Final Report

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Silverado Senior Living
Brookfield, WI

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Abstract

Silverado Senior Living

Brookfield, WI

General Information

Project Cost: 9.2 Million

Size: 45,230 Gross Square Feet

Single Story

Construction Dates: 9/12 – 9/13

Project Delivery: Design Bid Build

Project Team

Owner: Silverado Properties, LLC.

GC: Hunzinger Construction Co.

Epstein Uhen Architects

Civil: JSD Professional Services, Inc.

Structural: Pierce Engineers, Inc.

MEP: Matrix Group Engineering Consultants

Landscape: R.A. Smith National, Inc.

Architecture

- Assisted living facility with interior courtyard
- Natural stone thin veneer
- Suburban landscape
- 50 sleeping units
- 2 bistros with adjacent dining rooms
- Solarium
- Fiber cement siding

Structural

- Wood frame construction
- Shop fabricated truss system
- Interior shear walls
- 3000psi reinforced concrete footings
- 5" SOG on 6" sub-base poured in winter

Electrical

- 208Y/120 Volt, 1600 Amp MSB
- 3 Phase, 4 Wire
- Primarily fluorescent lighting
- 80 KW/100 KVA Generator Set
- 9 Distribution Panels

Mechanical

- Split system consisting of gas powered packaged RTU's
- Variable Air Volume (VAV) with electric reheat
- Sleeping units along interior façade served by PTAC's
- Quick response wet pipe sprinkler system

Cameron Mikkelson | Construction Management http://www.engr.psu.edu/ae/thesis/portfolios/2014/chm5046/index.html

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Executive Summary

Technical Analysis 1 – Prefabrication of Interior Wall Panels

This analysis explored utilizing on-site prefabrication of the interior panels including plumbing rough-in within a temporary enclosure. Although this process could potentially save 12.7 days of field installation time, it incurred expenses of roughly $84,000 after general conditions savings were accounted for. In addition, the added quality control risks posed too much of an issue and could result in higher costs as well as project delays. It was not recommended to implement this technique on Silverado.

Technical Analysis 2 – Installation of Solar Panels (Electrical and Structural Breadths)

This evaluation concluded that installing solar panels on the south-facing roof top of Silverado had financial benefits without requiring significant structural design changes. The 6.2 year payback proved that the endeavor would be worthwhile despite the additional labor and coordination efforts needed to phase installation of necessary electrical distribution components and equipment into the schedule. Potential issues can stem from the roof penetrations, but since the roofer warranty would remain valid, then these repairs can be handled without any additional cost for the owner. It was recommended to install a solar PV system for this project.

Technical Analysis 3 – SIPS for the Resident Rooms

Implementing SIPS for the electrical, mechanical, and fire protection rough-in also was deemed a cost effective process because of the 14 day reduction in schedule and resulting $31,000 saved in general conditions costs. Although there is extra coordination efforts needed to plan this process, these meetings are necessary to avoid field issues between subcontractors working in the same spaces. It was recommended to utilize SIPS for Silverado.

Technical Analysis 4 – Re-Sequencing of the Project Schedule

Although $105,000 of the winter conditions fund could be saved by postponing slab installation until mid-March, the 43 days of lost time and excessive labor and equipment expenses were too high to be cost effective. After performing a cost benefit analysis, this process would add a little under $10,000 to the project budget in addition to increased quality control risks. Thus, the original sequencing was the most appropriate fit for Silverado and re-sequencing the project schedule was not recommended.

Acknowledgements

Academic

Dr. Ed Gannon

Dr. Robert Leicht

Professor Parfitt

Penn State AE Faculty

Industry

James R. Hunzinger – Hunzinger Construction Company
Executive Vice President

Jon Sheahan – Hunzinger Construction Company
Senior Project Manager

Tim Verheyen – Hunzinger Construction Company
VDCC Coordinator, Senior Estimator

Jim Callen – Hunzinger Construction Company
Field Superintendent

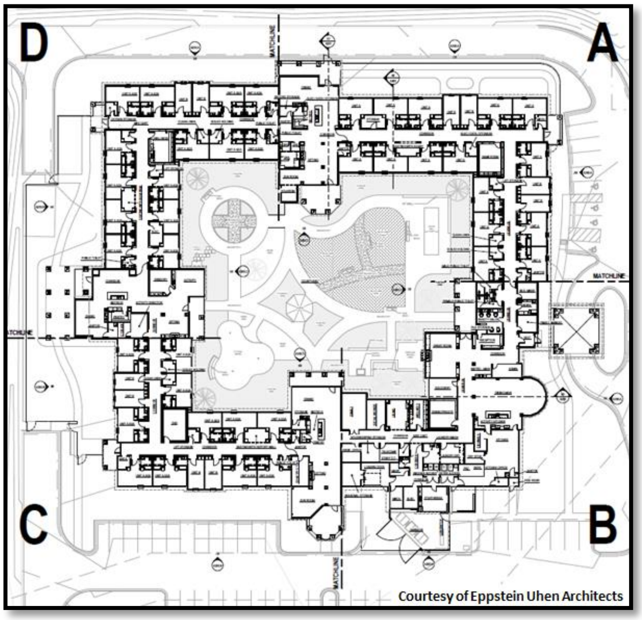
Kevin Ponder – Mahaffey Fabric Structures
Project Manager

Project Overview

Building Introduction

Silverado Senior Living, shown in Figure 1, is a high-end assisted living facility located in Brookfield, WI. With a focus on memory care, this roughly 45,000 square foot building will ultimately house up to 90 residents in 50 separate sleeping units. Total cost for the one story project totaled about $10 million, and construction began in September 2012 and was completed one year later in September 2013. Hunzinger Construction Co. was the general contractor for this facility, and the delivery method was Design-Bid-Build.

Silverado utilizes a "Back-of-House" layout that separates the employee areas from the spaces inhabited by the residents. The facility is broken into four quadrants that surround a central courtyard. The main entrance is on the east side of the building and is marked by a canopy so patients can be dropped off and protected from potentially harsh weather conditions. The kitchen, mechanical rooms, and employee areas are located in the Southeast corner of the building in quadrant B. The other three quadrants contain 50 sleeping units which house up to 90 residents. Interior amenities such as a solarium, great room, bistros, and activity rooms are located throughout the building.



Courtesy of Eppstein Uhen Architects

Figure 1: Overall Floor Plan *Courtesy of Hunzinger

Client Information

The owner of the project, Silverado, currently owns and operates 31 facilities nationwide, and has established themselves as a premier industry leader in at-home, hospice, and memory care for seniors. Silverado implements a philosophy called "normalization" into their treatment plan for the residents in addition to traditional methods. This approach focuses on treating patients as they were prior to diagnosis, which can provide them with a renewed sense of purpose. Part of this principle includes techniques such as pet therapy and giving residents jobs around the facility. In order to successfully implement this program, spaces for activities, dining areas, and high quality interior finishes help residents to live a relatively normal life.

Project Delivery

This project followed a design-bid-build procedure, Hunzinger Construction Company was brought on board as the general contractor. Hunzinger had recently completed a separate assisted living facility in the Milwaukee area, and the success from that project and other past endeavors made them a primary candidate. Based out of California, it was important for Silverado to hire a firm with strong ties to the area. Operating in Milwaukee since 1907, Hunzinger proved to be the best company for the job.

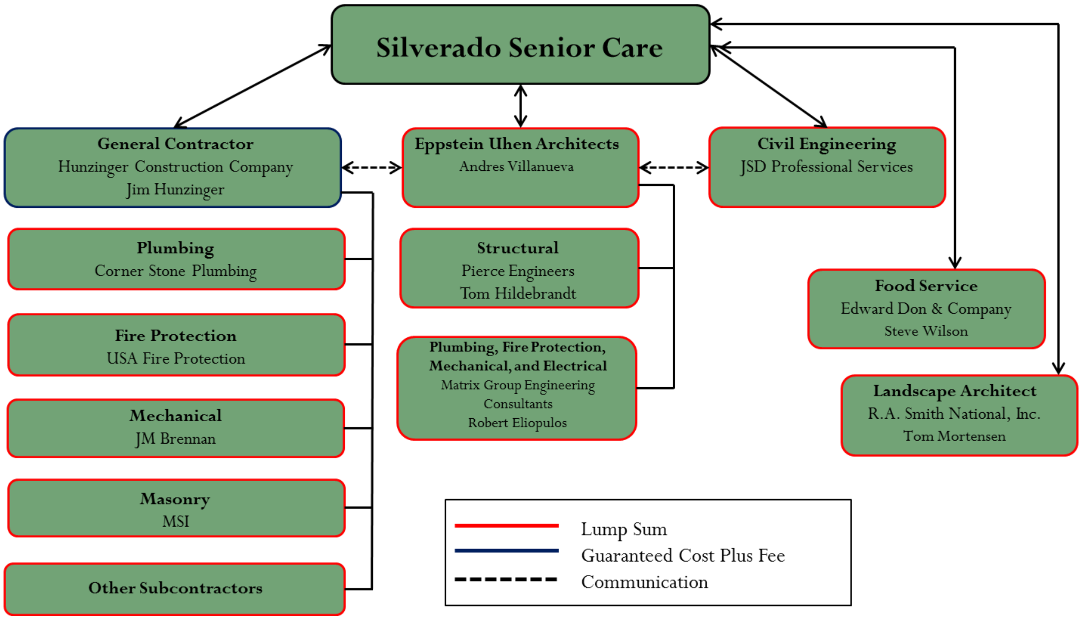


Figure 2: Project Delivery Tree

The basis of payment between Hunzinger and Silverado was a “Cost of the Work Plus a Fee with a Guaranteed Maximum Price” as modified by both parties (Figure 2). After much communication with the architect and engineers during the preconstruction phase, a final set of construction documents was developed. From this Hunzinger contracted out many of the major trades, while self-performing all concrete and finish carpentry.

