Pasadena Elementary School

Pasadena, MD

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Architectural Engineering
Construction Management Thesis
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Pasadena Elementary School • Pasadena, MD

Design and Construction Team

Owner	Anne Arundel County Public Schools
Tenant	Pasadena Elementary School
Construction Manager	Jacobs Facilities
Architect	Rubeling & Associates
Size	68,000 square feet

Architectural & Site Features

- Phase I includes construction of the new elementary school
- In Phase II the existing elementary school will be demolished completely and new sports field will take its place
- Two shades of brick masonry on building's exterior
- Courtyard separates the two wings of the north side of the building
- The courtyard is lined with windows along classroom exteriors
- Public centers of the building include gymnasium and cafeteria spaces

MEP Systems

- Variable Volume and Variable Temperature settings throughout the building
- 3 Rooftop units with Energy Recovery
- 6 Rooftop Air Handling Units
- 6 Ductless Split System Units
- Supply Air spread throughout the building from 1530-7500 cubic feet per minute
- Outdoor Air spread throughout from 375-2500 cubic feet per minute
- There is only 1 return fan in the units

Structural

- The foundation of the building has concrete footings below the exterior walls and columns throughout the building
- Flooring of the building consists of concrete slabs with Welded Wire Fabric reinforcement
- HSS shaped columns are different sizes throughout
- The second floor framing is made of W-shaped steel members below a concrete slab
- Below the roof, beams support joists and galvanized metal decking below the roof membrane

Construction

- There is no general contractor instead 14 prime contractors for each trade
- A Construction Management Agent handles the contracts for the owner

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Acknowledgements

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This includes Anne Arundel County for allowing me to study Pasadena Elementary School for my educational use and the following employees from Jacobs Facilities for their time and assistance:

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Executive Summary

Sustainability was not of great importance with the construction project of Pasadena Elementary School. In the following report sustainability issues will be analyzed.

The first is the research topic of how the building could have been LEED Certified. It was researched which measures could have been taken for the building's certification and was concluded that the project could have earned anywhere between 29 and 46 LEED credits which could have been either a Certified, Silver or Gold rating.

A greenroof could have aided in many of the LEED credits that could have been earned. Originally a conventional roof was designed for the elementary school, but a system of green blocks that are placed directly on the designed roof was looked into. It was found that at an increased cost of $111,125 greenblocks could have been placed on the northwest wing of the building. This greenroof could have saved 15% in energy use of that part of the building and could have collected 80% of the stormwater over a 2 year period which reduces total potable water use. A structural breadth analysis determined that the trusses original to the design of the building would not have been able to support the additional load that the greenroof would add.

The savings in both energy and cost that the use of solar lights in the parking lots could have had was researched. Solar lights use renewable energy from the sun which is a great alternative to the lights in the building's original design. It was found that monthly savings of $149.24 in the electric bill could have been attained. The lifetime expectancy of the proposed solar lights is 22 years. The monthly savings would have paid off the initial investment within 26 years of use of the lights, only a few years after their full like expectancy.

Finally the topic was studied on what the impact would be of renovating the original school building would have been instead of demolishing the existing elementary school and completely constructing a new building. No additional costs were found and it was found that the schedule could have been reduced. Although if this option was chosen, the school building occupants would have had to been relocated for at least one school year. This was probably the deciding factor when the owner originally made the decision on how to update the elementary school.

Introduction & Project Background

Project Background

Pasadena Elementary School is located in Pasadena, Maryland and is owned and maintained by Anne Arundel County School District. A new elementary school to replace the existing elementary school was designed to be 68,000 square feet and two stories above ground.

The original Pasadena Elementary School was built in 1954 on a 14 acre lot. In 1961 there was an interior renovation of the school to change an open space into classrooms for the use of kindergarten. The original building was 45,296 square feet and had 20 classrooms, a multi-purpose room including a stage and rooms for administrative use.

Due to its outdated construction it was decided back in 2001 to demolish the existing elementary school and build a brand new building in a new location on the existing site. In the original building's place multi-use sports fields will be constructed after the asbestos abatement and demolition of the existing elementary school.

Notice below an aerial photograph pointing out locations of interest on the project site. Also reference Appendix A for an existing site plan showing the two phases of the project.

Aerial View of Project Site

Project Delivery

The construction project delivery method was CM-Owner's Agent and 14 contractors, one for each trade of the project. Below is a list of the primary project team members and the contractors for Pasadena Elementary School.

Owner	Anne Arundel County Public Schools
Construction Manager	Jacobs Facilities, Inc.
Architect	Rubeling & Associates
Civil Engineer	KCI
MEP Engineer	Posey
Structural Engineer	Columbia Engineering, Inc.
Site Work	Pessoa Construction
Abatement & Demolition	GeoStructures, Inc.
Concrete	Canyon Contracting
Masonry	Moehrle Masonry
Steel	Jarvis Steel & Lumber
General Works	Hancock & Albanese
Roofing	Heidler Roofing
Windows	College Park Glass Company
Kitchen Equipment	Clark Food Service
Casework	Glover Equipment, Inc.
Technical Wiring	HP Electronics
Mechanical & Plumbing	G.E. Tignall
Fire Sprinkler	Fire-Mak, Inc.
Electrical	Action Electrical Contractors, Inc.

Project Schedule

Construction began in September 2006. Phase I of the project includes the construction of the new elementary school. This phase was completed in November 2007 and the new school building was occupied over Christmas break between 2007 and 2008.

Phase II of the project includes asbestos abatement and demolition of the existing elementary school and will begin after Phase I occupancy. This portion of the project is planned to be completed in May 2008. Also included in Phase II is the construction of the multi-use sports fields. The construction of the sports fields is the last stage of the project and is scheduled to be completed in July 2008.

Please reference Appendix B for the original project schedule.

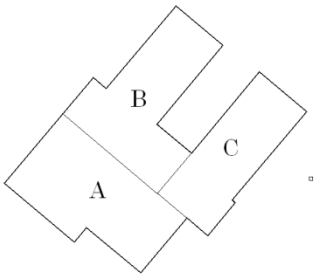
Cost Information

Below is a breakdown of the construction costs of the project separated by trade contractors. Notice the total cost of the project is $14,042,006.

Contract	Total Contract Amount
Sitework	$ 3,319,746
Abatement	$ 244,780
Demolition	$ 457,572
Concrete	$ 692,129
Masonry	$ 1,507,000
Structural Steel	$ 907,921
General Works	$ 1,727,333
Roofing	$ 440,500
Windows	$ 215,166
Kitchen	$ 99,500
Casework	$ 215,110
Tech Wiring	$ 76,419
Mechanical	$ 2,427,947
Fire Protection	$ 171,045
Electrical	$ 1,539,838
Total Project Cost	**$ 14,042,006**

Construction Sequencing

Below is the footprint of Pasadena Elementary School. Construction of the building was performed in 3 stages that are identified below as A, B, and C. Area A is made of the gymnasium, kitchen and music room. Area B consists of the Media Room and a corridor of one-story classrooms. Area C is two stories high of classrooms. The construction sequence goes from A to B to C.



Building Footprint

Architecture

The exterior of Pasadena Elementary School consists of brick masonry. The northeast and south sides of the building are two stories high. In the center of the interior contains the Media Center. On the north side of the Media Center there are two hallways lined with classrooms. In between these two wings a courtyard is located. Lining the courtyard there are many windows from the classrooms that allows occupants to look outside.

The south side of the Media Center contains public spaces such as the gymnasium, cafeteria and music rooms. The gymnasium and the cafeteria are double height ceiling spaces that connect with the second floor roof.

The second floor consists is one hallway of classrooms above one of the hallways on the north side of the first floor.

Notice below a photograph of the exterior of Pasadena Elementary School at the main entrance.

Building Exterior at Main Entrance

Electrical System

There is one main switchboard that runs to panelboards located in 5 electrical closets throughout the building. The system runs on 277/480 V power with a 3 phase 4-wire system. The panelboards range from supplying 100 Amps to 600 amps.

Lighting System

All interior lighting must comply with local codes and zoning requirements as well as NFPA 70 and NFPA 101. Interior lighting consists of both fluorescent and High Intensity Discharge (HID) lighting. All lighting fixtures will be supplied with 270 V power with the exception of a few accent fixtures of 120 V.

Mechanical System

There are 3 Rooftop Units with Energy Recovery (ERUs) and 3 Air Handling Units (AHUs). There are 6 Ductless Split System Units (DSS). The RAHUs only have a return fan that can supply between 1530-7500 cfm (cubic feet per minute). Outdoor air is supplied at 375-2500 cfm. The ERUs supply and return air between 258 and 454 MBH (Thousand BTUs/hr). All units are supplied with 480 volts at 3 phase power.

Structural System

Steel HSS columns of sizes varying from 5 to 8 inches are throughout the 2 North wings of the building with bays varying around 30' each. Steel beams support joists and composite metal roof decking with normal weight 4000 psi concrete. On the south size of the building load bearing walls made of concrete are the support system for the gymnasium and cafeteria areas which are double height areas. The roof above these areas consists of composite metal decking with normal weight concrete and roofing membrane.

Fire Protection System

An automatic wet-pipe sprinkler system runs throughout the classrooms, offices, cafeteria seating, auditorium seating, corridors, lobbies and rest rooms at 0.1 GPM/sq. ft. (Gallons per Minute per square foot) over every 1,500 square foot area. In the mechanical room, kitchen food preparation and storage areas water is pumped at 0.15 GPM/sq. ft. over every 1,500 square foot area. The gymnasium and platform is supplied with 0.2 GPM/sq. ft. The system consists of 2 zones.

Analysis 1: LEED Certification

Introduction

School boards and school districts are hesitant to support the construction of a green and sustainable building. It is thought that there is a large increase in initial costs of the building when that is not necessarily the case. The earlier it is decided that the building will attempt to become LEED certified, the less it tends to affect the initial costs of the project. Even if initial costs are slightly higher than non-LEED certified buildings, the lifetime savings are greater and the owner will save money over time during the use of the building.

LEED Certification was not sought after when constructing a new elementary school for Pasadena. The following research shows which credits could have been sought after to achieve a minimum of a LEED Certified Rating for the elementary school.

29 credits is the minimum for a certified building and it is what will be sought after in this study. Below are the credits that have been selected to be sought after that would minimally affect construction cost and sequencing. Following each in parenthesis is the amount of credits that can be obtained if the credit is earned.

Please see Appendix C for a LEED Credits Summary Sheet.

Sustainable Sites (SS)

SS Prerequisite 1: Construction Activity Pollution Prevention

Erosion during construction is caused by foot traffic that can kill vegetation on existing construction sites. Proper measures can be taken for sediment control to prevent this during construction. Site plan drawings showing proper erosion and sedimentation control measures were already included in the original construction documents. To achieve this credit nothing else needed to be done on this project.

SS Prerequisite 2: Environmental Site Assessment

A Phase I Environmental Site Assessment of the construction site as stated in ASTM E1527-05 must be performed to make sure that the site is not contaminated.

SS Credit 1: Site Selection (1)

It shall be confirmed that the site does not meet any of the following:

- Prime farmland
- It's elevation is lower than 5 feet above the elevation of 100-year flood (defined by FEMA) on previously undeveloped land

(continued on next page)

- Land is not reserved for habitat for endangered species
- Whichever is more stringent: within the proximity of 100 feet of wetlands or within setback distance of wetland defined by local authorities
- Land within 50 feet of a major body of water
- Land was not prior parkland

The construction site did not meet any of the above criteria.

SS Credit 4.4: Alternative Transportation Parking Capacity (1)
A new parking plan will be designed that will not be greater than the minimum local zoning code capacity. Also preferred parking will be given to vehicles that carpool for 5% of the total number of vehicle spaces.

SS Credit 5.1: Site Development: Protect or Restore Habitat (1)
This project site has previously been constructed on and to qualify for this credit a minimum of 50% of the site area must contain native or adapted vegetation. However if 75% is achieved an exemplary performance credit can be earned. This vegetation can be included in the greenroof that will be designed for the building.

The following criteria need to be given in order to receive credit:

- Provide the project site area
- Provide the project building footprint area
- Provide a narrative describing the project's approach to this credit. Include information regarding any special circumstances or considerations regarding the project
- Provide the area (sq. ft.) of the site that has been restored using native and/or adaptive planting
- Provide a copy of the project's site/landscape plan that provides information regarding the restored site area and the planting materials

Below is the extent to which the current design of the project site applies to this credit. Notice that more measures need to be taken in order to comply.

Project site area is 14 acres =	**609,840 sq. ft.**
Building footprint area =	**- 49,280 sq. ft.**
	560, 560 sq. ft.
	x 0.5
Minimum of Native Adaptation	**280,280 sq. ft.**

Since the project was previously developed, 280,280 square feet needs to be restored with native or adaptive vegetation.

The current Forest Conservation Plan in the construction documents is laid out below:

Area to be retained =	**30,928 sq. ft.**
Area to be reforested =	**74,052 sq. ft.**
Total Area Currently Conserved =	**104,980 sq. ft.**
Minimum Native Adaptation =	**280,280 sq. ft.**
Total Area Currently Conserved =	**- 104,980 sq. ft.**
Area needs to be added =	**175, 300 sq. ft.**

In order to meet the requirements for this LEED Credit a total of 175,300 sq. ft. needs to be added to the current Forest Conservation Plan.

SS Credit 5.2: Site Development: Maximize Open Space (1)
The local zoning open space requirement for the site must be exceeded by 25% with vegetated open space. Landscape drawings need to be performed that will highlight the vegetated open space.

SS Credit 7.1: Heat Island Effect: Non-Roof (1)
50% of the site's hardscape areas will be covered with shade or have a Solar Reflective Index of at least 29 to reduce heat islands. A site plan will be made showing both the shaded areas and where materials with a SRI of at least 29 are located.

SS Credit 7.2: Heat Island Effect: Roof (1)
The greenroof design will need to have at least 50% vegetation to receive this credit.

SS Credit 8: Light Pollution Reduction (1)
Requirements for this credit affect both interior and exterior lighting supply. For interior lighting automatic devices (shutoffs) must be supplied for all non-emergency lights.

For exterior lighting the lighting power density needs to be calculated using the fixture wattage. The lighting power density must comply with the following: 80% of lighting power density for exterior areas must not be exceeded and 50% for building's facades and landscape features. This will be done by creating a site illumination model using computer software.

The sports field lighting is not included in the exterior lighting. However, they must have an automatic shutoff device.

SS Credit 9: Site Master Plan (1)
This credit can be met because the following credits were gone after and will have been met:

- Credit 1 Site Selection
- Credit 5.1 Site Development, Protect or Restore Habitat
- Credit 5.2 Site Development, Maximize Open Space
- Credit 7.1 Heat Island Effect, Non-Roof
- Credit 8 Light Pollution Reduction

In addition, the master plan must be made in agreement with the Anne Arundel County School Board.

Water Efficiency (WE)

WE Credit 1.1: Water Efficient Landscaping: Reduce by 50% (1)
This credit can be earned with the help of the greenroof. A rainwater harvesting system needs to be designed and then the water collected can be reused in the building. In addition irrigation efficient practices will be put in place to reduce potable water use for landscaping by 50%.

Although the rainwater harvesting system may require initial costs, the savings of this system will be far greater as the building continues to be used.

WE Credit 3.1: Water Use Reduction: 20% Reduction (1)
The rainwater harvesting system discussed above will aid in this credit as well. If needed, high-efficiency plumbing fixtures will be used in the building's design to reduce water usage 20%.

Energy & Atmosphere (EA)

EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems
The following is required for this prerequisite:

- A Commissioning Authority shall oversee the commissioning process
- The owner shall create an Owner's Project Requirements and the design team shall develop a Basis of Design report
- Commissioning requirements need to be coordinated with construction documents
- A commissioning plan must be developed and implemented
- The installation and performance of the systems to be commissioned must be verified
- A summary commissioning report must be created

EA Prerequisite 2: Minimum Energy Performance
It must be confirmed that the project meets ASHRAE Std. 90.1-2004 requirements.

EA Prerequisite 3: Fundamental Refrigerant Management
It must be confirmed that the project has a phase-out plan for any CFC-based equipment from the existing elementary school. Also anything new must not use CFC refrigerants.

EA Credit 1: Optimize Energy Performance (2-10)
A whole building energy simulation needs to be performed using computer software. Energy cost savings will be found by comparing Pasadena Elementary School to a baseline building performance rating. Based on the percentage of energy savings, different amounts of credits can be earned.

EA Credit 3: Enhanced Commissioning (1)
In addition to EA Prerequisite 1 the following steps must be taken to receive this credit:

- An independent Commissioning Authority must be hired
- The commissioning authority must review the Owner's Project Requirements and the Basis of Design documents
- The commissioning authority shall review contractor submittals for systems being commissioned
- A systems manual shall be developed
- The requirements for training personnel such as the maintenance staff for the elementary school must be verified
- The commissioning authority shall review with the owner the building's performance 8-10 months after the building has been turned over

EA Credit 4: Enhanced Refrigerant Management (1)
Refrigerants will be selected that comply with the following formula:

$LCGWP + LCODP \times 10^5 \leq 100$

Refrigerants meeting the above criteria will be low in Ozone Depletion Potential and Global Warming Potential. The current systems in the building require R22 which is a single hydrochlorofluorocarbon (HCFC) compound. It has low chlorine content and ozone depletion potential and only a modest global warming potential.

ODP = 0.05
GWP = 1700

Below are the assumptions made for the following calculations:

- Equipment has a lifetime of 15 years.
- Lr (Leakage Rate) assumed 2%
- Mr=10%

LCODP = [ODPr x (Lr x Life + Mr) x Rc]/Life = 0.04 x (0.02 x 15 + 0.1) x 1.6] / 15 **= 17.06**
LCGWP = [GWPr x (Lr x Life + Mr) x Rc]/Life = 1780 x (0.02 x 15 + 0.1) x 1.6] /15 **= 75.95**
LCODP + LCGWP = 17.06 + 75.95 = 93.01

It was determined that the current AHUs had too high of refrigerant charge therefore new equipment needs to be chosen.

EA Credit 5: Measurement & Verification (1)
A Measurement and Verification plan must be developed and implemented. It shall be at least one year in length. This plan includes the evaluation of energy efficiency of the actual building to the baseline performance and can be done with the aid of computer software. Metering equipment needs to be installed in order to monitor and document the energy used by the building.

EA Credit 6: Green Power (1)
35% of the building's electricity shall come from a renewable energy resource from a local provider. There shall be a contract of at least two years in length.

Materials & Resources (MR)

MR Prerequisite 1: Storage and Collection of Recyclables
All office paper, cardboard, glass, plastic and metals needs to be recycled during construction.

MR Credit 1.1: Building Reuse: Maintain 75% of Existing Walls, Floors & Roof (1)
This project could have been a renovation of the existing elementary school. If that route was chosen, the calculation of the existing building being reused can be found. If the percentage reaches 95% an additional credit can be earned.

MR Credit 2: Construction Waste Management: Divert from Disposal (1-2)
Calculations will be performed to find how much waste from the construction site can either be recycled or salvaged. If 50% is reached one credit is earned and if 75% is reached two credits can be earned. Materials to be recycled can include but is not limited to: metal, plastic, wood, masonry, corrugated cardboard concrete and glass.

MR Credits 3.1/3.2: Material Reuse (1-2)
A percentage (based on cost) will be found for the amount of materials that can be reused from the existing elementary school. If 5% is found, one credit is earned and two credits are earned if 10% is found.

MR Credits 5.1/5.2: Regional Materials Extracted, Process & Manufactured Regionally (1-2)
If materials used for the building are extracted, processed or manufactured within 500 miles of the project site, they can qualify for this credit. If 10% of the total materials are local one credit is earned.

If 20% are used two credits are earned. This credit would not include much extra effort in order to be met; only chosen different manufacturers for materials would have been necessary.

MR Credit 7: Certified Wood (1)
If 50% of the wood used in the project is FSC (Forest Stewardship Council) certified this credit can be earned.

Indoor Environmental Quality (EQ)

EQ Prerequisite 1: Minimum IAQ Performance
The minimum requirements of sections 4-7 of ASHRAE 62.1-2004 must be met based on the building's ventilation design.

EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control
Smoking both first hand and second hand has been proven to have a negative effect on people's health. Children can especially be affected in a negative way.

