-4}) + (116.83 \times 3.98 \times 10^{-4}) + (48 \times 5.01 \times 10^{-3})} \right]$$

$= 29.5$ dB

Generator Sound Levels

Hz	125	250	500	1000	2000	4000
dB	~~(105.8)~~ 100.3 (Gr.)	(104.8)	(109.9)	(113.7)	(111.7)	(108.7)

Resulting Sound Level = Generator Base Level − Composite TL

$= 100.3 - 29.5$

$= 70.8$ dB*

Note: Please see following spreadsheet for values at remaining frequencies

Speech Range (50 - 70 dB)

- 50 dB - Office Activities
- 60 dB - Near Highway Traffic
- 70 dB - B-757 aircraft cabin during flight
  - Crackling of Plastic food wrapper (2 ft away)

Ultimate Goal (50 dB Office Activities)

- Please refer to following spreadsheet to see results of sound transmission reduction
- A similar procedure was followed on this section as was previously shown

2/2

General Information		
Wall Dimensions (ft.)	18.00 by 14.50	
Door Dimensions (ft.)	6.00 by 8.00	
Wall Type (height - ft.)		
Concrete	4.00	
CMU	4.33	
Resulting Area (sq. ft.)		
Concrete	106.00	39%
CMU	116.83	43%
Door	48.00	18%
Total	**270.83**	

Base Case

Transmission Loss						
	Frequency (Hz.)					
Material	**125**	**250**	**500**	**1000**	**2000**	**4000**
Concrete	38	43	52	59	67	72
CMU	34	40	44	49	59	64
Door	23	28	36	41	39	44

Sound Transmission						
Material	**Tau**					
Concrete	1.58E-04	5.01E-05	6.31E-06	1.26E-06	2.00E-07	6.31E-08
CMU	3.98E-04	1.00E-04	3.98E-05	1.26E-05	1.26E-06	3.98E-07
Door	5.01E-03	1.58E-03	2.51E-04	7.94E-05	1.26E-04	3.98E-05

Composite TL	29.5	34.6	41.9	47.0	46.4	51.4

Generator	100.3	104.8	109.9	113.1	111.7	109.7

Resulting Sound Level	70.8	70.2	68.0	66.1	65.3	58.3

Proposed Solution

Goal Transmission Loss						
	Frequency (Hz.)					
Location Type	125	250	500	1000	2000	4000
Office Activities	50	50	50	50	50	50
Classroom	66	72	77	74	68	60
Normal Conversation	57	62	63	57	48	40

Transmission Loss						
	Frequency (Hz.)					
Material	125	250	500	1000	2000	4000
Concrete	38	43	52	59	67	72
CMU	34	40	44	49	59	64
Door	23	28	36	41	39	44
Construction No. 7	17	31	33	40	38	36
Construction No. 8	15	30	34	44	46	41
Construction No. 9	23	28	29	46	54	44

Sound Transmission						
Material	Tau					
Concrete	1.58E-04	5.01E-05	6.31E-06	1.26E-06	2.00E-07	6.31E-08
CMU	3.98E-04	1.00E-04	3.98E-05	1.26E-05	1.26E-06	3.98E-07
Door	5.01E-03	1.58E-03	2.51E-04	7.94E-05	1.26E-04	3.98E-05
Construction No. 7	2.00E-02	7.94E-04	5.01E-04	1.00E-04	1.58E-04	2.51E-04
Construction No. 8	3.16E-02	1.00E-03	3.98E-04	3.98E-05	2.51E-05	7.94E-05
Construction No. 9	5.01E-03	1.58E-03	1.26E-03	2.51E-05	3.98E-06	3.98E-05

Composite TL						
Construction No. 7	46.5	65.6	74.9	87.0	84.4	87.4
Construction No. 8	44.5	64.6	75.9	91.0	92.4	92.4
Construction No. 9	52.5	62.6	70.9	93.0	100.4	95.4

Sound Level						
	Frequency (Hz.)					
	125	250	500	1000	2000	4000
Generator	100.3	104.8	109.9	113.1	111.7	109.7

Resulting Sound Level						
Construction No. 7	53.8	39.2	35.0	26.1	27.3	22.3
Construction No. 8	55.8	40.2	34.0	22.1	19.3	17.3
Construction No. 9	47.8	42.2	39.0	20.1	11.3	14.3

Summary							
	Frequency (Hz.)						Per Activity
	125	250	500	1000	2000	4000	
Construction No. 7							
Office Activities	✗	✓	✓	✓	✓	✓	✗
Classroom	✓	✓	✓	✓	✓	✓	✓
Normal Conversation	✓	✓	✓	✓	✓	✓	✓
Construction No. 8							
Office Activities	✗	✓	✓	✓	✓	✓	✗
Classroom	✓	✓	✓	✓	✓	✓	✓
Normal Conversation	✓	✓	✓	✓	✓	✓	✓
Construction No. 9							
Office Activities	✓	✓	✓	✓	✓	✓	✓
Classroom	✓	✓	✓	✓	✓	✓	✓
Normal Conversation	✓	✓	✓	✓	✓	✓	✓

Construction Description	
Construction No. 7	2 by 4 wood studs 16 in oc with 1/2-in gypsum board both sides
Construction No. 8	Construction No. 7 with 2-in glass-fiber insulation in cavity
Construction No. 9	2 by 4 staggered wood studs 16 in oc with 5/8-in gypsum board both sides

Appendix G –Energy Calculations Base (Backup Generator Analysis)

Cummins 300 kW Diesel Generator

Energy Calculations

Hours of Operation	
Daily	8 hours*
Weekly	40 hours*
Monthly	160 hours*
Yearly	2080 hours*
Electricity Rate	
	$0.1543 per kWh
Generator Output	
	300 kW
Cost of Diesel Fuel	
	$2.986

Fuel Usage

	Load			
	1/4	1/2	3/4	Full
	Gallons per Hour			
	6.67	11.57	17.12	23.15
Savings Subtotal				
Daily	$92.58	$185.16	$277.74	$370.32
Weekly	$462.90	$925.80	$1,388.70	$1,851.60
Monthly	$1,851.60	$3,703.20	$5,554.80	$7,406.40
Yearly	$24,070.80	$48,141.60	$72,212.40	$96,283.20
Fuel Consumption				
	Gallons			
Daily	53.36	92.56	136.96	185.20
Weekly	266.80	462.80	684.80	926.00
Monthly	1,067.20	1,851.20	2,739.20	3,704.00
Yearly	13,873.60	24,065.60	35,609.60	48,152.00
Fuel Costs				
Daily	$159.33	$276.38	$408.96	$553.01
Weekly	$796.66	$1,381.92	$2,044.81	$2,765.04
Monthly	$3,186.66	$5,527.68	$8,179.25	$11,060.14
Yearly	$41,426.57	$71,859.88	$106,330.27	$143,781.87

Net Savings				
Daily	($66.75)	($91.22)	($131.22)	($182.69)
Weekly	($333.76)	($456.12)	($656.11)	($913.44)
Monthly	($1,335.06)	($1,824.48)	($2,624.45)	($3,653.74)
Yearly	($17,355.77)	($23,718.28)	($34,117.87)	($47,498.67)

**Current fuel tank is rated for 4 hours of continuous operation.*

Break Even Scenarios

	Load			
	1/4	1/2	3/4	Full
	Gallons per Hour[a]			
Max. Fuel Consumption	*3.88*	*7.75*	*11.63*	*15.50*
	Cost per Gallon[b]			
Max. Fuel Cost	*$1.735*	*$2.000*	*$2.028*	*$2.000*
	Kilowatts[c]			
Min. Generator Capacity	*516*	*448*	*442*	*448*
	Cost per kWhr[d]			
Min. Electricity Rate	*$0.2656*	*$0.2303*	*$0.2272*	*$0.2304*

[a] *This is the max gallons per hour to make this analysis break even.*

[b] *This is the max fuel cost to make this analysis break even.*

[c] *This is the min generator output to make this analysis break even.*

[d] *This is the min electricity rate to make this analysis break even.*

Appendix H – Energy Calculations Proposed (Backup Generator Analysis)

CAT 350kW Natural Gas Generator

Energy Calculations

Hours of Operation	
Daily	8 hours
Weekly	40 hours
Monthly	160 hours
Yearly	2080 hours
Electricity Rate	
	$0.1543 per kWh
Generator Output	
	350 kW
Cost of Natural Gas	
	$12.080

Fuel Usage

	Load			
	1/4	1/2	3/4	Full
	Cubic Feet per Hour			
	1655	2701	3575	4472
Savings Subtotal				
Daily	$108.01	$216.02	$324.03	$432.04
Weekly	$540.05	$1,080.10	$1,620.15	$2,160.20
Monthly	$2,160.20	$4,320.40	$6,480.60	$8,640.80
Yearly	$28,082.60	$56,165.20	$84,247.80	$112,330.40
Fuel Consumption				
	Thousand Cubic Feet			
Daily	13.24	21.61	28.60	35.78
Weekly	66.19	108.04	143.00	178.88
Monthly	264.74	432.16	572.00	715.52
Yearly	3,441.65	5,618.08	7,436.00	9,301.76
Fuel Costs				
Daily	$159.90	$261.02	$345.49	$432.17
Weekly	$799.52	$1,305.12	$1,727.44	$2,160.87
Monthly	$3,198.09	$5,220.49	$6,909.76	$8,643.48
Yearly	$41,575.15	$67,866.41	$89,826.88	$112,365.26

