Environmental Studies Lab: Expansion

East coast, USA

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Tech Report 2
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Executive Summary

The technical report 2 was a cost and schedule analysis. The report consists of a detailed project schedule, a detailed structural systems estimate, an assemblies MEP estimate, site layout plans, a general conditions estimate, constructability challenges, and a BIM execution plan for The Environmental Studies Lab: Expansion.

The detailed project schedule was developed using Primavera. The construction began on October 31, 2011 and ended February 22, 2012. This schedule is organized by trade: earthwork, concrete, structural steel, miscellaneous metals, HVAC, electrical, fire suppression, plumbing, curtain wall, and specialty trades.

The detailed structural estimate was performed by taking a modular of several areas of the building depending on how similar each area was. Items such as slab on grade, slab on metal decking, column members, beams, and concrete were taken off. The total for this system was $2.1 million which is about $1.4 million short of the contract value.

When performing an MEP assemblies estimate, R.S. Means does not account for specific systems in the building. Several different packages were accounted for when executing the mechanical, electrical and plumbing takeoffs. The total for the MEP assemblies estimate was $3.9 million while the contract value is $11.6 million. This is a $7.7 million difference.

There are three critical phase of construction for The Environmental Studies Lab: Expansion, excavation, superstructure and finishes. Each are demonstrate a possible layout of construction at those particular phases.

The general conditions estimate included supervision and other project expenses. The other project expenses consisted of items such as safety equipment, office equipment, and temporary services. This total came to $3.9 million.

There were 3 major constructability challenges considered for this report. The confusion over the exterior skin delayed the schedule. The lack of coordination of MEP overhead rough-in delayed the schedule and also added cost to the project. The last challenge dealt with the cistern foundation and entry porch. All constructability challenges were resolved.

Building Information Modeling (BIM) was not used much on this project. In this report, there is an execution plan to implement BIM as well as a process map.

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Project Schedule

The overall duration for this project is 22 months from Notice to Proceed to Turnover. However, the project was extended due to constructability issues (which is not accounted for in this schedule). Notice to Proceed was June 1, 2011 and Turnover on the Environmental Studies Lab was April 22, 2013. The critical path for this building occurs during excavation, steel erection, most MEP overhead rough-ins, and ceiling close-ins.

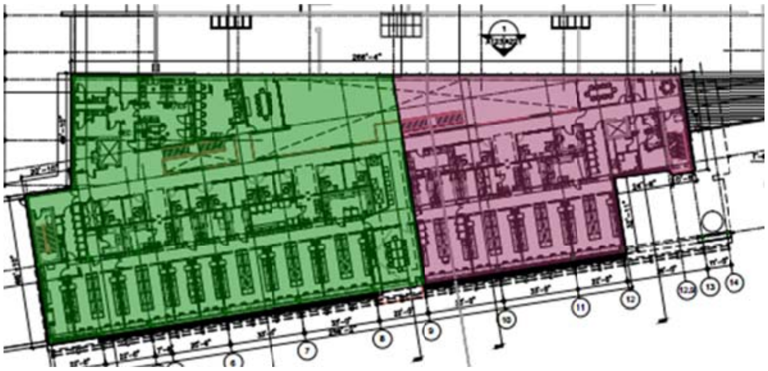


Figure 1 Sequencing

For easier, more manageable construction, the construction was phased into sequences that broke up the building into two sections: S2 and S3. S2 is the east side of the building (green) while S3 was the west side (purple), as shown in **Figure 1**. The basement was only in S3 while the penthouse was mainly in S2, but entered a little bit into S3. The construction on the inside went from west to east while some of the outside construction went east to west. This may have been because certain subcontractors could finish an area without needing to wait on another subcontractor to finish first.

See Appendix A for sequencing and project schedule

Earthwork

The earthwork on this schedule includes all excavation for the basement/foundation footings as well as for the weir walls, which plays a big factor in the wetlands. Excavation for the footings started in November 2011 while the excavation for the landscaping did not start until seven months later.

Concrete

Immediately after the footings were dug, Hensel Phelps (the general contractor) started forming, reinforcing, and pouring the footings (FRP) for the basement. The retaining wall and slab on grade (SOG) came shortly after. The basement level only has a SOG for S3, while the first floor foundation occurs in S2. After the foundation in the basement is poured, the FRP of the slab on metal decking (SOMD) is completed for S3 on level 1. The building continues to be poured in the order of S3 and then S2. A couple months after placement is done in the building, the site work begins. This is so Hensel Phelps can use their craft efficiently and effectively.

Structural Steel

Structural steel includes the erecting of columns and beams as well as installing decking and details. Since the basement was slab on grade, there was only the erecting of columns and beams in S3. This was followed by the installation of the metal decking and detailing of S3 for level 1. Then the erecting of columns and beams in S2 on level 1 was next since there was just SOG on level 1 S2 followed by the erecting of columns and beams on S3. On level 2, erecting the columns for S3 and installing the decking and detailing occurred at the same time. This is to speed up the installation process so the building can be enclosed as soon as possible. The topping out occurred on April 13, 2012 when the columns and beams were erected in S2.

Miscellaneous Metals

Before topping out occurs, the subcontractors started working on the building enclosures. In the basement, the metal framing and metal panels started and were finished about a month apart. The metal framing for the building was started and finished before the panels were even started on all the floors except the penthouse. The sequencing for this installation was also different than the concrete and structural steel. For level 1 and level 2 the order went as follows: install metal framing S3, install metal framing S2, install metal panels S2, and install metal panels S3. This order could have been to avoid work delay from subcontractors waiting on others to finish.

HVAC

The first activity that occurs on site is the excavation and drilling for the geothermal wells. This occurs on October 31, 2011 until January 11, 2012. The three vaults are immediately installed. After this, the excavation and the installation of the supply and return piping for the 250 geothermal wells occurred and took 70 days to complete. While the site work was happening, there were twelve water to water heat pumps being installed in the centralized utility plant (CUP). Most of the HVAC work in the basement happens in the CUP, including the installation of air handling unit four. Level 1 and level 2 were sequenced such that once one section was done the next section was started in both directions. For example, the installation of the ductwork on level 1 S3 started July 10, 2012 and ended August 6, 2012. On August 7, 2012 the installation for the ductwork in S2 began; and on August 2, 2012 the installation of ductwork on level 2 in S3 began. In the penthouse, air handling units 1A, 1B, 2A, and 2B were installed at the beginning of May.

Electrical

One of the new key electrical features to The Environmental Studies Lab was a new transformer that was installed in July 2012. There was electrical conduit that had to be installed in the basement slab. This had to be coordinated so the electrical contractor could rough-in the conduit before the slab was poured. This was also the case for the foundation slab in level 1. On each floor there were automated transfer switches that needed to be installed, set, and piped. The in wall (IW) rough-in branch electric was sequenced so that S3 was completed and immediately continued to S2. However, in the penthouse, S2 was completed on October 15, 2012 but S3 wasn't started until November 8, 2012.

Fire Protection

All steel beams had spray fire proofing that was coated on shortly after the beams were erected. The overhead (OH) rough-in for the fire protection started in the basement on April 7, 2012. In S3, it took twelve days while in S2, it only took 8.

Plumbing

On each floor, in each section, there was installation of storm, industrial waste, domestic water supply for hot and cold (H/C), and industrial water supply for H/C piping. All of S3 for each type of pipe was completed before S2 was completed. However, the different types of pipes were started at the same time. An example would be, the IW rough-in for the industrial pipe, domestic water supply H/C pipe, and Industrial water supply H/C pipe for level 1 S3 was started on June 21, 2012. After all three pipes were completed in S3, IW rough-in would be started for the same pipes in S2. This was the same for level 2 and the penthouse.

Curtain wall

The curtain wall system took a total of 63 continuous days to complete. On level 1 and level 2, installation started in S2 and went to S3. However, in the penthouse it started at S3 and finished in S2 on August 13, 2012.

Specialist Trades/Services

To help with storm-water runoff, a cistern was installed. The installation for the vault occurred when the excavation for the geothermal wells was happening so they could tie into each other. Installation of the cistern itself did not happen till months later. The fiber cement siding on the outside of the building was started shortly after the metal panels were started. The contractor that installed the fiber cement siding was directly behind the contractor who installed the metal panels. This means that the metal panels contractor could not be delayed because it would hold up the other contractor. The roof membrane for the building took twenty days to install and was finished June 13, 2012. In the basement, level 1, level 2, and the penthouse, the dry wall was hung before the walls were painted, which was followed by the finishes of the floors. The final walls in the penthouse were finished being painted on February 22, 2012, just two months before the turnover of the building.

Estimates

The cost of construction for The Environmental Studies Lab: Expansion is roughly $39,000,000 with the total project cost being $42,000,000. The detailed structural system estimate and the mechanical, electrical, and plumbing (MEP) assemblies estimate is generated by using R.S. Means.

See Appendix B for estimate break down.

Structural Systems Estimate

The main components of the structural systems estimate were: concrete, reinforcing, steel members, and metal decking. It was compiled by taking a modular of the building and generating a multiplier for that component. The multiplier is found by taking the area of the floor/similar section and dividing it by the modular chosen. However, it was necessary to take several different modulars in order get all the different materials accounted for.

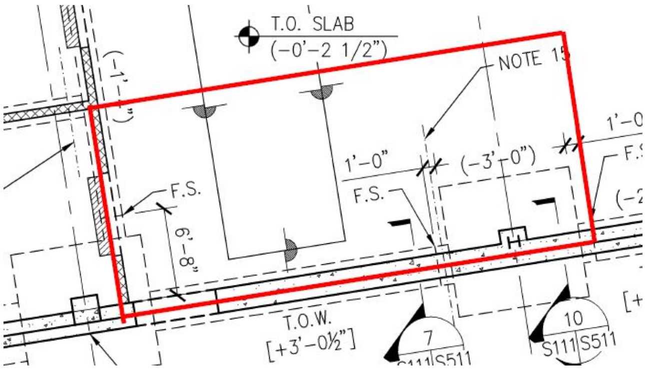


Figure 2 Basement Foundation

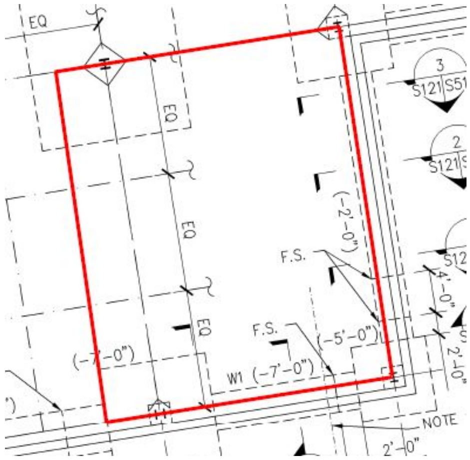


Figure 3 First Floor Foundation

The basement foundation, **Figure 2,** had a different modular than the first floor foundation, **Figure 3,** (S2). This was mainly because the slab type was different. Since it was two big areas that had the different types of slab on grade, combining would not make for an accurate estimate. Other than that, everything else was similar. The difference in the slab was the basement had a 6" slab at 3500 psi with a W2.0xW2.0 welded wire fabric (WWF), while the first floor foundation had a 4" slab with WWF of W1.4xW1.4. From the R.S. Means, the rebar for columns, footings, and walls were grouped together by type and size: #3-#7 and #8-#18. The modular for the basement foundation had an interior wall that was CMU masonry with a concrete footer. However, the masonry was not included in this estimate. Both foundation systems had similar columns that were assumed to be close to W10x45 per R.S. Means. Each section of the columns was assumed to be 15' in length unless otherwise specified in the column schedule. All of the quantities calculated were rounded up to include waste and any error in takeoffs on the drawings. The multiplier for the basement foundation was 20.2, which made the total basement foundation to be $395,948. The first floor foundation multiplier was calculated to be 19.0, which gave a total of $648,519.

The next part of the building that was grouped together is first floor (S3) and the whole second floor **Figure 4**. There was a lot less to this section because the floor is now slab on metal decking. The concrete for the slab on metal decking was 6" thick with WWF of W1.4xW1.4. The floor decking was found to be 3" 18 gage per the drawings. The modular for this area had similar beams throughout the floor: W24x68 and W24x76. When calculating the multiplier for this area it came to be 46.2. This brings a total of $548,719 for this part of the building.

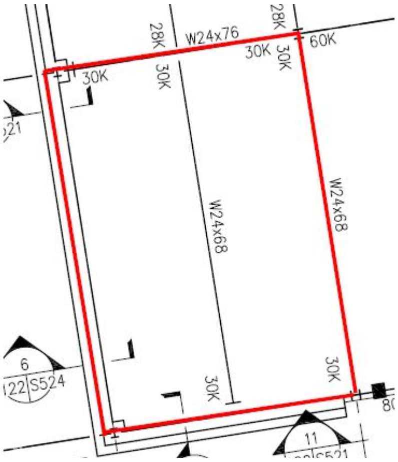


Figure 4 Modular

The rest of the building, **Figure 5**, the roof, did not have any concrete. It had roof decking, which was found to be 1.5" deep 18 gage per the drawing notes. The typical modular for the roof included W16x26, W24x55, and W24x76 beams. The total for this modular came to be $536,200 using a multiplier of 36.4.

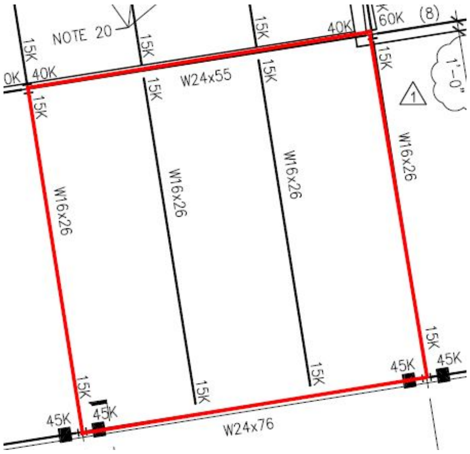


Figure 5 Roof Modular

After totaling each modular, the outcome of the structural systems estimate came to be $2,129,386. This was about $1.4 million short of what the contract value of the structural system was contracted for. The contract value for the structural system includes two different rebar subcontractors. One contractor supplied the rebar, and the other supplied and installed the rebar. There was also another contractor that did all the steel in the building that was included in this contract value. The concrete was self-performed by the general contractor; these contract values included material, pump truck, and labor. Since the contract value is what is being compared to the estimate, it could include other costs that are in that subcontractor's scope of work rather than just the structural cost. The costs also differ because the estimate was taken from modulars rather than a takeoff of the entire building.