To comply with this prerequisite, there will be no smoking in Pasadena Elementary School. Any smoking must be done at predetermined smoking stations at least 25 feet away from all entryways, outdoor air intakes and operable windows.

EQ Prerequisite 3: Minimum Acoustical Performance
Classrooms must be designed to meet reverberation time requirements as stated in ANSI Standard S12.60-2002, Acoustical Performance Criteria, Design Requirements and Guidelines for Schools. In addition classrooms must have a sound transmission class rating of at least 35. A maximum background noise for classrooms is 45 dBA.

EQ Credit 3.1: Construction IAQ Management Plan: During Construction (1)
During construction the following requirements must be met:

- Control Measures of the Sheet Metal and Air Conditioning Contractors National Association IAQ Guidelines for Occupied Buildings under Construction, Chapter 3 must at least be met
- Absorptive materials must be protected from moisture damage
- Filtration material must have a MERV rating of 8 or greater
- No smoking inside the building or within 25 feet of the building perimeter

EQ Credit 4: Low-Emitting Materials (1-4)
The following options will be sought after for materials earning four credits:

- Adhesives & Sealants must meet the requirements of California Department of Health Services *Standard Practice for the Testing of Volatile Organize Emissions from Various Sources Using Small-Scale Environmental Chambers*
- Paints & Coatings must meet the requirements of California Department of Health Services *Standard Practice for the Testing of Volatile Organize Emissions from Various Sources Using Small-Scale Environmental Chambers*
- Flooring Systems must meet the requirements of California Department of Health Services *Standard Practice for the Testing of Volatile Organize Emissions from Various Sources Using Small-Scale Environmental Chambers*
- Furniture & Furnishings must be GREENBUARD Children & Schools CertifiedSM

These credits can be achieved by choosing materials of the above nature that would not be odorous or irritating to the occupants of the building. Therefore no extreme measures would have been necessary to comply.

EQ Credit 5: Indoor Chemical & Pollutant Source Control (1)
The following measures must be taken for this credit:

- Permanently installed grates, grilles or slotted systems with cleaning allowed underneath must be located at entryways
- Exhausting spaces where hazardous gases or chemicals are present at least 0.5 cfm/sq. ft.
- Filtration media must have a MERV value of at least 13
- Hazardous liquid wastes must have separate containment drains for appropriate disposal

EQ Credit 8.1: Daylight & Views: Daylighting (1-3)
Classrooms having 75% of daylight needs to be achieved for one credit. If 90% is reached or 75% daylight in all areas of the building, additional credits can be earned.

EQ Credit 9: Enhanced Acoustical Performance (1-2)
Background noise in classroom spaces will have a maximum of 35 dBA for 2 credits earned. This is measured by using the Standard S12.60-2002.

Conclusions

If the above set of credits is met, a minimum of 29 credits would have been earned which is the minimum amount needed for a building to be LEED Certified. Additional credits could be earned due to exemplary performance points in certain credit's criteria or project specific innovation credits that designers or contractors may have come up with. A maximum of 46 credits could have been earned

if such exemplary performance points were gone after. Although unlikely, if 46 credits were earned the building could be LEED Certified Gold which is an excellent rating.

Measures were not taken to determine the full amount of time or if any additional costs would have been needed for a LEED Certified building. However, it is clear in the research above that achieving LEED credits and certain criteria can have many environmental benefits as well as cost savings throughout the lifetime of the building.

When it comes down to it, the earlier in the project's life that the decision is made to attempt to end up with a LEED Certified building, the better off the project will be. That way as the building is being designed and each part of the project team is performing their job, they can incorporate LEED strategies into the building and a better plan for design and construction can be obtained. Also, as a construction plan is coming into development, the contractors can know what measures they will have to take in order to achieve the criteria set by the design team. This coordinated effort cannot be successful if it decided after the building's design that the goal is to become a LEED Certified building.

Analysis 2: Greenroof Design

Introduction

Greenroofs can be a great alternative to conventional roofs that can be environmentally friendly and serve many other purposes including cost and energy savings. They can greatly help stormwater control, reduce heat island effects, create energy savings, cause a decrease in pollution and help with noise reduction.

In addition to environmental and economic effects, implementing a greenroof can greatly assist in receiving credits for a LEED Certified Building. The proposed greenroof will help with the following credits that were sought after for LEED Certification earlier in the report:

- SS Credit 5.1: Site Development: Protect or Restore Habitat (1)
- SS Credit 5.2: Site Development: Maximize Open Space (1)
- SS Credit 7.2: Heat Island Effect: Roof (1)
- WE Credit 1.1: Water Efficient Landscaping: Reduce by 50% (1)
- WE Credit 3.1: Water Use Reduction: 20% Reduction (1)
- EA Credit 1: Optimize Energy Performance (2-10)

Note: The number in parentheses after the credit name is the amount of credits that can be obtained.

When discussing greenroofs, there are two types to consider: extensive and intensive.

Extensive

Extensive is the simplest type of greenroof. The growing media ranges between 2 ½ inches and 6 inches. Due to a simpler design, this type of roof requires lesser and lighter layers, is less expensive and requires less maintenance than an intensive greenroof. Extensive greenroofs can be installed with slopes up to 30°. Costs can range between $14 and $25 per square foot.

Intensive

Intensive greenroofs are more complex than extensive. They generally have a growing media beginning at 8 inches and can be as large as 15 feet. With this increase in the amount dead loads applied to the roof, the structural capacity needs to be greater and as well as the mechanical capacity due to the increased stormwater drainage.

Expenses for an intensive greenroof will range from $25-$40 per square foot or more depending on the complexity.

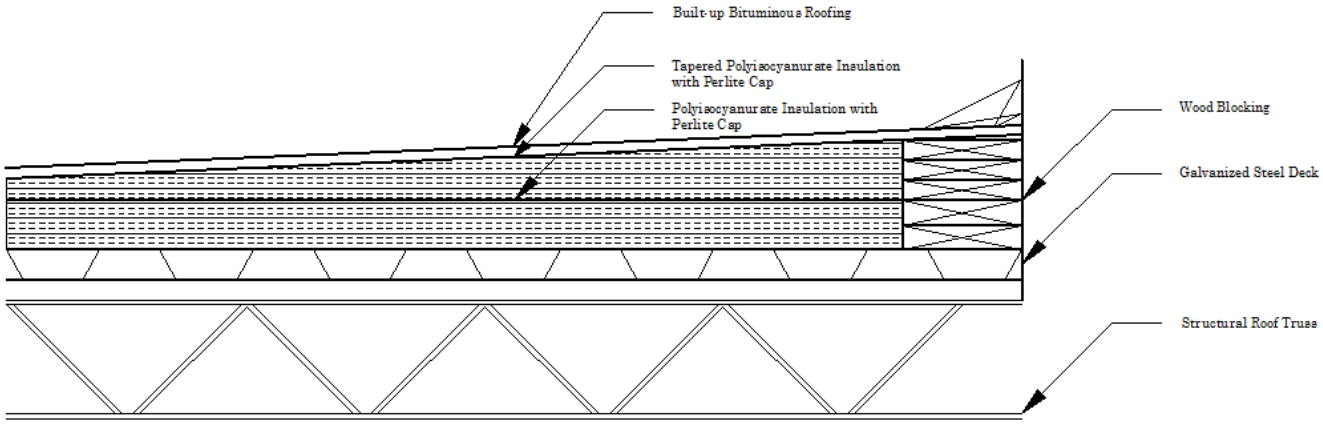
Components of a Greenroof

Greenroofs have the following necessary layers: waterproof membrane, insulation, drainage, filter fabric, growth media, plant material and water storage and irrigation.

Just as with a conventional roof, waterproofing is necessary and built-up bituminous roofing could be used. Insulation is not required, but with the proposal of reusing the existing Pasadena Elementary School, it may be recommended due to heat transfer from the water in the greenroof system into the building.

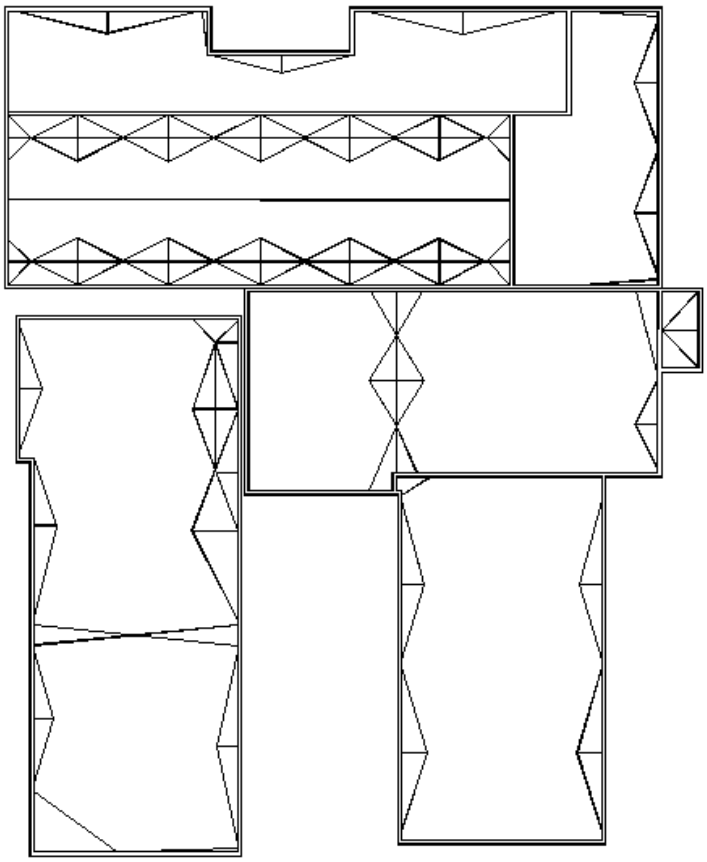
Original Roof Design

The original design of the school was a basic roofing system that mirrored today's standards. A 1-1/2", 20 gauge acoustic steel decking with tapered insulation that sits on top of steel roof trusses. There is cap flashing and thru-wall flashing below a bituminous membrane that serves as moisture protection. A section of the original design is shown below.



Existing Roof Section

Below is the original design for the roof plan for Pasadena Elementary School. Note that all slopes for tapered insulation shown on the plan are 25"/12".



Existing Roof Plan

Proposed System

A unique alternative to what most people think of greenroofs are Green Roof Blocks. They consist of 24" x 24" heavy gauge aluminum containers and are portable units that can be rearranged. They contain durable and drought resistant sedums that stand in 4" of growing medium. The lifetimes of the sedums are 100 years in length. The sedums sit on a 3/8" thick walk pad material that protects the roof from any moisture that the sedums might cause and in addition helps with roof drainage.

The types of plants are recommended based on the regional area the building is located in. Pre-planted sedums are chosen with some flexibility by the manufacturer.

Notice in Appendix D the types of plants that are recommended for the Pasadena, MD area.

This alternative is lightweight and is less expensive than other green roof options. Also for installation all you have to do is set the mobile units on top of the roof. Installation is performed by the same manufacturer and about 500 modules per day can be installed with the help of 8 workers.

The green blocks help with 15% energy savings and over a 2 year period can capture 80% stormwater. This captured stormwater can be reused in the building which reduces potable water use and can assist in obtaining LEED credits.

The units are manufactured by Green Roof Products which is a subsidiary of Saint Louis Metalworks Company located in Florissant, Missouri. Only a 3-week period is required for orders so it does not affect the schedule due to having a long-lead time.

Photo Taken from http://www.greenroofproducts.com/

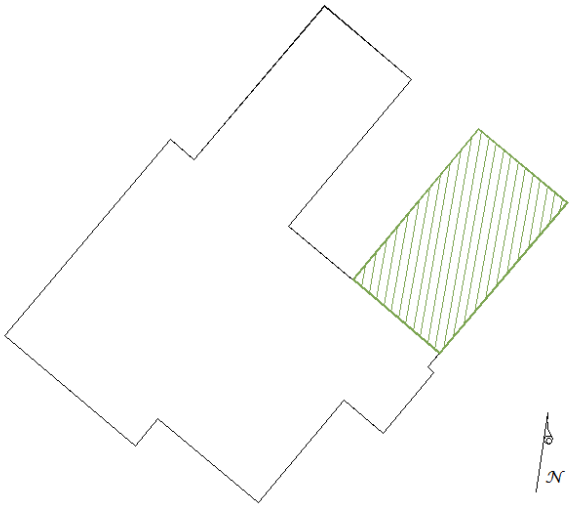
Green Roof Blocks

They are estimated at $12.50 per square foot. Since the area of the roof is 49,280 square feet the following is the estimate for these green roof blocks if used on the entire roof:

Price per square foot =	**$12.50**
Roof square footage =	**x 49,280**
Total Estimated Price =	**$616,000**

The cost of $616,000 is a great amount to add to construction costs and therefore, it would be difficult to convince most owners to purchase the system. Below is a calculation of the cost that would entail placing the green roof blocks on the northwest wing of the building only.

Price per square foot =	**$12.50**
Roof square footage =	**x 8,890**
Total Estimated Price =	**$111,125**



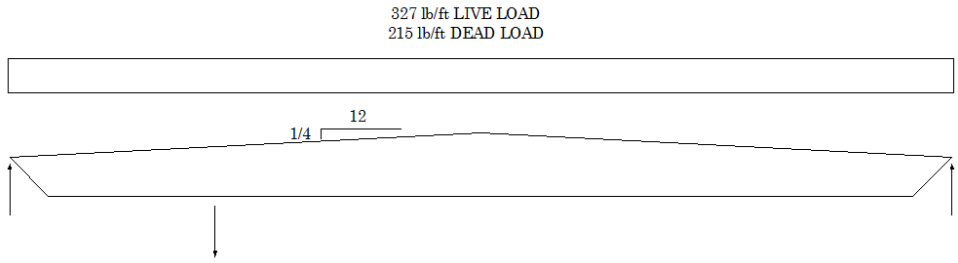
Footprint of Building with Shading of Location of Area Green Blocks to be Added

An amount of $111,125 is much less than that of $616,000 and would be easier to convince the owner of its value and that it is worth purchasing. Compared to a total project cost of $14,042,006, the amount to add green roof blocks is not that much and would be a great impact on the energy efficiency of the building.

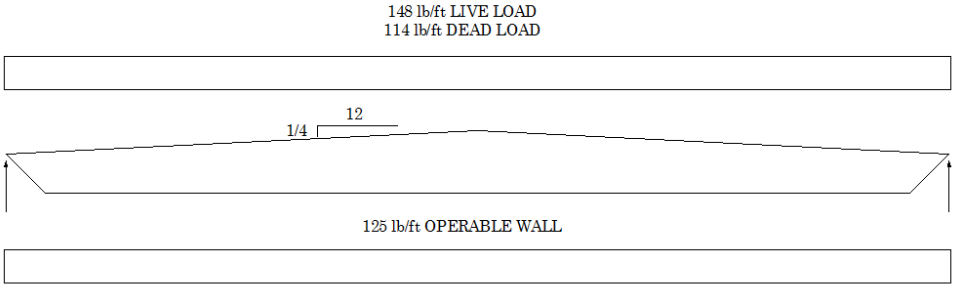
Installation of the roof blocks is performed at a rate of 500 modules per day with the help of 8 workers provided by the manufacturer at no additional cost. To install the roof blocks on the area of 8,890 square feet it would take 18 work days or just under 4 weeks to complete.

Structural System Analysis

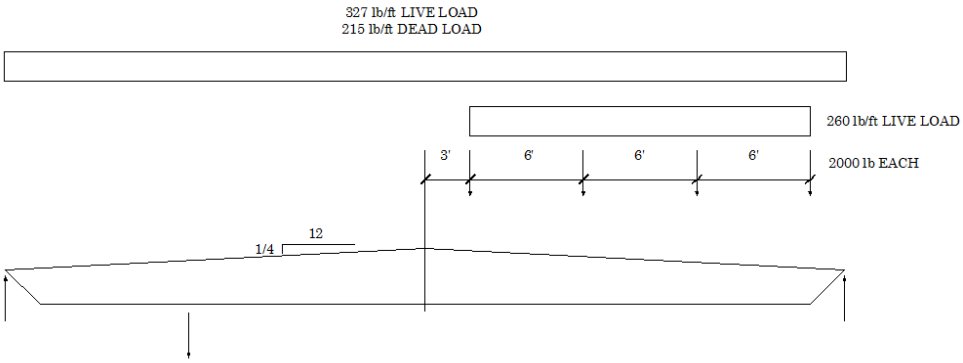
The original design loads (lb/ft) for the four structural trusses used in the building for support of the roof are below:



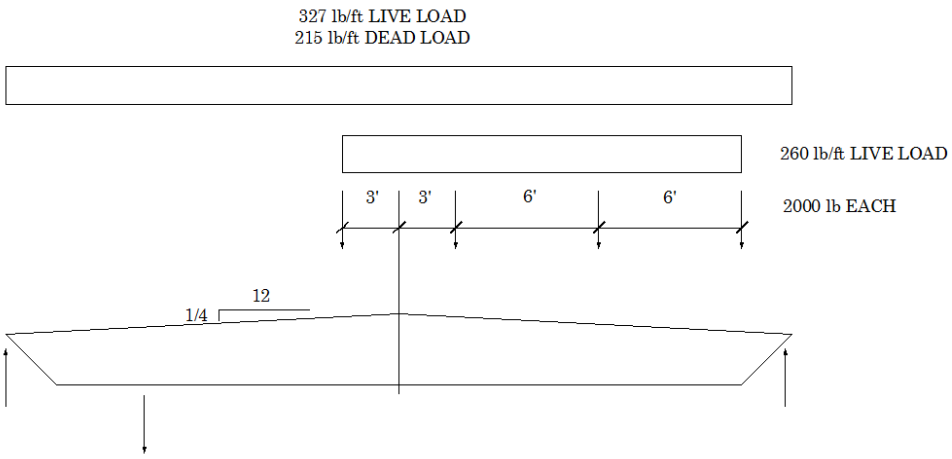
36LHSP1



36LHSP2



36LHSP3



36LHSP4

Note: For trusses 36LHSP1, 3 and 4 1000 lb live load at any location bottom chord shall be designed to transfer load to the adjacent panel points.

Below is the calculated dead load weight the roof trusses should be able to support based on weights from ASCE7-02 Table C3-1 Minimum Design Dead Loads. Notice the green roof blocks add a dead weight of 85 pounds per linear foot the trusses have to support.

	Weight (psf)	Weight (plf)
1 1/2" Galvanized Roof Deck (18 gauge)	3	15
Concrete	24	120
3' Polyisocyanurate Insulation with 1/2" Perlite Cap	2	12
Tapered Polyisocyanurate Insulation with 1/2" Perlite Cap (1/4"/ft min. slope)	7	34
Bituminous Membrane, gravel covered	6	28
Green Roof Blocks	17	85
Total	**59**	**293**

Designed Dead Load = 208 plf
Truss Dead Load Tolerance= 215 plf

There are four types of trusses used in the building as noted above. When first beginning to look into the green roof blocks a weight of such magnitude was not anticipated. The trusses original to the building's design are not capable of holding such a weight and therefore would need to be redesigned by the structural engineer.

Conclusions

A greenroof can be a great addition to a building causing an increase in energy efficiency at a minimal additional charge to the owner. Greenroof blocks are a slightly different alternative than what people typically think of when they think of greenroofs. However, they tend to be cheaper in price compared to other greenroofing options and provide minimal impact to the structural system of the building.

These blocks add 85 pounds per linear foot that the roof trusses must support. When originally looking at the system it was not realized that although lightweight, the greenroof system would weigh as much as it does. It was determined that the roof trusses could not support the extra weight of the green roof blocks and new trusses would have to be chosen by the structural engineer that could support the extra weight.

Analysis 3: Solar Parking Lot Lighting

Introduction

Renewable energy such as sunlight can be a great alternative to non-renewable energy that is commonly used to generate electricity. Non-renewable resources are lessening and we need to begin to use other sources for energy, especially in the use for buildings.

Renewable energy can provide benefits such as having a lower impact on the environment than non-renewable energy sources and lessening monthly electric bills. Also since renewable energy usually comes from a local source close to the building's site, it is great for the local economy. Finally it decreases our support for foreign oil supply which is a crisis our country is facing today.