Net Savings				
Daily	($51.89)	($45.00)	($21.46)	($0.13)
Weekly	($259.47)	($225.02)	($107.29)	($0.67)
Monthly	($1,037.89)	($900.09)	($429.16)	($2.68)
Yearly	($13,492.55)	($11,701.21)	($5,579.08)	($34.86)

**Based Upon Cat Natural Gas Generator Model G3412 350kW*

Break Even Scenarios

	Load			
	1/4	1/2	3/4	Full
	Cubic Feet per Hour[a]			
Max. Fuel Consumption	*1117.65*	*2235.31*	*3352.96*	*4470.61*
	Cost per Thousand Cubic Feet[b]			
Max. Fuel Cost	*$8.160*	*$9.997*	*$11.330*	*$12.076*
	Kilowatts[c]			
Min. Generator Capacity	*518*	*423*	*373*	*350.11*
	Cost per kWhr[d]			
Min. Electricity Rate	*$0.2284*	*$0.1864*	*$0.1645*	*$0.15435*

[a] *This is the max gallons per hour to make this analysis break even.*

[b] *This is the max fuel cost to make this analysis break even.*

[c] *This is the min generator output to make this analysis break even.*

[d] *This is the min electricity rate to make this analysis break even.*

Appendix I – Energy Calculations Proposed (Backup Generator Analysis)

CAT 450kW Natural Gas Generator

Energy Calculations

Hours of Operation	
Daily	8 hours
Weekly	40 hours
Monthly	160 hours
Yearly	2080 hours
Electricity Rate	
	$0.1543 per kWh
Generator Output	
	450 kW
Cost of Natural Gas	
	$12.080

Fuel Usage

	Load			
	1/4	1/2	3/4	Full
	Cubic Feet per Hour			
	2038	3200	4360	5507
Savings Subtotal				
Daily	$138.87	$277.74	$416.61	$555.48
Weekly	$694.35	$1,388.70	$2,083.05	$2,777.40
Monthly	$2,777.40	$5,554.80	$8,332.20	$11,109.60
Yearly	$36,106.20	$72,212.40	$108,318.60	$144,424.80
Fuel Consumption				
	Thousand Cubic Feet			
Daily	16.30	25.60	34.88	44.06
Weekly	81.50	128.00	174.40	220.28
Monthly	326.01	512.00	697.60	881.12
Yearly	4,238.19	6,656.00	9,068.80	11,454.56
Fuel Costs				
Daily	$196.91	$309.25	$421.35	$532.20
Weekly	$984.56	$1,546.24	$2,106.75	$2,660.98
Monthly	$3,938.25	$6,184.96	$8,427.01	$10,643.93
Yearly	$51,197.30	$80,404.48	$109,551.10	$138,371.08

Net Savings								
Daily	✗	($58.04)	✗	($31.51)	✗	($4.74)	✓	$23.28
Weekly	✗	($290.21)	✗	($157.54)	✗	($23.70)	✓	$116.42
Monthly	✗	($1,160.85)	✗	($630.16)	✗	($94.81)	✓	$465.67
Yearly	✗	($15,091.10)	✗	($8,192.08)	✗	($1,232.50)	✓	$6,053.72

**Based Upon Cat Natural Gas Generator Model G3412 450kW*

Break Even Scenarios

	Load			
	1/4	1/2	3/4	Full
	Cubic Feet per Hour[a]			
Max. Fuel Consumption	✗ *1436.98*	✗ *2873.97*	✗ *4310.95*	✓ *5747.93*
	Cost per Thousand Cubic Feet[b]			
Max. Fuel Cost	✗ *$8.519*	✗ *$10.849*	✗ *$11.944*	✓ *$12.608*
	Kilowatts[c]			
Min. Generator Capacity	✗ *638*	✗ *501*	✗ *455*	✓ *431*
	Cost per kWhr[d]			
Min. Electricity Rate	✗ *$0.2188*	✗ *$0.1718*	✗ *$0.1561*	✓ *$0.1478*

[a] *This is the max gallons per hour to make this analysis break even.*

[b] *This is the max fuel cost to make this analysis break even.*

[c] *This is the min generator output to make this analysis break even.*

[d] *This is the min electricity rate to make this analysis break even.*

Appendix J – Energy Calculations Proposed (Backup Generator Analysis)

CAT 1040kW Natural Gas Generator

Energy Calculations

Hours of Operation	
Daily	8 hours
Weekly	40 hours
Monthly	160 hours
Yearly	2080 hours
Electricity Rate	
	$0.1543 per kWh
Generator Output	
	1,040 kW
Cost of Natural Gas	
	$12.080

Fuel Usage

	Load			
	1/4	1/2	3/4	Full
	Cubic Feet per Hour			
	2923	4581	6161	7899
Savings Subtotal				
Daily	$320.94	$641.89	$962.83	$1,283.78
Weekly	$1,604.72	$3,209.44	$4,814.16	$6,418.88
Monthly	$6,418.88	$12,837.76	$19,256.64	$25,675.52
Yearly	$83,445.44	$166,890.88	$250,336.32	$333,781.76
Fuel Consumption				
	Thousand Cubic Feet			
Daily	23.38	36.65	49.29	63.19
Weekly	116.91	183.26	246.45	315.96
Monthly	467.62	733.03	985.80	1,263.84
Yearly	6,079.07	9,529.35	12,815.34	16,429.92
Fuel Costs				
Daily	$282.44	$442.75	$595.42	$763.36
Weekly	$1,412.21	$2,213.74	$2,977.10	$3,816.80
Monthly	$5,648.86	$8,854.97	$11,908.41	$15,267.19
Yearly	$73,435.17	$115,114.59	$154,809.28	$198,473.43

Net Savings				
Daily	$38.50	$199.14	$367.41	$520.42
Weekly	$192.51	$995.70	$1,837.06	$2,602.08
Monthly	$770.02	$3,982.79	$7,348.23	$10,408.33
Yearly	$10,010.27	$51,776.29	$95,527.04	$135,308.33

**Based Upon Cat Natural Gas Generator Model G3412 1040kW*

Break Even Scenarios

	Load			
	1/4	1/2	3/4	Full
	Cubic Feet per Hour[a]			
Max. Fuel Consumption	*3321.03*	*6642.05*	*9963.08*	*13284.11*
	Cost per Thousand Cubic Feet[b]			
Max. Fuel Cost	*$13.727*	*$17.513*	*$19.534*	*$20.315*
	Kilowatts[c]			
Min. Generator Capacity	*915*	*717*	*643*	*618*
	Cost per kWhr[d]			
Min. Electricity Rate	*$0.1358*	*$0.1064*	*$0.0954*	*$0.0917*

[a] *This is the max gallons per hour to make this analysis break even.*

[b] *This is the max fuel cost to make this analysis break even.*

[c] *This is the min generator output to make this analysis break even.*

[d] *This is the min electricity rate to make this analysis break even.*

Appendix K – Load Calculations (Green Roof Analysis)

Thesis

Timothy Conroy | Analysis II - Struc. Breadth | Date: 3/1/2010 Revised

Structural Breadth Example Calculation (Green Roof)

Please Refer to following Spreadsheet for more details

Beam 1

Size: W18 x35

Length: 36'-4"

Spacing: 7'-9"

Loads

Snow: 30 psf min (Snow load is used if greater than 30psf)

Live Roof: 100psf for green roof

Live Load: 20 psf

$\phi M_p = 249$ ft-k (Steel Manual)

Load Calc.

$M = \frac{w\ell^2}{8} \Rightarrow w = \frac{\phi M_p(8)}{\ell^2}$

$w = \frac{299(8)}{36.33^2} = 1.51$ k/ft $= 1508.96$ lbs/ft

Load Cases

1. $1.4D \Rightarrow D = 1077.83$ lb/ft
2. $1.6L + 1.2D + 0.5(L_r \text{ or } S \text{ or } R) \Rightarrow D = 1189.14$ lb/ft
3. $1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.8W) + 1.2D \Rightarrow D = 1,107.47$ lb/ft

See spreadsheet for remaining load combinations

Load Case One Controls $\Rightarrow DL = 1077.83$ lb/ft

Beam Self weight = 35 lbs/ft, Net Load = 1042.83 lb/ft or 134.56 lb/ft² (based upon spacing at 7.75')

1/2

Analysis II - Structural Breadth — Timothy Conroy

Chosen Deck

3C20 w/ 4" topping, 7" total Conc. NW

Weight: 53.00 lb/ft²

Capacity: ~~98.56~~ 98.00 lb/ft²

Net Allowable Load

= 134.56 - 53.00

= 81.56 < 98.00 ∴ Okay

After analyzing all beams, the controlling load was found to be

69.60 psf

Weight of Green roof

40 psf

Live Load (Maintenance Workers)

20 psf

Remaining Load

$= 69.60 - 40 \cdot \frac{20}{60} =$ 9.6 psf

Snow Water Equivalent

- 10% : 9.6/(.1)(62.4) = 1.54 ft = 18.46" (SWE when air temp is near 14°F)
- 20% : 9.6/(.2)(62.4) = 0.769 ft = 9.23" (SWE at 32°F)
- 30% : 6.15"
- 40% : 4.62"
- 50% : 3.69"
- 100% (water) : 1.85" (max distance between primary and secondary drain)

