

State College Area High School



Technical Report Part 2

Senior Thesis

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Construction Management

Project Location: State College, PA

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Bryce Burkentine | Construction | Dr. Anumba | State College Area High School | State College, PA | October 16th, 2015

Executive Summary

The South Building of State College Area High School is scheduled to start construction October 2015. The system that is going to play a key role in the construction sequence is the façade system or also known as the building wall. The façade system will start being constructed May 2015 and continue through August 2018. The schedule is based off the school calendar and is imperative that milestones are meant. The schedule, cost, and logistical analyses are based off the CMU structural wall, spray-on-insulation, air gap or metal studs, and outer material which could be stone, brick veneer, metal insulated panels, etc.

The cost estimate developed in Timberline totaled \$10,053,502. This is less than what was predicted by Massaro Construction Company. Massaro's estimated for the façade system was \$11,584,000. Massaro's estimate was below \$10 million in the beginning of August and since then has increased more than \$1.5 million. There a number of reasons for the difference between Timberline and Massaro's estimate from out of date information to whether the project is public or private.

The logistical approach for State College Area High School South Building façade system is broken up into three phases. The first phase will consist of Pods A and B being constructed, phase two Pods C and D will be constructed, and the final phase will entail demolition, renovation, and new construction on the existing South Building. The change from phase to phase allows relocation of resources for hardscapes and landscapes to be completed on the project. There are issues with the logistical approach Massaro is implementing with phase three which consists of the South Building and North Building construction. Working on two buildings at once will slow productivity since the students will be occupying the buildings. If temporary trailer facilities could be implemented for classrooms this would allow much more of an efficient construction process for phase three.

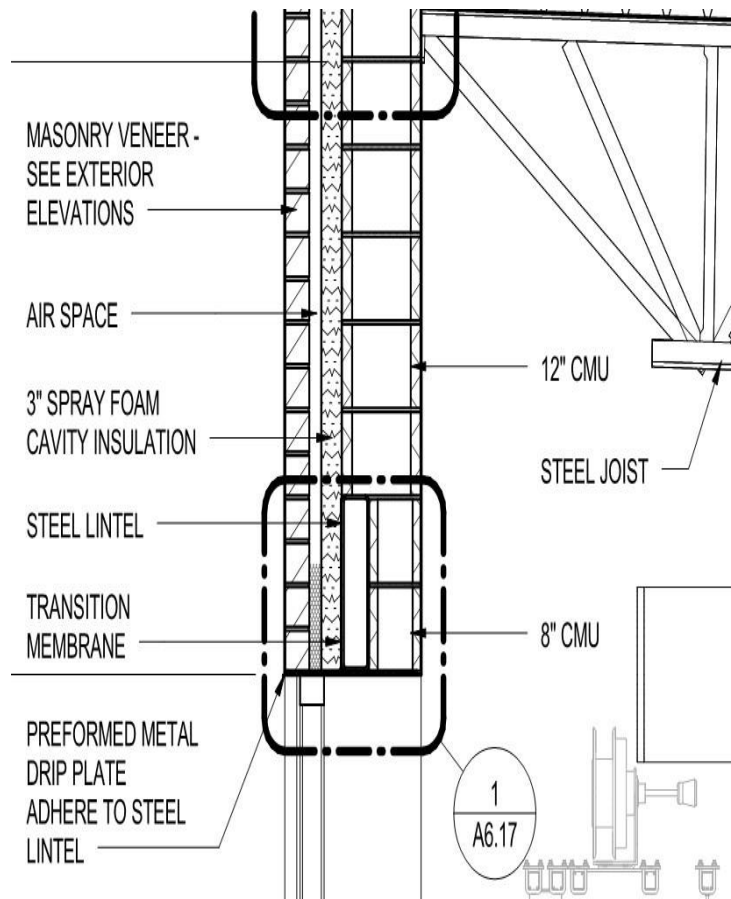
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Production Plan

The façade system on the South Building of the State College High School will involve coordination between the trades to ensure the work is to the standard and quality of the School. For this system the CMU wall will be structural bearing. Once the CMU walls are up then 3" spray foam cavity insulation will be applied directly to the CMU. In between the Brick and spray foam insulation will be a ½" air gap. To construct the CMU wall there will be scaffolding and hydraulic scaffolding platforms. The spray foam insulation will be applied by a man lift. The brick, insulated metal panel, aluminum curtain wall system, and window will be applied by using a man lift or scissor lift. The equipment that is essential to the completion of this task is a man lift and a scissor lift.

The performance standards will have to meet the specifications and LEED requirements. If a trade wants to use a different material than what was in the specification then that material will have to be approved by the architect and owner. The quality control program Massaro has set up will ensure the standards are meant. The three-phase control system first starts with a preparatory phase. This will entail the whole Massaro field and office team to sit down and discuss what results are expected out in the field. The next step is the initial phase, which will make sure the project is being implemented in the preliminary stage of work. Creating detailed sections for unclear items would happen in this stage. The final stage is the follow-up phase. This phase will consist of daily checks making sure the work is performed to the quality standard set forth in the specifications.

Figure 1: Exterior Wall Detail



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Production Analysis

The start for the façade system on the South Building will be from May 2015 until August 2018. The detailed schedule is effective and will be completed on time as it shows right now. One way this schedule works is the tasks are not treated as independent tasks. The independent tasks are treated as a sequence with flow between the trades. This is very important because it will only accelerate the schedule. An example of how flow is integrated in the schedule is the CMU wall, scaffolding, and spray on fireproofing will be done in sequential sections so all the tasks can be working at the same time just in different areas. Also, while the main tasks of the façade are being completed, the remaining items can be done simultaneously on the façade. Furthermore, the predecessor activity would be the foundation system and the successor activity would be the hardscape system. Having consistent flow with the predecessor and successor activities will come from the independent contractors and general contractors coordinating exactly what timeframes the activities can happen. This way the activities can flow right behind each other.

