HD WOODSON HIGH SCHOOL

Construction Project Management

Rendering courtesy of cox graae + spack

TECHNICAL ASSIGNMENT 2

Prepared For:
Dr. David Riley, PhD
Department of Architectural Engineering
The Pennsylvania State University

Prepared By:
Neal Diehl
Construction Option
October 27, 2010

TABLE OF CONTENTS

Contents

EXECUTIVE SUMMARY

Technical Report Two analyzes the key project features that effect project execution. Included in this report are four focus areas. A detailed project schedule, site layout planning, detailed structural steel and composite floor estimate and general conditions estimate. These four areas are identified as influencing the project execution effectiveness. Critical industry issues will be submitted separately at a later date and serve as a summary of the PACE Roundtable Meeting.

The detailed project schedule details the sequencing by area and by trade over the 566 day schedule. Multiple areas of the building will be constructed using a similar trade sequence and progress through the building in a logical manner. The M/E/P sequences are broken out to show the timing of rough-in, distribution and finishes.

Site layout and plan have been created in AutoCAD and drawn to scale. There are three access points for delivery and worker access. There is a large amount of earthwork and steel erection during the phase shown. Management trailers and material storage areas are main points on the plan.

The detailed structural steel and composite floor estimate involved a complete structural steel take off and elevated composite deck. RS Means 2010 was used as a price index and a location factor of 98.8. The total detailed structural steel and composite deck estimate came to $ 4.4 million. Details of takeoff and pricing can be found in both the estimate section and the appendices.

The general conditions estimate was generated with the use of RS Means and information from the Construction Manager. Over the 18 months of the project an estimated $5.9 million will be spent on general conditions.

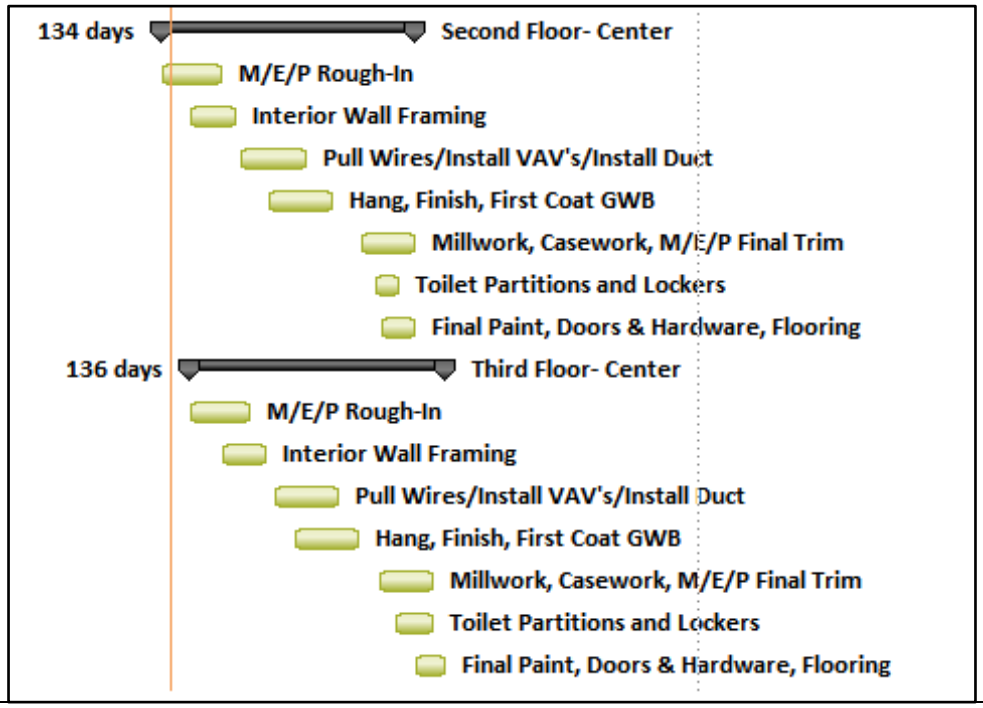
DETAILED PROJECT SCHEDULE

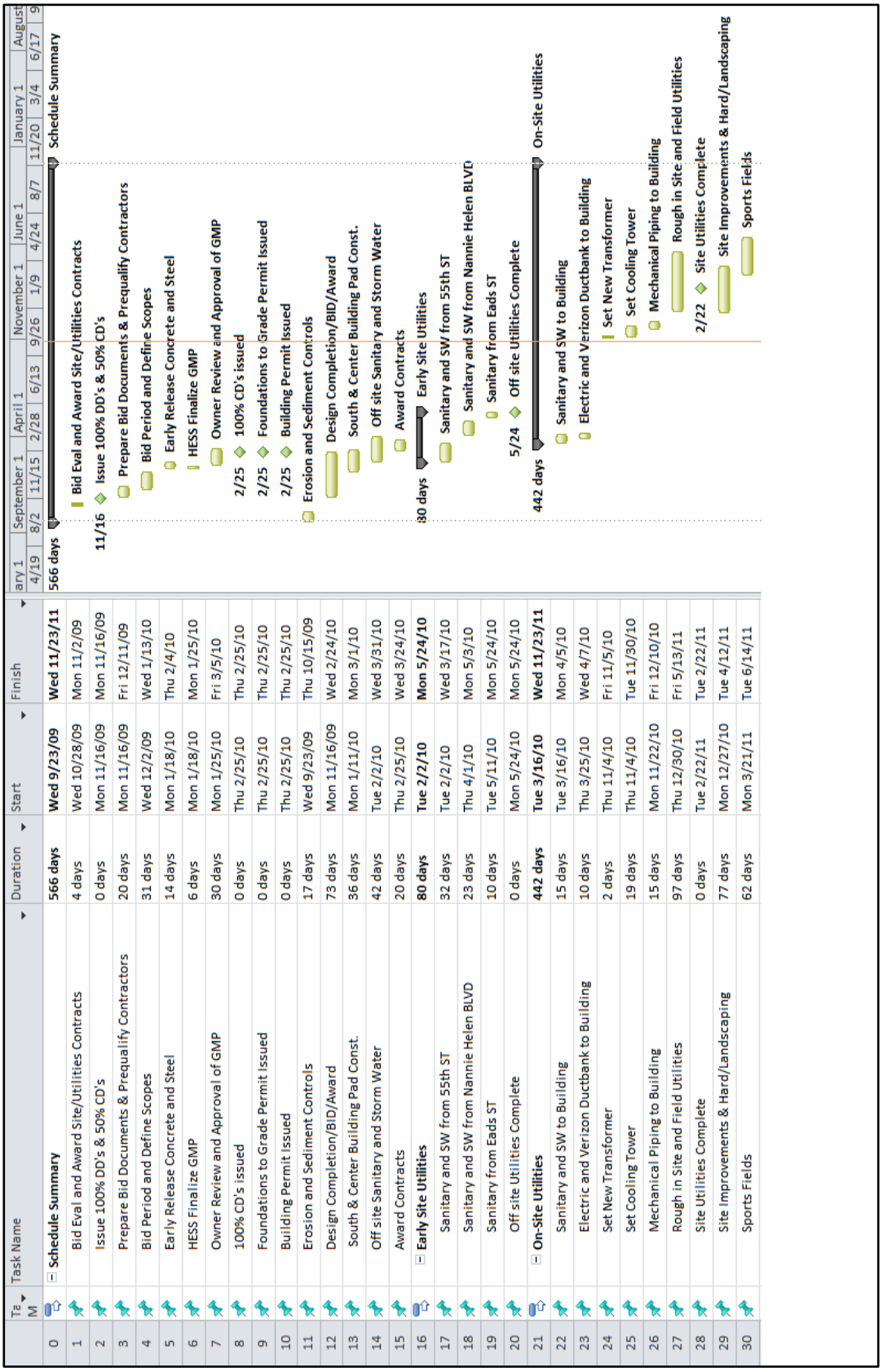
The Detailed project schedule further develops the schedule created in the Technical Report One. The schedule shown makes the sequencing of work understandable. The Three building areas are clearly separated out to show work grouped in certain areas at the same time. Rather than strictly show a sequential order or activities by date the grouped activities show order of trades and sequences of work.

The Center Building is the lead area, due to having the most floors and being the main core of the building. The South and North Building typically follow and work up by floor. As a trade finishes on a floor in an area the simply move up the building vertically rather than laterally. This is a logical approach that allows for highly efficient trade workers to know the order of their work on every floor in all three areas after going through the process once.