MEP Assemblies Estimate

The MEP assemblies estimate is a rough estimate of the building systems. It gives a general idea of the cost of the systems unlike a detailed unit estimate. The cost for this estimate was put together using R.S. Means. which was not tailored to The Environmental Studies Lab: Expansion.

The electrical assembly was broken down into lighting fixtures, receptacles, switchgear, panelboards, feeders, and a generator. When finding both the lighting fixtures and receptacles, a typical bay was used to determine the correct assembly. R.S. Means gave the option for a number of items per square feet, which is what was used for this estimate. There are two switchgears in the building: the main switchgear and the emergency switchgear. The assemblies for the switchgear included the installation, panels and circuit breakers for the sizes found in the schedule. There were 55 panel boards in the building that include four wires with conductor and conduit per the drawings and the assembly. The whole building hooks into one generator that runs at 750 kW that was included in the electrical assemblies. The total for this assembly came to $1,822,009. The contract value for the actual electrical system is $2.8 million. This is a difference of about $1 million.

The assembly estimate for the mechanical system was difficult because the system is very intricate. In The Environmental Studies Lab: Expansion, there are twelve water-to-water heat pumps and 29 water source heat pump air conditioning units. In R.S. Means, there wasn't distinction between the two so they were lumped together for this estimate. There is one boiler in the whole building that was found in the assemblies estimate. The air handling units were lumped into an assembly that included self-contained, water cooled air conditioner unit and ductwork. This was based on the square footage of the area in which the air handlers are located, the roof. The fin tube radiation was a big cost because there were only two of them serving the whole building. The total for the mechanical cost was $1,809,135.

The plumbing assemblies estimate was based a lot on items rather than square footage or length. This estimate accounted for toilets, showers, drinking fountains, sinks, and special lab sinks. There is two sinks in each of the big labs and at least one sink in the support labs. There were also four electric water heaters accounted for in this estimate. A rough takeoff was performed on the domestic water pipe and industrial water pipe. These were assumed to be the same type of PVC pressure pipe at ½" diameter. The plumbing total was estimated to be $260,183.

The total of all three systems was calculated to be $3,891,326. This is very low compared to the contract values for the MEP contractors. Since the mechanical contractor is the same as the plumbing contractor, the contract value is one number, $8.8 million. When combining the mechanical estimate and the plumbing estimate, the total comes to $2,069,317. This is a $6,730,083 difference, **Table 1**.

	Assemblies	Contract
Electrical	$1,822,009	$2,800,000
Mechanical	$1,809,135	$8,800,000
Plumbing	$260,183	
Total	$3,891,327	$11,600,000

Table 1 Assemblies Estimate

The reason that all of these numbers are so far off is because R.S. Means does not account for every specific item. Also included in the mechanical contract were 250 geothermal wells that R.S. Means assembly does not account for. It also does not consider individual ductwork, piping and fitting in the building, which can be very costly. Not having those in an estimate can really bring the price down.

Site Layout

Excavation was the first critical phase of construction for The Environmental Studies Lab: Expansion. The excavation of both the expansion and the geothermal wells occurred simultaneously. There were two excavators on site for this, one for the geothermal contractor and one for the general contractor, **Figure 6**. There was a haul road created between the two excavated areas that was used by the excavators. The excavation went from the west end of the site to the east end of the site. The laydown and connex area was close to the fence and construction entrance for easy access.

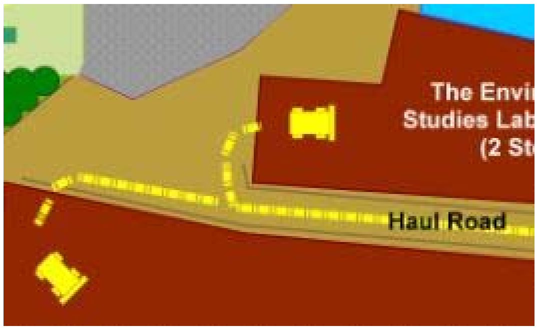


Figure 6 Excavation Site Plan

The next critical phase of construction was the superstructure. There were two crawler cranes on site for this phase. One crane was for steel and the other was for concrete. The site only needed crawler cranes because it is only a two story building with a mechanical penthouse, **Figure 7**. Since concrete started this phase, there was a concrete washout area needed for the concrete trucks after a pour. The laydown area was extended and another entrance was added. This is because more subcontractors are starting to come on site in this phase and they need the space for their materials. There was also a loading dock added to the northwest end of the building. In order for the deliveries to get back there, they must go around the existing building. The soil from the excavation was moved to the edge of the site into stockpiles. Since the site is accommodating wetlands, the general contractor made a pond for the water to runoff into which runs off into a bigger body of water. There is an area of sediment rocks next to the pond that the water runs over. This is to collect any extra unwanted particles in the pond.

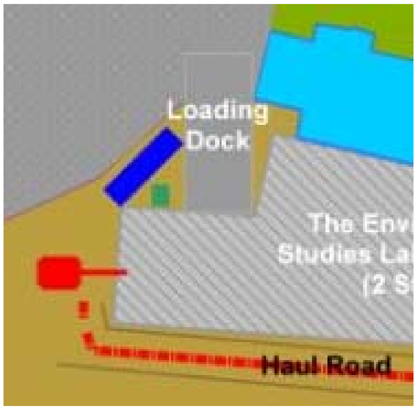


Figure 7 Superstructure Site Plan

The final critical phase for this project was the finishes phase. In this phase, more of the site work itself was being developed and work had shifted to mainly inside the building. A parking lot was added for the subcontractors since there was need for different subcontractors. The haul road was moved more south of the building because construction started on the site, **Figure 8**.

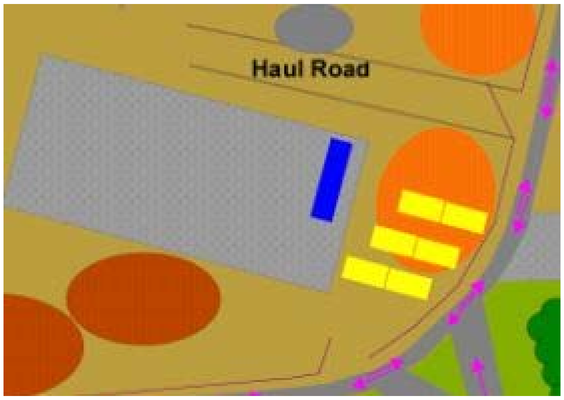


Figure 8 Finishes Site Plan

There were concrete weir walls being poured on the site to assist with wetland runoff. Most of the construction traffic would enter through the southeast entry way, however when the entry porch was being poured, traffic had to be directed to the loading dock area. This lasted the day of the pour and then foot traffic went back to the front entry porch.

Throughout the project, the trailers and walkways did not have to be moved. There were times when there was construction done close to the pedestrian walkway. This problem was resolved by rerouting traffic for a few days or until that section was completed. Traffic flow is not heavy back in this area because it is strictly for the scientist and other unknown buildings that require clearance to gain access to.

See Appendix C for site layout plans

General Conditions

The general conditions estimate includes all project and staffing costs. The staffing included in the general conditions estimate reflects the staffing plan presented in technical report 1. However, they were not all needed for the entire duration of the project, June 1, 2011 to April 22, 2013. The project engineer needs to be on the project the entire duration to handle financials. The project manager and project superintendent need to be there for some of procurement, the construction phase and into commissioning. Everybody else is at different durations depending on when they are needed on the project. The total for the supervision for this general condition came to $2,733,625.

Other general conditions cost include office equipment, safety equipment, temporary systems, and miscellaneous equipment costs. The total cost for the office equipment was $54,600. This cost included the copier and server, IT fee, miscellaneous office supplies, postage and stamping, field engineer equipment, telephones, the office trailer itself and the setup of it. The safety equipment included items such as hardhats, gloves, glasses, etc. Hensel Phelps gave out safety awards to their craft monthly. Other safety items included on the general conditions were hole protection during excavation and the maintenance to keep it up. It also included temporary handrails and barricades. Temporary systems that were accounted for in the general conditions consisted of fire protection, sanitary facilities, heating and electricity, and project fencing. Since Hensel Phelps self-performs concrete work, they included small concrete equipment and miscellaneous power equipment in the general conditions estimate. The other miscellaneous equipment included were the forklift and crane, and the fuel they use. There were two consultants that came in to assist with certain issues. A building envelop consultant, which is just a third party, came in and took a look at where there may be possible issues. They also hired an industrial hygienist to identify what hazards may come about that they should take preventative measures for. **Figure 9** shows these cost broken out.

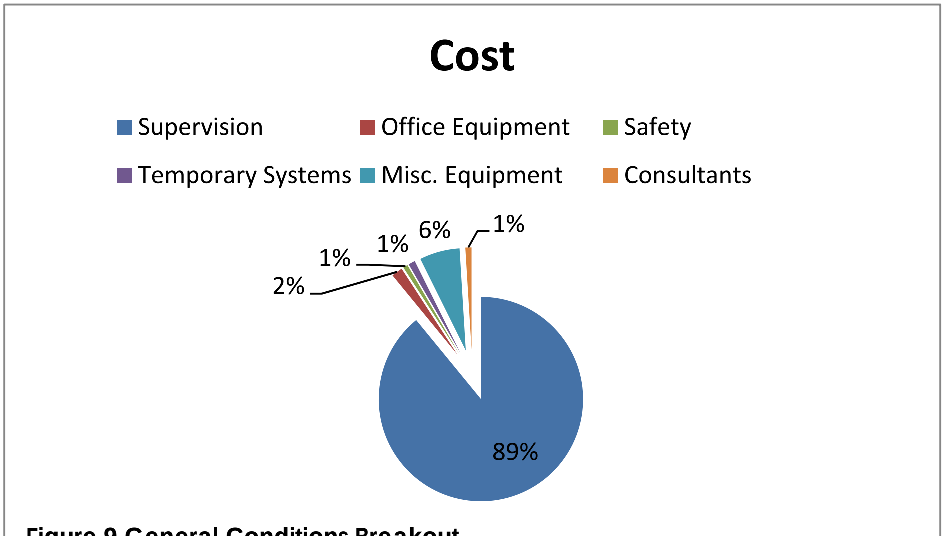


Figure 9 General Conditions Breakout

The overall cost for the general conditions with the staffing and project expenses came to $3,287,751. Including a 1.5% cost for bonds and insurance, the total came to $3,862,251.

See Appendix D for general conditions break down.

Constructability Challenges

Exterior Skin

Around the building is a very intricate façade and structure. The façade consists of brick veneer, fiber cement siding, curtain wall system, and metal panels alternating up the side of the building. Behind everything except for the curtain wall system, lays the same detailed structure. This system consists of 4" insulated metal panels, 6" cold form metal framing and then metal studs. The 6" cold form metal framing is sitting between steel tubing. The issue with the drawings was that the air vapor barrier (AVB) did not provide a true AVB. There were multiple request for information (RFI) written concerning this issue. The first RFI concerned where the AVB should be placed. It was decided that it should be located on the inside face of the 4" insulated panel and continue over the steel tube. After that issue was resolved, the architect, the general contractor, and the subcontractors that are involved met to coordinate the proper method of developing the AVB. **Figure 10** shows an example of what the meeting came up with and **Figure 11** shows the response to the RFI of what should be happening. It was decided that there was going to be a blue skin, which is a water proof membrane, to act as an AVB.