Note: following spreadsheet contains more scenarios for various roof types

2/2

Structural Calculations (Green Roof)

Function	No.	Size	Weight lb/lf	Length ft	Spacing ft	S	L_r	L	W	R	E	H	φM_P ft-K	Load k/ft	Load lb/ft	Load Case 1	Load Case 2	Load Case 3	Load Case 4	Load Case 5	Load Case 6	Load Case 7	Controlling Load	Beam Wt lb/ft	Net Load lb/ft	Net Load lb/ft^2	Deck Wt 7" (t=4") NW Type	Deck Wt 7" (t=4") NW lb/ft^2	Deck Wt 7" (t=4") NW Capacity	Net Allowable Load lb/ft^2
Beam	1	W18x35	35	36.33	7.75	30	100	20	0	0	0	0	249	1.51	1508.96	**1077.83**	1189.14	1107.47	1161.64	1235.80	1676.63	1676.63	1077.83	35	1042.83	134.56	3C20	53.00	98.00	81.56
	2	W18X35	35	35.08	8.50	30	100	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1280.34	1198.67	1252.84	1327.01	1798.23	1798.23	1156.00	35	1121.00	131.88	3C20	53.00	98.00	78.88
	3	W18x35	35	35.08	9.00	30	100	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1280.34	1198.67	1252.84	1327.01	1798.23	1798.23	1156.00	35	1121.00	124.56	3C20	53.00	98.00	71.56
	4	W18x35	35	35.08	6.75	30	100	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1280.34	1198.67	1252.84	1327.01	1798.23	1798.23	1156.00	35	1121.00	166.07	3C20	53.00	98.00	113.07
	5	W21X44	44	39.51	8.50	30	100	20	0	0	0	0	358	1.83	1834.64	**1310.45**	1460.53	1378.86	1433.03	1507.20	2038.48	2038.48	1310.45	44	1266.45	148.99	3C20	53.00	98.00	95.99
	6	W21X44	44	39.51	7.88	30	100	20	0	0	0	0	358	1.83	1834.64	**1310.45**	1460.53	1378.86	1433.03	1507.20	2038.48	2038.48	1310.45	44	1266.45	160.82	3C20	53.00	98.00	107.82
	7	W18x40	40	37.58	9.13	30	100	20	0	0	0	0	294	1.67	1665.12	**1189.37**	1319.27	1237.60	1291.77	1365.94	1850.14	1850.14	1189.37	40	1149.37	125.96	3C20	53.00	98.00	72.96
	8	W18x40	40	37.58	9.38	30	100	20	0	0	0	0	294	1.67	1665.12	**1189.37**	1319.27	1237.60	1291.77	1365.94	1850.14	1850.14	1189.37	40	1149.37	122.60	3C20	53.00	98.00	69.60
	9	W21x44	44	36.58	6.00	30	100	20	0	0	0	0	358	2.14	2139.96	**1528.55**	1714.97	1633.30	1687.47	1761.64	2377.74	2377.74	1528.55	44	1484.55	247.42	3C20	53.00	98.00	194.42
	10	W21X44	44	37.58	4.32	30	100	20	0	0	0	0	358	2.03	2027.60	**1448.29**	1621.33	1539.67	1593.83	1668.00	2252.89	2252.89	1448.29	44	1404.29	325.16	3C20	53.00	98.00	272.16
	*11**	*W18x76*	*76*	*35.08*	*9.00*	*30*	*100*	*20*	*0*	*0*	*0*	*0*	*611*	*3.97*	*3971.27*	***2836.62***	*3241.06*	*3159.39*	*3213.56*	*3287.73*	*4412.52*	*4412.52*	*2836.62*	*76*	*2760.62*	*306.75*	3C20	53.00	98.00	253.75
	*12**	*W18x60*	*60*	*36.33*	*7.75*	*30*	*100*	*20*	*0*	*0*	*0*	*0*	*461*	*2.79*	*2793.70*	***1995.50***	*2259.75*	*2178.09*	*2232.25*	*2306.42*	*3104.12*	*3104.12*	*1995.50*	*60*	*1935.50*	*249.74*	3C20	53.00	98.00	196.74
	13	W21x50	50	39.51	6.84	30	100	20	0	0	0	0	413	2.12	2116.49	**1511.78**	1695.41	1613.74	1667.91	1742.08	2351.66	2351.66	1511.78	50	1461.78	213.67	3C20	53.00	98.00	160.67
	14	W12x19	19	24.50	6.63	30	100	20	0	0	0	0	92.6	1.23	1234.15	881.54	960.13	**878.46**	932.63	1006.79	1371.28	1371.28	878.46	19	859.46	129.73	3C20	53.00	98.00	76.73
	15	W18x40	40	24.50	3.83	30	100	20	0	0	0	0	294	3.92	3918.37	**2798.83**	3196.97	3115.31	3169.47	3243.64	4353.74	4353.74	2798.83	40	2758.83	719.76	3C20	53.00	98.00	666.76
	16	W24x104	104	39.51	9.50	30	100	20	0	0	0	0	1080	5.53	5534.65	**3953.32**	4543.88	4462.21	4516.38	4590.55	6149.62	6149.62	3953.32	104	3849.32	405.19	3C20	53.00	98.00	352.19
	17	W16x26	26	23.25	5.79	30	100	20	0	0	0	0	166	2.46	2456.70	**1754.79**	1978.92	1897.25	1951.42	2025.58	2729.67	2729.67	1754.79	26	1728.79	298.58	3C20	53.00	98.00	245.58
	18	W12x14	14	6.50	5.75	30	100	20	0	0	0	0	65.2	12.35	12345.56	**8818.26**	10219.64	10137.97	10192.14	10266.30	13717.29	13717.29	8818.26	14	8804.26	1531.18	3C20	53.00	98.00	1478.18
	19	W14x22	22	11.50	17.50	30	100	20	0	0	0	0	125	7.56	7561.44	**5401.03**	6232.86	6151.20	6205.36	6279.53	8401.60	8401.60	5401.03	22	5379.03	307.37	3C20	53.00	98.00	254.37
	20	W21x44	44	23.25	5.25	30	100	20	0	0	0	0	358	5.30	5298.18	**3784.42**	4346.82	4265.15	4319.32	4393.49	5886.87	5886.87	3784.42	44	3740.42	712.46	3C20	53.00	98.00	659.46

**Non-economical Member Size*

**Controlling Load case is highlighted in green*

Minimum Net Load (psf) 98.00 69.60

Controlling Net Allowable Load (psf) 69.60

Green Roof

Snow Water Equivalent		
SWE		**Precip. (in.)**
Typical 10-20% winter and 20-40% spring	10%	18.46
	20%	9.23
	30%	6.15
	40%	4.62
	50%	3.69
Water	100%	1.85

Notes:

†10% SWE when air temp. near 14ºF

††20% SWE when air temp. near 32ºF

†††100% SWE is Max distance from primary drain to secondary

Structural Calculations (Solar Roof)