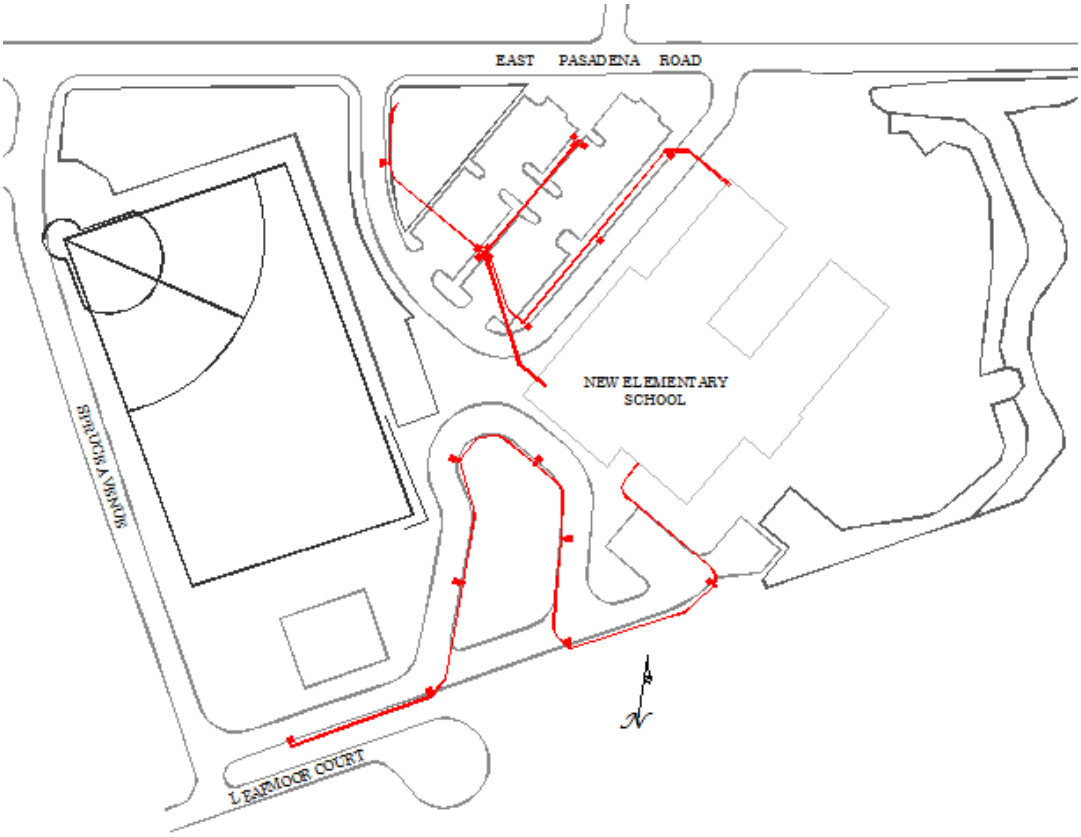
Solar lights can have high initial costs compared to conventional lights, but they can have considerable lifetime savings.

Original Exterior Lights

In the original design there are 14 light fixtures in the school parking lot with the following characteristics:

- Lamps: 1-400 Watt Metal Hallide (MH)
- Manufactured by Gardco, a Phillips group brand
- Catalog Number: G18 – 1 – 2XL – 400MH – 277/SSA5 – 28M
- Single High Intensity Discharge (HID) Unit
- Type II Distribution
- http://www.sitelighting.com/brochure/g_gullwing_broc.pdf

Notice below a siteplan showing the location of exterior lights.



Site Plan Showing Location of Exterior Lights

Previously metal halide lamps (will be referred to as MH from now on) have been used in many commercial applications. However, solid state lighting including light-emitting diode lamps (will be referred to as LED from now on) are increasing in numbers of applications due to their advantages over high intensity discharge lamps, which is the family that metal halide lamps belong to. Below is a comparison between LED lamps and MH.

MH	**LED**
Requires start-up time	Does not require start-up time
Life span around 20,000 hours	Lifespan around 100,000 hours
Causes light pollution	Reduces light pollution
Contains gases at high pressures	Contains no mercury or halogen gases

In addition, LED lamps generate less heat and have overall greater system efficiency than MH.

Proposed System

Below is information about the proposed solar parking lot lights to replace the lights from the original design:

Manufacturer	**Solar Illuminations**
	744 LED
	4500 lumens
Lifespan	**100,000 hours (22 years)**
Power	**140 Watts**
	24 Volt system
Finish	**Silver/Gray**
Price	**$3,325 with 26' pole**

Refer to Appendix E for further product specifications.

The lights are automated by photocells or light sensors and are able to reserve power for about 5 days in case of bad weather situations.

The lights come complete and ready to install with a battery box, 2-12 volt batteries and an installation kit. The light output is similar to that of a conventional exterior light produced by 200-400 watts which corresponds to the original design.

LED lamps do usually require a higher initial cost than other lamps due to a greater difficulty in their manufacturing process. The original schedule shows the site lights being installed from 13 June 2007 to 03 July 2007 for a total of 15 working days.

Lifetime Cost Savings Analysis

The average retail price of electricity was 11.39 cents/kilowatt hour for Maryland as of December 2007. Assuming the lamps will run for 12 hours each night a cost savings analysis is listed below.

Solar Lights (140 Watts)

12 hours x 0.14 kilowatts = 1.68 kW hour
11.39 ¢/ kW hour x 1.68 kW hour = 19.135¢ /lamp/day
19.135¢ x 14 lamps x 30 days/month = **$80.37 per month**

Original Metal Halide Lamps (400 Watts)

12 hours x 0.400 kilowatts = 4.8 kW hour
11.39¢/kW hour x 4.8 kW hour = 54.67¢ /lamp/day
54.67¢ x 14 lamps x 30 days/month = **$229.61 per month**

Monthly savings = 229.61 – 80.37 = $149.24

$3,325 x 14 / 149.24 = 26 years initial costs will be paid in full

This amount of time is only a small amount greater than the lifetime of the product and therefore the product basically pays for itself.

Conclusions

It was found that solar lights for the use of exterior lighting in the parking lot would have been a great alternative to the original design that uses metal halide lamps.

The solar lights use less energy than the conventional lights and provide the same atmosphere. Although they require a higher initial cost, there would have been a monthly savings of $149.24 in the electrical bill. The solar lights would have taken 26 years to completely pay themselves off which is only 4 years longer than their lifetime of 22 years.

Solar lights are beginning to gain popularity, but are not yet accepted fully or considered the norm in commercial buildings. It would most likely be hard to convince the owner of this option for use in their parking lot, but these lights provide a great savings in energy and use renewable resources that cannot be compared to the slightly higher initial cost of the product.

Analysis 4: Building Reuse

Introduction

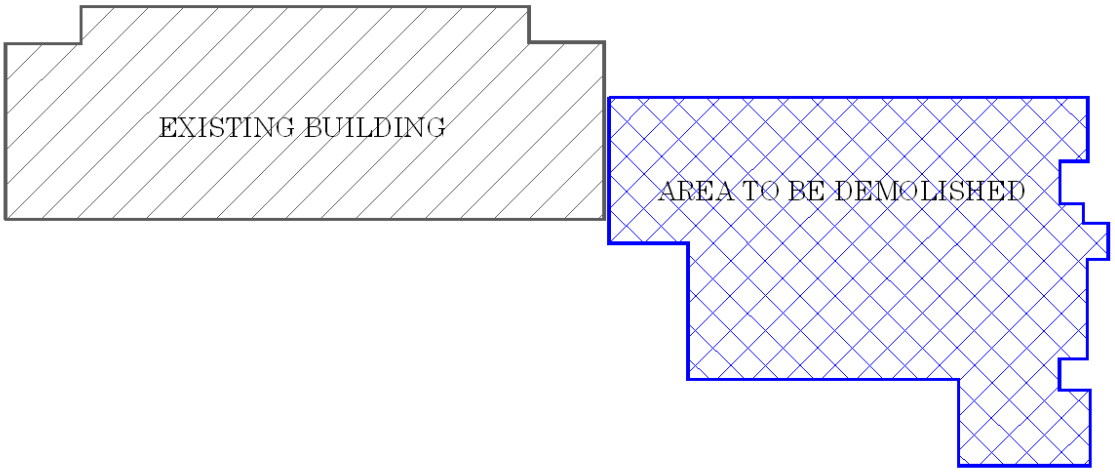
The existing Pasadena Elementary School was built in 1954 and has clearly outlived its original construction. Current codes and program requirements are no longer met and it was clear that action of some sort needed to be taken. After careful analysis and conversation it was decided that the original building be demolished and a brand new building be constructed on another part of the existing site. In the demolished building's place new multi-purpose sports fields are to be constructed.

Reusing buildings contribute to major savings in construction waste costs and also reduces a negative impact on the environment caused by demolition. There could have been major savings if the choice was made to renovate the existing school. Although some demolition and a possible new addition would be required, reuse of the building's structure could have saved time, money and materials in the construction process.

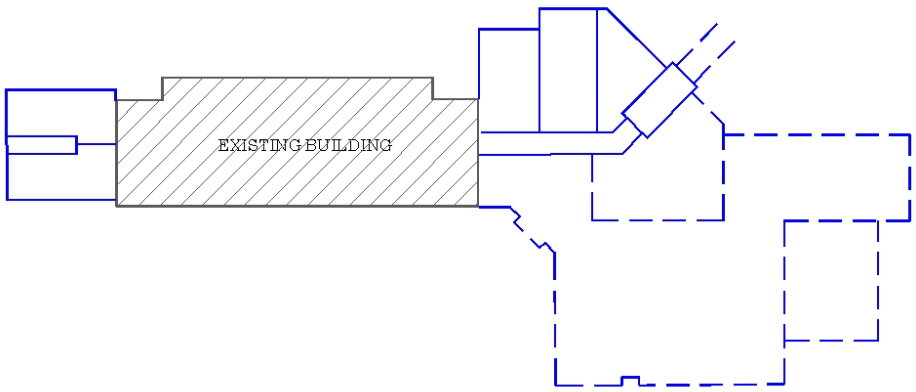
A feasibility study was performed in 2001 to go through all of the possibilities that could have been chosen to construct a new elementary school. Existing conditions of the building were examined and 4 proposals were given to the school board. The school board then decided in the current project of completely replacing the building. The following is an analysis of what the savings could have been had the school board chosen to renovate the original structure.

The major concern of this choice was the fact that relocation of the occupants would be necessary due to the disruption of the construction to the learning environment. In addition a great amount of sitework would be needed due to traffic flow issues and poor flow of egress.

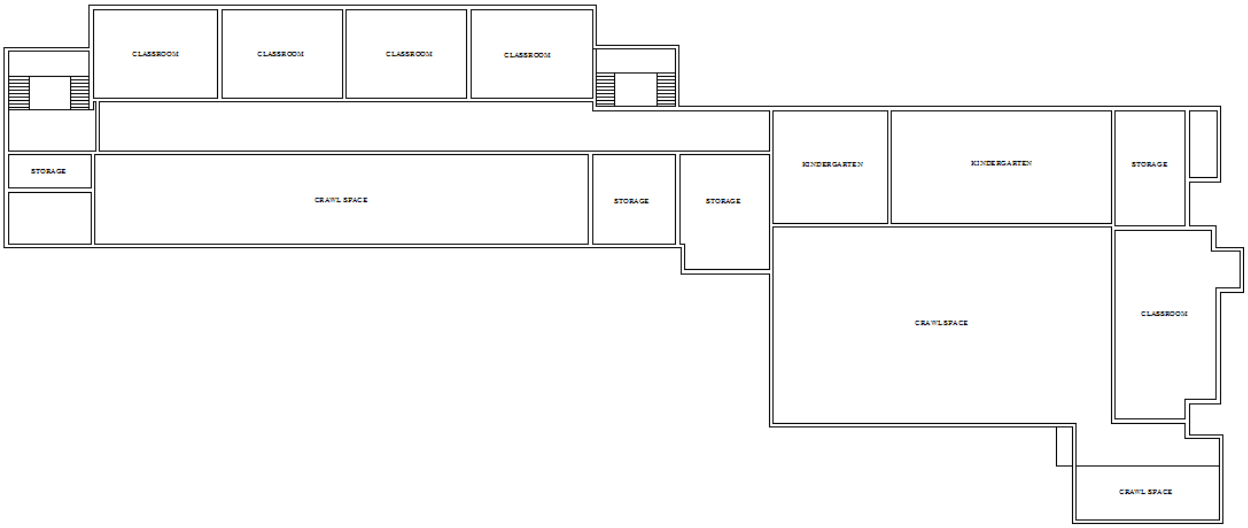
During the feasibility study the architect came up with a proposal for what could have been the elementary school had they chosen the renovation option. Notice on the next page both the existing building including the area to be demolished and the proposed new addition followed by the original floorplans of the building.



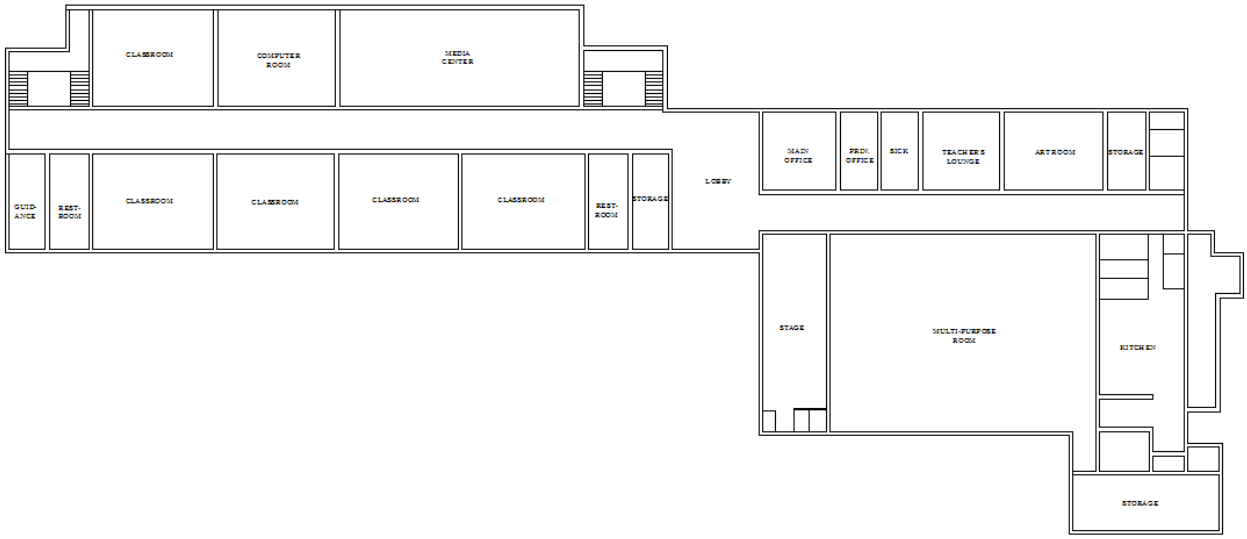
Existing Building Layout



Proposed Addition Layout



Existing Lower Level



Existing First Level

Existing Second Level

Only cost of demolition and new materials was considered when the school board made their decision in 2001. The following analysis will take all factors into consideration to determine if the current and implemented plan for Pasadena Elementary School was the correct one.

Existing Conditions

The following is a summary of the building's systems and their current state previous to the building demolition when the feasibility study was made. Some of the systems would have been useful in a renovation project, but some would need to be replaced.

Building Component	Needs to be Replaced	Partially Needs to be Replaced	Eventually Needs to be Replaced	Does Not Need to be Replaced
Exterior Brickwork		X		
Exterior Precast Sills & Lintels	X			
Windows	X			
Doors	X			
Louvers & Brickvents	X			
Roof		X		
Terrazzo Tile				X
Vinyl Tile	X			
Carpet		X		
SGFT Base				X
Interior Partitions				X
Interior Doors				X

Building Component	Needs to be Replaced	Partially Needs to be Replaced	Eventually Needs to be Replaced	Does Not Need to be Replaced
Ceilings				X
Lockers				X
Casework	X			
Display Boards			X	
Toilet Partitions	X			
Toilet Accessories	X			
Boilers				X
Boiler Accessories				X
Boiler Louvers				X
Steam Condensate System Pump				X
Steam/Steam Condensate Return Piping				X
Mechanical Heating Elements	X			
Air Conditioning System	X			
Exhaust Fans	X			
Ventillation System	X			
Temperature Controls				X
Domestic Water System				X
Sanitary and Stormwater System				X
Underground Oil Tank				X
Cast Iron Piping				X
Copper Piping	X			
Water Heater			X	
Plumbing Systems	X			
Sprinkler System	X			
Electrical Systems	X			
Lighting Systems			X	
Fire Alarm Systems	X			
Intercom System				X
Security System	X			
Data Wiring System				X
Central Cable System	X			
Telephone System				X

Site

The current paving on the project site would need to be demolished and redone. This is due to the fact that it creates difficulty for buses and parents to pick up and drop off the school children and it also does not meet current county codes.

Exterior Brickwork
Brickwork was in good condition with the exception of one panel on the kindergarten wing that was in need of replacement because of cracks due to settlement. Minor repairs were needed all over the building's exterior brickwork.

Exterior Precast Sills & Lintels
All precast concrete sills and lintels need to be replaced. Many of them were cracked and showed signs of water damage. In addition many cracks, chips, etc. were evident throughout. Many of the head joints were allowing water into the building due to missing mortar.

Windows
Both the windows throughout the building and the curtainwall system at the main staircase need to be replaced. Although in decent condition, the windows should be updated due to aging and need for basic maintenance such as sealing and repainting. They are also thermally inefficient. The curtainwall is covered in rust and some of the windows in the systems are broken.

Doors
The steel doors are thermally inefficient and it was suggested that they be replaced with insulated doors although they are in fair condition. Only new hardware and painting is necessary to update them to code standards.

Louvers and Brickvents
They all need to be replaced due to their poor condition.

Roof
The roof was recently replaced and is currently is good condition therefore it does not need to be replaced. However, there is one canopy adjacent to brickwork by the north stair tower that leaks and needs to be replaced.

Interior Flooring
Minor patches are needed in some areas of the terrazzo tile and therefore the tile does not need to be replaced.

Throughout the building the vinyl tile is in poor condition and needs to be replaced.

The carpet in the kindergarten rooms, media center and computer lab are in good condition and therefore do not need to be replaced. However, carpet throughout the rest of the building is in poor condition and does need to be replaced.

Structural glazed facing tile base throughout the building is in good condition.

Interior Partitions
Concrete Masonry Units and Structural Glazed Facing Tile make up the majority of the interior walls and partitions. Although minor patching and repairs are needed, they are in good condition and do not need to be replaced.

Interior Doors
Interior doors were in need of refinishing but do not need to be replaced.

Ceilings
The majority of the ceiling throughout the building consists of 12" x 12" acoustical ceiling tile that was in good condition. In the restroom areas the ceilings are made of gypsum board and are in good condition as well.

Lockers
The lockers were replaced ten years prior and are still in great condition. Therefore, the do not need to be replaced.

Casework
Both the countertops and the casework throughout are in poor condition and are in need of replacement.

Chalkboards
Although aged, the chalkboards are in good condition. They could be left alone at this time and be replaced at a later date.

Toilet Partitions
Some stall doors are missing and therefore need to be replaced.

Toilet Accessories
Toilet accessories throughout the building need to be replaced.

Heating Mechanical Systems
The current boilers (2) in the elementary school were just installed in 1997-1998 and are therefore in good condition. They are estimated to last for 35 more years. They were manufactured by H. B. Smith (Model 350) mills series cast iron sectional type, each having 3 sections. Each burner for each boiler has a combination gas-oil modulating fired and was built by Power Flame (model C2-G0-20A). Repairs may be needed for the blower fan on boiler No. 1 due to a clanging sound observed.

Boiler accessories were only 3-4 years old at the time of inspection and are therefore up to date according to Maryland State Boiler Code CSD-1 standards. Boiler accessories include one low water cut-off, a combination low water cut-off with boiler feed pump control, and a burner cut-off switch used for emergencies that is located at an exit in the boiler room.

Also observed was a masonry stack used for natural draft from each boiler including individual insulated welded steel breeching. There were no induced fans present.