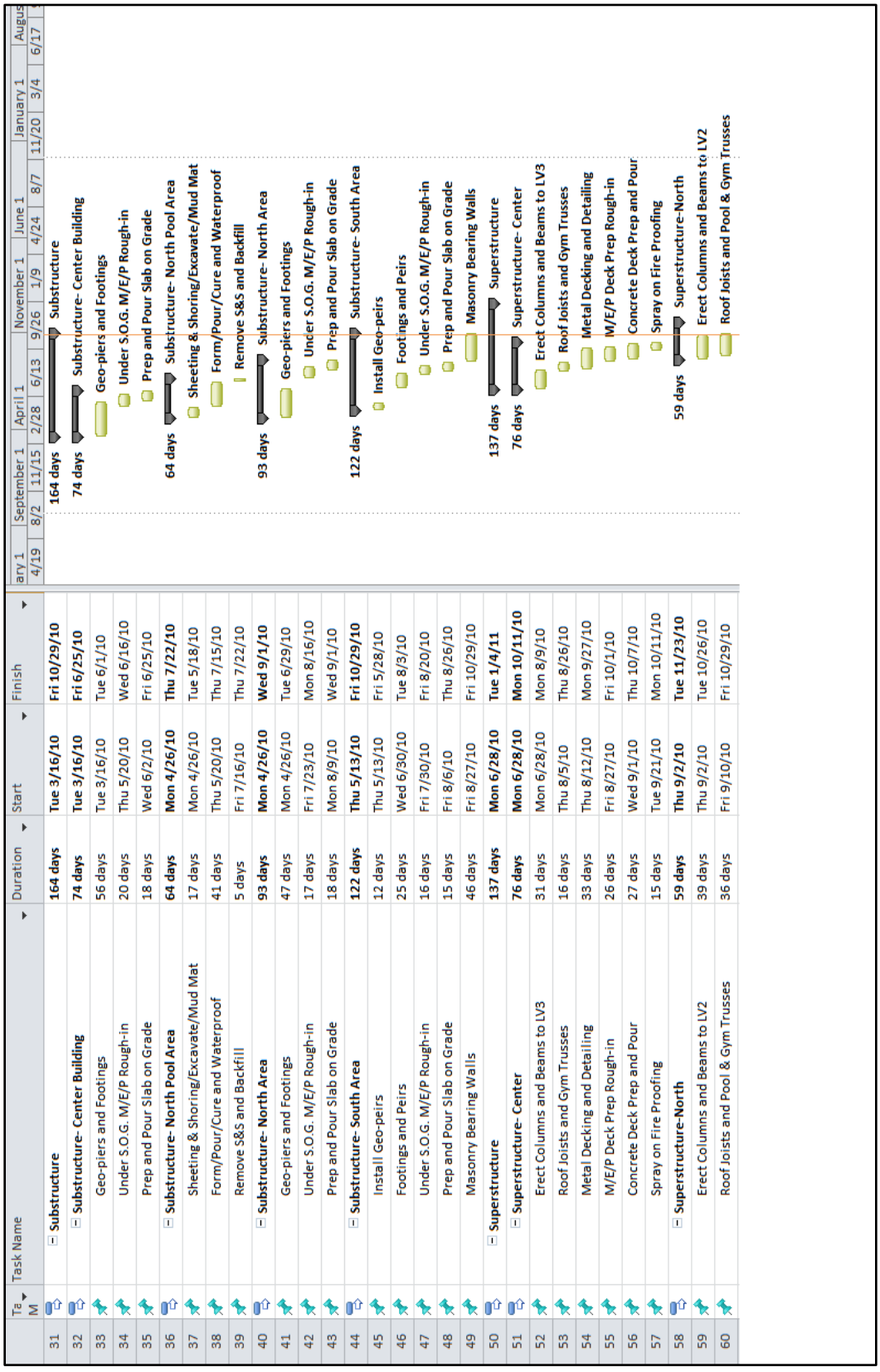
The Gymnasiums, Natatorium and Auditorium are slightly different as they do not have multiple floors to be constructed. The schedule shown for these areas takes that into account. The sequence is slightly different and durations vary widely. The complexity and variance in size is a contributing factor to these differences.

The Total Construction Duration is projected to be 566 days (1.55 years/18.8 months). Summaries are included on the schedule to clearly show the total durations of particular phases of Construction and to compare durations in different areas of the building. Below is an example of the typical sequence used in areas that were relatively similar.