The site constraints will hinder the productivity of moving material around the site. A way to fix this is to open up the site and have more area around the façade of the building. This will allow equipment to pass through easily. Having an organized flow of materials and work on the project will save time and money for the owner. Creating a wider area around the site would involve moving part of the access road to the existing South Building away from where it is now. This would cost more money and lessen the parking the school has already.

Cost Analysis

The cost estimate developed in Timberline totaled \$10,053,502. This is less than what was predicted by Massaro Construction Company. Massaro's estimated for the building wall or façade system was \$11,584,000. Massaro's estimate was below \$10 million in the beginning of August and since then has increased more than \$1.5 million. This happened because of change in higher quality building materials and adding some LEED features on the building façade.

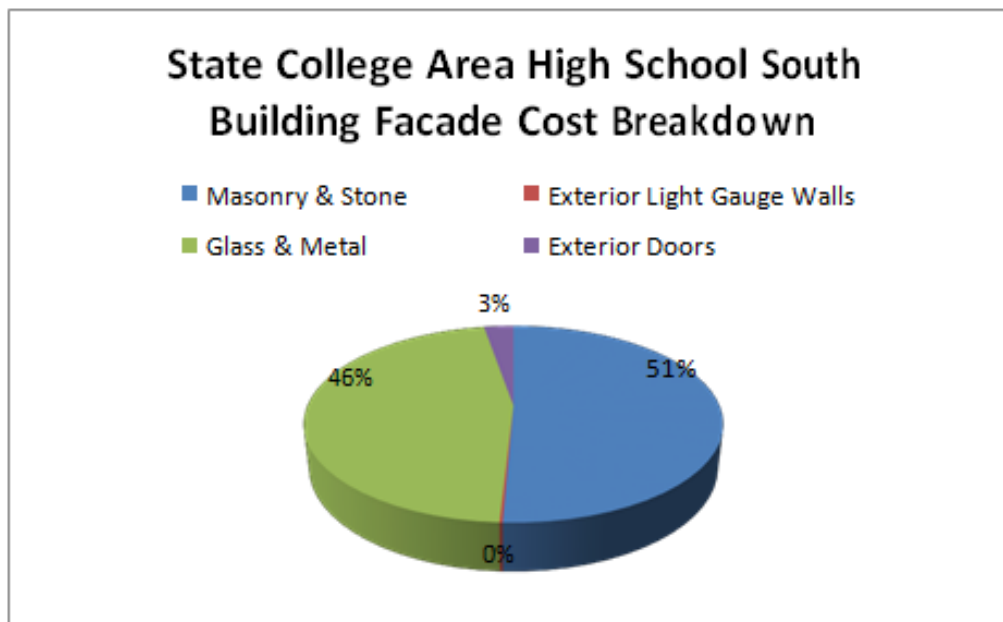
One reason Timberline's estimate resulted in a lower dollar amount could have been Timberline's data was not up to date. The labor rate, equipment cost, and material cost could have been out of date. This would most likely result in a lower estimate. The word, "most likely" should be used because if the economy would be in a recession then the estimate could turn out to be higher. It is very important to use updated information to ensure the proper estimate is obtained.

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Massaro uses historical data from previous projects. The projects Massaro receives their data from cannot be more than two years completed and has to be within 100 miles or else the data could be skewed. Location is a very important aspect in receiving updated cost information. Using historical information is the most accurate way to develop an estimate. Depending on whether you build in the country or the city will be a large determinate in which historical data the contractor uses. This will allow the contractor to use the most accurate data at the current economy's state.

Another assumption that could be made for why Timberline's estimate was lower than Massaro's could be the project type. Since the State College Area High School is a public project all contracts are low bid. This would entail the lowest cost on a project. The project just went out to bid the beginning of October. Massaro's estimate could match Timberline's estimate once the bids come in. Figure 2 shows how Massaro's façade estimate is broken down.

Figure 2: Massaro's Façade Estimate



Logistical Analysis

The logistical approach for State College Area High School South Building façade system is broken up into three phases. The first phase Pods A and B are constructed. Phase two consists of Pods C and D and phase three consists of demolition, renovation, new construction of the existing South Building. Changes from phase one to phase two is relocation of site laydown area, construction entrances, and temporary facilities. Moving these areas and items will allow the previous phases construction to be landscaped and finalized.

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The site logistics plan can be modified by providing more material laydown area. The façade system requires a lot of space for storing materials on site. One way to fix this issue is to provide material laydown areas across Westerly Parkway. This could be on the parking lot or a grass area. There is room to do so now where the test driving area is. Also, phase three consists of moving on to the North Building. One problem is how efficient can the contractor execute phase three while working on two different buildings during the school year. Something that would help the construction process be much more efficient and safer for the students is to have the students away from the construction. This could happen by having temporary trailer facilities in the fields north of the North Building. By having the classroom trailers away from the construction will allow the construction process to go more smoothly and promote a safer environment for the students. This in turn would increase project costs in the short coming, but will save time on the project possibly cutting costs for the School on the end of phase three.

A huge task of the project is to align key project dates with the school year calendar. This is imperative to do so because the students will need a place to learn while other buildings are being constructed. Temporary facilities for the students to take class in will lessen the time having to move logistical issues and more time focusing on completing the project.

Schedule Acceleration Scenarios

The façade system is a key aspect to the milestone schedule because once it is done with the roof you can start roughing in the MEP systems. A water tight enclosure can be done with the CMUs and installing the windows and doors. All other materials will help insulate and waterproof the exterior of the building. The biggest risk to the completion date is the weather. Creating a scaffolding system with plastic wrapped around it with heaters will maintain a constant temperature on the building wall. Spray-on-insulation cannot be applied unless the surface is 40 Degrees Fahrenheit. Mortar cannot be applied unless the surface is above freezing. It is imperative to keep the scaffolding covered and heated to ensure masonry work can continue. The critical activity for the façade system is the masonry. The masonry work is around 150,000 square feet. While other materials can still be applied to the building wall, the masonry trade will be the one driving the project, since it is the structural system and most of the façade system.