A high and low louver located in an existing window wall supplies combustion air for the boilers, each having a control damper. The Boiler Inspector approved the existing louvers that were installed with the new boilers. It has been recommended that the size be verified because it was observed that they appear to be too small. It was also noted that the lower louver for boiler No. 1 has only been opening partially as the boiler is on high fire.

Ventilation for the boiling room includes four operable windows which open into an area way. There is no positive ventilation for the space.

The pump used for the building steam condensate system was installed in 1997 and is in excellent condition. Steam condensate returns to the boilers through a combination condensate receiver and boiler feed unit. It was manufactured by Domestic Pump Company (Model 75CBM-15-25).

Also installed with the new boilers were the steam and steam condensate return piping along with the valves and accessories and are therefore in good condition as well.

Entrances, administrative offices, the health room, stage, kitchen, faculty lounge, restrooms and storage rooms are supplied heat via steam to fin tube radiation. The equipment was 47 years old at the time of inspection but appears to be in good condition because of lack of moving parts.

The largest space in the building, the multi-purpose room, is supplied each by two heating and ventilating units on each side of the stage. Each unit supplies air on the side at the face of the stage. Return air is collected through wood louvers at the face of the stage that runs into an air plenum that runs underneath the stage. Although in good condition, sprinklers would need to be installed for the return air systems to meet current code requirements due to the stage being combustible.

The classrooms and the Media Center are supplied heat by unit ventilators original to the building that are supplied by steam. They appear to be in good condition.

The insulation on fittings for the steam and steam condensate return piping appears to contain asbestos and therefore needs to be tested. The return piping including the valves, steam traps and accessories are original to the construction of the building. The entire steam system needs to be replaced due to the age of the system and likelihood of the system failing in the near future.

Air Conditioning Mechanical Systems

Only a small section of the existing building has air conditioning. The following areas have window cooling units: Health Room, Teachers Lounge, Administrative Offices, Guidance Offices, Media Center, Computer Rooms, and Meeting Room with server equipment.

In the third floor classrooms there is no air conditioning but they have paddle fans to help circulate air.

The current ventilation system at the 3-story classroom section of the building does not meet National Fire Protection regulations or the current building code. Outside air is brought into the building via classroom unit ventilators. When the classroom temperature is higher than outside air temperature and when heating is not required, the units which have economizer cycles, allow the classrooms to be supplied with 100% outside air. Large grilles are located at the top of each of the stairways and they are connected to a gravity ventilator which is located on the roof. Louvers in the classroom doors allow the air (if supplied by the economizer) to exit the classrooms and travel into the corridor. As it travels down the corridor it is then relieved into the stairways.

Fire dampers need to be installed in some of the ductwork that penetrates two or three floors. This arrangement does not meet current building codes.

In the Multi-Purpose room the pressure and relief grilles are visible and are operating in good condition. The air handling units in the space are similar to the units in the classroom with the exception that they are larger in size.

Exhaust fans ventilate the restroom areas and are in need of replacement. The areas had odors which led to believe that they are not working properly and the air quality does not meet air ventilation codes.

Natural ventilation through windows or a gravity ventilation system ventilates the storage rooms throughout the building. The spaces should be updated to have positive ventilation to agree with current codes. Also, some of the storage areas have been changed for use as offices and they do not have any windows. If the offices were chosen to remain through renovation, the gravity system will not meet code requirements.

Transfer of air from the Multi-Purpose room to the kitchen is required. Currently, the kitchen has a 35 square foot hood and does not have a make-up air unit.

Temperature Controls

Controls appear to be in good condition. Honeywell temperature controls are located throughout the building and are mostly pneumatic. A duplex air compressor with refrigerant air dryer serves the building system and is located in the boiler room. There are four occupied/unoccupied zones: Office Area, Multi-Purpose Room, Classrooms and Convectors.

Wall mounted pneumatic thermostats that control heating elements are located in each classroom by the doors.

Building Utilities

The domestic water system has been changed from a well system to water service connected the county water main. The original well had water treatment equipment and a hydropneumatic tank. Since the utility change the well has been capped off for health code regulations and the original equipment has been removed. The new water service has a main shut-off valve.

The existing sanitary and storm water mains in the building are in fair condition and do not need to be replaced. However, it was suggested that before connecting any new fixtures the mains should be cleaned by high pressure equipment and checked with a video scope to determine any problems that may arise in the future.

Within recent years a 10,000 gallon underground oil tank has been installed and currently meets present underground storage tank code requirements by the Environmental Protection Agency. The only thing that needs to be updated is the oil tank vent pipe is currently 9 feet above grade and the code requires 12 feet.

A natural gas device that currently exists in the building needs to be investigated by BGE.

Plumbing Systems

Most of the plumbing in the building is original to its construction. The cast iron piping that is used for sanitary and storm water is in good condition and does not need to be replaced. However, the copper piping that is used for water needs to be tested for lead due to older systems using lead based solder. If lead is found, the system needs to be replaced.

A water heater with a capacity of 85 gallons and 18 kW was installed in the boiler room for domestic hot water 5 years ago. The Rheem (Model EG18-85A-g) has an expected life of 10 to 15 years and therefore eventually needs to be replaced, but not at this time. A return circulator for hot water has been installed without an expansion tank and a mixing valve of an old age has been installed on the hot water pipe that serves the building's restrooms.

The existing plumbing fixtures do not meet American Disabilities Act code requirements and therefore need to be replaced. The majority of the building's plumbing fixtures are original to construction. The following are the fixture types that are found throughout the building:

- Floor mounted flush valves of vitreous china type with black open front seats serve water closets
- Flush valve type with stall units serve the urinals which do not meet current codes because the seal trap is not visible
- Enamel cast iron wall mounted lavatories are installed in the restrooms. The current faucets are self closing and only have cold water available for spaces that children use. Both cold and hot water are available for adult areas.

- Enamel cast iron drop-in type sinks are located in the classrooms. They are only supplied with cold water with a self closing faucet and a cold water bubbler mounted on the right side.

Fire Protection Systems

Currently the building does not have a fire protection or sprinkler system throughout. Although not necessarily required by present code, if installed a drop in insurance premiums may justify the installation of such a system. Also, updating the building structure may be more costly than installing a sprinkler system.

Electrical Systems

A 50kVa single phase pole mounted transformer that is located on the side of the building supplies the school. Service to the building is run from the pole underground through a CT cabinet that connects to a main fused disconnect switch (600 amps) that is located in the boiler room. 2-400 amp, Square D panelboards are fed by the breaker which serve the lighting and receptacle panelboards throughout the building and the mechanical equipment in the boiler room. There is a 100 amp enclosed circuit breaker for a portable classroom was installed in 1998.

The main disconnect switch for two additional circuit breakers has a service that is tapped ahead that used to feed the old fire alarm panel and the exit light load center.

All electrical systems including panelboards, wiring and equipment are of original building construction and need to be replaced.

No computer power distribution runs throughout the school building.

Lighting Systems

Throughout the school fluorescent 4 foot wrap around fixtures are used. They are surface mounted to the ceiling and have been installed where originally there were incandescent light fixtures.

In small spaces such as restrooms, storage rooms and exterior soffits, incandescent lights are used.

Wall-mounted battery units are used for emergency lighting used throughout the building.

Pendant-mounted incandescent light fixtures and one row of border lights are located on the stage area of the building. Also there are incandescent spot lights used for performances on the stage located in the Multi-Purpose Room. All lights are controlled by wall switches and do not contain dimmers.

Fire Alarm Systems

A 120V system by IBM serves the entire building. Throughout the building there are manual pull stations and bells. There are no parts that are available for this system. Certain aspects f the system

are lacking including visuals throughout the building to meet ADA and National Fire Protection Association criteria.

In the Main Office another fire alarm control panel was installed in 1998 that monitors the portable classroom, duct type smoke detectors and the existing IBM panel.

A digital communicator (Silent Knight) was added in later years for reporting purposes of the fire alarm system.

There is no annunciator panel within the building.

Telecommunication Systems

An intercom system is controlled from the Main Office. Calls can be made separately to each classroom and announcements can be made throughout the school through the system. Each classroom has both a speaker and a call switch. The call switches in the classrooms are difficult to reach due to the switch being located high above the chalkboards.

A separate system serves the Multi-Purpose room and has a wall cabinet with an Altec Lansing amplifier. Also included in the system are wall mounted speakers located on each side of the stage. There are also microphone outlets located at the front of the stage.

A C&K system serves as a security system for the building. The Main Office storage closet is the location of the main control panel. There is a key pad, motion detectors and also door sensors as part of the system as well.

A Cat 5 wiring system serves as the schools data wiring system. Each classroom has two receptacle outlets located at the front of the room. Hub equipment for the system is located in the first floor meeting room and consists of Baynetworks hubs and a Cisco router. This system connects the Computer Rooms, Library, Offices and Classrooms.

There is no central cable system located within the school.

A Lucent telephone system is located in the main office. The same pole located outside that supplies the electrical service supplies the telephone service. A terminal board located in the boiler room is where the wiring runs from the pole into the building.

Scope of Renovation

A simple renovation of the existing building would not be sufficient due to programmatic issues. An addition that would provide more space in the building would be necessary to meet current codes and regulations.

Some major phases of this plan are below:

- Demolition of the existing Cafeteria and Kindergarten wing will be performed.
- An addition will be built alongside the south side of the existing building and this addition will accommodate the following spaces:
    - Art room
    - Computer room
    - Kitchen
    - Stage
    - Offices
- The following new rooms will be added to the addition:
    - Media Center
    - Separate space for Cafeteria and Gymnasium
    - Administrative Spaces
- Another addition on the north end of the building will be used for kindergarten rooms
- A new elevator will be installed
- Restrooms will be updated to meet ADA requirements

Below is a summary of the demolition quantities based on the area of the building.

	Lower Level	**Level 1**	**Level 2**	**Total**
Demolition	12,041	11,681		**23,722**
Renovation	5,566	6,911	8,660	**21,137**
Improvements	1,530	3,578	1,829	**6,937**
Addition	9,196	26,645		**35,841**
Total	**16,292**	**37,134**	**10,489**	**63,915**

As stated earlier, sitework for this renovation project will be a great expense. The majority of the sitework construction includes:

- New parking location including new parent drop-off area
- New bus loop
- New drivable area for kitchen access
- New fire access lane and new waterline fire loop to meet Anne Arundel County Fire Department policy
- New hard and soft surface play areas

Due to the extensive architectural changes of the building new systems for both plumbing and mechanical systems will be required. All of the existing systems will be removed and new systems will be installed. In addition, the boiler room will be relocated due to the addition on the south side

of the building. New boilers with dual temperature chilled/heating water pumps will be installed to serve the entire building.

The new HVAC system will include the following:

- Classrooms: The dual temperature chilled/heating water system will serve all classrooms that are equipped with ducted fan coil units
- Administration Area: The area is served by 3 small air handling units with a Variable Air Volume distribution system. An air cooled condensing unit will allow cooling in the areas.
- Gymnasium, Media and Multi-Purpose Room: Constant volume air handling units connect to the dual temperature chilled/heating water system
- A direct digital control system will serve as the temperature control system for the building. It will allow the operation of the building to be local or remote and will provide economical and energy saving procedures

Abatement of hazardous materials, removal and replacement of systems and new construction is necessary for this plan. The disturbance that the construction would cause would require the students and the faculty to be relocated to another facility during the school year.

Cost Analysis

Below is an estimate of the cost of the renovation plan for the school. The numbers are based on square footage of the building and therefore are not completely accurate but area close estimate. Note that the total of $10,657,890 includes demolition and abatement and is less than the current building's project total of $14,042,006.

	Area (sq. ft.)	Unit Price ($/sq. ft.)	Total
Architectural/Engineering Fees			$ 810,000
Construction Management Fees			$ 375,000
Site Development			$ 978,655
Selective Demolition	23,722	$ 4.00	$ 94,888
Renovation	21,137	$ 60.00	$ 1,268,220
Modernization	6,937	$ 100.00	$ 693,700
New Construction	35,841	$ 150.00	$ 5,376,150
Contingency			$ 680,000
Inspection Fees			$ 42,500
Building Technology			$ 200,000
Abatement	46,259	$ 3.00	$ 138,777
Estimated Total			**$ 10,657,890**

The original building was 45,296 square feet. If the proposed renovation would have happened, only 23,735 square feet would have had to be demolished. Savings in cost of the demolition contractor would have been $217,942.

Schedule Analysis

The schedule could have been reduced due to the fact that the multi-purpose sports fields could have been in progress at the same time the building was in construction. Obviously with this major change the sequence of the project would have differed dramatically.

The construction of the sports fields would have taken place over a five and a half month period of time or 121 man days. In the original schedule, the construction of the fields does overlap with the asbestos abatement and the demolition phase of the project. However, the abatement and demolition phases are finished before the construction of the fields and in the final 3 months of the project only the construction of the fields is taking place. Therefore, this 3 month period of time could be saved by the new schedule proposal.

Below are some of the key dates to the original schedule. Turn to Appendix B for the complete original schedule.

	Start Date	**Completion Date**
Project Start Date	05 September 2006	
Sitework	05 September 2006	
Concrete	06 October 2006	
Masonry	13 November 2006	
Mechanical & Plumbing	21 November 2006	
Electrical	22 November 2006	
General Works	15 January 2007	
Structural Steel	01 March 2007	
Windows	30 March 2007	
Sprinkler	16 April 2007	
Technical Wiring	14 May 2007	
Kitchen Equipment	15 May 2007	
Playground Equipment	19 July 2007	
Casework	20 July 2007	
Abatement	21 January 2008	
Demolition	21 February 2008	07 April 2008
Phase II Sitework (Sports Fields)	21 January 2008	07 July 2008

Below are some of the key dates to the proposed new schedule.

	Start Date	Completion Date
Project Start Date	05 September 2006	
Abatement	05 September 2006	05 October 2006
Demolition	06 October 2006	31 October 2006

Below is a breakdown of where the above dates were generated from based on durations and rates from the original schedule. It was assumed that the same construction workers would work at the same rate.

	Duration	Sq. Footage	Rate
Abatement			
Original Schedule	22	45,296	2059 sf/day
Proposed Schedule	23	46,259	
Demolition			
Original Schedule	33	45,296	1373 sf/day
Proposed Schedule	18	23,722	

Conclusions

There could have been a great amount of savings if the Anne Arundel County would have chosen to renovate the original school building. This decision would have saved many new materials that were used but did not need to be.

The existing building would have caused a tremendous amount of waste that went to landfills for disposal. Some of this waste could have been avoided if the entire building was not demolished. The section of the building that would have had to be demolished could have been recycled which was not in the original construction waste management plan.

The original building, although out of date with many code standards, was still in good condition and the structure could have been reused. Many updates to the building have recently been performed such as a new roof system and the boilers were recently purchased.

Also, it would not have been more expensive or would not have taken more time than the project's current plan of demolishing the existing building and building a new one. In fact, it was found that the schedule could have been reduced.

The major inconvenience that would have come with this option would have been the necessity of relocating the school's occupants for the course of at least one school year. However, this small inconvenience would have been worth the savings of construction waste and unnecessary new materials that have a negative impact on our environment.

References

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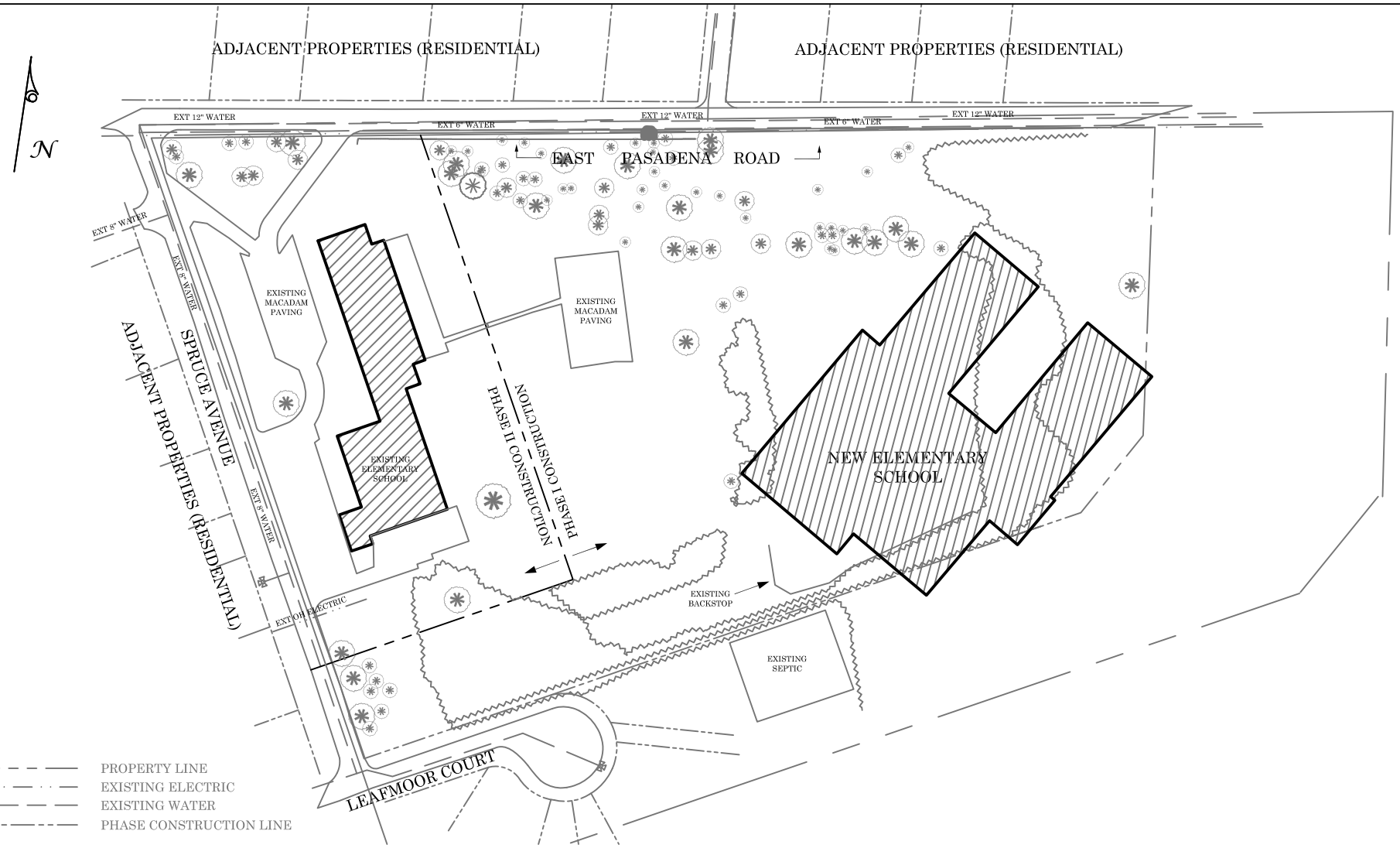
Appendix A