The staffing plan for Hunzinger is shown below in Figure 3. During the design development and schematic phases of this project, senior project manager Jon Sheahan and senior estimator Tim Verheyen also met on a bi-weekly basis with Silverado to develop budgets for the current scope and suggest any changes that may be cost effective for the owner.

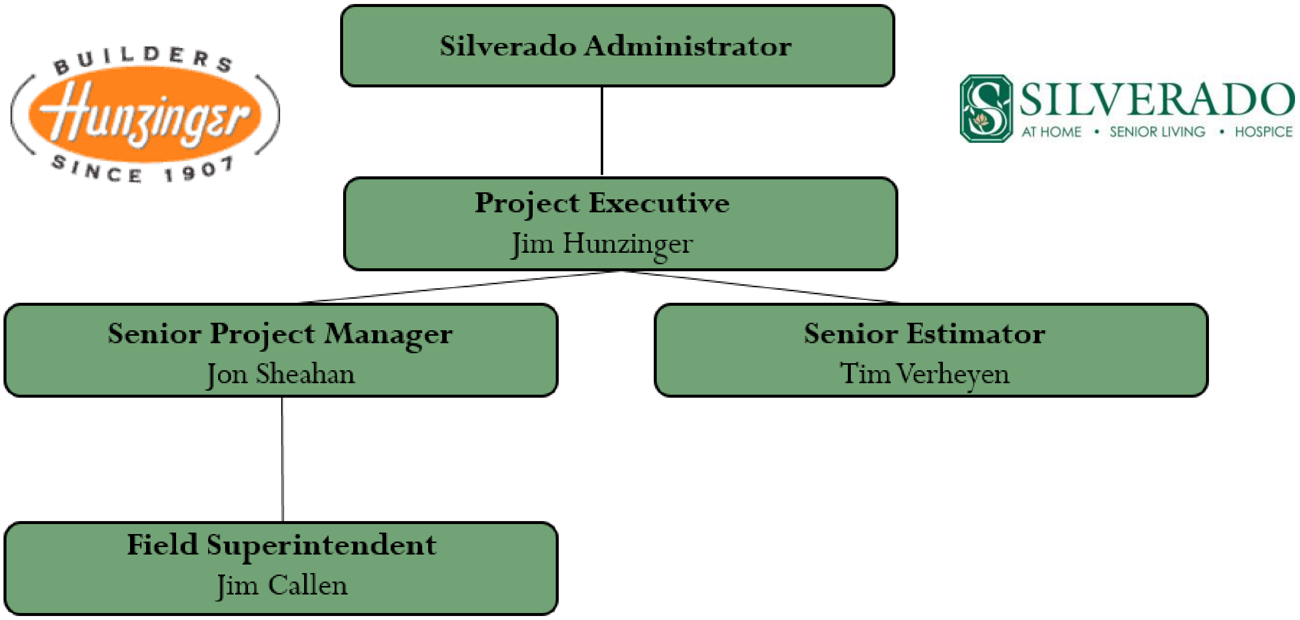


Figure 3 – Hunzinger Staffing Plan

Preconstruction and Material Procurement

The design and preconstruction phase of this project was important because the initial sitework was a major focus. The facility needed to be completed before the following winter due to financial constraints and so residents could settle in before the cold winter weather arrived. Hunzinger obtained an early work permit for the civil work before the final construction documents were finished to ensure that the necessary sitework could be completed on time. The final portion of this phase was to install the parking lot before winter, which would provide parking for workers as well as reduce the amount of dirt and mud spread around the jobsite during the spring.

Procurement was also a critical factor because both the wall panels and roof trusses were shop-fabricated and delivered to the jobsite “just-in-time” and installed immediately. In addition, the window and solarium materials, which needed four and twelve weeks respectively for fabrication, also comprised the other long lead items for this facility.

Civil and Sitework

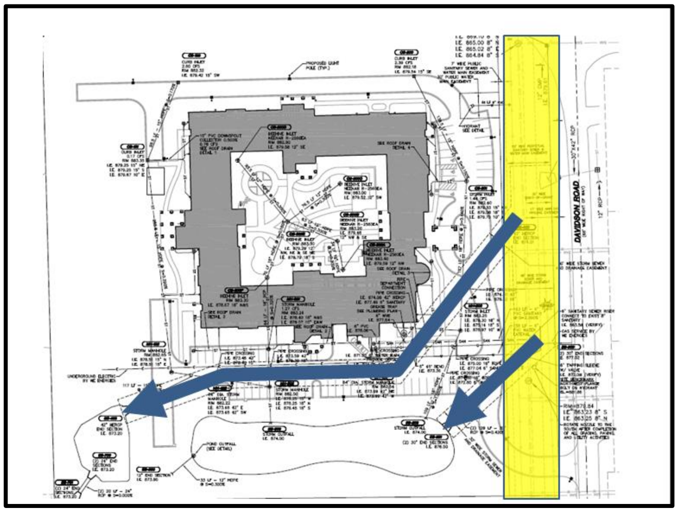


Figure 4 – Storm Sewer Locations ***Courtesy of Hunzinger**

Sitework was one of the most important phases in this project and needed to be complete before asphalt plants closed for the winter. This was broken into three phases, which included all earthwork, installation of two storm sewers, detention pond construction, and the parking lot. No fill dirt or topsoil was hauled off-site, so the objective was to use all fill material, but still maintain the grade so it drained from the north to the southwest portion of the property. The City of Brookfield required the two storm sewers be put in before the rest of the construction process could begin. Originally, the lot was a field that allowed water run-off to drain to the southern portion of the lot. Since the prospective senior living facility would interfere with the natural slope of the property, two temporary diversion swales had to be installed during the Phase 1 of grading and erosion control. These drained into a temporary construction sediment basin which would ultimately turn into the permanent detention pond for the property. A site logistics plan for this phase can be viewed in Appendix B.

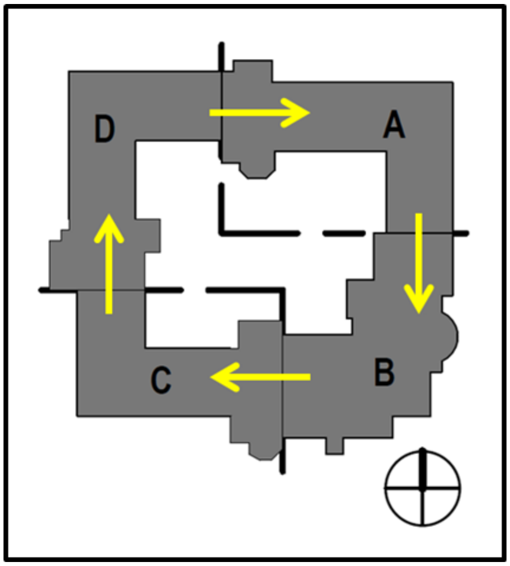


Figure 5 – Work Sequence ***Courtesy of Hunzinger**

Foundation and Slab on Grade

The foundation phase of this project consisted of the concrete footings, erecting the CMU foundation walls, and pouring the slab on grade. This work took place from mid-November to early March which meant that winter weather procedures were followed for those scopes.

First, first all under-slab plumbing and electrical rough-in was coordinated and completed by the respective contractors. Then the slab was then poured under a temporary, heated enclosure one section at a time. Although much more time consuming than pouring during the warmer months, this allowed for the superstructure to begin before the snow thawed and the job site became messy. Once the slab was poured in quadrant B, then the wall panels could be erected as the concrete work moved to quadrant C. Typically work began in quadrant B, and progressed to quadrants C then D until completion in quadrant A.

Architecture

Silverado Senior Living in Brookfield, WI, is divided into four quadrants. The building encloses a courtyard that provides a protected outdoor area for occupants to enjoy features such as a gazebo, putting green, and walking paths. In addition to the fifty rooms where the residents sleep, there are two bistros with adjacent dining rooms where the residents can enjoy a meal. These and several great rooms located throughout the building incorporate large windows to invite light inside the building, as well as include stone fireplaces the compliment the exterior natural stone veneer. A solarium on the South portion of the building provides an area where residents can go to soak in natural sunlight while being shielded from cold Wisconsin winters. The kitchen, employee break rooms, interior mechanical, telecommunication and administration rooms are located in quadrant B in the South East corner. This keeps the functional areas of the building separate from

Figure 6 – Exterior Façade ***Courtesy of Hunzinger**

the residents, and promotes a more "natural" living environment. The exterior rooftop mechanical areas are located at the interior corners of each quadrant, which houses the air handlers and other HVAC equipment. On the exterior building façade, a natural stone veneer encases the building until it transitions to fiber cement siding via a precast concrete sill (Figure 6). Silverado has two facades that are similar in composition, except that due to restrictions from the City of Brookfield, only the resident rooms facing the courtyard contain an in-wall PTAC.

Structural

Silverado is composed of reinforced concrete footings that support the CMU foundation wall, shear walls, roof truss system, cement siding, and masonry veneers. A 5" thick concrete slab on grade with welded-wire fabric reinforcing supports the floor system, and concrete piers are located by the main entrances to support overhead canopies. The foundation, SOG, and framing occurred during the winter months so cold weather procedures were followed for their respective scopes. Wooden shear wall panels support the overhead roof truss system. Trusses are typically spaced at 24" O.C., and all top chords are continuously braced with by the roof or floor decking. Trusses and wall panels were shop fabricated and delivered to the site ready to be installed. Exterior wall panel fabrication included sheathing and building wrap in addition to wood stud framing and bracing.

Figure 7 & 8 – Roof Trusses and Shear Walls, Panel Installation ***Courtesy of Hunzinger**

Electrical

Silverado Senior Living runs on a three phase, four wire, 208Y/120V electrical system which is serviced by WE Energies. Power is run underground from the west side of the property to the south side of quadrant B where it passes through a utility transformer, utility meter, and ultimately into the main switchboard (MSB). The MSB is 1600A and is located in quadrant B in electrical room B165. From there, power is distributed to the eleven 120/208 Wye branch panel boards that range from 100A to 400A. The main switchboard also serves the five RTUs located around the facility.