If the schedule was behind and needed to be accelerated, the masonry trade would be the one that could make up the time. Since the masonry work covers more than two thirds of the building wall the hardscapes can be started after this trade is done. The hardscapes will take over one month of the schedule per phase. Making up time on the masonry work will allow the hardscapes to finish early,

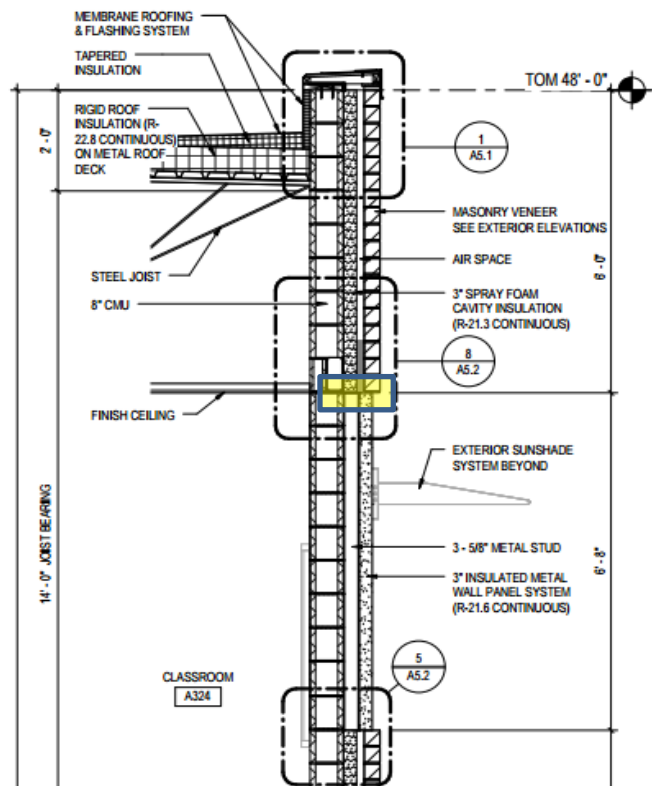
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allowing the building to be complete. The resources needed for the masonry trade to accelerate their schedule would be more laborers and masons. The sequence will be moving along the building wall with all crews working together. Once one section is complete the scaffolding can be moved down the building wall. The costs will be increased with the extra resources but this could be compensated with a change order if the schedule delay is caused by the general contractor or owner.

Constructability and Logistical Challenges

A challenge the Superintendent foresees is the integration between the brick veneer and insulated wall panels. The gap between the two materials was not clearly defined in the drawings and specifications. The superintendent for Massaro is concerned about this gap because of the spray-on-insulation will be directly open to the elements. This will wear and tear the insulation and lead to leaks through the building wall. As you can see in figure 3, the gap between the brick veneer and insulated wall panel needs to be addressed. An option to fix this issue is to develop a wall panel that has a flange to go behind the brick in the air gap. This will cover the gap and integrate the two independent materials as one system. Since it would go behind the brick veneer, the insulated wall panels will have to be installed first where these two materials are next to each other.

Figure 3: Gap between Brick Veneer and Insulated Metal Panel



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Appendix

- A. Interview Questions
- B. Primavera Detailed Façade System Schedule
- C. Timberline Detailed Façade System Cost Estimate
- D. Site Logistic Plans- 3 Phases
- E. Flow Diagram of Façade System

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Interview Questions: Keith Smith- Superintendent

1. How do you expect to construct the façade system on pods 1-4 and what will the sequence be?

Answer: The South Building will start with Pods A-D. A will start then start B concurrently and so forth. Pods A-D have to be finished until the demolition and renovation happens on the existing South Building.

2. Who are the predecessors and successors of this task?

Answer: The predecessors are the foundations and CMU structural bearing wall. The successors are the hardscapes and landscapes.

3. Who will be the most important trade during this construction phase?

Answer: The General Contractor will be the most important part of this system. It will be very important they have all the trades on the same schedule and sequence. In this system the masonry subcontractor will have the most square feet of work to do, so therefore it will be very important they are on schedule.

4. Are you worried about having areas where to different materials come together and leak?

Answer: Between the CMU and brick or metal panel there is spray foam insulation that is an insulator and vapor barrier. It is very important that nobody damages the spray foam insulation. If something were to happen it would cause a leak.

5. As you move from pods A-D and the renovation, how will your site logistics plan change?

Answer: Our strategy is to move three times on the South Building. Once Pods A-B are mostly complete we will move material laydown and some other items down the site. Once Pods C-D are complete then we will have to move all the materials and site logistics items near the demolition and renovation part of the South Building because the PODs will start being occupied.

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6. As the plan is right now, are you involved in trying to change something to make the process safer or more efficient?

Answer: Keeping a clean site will be very important in providing a safe environment to the school and workers. This is not a contained site; we have students, traffic, and the community coming in and through all areas of this High School. Most projects have an island with a fence around it but this project is different. Students will still have to cross Westerly Parkway during construction.

7. Could productivity change if the process were in a different order?

Answer: Staying on task and sequence the General Contractor gives will be the most efficient way to construct the system. If someone jumps out of order or sequence; it will act like a domino effect and cause all the other trades to be backed up.

8. Do you expect to have conflict between any trades during construction on this system?

Answer: Yes there will be conflict on the site. Most times it is with the General Contractor and another trade. Masonry and Spray on insulation should hopefully under the same contract. This will limit confusion between two trades and the one trade will be able to control those to sequences the most efficient way. Having a trade's work delayed and their predecessor coming behind them holding that trade up is always a receipt for agreements.