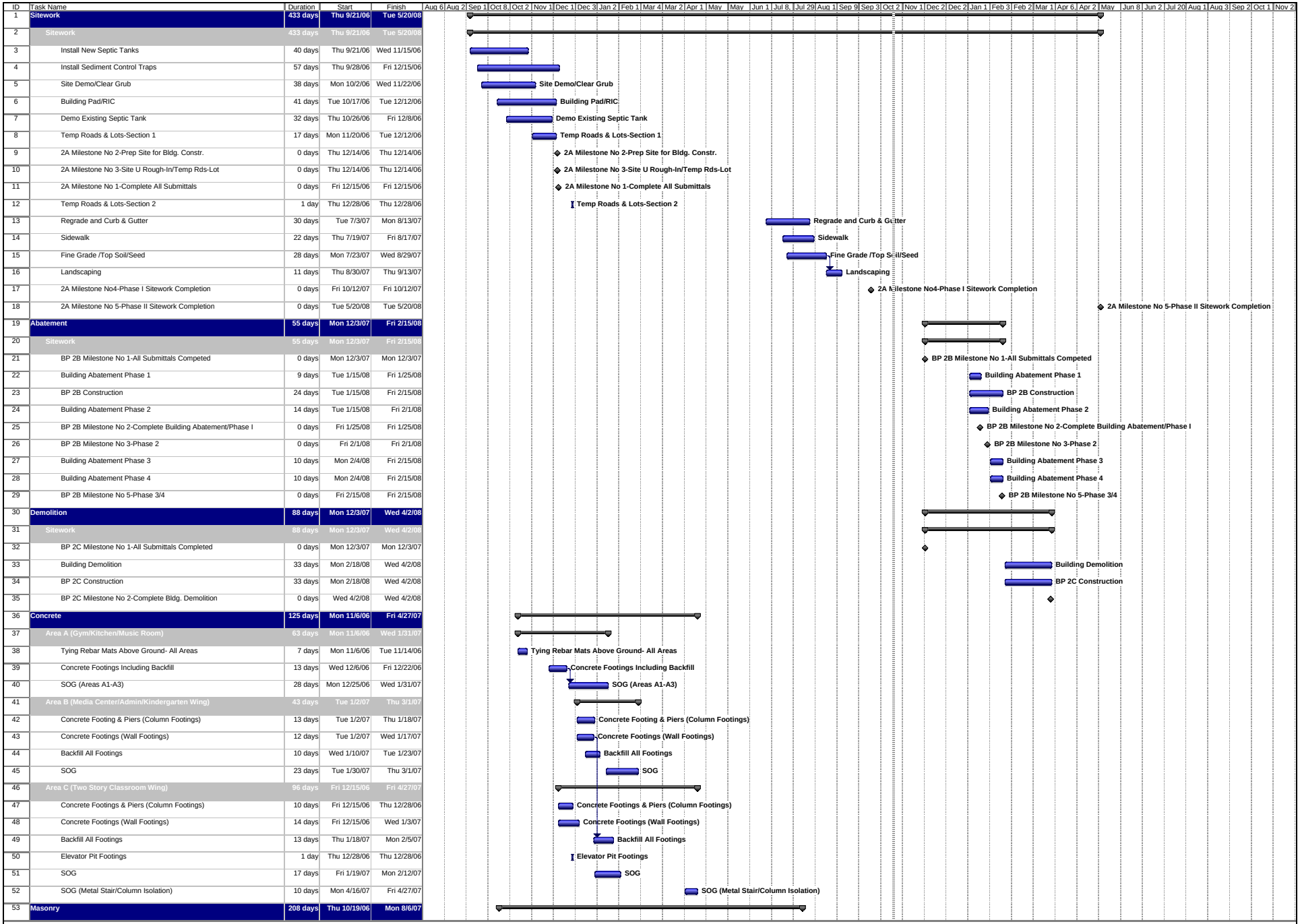


EXISTING CONDITIONS SITE PLAN

SCALE: $\frac{1}{128}$" = 1'

CATHERINE NEIDERER ARCHITECTURAL ENGINEERING SENIOR THESIS PORTFOLIO	PASADENA ELEMENTARY SCHOOL 105 SPRUCE AVENUE PASADENA, MD 21122	1 OF 1

Appendix B

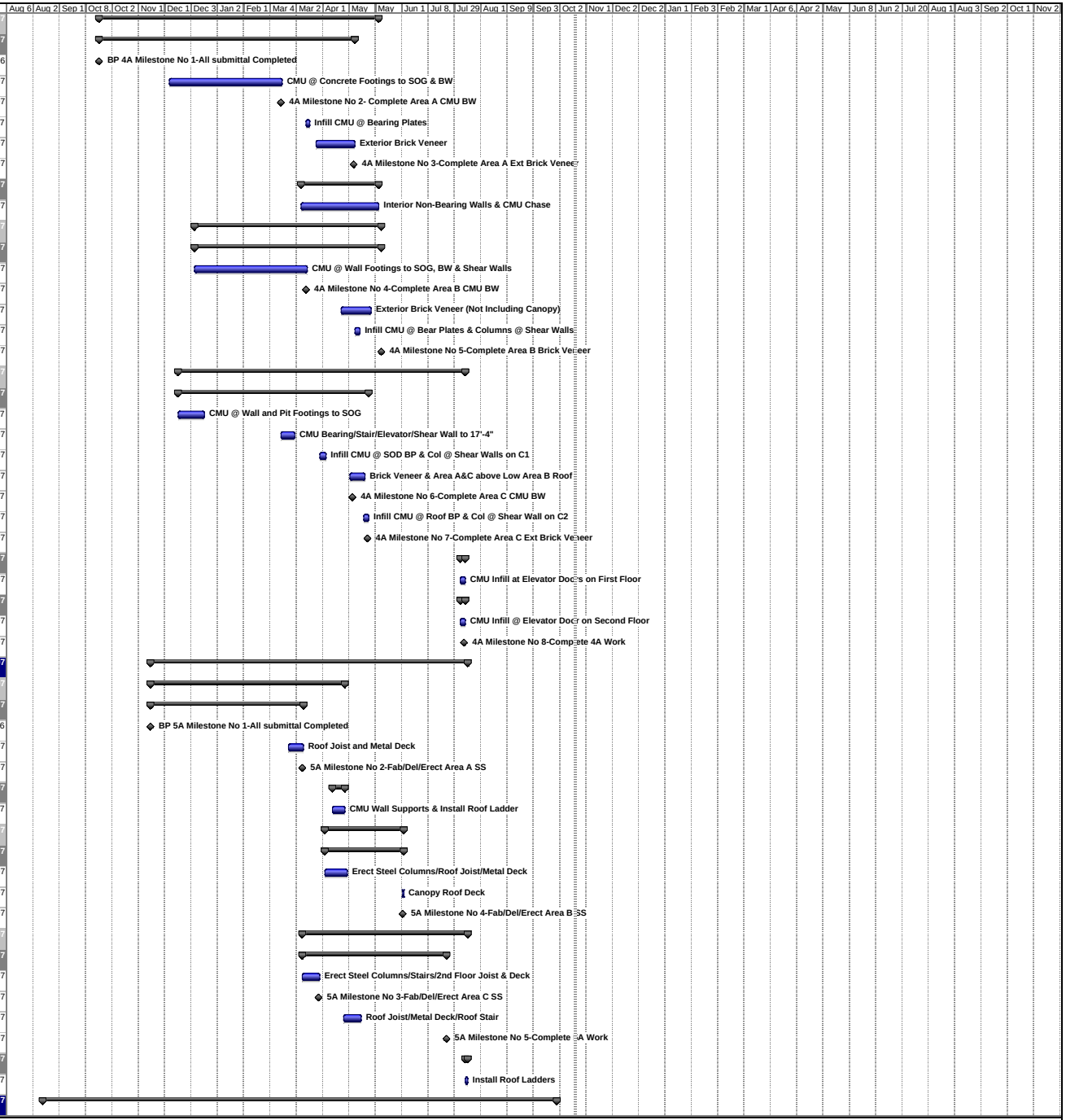


ID	Task Name	Duration	Start	Finish
1	**Sitework**	**433 days**	**Thu 9/21/06**	**Tue 5/20/08**
2	Sitework	433 days	Thu 9/21/06	Tue 5/20/08
3	Install New Septic Tanks	40 days	Thu 9/21/06	Wed 11/15/06
4	Install Sediment Control Traps	57 days	Thu 9/28/06	Fri 12/15/06
5	Site Demo/Clear Grub	38 days	Mon 10/2/06	Wed 11/22/06
6	Building Pad/RIC	41 days	Tue 10/17/06	Tue 12/12/06
7	Demo Existing Septic Tank	32 days	Thu 10/26/06	Fri 12/8/06
8	Temp Roads & Lots-Section 1	17 days	Mon 11/20/06	Tue 12/12/06
9	2A Milestone No 2-Prep Site for Bldg. Constr.	0 days	Thu 12/14/06	Thu 12/14/06
10	2A Milestone No 3-Site U Rough-In/Temp Rds-Lot	0 days	Thu 12/14/06	Thu 12/14/06
11	2A Milestone No 1-Complete All Submittals	0 days	Fri 12/15/06	Fri 12/15/06
12	Temp Roads & Lots-Section 2	1 day	Thu 12/28/06	Thu 12/28/06
13	Regrade and Curb & Gutter	30 days	Tue 7/3/07	Mon 8/13/07
14	Sidewalk	22 days	Thu 7/19/07	Fri 8/17/07
15	Fine Grade /Top Soil/Seed	28 days	Mon 7/23/07	Wed 8/29/07
16	Landscaping	11 days	Thu 8/30/07	Thu 9/13/07
17	2A Milestone No4-Phase I Sitework Completion	0 days	Fri 10/12/07	Fri 10/12/07
18	2A Milestone No 5-Phase II Sitework Completion	0 days	Tue 5/20/08	Tue 5/20/08
19	**Abatement**	**55 days**	**Mon 12/3/07**	**Fri 2/15/08**
20	Sitework	55 days	Mon 12/3/07	Fri 2/15/08
21	BP 2B Milestone No 1-All Submittals Competed	0 days	Mon 12/3/07	Mon 12/3/07
22	Building Abatement Phase 1	9 days	Tue 1/15/08	Fri 1/25/08
23	BP 2B Construction	24 days	Tue 1/15/08	Fri 2/15/08
24	Building Abatement Phase 2	14 days	Tue 1/15/08	Fri 2/1/08
25	BP 2B Milestone No 2-Complete Building Abatement/Phase I	0 days	Fri 1/25/08	Fri 1/25/08
26	BP 2B Milestone No 3-Phase 2	0 days	Fri 2/1/08	Fri 2/1/08
27	Building Abatement Phase 3	10 days	Mon 2/4/08	Fri 2/15/08
28	Building Abatement Phase 4	10 days	Mon 2/4/08	Fri 2/15/08
29	BP 2B Milestone No 5-Phase 3/4	0 days	Fri 2/15/08	Fri 2/15/08
30	**Demolition**	**88 days**	**Mon 12/3/07**	**Wed 4/2/08**
31	Sitework	88 days	Mon 12/3/07	Wed 4/2/08
32	BP 2C Milestone No 1-All Submittals Completed	0 days	Mon 12/3/07	Mon 12/3/07
33	Building Demolition	33 days	Mon 2/18/08	Wed 4/2/08
34	BP 2C Construction	33 days	Mon 2/18/08	Wed 4/2/08
35	BP 2C Milestone No 2-Complete Bldg. Demolition	0 days	Wed 4/2/08	Wed 4/2/08
36	**Concrete**	**125 days**	**Mon 11/6/06**	**Fri 4/27/07**
37	Area A (Gym/Kitchen/Music Room)	63 days	Mon 11/6/06	Wed 1/31/07
38	Tying Rebar Mats Above Ground- All Areas	7 days	Mon 11/6/06	Tue 11/14/06
39	Concrete Footings Including Backfill	13 days	Wed 12/6/06	Fri 12/22/06
40	SOG (Areas A1-A3)	28 days	Mon 12/25/06	Wed 1/31/07
41	Area B (Media Center/Admin/Kindergarten Wing)	43 days	Tue 1/2/07	Thu 3/1/07
42	Concrete Footing & Piers (Column Footings)	13 days	Tue 1/2/07	Thu 1/18/07
43	Concrete Footings (Wall Footings)	12 days	Tue 1/2/07	Wed 1/17/07
44	Backfill All Footings	10 days	Wed 1/10/07	Tue 1/23/07
45	SOG	23 days	Tue 1/30/07	Thu 3/1/07
46	Area C (Two Story Classroom Wing)	96 days	Fri 12/15/06	Fri 4/27/07
47	Concrete Footings & Piers (Column Footings)	10 days	Fri 12/15/06	Thu 12/28/06
48	Concrete Footings (Wall Footings)	14 days	Fri 12/15/06	Wed 1/3/07
49	Backfill All Footings	13 days	Thu 1/18/07	Mon 2/5/07
50	Elevator Pit Footings	1 day	Thu 12/28/06	Thu 12/28/06
51	SOG	17 days	Fri 1/19/07	Mon 2/12/07
52	SOG (Metal Stair/Column Isolation)	10 days	Mon 4/16/07	Fri 4/27/07
53	**Masonry**	**208 days**	**Thu 10/19/06**	**Mon 8/6/07**

Detailed Project Schedule
11/2/07

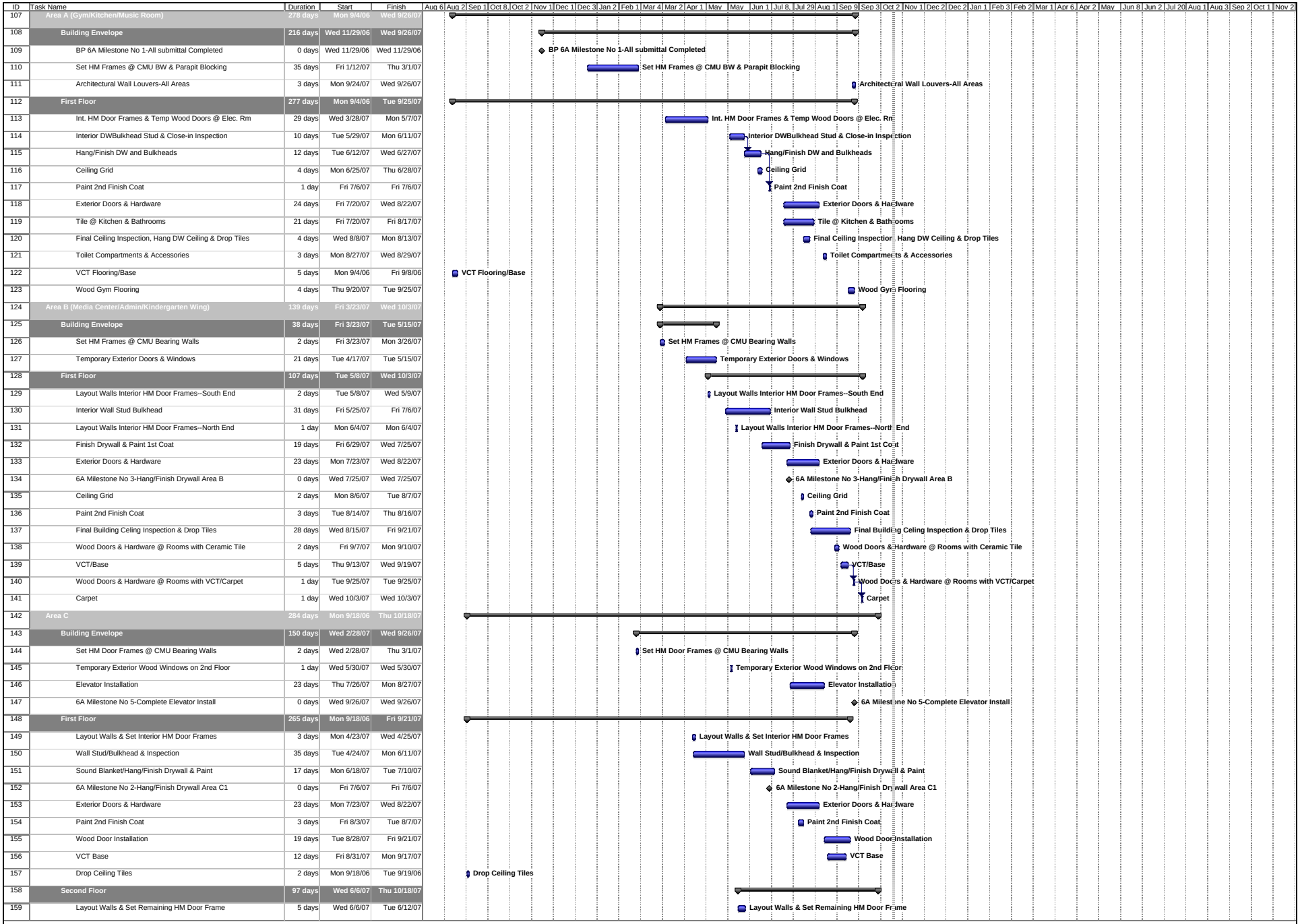
Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary | Deadline

ID	Task Name	Duration	Start	Finish
54	Area A (Gym/Kitchen/Music Room)	159 days	Thu 10/19/06	Tue 5/29/07
55	Building Envelope	146 days	Thu 10/19/06	Thu 5/10/07
56	BP 4A Milestone No 1-All submittal Completed	0 days	Thu 10/19/06	Thu 10/19/06
57	CMU @ Concrete Footings to SOG & BW	64 days	Thu 12/14/06	Tue 3/13/07
58	4A Milestone No 2- Complete Area A CMU BW	0 days	Tue 3/13/07	Tue 3/13/07
59	Infill CMU @ Bearing Plates	3 days	Mon 4/2/07	Wed 4/4/07
60	Exterior Brick Veneer	23 days	Tue 4/10/07	Thu 5/10/07
61	4A Milestone No 3-Complete Area A Ext Brick Veneer	0 days	Thu 5/10/07	Thu 5/10/07
62	First Floor	44 days	Thu 3/29/07	Tue 5/29/07
63	Interior Non-Bearing Walls & CMU Chase	44 days	Thu 3/29/07	Tue 5/29/07
64	Area B (Media Center/Admin/Kindergarten Wing)	107 days	Wed 1/3/07	Fri 6/1/07
65	Building Envelope	107 days	Wed 1/3/07	Fri 6/1/07
66	CMU @ Wall Footings to SOG, BW & Shear Walls	64 days	Wed 1/3/07	Mon 4/2/07
67	4A Milestone No 4-Complete Area B CMU BW	0 days	Mon 4/2/07	Mon 4/2/07
68	Exterior Brick Veneer (Not Including Canopy)	18 days	Mon 4/30/07	Wed 5/23/07
69	Infill CMU @ Bear Plates & Columns @ Shear Walls	2 days	Fri 5/11/07	Mon 5/14/07
70	4A Milestone No 5-Complete Area B Brick Veneer	0 days	Fri 6/1/07	Fri 6/1/07
71	Area C (Two Story Classroom Wing)	163 days	Thu 12/21/06	Mon 8/6/07
72	Building Envelope	108 days	Thu 12/21/06	Mon 5/21/07
73	CMU @ Wall and Pit Footings to SOG	15 days	Thu 12/21/06	Wed 1/10/07
74	CMU Bearing/Stair/Elevator/Shear Wall to 17'-4"	9 days	Tue 3/13/07	Fri 3/23/07
75	Infill CMU @ SOD BP & Col @ Shear Walls on C1	3 days	Fri 4/13/07	Tue 4/17/07
76	Brick Veneer & Area A&C above Low Area B Roof	10 days	Mon 5/7/07	Fri 5/18/07
77	4A Milestone No 6-Complete Area C CMU BW	0 days	Wed 5/9/07	Wed 5/9/07
78	Infill CMU @ Roof BP & Col @ Shear Wall on C2	2 days	Fri 5/18/07	Mon 5/21/07
79	4A Milestone No 7-Complete Area C Ext Brick Veneer	0 days	Mon 5/21/07	Mon 5/21/07
80	First Floor	2 days	Fri 8/3/07	Mon 8/6/07
81	CMU Infill at Elevator Doors on First Floor	2 days	Fri 8/3/07	Mon 8/6/07
82	Second Floor	2 days	Fri 8/3/07	Mon 8/6/07
83	CMU Infill @ Elevator Door on Second Floor	2 days	Fri 8/3/07	Mon 8/6/07
84	4A Milestone No 8-Complete 4A Work	0 days	Mon 8/6/07	Mon 8/6/07
85	Structural Steel	181 days	Wed 11/29/06	Wed 8/8/07
86	Area A (Gym/Kitchen/Music Room)	111 days	Wed 11/29/06	Wed 5/2/07
87	Building Envelope	88 days	Wed 11/29/06	Fri 3/30/07
88	BP 5A Milestone No 1-All submittal Completed	0 days	Wed 11/29/06	Wed 11/29/06
89	Roof Joist and Metal Deck	10 days	Mon 3/19/07	Fri 3/30/07
90	5A Milestone No 2-Fab/Del/Erect Area A SS	0 days	Fri 3/30/07	Fri 3/30/07
91	First Floor	8 days	Mon 4/23/07	Wed 5/2/07
92	CMU Wall Supports & Install Roof Ladder	8 days	Mon 4/23/07	Wed 5/2/07
93	Area B (Media Center/Admin/Kindergarten Wing)	45 days	Tue 4/17/07	Mon 6/18/07
94	Building Envelope	45 days	Tue 4/17/07	Mon 6/18/07
95	Erect Steel Columns/Roof Joist/Metal Deck	14 days	Tue 4/17/07	Fri 5/4/07
96	Canopy Roof Deck	1 day	Mon 6/18/07	Mon 6/18/07
97	5A Milestone No 4-Fab/Del/Erect Area B SS	0 days	Mon 6/18/07	Mon 6/18/07
98	Area C (Two Story Classroom Wing)	94 days	Fri 3/30/07	Wed 8/8/07
99	Building Envelope	81 days	Fri 3/30/07	Mon 7/23/07
100	Erect Steel Columns/Stairs/2nd Floor Joist & Deck	10 days	Fri 3/30/07	Thu 4/12/07
101	5A Milestone No 3-Fab/Del/Erect Area C SS	0 days	Thu 4/12/07	Thu 4/12/07
102	Roof Joist/Metal Deck/Roof Stair	10 days	Wed 5/2/07	Tue 5/15/07
103	5A Milestone No 5-Complete 5A Work	0 days	Mon 7/23/07	Mon 7/23/07
104	Second Floor	2 days	Tue 8/7/07	Wed 8/8/07
105	Install Roof Ladders	2 days	Tue 8/7/07	Wed 8/8/07
106	General Works	294 days	Mon 9/4/06	Thu 10/18/07