Mechanical

The HVAC for Silverado is provided via a split system with packaged RTU's with variable air volume and electric reheat that serve the exterior spaces of the building. In-wall gas PTAC's serve all sleeping units on the interior portion of the complex. Due to restrictions made by the City of Brookfield, PTAC's were not allowed on the exterior façade of the building. The facility implements multi-zone controls based on the type of occupancy. All major mechanical equipment is located in one of the rooftop mechanical areas in each of the four quadrants.

Figure 9 – Rooftop Mechanical Area (left) and RTU for Quadrant D (right) ***Courtesy of Hunzinger**

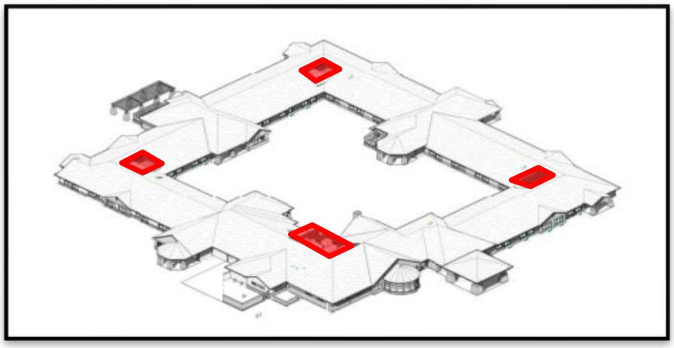


Figure 10 – Rooftop Mechanical Areas ***Courtesy of Hunzinger**

Fire Protection

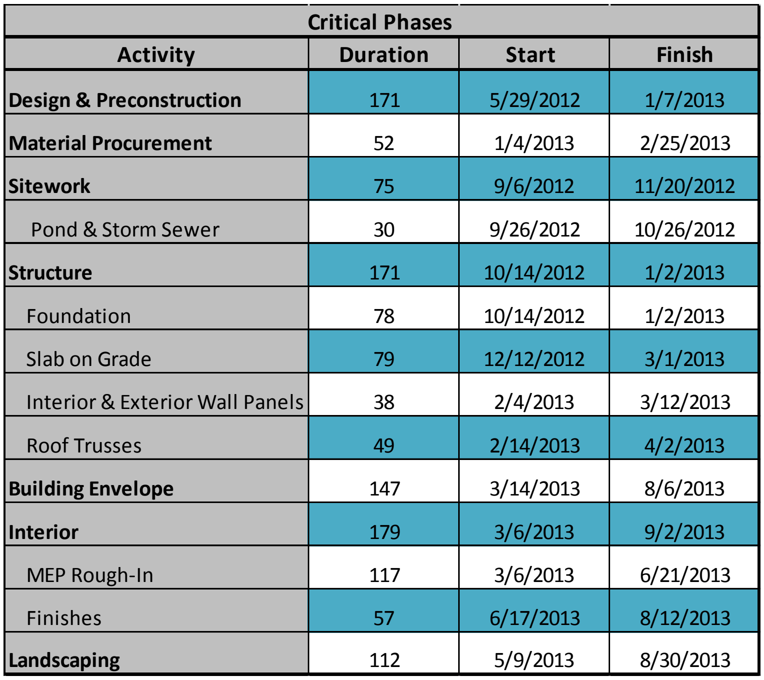
Common use areas in Silverado are deemed as light hazard per NFPA 13. One-hour firewalls separate each quadrant with two-hour firewalls separating quadrant C from D and quadrant B from A. A wet-pipe sprinkler system is utilized throughout the facility except in the attic which uses a dry-pipe sprinkler system. All sprinklers are automatic and quick-response sprinkler heads. Fifteen fire extinguishers are located throughout the complex.

Sustainability and LEED

The focus of this building was to provide an above average assisted living facility through amenities that would make the residents feel at home. Because this was the primary focus of this project, LEED was not a major concern for the owner and many of the sustainable features of the project came from the construction, material procurement, and high-performance mechanical and electrical systems. Local materials included mechanical equipment for the HVAC system came from Rockwell Automation, as well as the natural stone veneer which came from Halquist, a local quarry in Milwaukee. Hunzinger, the general contractor, also incorporated recycling and other waste management programs that ultimately reduced the impact on the surrounding environment. Hunzinger minimized disturbance to the surrounding residential area also by minimizing dust, fume, and noise pollution throughout construction.

Project Schedule

Silverado began construction September of 2012 and was completed on time in September of 2013. Major phases of construction are listed below in Figure 11 and a more detailed schedule can be viewed in Appendix C. Once the design was nearing completion, Hunzinger obtained an early work permit to begin excavation and work on the storm sewers before harsh winter conditions arrived. Once the sitework was complete, the foundations, SOG, and wood structure were erected. These operations took place under cold weather conditions which mean special considerations were taken to ensure proper construction. All major scopes were sequenced to begin while the preceding trade was working in the following quadrant. Work began in quadrant B, and progressed clockwise until completion in quadrant A. Because the building contained a central courtyard, a portion of quadrant A was left open to allow for installation of the rooftop mechanical equipment.



Critical Phases			
Activity	**Duration**	**Start**	**Finish**
Design & Preconstruction	171	5/29/2012	1/7/2013
Material Procurement	52	1/4/2013	2/25/2013
Sitework	75	9/6/2012	11/20/2012
Pond & Storm Sewer	30	9/26/2012	10/26/2012
Structure	171	10/14/2012	1/2/2013
Foundation	78	10/14/2012	1/2/2013
Slab on Grade	79	12/12/2012	3/1/2013
Interior & Exterior Wall Panels	38	2/4/2013	3/12/2013
Roof Trusses	49	2/14/2013	4/2/2013
Building Envelope	147	3/14/2013	8/6/2013
Interior	179	3/6/2013	9/2/2013
MEP Rough-In	117	3/6/2013	6/21/2013
Finishes	57	6/17/2013	8/12/2013
Landscaping	112	5/9/2013	8/30/2013

Figure 11 – Major Construction Dates

Cost Overview

Because the Silverado is supported by wood structural framing, and the owner's desire for high quality interior finishes, these two areas constituted the two largest costs for the project. The major expenses for this project are shown in Figure 12 below. The general conditions estimate conducted for this project totaled approximately $805,800 which was 8.7% of the building cost and within the anticipated range. The job site was relatively open and did not require any unique permitting due the location of the jobsite. A detailed estimate for the general conditions is located in Appendix D. It's important to note that because the foundation CMU walls, slab on grade, and wood structure occurred from November to March, $175,000 was allocated for "winter weather" conditions to combat the cold environment.

Description	Total $	Cost $/SF
Concrete	$436,175	$9.64
Wood, Plastics, & Composites	$1,721,323	$38.06
HVAC	$576,000	$12.73
Plumbing	$317,171	$7.01
Electrical	$760,746	$16.82
Fire Protection	$211,512	$4.68
Finishes	$1,009,145	$22.31
Earthwork	$421,986	$9.33
Masonry	$438,823	$9.70

Figure 12 – Cost Summary Table

Technical Analysis 1: Prefabrication of the Interior Structural Wall Panels

Problem Identification

Silverado's structure is composed of shop-fabricated wood wall panels and roof-trusses. These are assembled by Great Lakes Components and delivered to the jobsite ready to be installed. Because of large open space within the enclosed courtyard, an opportunity exists for further on-site prefabrication purposes by including the in-wall plumbing rough-in. Silverado is under a strict September deadline, and any decrease in overall schedule could allow the earlier phases of construction to avoid operating in unfavorable winter conditions.

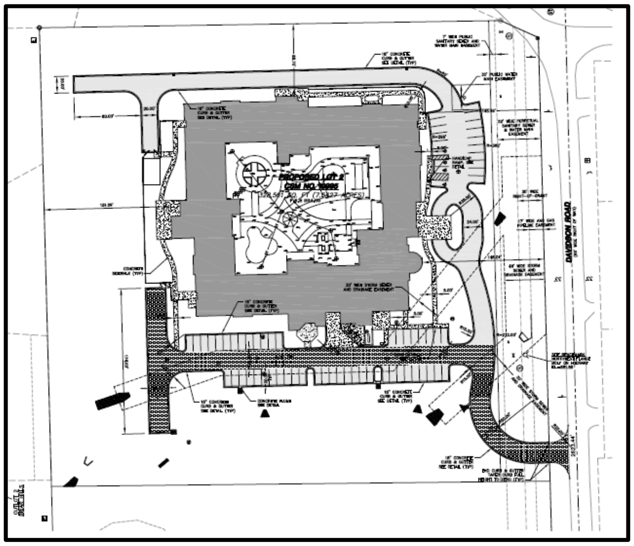


Figure 13 – Site Plan *Courtesy of Hunzinger

This process would require earlier involvement of the general contractor (Hunzinger), architect, consultants, plumbing, and rough carpentry subcontractors in the design and fabrication process. Panels that contain plumbing rough-in would need to be identified early and shipped to the project on an earlier date to allow time for the rough-in installation. If this procedure was implemented early enough in the schedule and carried out properly, then the time saved could be an important means of reducing the overall schedule.

Background Information

Prefabrication has become an increasingly popular construction technique used to help decrease field installation time which can ultimately result in savings. In order to facilitate this process, the involved parties would include the following:

- Silverado (owner)
- Hunzinger (general contractor)

- Matrix Group Consultants (MEP)
- Pierce Engineering (Structural)
- Cornerstone (Plumbing)
- Wellenstein (Rough carpentry)
- Great Lakes Components (Wall panel and truss fabricator)

The firms listed above would all need to be on board earlier in the project which means that all engineering and design of any structural components need to account for the prefabrication of plumbing rough-in prior to final installation.