Function	No.	Size	Weight lb/lf	Length ft	Spacing ft	S	L_r	L	W	R	E	H	φM_P ft-K	Load k/ft	Load lb/ft	Load Case 1	Load Case 2	Load Case 3	Load Case 4	Load Case 5	Load Case 6	Load Case 7	Controlling Load	Beam Wt lb/ft	Net Load lb/ft	Net Load lb/ft^2	Deck Wt 7" (t=4") NW Type	Deck Wt 7" (t=4") NW lb/ft^2	Deck Wt 7" (t=4") NW Capacity	Net Allowable Load lb/ft^2
Beam	1	W18x35	35	36.33	7.75	30	20	20	0	0	0	0	249	1.51	1508.96	**1077.83**	1218.30	1200.80	1228.30	1235.80	1676.63	1676.63	1077.83	35	1042.83	134.56	2C18	35.00	87.00	99.56
	2	W18X35	35	35.08	8.50	30	20	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1309.51	1292.01	1319.51	1327.01	1798.23	1798.23	1156.00	35	1121.00	131.88	2C18	35.00	87.00	96.88
	3	W18x35	35	35.08	9.00	30	20	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1309.51	1292.01	1319.51	1327.01	1798.23	1798.23	1156.00	35	1121.00	124.56	2C18	35.00	87.00	89.56
	4	W18x35	35	35.08	6.75	30	20	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1309.51	1292.01	1319.51	1327.01	1798.23	1798.23	1156.00	35	1121.00	166.07	2C18	35.00	87.00	131.07
	5	W21X44	44	39.51	8.50	30	20	20	0	0	0	0	358	1.83	1834.64	**1310.45**	1489.70	1472.20	1499.70	1507.20	2038.48	2038.48	1310.45	44	1266.45	148.99	2C18	35.00	87.00	113.99
	6	W21X44	44	39.51	7.88	30	20	20	0	0	0	0	358	1.83	1834.64	**1310.45**	1489.70	1472.20	1499.70	1507.20	2038.48	2038.48	1310.45	44	1266.45	160.82	2C18	35.00	87.00	125.82
	7	W18x40	40	37.58	9.13	30	20	20	0	0	0	0	294	1.67	1665.12	**1189.37**	1348.44	1330.94	1358.44	1365.94	1850.14	1850.14	1189.37	40	1149.37	125.96	2C18	35.00	87.00	90.96
	8	W18x40	40	37.58	9.38	30	20	20	0	0	0	0	294	1.67	1665.12	**1189.37**	1348.44	1330.94	1358.44	1365.94	1850.14	1850.14	1189.37	40	1149.37	122.60	2C18	35.00	87.00	87.60
	9	W21x44	44	36.58	6.00	30	20	20	0	0	0	0	358	2.14	2139.96	**1528.55**	1744.14	1726.64	1754.14	1761.64	2377.74	2377.74	1528.55	44	1484.55	247.42	2C18	35.00	87.00	212.42
	10	W21X44	44	37.58	4.32	30	20	20	0	0	0	0	358	2.03	2027.60	**1448.29**	1650.50	1633.00	1660.50	1668.00	2252.89	2252.89	1448.29	44	1404.29	325.16	2C18	35.00	87.00	290.16
	*11**	*W18x76*	*76*	*35.08*	*9.00*	*30*	*20*	*20*	*0*	*0*	*0*	*0*	*611*	*3.97*	*3971.27*	***2836.62***	*3270.23*	*3252.73*	*3280.23*	*3287.73*	*4412.52*	*4412.52*	*2836.62*	*76*	*2760.62*	*306.75*	*2C18*	*35.00*	*87.00*	*271.75*
	*12**	*W18x60*	*60*	*36.33*	*7.75*	*30*	*20*	*20*	*0*	*0*	*0*	*0*	*461*	*2.79*	*2793.70*	***1995.50***	*2288.92*	*2271.42*	*2298.92*	*2306.42*	*3104.12*	*3104.12*	*1995.50*	*60*	*1935.50*	*249.74*	*2C18*	*35.00*	*87.00*	*214.74*
	13	W21x50	50	39.51	6.84	30	20	20	0	0	0	0	413	2.12	2116.49	**1511.78**	1724.58	1707.08	1734.58	1742.08	2351.66	2351.66	1511.78	50	1461.78	213.67	2C18	35.00	87.00	178.67
	14	W12x19	19	24.50	6.63	30	20	20	0	0	0	0	92.6	1.23	1234.15	**881.54**	989.29	971.79	999.29	1006.79	1371.28	1371.28	881.54	19	862.54	130.19	2C18	35.00	87.00	95.19
	15	W18x40	40	24.50	3.83	30	20	20	0	0	0	0	294	3.92	3918.37	**2798.83**	3226.14	3208.64	3236.14	3243.64	4353.74	4353.74	2798.83	40	2758.83	719.76	2C18	35.00	87.00	684.76
	16	W24x104	104	39.51	9.50	30	20	20	0	0	0	0	1080	5.53	5534.65	**3953.32**	4573.05	4555.55	4583.05	4590.55	6149.62	6149.62	3953.32	104	3849.32	405.19	2C18	35.00	87.00	370.19
	17	W16x26	26	23.25	5.79	30	20	20	0	0	0	0	166	2.46	2456.70	**1754.79**	2008.08	1990.58	2018.08	2025.58	2729.67	2729.67	1754.79	26	1728.79	298.58	2C18	35.00	87.00	263.58
	18	W12x14	14	6.50	5.75	30	20	20	0	0	0	0	65.2	12.35	12345.56	**8818.26**	10248.80	10231.30	10258.80	10266.30	13717.29	13717.29	8818.26	14	8804.26	1531.18	2C18	35.00	87.00	1496.18
	19	W14x22	22	11.50	17.50	30	20	20	0	0	0	0	125	7.56	7561.44	**5401.03**	6262.03	6244.53	6272.03	6279.53	8401.60	8401.60	5401.03	22	5379.03	307.37	2C18	35.00	87.00	272.37
	20	W21x44	44	23.25	5.25	30	20	20	0	0	0	0	358	5.30	5298.18	**3784.42**	4375.99	4358.49	4385.99	4393.49	5886.87	5886.87	3784.42	44	3740.42	712.46	2C18	35.00	87.00	677.46

**Non-economical Member Size*

**Controlling Load case is highlighted in green*

Minimum Net Load (psf)	87.00	87.60
Controlling Net Allowable Load (psf)		**87.00**

Solar Roof

Snow Water Equivalent		
SWE		**Precip. (in.)**
Typical 10-20% winter and 20-40% spring	10%	123.81
	20%	61.90
	30%	41.27
	40%	30.95
	50%	24.76
Water	100%	12.38

Notes:

†10% SWE when air temp. near 14°F

††20% SWE when air temp. near 32°F

†††100% SWE is Max distance from primary drain to secondary

Structural Calculations (Cool Roof)

Function	No.	Size	Weight lb/lf	Length ft	Spacing ft	S	L_r	L	W	R	E	H	φM_P ft-K	Load k/ft	Load lb/ft	Load Case 1	Load Case 2	Load Case 3	Load Case 4	Load Case 5	Load Case 6	Load Case 7	Controlling Load	Beam Wt lb/ft	Net Load lb/ft	Net Load lb/ft^2	Deck Wt Type	Deck Wt lb/ft^2	Deck Wt Capacity	Net Allowable Load lb/ft^2
Beam	1	W18x35	35	36.33	7.75	30	20	20	0	0	0	0	249	1.51	1508.96	**1077.83**	1218.30	1200.80	1228.30	1235.80	1676.63	1676.63	1077.83	35	1042.83	134.56	3N22	2.26	70.00	132.30
	2	W18X35	35	35.08	8.50	30	20	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1309.51	1292.01	1319.51	1327.01	1798.23	1798.23	1156.00	35	1121.00	131.88	3N22	2.26	70.00	129.62
	3	W18x35	35	35.08	9.00	30	20	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1309.51	1292.01	1319.51	1327.01	1798.23	1798.23	1156.00	35	1121.00	124.56	3N22	2.26	70.00	122.30
	4	W18x35	35	35.08	6.75	30	20	20	0	0	0	0	249	1.62	1618.41	**1156.00**	1309.51	1292.01	1319.51	1327.01	1798.23	1798.23	1156.00	35	1121.00	166.07	3N22	2.26	70.00	163.81
	5	W21X44	44	39.51	8.50	30	20	20	0	0	0	0	358	1.83	1834.64	**1310.45**	1489.70	1472.20	1499.70	1507.20	2038.48	2038.48	1310.45	44	1266.45	148.99	3N22	2.26	70.00	146.73
	6	W21X44	44	39.51	7.88	30	20	20	0	0	0	0	358	1.83	1834.64	**1310.45**	1489.70	1472.20	1499.70	1507.20	2038.48	2038.48	1310.45	44	1266.45	160.82	3N22	2.26	70.00	158.56
	7	W18x40	40	37.58	9.13	30	20	20	0	0	0	0	294	1.67	1665.12	**1189.37**	1348.44	1330.94	1358.44	1365.94	1850.14	1850.14	1189.37	40	1149.37	125.96	3N22	2.26	70.00	123.70
	8	W18x40	40	37.58	9.38	30	20	20	0	0	0	0	294	1.67	1665.12	**1189.37**	1348.44	1330.94	1358.44	1365.94	1850.14	1850.14	1189.37	40	1149.37	122.60	3N22	2.26	70.00	120.34
	9	W21x44	44	36.58	6.00	30	20	20	0	0	0	0	358	2.14	2139.96	**1528.55**	1744.14	1726.64	1754.14	1761.64	2377.74	2377.74	1528.55	44	1484.55	247.42	3N22	2.26	70.00	245.16
	10	W21X44	44	37.58	4.32	30	20	20	0	0	0	0	358	2.03	2027.60	**1448.29**	1650.50	1633.00	1660.50	1668.00	2252.89	2252.89	1448.29	44	1404.29	325.16	3N22	2.26	70.00	322.90
	*11**	*W18x76*	*76*	*35.08*	*9.00*	*30*	*20*	*20*	*0*	*0*	*0*	*0*	*611*	*3.97*	*3971.27*	***2836.62***	*3270.23*	*3252.73*	*3280.23*	*3287.73*	*4412.52*	*4412.52*	*2836.62*	*76*	*2760.62*	*306.75*	*3N22*	*2.26*	*70.00*	*304.49*
	*12**	*W18x60*	*60*	*36.33*	*7.75*	*30*	*20*	*20*	*0*	*0*	*0*	*0*	*461*	*2.79*	*2793.70*	***1995.50***	*2288.92*	*2271.42*	*2298.92*	*2306.42*	*3104.12*	*3104.12*	*1995.50*	*60*	*1935.50*	*249.74*	*3N22*	*2.26*	*70.00*	*247.48*
	13	W21x50	50	39.51	6.84	30	20	20	0	0	0	0	413	2.12	2116.49	**1511.78**	1724.58	1707.08	1734.58	1742.08	2351.66	2351.66	1511.78	50	1461.78	213.67	3N22	2.26	70.00	211.41
	14	W12x19	19	24.50	6.63	30	20	20	0	0	0	0	92.6	1.23	1234.15	**881.54**	989.29	971.79	999.29	1006.79	1371.28	1371.28	881.54	19	862.54	130.19	3N22	2.26	70.00	127.93
	15	W18x40	40	24.50	3.83	30	20	20	0	0	0	0	294	3.92	3918.37	**2798.83**	3226.14	3208.64	3236.14	3243.64	4353.74	4353.74	2798.83	40	2758.83	719.76	3N22	2.26	70.00	717.50
	16	W24x104	104	39.51	9.50	30	20	20	0	0	0	0	1080	5.53	5534.65	**3953.32**	4573.05	4555.55	4583.05	4590.55	6149.62	6149.62	3953.32	104	3849.32	405.19	3N22	2.26	70.00	402.93
	17	W16x26	26	23.25	5.79	30	20	20	0	0	0	0	166	2.46	2456.70	**1754.79**	2008.08	1990.58	2018.08	2025.58	2729.67	2729.67	1754.79	26	1728.79	298.58	3N22	2.26	70.00	296.32
	18	W12x14	14	6.50	5.75	30	20	20	0	0	0	0	65.2	12.35	12345.56	**8818.26**	10248.80	10231.30	10258.80	10266.30	13717.29	13717.29	8818.26	14	8804.26	1531.18	3N22	2.26	70.00	1528.92
	19	W14x22	22	11.50	17.50	30	20	20	0	0	0	0	125	7.56	7561.44	**5401.03**	6262.03	6244.53	6272.03	6279.53	8401.60	8401.60	5401.03	22	5379.03	307.37	3N22	2.26	70.00	305.11
	20	W21x44	44	23.25	5.25	30	20	20	0	0	0	0	358	5.30	5298.18	**3784.42**	4375.99	4358.49	4385.99	4393.49	5886.87	5886.87	3784.42	44	3740.42	712.46	3N22	2.26	70.00	710.20