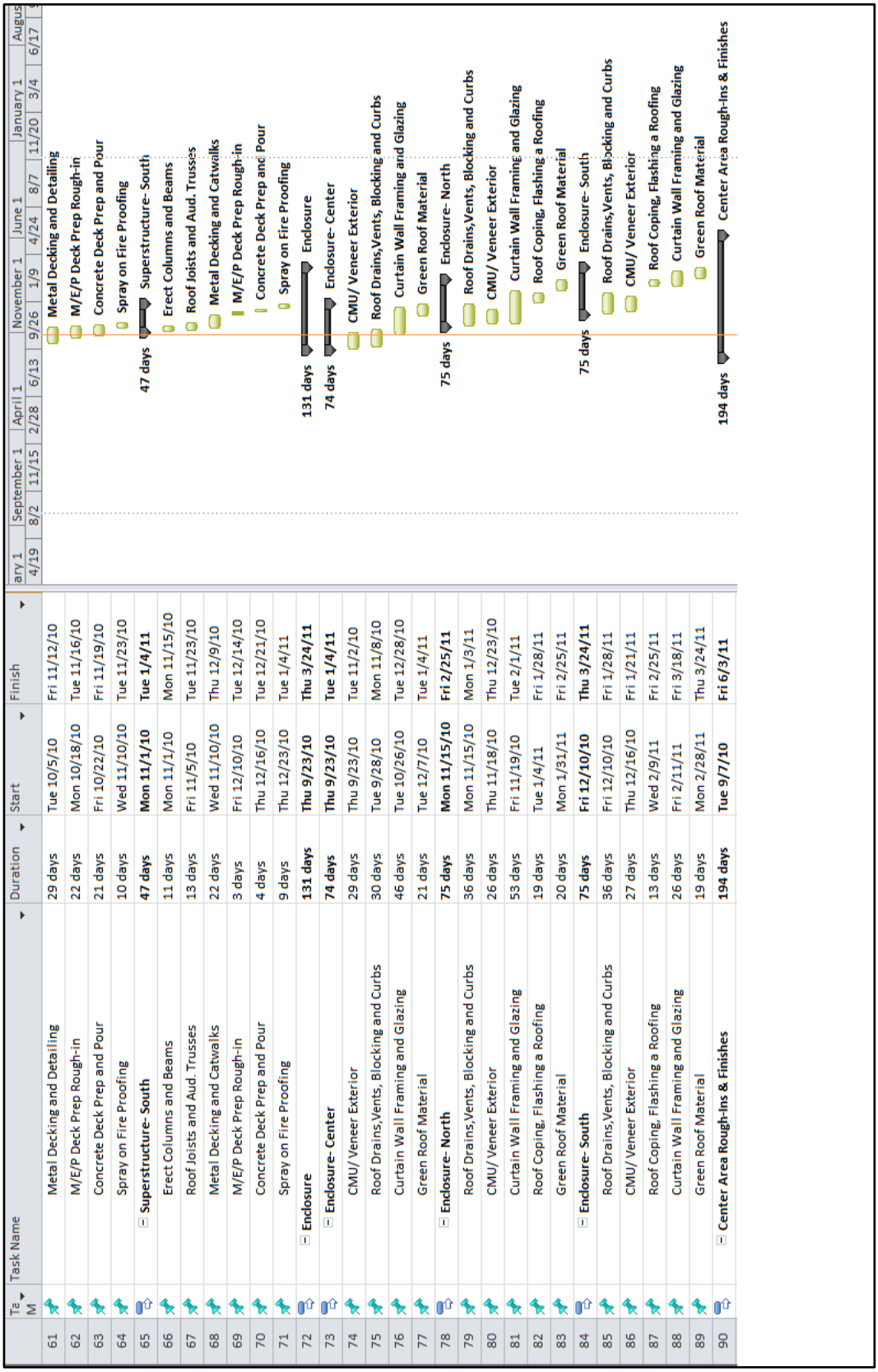




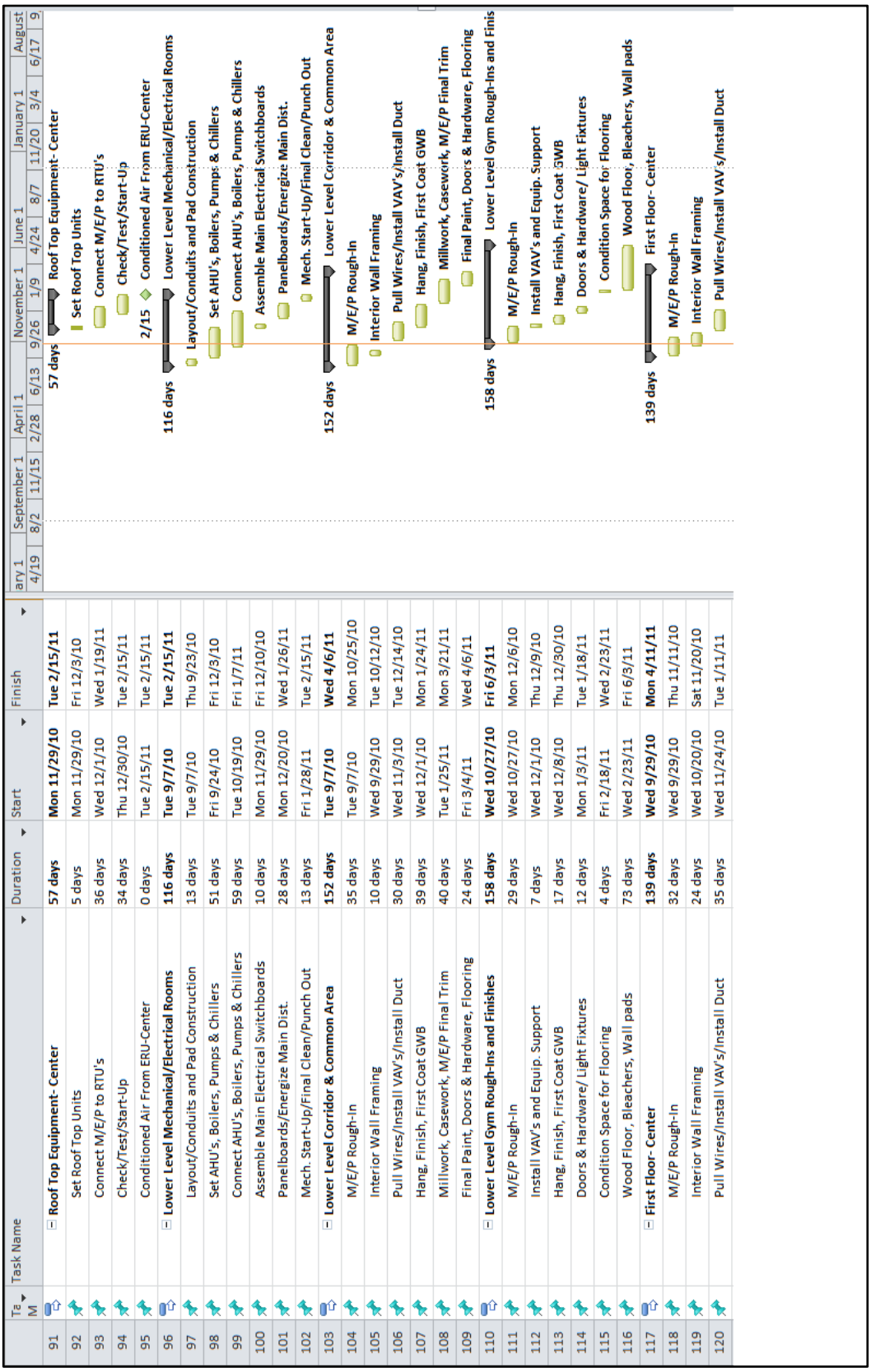
	Task Mode	Task Name	Duration	Start	Finish
0		**Schedule Summary**	**566 days**	**Wed 9/23/09**	**Wed 11/23/11**
1		Bid Eval and Award Site/Utilities Contracts	4 days	Wed 10/28/09	Mon 11/2/09
2		Issue 100% DD's & 50% CD's	0 days	Mon 11/16/09	Mon 11/16/09
3		Prepare Bid Documents & Prequalify Contractors	20 days	Mon 11/16/09	Fri 12/11/09
4		Bid Period and Define Scopes	31 days	Wed 12/2/09	Wed 1/13/10
5		Early Release Concrete and Steel	14 days	Mon 1/18/10	Thu 2/4/10
6		HESS Finalize GMP	6 days	Mon 1/18/10	Mon 1/25/10
7		Owner Review and Approval of GMP	30 days	Mon 1/25/10	Fri 3/5/10
8		100% CD's issued	0 days	Thu 2/25/10	Thu 2/25/10
9		Foundations to Grade Permit Issued	0 days	Thu 2/25/10	Thu 2/25/10
10		Building Permit Issued	0 days	Thu 2/25/10	Thu 2/25/10
11		Erosion and Sediment Controls	17 days	Wed 9/23/09	Thu 10/15/09
12		Design Completion/BID/Award	73 days	Mon 11/16/09	Wed 2/24/10
13		South & Center Building Pad Const.	36 days	Mon 1/11/10	Mon 3/1/10
14		Off site Sanitary and Storm Water	42 days	Tue 2/2/10	Wed 3/31/10
15		Award Contracts	20 days	Thu 2/25/10	Wed 3/24/10
16		**Early Site Utilities**	**80 days**	**Tue 2/2/10**	**Mon 5/24/10**
17		Sanitary and SW from 55th ST	32 days	Tue 2/2/10	Wed 3/17/10
18		Sanitary and SW from Nannie Helen BLVD	23 days	Thu 4/1/10	Mon 5/3/10
19		Sanitary from Eads ST	10 days	Tue 5/11/10	Mon 5/24/10
20		Off site Utilities Complete	0 days	Mon 5/24/10	Mon 5/24/10
21		**On-Site Utilities**	**442 days**	**Tue 3/16/10**	**Wed 11/23/11**
22		Sanitary and SW to Building	15 days	Tue 3/16/10	Mon 4/5/10
23		Electric and Verizon Ductbank to Building	10 days	Thu 3/25/10	Wed 4/7/10
24		Set New Transformer	2 days	Thu 11/4/10	Fri 11/5/10
25		Set Cooling Tower	19 days	Thu 11/4/10	Tue 11/30/10
26		Mechanical Piping to Building	15 days	Mon 11/22/10	Fri 12/10/10
27		Rough in Site and Field Utilities	97 days	Thu 12/30/10	Fri 5/13/11
28		Site Utilities Complete	0 days	Tue 2/22/11	Tue 2/22/11
29		Site Improvements & Hard/Landscaping	77 days	Mon 12/27/10	Tue 4/12/11
30		Sports Fields	62 days	Mon 3/21/11	Tue 6/14/11



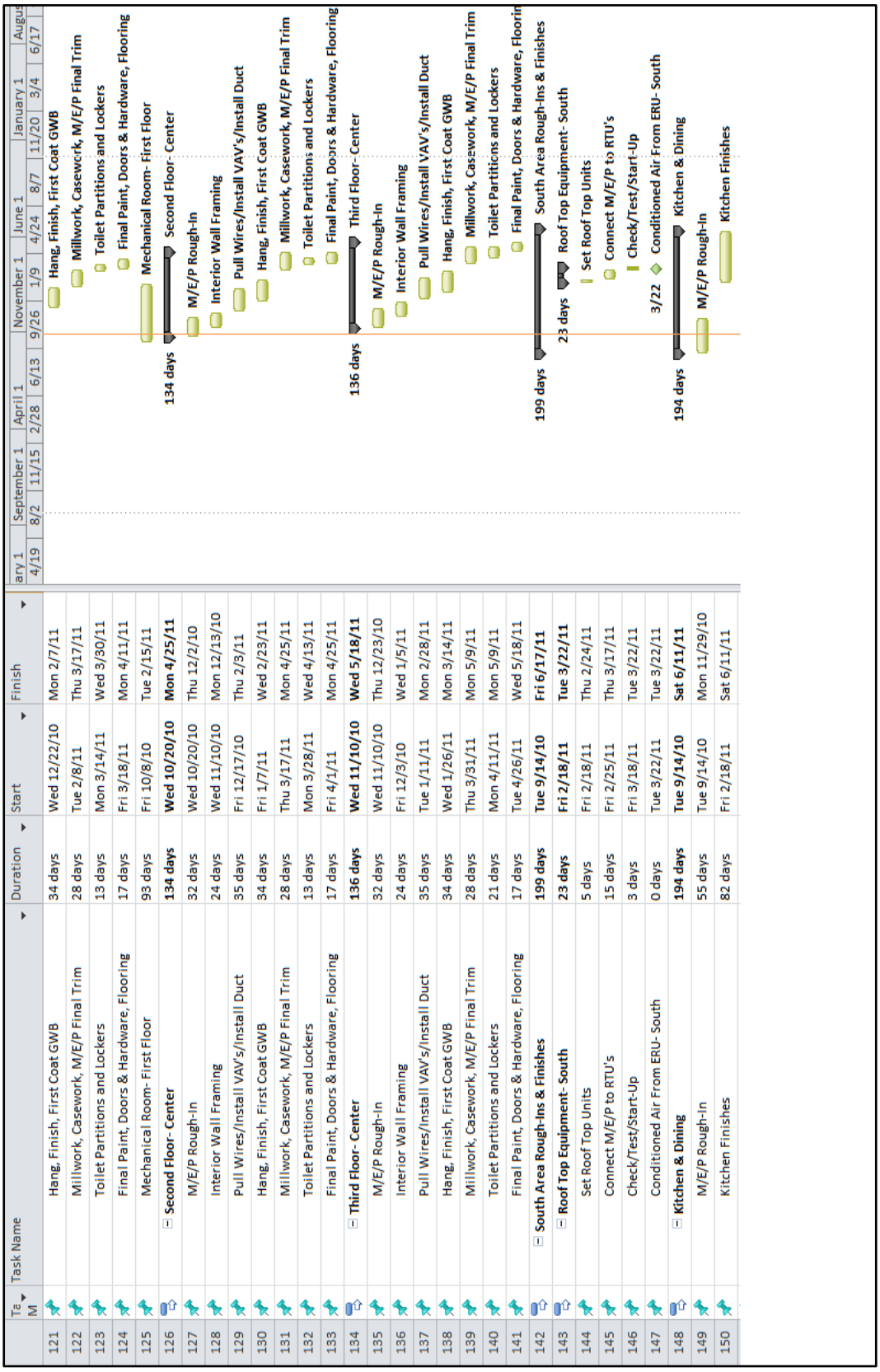
	Task Mode	Task Name	Duration	Start	Finish
31		**Substructure**	**164 days**	**Tue 3/16/10**	**Fri 10/29/10**
32		**Substructure- Center Building**	**74 days**	**Tue 3/16/10**	**Fri 6/25/10**
33		Geo-piers and Footings	56 days	Tue 3/16/10	Tue 6/1/10
34		Under S.O.G. M/E/P Rough-in	20 days	Thu 5/20/10	Wed 6/16/10
35		Prep and Pour Slab on Grade	18 days	Wed 6/2/10	Fri 6/25/10
36		**Substructure- North Pool Area**	**64 days**	**Mon 4/26/10**	**Thu 7/22/10**
37		Sheeting & Shoring/Excavate/Mud Mat	17 days	Mon 4/26/10	Tue 5/18/10
38		Form/Pour/Cure and Waterproof	41 days	Thu 5/20/10	Thu 7/15/10
39		Remove S&S and Backfill	5 days	Fri 7/16/10	Thu 7/22/10
40		**Substructure- North Area**	**93 days**	**Mon 4/26/10**	**Wed 9/1/10**
41		Geo-piers and Footings	47 days	Mon 4/26/10	Tue 6/29/10
42		Under S.O.G. M/E/P Rough-in	17 days	Fri 7/23/10	Mon 8/16/10
43		Prep and Pour Slab on Grade	18 days	Mon 8/9/10	Wed 9/1/10
44		**Substructure- South Area**	**122 days**	**Thu 5/13/10**	**Fri 10/29/10**
45		Install Geo-peirs	12 days	Thu 5/13/10	Fri 5/28/10
46		Footings and Peirs	25 days	Wed 6/30/10	Tue 8/3/10
47		Under S.O.G. M/E/P Rough-in	16 days	Fri 7/30/10	Fri 8/20/10
48		Prep and Pour Slab on Grade	15 days	Fri 8/6/10	Thu 8/26/10
49		Masonry Bearing Walls	46 days	Fri 8/27/10	Fri 10/29/10
50		**Superstructure**	**137 days**	**Mon 6/28/10**	**Tue 1/4/11**
51		**Superstructure- Center**	**76 days**	**Mon 6/28/10**	**Mon 10/11/10**
52		Erect Columns and Beams to LV3	31 days	Mon 6/28/10	Mon 8/9/10
53		Roof Joists and Gym Trusses	16 days	Thu 8/5/10	Thu 8/26/10
54		Metal Decking and Detailing	33 days	Thu 8/12/10	Mon 9/27/10
55		M/E/P Deck Prep Rough-in	26 days	Fri 8/27/10	Fri 10/1/10
56		Concrete Deck Prep and Pour	27 days	Wed 9/1/10	Thu 10/7/10
57		Spray on Fire Proofing	15 days	Tue 9/21/10	Mon 10/11/10
58		**Superstructure-North**	**59 days**	**Thu 9/2/10**	**Tue 11/23/10**
59		Erect Columns and Beams to LV2	39 days	Thu 9/2/10	Tue 10/26/10
60		Roof Joists and Pool & Gym Trusses	36 days	Fri 9/10/10	Fri 10/29/10