9. Are there any constraints that would slow you down?

Answer: Weather will be a big constraint for the façade system. Masons will have to heat their space in the winter to ensure the CMU and brick are not below freezing. The spray on insulation can only be applied at 40 degrees Fahrenheit and above.

10. Will LEED affect the way you construct this system?

Answer: The windows and sunshades will be part of the LEED certification.

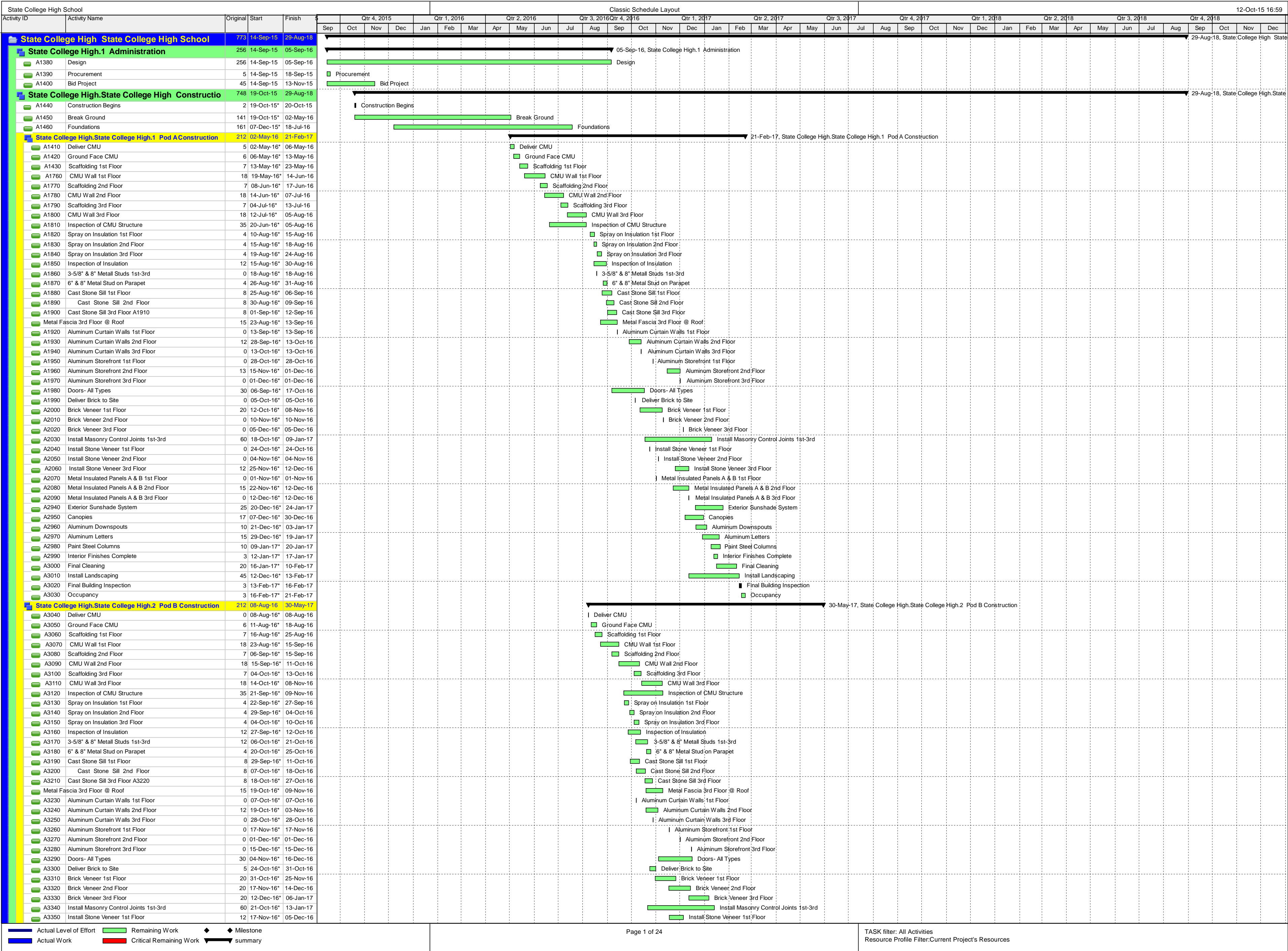
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11. Are there any penalties that if you do not complete this task on time you will accrue?