**Non-economical Member Size*

**Controlling Load case is highlighted in green*

Minimum Net Load (psf) 70.00 120.34

Controlling Net Allowable Load (psf) **70.00**

Cool Roof

Snow Water Equivalent		
SWE		**Precip. (in.)**
Typical 10-20% winter and 20-40% spring	10%	94.65
	20%	47.33
	30%	31.55
	40%	23.66
	50%	18.93
Water	100%	9.47

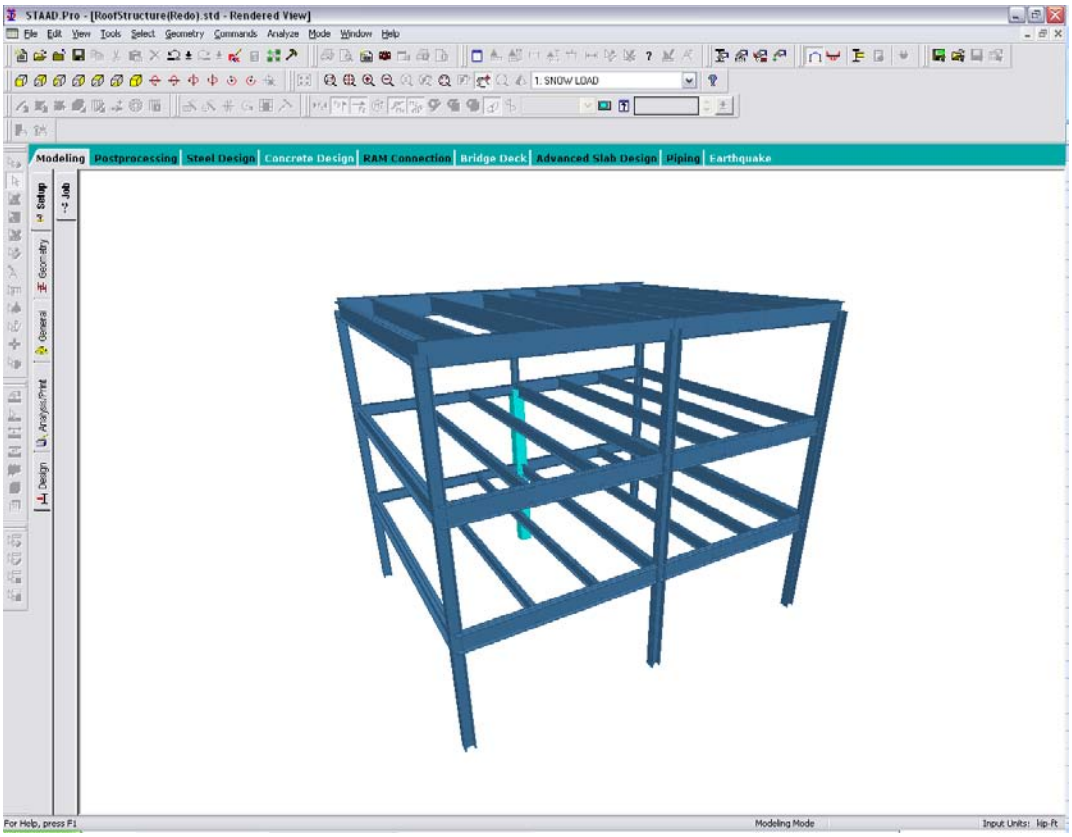
Notes:

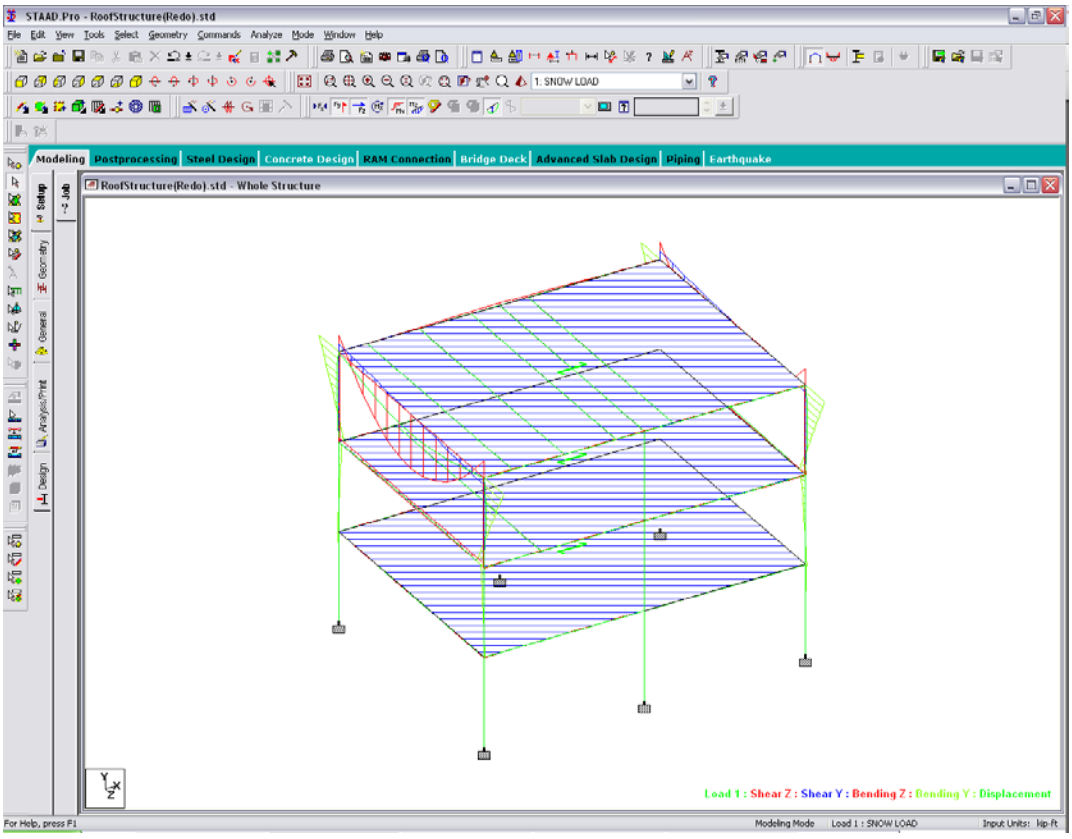
†10% SWE when air temp. near 14°F

††20% SWE when air temp. near 32°F

†††100% SWE is Max distance from primary drain to secondary

Appendix L –STADD Results (Green Roof Analysis)


STAAD.Pro - [RoofStructure(Redo).std - Rendered View]
1. SNOW LOAD
Modeling
Postprocessing
Steel Design
Concrete Design
RAM Connection
Bridge Deck
Advanced Slab Design
Piping
Earthquake


STAAD.Pro - RoofStructure(Redo).std
1. SNOW LOAD
Modeling
Postprocessing
Steel Design
Concrete Design
RAM Connection
Bridge Deck
Advanced Slab Design
Piping
Earthquake
RoofStructure(Redo).std - Whole Structure
Load 1 : Shear Z : Shear Y : Bending Z : Bending Y : Displacement

Appendix M –Thermal Calculations (Green Roof Analysis)

Timothy Conroy | Thesis Analysis II - Mech. Breadth | Date: 2/23/2010

Reference Roof (Base Case) - Black Built-up roof
- Membrane Temp. Max equals 158°F

Vegetated (Green) Roof - Extensive Modular
- Membrane Temp. Max equals 86°F

Assumptions - Due to nature of modular construction, green roof will add nothing to the roof "R" value. This is because air space beneath pans is not sealed (worse case scenario)
- Green Roof Membrane Temp is the temperature of membrane outbound at roof system beneath green roof modules.