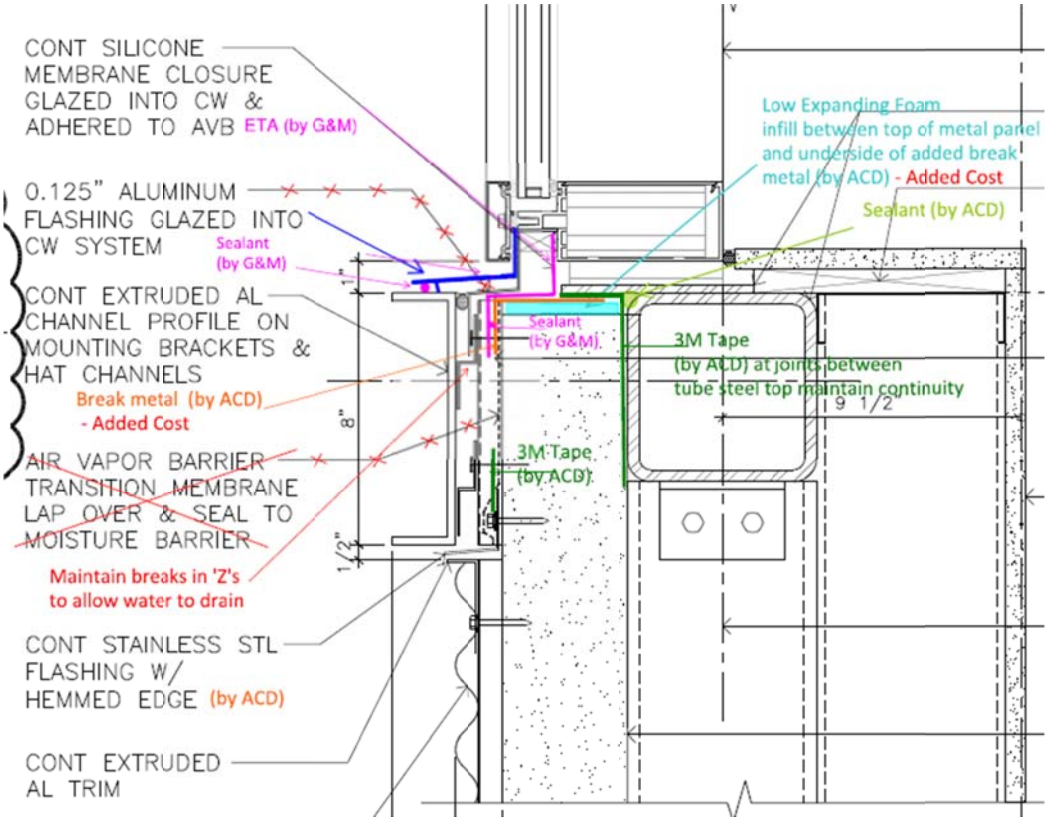


Figure 10 AVB Proposed Solution

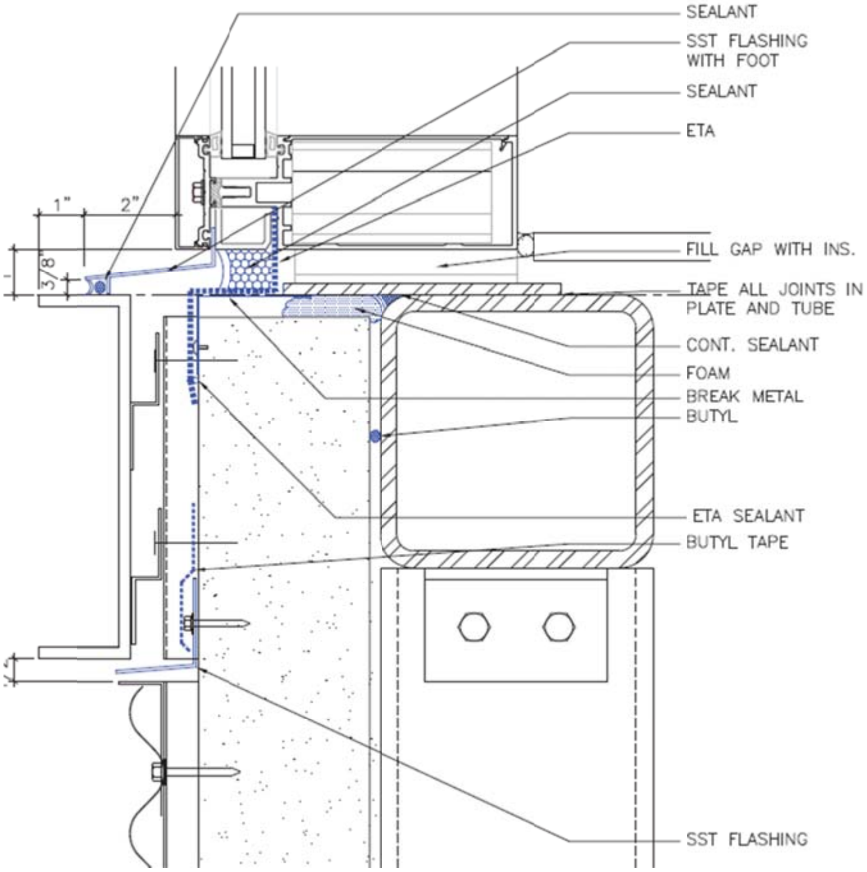


Figure 11 AVB Solution

Coordination MEP Overhead Rough-In

The coordination for the MEP overhead rough-in was difficult for each system. Everything clashed with the ductwork. The electrical drawings did not show how to run the conduit in certain areas which ended up interfering with the duct locations. The biggest issue with the overhead rough-in was the sprinklers and the duct clashing. Unfortunately this problem was not caught before both systems were installed and it had to be fixed out in the field. It was decided that the sprinkler pipe had to be moved since there was more room to move that pipe rather than move large ductwork. This whole issue may have been avoided if the designers ran a clash detection. There was a meeting to look for clashes in the drawings but nothing was ever coordinated and tested for a clash.

Cistern Foundation

The cistern concrete foundation was installed on January 6, 2012. It is located on the entry porch way. According to drawing detail 4/S514, **Figure 12,** there are #4 dowels at a spacing of 24” o.c. that are supposed to tie into the entrance slab. However, due to the constructability, this was not possible. The general contractor suggested drilling and epoxying the #4 dowels. This was approved but was strongly advised to follow the manufacturer’s instructions when it came to the drilling and cleaning the holes. This is because all the dust has to be clear of the hole. It is typically not the best idea to drill and epoxy rebar into concrete because it does not bond as well. Rebar is supposed to be placed before the concrete so they can bond together and create a stronger foundation.

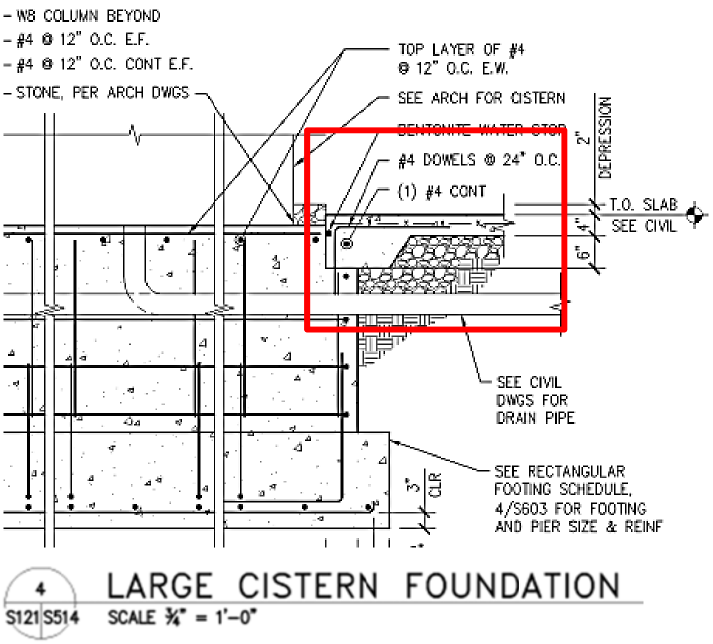


Figure 12 Cistern Foundation Detail

BIM

The Environmental Studies Lab: Expansion did not use much Building Information Modeling (BIM). However, a 3D model was created and Navisworks was used. The Navisworks model was not used for clash detection though. **Table 2** shows where BIM could have been used.

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING		DESIGN AUTHORING		SITE UTILIZATION PLANNING		BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS	X	DESIGN REVIEWS	X	CONSTRUCTION SYSTEM DESIGN		BUILDING SYSTEM ANALYSIS
		X	3D COORDINATION	X	3D COORDINATION		ASSET MANAGEMENT
			STRUCTURAL ANALYSIS		DIGITAL FABRICATION		SPACE MANAGEMENT / TRACKING
			LIGHTING ANALYSIS		3D CONTROL AND PLANNING		DISASTER PLANNING
			ENERGY ANALYSIS		RECORD MODELING		RECORD MODELING
			MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
			SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
X	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION		COST ESTIMATION		COST ESTIMATION		COST ESTIMATION
X	EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING

Table 2 BIM Possibilities

See Appendix E for BIM process map

Phase Planning (4D Modeling):

A 4D model would be useful on The Environmental Studies Lab: Expansion for several reasons. It would make it easier to plan for the phase development and sequence. This would also point out sequencing and scheduling issues. A 4D model can be used to make for easier operations and constructability. Since this project ended up being delayed, a 4D model may have been a preventive measure to help get the project done in time.

Design Reviews

In a design review, stakeholders review the 3D model and essentially get a preview and give their opinion of the building. Having different opinions creates alternatives which the owner may like better. It could also shorten the design process. A design would help with communication and coordination between all parties involved on the project which could reduce the amount of conflict on the project.

3D Coordination

3D coordination was used on The Environmental Studies Lab: Expansion, but it may not have been used properly. Since clash detection would have greatly helped the project reduce coordination issues, 3D coordination would have helped. It increases productivity and reduces the construction cost and time.

Existing Conditions Modeling

This is a where a model is developed by surveying techniques to show the existing conditions and facilities. This model can be used in the future if there needs to be more work on the site. It would also be valuable because it is a good source for “pre-disaster planning”. Since there was a lot of layout for the site on this building, the existing conditions model would have been useful because it does provide detailed layout information.

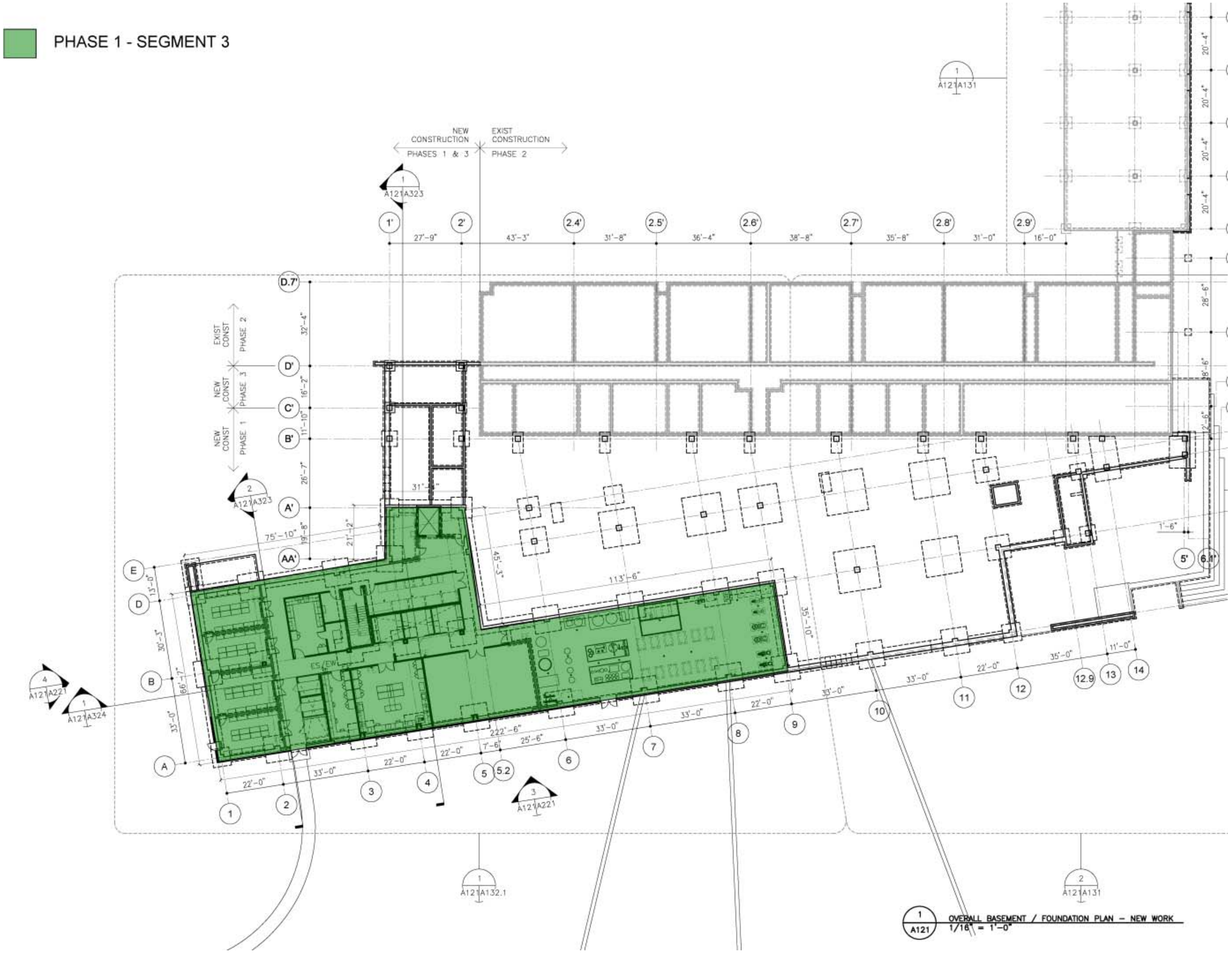
Construction Systems Design (Virtual Mockup)

This process would have been very useful because of its application. It is used to analyze and design intricate systems. Since the exterior skin was so complex and difficult to coordinate, this would have saved a lot of time. Another very good aspect of the construction systems design is it increases safety attentiveness for the system.

The most valuable system that could have been used on this project was the 3D coordination. It would have reduced time and money if a clash detection was used. The coordination issues would have been discovered and avoided with the MEP overhead rough-in.