Detailed Project Schedule
11/2/07

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

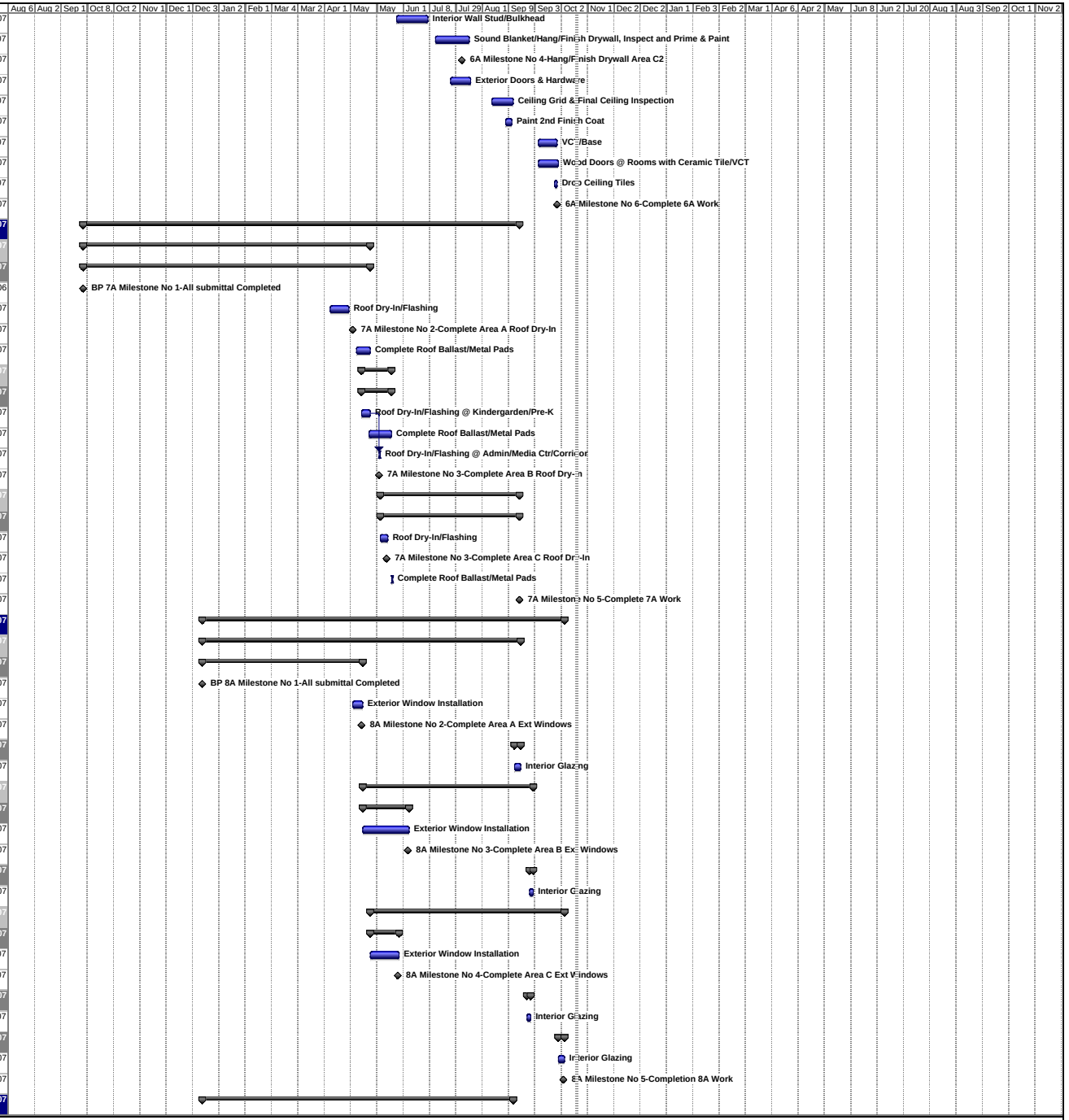


ID	Task Name	Duration	Start	Finish
107	**Area A (Gym/Kitchen/Music Room)**	**278 days**	**Mon 9/4/06**	**Wed 9/26/07**
108	**Building Envelope**	**216 days**	**Wed 11/29/06**	**Wed 9/26/07**
109	BP 6A Milestone No 1-All submittal Completed	0 days	Wed 11/29/06	Wed 11/29/06
110	Set HM Frames @ CMU BW & Parapit Blocking	35 days	Fri 1/12/07	Thu 3/1/07
111	Architectural Wall Louvers-All Areas	3 days	Mon 9/24/07	Wed 9/26/07
112	**First Floor**	**277 days**	**Mon 9/4/06**	**Tue 9/25/07**
113	Int. HM Door Frames & Temp Wood Doors @ Elec. Rm	29 days	Wed 3/28/07	Mon 5/7/07
114	Interior DWBulkhead Stud & Close-in Inspection	10 days	Tue 5/29/07	Mon 6/11/07
115	Hang/Finish DW and Bulkheads	12 days	Tue 6/12/07	Wed 6/27/07
116	Ceiling Grid	4 days	Mon 6/25/07	Thu 6/28/07
117	Paint 2nd Finish Coat	1 day	Fri 7/6/07	Fri 7/6/07
118	Exterior Doors & Hardware	24 days	Fri 7/20/07	Wed 8/22/07
119	Tile @ Kitchen & Bathrooms	21 days	Fri 7/20/07	Fri 8/17/07
120	Final Ceiling Inspection, Hang DW Ceiling & Drop Tiles	4 days	Wed 8/8/07	Mon 8/13/07
121	Toilet Compartments & Accessories	3 days	Mon 8/27/07	Wed 8/29/07
122	VCT Flooring/Base	5 days	Mon 9/4/06	Fri 9/8/06
123	Wood Gym Flooring	4 days	Thu 9/20/07	Tue 9/25/07
124	**Area B (Media Center/Admin/Kindergarten Wing)**	**139 days**	**Fri 3/23/07**	**Wed 10/3/07**
125	**Building Envelope**	**38 days**	**Fri 3/23/07**	**Tue 5/15/07**
126	Set HM Frames @ CMU Bearing Walls	2 days	Fri 3/23/07	Mon 3/26/07
127	Temporary Exterior Doors & Windows	21 days	Tue 4/17/07	Tue 5/15/07
128	**First Floor**	**107 days**	**Tue 5/8/07**	**Wed 10/3/07**
129	Layout Walls Interior HM Door Frames--South End	2 days	Tue 5/8/07	Wed 5/9/07
130	Interior Wall Stud Bulkhead	31 days	Fri 5/25/07	Fri 7/6/07
131	Layout Walls Interior HM Door Frames--North End	1 day	Mon 6/4/07	Mon 6/4/07
132	Finish Drywall & Paint 1st Coat	19 days	Fri 6/29/07	Wed 7/25/07
133	Exterior Doors & Hardware	23 days	Mon 7/23/07	Wed 8/22/07
134	6A Milestone No 3-Hang/Finish Drywall Area B	0 days	Wed 7/25/07	Wed 7/25/07
135	Ceiling Grid	2 days	Mon 8/6/07	Tue 8/7/07
136	Paint 2nd Finish Coat	3 days	Tue 8/14/07	Thu 8/16/07
137	Final Building Celing Inspection & Drop Tiles	28 days	Wed 8/15/07	Fri 9/21/07
138	Wood Doors & Hardware @ Rooms with Ceramic Tile	2 days	Fri 9/7/07	Mon 9/10/07
139	VCT/Base	5 days	Thu 9/13/07	Wed 9/19/07
140	Wood Doors & Hardware @ Rooms with VCT/Carpet	1 day	Tue 9/25/07	Tue 9/25/07
141	Carpet	1 day	Wed 10/3/07	Wed 10/3/07
142	**Area C**	**284 days**	**Mon 9/18/06**	**Thu 10/18/07**
143	**Building Envelope**	**150 days**	**Wed 2/28/07**	**Wed 9/26/07**
144	Set HM Door Frames @ CMU Bearing Walls	2 days	Wed 2/28/07	Thu 3/1/07
145	Temporary Exterior Wood Windows on 2nd Floor	1 day	Wed 5/30/07	Wed 5/30/07
146	Elevator Installation	23 days	Thu 7/26/07	Mon 8/27/07
147	6A Milestone No 5-Complete Elevator Install	0 days	Wed 9/26/07	Wed 9/26/07
148	**First Floor**	**265 days**	**Mon 9/18/06**	**Fri 9/21/07**
149	Layout Walls & Set Interior HM Door Frames	3 days	Mon 4/23/07	Wed 4/25/07
150	Wall Stud/Bulkhead & Inspection	35 days	Tue 4/24/07	Mon 6/11/07
151	Sound Blanket/Hang/Finish Drywall & Paint	17 days	Mon 6/18/07	Tue 7/10/07
152	6A Milestone No 2-Hang/Finish Drywall Area C1	0 days	Fri 7/6/07	Fri 7/6/07
153	Exterior Doors & Hardware	23 days	Mon 7/23/07	Wed 8/22/07
154	Paint 2nd Finish Coat	3 days	Fri 8/3/07	Tue 8/7/07
155	Wood Door Installation	19 days	Tue 8/28/07	Fri 9/21/07
156	VCT Base	12 days	Fri 8/31/07	Mon 9/17/07
157	Drop Ceiling Tiles	2 days	Mon 9/18/06	Tue 9/19/06
158	**Second Floor**	**97 days**	**Wed 6/6/07**	**Thu 10/18/07**
159	Layout Walls & Set Remaining HM Door Frame	5 days	Wed 6/6/07	Tue 6/12/07

Detailed Project Schedule
11/2/07

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary | Deadline

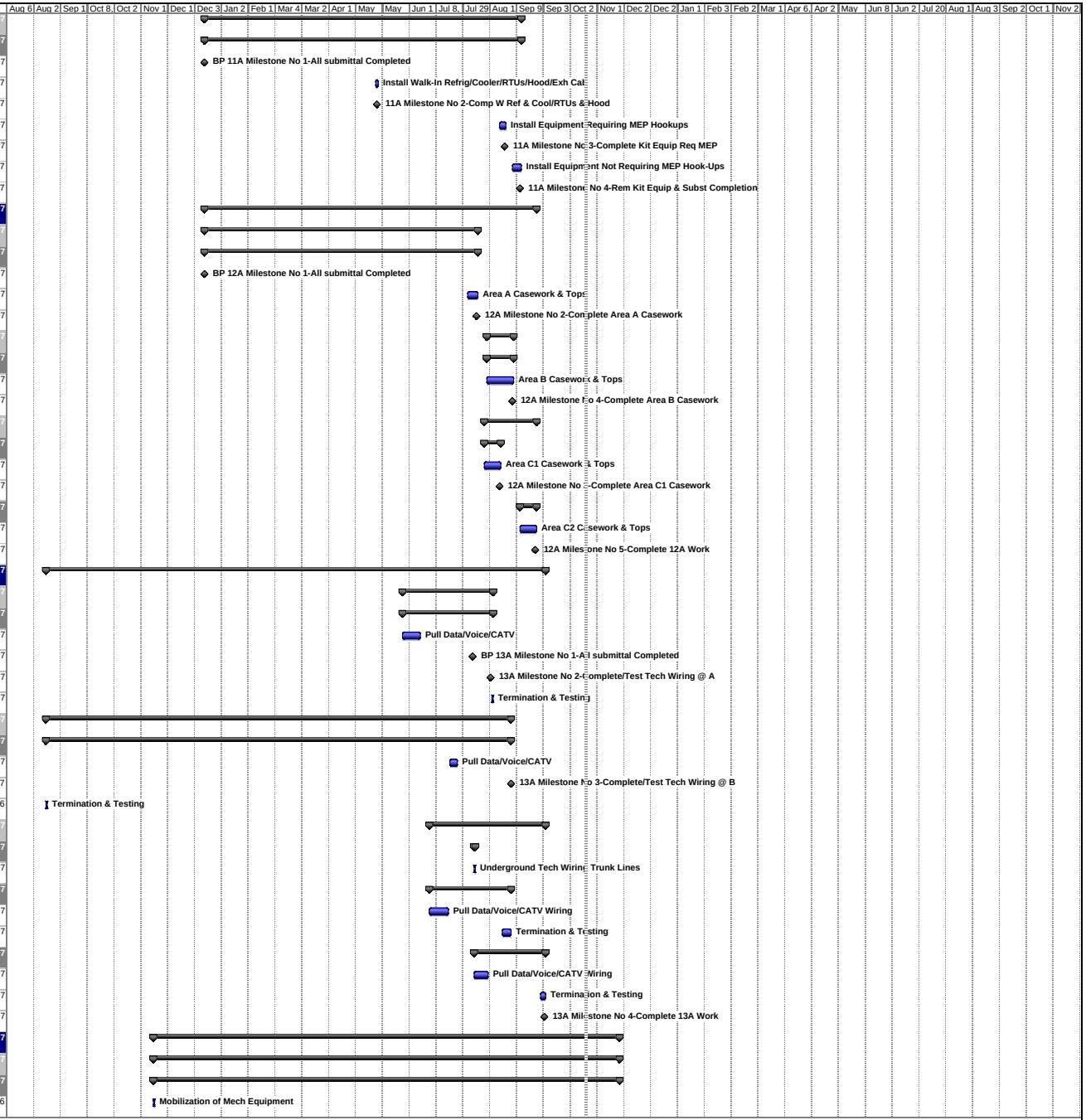
ID	Task Name	Duration	Start	Finish
160	Interior Wall Stud/Bulkhead	19 days	Tue 6/12/07	Fri 7/6/07
161	Sound Blanket/Hang/Finish Drywall, Inspect and Prime & Paint	19 days	Fri 7/13/07	Wed 8/8/07
162	6A Milestone No 4-Hang/Finish Drywall Area C2	0 days	Fri 8/3/07	Fri 8/3/07
163	Exterior Doors & Hardware	12 days	Wed 7/25/07	Thu 8/9/07
164	Ceiling Grid & Final Ceiling Inspection	13 days	Mon 8/27/07	Wed 9/12/07
165	Paint 2nd Finish Coat	3 days	Fri 9/7/07	Tue 9/11/07
166	VCT/Base	11 days	Wed 10/3/07	Wed 10/17/07
167	Wood Doors @ Rooms with Ceramic Tile/VCT	12 days	Wed 10/3/07	Thu 10/18/07
168	Drop Ceiling Tiles	2 days	Tue 10/16/07	Wed 10/17/07
169	6A Milestone No 6-Complete 6A Work	0 days	Thu 10/18/07	Thu 10/18/07
170	**Roofing**	**248 days**	**Thu 10/5/06**	**Tue 9/18/07**
171	**Area A (Gym/Kitchen/Music Room)**	**163 days**	**Thu 10/5/06**	**Mon 5/21/07**
172	**Building Envelope**	**163 days**	**Thu 10/5/06**	**Mon 5/21/07**
173	BP 7A Milestone No 1-All submittal Completed	0 days	Thu 10/5/06	Thu 10/5/06
174	Roof Dry-In/Flashing	11 days	Fri 4/20/07	Fri 5/4/07
175	7A Milestone No 2-Complete Area A Roof Dry-In	0 days	Tue 5/8/07	Tue 5/8/07
176	Complete Roof Ballast/Metal Pads	7 days	Fri 5/11/07	Mon 5/21/07
177	**Area B (Media Center/Admin/Kindergarten Wing)**	**18 days**	**Tue 5/15/07**	**Thu 6/7/07**
178	**Building Envelope**	**18 days**	**Tue 5/15/07**	**Thu 6/7/07**
179	Roof Dry-In/Flashing @ Kindergarden/Pre-K	5 days	Tue 5/15/07	Mon 5/21/07
180	Complete Roof Ballast/Metal Pads	14 days	Mon 5/21/07	Thu 6/7/07
181	Roof Dry-In/Flashing @ Admin/Media Ctr/Corridor	1 day	Tue 5/29/07	Tue 5/29/07
182	7A Milestone No 3-Complete Area B Roof Dry-In	0 days	Tue 5/29/07	Tue 5/29/07
183	**Area C (Two Story Classroom Wing)**	**79 days**	**Wed 5/30/07**	**Tue 9/18/07**
184	**Building Envelope**	**79 days**	**Wed 5/30/07**	**Tue 9/18/07**
185	Roof Dry-In/Flashing	4 days	Wed 5/30/07	Mon 6/4/07
186	7A Milestone No 3-Complete Area C Roof Dry-In	0 days	Mon 6/4/07	Mon 6/4/07
187	Complete Roof Ballast/Metal Pads	1 day	Fri 6/8/07	Fri 6/8/07
188	7A Milestone No 5-Complete 7A Work	0 days	Tue 9/18/07	Tue 9/18/07
189	**Windows**	**207 days**	**Mon 1/8/07**	**Tue 10/23/07**
190	**Area A (Gym/Kitchen/Music Room)**	**182 days**	**Mon 1/8/07**	**Tue 9/18/07**
191	**Building Envelope**	**92 days**	**Mon 1/8/07**	**Tue 5/15/07**
192	BP 8A Milestone No 1-All submittal Completed	0 days	Mon 1/8/07	Mon 1/8/07
193	Exterior Window Installation	6 days	Tue 5/8/07	Tue 5/15/07
194	8A Milestone No 2-Complete Area A Ext Windows	0 days	Tue 5/15/07	Tue 5/15/07
195	**First Floor**	**3 days**	**Fri 9/14/07**	**Tue 9/18/07**
196	Interior Glazing	3 days	Fri 9/14/07	Tue 9/18/07
197	**Area B (Media Center/Admin/Kindergarten Wing)**	**98 days**	**Wed 5/16/07**	**Fri 9/28/07**
198	**Building Envelope**	**27 days**	**Wed 5/16/07**	**Thu 6/21/07**
199	Exterior Window Installation	27 days	Wed 5/16/07	Thu 6/21/07
200	8A Milestone No 3-Complete Area B Ext Windows	0 days	Thu 6/21/07	Thu 6/21/07
201	**First Floor**	**3 days**	**Wed 9/26/07**	**Fri 9/28/07**
202	Interior Glazing	3 days	Wed 9/26/07	Fri 9/28/07
203	**Area C (Two Story Classroom Wing)**	**111 days**	**Tue 5/22/07**	**Tue 10/23/07**
204	**Building Envelope**	**17 days**	**Tue 5/22/07**	**Wed 6/13/07**
205	Exterior Window Installation	17 days	Tue 5/22/07	Wed 6/13/07
206	8A Milestone No 4-Complete Area C Ext Windows	0 days	Wed 6/13/07	Wed 6/13/07
207	**First Floor**	**3 days**	**Mon 9/24/07**	**Wed 9/26/07**
208	Interior Glazing	3 days	Mon 9/24/07	Wed 9/26/07
209	**Second Floor**	**3 days**	**Fri 10/19/07**	**Tue 10/23/07**
210	Interior Glazing	3 days	Fri 10/19/07	Tue 10/23/07
211	8A Milestone No 5-Completion 8A Work	0 days	Tue 10/23/07	Tue 10/23/07
212	**Kitchen Equipment**	**178 days**	**Mon 1/8/07**	**Wed 9/12/07**