Calculations

- Governing Eqn. $\dot{q} = UA(t_o - t_i)$ Heat Gain
- Reference Roof

$\dot{q} = 22(10,000)(158 - 72°F)$ ← Interior Design Temp.

$= 18,920$ kBTU

- Green Roof

$\dot{q} = 22(10,000)(86 - 72°F)$

$= 3,080$ kBTU

- Reduction

$= \frac{\text{Reference Roof} - \text{Green Roof}}{\text{Reference Roof}} \times 100$

$= \frac{18,920 - 3,080}{18,920} \times 100$

$= 84\%$ Reduction

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Analysis II - Mech. Breadth — Timothy Conroy

Building Surface Area

- Wall Area

  Levels 1 thru 9 (Building Perimeter)

  = 9 (13')(431.54')

  = ~~44,880 ft²~~ 50,490 ft²

  Levels 10 - 11

  = 2 (13')(410.75')

  = 10,680 ft²

- Roof Area

  Green Roof

  = 6,500 ft²

  Non-Green Roof

  = 10,000 - 6,500

  = 3,500 ft²

Reduction of Thermal Loads

- Enhanced Area

  = 6,500 ft²

- Non-Enhanced Area

  = 50,490 + 10,680 + 3,500 ft²

  = 64,670 ft²

- Roof (Green) Ratio

  = $\frac{6,500}{64,670} \times 100$

  = 10 %

2/3

Analysis II - Mech. Breadth | Timothy Conroy

- Overall Reduction of Thermal Gain
  - = Percent Roof Area × Roof Gain Reduction
  - = 10% (84%)
  - = 8.4% Reduction in total Thermal Gain accross the building envelope.*

    * Holding all other factors constant

Notes:

(1) Based upon properties of a modular green roof system, there is no benefit associated with thermal losses. Again this is due to the non-sealed air space beneath the modular trays.

(2) A modular system was selected because the vegetation can be given several growing seasons (depending on the duration of the schedule) to develop prior to installation on the roof thereby giving the owner maximum visual benefit.

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Appendix N – Lifecycle Cost Comparison (Green Roof Analysis)

Lifecycle Cost Analysis					
Year	EPDM		Green Roof		Difference
0	$ (60,500.00)	$ (60,500.00)	$ (105,924.36)	$ (105,924.36)	$ (45,424.36)
1	$ (1,100.00)	$ (61,600.00)	$ 5,056.29	$ (100,868.07)	$ (39,268.07)
2	$ (1,100.00)	$ (62,700.00)	$ 5,056.29	$ (95,811.78)	$ (33,111.78)
3	$ (1,100.00)	$ (63,800.00)	$ 5,056.29	$ (90,755.48)	$ (26,955.48)
4	$ (1,100.00)	$ (64,900.00)	$ 5,056.29	$ (85,699.19)	$ (20,799.19)
5	$ (1,100.00)	$ (66,000.00)	$ 5,056.29	$ (80,642.90)	$ (14,642.90)
6	$ (1,100.00)	$ (67,100.00)	$ 5,056.29	$ (75,586.61)	$ (8,486.61)
7	$ (1,100.00)	$ (68,200.00)	$ 5,056.29	$ (70,530.32)	$ (2,330.32)
8	$ (1,100.00)	$ (69,300.00)	$ 5,056.29	$ (65,474.02)	$ 3,825.98
9	$ (1,100.00)	$ (70,400.00)	$ 5,056.29	$ (60,417.73)	$ 9,982.27
10	$ (1,100.00)	$ (71,500.00)	$ 5,056.29	$ (55,361.44)	$ 16,138.56
11	$ (1,100.00)	$ (72,600.00)	$ 5,056.29	$ (50,305.15)	$ 22,294.85
12	$ (61,600.00)	$ (134,200.00)	$ 5,056.29	$ (45,248.86)	$ 88,951.14
13	$ (1,100.00)	$ (135,300.00)	$ 5,056.29	$ (40,192.56)	$ 95,107.44
14	$ (1,100.00)	$ (136,400.00)	$ 5,056.29	$ (35,136.27)	$ 101,263.73
15	$ (1,100.00)	$ (137,500.00)	$ 5,056.29	$ (30,079.98)	$ 107,420.02
16	$ (1,100.00)	$ (138,600.00)	$ 5,056.29	$ (25,023.69)	$ 113,576.31
17	$ (1,100.00)	$ (139,700.00)	$ 5,056.29	$ (19,967.40)	$ 119,732.60
18	$ (1,100.00)	$ (140,800.00)	$ 5,056.29	$ (14,911.10)	$ 125,888.90
19	$ (1,100.00)	$ (141,900.00)	$ 5,056.29	$ (9,854.81)	$ 132,045.19
20	$ (1,100.00)	$ (143,000.00)	$ 5,056.29	$ (4,798.52)	$ 138,201.48
21	$ (1,100.00)	$ (144,100.00)	$ 5,056.29	$ 257.77	$ 144,357.77
22	$ (1,100.00)	$ (145,200.00)	$ 5,056.29	$ 5,314.07	$ 150,514.07
23	$ (1,100.00)	$ (146,300.00)	$ 5,056.29	$ 10,370.36	$ 156,670.36
24	$ (61,600.00)	$ (207,900.00)	$ 5,056.29	$ 15,426.65	$ 223,326.65
25	$ (1,100.00)	$ (209,000.00)	$ 5,056.29	$ 20,482.94	$ 229,482.94
26	$ (1,100.00)	$ (210,100.00)	$ 5,056.29	$ 25,539.23	$ 235,639.23
27	$ (1,100.00)	$ (211,200.00)	$ 5,056.29	$ 30,595.53	$ 241,795.53
28	$ (1,100.00)	$ (212,300.00)	$ 5,056.29	$ 35,651.82	$ 247,951.82
29	$ (1,100.00)	$ (213,400.00)	$ 5,056.29	$ 40,708.11	$ 254,108.11
30	$ (1,100.00)	$ (214,500.00)	$ 5,056.29	$ 45,764.40	$ 260,264.40
31	$ (1,100.00)	$ (215,600.00)	$ 5,056.29	$ 50,820.69	$ 266,420.69
32	$ (1,100.00)	$ (216,700.00)	$ 5,056.29	$ 55,876.99	$ 272,576.99
33	$ (1,100.00)	$ (217,800.00)	$ 5,056.29	$ 60,933.28	$ 278,733.28
34	$ (1,100.00)	$ (218,900.00)	$ 5,056.29	$ 65,989.57	$ 284,889.57
35	$ (1,100.00)	$ (220,000.00)	$ 5,056.29	$ 71,045.86	$ 291,045.86
36	$ (61,600.00)	$ (281,600.00)	$ 5,056.29	$ 76,102.15	$ 357,702.15
37	$ (1,100.00)	$ (282,700.00)	$ 5,056.29	$ 81,158.45	$ 363,858.45
38	$ (1,100.00)	$ (283,800.00)	$ 5,056.29	$ 86,214.74	$ 370,014.74
39	$ (1,100.00)	$ (284,900.00)	$ 5,056.29	$ 91,271.03	$ 376,171.03
40	$ (1,100.00)	$ (286,000.00)	$ 5,056.29	$ 96,327.32	$ 382,327.32
41	$ (1,100.00)	$ (287,100.00)	$ 5,056.29	$ 101,383.61	$ 388,483.61
42	$ (1,100.00)	$ (288,200.00)	$ 5,056.29	$ 106,439.91	$ 394,639.91
43	$ (1,100.00)	$ (289,300.00)	$ 5,056.29	$ 111,496.20	$ 400,796.20
44	$ (1,100.00)	$ (290,400.00)	$ 5,056.29	$ 116,552.49	$ 406,952.49
45	$ (1,100.00)	$ (291,500.00)	$ 5,056.29	$ 121,608.78	$ 413,108.78
46	$ (1,100.00)	$ (292,600.00)	$ 5,056.29	$ 126,665.07	$ 419,265.07
47	$ (1,100.00)	$ (293,700.00)	$ 5,056.29	$ 131,721.37	$ 425,421.37
48	$ (61,600.00)	$ (355,300.00)	$ 5,056.29	$ 136,777.66	$ 492,077.66
49	$ (1,100.00)	$ (356,400.00)	$ 5,056.29	$ 141,833.95	$ 498,233.95
50	$ (1,100.00)	$ (357,500.00)	$ 5,056.29	$ 146,890.24	$ 504,390.24
	EPDM		Green Roof		
Payback	N/A		20.9		7.4

Appendix O – Energy Savings Calculations (Curtain Wall Redesign Analysis)