Appendix A: Sequencing and Project Schedule

🟩 PHASE 1 - SEGMENT 3



1 A121 OVERALL BASEMENT / FOUNDATION PLAN – NEW WORK
1/16" = 1'-0"

🟪 PHASE 1 - SEGMENT 2

🟩 PHASE 1 - SEGMENT 3

🟦 PHASE 2 - SEGMENT 1

🟧 PHASE 2 - SEGMENT 2

🟥 PHASE 2 - SEGMENT 3

1 A122 OVERALL FIRST FLOOR PLAN – NEW WORK
1/16" = 1'-0"

🟪 PHASE 1 - SEGMENT 2

🟩 PHASE 1 - SEGMENT 3

1 A123 OVERALL SECOND FLOOR PLAN – NEW WORK
1/16" = 1'-0"

🟪 PHASE 1 - SEGMENT 2

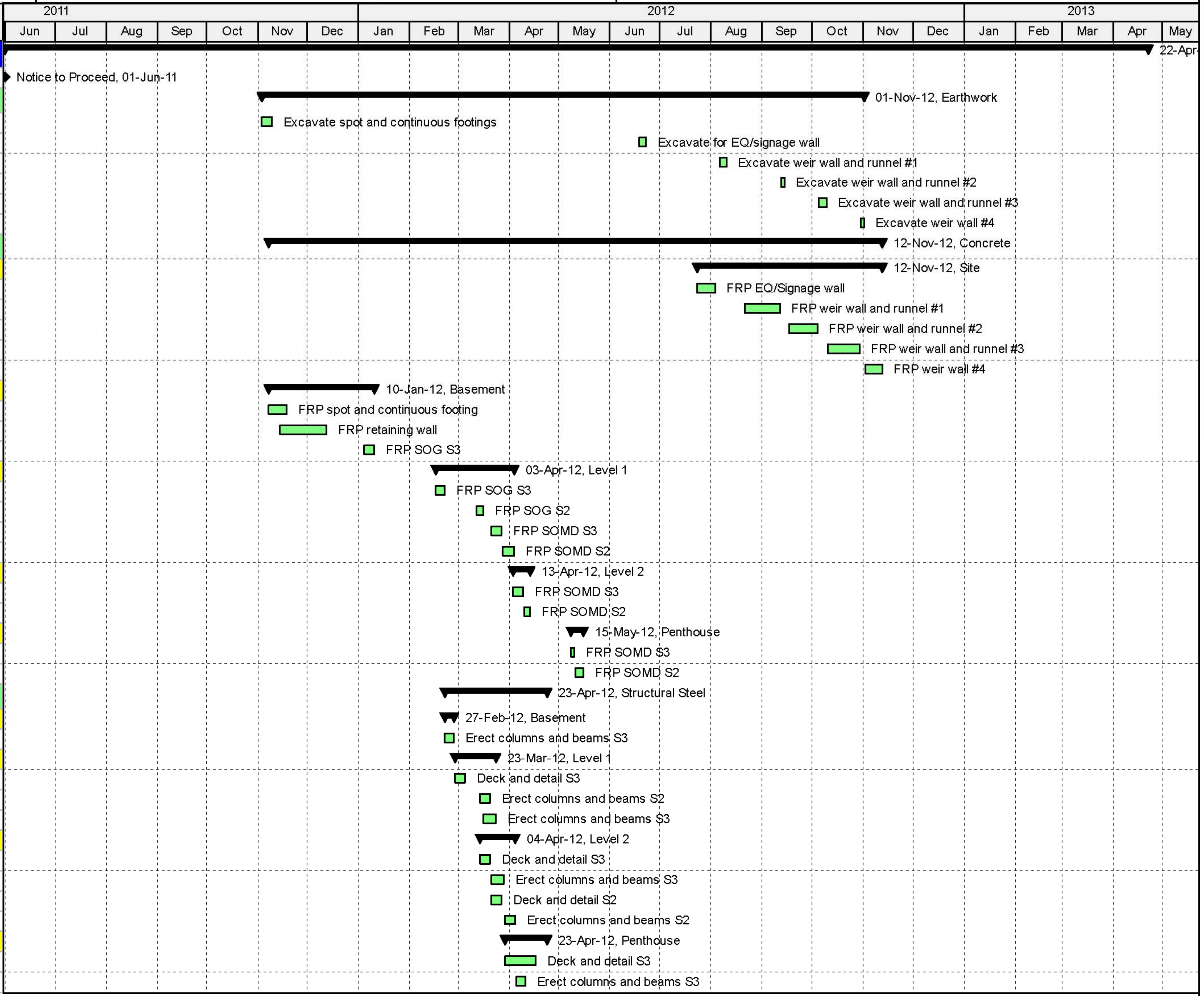
🟩 PHASE 1 - SEGMENT 3

1 A124 OVERALL PENTHOUSE PLAN – NEW WORK
1/16" = 1'-0"

Classic Schedule Layout

15-Oct-13 03:29

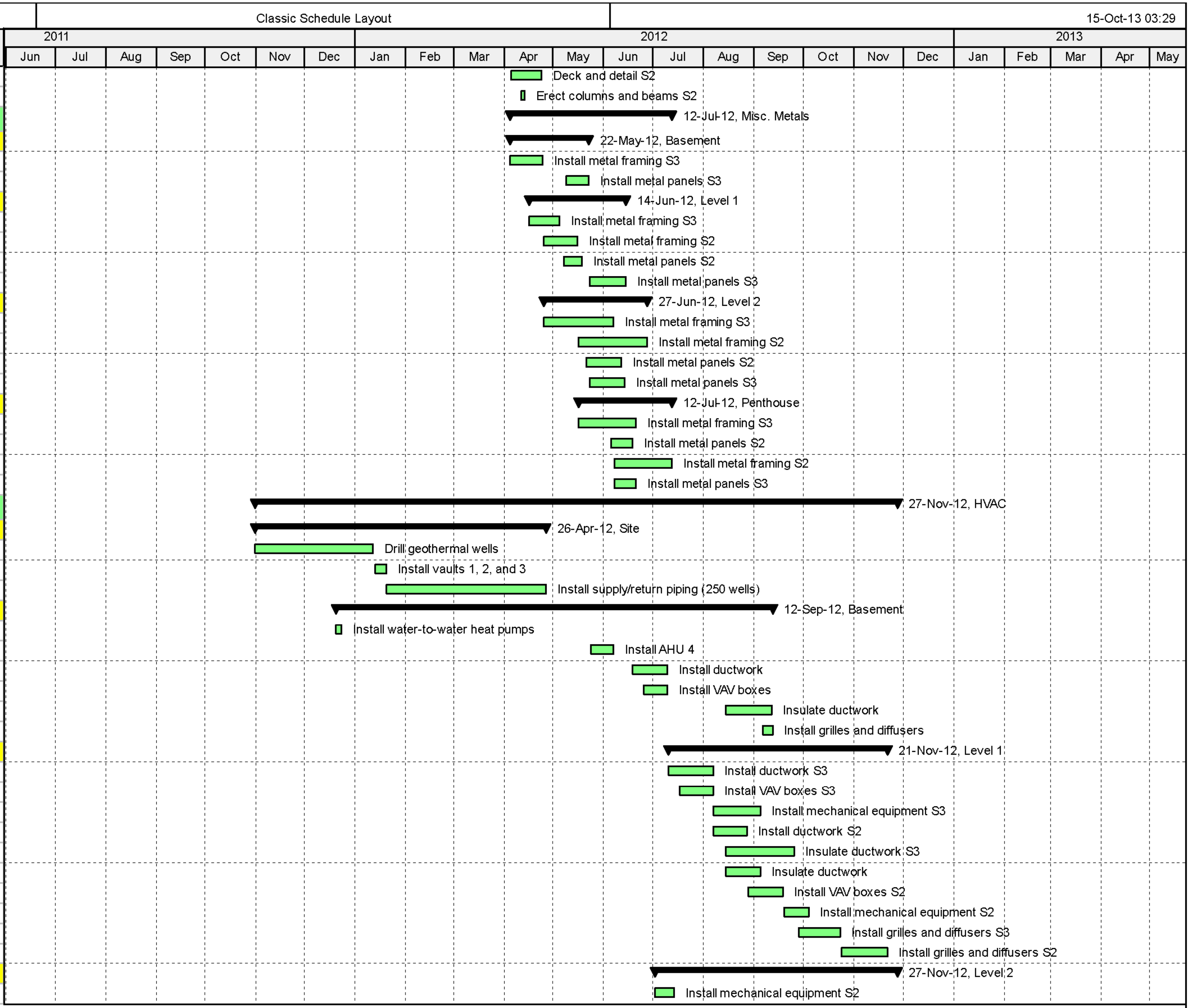
#	Activity Name	Original Duration	Start	Finish
1	**Detailed Schedule**	483	01-Jun-11	22-Apr-13
2	Notice to Proceed	0	01-Jun-11	
3	**Earthwork**	255	03-Nov-11	01-Nov-12
4	Excavate spot and continuous footings	5	03-Nov-11	09-Nov-11
5	Excavate for EQ/signage wall	5	18-Jun-12	22-Jun-12
6	Excavate weir wall and runnel #1	5	06-Aug-12	10-Aug-12
7	Excavate weir wall and runnel #2	3	12-Sep-12	14-Sep-12
8	Excavate weir wall and runnel #3	3	05-Oct-12	09-Oct-12
9	Excavate weir wall #4	3	30-Oct-12	01-Nov-12
10	**Concrete**	260	07-Nov-11	12-Nov-12
11	**Site**	80	23-Jul-12	12-Nov-12
12	FRP EQ/Signage wall	10	23-Jul-12	03-Aug-12
13	FRP weir wall and runnel #1	15	21-Aug-12	11-Sep-12
14	FRP weir wall and runnel #2	14	17-Sep-12	04-Oct-12
15	FRP weir wall and runnel #3	14	10-Oct-12	29-Oct-12
16	FRP weir wall #4	7	02-Nov-12	12-Nov-12
17	**Basement**	44	07-Nov-11	10-Jan-12
18	FRP spot and continuous footing	10	07-Nov-11	18-Nov-11
19	FRP retaining wall	20	14-Nov-11	12-Dec-11
20	FRP SOG S3	5	04-Jan-12	10-Jan-12
21	**Level 1**	34	16-Feb-12	03-Apr-12
22	FRP SOG S3	4	16-Feb-12	21-Feb-12
23	FRP SOG S2	5	12-Mar-12	16-Mar-12
24	FRP SOMD S3	5	21-Mar-12	27-Mar-12
25	FRP SOMD S2	5	28-Mar-12	03-Apr-12
26	**Level 2**	9	03-Apr-12	13-Apr-12
27	FRP SOMD S3	5	03-Apr-12	09-Apr-12
28	FRP SOMD S2	4	10-Apr-12	13-Apr-12
29	**Penthouse**	6	08-May-12	15-May-12
30	FRP SOMD S3	3	08-May-12	10-May-12
31	FRP SOMD S2	3	11-May-12	15-May-12
32	**Structural Steel**	44	22-Feb-12	23-Apr-12
33	**Basement**	4	22-Feb-12	27-Feb-12
34	Erect columns and beams S3	4	22-Feb-12	27-Feb-12
35	**Level 1**	19	28-Feb-12	23-Mar-12
36	Deck and detail S3	5	28-Feb-12	05-Mar-12
37	Erect columns and beams S2	5	14-Mar-12	20-Mar-12
38	Erect columns and beams S3	6	16-Mar-12	23-Mar-12
39	**Level 2**	16	14-Mar-12	04-Apr-12
40	Deck and detail S3	5	14-Mar-12	20-Mar-12
41	Erect columns and beams S3	6	21-Mar-12	28-Mar-12
42	Deck and detail S2	5	21-Mar-12	27-Mar-12
43	Erect columns and beams S2	5	29-Mar-12	04-Apr-12
44	**Penthouse**	18	29-Mar-12	23-Apr-12
45	Deck and detail S3	13	29-Mar-12	16-Apr-12
46	Erect columns and beams S3	4	05-Apr-12	10-Apr-12



▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
▬ Actual Work	🟥 Critical Remaining Work	▼▼ summary

TASK filter: All Activities

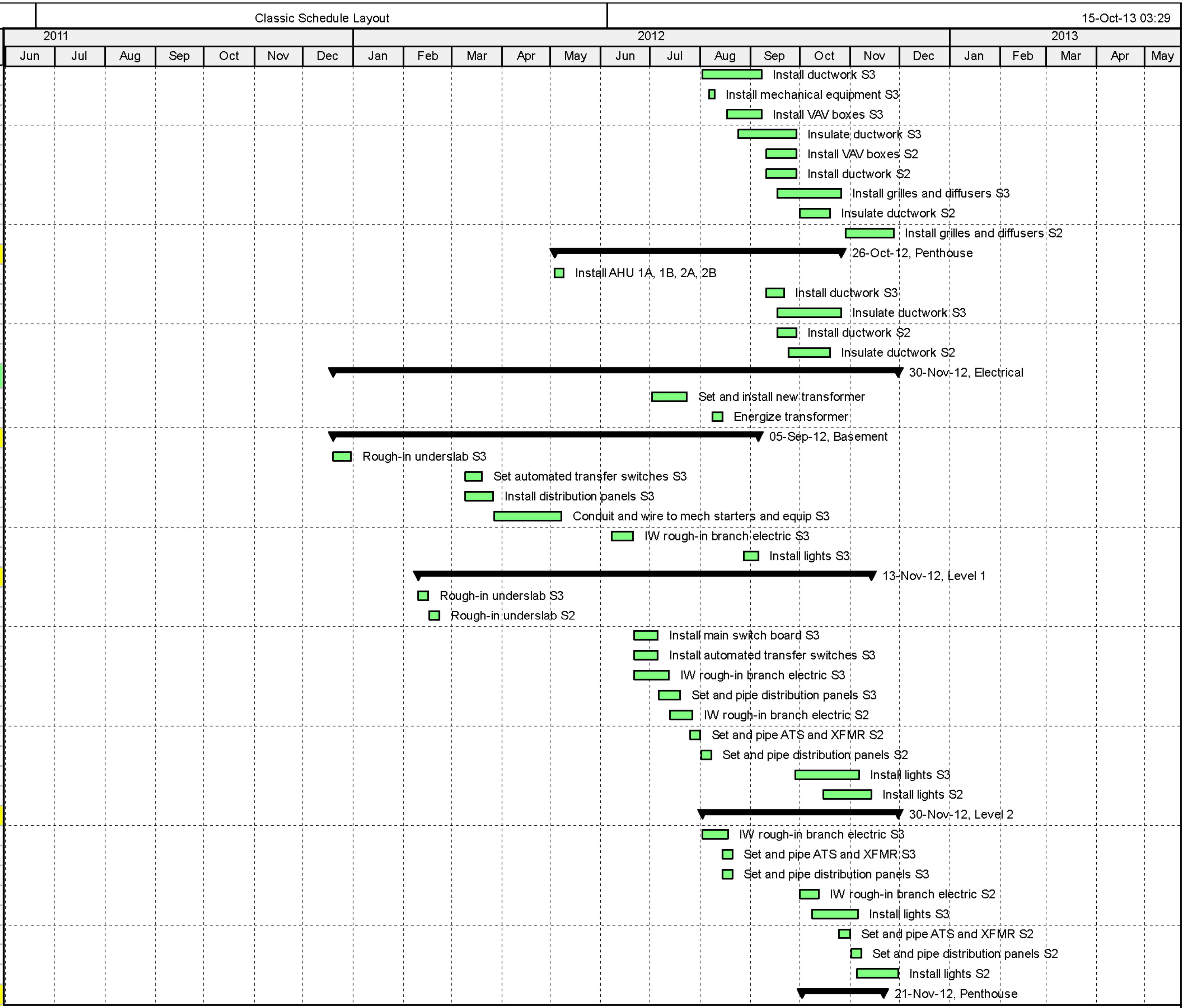
#	Activity Name	Original Duration	Start	Finish
47	Deck and detail S2	13	05-Apr-12	23-Apr-12
48	Erect columns and beams S2	3	11-Apr-12	13-Apr-12
49	**Misc. Metals**	70	04-Apr-12	12-Jul-12
50	**Basement**	35	04-Apr-12	22-May-12
51	Install metal framing S3	15	04-Apr-12	24-Apr-12
52	Install metal panels S3	10	09-May-12	22-May-12
53	**Level 1**	43	16-Apr-12	14-Jun-12
54	Install metal framing S3	15	16-Apr-12	04-May-12
55	Install metal framing S2	15	25-Apr-12	15-May-12
56	Install metal panels S2	10	07-May-12	18-May-12
57	Install metal panels S3	16	23-May-12	14-Jun-12
58	**Level 2**	45	25-Apr-12	27-Jun-12
59	Install metal framing S3	30	25-Apr-12	06-Jun-12
60	Install metal framing S2	30	16-May-12	27-Jun-12
61	Install metal panels S2	15	21-May-12	11-Jun-12
62	Install metal panels S3	15	23-May-12	13-Jun-12
63	**Penthouse**	40	16-May-12	12-Jul-12
64	Install metal framing S3	25	16-May-12	20-Jun-12
65	Install metal panels S2	10	05-Jun-12	18-Jun-12
66	Install metal framing S2	25	07-Jun-12	12-Jul-12
67	Install metal panels S3	10	07-Jun-12	20-Jun-12
68	**HVAC**	275	31-Oct-11	27-Nov-12
69	**Site**	126	31-Oct-11	26-Apr-12
70	Drill geothermal wells	50	31-Oct-11	11-Jan-12
71	Install vaults 1, 2, and 3	5	13-Jan-12	19-Jan-12
72	Install supply/return piping (250 wells)	70	20-Jan-12	26-Apr-12
73	**Basement**	187	20-Dec-11	12-Sep-12
74	Install water-to-water heat pumps	4	20-Dec-11	23-Dec-11
75	Install AHU 4	9	24-May-12	06-Jun-12
76	Install ductwork	15	18-Jun-12	09-Jul-12
77	Install VAV boxes	10	25-Jun-12	09-Jul-12
78	Insulate ductwork	20	14-Aug-12	11-Sep-12
79	Install grilles and diffusers	5	06-Sep-12	12-Sep-12
80	**Level 1**	96	10-Jul-12	21-Nov-12
81	Install ductwork S3	20	10-Jul-12	06-Aug-12
82	Install VAV boxes S3	15	17-Jul-12	06-Aug-12
83	Install mechanical equipment S3	20	07-Aug-12	04-Sep-12
84	Install ductwork S2	15	07-Aug-12	27-Aug-12
85	Insulate ductwork S3	30	14-Aug-12	25-Sep-12
86	Insulate ductwork	15	14-Aug-12	04-Sep-12
87	Install VAV boxes S2	15	28-Aug-12	18-Sep-12
88	Install mechanical equipment S2	12	19-Sep-12	04-Oct-12
89	Install grilles and diffusers S3	18	28-Sep-12	23-Oct-12
90	Install grilles and diffusers S2	21	24-Oct-12	21-Nov-12
91	**Level 2**	104	02-Jul-12	27-Nov-12
92	Install mechanical equipment S2	9	02-Jul-12	13-Jul-12



▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
▬ Actual Work	🟥 Critical Remaining Work	▼▬▼ summary

TASK filter: All Activities

#	Activity Name	Original Duration	Start	Finish
93	Install ductwork S3	26	02-Aug-12	07-Sep-12
94	Install mechanical equipment S3	4	06-Aug-12	09-Aug-12
95	Install VAV boxes S3	15	17-Aug-12	07-Sep-12
96	Insulate ductwork S3	25	24-Aug-12	28-Sep-12
97	Install VAV boxes S2	15	10-Sep-12	28-Sep-12
98	Install ductwork S2	15	10-Sep-12	28-Sep-12
99	Install grilles and diffusers S3	30	17-Sep-12	26-Oct-12
100	Insulate ductwork S2	15	01-Oct-12	19-Oct-12
101	Install grilles and diffusers S2	21	29-Oct-12	27-Nov-12
102	**Penthouse**	**124**	**03-May-12**	**26-Oct-12**
103	Install AHU 1A, 1B, 2A, 2B	4	03-May-12	08-May-12
104	Install ductwork S3	10	10-Sep-12	21-Sep-12
105	Insulate ductwork S3	30	17-Sep-12	26-Oct-12
106	Install ductwork S2	10	17-Sep-12	28-Sep-12
107	Insulate ductwork S2	20	24-Sep-12	19-Oct-12
108	**Electrical**	244	19-Dec-11	30-Nov-12
109	Set and install new transformer	15	02-Jul-12	23-Jul-12
110	Energize transformer	5	08-Aug-12	14-Aug-12
111	**Basement**	**183**	**19-Dec-11**	**05-Sep-12**
112	Rough-in underslab S3	9	19-Dec-11	30-Dec-11
113	Set automated transfer switches S3	7	09-Mar-12	19-Mar-12
114	Install distribution panels S3	12	09-Mar-12	26-Mar-12
115	Conduit and wire to mech starters ar	30	27-Mar-12	07-May-12
116	IW rough-in branch electric S3	10	07-Jun-12	20-Jun-12
117	Install lights S3	7	27-Aug-12	05-Sep-12
118	**Level 1**	**196**	**09-Feb-12**	**13-Nov-12**
119	Rough-in underslab S3	5	09-Feb-12	15-Feb-12
120	Rough-in underslab S2	5	16-Feb-12	22-Feb-12
121	Install main switch board S3	10	21-Jun-12	05-Jul-12
122	Install automated transfer switches	10	21-Jun-12	05-Jul-12
123	IW rough-in branch electric S3	15	21-Jun-12	12-Jul-12
124	Set and pipe distribution panels S3	10	06-Jul-12	19-Jul-12
125	IW rough-in branch electric S2	10	13-Jul-12	26-Jul-12
126	Set and pipe ATS and XFMR S2	5	25-Jul-12	31-Jul-12
127	Set and pipe distribution panels S2	5	01-Aug-12	07-Aug-12
128	Install lights S3	28	28-Sep-12	06-Nov-12
129	Install lights S2	22	15-Oct-12	13-Nov-12
130	**Level 2**	**85**	**02-Aug-12**	**30-Nov-12**
131	IW rough-in branch electric S3	12	02-Aug-12	17-Aug-12
132	Set and pipe ATS and XFMR S3	5	14-Aug-12	20-Aug-12
133	Set and pipe distribution panels S3	5	14-Aug-12	20-Aug-12
134	IW rough-in branch electric S2	10	01-Oct-12	12-Oct-12
135	Install lights S3	21	08-Oct-12	05-Nov-12
136	Set and pipe ATS and XFMR S2	5	25-Oct-12	31-Oct-12
137	Set and pipe distribution panels S2	5	01-Nov-12	07-Nov-12
138	Install lights S2	19	05-Nov-12	30-Nov-12
139	**Penthouse**	**37**	**02-Oct-12**	**21-Nov-12**



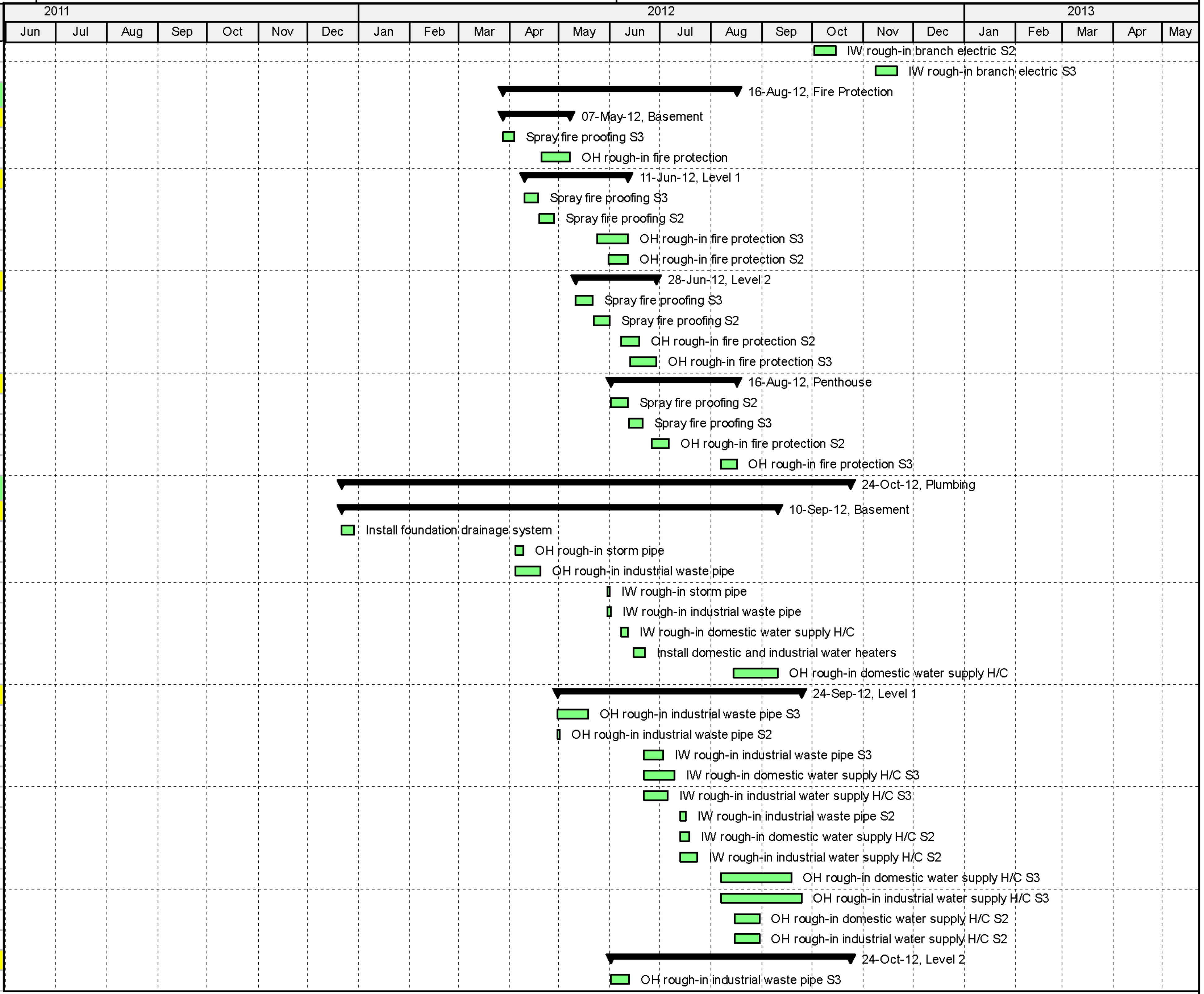
▬ Actual Level of Effort	🟩 Remaining Work	◆ ◆ Milestone
▬ Actual Work	🟥 Critical Remaining Work	▼▬▼ summary

TASK filter: All Activities

Classic Schedule Layout

15-Oct-13 03:29

#	Activity Name	Original Duration	Start	Finish
140	IW rough-in branch electric S2	10	02-Oct-12	15-Oct-12
141	IW rough-in branch electric S3	10	08-Nov-12	21-Nov-12
142	**Fire Protection**	100	28-Mar-12	16-Aug-12
143	**Basement**	29	28-Mar-12	07-May-12
144	Spray fire proofing S3	5	28-Mar-12	03-Apr-12
145	OH rough-in fire protection	12	20-Apr-12	07-May-12
146	**Level 1**	44	10-Apr-12	11-Jun-12
147	Spray fire proofing S3	7	10-Apr-12	18-Apr-12
148	Spray fire proofing S2	7	19-Apr-12	27-Apr-12
149	OH rough-in fire protection S3	12	24-May-12	11-Jun-12
150	OH rough-in fire protection S2	8	31-May-12	11-Jun-12
151	**Level 2**	34	11-May-12	28-Jun-12
152	Spray fire proofing S3	7	11-May-12	21-May-12
153	Spray fire proofing S2	7	22-May-12	31-May-12
154	OH rough-in fire protection S2	8	07-Jun-12	18-Jun-12
155	OH rough-in fire protection S3	12	13-Jun-12	28-Jun-12
156	**Penthouse**	54	01-Jun-12	16-Aug-12
157	Spray fire proofing S2	7	01-Jun-12	11-Jun-12
158	Spray fire proofing S3	7	12-Jun-12	20-Jun-12
159	OH rough-in fire protection S2	8	26-Jun-12	06-Jul-12
160	OH rough-in fire protection S3	8	07-Aug-12	16-Aug-12
161	**Plumbing**	216	21-Dec-11	24-Oct-12
162	**Basement**	184	21-Dec-11	10-Sep-12
163	Install foundation drainage system	5	21-Dec-11	28-Dec-11
164	OH rough-in storm pipe	4	04-Apr-12	09-Apr-12
165	OH rough-in industrial waste pipe	12	04-Apr-12	19-Apr-12
166	IW rough-in storm pipe	2	30-May-12	31-May-12
167	IW rough-in industrial waste pipe	3	30-May-12	01-Jun-12
168	IW rough-in domestic water supply H	3	07-Jun-12	11-Jun-12
169	Install domestic and industrial water I	5	15-Jun-12	21-Jun-12
170	OH rough-in domestic water supply I	19	14-Aug-12	10-Sep-12
171	**Level 1**	103	30-Apr-12	24-Sep-12
172	OH rough-in industrial waste pipe S3	15	30-Apr-12	18-May-12
173	OH rough-in industrial waste pipe S2	2	30-Apr-12	01-May-12
174	IW rough-in industrial waste pipe S3	8	21-Jun-12	02-Jul-12
175	IW rough-in domestic water supply H	12	21-Jun-12	09-Jul-12
176	IW rough-in industrial water supply H	10	21-Jun-12	05-Jul-12
177	IW rough-in industrial waste pipe S2	2	13-Jul-12	16-Jul-12
178	IW rough-in domestic water supply H	4	13-Jul-12	18-Jul-12
179	IW rough-in industrial water supply H	7	13-Jul-12	23-Jul-12
180	OH rough-in domestic water supply I	30	07-Aug-12	18-Sep-12
181	OH rough-in industrial water supply I	34	07-Aug-12	24-Sep-12
182	OH rough-in domestic water supply I	12	15-Aug-12	30-Aug-12
183	OH rough-in industrial water supply I	12	15-Aug-12	30-Aug-12
184	**Level 2**	102	01-Jun-12	24-Oct-12
185	OH rough-in industrial waste pipe S3	8	01-Jun-12	12-Jun-12