The plumbing rough-in and insulation phase is scheduled to take 35 days, and while the majority of this work is not within the wall panels, there still remains a meaningful amount of time to be saved if in-wall rough in was already installed. Assembly would occur under a temporary warehouse enclosure located in the central courtyard, which provides a safer, controlled atmosphere compared to field installation. This also allows other trades to begin their work at an earlier date and ultimately expedites the over schedule.

The most significant change to the original fabrication and delivery process would involve identifying which panels would require in-wall plumbing prefabrication. Once these panels were selected, they would require Great Lakes Components to ship these with enough time for assembly prior to the final installation, resulting in additional shipments and earlier fabrication deadlines

Analysis Goals

Silverado was already on a strict schedule to be completed by September 2013, and as Analysis 4 will explore, winter conditions added $175,000 to the construction costs. Any means of reducing field installation times could result in savings both from general conditions as well improving quality of work by avoiding cold weather procedures for the slab on grade.

The goal of this analysis is to determine how much time could ultimately be saved from prefabricating the in-wall plumbing rough-in using an on-site location. Once the duration of panel assembly was determined, the additional labor and equipment costs would be compared to the potential savings to conclude if this was a worthwhile endeavor. Costs for prefabrication are generally higher initially that those associated with typical field installation, so this evaluation will show where any expenses and savings originate.

Process

This analysis first determined which panels contained in-wall plumbing rough-in, and then determined the duration of installing the necessary plumbing distribution components for each panel. Wall panels were delivered in three different shipments, and take offs were based off which phase the panel was brought to the jobsite. Rough-in components for each panel were separated into supply/return piping and drainage, waste, and ventilation (DWV). Once these durations were calculated, crew sizes and personnel were determined in order to maximize panel rough-in to fit within the adjusted schedule.

Once the time requirement for rough-in was calculated, then a schedule was developed to accommodate the on-site panel assembly while maintaining the original installation dates and sequence. The adjusted schedule for delivery, assembly, storage, and installation is shown in Figure 14. Factors other than rough-in duration that affected this fabrication schedule included size and lease dates of a temporary structure (including set-up and take-down), panel and truss installation dates, original delivery of panels that did not contain any rough-in, material storage, and present crane location. Because this process would require separate shipments for the panels, additional permitting costs and trucking expensed needed to be included in the final analysis. Panel B and C deliveries each required an additional shipment and Quadrant A/D delivery required two truckloads to accommodate all 86 panels. Number and dates of those shipments were based on panel size, weight, and trucking limitations in Wisconsin. Shipments stayed within Wisconsin trucking limitations of 12’ maximum width and 13’6” maximum height so no escorts were needed in this process.

Panel Quadrant Delivery	No. of Panels	Delivery	Assembly	Storage	Install
B	25	17-Dec	Dec 17 - Dec 28	Jan 17 - Feb 6	Jan 25 - Feb 6
C	32	28-Dec	Dec 28 - Jan 7	Dec 28 -Feb 15	Feb 6 - Feb 15
A/D	86	17-Jan	Jan 17 - March 6	Jan 17 - March 8	Feb 15 - March 8th

Figure 14 – Panel Delivery, Assembly, and Installation Schedule

Providing and enclosed location for panel assembly required a temporary warehouse that could fit inside the space for the interior courtyard without interfering with other operations such as pouring the slab on grade. Concrete trucks would need access to areas of the building located adjacent to the courtyard so adequate space was left to allow for construction vehicles. A project manager for Mahaffy Fabric Structures was contacted for this information regarding delivery, installation, function, take down, and pricing to use in the cost benefit analysis. Detailed site logistics plans for each panel delivery can be found in Appendix I.

Once the warehouse was selected, additional equipment and labor would be needed in order to hoist, transport, and store completed panels until they were ready to be installed. The largest panels were 16’ x 12’ in height, so it was critical to find equipment that could transport the panels within the enclosure without damaging them. A typical 12’ x 16’ panel is shown in Figure 15. Because many of the panels would be assembled well before its time for final installation, it was necessary to store them in a sequence that reflected the order they would be set into place. This would avoid delays due to sorting through completed panels to find to correct panel to be installed. The majority of the space within the enclosure would be dedicated to panels that still needed to be roughed-in. Shipments would be delivered and stored immediately within the enclosure. Panels that were completed were relocated to an outdoor location in their respective quadrants where the crane could hoist them into place from a single location.

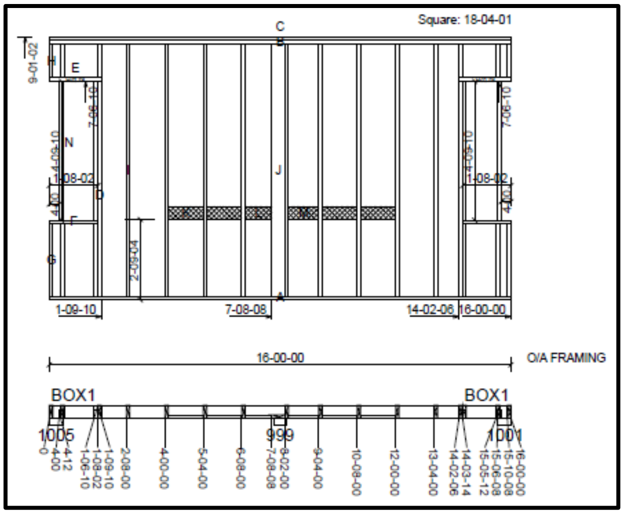


Figure 15 – Panel Dimensions *Courtesy of Hunzinger

Results

Once the duration for total panel assembly in each delivery zone time was calculated (Figure 16), costs incurred during the prefabrication process were determined. These expenses were compared to the savings generated from the reduction in schedule and are outlined in Figure 17.

Panel Quadrant Delivery	DWV Labor Hours	Supply/Return Piping Labor Hours	Total Labor Hours	Total Field Time Saved (Days)
B	82	69	151	2.1
C	75	155	230	3.2
A/D	150	381	531	7.4
	Net-Total		**912**	**12.7**

Figure 16 – Time Save by quadrant

Source	Description	Total Cost
	Temporary Warehouse	
Mahaffy Quote	66' x 82' Temporary Structure	$40,745.00
	Trucking Costs	
Great Lakes Components	Number of truckloads	$1,520.00
Great Lakes Components	Permits	$150.00
	Equipment	
RS MEANS	Forklift Crew(1 A.T. Forklift, 42' Lift, 1 Euip. Oper.)	$38,580.00
	Assembly Labor Rates	
RS MEANS	Labor for panel transportation and storage	$32,160.00
Total		**$113,155.00**

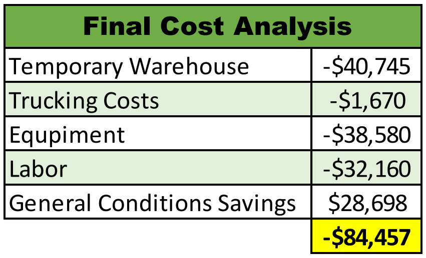
Figure 17 – Expense Summary

The primary source of additional expenses stemmed from the labor, equipment, and facilities needed for the onsite prefabrication. The temporary fabric structure accounted for 36% of the total fabrication cost. A project manager at Mahaffy Fabric Structures was contacted to obtain the most accurate price for a three month lease that included delivery, temporary power, lighting, installation, take-down, and removal from site. Mahaffy also provides a work platform for plumbers to rough-in each panel. This assembly space would take up about a fourth of the enclosure space, which allows ample room for subsequent panel delivery and storage. The enclosure was also large enough to allow for a forklift to maneuver within the space when removing completed panels to outdoor storage areas. The cost for 60 day fork lift rental and equipment operator resulted about 34% of the total expenses.

The additional delivery for the selected panels resulted in four additional truckloads. Using a standard flatbed truck, this estimation included permitting, truck rental, as well as operator costs. This was calculated to be $380 per shipment as well four permits at $37.5 each. Because the width and height of the load did not exceed Wisconsin restrictions, no escort was needed to accompany the truck for the 32 mile drive.

Because panels were constantly being assembled and relocated, an additional laborer was needed to help with the transfer from delivery zone, to assembly location, and storage. Over the 960 hours of assembly time, the cost for a general laborer totaled 28.4%. Plumbing rough-in was composed of two crews that included one plumber and one apprentice. Because this labor was already accounted for in the original quote, it was not included in cost analysis. However, mobilization costs for forklift crews were accounted for in the equipment costs.

Savings for this process stemmed from the thirteen day reduction of field installation time. These thirteen days shortened the overall schedule which was important especially if pouring the slab was postponed until March instead of the over the winter. Direct general conditions savings for those thirteen days totaled $28,698. Final cost of the proposed onsite prefabrication included savings from general conditions and amounted to $84,457 as show below in Figure 18.



Final Cost Analysis	
Temporary Warehouse	-$40,745
Trucking Costs	-$1,670
Equipment	-$38,580
Labor	-$32,160
General Conditions Savings	$28,698
	-$84,457

Figure 18 – Cost Analysis

Conclusion and Recommendation

Fabrication costs increased the total cost of the project by 9.2% and decreased the overall schedule by thirteen days. Savings totaled $28,698 from general conditions, but this was not sufficient to compensate for the other expenses. Typically this type of process would need to occur on a larger project because a short term lease of a temporary warehouse along with added labor expenses drove the price of prefabrication too high.

Material procurement is also a major hassle in this situation because the panel fabricator and plumber both need to mobilize at least one additional time and this leads to higher costs as well as more coordination efforts. Panels containing rough-in would need to be selected out the original order which would invite logistical problems that could potentially cause delays.

The primary issue with this process is quality control. Many issues are resolved in the field especially for plumbing and other MEP rough-in. Every in-wall component would have to match the riser roughed-in under the slab two months prior. If a panel is prefabricated and the drawings do not match what is the field, the panel must be disassembled, and installed properly leading to twice as much work as originally planned. Also, because of the increased transportation of the panels the chance to cause damage to either the wood framing or installed plumbing rough-in is raised significantly. Transporting assembled panels with existing plumbing rough-in and storing them in separate location is another concern because pipes can crack, bend, or dislodge if bumped hard enough by another panel or other materials.