Detailed Project Schedule
11/2/07

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary | Deadline

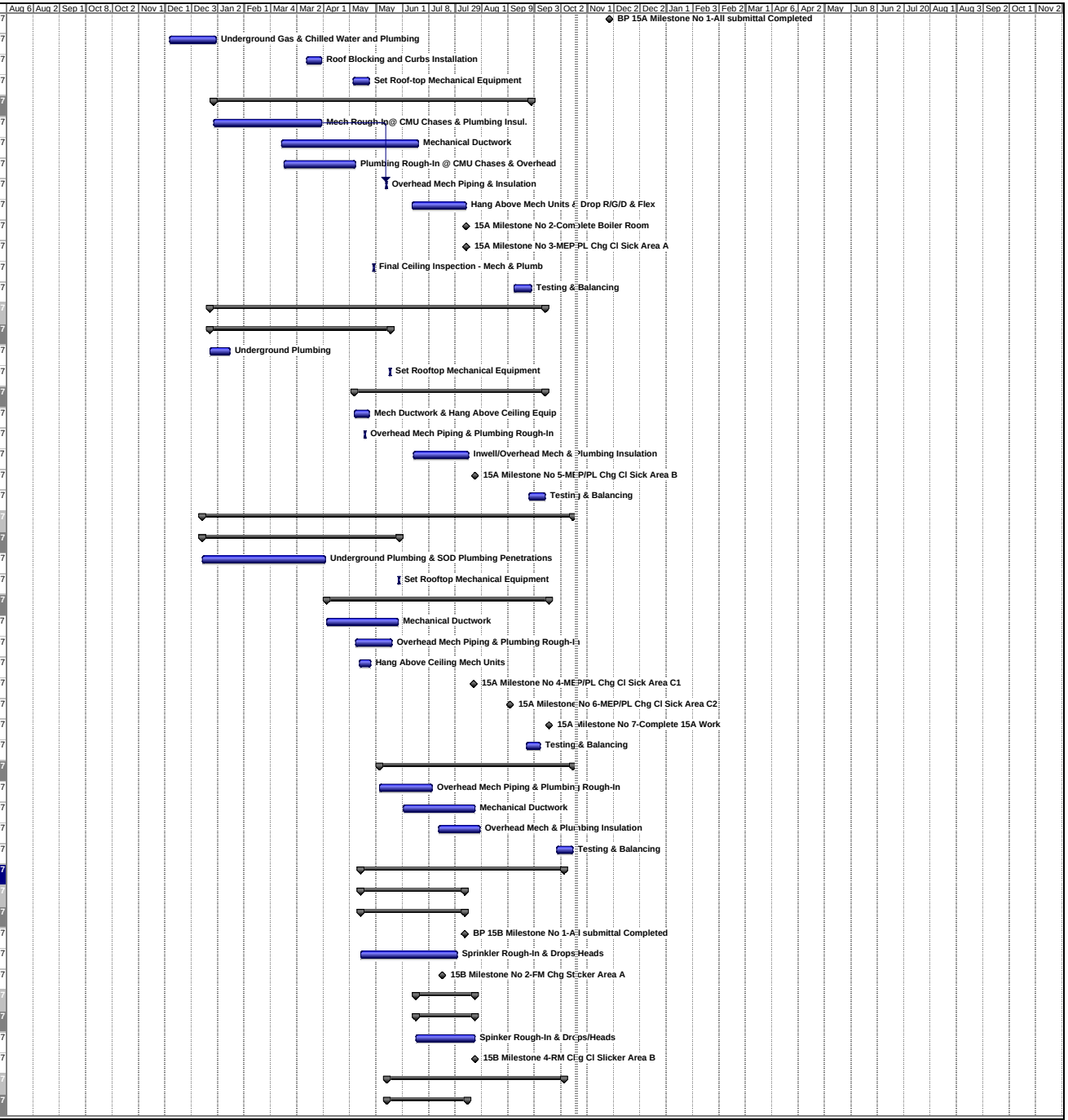
ID	Task Name	Duration	Start	Finish
213	Area A (Gym/Kitchen/Music Room)	178 days	Mon 1/8/07	Wed 9/12/07
214	First Floor	178 days	Mon 1/8/07	Wed 9/12/07
215	BP 11A Milestone No 1-All submittal Completed	0 days	Mon 1/8/07	Mon 1/8/07
216	Install Walk-In Refrig/Cooler/RTUs/Hood/Exh Cab	2 days	Tue 5/22/07	Wed 5/23/07
217	11A Milestone No 2-Comp W Ref & Cool/RTUs & Hood	0 days	Wed 5/23/07	Wed 5/23/07
218	Install Equipment Requiring MEP Hookups	5 days	Mon 8/27/07	Fri 8/31/07
219	11A Milestone No 3-Complete Kit Equip Req MEP	0 days	Fri 8/31/07	Fri 8/31/07
220	Install Equipment Not Requiring MEP Hook-Ups	5 days	Thu 9/6/07	Wed 9/12/07
221	11A Milestone No 4-Rem Kit Equip & Subst Completion	0 days	Wed 9/12/07	Wed 9/12/07
222	Casework	186 days	Mon 1/8/07	Mon 9/24/07
223	Area A (Gym/Kitchen/Music Room)	154 days	Mon 1/8/07	Thu 8/9/07
224	First Floor	154 days	Mon 1/8/07	Thu 8/9/07
225	BP 12A Milestone No 1-All submittal Completed	0 days	Mon 1/8/07	Mon 1/8/07
226	Area A Casework & Tops	6 days	Thu 8/2/07	Thu 8/9/07
227	12A Milestone No 2-Complete Area A Casework	0 days	Thu 8/9/07	Thu 8/9/07
228	Area B (Media Center/Admin/Kindergarten Wing)	15 days	Fri 8/17/07	Thu 9/6/07
229	First Floor	15 days	Fri 8/17/07	Thu 9/6/07
230	Area B Casework & Tops	15 days	Fri 8/17/07	Thu 9/6/07
231	12A Milestone No 4-Complete Area B Casework	0 days	Thu 9/6/07	Thu 9/6/07
232	Area C (Two Story Classroom Wing)	29 days	Wed 8/15/07	Mon 9/24/07
233	First Floor	9 days	Wed 8/15/07	Mon 8/27/07
234	Area C1 Casework & Tops	9 days	Wed 8/15/07	Mon 8/27/07
235	12A Milestone No 3-Complete Area C1 Casework	0 days	Mon 8/27/07	Mon 8/27/07
236	Second Floor	9 days	Wed 9/12/07	Mon 9/24/07
237	Area C2 Casework & Tops	9 days	Wed 9/12/07	Mon 9/24/07
238	12A Milestone No 5-Complete 12A Work	0 days	Mon 9/24/07	Mon 9/24/07
239	Technical Wiring	279 days	Wed 9/6/06	Mon 10/1/07
240	Area A (Gym/Kitchen/Music Room)	51 days	Tue 6/12/07	Tue 8/21/07
241	First Floor	51 days	Tue 6/12/07	Tue 8/21/07
242	Pull Data/Voice/CATV	10 days	Tue 6/12/07	Mon 6/25/07
243	BP 13A Milestone No 1-All submittal Completed	0 days	Mon 8/6/07	Mon 8/6/07
244	13A Milestone No 2-Complete/Test Tech Wiring @ A	0 days	Mon 8/20/07	Mon 8/20/07
245	Termination & Testing	1 day	Tue 8/21/07	Tue 8/21/07
246	Area B (Media Center/Admin/Kindergarten Wing)	260 days	Wed 9/6/06	Wed 9/5/07
247	First Floor	260 days	Wed 9/6/06	Wed 9/5/07
248	Pull Data/Voice/CATV	4 days	Thu 7/19/07	Tue 7/24/07
249	13A Milestone No 3-Complete/Test Tech Wiring @ B	0 days	Wed 9/5/07	Wed 9/5/07
250	Termination & Testing	1 day	Wed 9/6/06	Wed 9/6/06
251	Area C (Two Story Classroom Wing)	65 days	Tue 7/3/07	Mon 10/1/07
252	Building Envelope	1 day	Tue 8/7/07	Tue 8/7/07
253	Underground Tech Wiring Trunk Lines	1 day	Tue 8/7/07	Tue 8/7/07
254	First Floor	46 days	Tue 7/3/07	Tue 9/4/07
255	Pull Data/Voice/CATV Wiring	11 days	Tue 7/3/07	Tue 7/17/07
256	Termination & Testing	5 days	Wed 8/29/07	Tue 9/4/07
257	Second Floor	40 days	Tue 8/7/07	Mon 10/1/07
258	Pull Data/Voice/CATV Wiring	9 days	Tue 8/7/07	Fri 8/17/07
259	Termination & Testing	2 days	Fri 9/28/07	Mon 10/1/07
260	13A Milestone No 4-Complete 13A Work	0 days	Mon 10/1/07	Mon 10/1/07
261	Mechanical & Plumbing	261 days	Wed 11/29/06	Thu 11/29/07
262	Area A (Gym/Kitchen/Music Room)	261 days	Wed 11/29/06	Thu 11/29/07
263	Building Envelope	261 days	Wed 11/29/06	Thu 11/29/07
264	Mobilization of Mech Equipment	1 day	Wed 11/29/06	Wed 11/29/06



Detailed Project Schedule
11/2/07

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary | Deadline

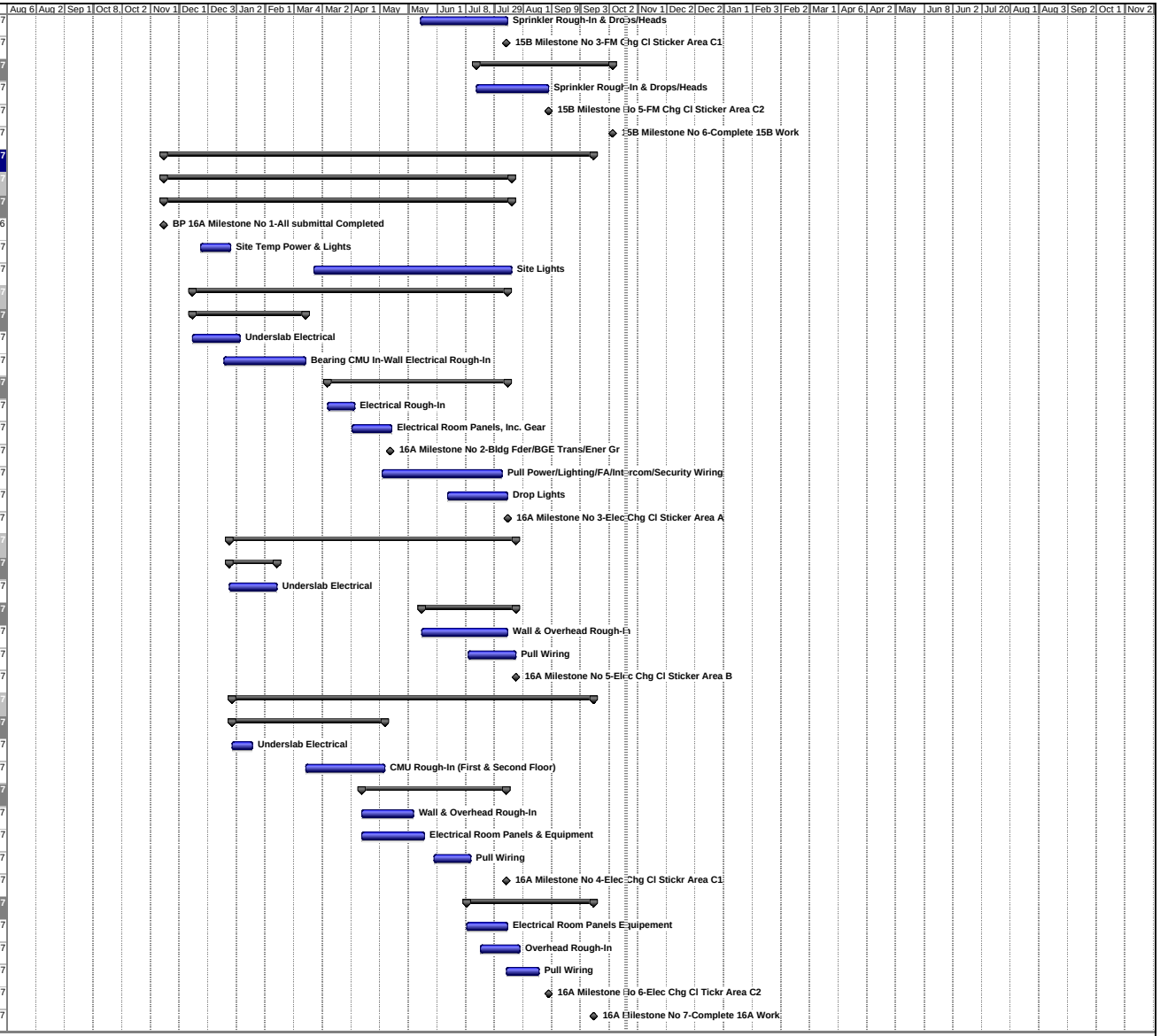
ID	Task Name	Duration	Start	Finish
265	BP 15A Milestone No 1-All submittal Completed	0 days	Thu 11/29/07	Thu 11/29/07
266	Underground Gas & Chilled Water and Plumbing	27 days	Thu 12/14/06	Fri 1/19/07
267	Roof Blocking and Curbs Installation	10 days	Mon 4/2/07	Fri 4/13/07
268	Set Roof-top Mechanical Equipment	9 days	Wed 5/9/07	Mon 5/21/07
269	First Floor	181 days	Thu 1/18/07	Thu 9/27/07
270	Mech Rough-In@ CMU Chases & Plumbing Insul.	62 days	Thu 1/18/07	Fri 4/13/07
271	Mechanical Ductwork	79 days	Tue 3/13/07	Fri 6/29/07
272	Plumbing Rough-In @ CMU Chases & Overhead	41 days	Thu 3/15/07	Thu 5/10/07
273	Overhead Mech Piping & Insulation	1 day	Mon 6/4/07	Mon 6/4/07
274	Hang Above Mech Units & Drop R/G/D & Flex	31 days	Mon 6/25/07	Mon 8/6/07
275	15A Milestone No 2-Complete Boiler Room	0 days	Tue 8/7/07	Tue 8/7/07
276	15A Milestone No 3-MEP/PL Chg Cl Sick Area A	0 days	Tue 8/7/07	Tue 8/7/07
277	Final Ceiling Inspection - Mech & Plumb	1 day	Fri 5/25/07	Fri 5/25/07
278	Testing & Balancing	10 days	Fri 9/14/07	Thu 9/27/07
279	Area B (Media Center/Admin/Kintergarten Wing)	191 days	Mon 1/15/07	Mon 10/8/07
280	Building Envelope	104 days	Mon 1/15/07	Thu 6/7/07
281	Underground Plumbing	12 days	Mon 1/15/07	Tue 1/30/07
282	Set Rooftop Mechanical Equipment	1 day	Thu 6/7/07	Thu 6/7/07
283	First Floor	108 days	Thu 5/10/07	Mon 10/8/07
284	Mech Ductwork & Hang Above Ceiling Equip	8 days	Thu 5/10/07	Mon 5/21/07
285	Overhead Mech Piping & Plumbing Rough-In	1 day	Fri 5/18/07	Fri 5/18/07
286	Inwell/Overhead Mech & Plumbing Insulation	32 days	Tue 6/26/07	Wed 8/8/07
287	15A Milestone No 5-MEP/PL Chg Cl Sick Area B	0 days	Tue 8/14/07	Tue 8/14/07
288	Testing & Balancing	9 days	Wed 9/26/07	Mon 10/8/07
289	Area C (Two Story Classroom Wing)	211 days	Tue 1/9/07	Tue 10/30/07
290	Building Envelope	113 days	Tue 1/9/07	Thu 6/14/07
291	Underground Plumbing & SOD Plumbing Penetrations	70 days	Tue 1/9/07	Mon 4/16/07
292	Set Rooftop Mechanical Equipment	1 day	Thu 6/14/07	Thu 6/14/07
293	First Floor	127 days	Wed 4/18/07	Fri 10/12/07
294	Mechanical Ductwork	41 days	Wed 4/18/07	Wed 6/13/07
295	Overhead Mech Piping & Plumbing Rough-In	21 days	Fri 5/11/07	Fri 6/8/07
296	Hang Above Ceiling Mech Units	7 days	Mon 5/14/07	Tue 5/22/07
297	15A Milestone No 4-MEP/PL Chg Cl Sick Area C1	0 days	Mon 8/13/07	Mon 8/13/07
298	15A Milestone No 6-MEP/PL Chg Cl Sick Area C2	0 days	Tue 9/11/07	Tue 9/11/07
299	15A Milestone No 7-Complete 15A Work	0 days	Fri 10/12/07	Fri 10/12/07
300	Testing & Balancing	9 days	Mon 9/24/07	Thu 10/4/07
301	Second Floor	110 days	Wed 5/30/07	Tue 10/30/07
302	Overhead Mech Piping & Plumbing Rough-In	30 days	Wed 5/30/07	Tue 7/10/07
303	Mechanical Ductwork	41 days	Mon 6/18/07	Mon 8/13/07
304	Overhead Mech & Plumbing Insulation	25 days	Mon 7/16/07	Fri 8/17/07
305	Testing & Balancing	9 days	Thu 10/18/07	Tue 10/30/07
306	Sprinklers	116 days	Tue 5/15/07	Wed 10/24/07
307	Area A (Gym/Kitchen/Music Room)	59 days	Tue 5/15/07	Mon 8/6/07
308	Fist Floor	59 days	Tue 5/15/07	Mon 8/6/07
309	BP 15B Milestone No 1-All submittal Completed	0 days	Mon 8/6/07	Mon 8/6/07
310	Sprinkler Rough-In & Drops/Heads	55 days	Tue 5/15/07	Mon 7/30/07
311	15B Milestone No 2-FM Chg Sticker Area A	0 days	Thu 7/19/07	Thu 7/19/07
312	Area B (Media Center/Admin/Kintergarten Wing)	33 days	Thu 6/28/07	Tue 8/14/07
313	First Floor	33 days	Thu 6/28/07	Tue 8/14/07
314	Spinker Rough-In & Drops/Heads	33 days	Thu 6/28/07	Mon 8/13/07
315	15B Milestone 4-RM Chg Cl Slicker Area B	0 days	Tue 8/14/07	Tue 8/14/07
316	Area C (Two Story Classroom Wing)	101 days	Tue 6/5/07	Wed 10/24/07
317	First Floor	46 days	Tue 6/5/07	Tue 8/7/07