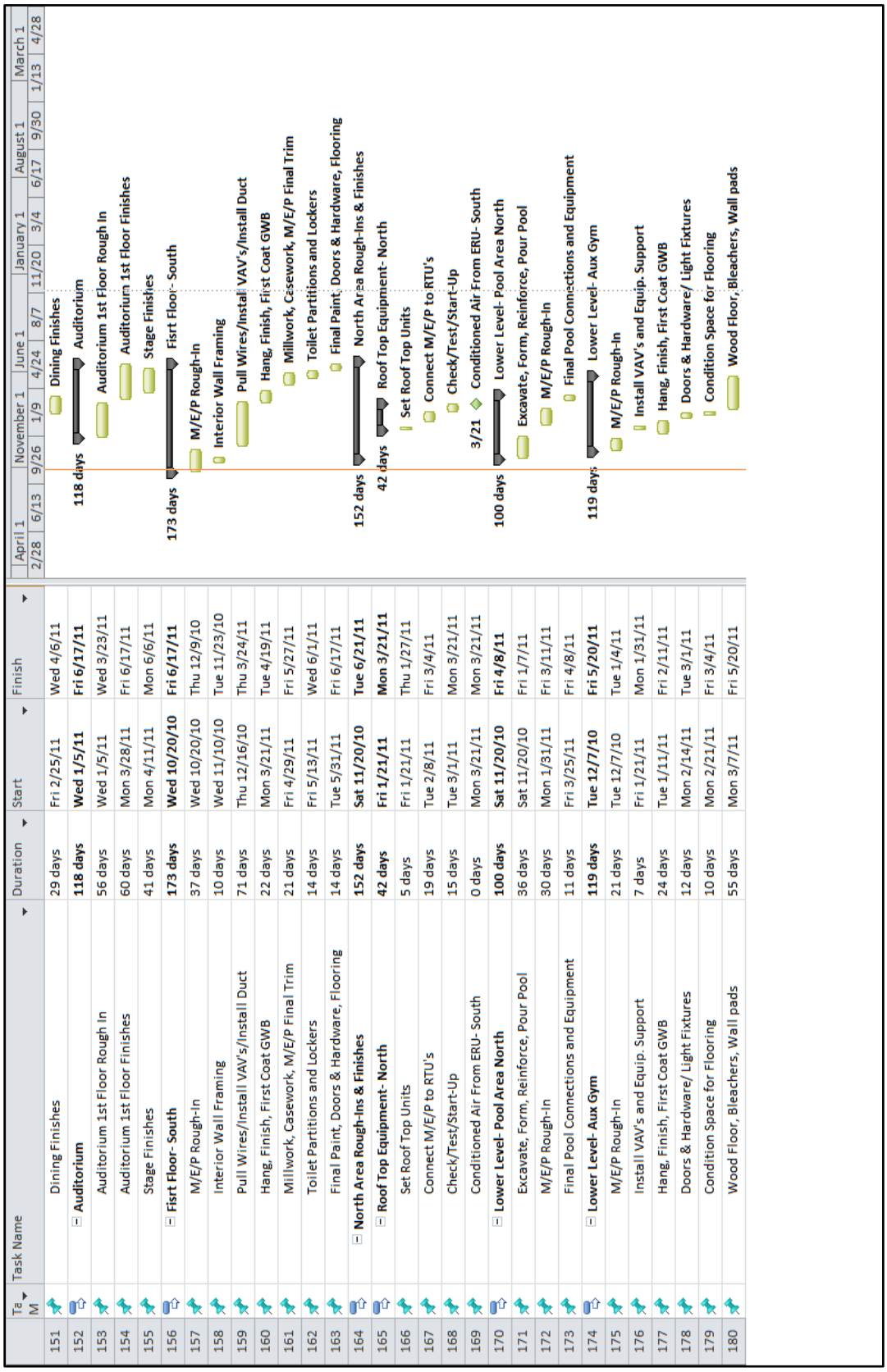
	Task Mode	Task Name	Duration	Start	Finish
61		Metal Decking and Detailing	29 days	Tue 10/5/10	Fri 11/12/10
62		M/E/P Deck Prep Rough-in	22 days	Mon 10/18/10	Tue 11/16/10
63		Concrete Deck Prep and Pour	21 days	Fri 10/22/10	Fri 11/19/10
64		Spray on Fire Proofing	10 days	Wed 11/10/10	Tue 11/23/10
65		**Superstructure- South**	**47 days**	**Mon 11/1/10**	**Tue 1/4/11**
66		Erect Columns and Beams	11 days	Mon 11/1/10	Mon 11/15/10
67		Roof Joists and Aud. Trusses	13 days	Fri 11/5/10	Tue 11/23/10
68		Metal Decking and Catwalks	22 days	Wed 11/10/10	Thu 12/9/10
69		M/E/P Deck Prep Rough-in	3 days	Fri 12/10/10	Tue 12/14/10
70		Concrete Deck Prep and Pour	4 days	Thu 12/16/10	Tue 12/21/10
71		Spray on Fire Proofing	9 days	Thu 12/23/10	Tue 1/4/11
72		**Enclosure**	**131 days**	**Thu 9/23/10**	**Thu 3/24/11**
73		**Enclosure- Center**	**74 days**	**Thu 9/23/10**	**Tue 1/4/11**
74		CMU/ Veneer Exterior	29 days	Thu 9/23/10	Tue 11/2/10
75		Roof Drains,Vents, Blocking and Curbs	30 days	Tue 9/28/10	Mon 11/8/10
76		Curtain Wall Framing and Glazing	46 days	Tue 10/26/10	Tue 12/28/10
77		Green Roof Material	21 days	Tue 12/7/10	Tue 1/4/11
78		**Enclosure- North**	**75 days**	**Mon 11/15/10**	**Fri 2/25/11**
79		Roof Drains,Vents, Blocking and Curbs	36 days	Mon 11/15/10	Mon 1/3/11
80		CMU/ Veneer Exterior	26 days	Thu 11/18/10	Thu 12/23/10
81		Curtain Wall Framing and Glazing	53 days	Fri 11/19/10	Tue 2/1/11
82		Roof Coping, Flashing a Roofing	19 days	Tue 1/4/11	Fri 1/28/11
83		Green Roof Material	20 days	Mon 1/31/11	Fri 2/25/11
84		**Enclosure- South**	**75 days**	**Fri 12/10/10**	**Thu 3/24/11**
85		Roof Drains,Vents, Blocking and Curbs	36 days	Fri 12/10/10	Fri 1/28/11
86		CMU/ Veneer Exterior	27 days	Thu 12/16/10	Fri 1/21/11
87		Roof Coping, Flashing a Roofing	13 days	Wed 2/9/11	Fri 2/25/11
88		Curtain Wall Framing and Glazing	26 days	Fri 2/11/11	Fri 3/18/11
89		Green Roof Material	19 days	Mon 2/28/11	Thu 3/24/11
90		**Center Area Rough-Ins & Finishes**	**194 days**	**Tue 9/7/10**	**Fri 6/3/11**