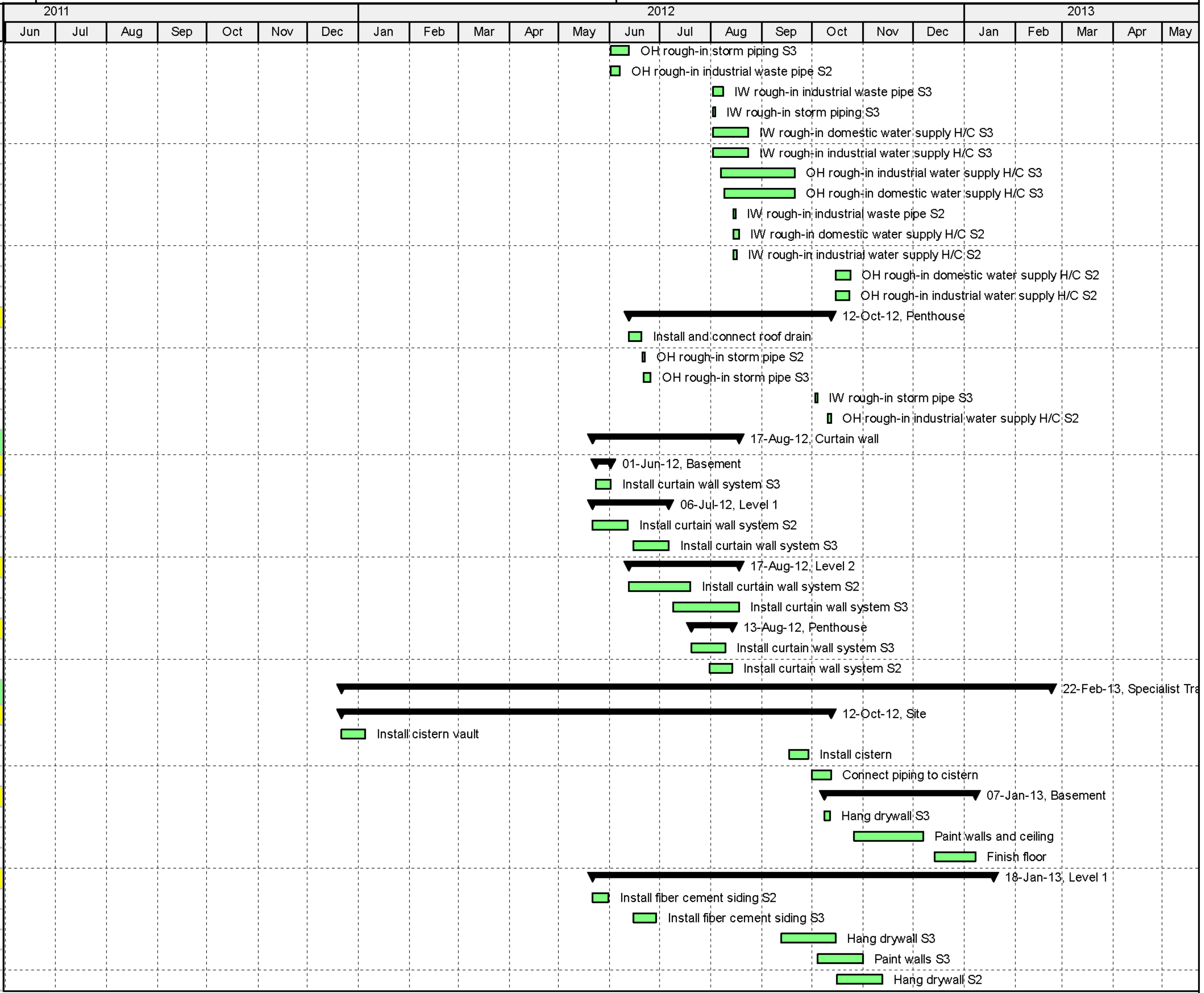
▬ Actual Level of Effort	🟩 Remaining Work	◆	◆ Milestone
▬ Actual Work	🟥 Critical Remaining Work	▬ summary	

TASK filter: All Activities

Classic Schedule Layout

15-Oct-13 03:29

#	Activity Name	Original Duration	Start	Finish
186	OH rough-in storm piping S3	8	01-Jun-12	12-Jun-12
187	OH rough-in industrial waste pipe S2	4	01-Jun-12	06-Jun-12
188	IW rough-in industrial waste pipe S3	5	02-Aug-12	08-Aug-12
189	IW rough-in storm piping S3	2	02-Aug-12	03-Aug-12
190	IW rough-in domestic water supply H	16	02-Aug-12	23-Aug-12
191	IW rough-in industrial water supply H	16	02-Aug-12	23-Aug-12
192	OH rough-in industrial water supply I	32	07-Aug-12	20-Sep-12
193	OH rough-in domestic water supply I	30	09-Aug-12	20-Sep-12
194	IW rough-in industrial waste pipe S2	2	14-Aug-12	15-Aug-12
195	IW rough-in domestic water supply H	4	14-Aug-12	17-Aug-12
196	IW rough-in industrial water supply H	3	14-Aug-12	16-Aug-12
197	OH rough-in domestic water supply I	8	15-Oct-12	24-Oct-12
198	OH rough-in industrial water supply I	7	15-Oct-12	23-Oct-12
199	**Penthouse**	87	12-Jun-12	12-Oct-12
200	Install and connect roof drain	6	12-Jun-12	19-Jun-12
201	OH rough-in storm pipe S2	2	20-Jun-12	21-Jun-12
202	OH rough-in storm pipe S3	3	21-Jun-12	25-Jun-12
203	IW rough-in storm pipe S3	2	03-Oct-12	04-Oct-12
204	OH rough-in industrial water supply I	3	10-Oct-12	12-Oct-12
205	**Curtain wall**	63	21-May-12	17-Aug-12
206	**Basement**	7	23-May-12	01-Jun-12
207	Install curtain wall system S3	7	23-May-12	01-Jun-12
208	**Level 1**	33	21-May-12	06-Jul-12
209	Install curtain wall system S2	15	21-May-12	11-Jun-12
210	Install curtain wall system S3	15	15-Jun-12	06-Jul-12
211	**Level 2**	48	12-Jun-12	17-Aug-12
212	Install curtain wall system S2	27	12-Jun-12	19-Jul-12
213	Install curtain wall system S3	30	09-Jul-12	17-Aug-12
214	**Penthouse**	17	20-Jul-12	13-Aug-12
215	Install curtain wall system S3	15	20-Jul-12	09-Aug-12
216	Install curtain wall system S2	10	31-Jul-12	13-Aug-12
217	**Specialist Trades/Services**	300	21-Dec-11	22-Feb-13
218	**Site**	208	21-Dec-11	12-Oct-12
219	Install cistern vault	9	21-Dec-11	04-Jan-12
220	Install cistern	10	17-Sep-12	28-Sep-12
221	Connect piping to cistern	10	01-Oct-12	12-Oct-12
222	**Basement**	63	08-Oct-12	07-Jan-13
223	Hang drywall S3	4	08-Oct-12	11-Oct-12
224	Paint walls and ceiling	30	26-Oct-12	07-Dec-12
225	Finish floor	15	14-Dec-12	07-Jan-13
226	**Level 1**	169	21-May-12	18-Jan-13
227	Install fiber cement siding S2	7	21-May-12	30-May-12
228	Install fiber cement siding S3	10	15-Jun-12	28-Jun-12
229	Hang drywall S3	24	12-Sep-12	15-Oct-12
230	Paint walls S3	20	04-Oct-12	31-Oct-12
231	Hang drywall S2	20	16-Oct-12	12-Nov-12



▬	Actual Level of Effort	🟩	Remaining Work	◆ ◆	Milestone
▬	Actual Work	🟥	Critical Remaining Work	▼▼	summary

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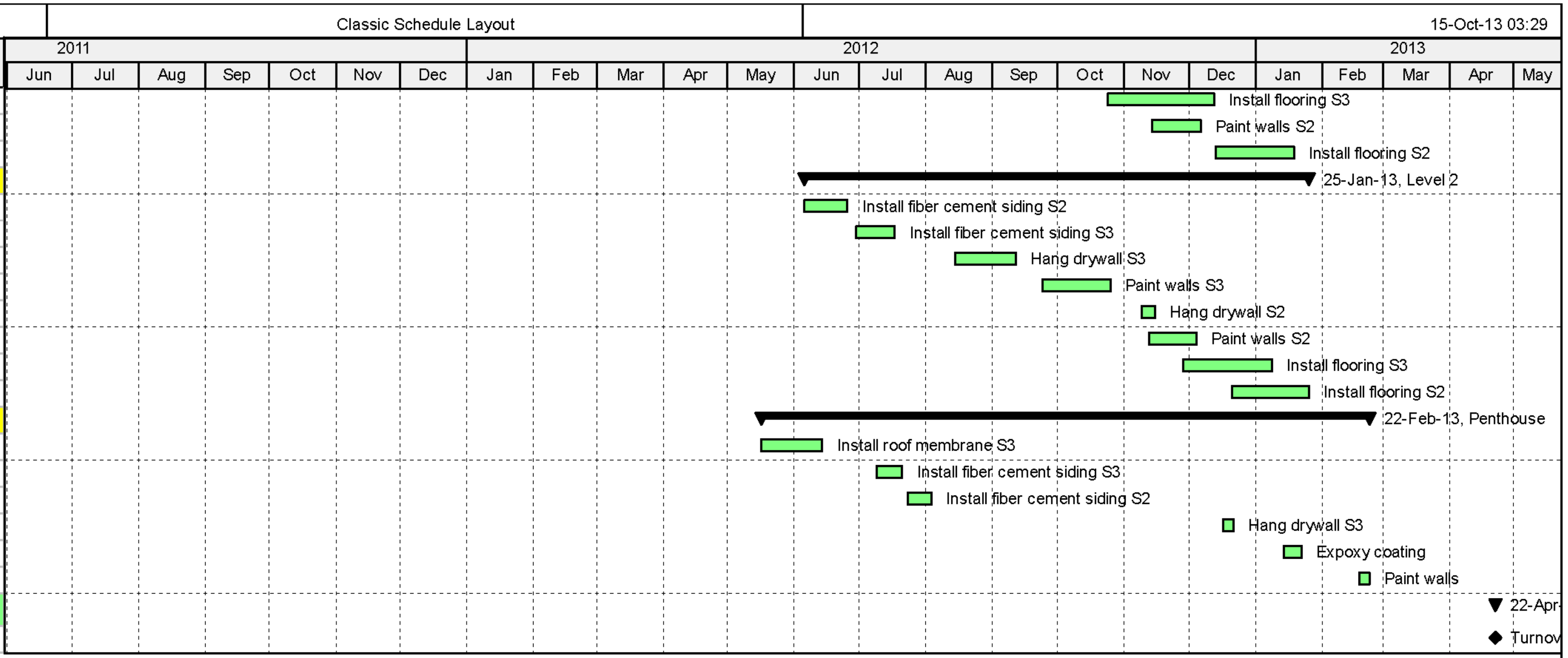
TASK filter: All Activities

Classic Schedule Layout

#	Activity Name	Original Duration	Start	Finish
232	Install flooring S3	35	24-Oct-12	12-Dec-12
233	Paint walls S2	16	14-Nov-12	06-Dec-12
234	Install flooring S2	25	13-Dec-12	18-Jan-13
235	**Level 2**	**164**	**05-Jun-12**	**25-Jan-13**
236	Install fiber cement siding S2	15	05-Jun-12	25-Jun-12
237	Install fiber cement siding S3	12	29-Jun-12	17-Jul-12
238	Hang drywall S3	20	14-Aug-12	11-Sep-12
239	Paint walls S3	24	24-Sep-12	25-Oct-12
240	Hang drywall S2	5	09-Nov-12	15-Nov-12
241	Paint walls S2	16	12-Nov-12	04-Dec-12
242	Install flooring S3	28	28-Nov-12	08-Jan-13
243	Install flooring S2	24	21-Dec-12	25-Jan-13
244	**Penthouse**	**197**	**16-May-12**	**22-Feb-13**
245	Install roof membrane S3	20	16-May-12	13-Jun-12
246	Install fiber cement siding S3	10	09-Jul-12	20-Jul-12
247	Install fiber cement siding S2	10	23-Jul-12	03-Aug-12
248	Hang drywall S3	5	17-Dec-12	21-Dec-12
249	Expoxy coating	7	14-Jan-13	22-Jan-13
250	Paint walls	5	18-Feb-13	22-Feb-13
251	**Closeout**	0	22-Apr-13	22-Apr-13
252	Turnover	0		22-Apr-13



🟦 Actual Level of Effort
🟩 Remaining Work
◆ ◆ Milestone
🟦 Actual Work
🟥 Critical Remaining Work
▼ summary

TASK filter: All Activities

Appendix B: Structural and MEP Estimate

Structural Systems Estimate

Basement Foundation

Code	Description	Quantity	Unit	Material ($)	Labor ($)	Equipment ($)	Total ($)
51223177000	W10x45 Columns	45	LF	2,903	120	67	3,089
33053404820	SOG 3500 psi 6"	590	SF	1,109	519	6	1,634
32110600252	Column rebar #8	128	LB	64	45	-	109
32110600202	Column rebar #3-#7	4	LB	2	2	-	4
32110600502	Footing rebar #7	198	LB	99	75	-	174
32110600202	Footing rebar #4	68	LB	34	26	-	60
32110602410	Footing Dowels #4	42	EA	31	70	-	100
32110600702	Wall rebar #4	698	LB	349	188	-	538
32205500200	6x6 WWF W2.0	6	CSF	102	150	-	253
33053404270	Wall 12" thick	24	CY	3,600	5,352	449	9,401
33053400920	24"x24" column	1	CY	430	510	42	982
33053403940	3000 psi footer	14	CY	1,848	1,400	10	3,258
Subtotal							19,601
Multiplier							20.2
Total							$395,948

First Floor Foundation

Code	Description	Quantity	Unit	Material ($)	Labor ($)	Equipment ($)	Total ($)
51223177000	W10x45 Columns	60	LF	3,870	160	89	4,118
33053404760	SOG 3500 psi 4"	883	SF	1,138	759	9	1,905
32110600202	Column rebar #3-#7	37	LB	19	20	-	38
32110600502	Footing rebar #7	198	LB	99	75	-	174
32110600202	Footing rebar #6	566	LB	283	215	-	498
32110600702	Wall rebar #6	1,222	LB	611	330	-	941
32205500100	6x6 WWF W1.4	9	CSF	129	203	-	332
33053404350	Wall 15" thick	61	CY	8,235	10,614	891	19,740
33053400920	24"x24" column	2	CY	860	1,020	84	1,964
33053403940	3000 psi footer	19	CY	2,508	1,900	13	4,421
Subtotal							34,133
Multiplier							19.0
Total							$648,519