Mechanical Load Calculations

	General Building Data						Summer				Winter				Reduction	
	Level	Elevation	Material	Length (ft)	Height (ft)	Area (ft^2)	U-Value [BTU/(hr-ft2-F)]	T_{out} (°F)	T_{in} (°F)	Heat Flow BTU/hr	U-Value [BTU/(hr-ft2-F)]	T_{out} (°F)	T_{in} (°F)	Heat Flow (BTU/hr)	Summer %	Winter %
Existing Desing	9	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.31	85	70	8276	0.29	46	68	-11355		
		West	Curtain Wall	60.39	13	785.07	0.31	85	70	3651	0.29	46	68	-5009		
	10	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.31	85	70	8276	0.29	46	68	-11355		
		West	Curtain Wall	60.39	13	785.07	0.31	85	70	3651	0.29	46	68	-5009		
	11	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.31	85	70	8276	0.29	46	68	-11355		
		West	Curtain Wall	60.39	13	785.07	0.31	85	70	3651	0.29	46	68	-5009		
										43846				-60922	N/A	N/A
Proposed Design	9	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.14	85	70	3762	0.14	46	68	-5518		
		West	Curtain Wall	60.39	13	785.07	0.14	85	70	1659	0.14	46	68	-2434		
	10	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.14	85	70	3762	0.14	46	68	-5518		
		West	Curtain Wall	60.39	13	785.07	0.14	85	70	1659	0.14	46	68	-2434		
	11	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.14	85	70	3762	0.14	46	68	-5518		
		West	Curtain Wall	60.39	13	785.07	0.14	85	70	1659	0.14	46	68	-2434		
										24331				-35685	45	41

Energy Savings

Annual Building Electrical Usage	1,730,769		kWhr
Percent Used by Mech. Systems	60%		
Electricity Usage Breakdown			
Per Floor	129,808		kWhr
Levels 1-8	1,038,462		kWhr
Electricity Savings			
Glazing Redesign	43%	167,323	kWhr
Total Savings	167,323		kWhr
Total Electicity Usage			
Existing Design	2,120,192		kWhr
Proposed Design	1,260,561		kWhr
Cost of Electricity	$0.1543		per kWhr
Total Electicity Cost			
Existing Design	$327,145.67		
Proposed Design	$194,504.60		
Total Savings	$132,641.08		per year

Payback Period

Year	Glazing Redesign			Non-Vision Only			Both Collectors		
	Incentive	Savings	Net Cost	Incentive	Savings	Net Cost	Incentive	Savings	Net Cost
0	$ -	$ -	$ (807,943.50)	$ -	$ -	$ (846,417.00)	$ -	$ -	$ (961,837.50)
1	$13,850.46	$132,641.08	$ (661,451.96)	$46,850.46	$138,682.36	$ (660,884.18)	$46,850.46	$152,623.79	$ (762,363.25)
2	$13,850.46	$132,641.08	$ (514,960.43)	$46,850.46	$138,682.36	$ (475,351.35)	$46,850.46	$152,623.79	$ (562,888.99)
3	$13,850.46	$132,641.08	$ (368,468.89)	$13,850.46	$138,682.36	$ (322,818.53)	$13,850.46	$152,623.79	$ (396,414.74)
4	$ -	$132,641.08	$ (235,827.81)	$ -	$138,682.36	$ (184,136.17)	$ -	$152,623.79	$ (243,790.94)
5	$ -	$132,641.08	$ (103,186.74)	$ -	$138,682.36	$ (45,453.80)	$ -	$152,623.79	$ (91,167.15)
6	$ -	$132,641.08	$ 29,454.34	$ -	$138,682.36	$ 93,228.56	$ -	$152,623.79	$ 61,456.65
7	$ -	$132,641.08	$ 162,095.41	$ -	$138,682.36	$ 231,910.92	$ -	$152,623.79	$ 214,080.44
8	$ -	$132,641.08	$ 294,736.49	$ -	$138,682.36	$ 370,593.29	$ -	$152,623.79	$ 366,704.24
9	$ -	$132,641.08	$ 427,377.57	$ -	$138,682.36	$ 509,275.65	$ -	$152,623.79	$ 519,328.03
10	$ -	$132,641.08	$ 560,018.64	$ -	$138,682.36	$ 647,958.01	$ -	$152,623.79	$ 671,951.83
15	$ -	$132,641.08	$ 1,223,224.02	$ -	$138,682.36	$ 1,341,369.83	$ -	$152,623.79	$ 1,435,070.80
20	$ -	$132,641.08	$ 1,886,429.41	$ -	$138,682.36	$ 2,034,781.65	$ -	$152,623.79	$ 2,198,189.78
25	$ -	$132,641.08	$ 2,549,634.79	$ -	$138,682.36	$ 2,728,193.46	$ -	$152,623.79	$ 2,961,308.75
30	$ -	$132,641.08	$ 3,212,840.17	$ -	$138,682.36	$ 3,421,605.28	$ -	$152,623.79	$ 3,724,427.73
35	$ -	$132,641.08	$ 3,876,045.55	$ -	$138,682.36	$ 4,115,017.10	$ -	$152,623.79	$ 4,487,546.70
40	$ -	$132,641.08	$ 4,539,250.93	$ -	$138,682.36	$ 4,808,428.91	$ -	$152,623.79	$ 5,250,665.68
		$133,679.86	5.78		$141,371.15	5.33		$155,312.58	5.60

Appendix P – Federal and State Financial Incentives (Curtain Wall Redesign Analysis)

DSIRE
Database of State Incentives for Renewables & Efficiency

ENERGY Energy Efficiency & Renewable Energy
North Carolina Solar Center
IREC

3/20/10

Federal

Incentives/Policies for Renewables & Efficiency

Energy-Efficient Commercial Buildings Tax Deduction

Last DSIRE Review: 11/17/2009

Program Overview:

State:	Federal
Incentive Type:	Corporate Deduction
Eligible Efficiency Technologies:	Equipment Insulation, Water Heaters, Lighting, Lighting Controls/Sensors, Chillers , Furnaces , Boilers, Heat pumps, Central Air conditioners, Caulking/Weather-stripping, Duct/Air sealing, Building Insulation, Windows, Doors, Siding, Roofs, Comprehensive Measures/Whole Building
Applicable Sectors:	Commercial, Construction, State Government, Fed. Government, (Deductions associated with government buildings are transferred to the designer)
Amount:	$0.30-$1.80 per square foot, depending on technology and amount of energy reduction
Maximum Incentive:	$1.80 per square foot
Equipment Requirements:	Not specified, but building must be certified as meeting specific energy reduction targets as a result of improvements in interior lighting; building envelope; or heating, cooling, ventilation, or hot water systems.
Web Site:	http://www.efficientbuildings.org
Authority 1:	26 USC § 179D
Date Enacted:	8/8/2005 (subsequently amended)
Date Effective:	1/1/2006
Expiration Date	12/31/2013
Authority 2:	H.R. 1424: Div. B, Sec. 303 (The Energy Improvement and Extension Act of 2008)
Date Enacted:	10/3/2008
Expiration Date	12/31/2013

Summary:
The federal Energy Policy Act of 2005 established a tax deduction for energy-efficient commercial buildings applicable to qualifying systems and buildings placed in service from January 1, 2006, through December 31, 2007. This deduction was subsequently extended through 2008, and then again through 2013 by Section 303 of the federal Energy Improvement and Extension Act of 2008 (H.R. 1424, Division B), enacted in October 2008.

A tax deduction of $1.80 per square foot is available to owners of new or existing buildings who install (1) interior lighting; (2) building envelope, or (3) heating, cooling, ventilation, or hot water systems that reduce the building's total energy and power cost by 50% or more in comparison to a building meeting minimum requirements set by ASHRAE Standard 90.1-2001. Energy savings must be calculated using qualified computer software approved by the IRS. Click here for the list of approved software.

Deductions of $0.60 per square foot are available to owners of buildings in which individual lighting, building envelope, or heating and cooling systems meet target levels that would reasonably contribute to an overall building savings of 50% if additional systems were installed.

The deductions are available primarily to building owners, although tenants may be eligible if they make construction expenditures. In the case of energy efficient systems installed on or in government property, tax deductions will be given to the person primarily responsible for the systems' design. Deductions are taken in the year when construction is completed.

The IRS released interim guidance (IRS Notice 2006-52) in June 2006 to establish a process to allow taxpayers to obtain a certification that the property satisfies the energy efficiency requirements contained in the statute. IRS Notice 2008-40 was issued in March of 2008 to further clarify the rules. NREL published a report (NREL/TP-550-40228) in February 2007 which provides guidelines for the modeling and inspection of energy savings required by the statute, and the US Department of Energy has compiled a list of qualified computer software for calculating commercial building energy and power cost savings.

Click here for answers to frequently asked questions provided by the *Commercial Building Tax Deduction Coalition.*

For more information, visit the Energy Star web site.

Contact:

Public Information - IRS
U.S. Internal Revenue Service
1111 Constitution Avenue, N.W.
Washington, DC 20224
Phone: (800) 829-1040
Web Site: http://www.irs.gov

DSIRE
Database of State Incentives for Renewables & Efficiency

ENERGY | Energy Efficiency & Renewable Energy
North Carolina Solar Center
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3/20/10

District of Columbia

Incentives/Policies for Renewables & Efficiency

Renewable Energy Incentive Program

Last DSIRE Review: 02/04/2010

Program Overview:

State:	District of Columbia
Incentive Type:	State Rebate Program
Eligible Renewable/Other Technologies:	Photovoltaics, Wind
Applicable Sectors:	Commercial, Residential, Nonprofit, Multi-Family Residential, Private Schools
Amount:	$3/W DC for first 3 kW installed capacity; $2/W DC for next 7 kW; $1/W DC for next 10 kW
Maximum Incentive:	$33,000 per site per program year
Eligible System Size:	1 kW DC minimum; system must be sized not to exceed on-site consumption
Equipment Requirements:	System must be new and have a performance meter; larger systems must have a performance meter with remote communications capability; system must carry a one-year warranty and meter must carry a five-year warranty.
Installation Requirements:	System must be grid-connected and installed by a licensed contractor; one-year warranty on installation required
Program Budget:	$2 million/yr for fiscal years 2009-2012
Ownership of Renewable Energy Credits:	Customer-generator
Funding Source:	Sustainable Energy Trust Fund (public benefits fund)
Expiration Date:	09/30/2012 (program year expiration each September)
Web Site:	http://green.dc.gov/green/cwp/view,a,1244,q,4...