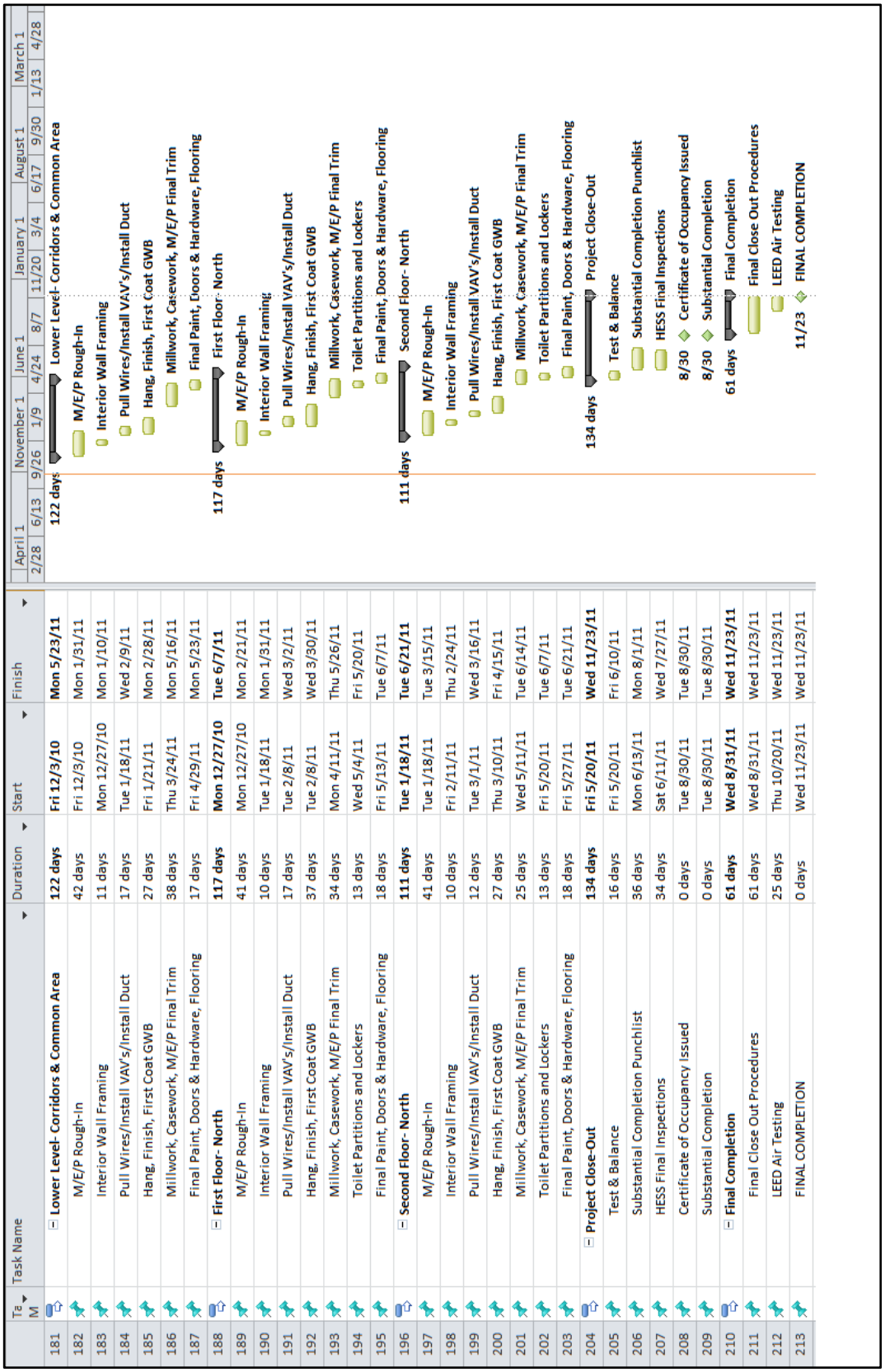
	Task Mode	Task Name	Duration	Start	Finish
91		**Roof Top Equipment- Center**	**57 days**	**Mon 11/29/10**	**Tue 2/15/11**
92		Set Roof Top Units	5 days	Mon 11/29/10	Fri 12/3/10
93		Connect M/E/P to RTU's	36 days	Wed 12/1/10	Wed 1/19/11
94		Check/Test/Start-Up	34 days	Thu 12/30/10	Tue 2/15/11
95		Conditioned Air From ERU-Center	0 days	Tue 2/15/11	Tue 2/15/11
96		**Lower Level Mechanical/Electrical Rooms**	**116 days**	**Tue 9/7/10**	**Tue 2/15/11**
97		Layout/Conduits and Pad Construction	13 days	Tue 9/7/10	Thu 9/23/10
98		Set AHU's, Boilers, Pumps & Chillers	51 days	Fri 9/24/10	Fri 12/3/10
99		Connect AHU's, Boilers, Pumps & Chillers	59 days	Tue 10/19/10	Fri 1/7/11
100		Assemble Main Electrical Switchboards	10 days	Mon 11/29/10	Fri 12/10/10
101		Panelboards/Energize Main Dist.	28 days	Mon 12/20/10	Wed 1/26/11
102		Mech. Start-Up/Final Clean/Punch Out	13 days	Fri 1/28/11	Tue 2/15/11
103		**Lower Level Corridor & Common Area**	**152 days**	**Tue 9/7/10**	**Wed 4/6/11**
104		M/E/P Rough-In	35 days	Tue 9/7/10	Mon 10/25/10
105		Interior Wall Framing	10 days	Wed 9/29/10	Tue 10/12/10
106		Pull Wires/Install VAV's/Install Duct	30 days	Wed 11/3/10	Tue 12/14/10
107		Hang, Finish, First Coat GWB	39 days	Wed 12/1/10	Mon 1/24/11
108		Millwork, Casework, M/E/P Final Trim	40 days	Tue 1/25/11	Mon 3/21/11
109		Final Paint, Doors & Hardware, Flooring	24 days	Fri 3/4/11	Wed 4/6/11
110		**Lower Level Gym Rough-Ins and Finishes**	**158 days**	**Wed 10/27/10**	**Fri 6/3/11**
111		M/E/P Rough-In	29 days	Wed 10/27/10	Mon 12/6/10
112		Install VAV's and Equip. Support	7 days	Wed 12/1/10	Thu 12/9/10
113		Hang, Finish, First Coat GWB	17 days	Wed 12/8/10	Thu 12/30/10
114		Doors & Hardware/ Light Fixtures	12 days	Mon 1/3/11	Tue 1/18/11
115		Condition Space for Flooring	4 days	Fri 2/18/11	Wed 2/23/11
116		Wood Floor, Bleachers, Wall pads	73 days	Wed 2/23/11	Fri 6/3/11
117		**First Floor- Center**	**139 days**	**Wed 9/29/10**	**Mon 4/11/11**
118		M/E/P Rough-In	32 days	Wed 9/29/10	Thu 11/11/10
119		Interior Wall Framing	24 days	Wed 10/20/10	Sat 11/20/10
120		Pull Wires/Install VAV's/Install Duct	35 days	Wed 11/24/10	Tue 1/11/11



	Task Name	Duration	Start	Finish
121	Hang, Finish, First Coat GWB	34 days	Wed 12/22/10	Mon 2/7/11
122	Millwork, Casework, M/E/P Final Trim	28 days	Tue 2/8/11	Thu 3/17/11
123	Toilet Partitions and Lockers	13 days	Mon 3/14/11	Wed 3/30/11
124	Final Paint, Doors & Hardware, Flooring	17 days	Fri 3/18/11	Mon 4/11/11
125	Mechanical Room- First Floor	93 days	Fri 10/8/10	Tue 2/15/11
126	**Second Floor- Center**	**134 days**	**Wed 10/20/10**	**Mon 4/25/11**
127	M/E/P Rough-In	32 days	Wed 10/20/10	Thu 12/2/10
128	Interior Wall Framing	24 days	Wed 11/10/10	Mon 12/13/10
129	Pull Wires/Install VAV's/Install Duct	35 days	Fri 12/17/10	Thu 2/3/11
130	Hang, Finish, First Coat GWB	34 days	Fri 1/7/11	Wed 2/23/11
131	Millwork, Casework, M/E/P Final Trim	28 days	Thu 3/17/11	Mon 4/25/11
132	Toilet Partitions and Lockers	13 days	Mon 3/28/11	Wed 4/13/11
133	Final Paint, Doors & Hardware, Flooring	17 days	Fri 4/1/11	Mon 4/25/11
134	**Third Floor- Center**	**136 days**	**Wed 11/10/10**	**Wed 5/18/11**
135	M/E/P Rough-In	32 days	Wed 11/10/10	Thu 12/23/10
136	Interior Wall Framing	24 days	Fri 12/3/10	Wed 1/5/11
137	Pull Wires/Install VAV's/Install Duct	35 days	Tue 1/11/11	Mon 2/28/11
138	Hang, Finish, First Coat GWB	34 days	Wed 1/26/11	Mon 3/14/11
139	Millwork, Casework, M/E/P Final Trim	28 days	Thu 3/31/11	Mon 5/9/11
140	Toilet Partitions and Lockers	21 days	Mon 4/11/11	Mon 5/9/11
141	Final Paint, Doors & Hardware, Flooring	17 days	Tue 4/26/11	Wed 5/18/11
142	**South Area Rough-Ins & Finishes**	**199 days**	**Tue 9/14/10**	**Fri 6/17/11**
143	**Roof Top Equipment- South**	**23 days**	**Fri 2/18/11**	**Tue 3/22/11**
144	Set Roof Top Units	5 days	Fri 2/18/11	Thu 2/24/11
145	Connect M/E/P to RTU's	15 days	Fri 2/25/11	Thu 3/17/11
146	Check/Test/Start-Up	3 days	Fri 3/18/11	Tue 3/22/11
147	Conditioned Air From ERU- South	0 days	Tue 3/22/11	Tue 3/22/11
148	**Kitchen & Dining**	**194 days**	**Tue 9/14/10**	**Sat 6/11/11**
149	M/E/P Rough-In	55 days	Tue 9/14/10	Mon 11/29/10
150	Kitchen Finishes	82 days	Fri 2/18/11	Sat 6/11/11