Overall this is not a viable option because the risk of quality control issues as well as logistical complications involved in this particular prefabrication process. In addition, cumulative expenses greatly outweigh the potential savings in cost and schedule.

Technical Analysis 2: Installation of Rooftop Solar Panels (Electrical and Structural Breadths)

Problem Identification

Silverado utilizes a sloped roof at 26.5° that contains a significant amount of south-facing area that could be utilized for installing solar photovoltaic panels. These panels generate DC power that is sent to an inverter, which in this case, converts it from DC to AC within one piece of equipment. This electricity then goes to an AC panel and ultimately feeds back to the utility. The magnitude of this electricity would be metered and sold back to the electric utility company (WE Energies). Because of the available roof space, implementing this system could prove beneficial to Silverado depending if the annual solar elevation angles and shading calculations show that panels would receive adequate sunlight. Silverado did not pursue any LEED certification, but usage of low flow fixtures, high efficiency lighting, and other LEED criteria has potential to lead to a certification if the solar PV array is implemented. This analysis explores how many solar panels in the array would be optimal, and how the procurement and installation process would assimilate with the current project schedule. Once the output of the array has been calculated, then satisfied LEED criteria will be summed and ultimately determined if the contribution is adequate to earn a certification.

Background Research

Of the total south facing roof top area, approximately half is unusable to due to aesthetic restrictions by the City of Brookfield. Of the remaining usable roof space, which is located in quadrants A and D and highlighted in orange in Figure 20, has been considered unusable because of obstructions that cast shadows on the solar panels. Because the best performance of a solar array consists of south-facing panels, the remainder of the roof is not suitable.

A solar PV system typically consists of two different function. An off-grid system uses the electricity produced to directly supply power to the facility or stores it in batteries until its needed. A grid-tie system, which is best option for Silverado, takes the power generated and converts it to AC so it can be sold back into the utility grid. Typically these systems are composed of solar modules, DC disconnect, inverter, combiner box, AC disconnect, circuit breaker, and if needed a larger distribution panel to feed the power back into the grid (Figure 20). The inverter model selected for Silverado functions as the combiner box, DC disconnect, inverter, and AC disconnect within one piece of equipment. Conductors transfer the power from the panels to the inverter, and from the inverter to main electrical connection. The panels will be located in highlighted area of Figure 20 in two horizontal rows below the eave of the roof. A third row of panels could spatially be accommodated, but due to the surrounding roof heights, this row would not receive sufficient sunlight.

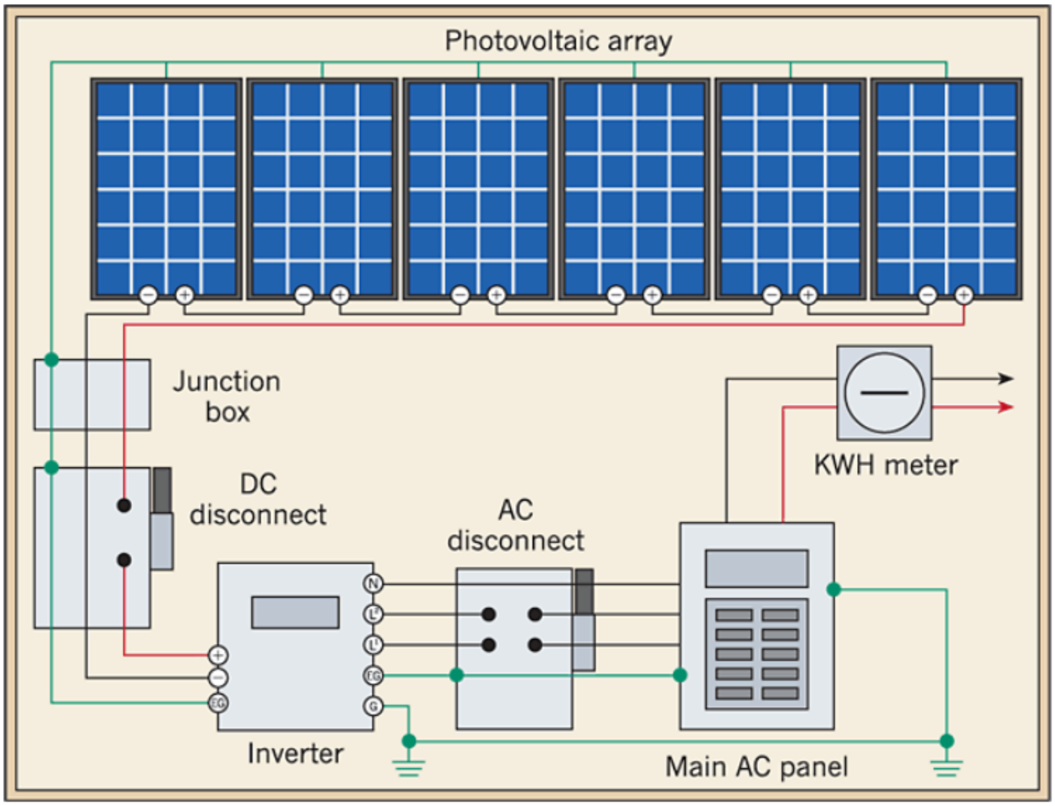


Figure 19 – PV Array diagram *Courtesy of ProSolar

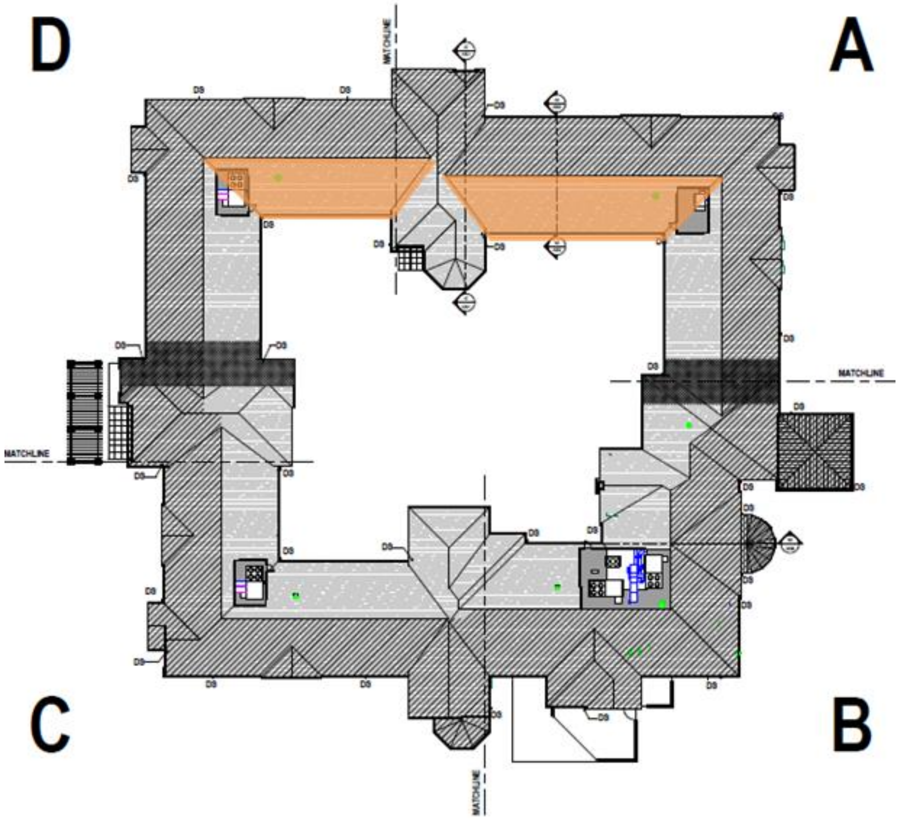


Figure 20 – Usable Roof Space *Courtesy of Hunzinger

Analysis Goals

This analysis explores the optimal number and location of solar panels in an array, and how the procurement and installation process would assimilate with the current project schedule. A cost benefit analysis will determine if implementation of a solar PV system would financially beneficial to the owner after a lifecycle cost and added risks regarding quality control and safety have been considered. Scheduling and phasing implications will be explored and determined if they ultimately cause any delays. Once the output of the array has been calculated, then any satisfied LEED criteria will be summed and concluded if the contribution is significant.

Process

The first step in designing a solar PV system is determining where the panels can be located and receive adequate sunlight. Shading calculations were calculated for panels in both rows to determine the distance from adjacent roof tops and mechanical screen walls that obstruct the incoming sunlight. Using the solar shading chart for Milwaukee provided by the University of Oregon SRML in Figure 21, minimum distance from those obstructions was calculated. For solar panels in Milwaukee, Wisconsin, six hours of exposure in the winter is recommended. For each string of panels in series, the panel that has the smallest output will limit the other panels in that string. Row specific shading diagrams can be found in Appendix J.