Summary:
In February 2009, the District Department of the Environment (DDOE) introduced the Renewable Energy Incentive Program (REIP), a rebate for solar photovoltaic (PV) and wind energy systems. The REIP is funded through the Sustainable Energy Trust which is supported by a public benefits charge on utility bills. The DDOE ultimately plans to introduce incentives for additional technologies, including solar water heating, solar space heating, geothermal, and methane/waste gas capture.

Most PEPCO customers within the District of Columbia are eligible for incentives under this program; however, the federal government, the D.C. government, and public schools are specifically identified as ineligible. Systems must be at least 1 kW in order to qualify and should be sized not to exceed on-site energy consumption as measured for the previous 12 months. There is no maximum system size, although incentives are capped at $33,000 per site per fiscal year. The current incentives for solar and wind energy systems are as follows:

- $3/watt for first 3 kW installed capacity
- $2/watt for next 7 kW installed capacity

- $1/watt for next 10 kW installed capacity

Applicants must get a site assessment and conduct a pre-qualification application to get a reservation number. Once the pre-qualification application is approved, the applicant must complete a final application. If funds run out for a given year, applicants hold their place in line for one year with their reservation number and may receive funding the next year. The system must be completed within six months of the award date. If the system is not completed, the applicant may get a six month extension. If the system is not completed at the end of the extension, then the rebate must be returned to DDOE.

Projects must be located within the District of Columbia and applicants must be customers of Pepco. Projects receiving incentives must be grid-connected and must follow the interconnection, operation, and metering guidelines set by Pepco and the DC Public Service Commission. Large systems must have remote communication capabilities for monitoring of the performance meter.

For more information, please view the program guidelines .

Contact:

Green Energy DC
District Department of the Environment
Energy Division
51 N Street NE
Washington, DC 20002
Phone: (202) 673-6700
E-Mail: greenenergy@dc.gov
Web Site: http://ddoe.dc.gov/ddoe

Appendix Q – Energy Savings Calculations (Smart Power Strip Analysis)

Thesis

Timothy Conroy | Analysis IV - Energy Calcs. | Date: 1/28/2010

Number of Workdays per year = 5 days/wks × 52 wks/yr = 260 days

Power Usage

Workday: 8 hrs per 24 hrs (day)

Weekend: 0 hrs per 24 hrs (day)

Total Usage: 8(5) = 40 hrs per week (1 wk = 168 hrs)

Down Time: 168 - 40 = 128 hrs per week

128 hrs/wk × 52 wks/yr = 6,656 hr/yr

Elec. Rate: $0.1543 (Pepco Electric)

Elec Usage

Desktop PC (DELL): 235 watts = 0.235 kw

Monitor 22" (DELL): 22 watts = 0.022 kw

Total Savings:

Desktop PC: 6,656 hr/yr × 0.235 kw × 0.1543/kwhr = $241.35/yr

Monitor 22": 6,656 hr/yr × 0.022 kw × 0.1543/kwhr = $22.59/yr

Number of Computers: 400

Total Savings:

Desktop PC: $24.35 × 400 = $9,540/yr

Monitor 22": $22.59 × 400 = $9,038/yr

$10,578 per year

Building Lifespan: 50 yrs

Desktop PC: $96,540 × 50 yrs = $4,826,998

Monitor 22": $9,038 × 50 yrs = $451,889

$5,278,887 ($13,197 per computer)

Please refer to following Spreadsheet for more details

Energy Savings Calculation

Work Weeks		
	52	per year
Power Uasage		
Work Days	8	per day
Weekend	-	per day
Total	40	per week
Downtime	128	per week
	6,656	per year
Cost of Electricity[a]		
	$0.1543	per kwh
Electrical Usage		
Desktop PC (Dell)[b]	235	watts
Monitor 22" (Dell)[c]	22	watts
Savings		
Desktop PC (Dell)[b]	$241.33	per year
	1,564.16	*kW*
	2,052.96	*kW*
	76%	*annual savings*
Monitor 22" (Dell)[c]	$22.59	per year
	146.43	*kW*
	192.19	*kW*
	76%	*annual savings*
Number of Computers	400	
Total		
Desktop PC (Dell)[b]	$96,533.70	per year
	625,664.00	*kW*
Monitor 22" (Dell)[c]	$9,037.20	per year
	58,572.80	*kW*
Total	$105,570.90	per year
	684,236.80	*kW*

Building Lifespan	50 years
Desktop PC (Dell)[b]	$4,826,684.93
	31,283,200.00 kW
Monitor 22" (Dell)[c]	$451,859.87
	$2,928,640.00 kW
Subtotal	
	$5,278,544.79 per 50 yrs
	34,211,840.00 kW
	$13,196.36 per computer
	85,529.60 kW
Cost of Power Strip[d]	$29.99 per unit
	$11,996.00 total
Payback Period	
	1.4 months
Grand Total	
	$93,574.90 first year
	$105,570.90 each subsequent year
	$5,266,548.79 50 year span
	$13,166.37 per computer (50 yr span)

Notes:

[a] *Pepco. (2010, February 22). GENERAL SERVICE PRIMARY SERVICE. http://www.pepco.com/_res/documents/dc_schedule-gs-3a.pdf*

[b] *Dell. (n.d.). OptiPlex 280 Desktop Computer. Retrieved January 24, 2010, from Dell Small Buisness: http://www.dell.com/us/en/business/desktops/optiplex-380/pd.aspx?refid=optiplex-380&s=bsd&cs=04*

[c] *Dell. (n.d.). P2210 22inch Widescreen Monitor. Retrieved January 24, 2010, from Dell Small Buisness: http://accessories.us.dell.com/sna/products/Displays/productdetail.aspx?c=us&l=en&s=bsd&cs=04&sku=320-8103*

[d] *Best Buy. (n.d.). APC - 8-Outlet Surge Protector - White. Retrieved January 28, 2010, from BestBuy.com: http://www.bestbuy.com/site/APC+-+8-Outlet+Surge+Protector+-+White/9665532.p?id=1218142381283&skuId=9665532&st=surge protector&cp=1&lp=14*

Appendix R – Energy Savings Guide (Smart Power Strip Analysis)

Energy Savings Guide

Work Weeks		
	52	per year
Power Uasage		
Work Days	8	per day
Weekend	-	per day
Total	40	per week
Downtime	128	per week
	6,656	per year
Cost of Electricity[a]		
	$0.1543	per kwh
Electrical Usage		
Desktop PC (Dell)[b]	235	watts
Monitor 22" (Dell)[c]	22	watts
Savings		
Desktop PC (Dell)[b]	$241.33	per year
	1,564.16	*kW*
	2,052.96	*kW*
	76%	*annual savings*
Monitor 22" (Dell)[c]	$22.59	per year
	146.43	*kW*
	192.19	*kW*
	76%	*annual savings*
Number of Computers	1	
Total		
Desktop PC (Dell)[b]	$241.33	per year
	1,564.16	*kW*
Monitor 22" (Dell)[c]	$22.59	per year
	146.43	*kW*
Total	$263.93	per year
	1,710.59	*kW*

Building Lifespan	50 years
Desktop PC (Dell)[b]	$12,066.71
	78,208.00 kW
Monitor 22" (Dell)[c]	$1,129.65
	$7,321.60 kW
Subtotal	
	$13,196.36 per 50 yrs
	85,529.60 kW
	$13,196.36 per computer
	85,529.60 kW
Cost of Power Strip[d]	$29.99 per unit
	$29.99 total
Payback Period	
	1.4 months
Grand Total	
	$233.94 first year
	$263.93 each subsequent year
	$13,166.37 50 year span
	$13,166.37 per computer (50 yr span)

Notes:

[a] *Pepco. (2010, February 22). GENERAL SERVICE PRIMARY SERVICE. http://www.pepco.com/_res/documents/dc_schedule-gs-3a.pdf*

[b] *Dell. (n.d.). OptiPlex 280 Desktop Computer. Retrieved January 24, 2010, from Dell Small Business: http://www.dell.com/us/en/business/desktops/optiplex-380/pd.aspx?refid=optiplex-380&s=bsd&cs=04*

[c] *Dell. (n.d.). P2210 22inch Widescreen Monitor. Retrieved January 24, 2010, from Dell Small Business: http://accessories.us.dell.com/sna/products/Displays/productdetail.aspx?c=us&l=en&s=bsd&cs=04&sku=320-8103*

[d] *Best Buy. (n.d.). APC - 8-Outlet Surge Protector - White. Retrieved January 28, 2010, from BestBuy.com: http://www.bestbuy.com/site/APC+-+8-Outlet+Surge+Protector+-+White/9665532.p?id=1218142381283&skuId=9665532&st=surge protector&cp=1&lp=14*

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