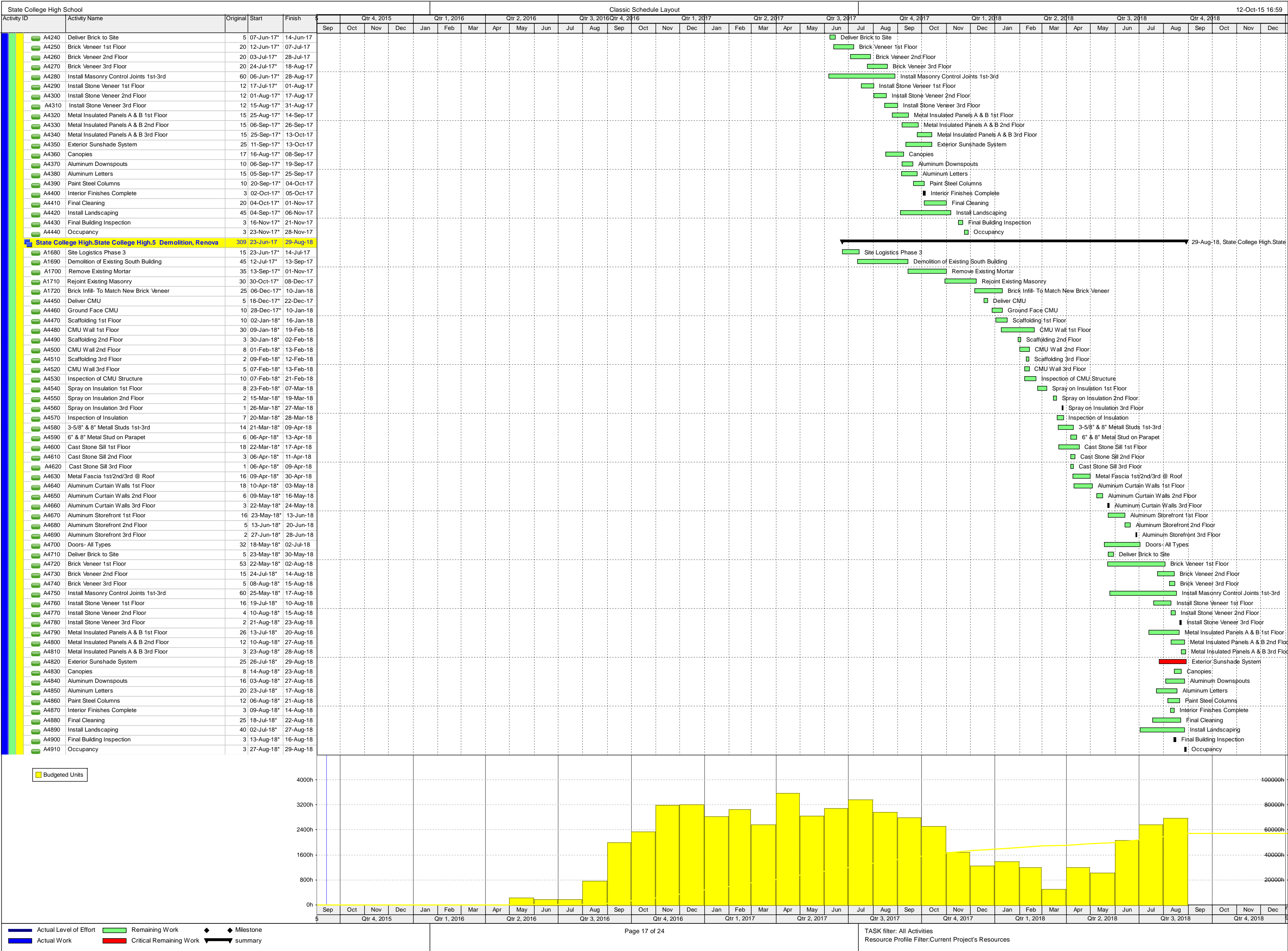
Answer: The General Contractor will accrue a penalty of \$1,500 a day, every day the project is late. There are four dates that have to be met or the penalty starts accumulating.

12. Who do you believe will need an additional crew to stay with the flow of work?

Answer: We will have to determine who is slipping on their end and have a talk with that particular trade to see how to resolve the problem. Sometimes with the low bid process we do get stuck with inadequate trades who cannot meet the schedule.