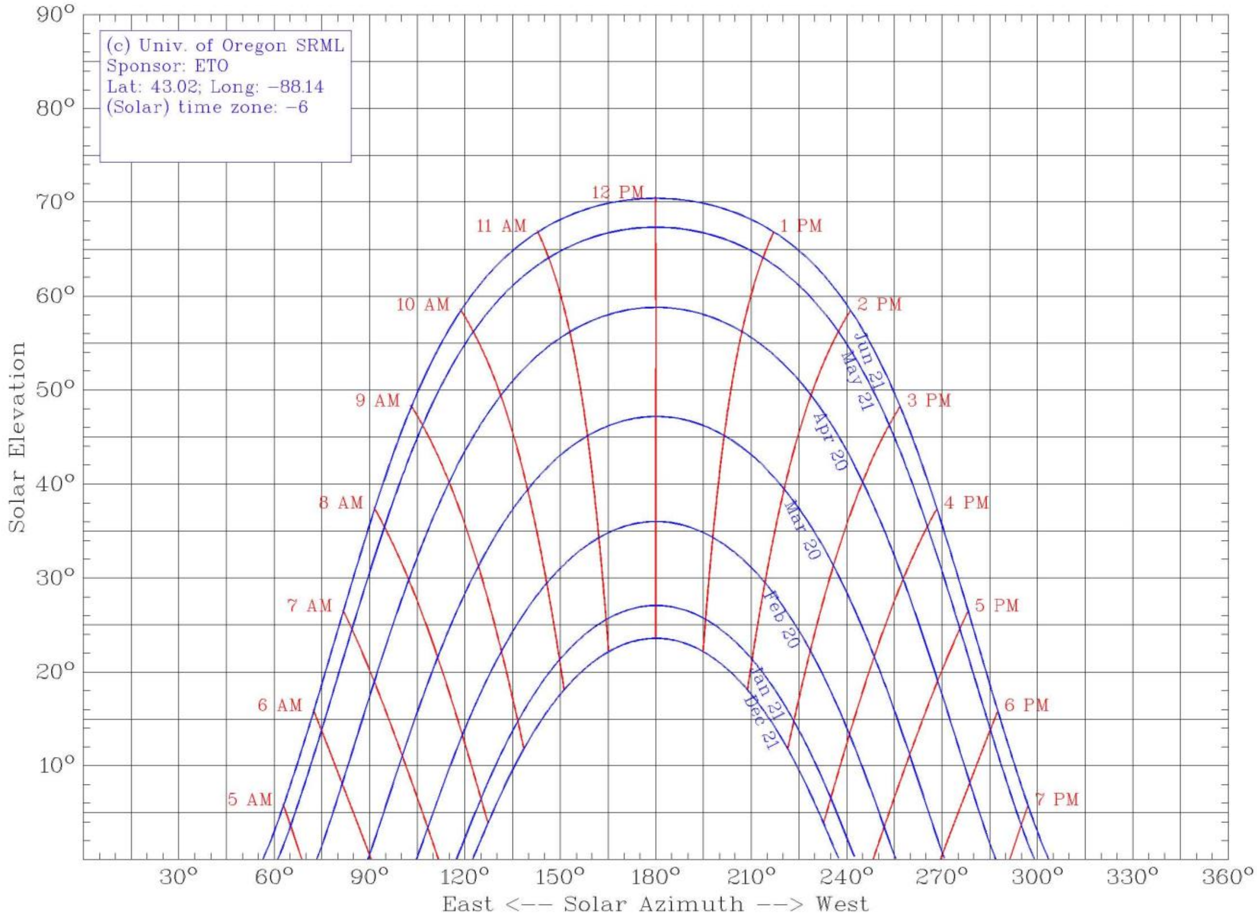


Figure 21 – Shading Chart for Milwaukee ***Courtesy of University of Oregon SRML**

In Silverado's case, the nearest obstruction was the mechanical screen wall which was located in both quadrants A and D. The top row of solar panels were not inhibited by this obstruction, however, the rooftop of the adjacent perpendicular roof sections did impede the sunlight if the panel was located too close. Based on shading calculations, it was determined that to receive at least six hours of sunlight the panels in the top row had to be a minimum of 19.6' away from a roof top obstruction on either side. The second row had to be minimum of 28.7' away from the nearest rooftop or mechanical screen wall obstruction. In quadrant A, this resulted in the installment of three strings of 11 panels placed in two rows which consisted of 18 and 15 modules in the top and bottom rows respectively. In quadrant D, two strings containing two rows of 12 and 10 modules in the top and bottom rows respectively.

Solar Module

Once location was determined for the solar modules, then a specific panel needed to be chosen. For this project, it was recommended that the250 W Sharp ND-250QCS was the most appropriate for a small commercial application like Silverado. This module is typically used for residential and light commercial applications which was conducive for Silverado's electrical system that runs on three phase, 120/208 Y power. The model is also rated to withstand up to 50 psf of potential load from snow. The design load for snow for this facility is 30 psf, so this panel design is more than sufficient. Specifications for the solar module can be found in Appendix K.

Figure 22 - Sharp ND-250QCS *Courtesy of Sharp

Inverter

Once module location, size, and number were determined, an inverter was selected based on the solar panels open circuit voltage and short circuit current. In this case, Solectrias PVI 14TL inverter was chosen because the total combined output open circuit voltage and short circuit current for each string of 11 modules was within the range of given on the inverter specifications. Continuous output power was listed as 14 KW, which is more than adequate for the designed 13.75 KW output power of the array of solar panels. The chosen inverter came with the option of an integrated DC fused string combiner, which allowed for five strings to be connected over the original two that the standard model was specified for. The inverter was installed in the roof top mechanical area in quadrant D because this was closest possible location to the solar array. When finding a location for the inverter, it is important to minimize the DC run from the panels to the DC disconnect. Because the closest AC panel was located in Rm D130.3 Figure 22, installation in the roof top mechanical area was deemed the best location. These specifications can also be found in Appendix K.

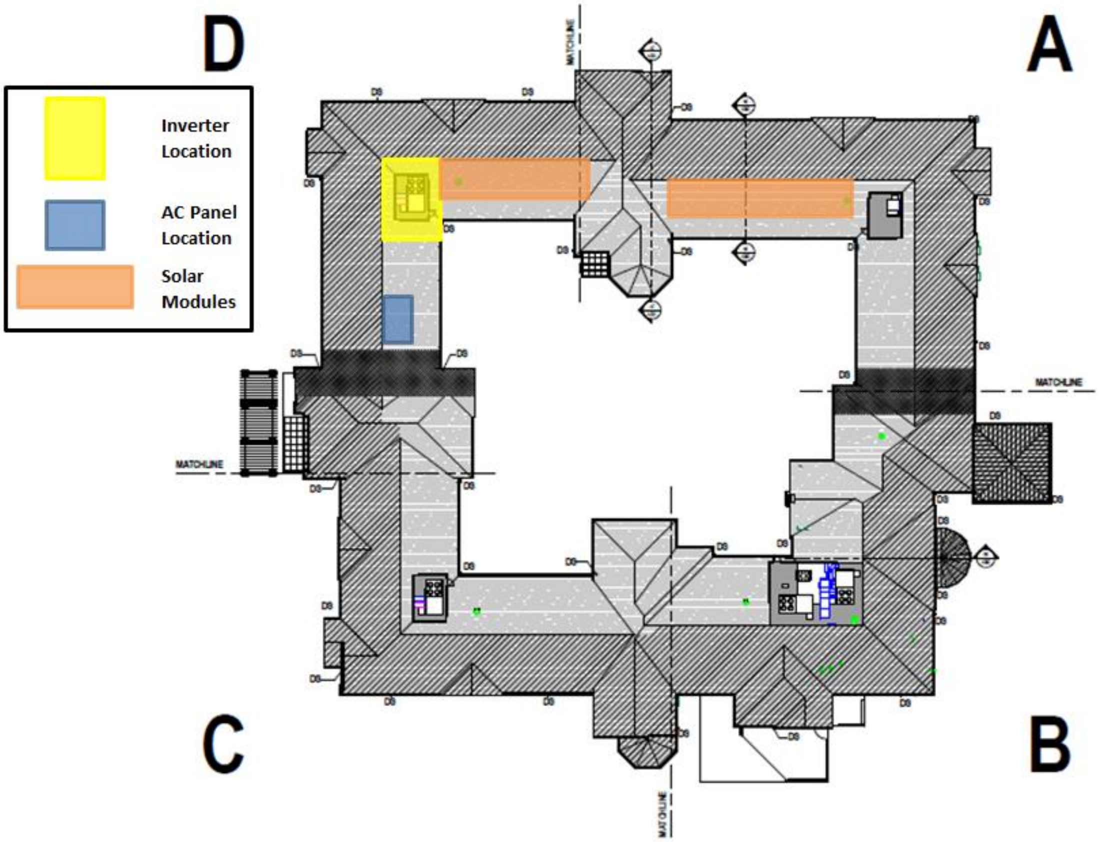


Figure 23 – Inverter and AC Panel Locations ***Courtesy of Hunzinger**

Mount and Racking

Because the panels would adhere to the roof itself, Quick Mount PV Classic Composition Mount was selected for this project. Designed for a composite asphalt shingle roof, this type of mount is drilled through the roof and fastened directly into the wood trusses. Although this involves many more penetrations into the roof, the roofing contractor will usually absorb this additional work and install flashing as they work their way up the roof. If a separate contractor handles this scope, then the roofer warranty will become void. In Silverado's case it is assumed the roofers carried out this task to ensure a better finished product.

Once the mounts are in place, ProSolar recommended using a RoofTrac mounting system because it compatible with both the Classic Composition Mount as well as the Sharp solar module selected. These are mounted every four feet on center, so it is compatible with the roof trusses which are spaced 24" O.C.

Figure 24 – Classic Composition Mount ***Courtesy of homepower.com**

Labor & Cost Analysis

Installation was estimated at $2.80/watt for this type of PV system according to a representative at SolarCity. Durations for installing each component were taken from RS MEANS and totaled approximately 291 labor hours. The roofing contractor is responsible for setting the mounts into place and installing the racking. Once the shingles were installed, then the electrical subcontractor could install the solar modules and subsequently the inverter. Once those components were in place, then conduit and conductors would be connected to each panel, routed through the inverter, and to the AC panel located in Rm D130.3. All hangers, supports, bends, electrical boxes, and fittings are included in the cost and labor analysis estimate. This labor estimate also includes all equipment mobilization, electrical connections, system checks, and balances.