	Task Name	Duration	Start	Finish
151	Dining Finishes	29 days	Fri 2/25/11	Wed 4/6/11
152	**Auditorium**	**118 days**	**Wed 1/5/11**	**Fri 6/17/11**
153	Auditorium 1st Floor Rough In	56 days	Wed 1/5/11	Wed 3/23/11
154	Auditorium 1st Floor Finishes	60 days	Mon 3/28/11	Fri 6/17/11
155	Stage Finishes	41 days	Mon 4/11/11	Mon 6/6/11
156	**Fisrt Floor- South**	**173 days**	**Wed 10/20/10**	**Fri 6/17/11**
157	M/E/P Rough-In	37 days	Wed 10/20/10	Thu 12/9/10
158	Interior Wall Framing	10 days	Wed 11/10/10	Tue 11/23/10
159	Pull Wires/Install VAV's/Install Duct	71 days	Thu 12/16/10	Thu 3/24/11
160	Hang, Finish, First Coat GWB	22 days	Mon 3/21/11	Tue 4/19/11
161	Millwork, Casework, M/E/P Final Trim	21 days	Fri 4/29/11	Fri 5/27/11
162	Toilet Partitions and Lockers	14 days	Fri 5/13/11	Wed 6/1/11
163	Final Paint, Doors & Hardware, Flooring	14 days	Tue 5/31/11	Fri 6/17/11
164	**North Area Rough-Ins & Finishes**	**152 days**	**Sat 11/20/10**	**Tue 6/21/11**
165	**Roof Top Equipment- North**	**42 days**	**Fri 1/21/11**	**Mon 3/21/11**
166	Set Roof Top Units	5 days	Fri 1/21/11	Thu 1/27/11
167	Connect M/E/P to RTU's	19 days	Tue 2/8/11	Fri 3/4/11
168	Check/Test/Start-Up	15 days	Tue 3/1/11	Mon 3/21/11
169	Conditioned Air From ERU- South	0 days	Mon 3/21/11	Mon 3/21/11
170	**Lower Level- Pool Area North**	**100 days**	**Sat 11/20/10**	**Fri 4/8/11**
171	Excavate, Form, Reinforce, Pour Pool	36 days	Sat 11/20/10	Fri 1/7/11
172	M/E/P Rough-In	30 days	Mon 1/31/11	Fri 3/11/11
173	Final Pool Connections and Equipment	11 days	Fri 3/25/11	Fri 4/8/11
174	**Lower Level- Aux Gym**	**119 days**	**Tue 12/7/10**	**Fri 5/20/11**
175	M/E/P Rough-In	21 days	Tue 12/7/10	Tue 1/4/11
176	Install VAV's and Equip. Support	7 days	Fri 1/21/11	Mon 1/31/11
177	Hang, Finish, First Coat GWB	24 days	Tue 1/11/11	Fri 2/11/11
178	Doors & Hardware/ Light Fixtures	12 days	Mon 2/14/11	Tue 3/1/11
179	Condition Space for Flooring	10 days	Mon 2/21/11	Fri 3/4/11
180	Wood Floor, Bleachers, Wall pads	55 days	Mon 3/7/11	Fri 5/20/11



	Task Name	Duration	Start	Finish
181	**Lower Level- Corridors & Common Area**	**122 days**	**Fri 12/3/10**	**Mon 5/23/11**
182	M/E/P Rough-In	42 days	Fri 12/3/10	Mon 1/31/11
183	Interior Wall Framing	11 days	Mon 12/27/10	Mon 1/10/11
184	Pull Wires/Install VAV's/Install Duct	17 days	Tue 1/18/11	Wed 2/9/11
185	Hang, Finish, First Coat GWB	27 days	Fri 1/21/11	Mon 2/28/11
186	Millwork, Casework, M/E/P Final Trim	38 days	Thu 3/24/11	Mon 5/16/11
187	Final Paint, Doors & Hardware, Flooring	17 days	Fri 4/29/11	Mon 5/23/11
188	**First Floor- North**	**117 days**	**Mon 12/27/10**	**Tue 6/7/11**
189	M/E/P Rough-In	41 days	Mon 12/27/10	Mon 2/21/11
190	Interior Wall Framing	10 days	Tue 1/18/11	Mon 1/31/11
191	Pull Wires/Install VAV's/Install Duct	17 days	Tue 2/8/11	Wed 3/2/11
192	Hang, Finish, First Coat GWB	37 days	Tue 2/8/11	Wed 3/30/11
193	Millwork, Casework, M/E/P Final Trim	34 days	Mon 4/11/11	Thu 5/26/11
194	Toilet Partitions and Lockers	13 days	Wed 5/4/11	Fri 5/20/11
195	Final Paint, Doors & Hardware, Flooring	18 days	Fri 5/13/11	Tue 6/7/11
196	**Second Floor- North**	**111 days**	**Tue 1/18/11**	**Tue 6/21/11**
197	M/E/P Rough-In	41 days	Tue 1/18/11	Tue 3/15/11
198	Interior Wall Framing	10 days	Fri 2/11/11	Thu 2/24/11
199	Pull Wires/Install VAV's/Install Duct	12 days	Tue 3/1/11	Wed 3/16/11
200	Hang, Finish, First Coat GWB	27 days	Thu 3/10/11	Fri 4/15/11
201	Millwork, Casework, M/E/P Final Trim	25 days	Wed 5/11/11	Tue 6/14/11
202	Toilet Partitions and Lockers	13 days	Fri 5/20/11	Tue 6/7/11
203	Final Paint, Doors & Hardware, Flooring	18 days	Fri 5/27/11	Tue 6/21/11
204	**Project Close-Out**	**134 days**	**Fri 5/20/11**	**Wed 11/23/11**
205	Test & Balance	16 days	Fri 5/20/11	Fri 6/10/11
206	Substantial Completion Punchlist	36 days	Mon 6/13/11	Mon 8/1/11
207	HESS Final Inspections	34 days	Sat 6/11/11	Wed 7/27/11
208	Certificate of Occupancy Issued	0 days	Tue 8/30/11	Tue 8/30/11
209	Substantial Completion	0 days	Tue 8/30/11	Tue 8/30/11
210	**Final Completion**	**61 days**	**Wed 8/31/11**	**Wed 11/23/11**
211	Final Close Out Procedures	61 days	Wed 8/31/11	Wed 11/23/11
212	LEED Air Testing	25 days	Thu 10/20/11	Wed 11/23/11
213	FINAL COMPLETION	0 days	Wed 11/23/11	Wed 11/23/11

SITE LAYOUT PLANNING

The site layout plan developed is showing a phase of steel erection. The center building is the focus during this phase. Prior to the west portion of the Center building being erected the 200 ton mobile crane would set inside the building footprint to reach where required. The boom has a boom that extends from 43' to 236'. Three trailers are set up for the HESS Construction + Engineering Services and many of the trade contractors are established on site.

Excavation activity for the football field is in progress during steel erection. Site access is from three points. The main entrance, off 55th provides the primary site access. Through the other two access points the excavation trucking can be sustained and one-way deliveries are accommodated. The site plan shows typical traffic flow, management trailers, storage locations and road access.

The site plan for the actual project is very similar in layout to what is shown Steel Erection Site Plan. The site provides room for laydown and shakeout areas for steel components and ample storage space for materials. Three access points allow traffic to flow smoothly around the site without restriction.

See Appendix E for Site Plan.

DETAILED STRUCTURAL STEEL ESTIMATE

The detailed structural steel and composite deck estimate was created by performing a hand takeoff of the individual beams, joists on the structural plans and the column schedule. RS Means Building Construction Cost Data 2010 was used as a pricing index. The estimate includes the steel from above foundation, concrete on metal decking and metal roof decking. It excludes slab on grade, foundation work and masonry bearing walls. Refer to appendices for take-off and cost details.

The modification for location in RS Means for Washington DC is comprised of a 104.00 for material, 92.2 for installation which creates a 98.8 total cost adjustment. This number means that the national average cost for construction work in 2010 would be considered 100 percent. In Washington DC the average is 98.8 percent, 1.2% lower than the national average. For steel shapes not listed in RS Means two different methods were used to calculate cost per linear foot. If the shape was between two known shapes a cost between the two shapes was selected. If the shape was larger than listed in means, an approximation based on the shapes listed was used.

ASSUMPTIONS

- Concrete finish- Power Screed, bull float, machine float, and ride on trowel
- Concrete will be pumped where required for placement
- Custom Trusses for above gymnasium used allowance
- Edge forms were 4 time use up to 6” high

Detailed Structural Steel and Composite Deck Estimate Summary			
03	11	Concrete Forming	$ 10,824.00
03	22	Welded Wire Fabric Reinforcing	$ 83,812.00
03	31	Structural Concrete	$ 410,860.00
03	35	Concrete Finishing	$ 56,198.00
05	12	Structural Steel Framing	$ 2,655,502.00
05	21	Steel Joist Framing	$ 683,283.00
05	31	Steel Decking	$ 520,087.00
		subtotal	$ 4,420,566.00
		location factor	98.80
		TOTAL	**$ 4,367,519.21**

The detailed estimate started as a hand takeoff of each floor and roof of the structural drawings to identify and count the beams and joists used to make up the floor structure. The column schedule was then tallied. RS Means lists W sections and C channels in terms of cost per linear foot. Using excel each shapes total linear feet was calculated. The number used out of RS Means was the total cost for material and installation, not including overhead and profit. Some assumptions were made and are listed above, under assumptions. The main assumptions are the placement and finish procedures.

To allow comparison to other buildings below is a table summarizing the unit costs developed for the steel and composite deck structure. Steel came out to be a total of 1,122 tons and $2,977 per ton. Concrete for slab on metal deck construction only came out to be a total of 3, 290 cubic yards and at a cost of $171 per cubic yard. This number includes the material, placement, forming and finishing.

Steel		
Tons	Cost	$ per ton
1121.721	$3,338,783.65	**$2,976.48**
Concrete		
Cubic Yds.	Cost	$ per Cu. Yd.
3290	$561,693.90	**$170.73**

The metal decking and concrete take-off and cost calculations can be seen below. The Roof decking is 1 ½" 22 GA galvanized metal deck. Composite floor decking is 2" 18 GA galvanized deck. The concrete is specified as 4,000 psi and uses a 6x6 Welded Wire Fabric

Metal Decking					
Composite (concrete floors)					
SF	Depth (in)	GA	Galvanized	$ per SF	Cost
193784	2	18	G60	$2.18	$422,449.12
Roof Decking					
SF	Depth (in)	GA	Galvanized	$ per SF	Cost
72864	1.5	22	G60	$1.34	$97,637.76
subtotal					**$520,086.88**
Concrete 4,000 psi					
SF	Thickness	cu.ft.	cu. Yd.	$ per cu. Yd.	Cost
138168	0.45833	63326.5394	2345.4274	$103.00	$241,579.02
55616	0.45833	25490.4813	944.0919	$103.00	$97,241.47
subtotal			3289.5193	yds.	**$338,820.49**
Concrete Edge Forming					
Height	LF			$ per LF	Cost
0.45833	4100			$2.64	$10,824.00
Welded Wire Fabric					
CSF	type	Weight		$ per CSF	Cost
193784	6X6	W2.1xW2.1		$ 43.25	$ 83,811.58
Concrete Placing					
Cu. Yd.				$ per cu. Yd.	Cost
3289.519				$ 21.90	$ 72,040.47
Concrete Finishing					
Sq. ft.				$ per SF	Cost
193784				$ 0.29	$ 56,197.36
subtotal					**$ 222,873.41**

GENERAL CONDITIONS ESTIMATE

The General Conditions Estimate for HD Woodson High School was developed by using both RS Means data as well as some information provided by HESS Construction + Engineering Services. Quantities and amount of time required for each item was collected from the schedule and tailored to not include paying for items more than they will be required to be on site. The total value for general conditions is projected to be $5,950,000. Below is a breakdown of cost categories and their subtotals.