Modular

Code	Description	Quantity	Unit	Material ($)	Labor ($)	Equipment ($)	Total ($)
53113505900	Floor decking	783	SF	2,145	446	39	2,631
51223755302	W24x68 Beam	66	LF	6,402	236	99	6,737
51223755502	W24x76 Beam	22	LF	2,398	79	33	2,510
32205500100	6x6 WWF W1.4	8	CSF	114	180	-	294
33053403200	SOMD 4000 psi 6"	783	SF	1,543	673	219	2,435
Subtotal							11,877
Multiplier							46.2
Total							$548,719

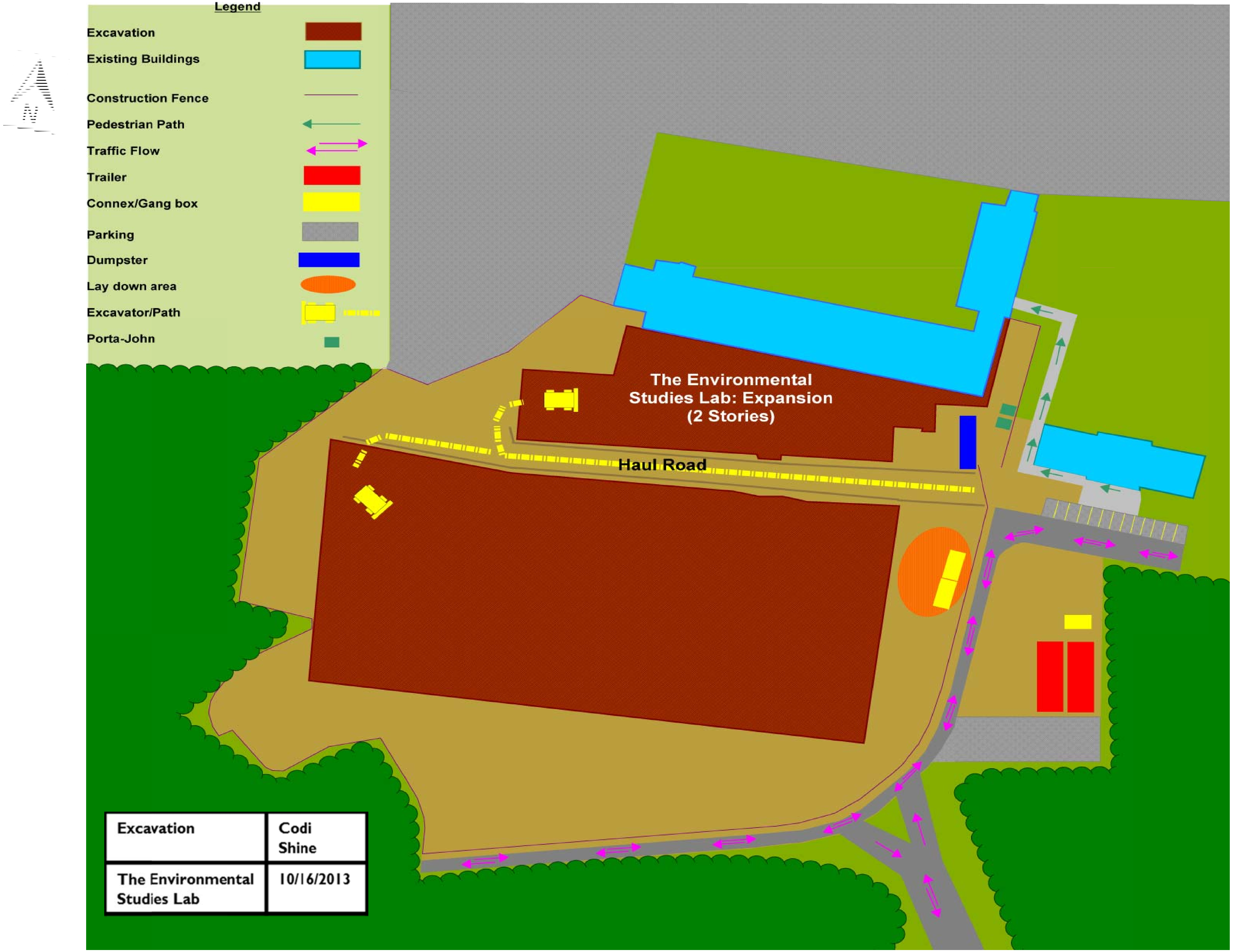
Roof Modular

Code	Description	Quantity	Unit	Material ($)	Labor ($)	Equipment ($)	Total ($)
53126302900	Roof decking	1,100	SF	2,310	418	33	2,761
51223752702	W16x26 Beam	132	LF	4,884	363	201	5,448
51223755902	W24x55 Beam	33	LF	2,591	118	50	2,758
51223755502	W24x76 Beam	33	LF	3,597	118	50	3,764
Subtotal							14,731
Multiplier							36.4
Total							$536,200

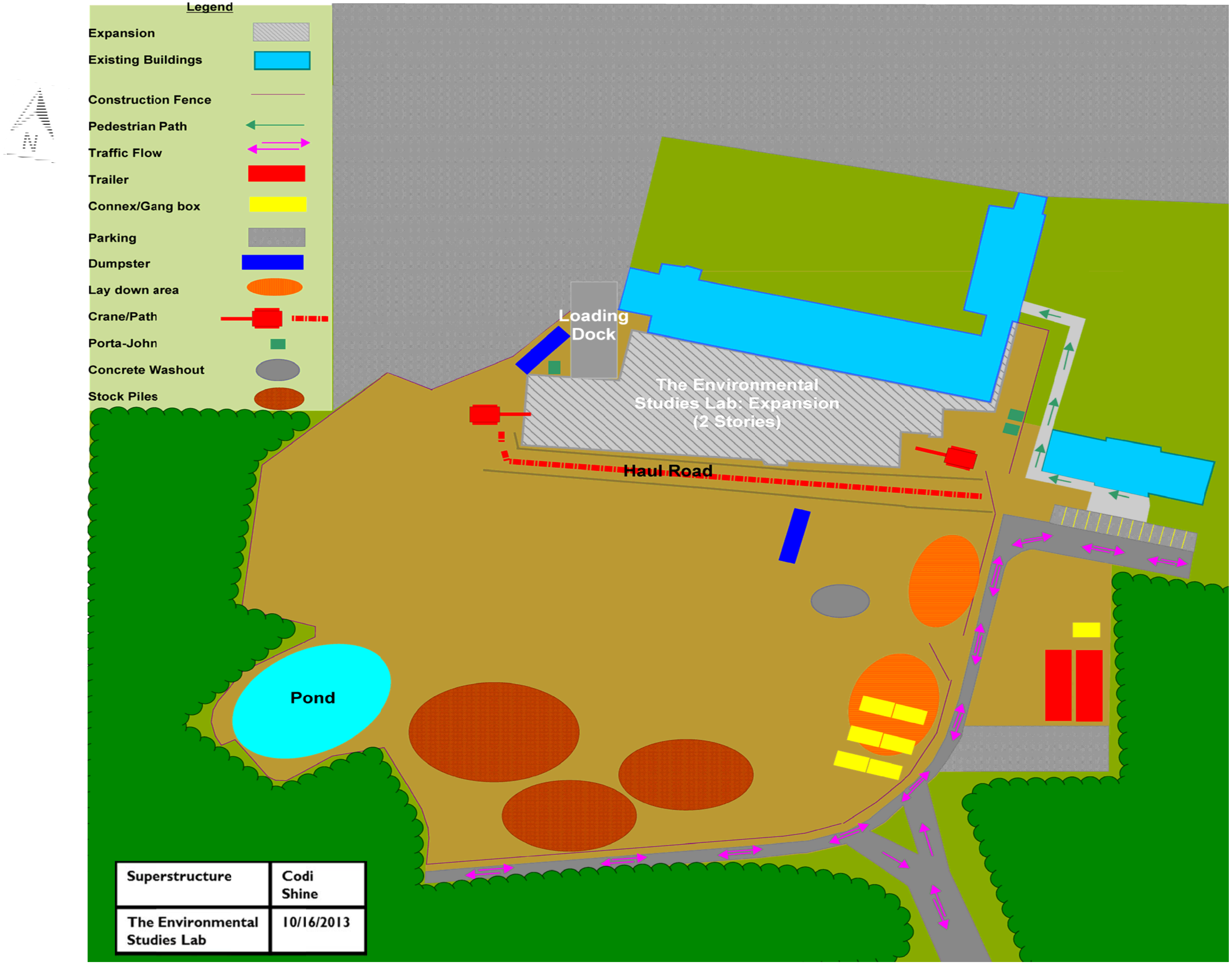
Structural Total	**$2,129,386**

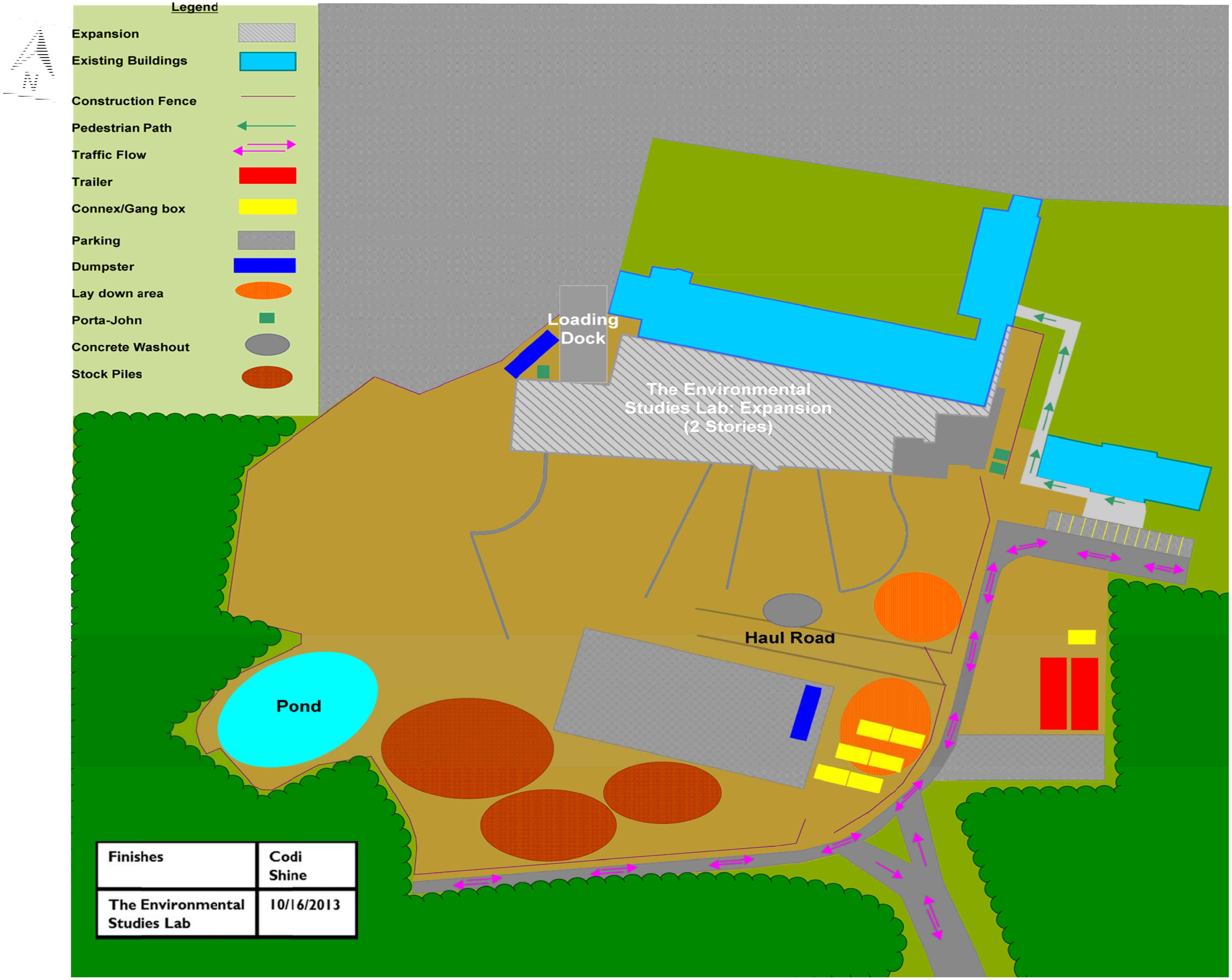
	Assembly Number	Description	Quantity	Unit	Total O&P	Ext. Total O&P
Electrical	D50202080640	Fluorescent fixtures, type A, 23 fixtures per 1600 SF	72000	S.F.	$ 7.53	$ 542,160.00
	D50201100680	Receptacles incl plate, box, conduit, wire, 20 per 1000 SF,2.4 watts per SF	72000	S.F.	$ 3.88	$ 279,360.00
	D50102400620	Switchgear installation, incl switchboard, panels & circuit breaker, 277/480 V, 2000 A	2	Ea.	$ 51,975.00	$ 103,950.00
	D50102502080	Panelboard, 4 wire w/conductor & conduit, NQOD, 120/208 V, 400 A, 1 stories, 25' horizontal	55	Ea.	$ 9,475.00	$ 521,125.00
	D50102300560	Feeder installation 600 V, including RGS conduit and XHHW wire, 2000 A	664	L.F.	$ 565.00	$ 375,160.00
	D50902101200	Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 750 kW	1	kW	$ 253.86	$ 253.86
	Total					**$ 1822008.86**
Mechanical	D30302141500	Heating/cooling system , heat pump 5 ton, one zone, SEER 14, 2000 SF	41	Ea.	$ 14,350.00	$ 588,350.00
	D30201060680	Boiler, electric, steel, hot water, 210 KW, 716 MBH	1	Ea.	$ 11,225.00	$ 11,225.00
	D30501604040	Self-contained, water cooled unit, schools and colleges, 10,000 SF, 38.33 ton	32000	S.F.	$ 11.52	$ 368,640.00
	D30105202000	Commercial building heating system, fin tube radiation, forced hot water, 10,000 SF, 100,000 CF, total 2 floors	72000	S.F.	$ 10.46	$ 753,120.00
	D30501850580	Computer room unit, air cooled, includes remote condenser, 3 ton	4	Ea.	$ 21,950.00	$ 87,800.00
	Total					**$ 1809135.00**
Plumbing	D20101102160	Water closet, vitreous china, bowl only with flush valve, floor mount, 18" high bowl, ADA compliant	10	Ea.	$ 1,630.00	$ 16,300.00
	D20102102000	Urinal, vitreous china, wall hung	2	Ea.	$ 1,425.00	$ 2,850.00
	D20104301840	Lab sink w/trim, polyethylene, single bowl, flanged, 23-1/2" x 20-1/2" OD	94	Ea.	$ 1,575.00	$ 148,050.00
	D20107101640	Shower, stall, baked enamel, terrazzo receptor, 32" square	2	Ea.	$ 2,810.00	$ 5,620.00
	D20108101920	Drinking fountain, 1 bubbler, wall mounted, non recessed, stainless steel, no back	2	Ea.	$ 1,995.00	$ 3,990.00
	D20103101600	Lavatory w/trim, vanity top, PE on CI, 19" x 16" oval	12	Ea.	$ 1,345.00	$ 16,140.00
	D20202401940	Electric water heater, commercial, 100< F rise, 120 gal, 36 KW 147 GPH	4	Ea.	$ 11,550.00	$ 46,200.00
	D20908103010	Pipe plastic, PVC, DWV, pressure pipe 200 PSI, 1/2" diameter	1364	L.F.	$ 15.42	$ 21,032.88
	Total					**$ 260182.88**
		MEP Total				**$ 3,891,326.74**