Reference	Item	Crew	Qty	Unit	Labor Hours/unit	Total Duration
RS MEANS	Classic Composition Mount	Roofer	55	Per Panel	1.455	80.0
RS MEANS	Rooftrac Racking	Roofer	7	Per 8 Panels	0.78	5.5
RS MEANS	Sharp Solar Module	Electrician	55	Per Panel	1	55.0
RS MEANS	Inverter	Electrician	1	Ea.	4	4.0
RS MEANS	60 Amp Circuit Breaker	Electrician	1	Ea.	1.702	1.7
RS MEANS	#12 AWG conductor	Electrician	50.24	CLF	0.727	36.5
RS MEANS	#8 AWG conductor	Electrician	4.15	CLF	1	4.2
RS MEANS	Conduit 3/4"	Electrician	1256	LF	0.055	69.1
RS MEANS	Conduit 1/2"	Electrician	83	LF	0.42	34.9
						290.8

Figure 25 – Labor Durations

Totaled installed cost of the PV system came to $73,395.15. Installation consisted of 52.1% of this number and is distributed to roofing and electrical contractors. A breakout of direct costs was outlined in Figure 26.

Source	Item	Cost/Unit	Qty	Total Cost
Civic Solar	Solar Module (Sharp ND - 250QCS)	$268/Ea	55	$14,740.00
Civic Solar	Inverter (PVI_14TL w/ string combiner)	$5253.25/Ea	1	$5,253.25
RS MEANS	60 Amp Circuit Breaker	896/Ea	1	$896.00
Platt	Classic Composition Mount	$0.10/Watt	13750	$1,375.00
ProSolar	Racking	$234.80/Ea	6	$1,408.80
RS MEANS	#12 AWG conductor (THWN-2)	$52.55/CLF	50.24	$2,640.00
RS MEANS	#8 AWG conductor (THWN-2)	$91.50/CLF	4.15	$380.00
RS MEANS	Conduit 1/2"	$3.22/LF	1256	$4,044.30
RS MEANS	Conduit 3/4"	$4.01/LF	83	$332.80
SolarCity	Solar Panel Installation	$2.80/Watt	13750	$38,500.00
RS MEANS	Daily Crane Crew	$1275/day	3	$3,825.00
				$73,395.15

Figure 26 – Direct Costs

Constructability Concerns

Issues involving solar panel installation for Silverado stem from phasing the work into the original schedule, as well as causing potential damage or leaks to the roof system from the increased number of roof penetrations. Scheduling concerns are alleviated because the roofing contractor has no succeeding trades dependent on the completion date of the asphalt roof. Since the electrical contractor will be responsible for the additional electrical distribution network work, they will be able to complete their original rough-in as scheduled and install the conduit and pull conductors after the fact. Because the increased number of roofing penetrations is always a cause for concern with solar panels, The Classic Composition Mount will be installed by the roofer. Thus maintaining the warranty for the work they performed.

Conclusion and Recommendation

Silverado has the opportunity to generate a portion of their energy which always promotes better standing in the community, but from a LEED standpoint, this is not economical because it only provides one additional point toward certification. From a quality control standpoint the increased number of roof penetrations is always a concern, but the risk is reduced because the roofer will install the mounts racking components. This will maintain the warranty for their work, whereas this type of procedure on an existing roof would likely void the roofers warranty as well increase the chance for poor installation practices. This in turn increases the chance for leaks that can ultimately cause major damage in any building.

Overall, installing solar panels on the interior roof maintains the desired aesthetics form outside viewers. Financially the system will pay for itself over the course of 6.2 years as shown in electrical breadth. Structurally, the current truss design is adequately designed so no major structural changes are needed. Because of the cumulative benefits from installing a solar PV system, this is a recommended endeavor for Silverado.

Electrical Breadth: Sizing of Electrical Distribution Network and PV System Analysis

This analysis explores the sizing of conductors for the PV array and will determine the expected payback period and LEED contribution. In addition to the criteria for Inverter and Module selection listed in Analysis 2, conductors need to be properly sized in order to distribute the generated electricity safely and efficiently.

Conductor Sizing and Voltage Drop

Silverado operates on a three phase, four wire 120/208Y system. Each string of eleven modules contains four #12 AWG conductors for both the (+) and (-) directions for each PV circuit that connects to Inverter. On the AC side, five #8 conductors are needed from the inverter to electrical tie in. These are specified in the installation manual for the solar module and inverter, but calculations can also be used to determine the minimum size. Tables used for sizing wires and voltage drop are listed in Appendix L. Because the inverter contains a string combiner box, only conductors from the PV panels to the inverter and from the inverter to AC panel are needed.

DC Circuit Conductors

1. Isc = Rated short circuit current = 8.9 A @ 90°C
2. Required Ampacity for solar circuit = 1.25 x 1.25 x 8.9 = 13.9 Amps → #12 AWG✓
3. Adjustment for Conduit Fill
    a. 5 conductors = .80 derating factor → #12 AWG
    b. 13.9 Amps/.80 = 17.375 A → #12 AWG ✓
4. Adjustment for Ambient Temperature (90°F for Milwaukee)
    a. Factor = .96
    b. Adjusted Ampacity = 17.375 Amp x .96 = 16.69 Amps
5. Adjustment for height above roof

   a. ½” to 3.5” → 40°F rise in ambient temperature
   b. 134° → Factor = .71
   c. Needed Ampacity = .71 x .80 x 30 A = 17.04 Amp

6. #12 AWG THWN-2 rating 30 Amp @ 90°C > 17.04 Amp → #12 AWG ✓

AC (Inverter to Utility) Circuit Conductors

1. Min Ampacity = 39 A x 1.25 = 48.75 Amps A → #8 AWG ✓
2. Conduit Fill → 5 Conductors = .80 derating factor
3. Ambient Temperature→ .96
4. Height above roof (1/2” – 3.5”) ” → 40°F rise in ambient temperature →

   New Factor = .71
5. Needed Ampacity = 55 Amps x .80 x .71 = 31.24 Amps
6. #8 AWG THWN-2 rating → 55 Amp @ 90°C > 31.24 Amp → #8 AWG ✓

Voltage Drop DC

VD = 1.732 x L x R x I / 1000

1. Vpm = 29.8 V x 11 modules in series = 327.8 Volts
2. Imp = 8.4 A, R (#12 AWG)=5.320 ohm/km, L = 80’ max length
3. VD = {2 x 80’ max length x 5.230 ohm/km x 8.4 A} / 1000 = 6.19 Volts
4. 6.19 V/327.8 V = 1.8% Voltage drop < 3% ✓

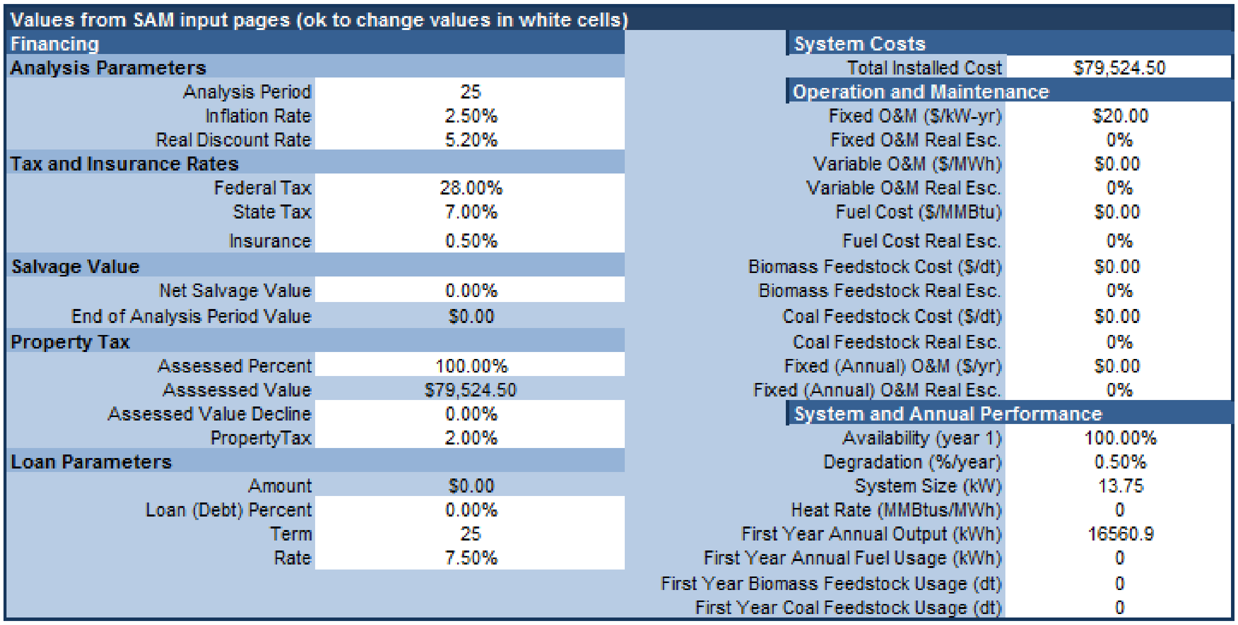
Voltage Drop AC

VD = 1.732 x L x R x I / 1000

1. Vpm = 29.8 V x 11 modules in series = 208 Volts
2. I = 39 A, R (#8 AWG) = 0.6401 ohm/km, L = 75’ max length
3. VD = {1.732 x 75’ max length x 0.6401 ohm/km x 39 A} / 1000 = 3.24 Volts
4. 3.24 V/208 V = 1.6% Voltage drop < 2% ✓

Payback Analysis

In determining how much electricity the PV system at Silverado would generate, System Advisory Model (SAM), which is a performance and financial modeling program, was used to develop a cost analysis. SAM uses local energy estimates, weather data, government incentives, utility rates, and other related criteria for a given location to determine yearly cash flow and other financial information. Inputs into SAM are shown below in Figure 27, in addition to the direct costs shown in Figure 26.