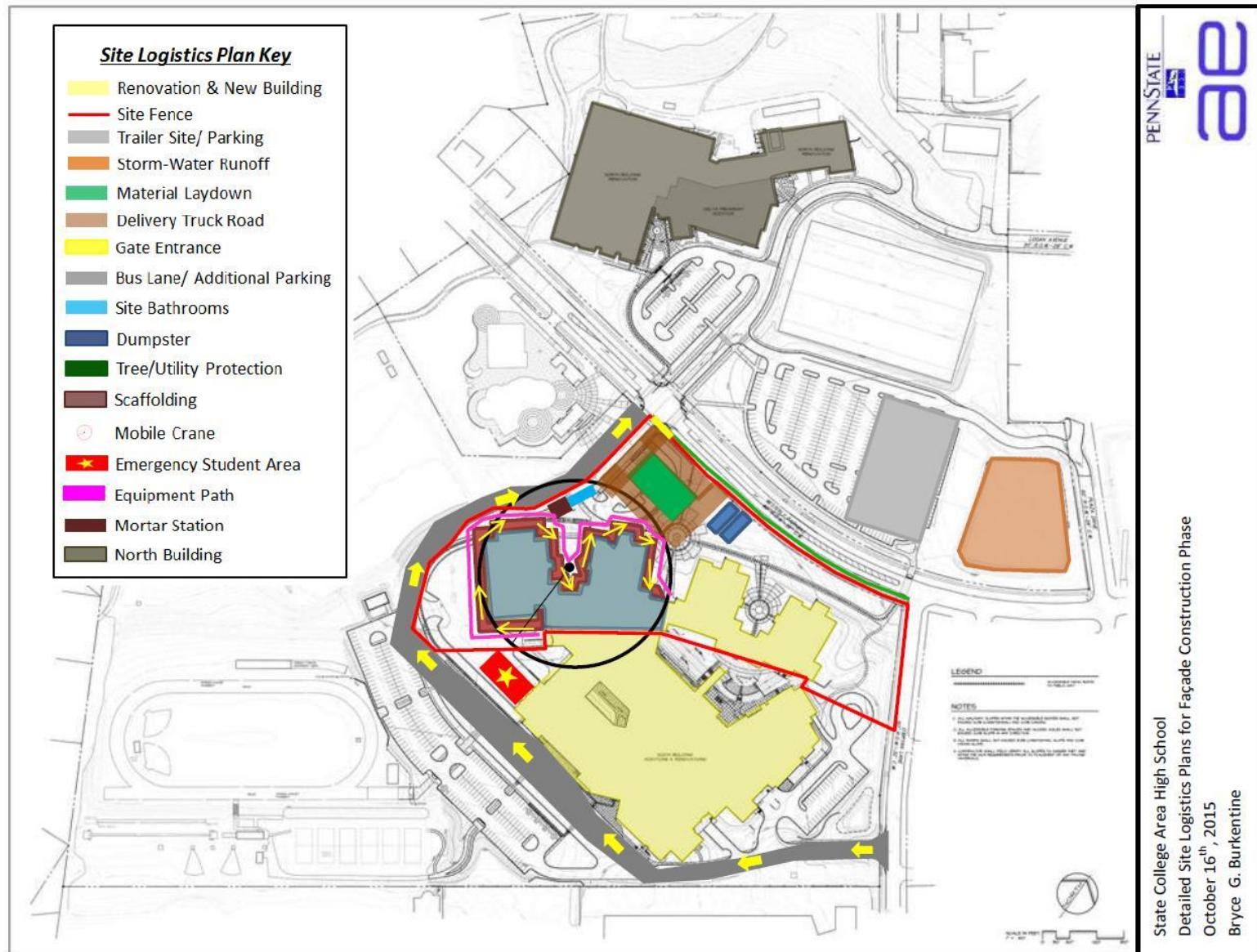
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Section	Item	Spreadsheet Level	Takeoff Quantity		Labor Cost/Unit		Labor Price		Labor Amount		Material Price		Material Amount		Equip Price	Equip Amount	Total Cost/Unit		Total Amount	
4000.000 MASONRY																				
	4060.100 Mortar: All Types																			
		Std Brk-Mortar Type N-Red	200.00	cy							4.80	/bags	11,616	/bags			58.08	/cy	11,616	
		Sand Fill CMU (sqft)	75,000.00	sf	0.87	/sf	46.00	/hr	65,550	/hr	0.13	/sf	10,890	/sf			1.02	/sf	76,440	
		Premixed Mortar	1,424.00	bag							14.00	/bag	20,933	/bag			14.70	/bag	20,933	
	4070.100 Mortar: Grout Fill Conc																			
		Portland Cement	1,000.00	cy	40.00	/cy	40.00	/hr	40,000	/hr	5.40	/bags	51,030	/bags			91.03	/cy	91,030	
		Sand @ Grout	4,300.00	cy	40.00	/cy	40.00	/hr	172,000	/hr	13.80	/ton	84,114	/ton			59.56	/cy	256,114	
	4080.100 Reinforce: Horizontl Wall																			
		Horiz Wall Reinf 8" Hot Dippd	600.00	mlf	100.00	/mlf	40.00	/hr	60,000	/hr	114.00	/mlf	71,820	/mlf			219.70	/mlf	131,820	
		Horiz Wall Reinf 12" Hot Dippd	230.00	mlf	100.00	/mlf	40.00	/hr	23,000	/hr	127.20	/mlf	30,719	/mlf			233.56	/mlf	53,719	
		Horiz Wall Reinf 16" Hot Dippd	150.00	mlf	100.00	/mlf	40.00	/hr	15,000	/hr	139.20	/mlf	21,924	/mlf			246.16	/mlf	36,924	
	4080.110 Reinforce: Brick Anchors																			
		Metal Insulated Panel Anchors	350.00	ea	0.40	/ea	40.00	/hr	140	/hr	127.20	/ea	46,746	/ea			133.96	/ea	46,886	
		Brick/Stone Anchors Z Ties 6"	50,000.00	ea							0.02	/ea	1,260	/ea			0.03	/ea	1,260	
	4090.100 Access: Control Joint																			
		Control Joint PEJ - 4"	15,000.00	lf							0.22	/lf	3,402	/lf			0.23	/lf	3,402	
		Control Joint Sealant	15,000.00	lf	2.00	/lf	40.00	/hr	30,000	/hr	0.12	/lf	1,890	/lf			2.13	/lf	31,890	
	4090.110 Access: Wall Flashing																			
		Wall Flashing	120,000.00	sf	0.40	/sf	40.00	/hr	48,000	/hr	0.04	/sf	4,536	/sf			0.44	/sf	52,536	
	4090.120 Access: Weep Holes																			
		Weepholes - Metal	10,000.00	ea	0.80	/ea	40.00	/hr	8,000	/hr	0.18	/ea	1,890	/ea			0.99	/ea	9,890	
	4210.100 Brick: All Types																			
		Common Brick	110,000.00	sf	2.25	/sf	40.00	/hr	247,500	/hr	22.00	/sf	2,541,000	/sf			25.35	/sf	2,788,500	
	4220.100 Conc. Block: 12"																			
		Blk 12" 2 hr Stand Face Lt Wt	62,000.00	sf	5.00	/sf	40.00	/hr	310,000	/hr	5.50	/sf	358,050	/sf			10.78	/sf	668,050	
	4220.110 Conc. Block: 8"																			
		Blk 8" 2 hr Stand Face Lt Wt	95,000.00	sf	4.00	/sf	40.00	/hr	380,000	/hr	3.00	/sf	299,250	/sf			7.15	/sf	679,250	
	4220.150 Conc. Block: 16" Lintel																			
		Lintel 16" Stand Face Lt Wt	62.00	ea	6.00	/ea	40.00	/hr	372	/hr	1.44	/ea	94	/ea			7.51	/ea	466	
	4220.160 Conc. Block: 12" Lintel																			
		Lintel 12" Stand Face Lt Wt	45.00	ea	5.00	/ea	40.00	/hr	225	/hr	1.44	/ea	68	/ea			6.51	/ea	293	
	4220.170 Conc. Block: 8" Lintel																			
		Lintel 8" Stand Face Lt Wt	60.00	ea	4.00	/ea	40.00	/hr	240	/hr	1.20	/ea	76	/ea			5.26	/ea	316	
	4220.190 Conc. Block: Opening Form																			
		Block Masonry Opening Forms	300.00	ea	40.00	/ea	40.00	/hr	12,000	/hr	24.00	/ea	7,560	/ea			65.20	/ea	19,560	
	4440.500 Stone Veneer																			
		Ashlar Stone Veneer 2"	23,000.00	sf	5.50	/sf	40.00	/hr	126,500	/hr	24.00	/sf	579,600	/sf			30.70	/sf	706,100	
	4930.100 Cleaning: Masonry																			
		Clean Brick - General	150,000.00	sf	0.40	/sf	40.00	/hr	60,000	/hr	0.02	/sf	3,780	/sf			0.43	/sf	63,780	
		Clean Stone Veneer	20,000.00	sf	0.40	/sf	40.00	/hr	8,000	/hr	0.02	/sf	504	/sf			0.43	/sf	8,504	
5000.000 METALS																				
	5500.010 Misc: Lintels																			
		Steel Lintels 3x3x1/4	105.00	ea	20.00	/ea	40.00	/hr	2,100	/hr	18.00	/ea	1,890	/ea			38.00	/ea	3,990	
04-43-00.00 Stone Masonry																				
	04-43-10.10 Bluestone																			
		Scaffolding	33,000.00	sf	11.45	/sf	11.45	/sf	377,850	/sf	6.50	/sf	214,500	/sf			17.95	/sf	592,350	
05-12-23.00 Structural Steel																				
	05-12-23.05 Canopy Framing																			
		Canopy framing, structural steel, 6" and 8" members, shop fabricated	10,500.00	lb	0.57	/lb	0.57	/lb	5,985	/lb	1.59	/lb	16,695	/lb	0.05	/lb	525	2.21	/lb	23,205
	05-12-23.40 Lightweight Framing																			
		Channel framing, structural steel, field fabricated, C3x4.1, incl cutting & welding	575.00	lf	16.00	/lf	16.00	/lf	9,200	/lf	3.26	/lf	1,875	/lf	1.82	/lf	1,047	21.08	/lf	12,121
		Channel framing, structural steel, field fabricated, C6x8.2, incl cutting & welding	400.00	lf	23.50	/lf	23.50	/lf	9,400	/lf	6.30	/lf	2,520	/lf	2.65	/lf	1,060	32.45	/lf	12,980
		Channel framing, structural steel, field fabricated, C8x11.5, incl cutting & welding	400.00	lf	35.50	/lf	35.50	/lf	14,200	/lf	9.15	/lf	3,660	/lf	4.05	/lf	1,620	48.70	/lf	19,480
07-21-29.00 Sprayed Insulation																				
	07-21-29.10 Sprayed-On Insulation																			
		Insulation, polyurethane foam, 2#/CF density, 3" thick, R19.5, sprayed	150,000.00	sf	0.43	/sf	0.43	/sf	64,500	/sf	1.58	/sf	237,000	/sf	0.36	/sf	54,000	2.37	/sf	355,500
07-42-13.00 Metal Wall																				
	07-42-13.20 Aluminum Siding Panels																			
		Aluminum siding, sandwich panels, embossed white, insulated, double 4" pattern, .019" thick	46,000.00	sf	1.14	/sf	1.14	/sf	52,440	/sf	2.67	/sf	122,820	/sf			3.81	/sf	175,260	
07-71-43.00 Drip Edge																				
	07-71-43.10 Drip Edge, Rake Edge, Ice Belts																			
		Aluminum drip edge, mill finish, .016" thick, 5" wide	30,000.00	lf	0.94	/lf	0.94	/lf	28,200	/lf	0.55	/lf	16,500	/lf			1.49	/lf	44,700	
08-11-00.00 Metal Doors And Frames																				
	08-11-16.10 Entrance Doors																			
		Doors & frames, aluminum, entrance, narrow stile, clear finish, 3'-0" x 7'-0" opening, incl. standard hardware, excl. glass	105.00	3	420.00	/3	420.00	/3	44,100	/3	915.00	/3	96,075	/3			1,335.00	/3	140,175	
		Doors & frames, aluminum, entrance, narrow stile, clear finish, 6'-0" x 7'-0" opening, incl. standard hardware, excl. glass	100.00	ea	650.00	/ea	650.00	/ea	65,000	/ea	1,200.00	/ea	120,000	/ea			1,850.00	/ea	185,000	
08-13-13.00 Hollow Metal Doors																				
	08-13-13.15 Metal Fire Doors																			