Detailed Project Schedule
11/2/07

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

ID	Task Name	Duration	Start	Finish
318	Sprinkler Rough-In & Drops/Heads	46 days	Tue 6/5/07	Tue 8/7/07
319	15B Milestone No 3-FM Chg Cl Sticker Area C1	0 days	Tue 8/7/07	Tue 8/7/07
320	**Second Floor**	**72 days**	**Mon 7/16/07**	**Wed 10/24/07**
321	Sprinkler Rough-In & Drops/Heads	39 days	Mon 7/16/07	Thu 9/6/07
322	15B Milestone No 5-FM Chg Cl Sticker Area C2	0 days	Fri 9/7/07	Fri 9/7/07
323	15B Milestone No 6-Complete 15B Work	0 days	Wed 10/24/07	Wed 10/24/07
324	**Electrical**	**225 days**	**Wed 11/29/06**	**Wed 10/10/07**
325	**Site Work**	**183 days**	**Wed 11/29/06**	**Fri 8/10/07**
326	**Building Envelope**	**183 days**	**Wed 11/29/06**	**Fri 8/10/07**
327	BP 16A Milestone No 1-All submittal Completed	0 days	Wed 11/29/06	Wed 11/29/06
328	Site Temp Power & Lights	16 days	Tue 12/26/06	Tue 1/16/07
329	Site Lights	105 days	Mon 3/19/07	Fri 8/10/07
330	**Area A (Gym/Kitchen/Music Room)**	**165 days**	**Wed 12/20/06**	**Wed 8/8/07**
331	**Building Envelope**	**59 days**	**Wed 12/20/06**	**Mon 3/12/07**
332	Underslab Electrical	25 days	Wed 12/20/06	Tue 1/23/07
333	Bearing CMU In-Wall Electrical Rough-In	42 days	Fri 1/12/07	Mon 3/12/07
334	**First Floor**	**94 days**	**Thu 3/29/07**	**Wed 8/8/07**
335	Electrical Rough-In	14 days	Thu 3/29/07	Tue 4/17/07
336	Electrical Room Panels, Inc. Gear	21 days	Mon 4/16/07	Mon 5/14/07
337	16A Milestone No 2-Bldg Fder/BGE Trans/Ener Gr	0 days	Mon 5/14/07	Mon 5/14/07
338	Pull Power/Lighting/FA/Intercom/Security Wiring	64 days	Tue 5/8/07	Fri 8/3/07
339	Drop Lights	32 days	Mon 6/25/07	Tue 8/7/07
340	16A Milestone No 3-Elec Chg Cl Sticker Area A	0 days	Wed 8/8/07	Wed 8/8/07
341	**Area B (Media Center/Admin/Kintergarten Wing)**	**150 days**	**Tue 1/16/07**	**Tue 8/14/07**
342	**Building Envelope**	**25 days**	**Tue 1/16/07**	**Mon 2/19/07**
343	Underslab Electrical	25 days	Tue 1/16/07	Mon 2/19/07
344	**First Floor**	**49 days**	**Wed 6/6/07**	**Tue 8/14/07**
345	Wall & Overhead Rough-In	45 days	Wed 6/6/07	Tue 8/7/07
346	Pull Wiring	25 days	Tue 7/10/07	Mon 8/13/07
347	16A Milestone No 5-Elec Chg Cl Sticker Area B	0 days	Tue 8/14/07	Tue 8/14/07
348	**Area C (Two Story Classroom Wing)**	**189 days**	**Thu 1/18/07**	**Wed 10/10/07**
349	**Building Envelope**	**80 days**	**Thu 1/18/07**	**Wed 5/9/07**
350	Underslab Electrical	11 days	Thu 1/18/07	Thu 2/1/07
351	CMU Rough-In (First & Second Floor)	42 days	Tue 3/13/07	Wed 5/9/07
352	**First Floor**	**76 days**	**Mon 4/23/07**	**Tue 8/7/07**
353	Wall & Overhead Rough-In	28 days	Mon 4/23/07	Wed 5/30/07
354	Electrical Room Panels & Equipment	34 days	Mon 4/23/07	Thu 6/7/07
355	Pull Wiring	19 days	Fri 6/15/07	Wed 7/11/07
356	16A Milestone No 4-Elec Chg Cl Stickr Area C1	0 days	Tue 8/7/07	Tue 8/7/07
357	**Second Floor**	**67 days**	**Mon 7/9/07**	**Wed 10/10/07**
358	Electrical Room Panels Equipement	22 days	Mon 7/9/07	Tue 8/7/07
359	Overhead Rough-In	21 days	Thu 7/19/07	Thu 8/16/07
360	Pull Wiring	18 days	Tue 8/7/07	Thu 8/30/07
361	16A Milestone No 6-Elec Chg Cl Tickr Area C2	0 days	Fri 9/7/07	Fri 9/7/07
362	16A Milestone No 7-Complete 16A Work	0 days	Wed 10/10/07	Wed 10/10/07



Appendix C

LEED for Schools 2007
Registered Project Checklist

Project Name: Pasadena Elementary School
Project Address:

Yes	?	No			
8				**Sustainable Sites**	**16** Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
Y			Prereq 2	**Environmental Site Assessment**	Required
1			Credit 1	**Site Selection**	1
			Credit 2	**Development Density & Community Connectivity**	1
			Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
			Credit 4.2	**Alternative Transportation**, Bicycle Use	1
			Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel-Efficient Vehicles	1
			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1			Credit 5.1	**Site Development,** Protect or Restore Habitat	1
1			Credit 5.2	**Site Development,** Maximize Open Space	1
			Credit 6.1	**Stormwater Design,** Quantity Control	1
			Credit 6.2	**Stormwater Design,** Quality Control	1
1			Credit 7.1	**Heat Island Effect,** Non-Roof	1
1			Credit 7.2	**Heat Island Effect,** Roof	1
1			Credit 8	**Light Pollution Reduction**	1
1			Credit 9	**Site Master Plan**	1
			Credit 10	**Joint Use of Facilities**	1

Yes	?	No			
2				**Water Efficiency**	7 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
			Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
			Credit 3.2	**Water Use Reduction**, 30% Reduction	1
			Credit 3.3	**Water Use Reduction,** 40% Reduction	1
			Credit 4	**Process Water Use Reduction,** 20% Reduction	1

6				**Energy & Atmosphere**	**17** Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
2			Credit 1	**Optimize Energy Performance (2 pt minimum)**	2 to 10
				14% New Buildings or 7% Existing Building Renovations	2
				17.5% New Buildings or 10.5% Existing Building Renovations	3
				21% New Buildings or 14% Existing Building Renovations	4
				24.5% New Buildings or 17.5% Existing Building Renovations	5
				28% New Buildings or 21% Existing Building Renovations	6
				31.5% New Buildings or 24.5% Existing Building Renovations	7
				35% New Buildings or 28% Existing Building Renovations	8
				38.5% New Buildings or 31.5% Existing Building Renovations	9
				42% New Buildings or 35% Existing Building Renovations	10
			Credit 2	**On-Site Renewable Energy**	1 to 3
				2.5% Renewable Energy	1
				7.5% Renewable Energy	2
				12.5% Renewable Energy	3
1			Credit 3	**Enhanced Commissioning**	1
1			Credit 4	**Enhanced Refrigerant Management**	1
1			Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

continued…

Yes	?	No			
8				**Materials & Resources**	**13** Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
1			Credit 1.1	**Building Reuse,** Maintain 75% of Existing Walls, Floors & Roof	1
			Credit 1.2	**Building Reuse**, Maintain 95% of Existing Walls, Floors & Roof	1
			Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
1			Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
1			Credit 3.1	**Materials Reuse**, 5%	1
1			Credit 3.2	**Materials Reuse**,10%	1
			Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
			Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
1			Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regionally	1
1			Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regionally	1
			Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1
Yes	?	No			
5				**Indoor Environmental Quality**	**20** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
Y			Prereq 3	**Minimum Acoustical Performance**	Required
			Credit 1	**Outdoor Air Delivery Monitoring**	1
			Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4	**Low-Emitting Materials**	1 to 4
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
			Credit 6.1	**Lighting System Design & Controllability**	1
			Credit 6.2	**Thermal Comfort,** Controllability	1
			Credit 7.1	**Thermal Comfort**, Design	1
			Credit 7.2	**Thermal Comfort**, Verification	1
1			Credit 8.1	**Daylight & Views,** Daylighting	1 to 3
				1 75% of classrooms (*required for either points below)*	1
				90% of classrooms	2
				75% of other spaces	3
			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
1			Credit 9	**Enhanced Acoustical Performance**	1 to 2
			Credit 10	**Mold Prevention**	1
Yes	?	No			
	2			**Innovation & Design Process**	6 Points
			Credit 1.1	**Innovation in Design**: Provide Specific Title	1
			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
			Credit 1.3	**Innovation in Design**: Provide Specific Title	1
			Credit 1.4	**Innovation in Design**: Provide Specific Title	1
	1		Credit 2	**LEED® Accredited Professional**	1
	1		Credit 3	**School as a Teaching Tool**	1
Yes	?	No			
29	2			**Project Totals (pre-certification estimates)**	**79** Points

Certified: 29-36 points, **Silver:** 37-43 points, **Gold:** 44-57 points, **Platinum:** 58-79 points

Appendix D

Sedum album

Botanical Name: Sedum album
Hardiness Zone: 4
Heat Zone: 3-8
Flower Color: White
Bloom Time: May-June
Foliage Color: Green
Winter Interest: No
Height: 4”
Spread: 12”
Drought Tolerance: Very High
Moisture Tolerance: No
Shade Tolerance: No
N. American Native: No

Sedum floriferum ‘Weihenstephaner Gold’

Botanical Name: Sedum floriferum ‘Weihenstephaner Gold’
Hardiness Zone: 3
Heat Zone: 3-7
Flower Color: Yellow
Bloom Time: July-August
Foliage Color: Green
Winter Interest: Yes
Height: 4”
Spread: 10”
Drought Tolerance: Very High
Moisture Tolerance: No
Shade Tolerance: No
N. American Native: No

An excellent groundcover for roofs and for at grade landscaping known for its floriferous flower habit.

Sedum Reflexum
Botanical Name: Sea Gold
Hardiness Zone:
Heat Zone:
Flower Color:
Bloom Time:
Foliage Color: Winter Interest: yes
Height: 3”
Spread: 12”
Drought Tolerance:
Moisture Tolerant:
Shade Tolerant:
N. American Native:

Sedum kamtschaticum

Botanical Name: Sedum kamtschaticum
Hardiness Zone: 4
Heat Zone: 3-8
Flower Color: Yellow
Bloom Time: June-July
Foliage Color: Green
Winter Interest: No
Height: 6”
Spread: 10”
Drought Tolerance: Very High
Moisture Tolerance: Yes
Shade Tolerance: Yes
N. American Native: No

A somewhat taller and fleshy Sedum its remarkably tough and drought tolerant plant for its size.

Sedum reflexum

Botanical Name: Sedum reflexum
Hardiness Zone: 4
Heat Zone: 3-7
Flower Color: Yellow
Bloom Time: June-July
Foliage Color: Blue
Winter Interest: No
Height: 4”
Spread: 8”
Drought Tolerance: Very High
Moisture Tolerance: No
Shade Tolerance: No
N. American Native: No

Sedum reflexum looks like a little Blue Spruce tree. It gives a nice touch of blue/grey on the roof. Many other choices in the rupestre group can give a similar look.

Sedum sexangulare

Botanical Name: Sedum sexangulare
Hardiness Zone: 4
Heat Zone: 3-7
Flower Color: Yellow
Bloom Time: June-July
Foliage Color: Green
Winter Interest: Yes
Height: 4”
Spread: 8”
Drought Tolerance: Very High
Moisture Tolerance: No
Shade Tolerance: Yes
N. American Native: No

Very similar in appearance to Sedum acre, but a much tougher plant. Performs equally well in full sun or in shade.

Sedum spurium ‘Fuldaglut‘

Botanical Name: Sedum spurium ‘Fuldaglut‘
Hardiness Zone: 4
Heat Zone: 3-7
Flower Color: Pink
Bloom Time: September-October
Foliage Color: Green
Winter Interest: Yes
Height: 6”
Spread: 8”
Drought Tolerance: Very High
Moisture Tolerance: Yes
Shade Tolerance: Yes
N. American Native: No

One of the red foliage Sedum spuriums. The most reliable from our experience. Also give Sedum spurium 'Voodoo' a look.

Sedum spurium ‘John Creech’

Botanical Name: Sedum spurium ‘John Creech’
Hardiness Zone: 5
Heat Zone: 3-7
Flower Color: Pink
Bloom Time: July-August
Foliage Color: Green
Winter Interest: No
Height: 4”
Spread: 10”
Drought Tolerance: Very High
Moisture Tolerance: Yes
Shade Tolerance: Yes
N. American Native: No

A nice low growing habit make this spurium a nice selection.

Appendix E

The following are product specifications that were taken directly from the manufacturer's website: http://www.solarilluminations.com/

SL01 Solar 'High-Lux' Street Light (Complete With 20', 26' or 33' Pole)
TECHNICAL SPECIFICATIONS

GENERAL
Operating voltage is 24 v. DC.
Operating temperature -40 deg. F ~ 125 deg. F.
Special control system to prevent over-charging and over-discharging.
Power consumption of the 744 LED system is 24v / 1.6A / 38W
Power consumption of the 972 LED system is 24 v / 2.1A / 50W
Generally, approximately 5 hours of strong direct sunshine will enable a full charge.
Illumination time is up to 12 hours or more, generally dusk to dawn.
Typically dusk to dawn illumination in most geographic locations.
Several successive cloudy or alternating overcast days typically will not affect illumination time.
A photocell (light sensor) controls automatic on and off illumination, when required.

BATTERY CAPACITY
Two 12 v. DC lead acid or GEL type batteries
Battery capacity is subject to the specification of the system.
Battery capacity is from 100 Amp/Hr to 120 Amp/Hr. each battery.
Battery approval - UL Listed.
Battery type is rechargeable, maintenance free, sealed lead acid or GEL type.
Battery dimensions vary subject to battery capacity.
Battery weight will vary subject to battery capacity.
Typical battery life is approximately 3-4 years subject to environmental factors.
Over charge and over discharge protection system.
Each battery voltage maintained at or below 14.2 v. DC maximum and at or above 11 v. DC.
Each battery charge voltage is programmed to 16.9 v. DC.
The size of the solar panel will affect the capacity of the battery required.
The amount of LED's within the lamp head will affect the capacity of the battery required.

SOLAR PANEL
Highly efficient polycrystalline solar panel made by Sharp, in Japan.
UL Listed & IEC approved.
Aluminum frame with anti-aging and encapsulated.
Low reflecting tempered glass.
Wattage of solar panel is subject to the specification of the system
Wattage available from 140w to 290w.
The 140w solar panel is rated at 34v / 4.2A.
The 180w solar panel is rated at 34v / 5.3A.
Typical solar panel life is approximately 15-20 years subject to environmental factors.
The geographic location of the street light will affect the size/wattage of the solar panel required.
The amount of LED's within the lamp head will affect the size/wattage of the solar panel required.

LAMP UNIT (LIGHT HEAD)
Fitted with 744 to 972 LED's (subject to desired specifications).

All LED's are white. Amber or white/amber or other LED color temperatures possible, via special order only and at extra cost.
Each LED has a light output of greater than 8000 mcd and approx. 6 Lux (Lumens per square metre).
Each LED is rated at 3v dc and 15mA.
744 LED lamp provides approx. 4500 Lux (Lumens per square metre) or approx. 358 Candela.
972 LED lamp provides approx. 6000 Lux (Lumens per square metre) or approx. 517 Candela.
Using a 20' (6 metre) pole, average light pattern will provide approximately 40 Lux (Lumens per square metre) or 3.7 fc/ftc.
Using a 26' (8 metre) pole, average light pattern will provide approximately 30 Lux (Lumens per square metre) or 2.7 fc/ftc.
Using a 33' (10 metre) pole, light pattern will provide approximately 20 Lux (Lumens per square metre) or 1.7 fc/ftc.
744 LED lamp is recommended for 20' (6 metre) pole, but LED quantity can be increased or decreased by special order.
744 or 972 LED lamp is recommended for 26' (8 metre) pole, but LED quantity can be increased or decreased by special order.
972 LED lamp is recommended for 33' (10 metre) pole, but LED quantity can be increased or decreased by special order.
Other LED quantities within the lamp are available by special order.
Polarity protected circuitry.
LED life is typically 100,000 hours or equal to about 22 years.
No bulb changes unlike other street lights.
Removable LED circuit board with easy plug-in connections.
Fixture attaches to the arm which in turn attaches to the post or pole.
Silver/gray color finish.
Custom colors by special order only.

ARM
Galvanized steel arm to accommodate the lamp unit (light head).
Attaches to the post or pole.
Can be ordered to attach to an existing post, pole or for wall or building mount.
Silver/gray color finish.
Custom colors by special order only.

POST / POLE
Galvanized steel pole with base unit to enable secure installation.
Fixing bolts for base not included.
Pole height available in several choices, approximately 20', 26', 33' etc. (6m, 8m, 10m etc.)
Custom height pole by special order only.
Silver/gray color finish.
Custom colors by special order only.

BATTERY BOX
Galvanized steel battery box will accommodate the rechargeable battery.
Welded anchor plates or pre-drilled holes to enable secure installation.
Silver/gray color finish.
Battery box is approx. 21" x 15" x 8" (LxWxD).
Custom colors by special order only.

INTERCONNECTING CABLING
Connection wiring between the battery box, solar panel and lamp unit is included.

PHOTOMETRICS
744 LED lamp at 20' (6 Metres)
4464 Lumens at source, approximately.
Approximate Lux distribution:
At the base of the 20' (6 Metre) pole, 1 metre forward = 47 Lux.
2 metres forward =49 Lux, 3 metres forward =46 Lux, 4 metres forward =40 Lux, 5 metres forward =33 Lux, 6 metres forward =25 Lux, 7 metres forward =14 Lux.
At the base of the 20' (6 Metre) pole, 1 metre to the left or 1 metre to the right = 42 Lux.
2 metres left/right =37 Lux, 3 metres left/right =27 Lux, 4 metres left/right =15 Lux, 5 metres left/right =12 Lux, 6 metres left/right =10 Lux, 7 metres left/right =4 Lux.
At the base of the 20' (6 Metre) pole, 1 metre to the rear = 38 Lux.
2 metres rear =32 Lux, 3 metres rear =26 Lux, 4 metres rear = 20 Lux.

972 LED lamp at 26' (8 Metres)
5832 Lumens at source, approximately.
Approximate Lux distribution:
At the base of the 26' (8 Metre) pole, 1 metre forward = 38 Lux.
2 metres forward =37 Lux, 3 metres forward =32 Lux, 4 metres forward =32 Lux, 5 metres forward =19 Lux, 6 metres forward =16 Lux, 7 metres forward =14 Lux.
At the base of the 26' (8 Metre) pole, 1 metre to the left or 1 metre to the right = 32 Lux.
2 metres left/right =26 Lux, 3 metres left/right =18 Lux, 4 metres left/right =16 Lux, 5 metres left/right =13 Lux, 6 metres left/right =9 Lux, 7 metres left/right =6 Lux, 8 metres left/right =4 Lux.
At the base of the 26' (8 Metre) pole, 1 metre to the rear = 38 Lux.
2 metres rear =32 Lux, 3 metres rear =26 Lux, 4 metres rear = 16 Lux.

ORDERING
This is a 'special order' product and our special order Terms, Conditions & Policies apply.
If product is in stock order can be released within approximately 5 business days.
If product is not in stock, order can be released within approximately 60-90 business days.
For smaller orders, 100% payment must be made in advance, at time of order and is non-refundable.
For larger orders, payment may be made as a 50% non-refundable deposit with the 50% balance payment must be paid when order is ready to ship.
This product is non-returnable unless faulty during the warranty period. In such circumstances only the faulty part need be returned for repair or replacement only. No refunds. All sales are final.

QUALITY ASSURED
This street light is manufactured in a 'Quality Assured' facility to high standards and accredited with the internationally recognised standard BS.EN.ISO9001:2000

WARRANTY/GUARANTEE
One year limited warranty against manufacturing defects and/or failure (excluding rechargeable battery, if supplied).
Warranty/guarantee excludes deliberate and/or accidental damage. See our general Terms, Conditions & Policies for more information.

INSTALLATION
Installation guide included.
Upon curbside delivery, installation is entirely at the risk of the customer and/or the customer's appointed installer.

SERVICE/MAINTENANCE
Service & maintenance is entirely at the risk of the customer and/or the customer's appointed servicer/maintainer.
Generally, Solar Illuminations, carries all necessary spare parts to allow the servicing and maintenance of this product for the foreseeable future.

SPECIAL FACTORY ORDER
It must be noted that if this product is not in stock at our warehouse and/or is confirmed as a 'special factory order', then an order processing time of 60-120 business days must be allowed for the order to be processed, manufactured and shipped. For an estimated supply timeframe or for an availability status you must contact us first. If you do not contact us before ordering then you must allow for order processing time. If the product is confirmed as 'in stock' then the order is usually processed and shipped within 7-14 business days.

Time length of night time illumination is estimated and subject to various factors including geographic location, seasons, weather conditions & location of product etc.
Shorter illumination time due to one or more of the above factors does not define the fixture as being defective or define the fixture as being advertised incorrectly.
We advertise and supply our solar lights to customers all over the world are therefore, naturally, we are unable to guarantee the nightly illumination time as it can vary and any time stated is quoted as 'up to' x amount hours.
Minor errors & omissions must be accepted.
Although unlikely, we reserve the right to supply this product with any minor alterations or minor changes to the specifications (shown above by text description or by photographs) due to different supplies or product batches received, incorporating such product changes made by the manufacturer, without further notice.
Descriptions, specifications and photographs are updated regularly but may not be current when minor changes to a product have only recently been made.
All solar lights must be used in a completely dark location at night time otherwise they may not illuminate.
Nearby strong lighting sources or ambient lighting may affect the operation of a solar light. This does not define the fixture as being defective.
Descriptions, specifications and photographs are updated regularly but may not be current when minor changes to a product have only recently been made.