General Conditions			
Project Staff	Monthly cost	Months	Total Cost
1 PROJECT EXECUTIVE (3200)	$ 3,200	15	$ 48,000
1SUPERINTENDENT (2800)	$ 2,800	18	$ 50,400
1 SUPERINTENDENT (2800)	$ 2,800	22	$ 61,600
2 ASST SUPER (2400)	$ 4,800	12	$ 57,600
1 ASST SUPER (2400)	$ 2,400	18	$ 43,200
2 ASST SUPER (2400)	$ 4,800	15	$ 72,000
1 FIELD ENGINEER (1875)	$ 1,875	15	$ 28,125
BIM MANAGER	$ 1,000	12	$ 12,000
SCHEDULING	$ 500	15	$ 7,500
QUALITY CONTROL	$ 1,500	15	$ 22,500
Subtotal			**$ 402,925**
Temporary Utilities/Facilities	Monthly cost	Months	Total Cost
OFFICE TRAILER (3 WIDE)	$ 2,500	15	$ 37,500
TRAILER SETUP/REMOVAL FEE			$ 30,000
10 PORTABLE TOILETS	$ 1,700	15	$ 25,500
SECURITY	$ 350	18	$ 6,300
PHOTOGRAPHY	$ 200	18	$ 3,600
PRINTING/EXTRA PRINTS	$ 150	18	$ 2,700
TOOLS & EQUIPMENT	$ 500	15	$ 7,500
SAFETY	$ 1,500	18	$ 27,000
TEMP. PHONE/INTERNET	$ 200	15	$ 3,000
TEMP. POWER	$ 1,100	15	$ 16,500
TEMP. HEATING/COOLING	$ 120	15	$ 1,800
Subtotal			**$ 161,400**

Insurance and Bonds			
Type	Contract Value	Percent	Total Cost
BUILDER'S RISK INS.	$ 89,000,000	0.64	$ 569,600
PERMITS	$ 89,000,000	2	$ 1,780,000
BONDS	$ 89,000,000	2.5	$ 2,225,000
Subtotal			**$ 4,574,600**
General Requirements			
RECYCLING			$ 150,000
REFUSE			$ 300,000
CLEANING			$ 60,000
SITE FENCING			$ 300,000
Subtotal			**$ 810,000**
TOTAL GENERAL CONDITIONS			**$ 5,948,925**

Appendix A

W Sections					W Sections				
depth	lb/ft	lin. Ft.	$ per LF	Cost	depth	lb/ft	lin. Ft.	$ per LF	Cost
6	9	16	$17.84	$285.44	16	36	114	$53.70	$6,121.80
8	10	1204	$19.04	$22,924.16	18	35	1290	$48.18	$62,152.20
8	15	498.5	$25.09	$12,507.37	18	40	1897	$54.18	$102,779.46
8	18	196	$30.09	$5,897.64	18	46	54	$61.18	$3,303.72
8	28	30	$41.56	$1,246.80	18	50	30	$66.47	$1,994.10
10	12	17.5	$21.44	$375.20	18	56	67	$72.47	$4,855.49
10	15	114	$25.09	$2,860.26	18	76	24	$98.06	$2,353.44
10	19	114	$28.09	$3,202.26	21	44	2803	$58.12	$162,910.36
10	22	105	$33.44	$3,511.20	21	48	515.5	$62.25	$32,089.88
10	33	933	$47.56	$44,373.48	21	50	327.5	$65.62	$21,490.55
10	39	101	$50.02	$5,052.02	21	55	159.5	$68.99	$11,003.91
10	45	697	$61.26	$42,698.22	21	62	89	$80.26	$7,143.14
10	49	590	$67.06	$39,565.40	21	93	206	$118.45	$24,400.70
10	54	375	$70.21	$26,328.75	21	122	206	$153.45	$31,610.70
10	60	277	$72.26	$20,016.02	24	28	35	$51.41	$1,799.35
10	68	262	$75.65	$19,820.30	24	55	1412.5	$71.41	$100,866.63
10	77	182	$78.96	$14,370.72	24	62	1616.5	$79.91	$129,174.52
10	88	156	$82.12	$12,810.72	24	68	1086	$87.41	$94,927.26
12	12	51	$21.12	$1,077.12	24	76	432.5	$96.91	$41,913.58
12	14	415	$22.26	$9,237.90	24	84	494	$107.04	$52,877.76
12	15	12	$23.62	$283.44	24	94	717	$119.04	$85,351.68
12	16	1224.5	$24.08	$29,485.96	24	103	72	$125.62	$9,044.64
12	19	781.5	$24.54	$19,178.01	24	104	137	$131.19	$17,973.03
12	22	464	$31.23	$14,490.72	24	117	235	$147.19	$34,589.65
12	26	716	$36.23	$25,940.68	24	146	28.5	$182.19	$5,192.42
12	30	39	$41.23	$1,607.97	24	162	168	$217.19	$36,487.92
12	65	82	$66.23	$5,430.86	24	207	36	$252.19	$9,078.84
12	79	159	$93.50	$14,866.50	24	250	66	$287.19	$18,954.54
12	96	110	$111.50	$12,265.00	24	279	66	$322.19	$21,264.54
12	120	680	$129.50	$88,060.00	24	335	66	$357.19	$23,574.54
12	136	914	$147.50	$134,815.00	27	84	233	$106.58	$24,833.14
12	152	1222	$165.50	$202,241.00	27	114	170	$142.73	$24,264.10
12	190	373	$183.50	$68,445.50	27	129	396	$178.88	$70,836.48
14	12	220.5	$33.74	$7,439.67	27	146	66	$181.73	$11,994.18

14	22	4403	$35.70	$157,187.10	27	161	66	$199.73	$13,182.18
14	30	144	$41.13	$5,922.72	30	90	36	$124.54	$4,483.44
14	38	150	$46.13	$6,919.50	30	108	36	$135.54	$4,879.44
16	26	3683.5	$35.66	$131,353.61	30	148	162	$183.70	$29,759.40
16	31	1392	$42.13	$58,644.96					
subtotal				**$1,272,739.18**	**subtotal**				**$1,341,512.68**

Appendix B

C Sections				
Depth	lb/ft	lin. Ft.	$ per LF	Cost
8	11.5	376	$43.15	$16,224.40
8	13.7	314	$53.15	$16,689.10
8	18.7	132	$63.15	$8,335.80
subtotal				**$41,249.30**
Custom Truss Allowance				
Name	Amount	lin. ft.	$ Each	Cost
T1	2	100	$28,000.00	$56,000.00
T2	10	100	$28,000.00	$280,000.00
T3	1	100	$28,000.00	$28,000.00
T4	3	100	$28,000.00	$84,000.00
T5	1	105	$30,000.00	$30,000.00
subtotal				**$478,000.00**

Appendix C

Joists						
Depth	Type	Length	Quantity	Linear ft.	$ per LF	Cost
28	KSP1	44	28	1232	$8.68	$10,693.76
20	KSP2	22	12	264	$6.90	$1,821.60
20	K3	22	3	66	$6.90	$455.40
20	K3	23	7	161	$6.90	$1,110.90
18	KSP4	20	17	340	$6.73	$2,288.20
10	K1	6	8	48	$7.21	$346.08
56	DLH12	94	34	3196	$18.25	$58,327.00
22	K6	28	10	280	$7.20	$2,016.00
10	K1	11	10	110	$7.21	$793.10
24	K9	34.5	10	345	$9.09	$3,136.05
18	LH04	27.5	2	55	$10.80	$594.00
18	LH04	23.5	6	141	$10.80	$1,522.80
24	LH09	23.5	14	329	$14.75	$4,852.75
24	LHSP3	23.5	8	188	$11.35	$2,133.80
24	LHSP6	30.5	24	732	$17.00	$12,444.00
28	LH09	42.5	9	382.5	$17.20	$6,579.00
28	LH09	35.5	9	319.5	$17.20	$5,495.40
18	LH02	29	13	377	$10.80	$4,071.60
24	LH06	35	7	245	$11.35	$2,780.75
24	LH07	29	7	203	$12.62	$2,561.86
28	LH09	36	9	324	$17.20	$5,572.80
28	LH09	29	18	522	$17.20	$8,978.40
25	LHSP5	23	8	184	$17.00	$3,128.00
20	LH06	29	9	261	$14.75	$3,849.75
22	K4	28.5	6	171	$7.00	$1,197.00
22	K5	28.5	12	342	$7.20	$2,462.40
20	K3	24.5	6	147	$6.75	$992.25
18	K4	24.5	12	294	$6.73	$1,978.62
10	K1	11.5	6	69	$7.21	$497.49
24	K7	34.5	6	207	$7.39	$1,529.73
20	K4	26	12	312	$6.90	$2,152.80
28	LH10	42.5	29	1232.5	$17.20	$21,199.00
28	LHSP9	42.5	17	722.5	$17.20	$12,427.00
28	LHSP7	42.5	14	595	$17.89	$10,644.55
28	LHSP8	42.5	6	255	$18.23	$4,648.65
subtotal						**$205,282.49**

Appendix D

PACE Roundtable Summary

Transformation: What Are the Innovations That Will Transform Our Industry?
Moderator: John I. Messner, Ph.D.