Appendix C: Site Layouts



Excavation	Codi Shine
The Environmental Studies Lab	10/16/2013


Legend
Expansion
Existing Buildings
Construction Fence
Pedestrian Path
Traffic Flow
Trailer
Connex/Gang box
Parking
Dumpster
Lay down area
Crane/Path
Porta-John
Concrete Washout
Stock Piles
N
Loading Dock
The Environmental Studies Lab: Expansion (2 Stories)
Haul Road
Pond
Superstructure
Codi Shine
The Environmental Studies Lab
10/16/2013



Finishes	Codi Shine
The Environmental Studies Lab	10/16/2013

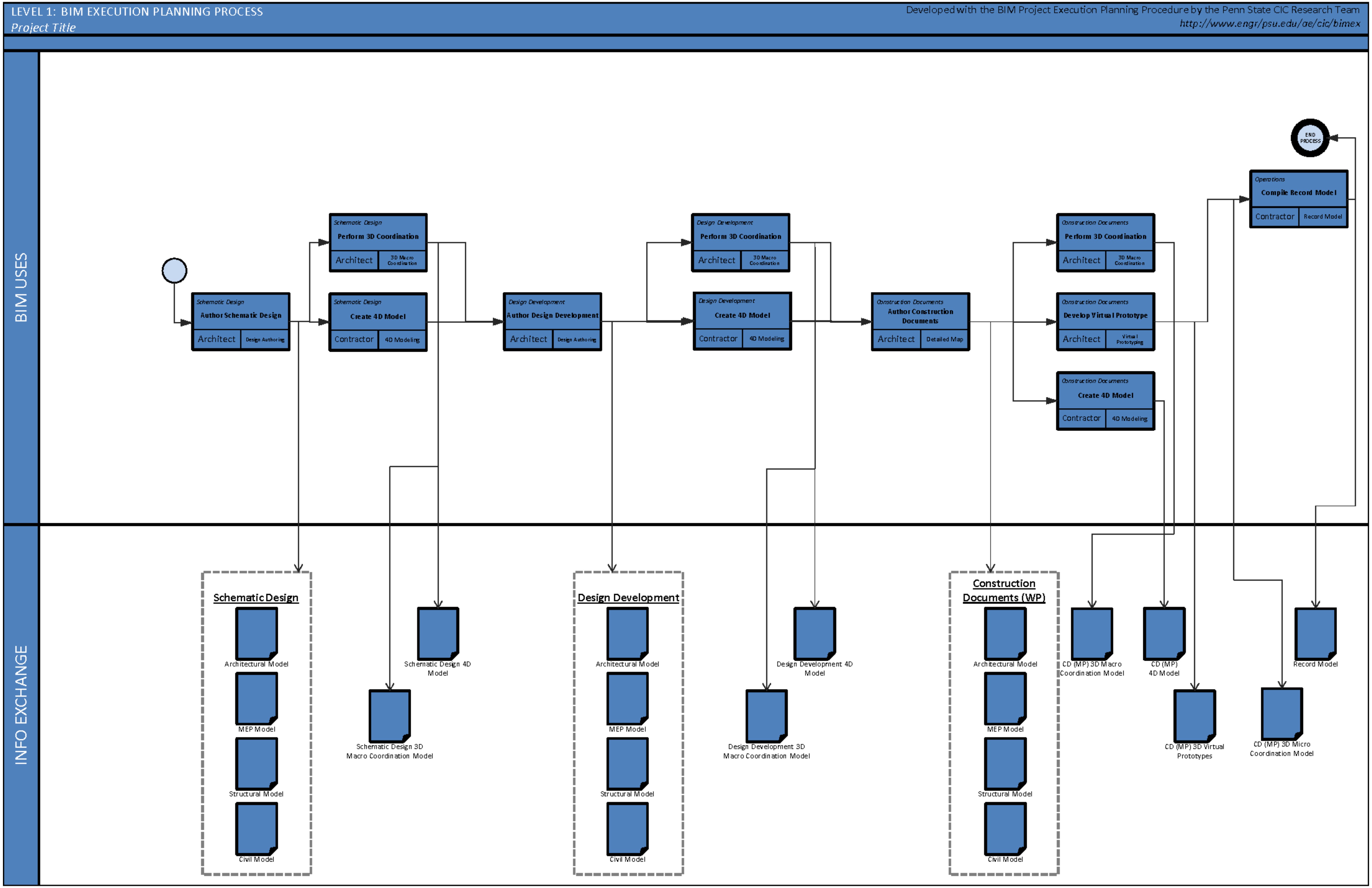
Appendix D: General Conditions Estimate

General Conditions

Item Description	Quantity	Unit	Unit Cost	Material	Unit Cost	Equip or Sub	Unit Cost	Labor	Total
PROJECT MANAGER	18	MO	-	-	-	-	20,500	369,000	389,500
PROJECT ENGINEER	21	MO	-	-	-	-	16,375	343,875	360,250
OFFICE ENGINEER	15	MO	-	-	-	-	14,500	217,500	232,000
OFFICE ENGINEER	15	MO	-	-	-	-	14,500	217,500	232,000
PROJECT SUPERINTENDENT	18	MO	-	-	-	-	20,375	366,750	387,125
AREA SUPERINTENDENT	16	MO	-	-	-	-	18,250	292,000	310,250
AREA SUPERINTENDENT	15	MO	-	-	-	-	18,250	273,750	292,000
LEED QUALITY CONTROL ENGINEER	10	MO	-	-	-	-	17,500	175,000	192,500
FIELD ENGINEER	13	MO	-	-	-	-	14,500	188,500	203,000
ADMINISTRATOR	11	MO	-	-	-	-	9,500	104,500	114,000
INTERN	6	MO	-	-	-	-	3,000	18,000	21,000
FIELD ENG. EQUIP & SUP	13	MO	50	650	200	2,600	-	-	3,250
OUTSIDE PROFESSIONAL SURVEY	40	HR	-	-	75	3,000	-	-	3,000
PLANS & SPECIFICATIONS (AS-BUILTS)	8	EA	250	2,000		-	-	-	2,000
CADD COORDINATION DRAWINGS	1	EA	1,000	1,000		-	-	-	1,000
SCHEDULING	1	LS	-	-		-	11,490	11,490	11,490
JANITORIAL SERVICE	13	MO	-	-	2,500	32,500	-	-	32,500
THIRD PARTY CRANE INSPECTIONS	4	EA	-	-		-	400	1,600	1,600
PROGRESS PHOTOS	13	MO	-	-	300	3,900	-	-	3,900
OFFICE EQUIPMENT - COPIER/SERV	2	EA	-	-	4,000	8,000	-	-	8,000
IT FEE	1	LS	-	-	2,000	2,000	-	-	2,000
PROJECT SYSTEMS COST	13	MO	-	-	1,000	13,000	-	-	13,000
OFFICE SUPPLIES	13	MO	750	9,750		-	-	-	9,750
POSTAGE & SHIPPING	13	MO	-	-	400	5,200	-	-	5,200
JOB PRSNL TRAVEL & LODG	10	EA	200	2,000		-	-	-	2,000
TEMPORARY HOUSING - INTER	6	MO	-	-	1,000	6,000	-	-	6,000
MOVING COSTS	3	EA	-	-	10,000	30,000	-	-	30,000
OUTSIDE TEST,INSPEC & LAB	13	MO	-	-	-	-	400	5,200	5,200
BUILDING ENVEL. CONSULTANT	1	EA	-	-	-	-	15,000	15,000	15,000
INDUSTRIAL HYGIENIST	1	EA	-	-	-	-	15,000	15,000	15,000
TEMPORARY FIRE PROTECTION	13	MO	50	650	-	-	6	78	728
BACKRAILS (SAFETY CABLE)	2000	LF	2	4,000	-	-	3	6,000	10,000
HOLE PROTECTION	6	MO	200	1,200	-	-	-	-	1,200
HOLE & OPENING PROT. MAINT.	7	MO	50	350	-	-	-	-	350
EXCAVATION BARRICADES	5	MO	50	250	-	-	-	-	250
LADDERS & STAIRS	10	EA	250	2,500	-	-	-	-	2,500
SAFETY EQUIPMENT	100	EA	100	10,000	-	-	-	-	10,000
SAFETY PROGRAMS/AWARDS	13	MO	-	-	-	-	100	1,300	1,300
PARTNERING	1	EA	-	-	800	800	-	-	800
TELEPHONE INSTALL& EQUIPM	13	MO	-	-	1,050	13,650	-	-	13,650
WATER SERVICE	13	MO	-	-	200	2,600	-	-	2,600
TEMP SANITARY FACILITY	13	MO	-	-	80	1,040	-	-	1,040
TEMPORARY HEATING/ELECTRIC	13	MO	-	-	1,000	13,000	-	-	13,000

CELL PHONES	5	EA	-	-	100	500	-	-	500
RADIOS	12	EA	-	-	1,000	12,000	-	-	12,000
OFFICE TRAILER	13	MO	50	650	650	8,450	50	650	9,750
FLD OFF - SETUP	2	EA	300	600	-	-	1,200	2,400	3,000
ACCESS & HAUL ROADS	2222	SY	4	9,666	1	1,133	3	5,599	16,398
TEMPORARY PROJECT FENCE	1800	LF	-	-	10	18,000	-	-	18,000
STORMWATER MAINT. CONSULTANT	13	MO	-	-	-	-	100	1,300	1,300
PROJ SIGNS & BULLETIN BRD	13	MO	750	9,750	400	5,200	250	3,250	18,200
PICKUP	13	MO	300	3,900	525	6,825	-	-	10,725
CAR	13	MO	300	3,900	525	6,825	-	-	10,725
CRANES- ROUGH TERRAIN OPER	13	MO	-	-	10,000	130,000	-	-	130,000
FORKLIFT	13	MO	800	10,400	2,500	32,500	-	-	42,900
SMALL EQUIPMENT (CONCRETE)	7	MO	150	1,050	-	-	-	-	1,050
COMPRESSOR	13	MO	600	7,800	300	3,900	-	-	11,700
SMALL TOOLS & SUPPLIES	1	LS	1,000	1,000	-	-	-	-	1,000
MISC. POWER EQUIP (CONC)	6	MO	300	1,800	-	-	-	-	1,800
EQUIPMENT MINOR REPAIRS	1	LS	-	-	1,500	1,500	-	-	1,500
FUEL, OIL, GAS	13	MO	1,500	19,500	-	-	-	-	19,500
MISCELLANEOUS POWER EQUIP	1	LS	-	-	1,000	1,000	-	-	1,000
WEEKLY CLEAN-UP	2	WK	10	20	-	-	-	-	20
FINAL CLEANING	73000	SF	-	-	0	8,760	-	-	8,760
EAI - DUMPSTER RENTAL (PER DUMP)	13	EA	-	-	350	4,550	-	-	4,550
RODENT/PEST CONTROL	13	MO	80	1,040	-	-	-	-	1,040
PROJECT RECORD DOCS(O&M)	7	EA	200	1,400	-	-	-	-	1,400
Subtotal				106,826		378,433		2,635,242	3,287,751
Bonds and Insurance (1.5%)									574,500
Total									**3,862,251**

Appendix E: BIM Process Map


LEVEL 1: BIM EXECUTION PLANNING PROCESS
Project Title
Developed with the BIM Project Execution Planning Procedure by the Penn State CIC Research Team
http://www.engr/psu.edu/ae/cic/bimex
BIM USES
INFO EXCHANGE
Schematic Design
Author Schematic Design
Architect
Design Authoring
Schematic Design
Perform 3D Coordination
Architect
3D Macro Coordination
Schematic Design
Create 4D Model
Contractor
4D Modeling
Design Development
Author Design Development
Architect
Design Authoring
Design Development
Perform 3D Coordination
Architect
3D Macro Coordination
Design Development
Create 4D Model
Contractor
4D Modeling
Construction Documents
Author Construction Documents
Architect
Detailed Map
Construction Documents
Perform 3D Coordination
Architect
3D Macro Coordination
Construction Documents
Develop Virtual Prototype
Architect
Virtual Prototyping
Construction Documents
Create 4D Model
Contractor
4D Modeling
Operations
Compile Record Model
Contractor
Record Model
END PROCESS
Schematic Design
Architectural Model
MEP Model
Structural Model
Civil Model
Schematic Design 3D Macro Coordination Model
Schematic Design 4D Model
Design Development
Architectural Model
MEP Model
Structural Model
Civil Model
Design Development 3D Macro Coordination Model
Design Development 4D Model
Construction Documents (WP)
Architectural Model
MEP Model
Structural Model
Civil Model
CD (MP) 3D Macro Coordination Model
CD (MP) 4D Model
CD (MP) 3D Virtual Prototypes
CD (MP) 3D Micro Coordination Model
Record Model