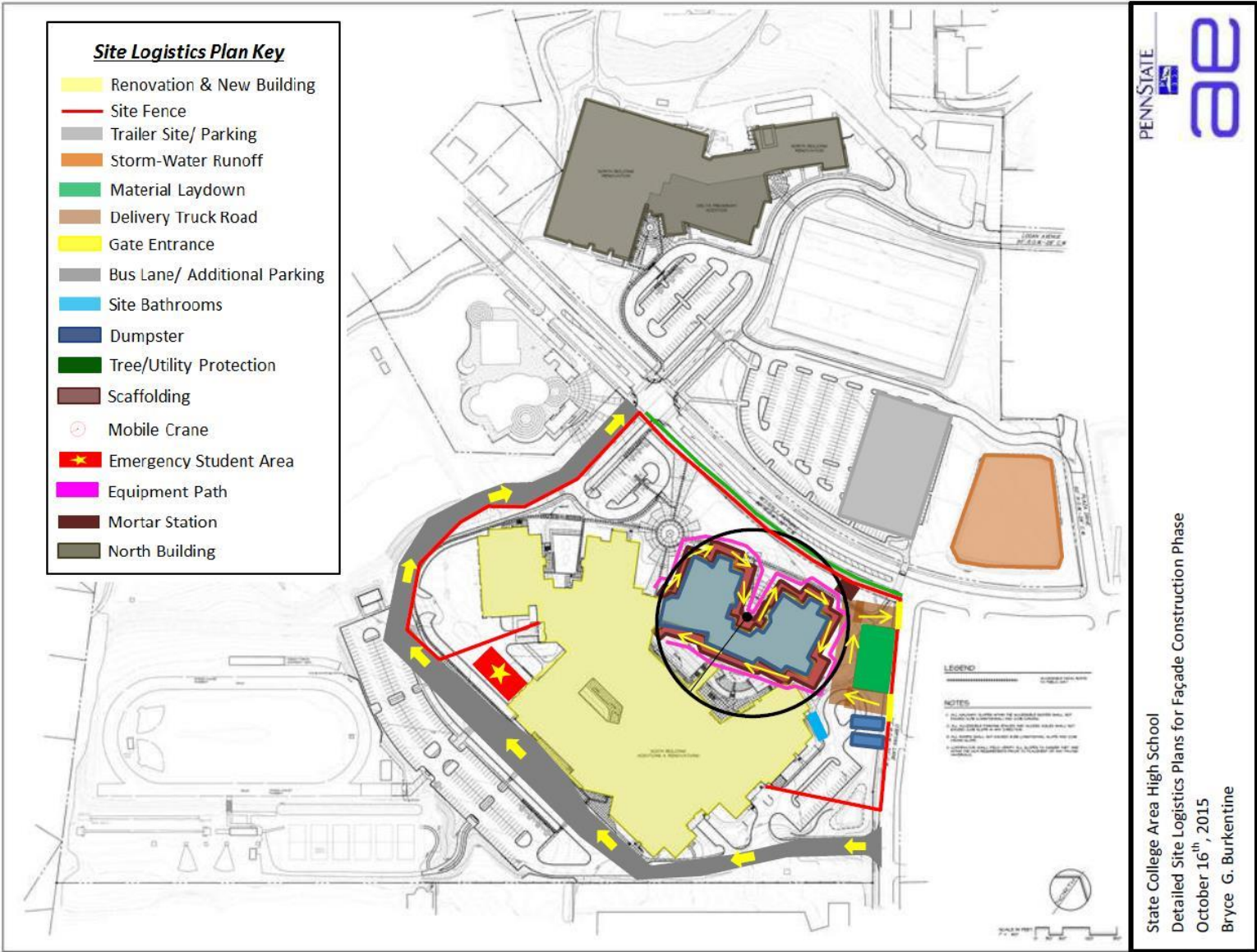
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Site Logistics Plans- Phase 1:



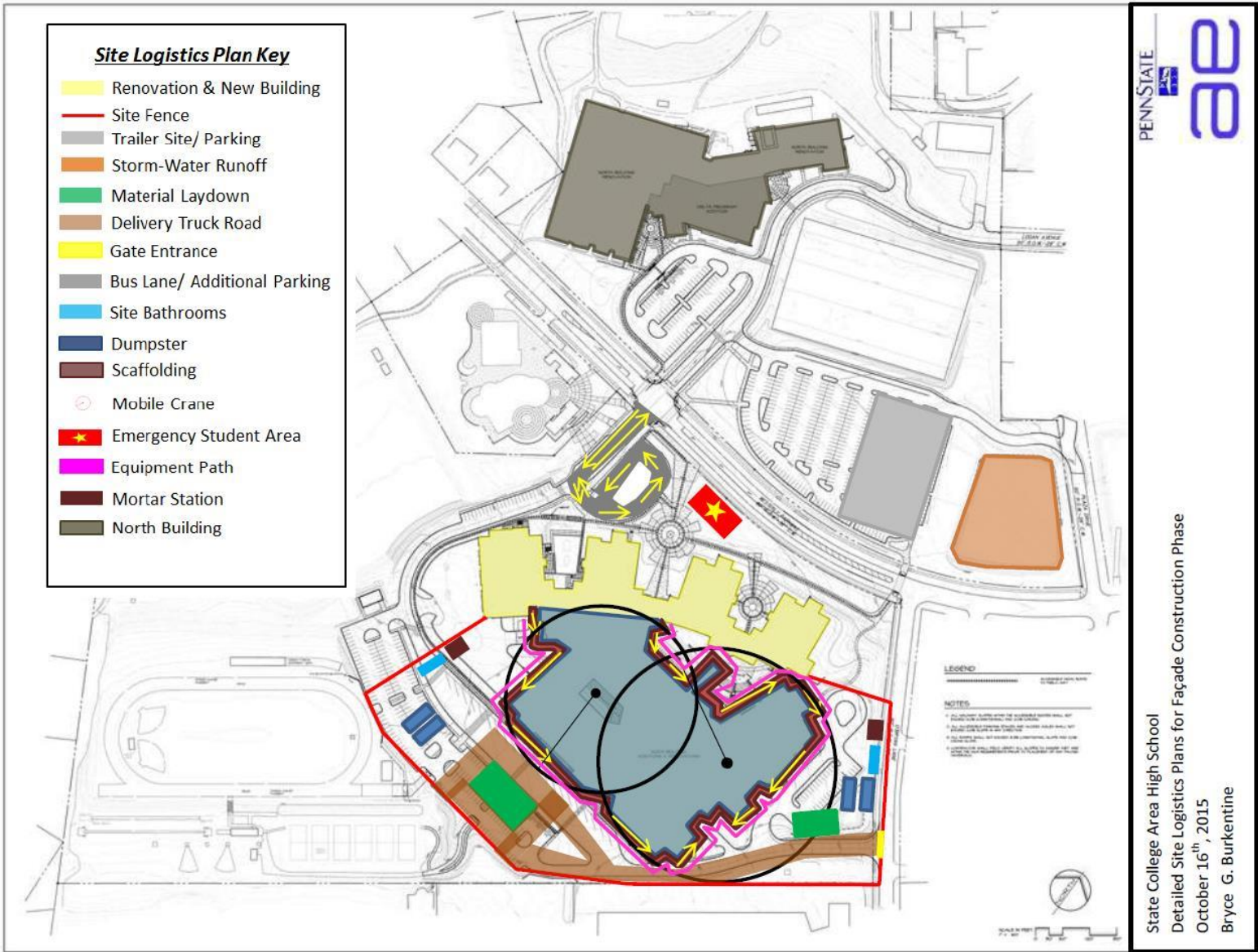
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Phase 2:



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Phase 3:



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Flow Diagram of Façade System