The theme of this discussion began to take shape as a focus on how innovations can be measured on projects and in what ways technologies can make business sense to increase appeal. A large portion of time was also focused on developing a better way to provide intelligent models that are manageable for Operations and Maintenance efforts to appeal to owners.

Some of the new technologies recently being put into practice were brought up by industry professionals. Chuck Tomasco from Truland Systems Corporation explained how Truland recently invested in robotic layout technology. They feel that by implementing a more accurate layout system with the use of robots and building models that an increased efficiency and more accurate layout will be the end result.

The idea of using technologies to further explore the ability to prefabricate larger portions of projects and install in large pieces was discussed. The main concept was for MEP corridors that can have all trades prefab large runs of mechanical components off-site. By coordinating prior to install in a safer and more efficient way and then install large racks of mechanical systems to improve on-site construction time. The key component to using prefab in this manner is technology. Being able to visually break down the congested spaces and coordinate prior to prefab and then seeing how the prefabbed sections fit together allows the process to be very efficient.

Discussion of a Technology Metric also came up multiple times. A need for a standard way to measure how the technology implemented on projects is saving the users and owners. A way to measure the overall effectiveness of BIM is not currently something that is being looked at in depth in the industry.

Electronic Punchlist and Commissioning technologies were discussed. Latista is a current program available as a web based program for electronic Punchlist and commissioning. It allows for real time capture of information and updating. The main benefit with using an electronic program such as this for commissioning is the ability to capture and turn over the commissioning reports to owners.

Owner benefits of BIM and technologies were discussed. The main issue with the BIM models are the size and complexity that are used for construction tend to be very hard to manage after Owner Occupancy. How can we reduce the models down to allow for easy extraction of information needed? A program that has potential in the future for the Operations and Maintenance of buildings would be one that allows anyone to navigate the model and easily extract the information they need. This topic again brought up the technology making a business case. If the owner knew prior to construction that he would actually be able to use the model provided by the builder without paying consultants to navigate the model he would be more willing to pay for the creation of the BIM model.

A very new concept to the industry is the advent of event simulation. This is a breakthrough from the gaming industry that allows the end user of a space to virtually explore the space. Through a gaming engine environment a nurse would be able to walk through the model and virtually perform daily tasks. This technology is another way to incorporate as much pre planning as possible to avoid costly changes post construction.

Designing the BIM model is an arduous task in itself, however a main hurdle in this difficult task is figuring out when and who does what. Currently a lot of time is being spent on designing the design process. More and more projects are using pre-construction collaboration amongst trades the need to know who and when gives what to who is very important. The Design process itself must now be examined by the design team on a project basis and design how they will create their BIM model. This will allow the maximum use of design ideas and technology to increase efficiency.

I got a lot out of this session and was surprised about how little the owner is being taken care of post construction from a technology base. The models that are typically given are complicated and generally go to waste because no one on their staff can use them. Some issues discussed that may apply to my thesis are the use of an electronic Punchlist and commissioning program. This would be very helpful, especially with all the commissioning required for LEED Rating.

The Smart Grid: Energy Impacts in the building industry
Moderator: David Riley, Ph.D.

The general discussion to start the session brought out three main topics: advanced metering, distributed energy generation and energy efficiency and controls. These three topics were discussed in detail throughout the rest of the session.

Advanced Metering is a way to gather knowledge about the power being used in buildings. By providing quantities and times of the energy used a behavior change is more likely. Humans tend to respond to a problem or alter behavior more quickly when they get real time feedback. By studying the behavioral impacts of energy use a more consciences occupant will use less energy.

Energy Efficiency in buildings was discussed. Some ideas that came out of this were a number of make-sense ways to easily reduce energy use. Phantom loads, such as chargers and emergency transformers are loads that most of the time are not providing power that is being used by anyone in the building but tend to still use electricity. Advanced lighting controls, i.e. occupancy and daylight sensors can reduce electricity use. Providing occupants with individual temperature controls, typically a lower level of heating or cooling will be required for the entire building. Mechanical systems operating as intended can also increase energy efficiency. A creative way that some owner/builder teams are ensuring this happens is by using a transition team. This team consists of people involved in the construction process and people that are part of the building operations and maintenance team. A smooth transition with proper training of the owners will allow the building to continue running properly throughout its lifespan. Some possible ways to reduce the demand for power bought from utility companies are photovoltaic panels and wind turbines. A very interesting tangent came up from this topic about financing programs for these systems.

Distributed energy generation is a way to reduce the losses incurred from long transmission distances. These long lengths require more energy to be produced due to resistance in power lines. By having many smaller plants the distance is reduced and will require less energy. Some possible sources for these energy producing plants are Solar, Wind and Geothermal. By using multiple sustainable resources as a power supply a lot of good comes out of it. Reduced carbon footprint and lower energy costs as the source for energy costs will be reduced. Solar power however creates electricity as DC Power. Some DC power distribution systems are actually starting to be designed so that a converter will not be needed and maximum efficiency can be achieved.

This session was very informative about the Smart grid and how it can be beneficial. I was surprised to find out about how much energy can be saved just by doing little things, such as altering times that activities occur in a building. Issues that may apply to my thesis project are the use of occupancy and daylight sensors, and Operations and maintenance ability to use the model created by the builder.

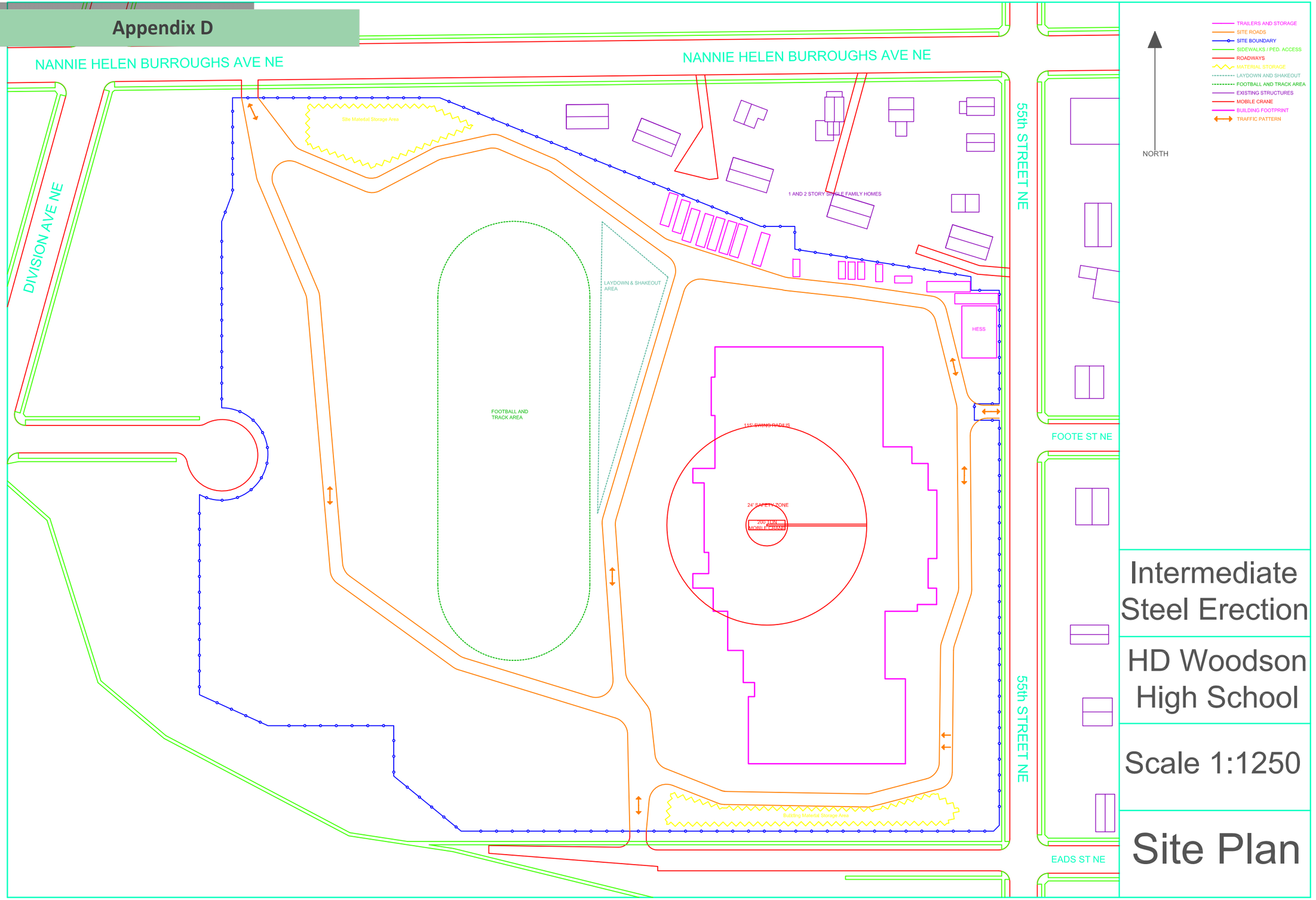
General thoughts and contacts

Some ideas that I got from the PACE Roundtable event are the use of a dashboard in the HS project to allow the building to become an interactive learning tool itself. The interaction capabilities of such a system would exemplify the STEM system and allow the Owner to get a lot of valuable data about where they are spending their money on energy. Overall the ideas brought up about technology implementation and the possibility of developing a way to measure the helpfulness of technology really intrigues me, this is something I will consider for my thesis project.

Key contacts that I got from the PACE Roundtable or previously that may help to further develop some of the concepts I wish to look into are: Chuck Tomasco, Tyler Swartzwelder, Matt Hedrick, Matt Orosz and Jim Salvino

Appendix E

Appendix D



Intermediate Steel Erection

HD Woodson High School

Scale 1:1250

Site Plan