Values from SAM input pages (ok to change values in white cells)

Financing		System Costs	
Analysis Parameters		Total Installed Cost	$79,524.50
Analysis Period	25	Operation and Maintenance	
Inflation Rate	2.50%	Fixed O&M ($/kW-yr)	$20.00
Real Discount Rate	5.20%	Fixed O&M Real Esc.	0%
Tax and Insurance Rates		Variable O&M ($/MWh)	$0.00
Federal Tax	28.00%	Variable O&M Real Esc.	0%
State Tax	7.00%	Fuel Cost ($/MMBtu)	$0.00
Insurance	0.50%	Fuel Cost Real Esc.	0%
Salvage Value		Biomass Feedstock Cost ($/dt)	$0.00
Net Salvage Value	0.00%	Biomass Feedstock Real Esc.	0%
End of Analysis Period Value	$0.00	Coal Feedstock Cost ($/dt)	$0.00
Property Tax		Coal Feedstock Real Esc.	0%
Assessed Percent	100.00%	Fixed (Annual) O&M ($/yr)	$0.00
Asssessed Value	$79,524.50	Fixed (Annual) O&M Real Esc.	0%
Assessed Value Decline	0.00%	System and Annual Performance	
PropertyTax	2.00%	Availability (year 1)	100.00%
Loan Parameters		Degradation (%/year)	0.50%
Amount	$0.00	System Size (kW)	13.75
Loan (Debt) Percent	0.00%	Heat Rate (MMBtus/MWh)	0
Term	25	First Year Annual Output (kWh)	16560.9
Rate	7.50%	First Year Annual Fuel Usage (kWh)	0
		First Year Biomass Feedstock Usage (dt)	0
		First Year Coal Feedstock Usage (dt)	0

Figure 27 – Input Value ***Courtesy of SAM**

After running SAM with the aforementioned inputs, SAM produced annual expected cash flow which is shown in Figure 28. Using SAM's model, an expected payback period of 6.2 years was calculated.

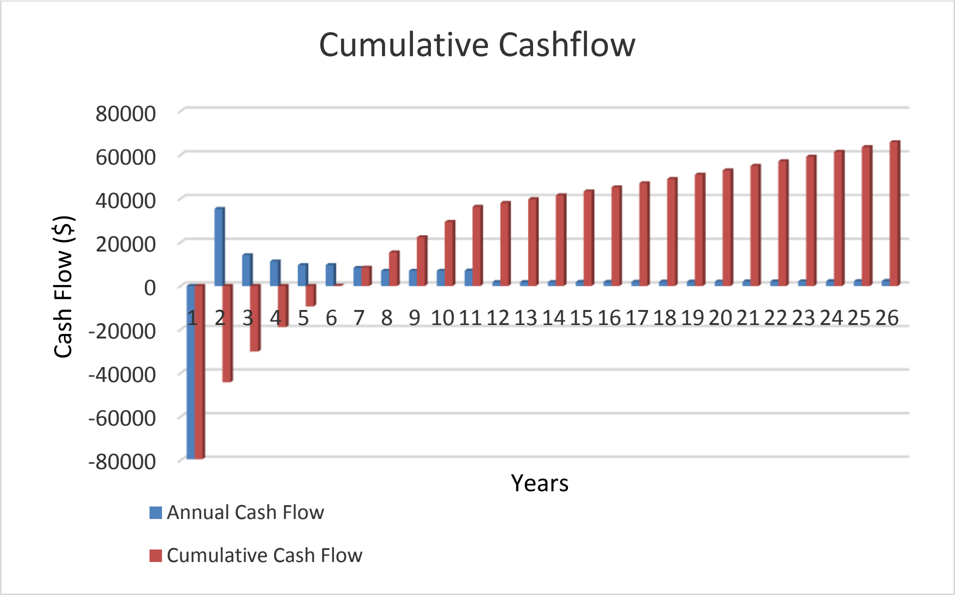


Figure 28 – Annual Cash Flow

LEED

After a LEED scorecard was completed for Silverado, it was determined that the assisted living facility only qualified for 23 points which is 16 point shy of standard certification. After estimating Silverado's annual energy consumption of 1,155 KW, speculated annual energy production from the solar panels equaled approximate 15 KW a year. This totaled about 1.2 % of the yearly consumption of power which results in one additional point towards LEED.

Conclusion

After analyzing the annual cash flow and comparing that to the direct and indirect cost of installing and operating a solar PV system, it was concluded from an electrical and performance standpoint that this is a worthwhile feature to pursue.

Structural Breadth: Structural Implications of Solar PV System

Overview

Although solar panels represent a relatively small amount of dead load compared to most roof systems, the current design must always be evaluated to determine if the structural system can support a solar PV array. Roofs are typically designed to accommodate a 15% increase of dead load without redesign. This first evaluation shows, from the magnitude of dead load, that the panels do not impose a “significant increase” which constitutes anything greater than a 15% increase.

The second evaluation determines if the maximum reactions at either end of the truss can support the additional weight from the solar panels. The panel’s dead load is calculated using its weight divided by area, and then calculating the final reaction for R1, which is the worst case scenario for any particular truss.

Increase in Dead Load from Solar Panels

Truss and Roof DL = 10 PSF

Truss Spacing = 24” O.C.

Spacing between Panel rails = 4.73’

10 PSF x (24”/12) = 20 PLF

20 PLF x 23.667 = 473.34lbs

Panel DL = 41.9 lbs/(5.38’ x 3.25’) = 2.395 PSF

2.4 PSF x (24” / 12) = 4.79 PLF per row

4.79 PLF x 2 rows = 9.58 PLF

2.4’ x (5.38’ / 2’) x 4.73’ = 30.47 lbs

30.47 lbs x 2 rows = 60.94 lbs

60.9 lbs / 473.3 lbs = .129 = 12.9% < 15% ✓ Not a Significant Increase in Dead Load

Maximum Design Load

Panel Dead Load = 41.9 lbs / (5.38’ x 3.25’) = 2.395 PSF

Design DL = 50 PSF x 2’ = 100 PLF

R1 = R2 = 100 PLF x 26.44’ = 2644 lbs

DL with Solar Panel = 2.4 PSF x 2’ = 4.8 PLF

R1’= (4.8 PLF x 8.46’) + 26.44’ = 2685 lbs < Max design load R1 = 2690 lbs ✓

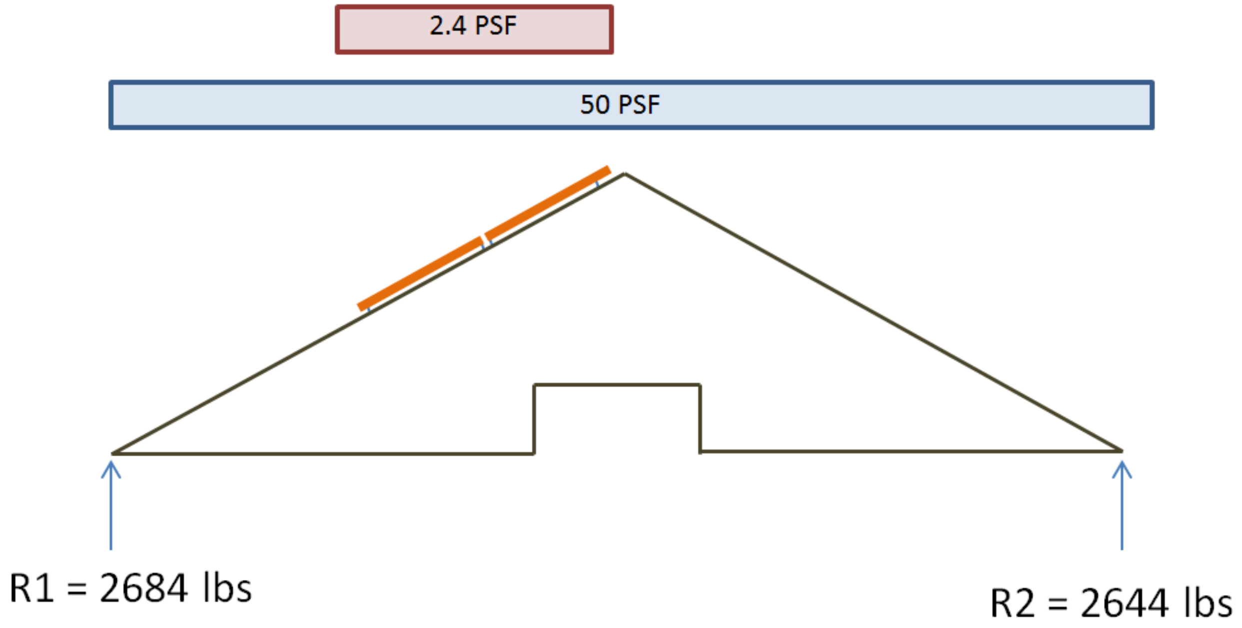


Figure 29 – Simplified Truss Diagram

Conclusion

After these two evaluations were performed, it was concluded that the current roof truss system was adequate to handle the additional load imposed by the solar panels. No structural redesign is necessary because the increase in DL imposed by the roof is only 12.8%, and the reaction at R1 is less than the maximum design load of 2690 lbs.

Technical Analysis 3: SIPS Implementation for Resident Rooms

Problem Identification

At full capacity, Silverado will be able to accommodate up to 90 full time residents within the 50 sleeping units located throughout quadrants A, C, and D. These rooms consist of three different layouts, which vary slightly depending if they facing the courtyard or exterior facade. With a strict September deadline, this provides an opportunity to make up lost time for the mechanical, electrical, and fire protection rough-in through SIPS. Plumbing was not included in this analysis because of an irregular distribution of piping that made it difficult to quantify the time saved based on individual room layouts.

Background Research

Short Interval Production Schedule (SIPS) is a means of analyzing on specific operation down to each basic step. In this case, activity durations will be broken down by the hour corresponding to the electrical, mechanical, or fire protection subcontractors. SIPS functions similar to an assembly line, with one trade following the other in a fluent and efficient manner. Although typically used for larger scale buildings with repetitive plans, this strategy could reduce rough-in duration for Silverado because the sleeping units have very similar layouts.

Implementing SIPS on any project requires early collaboration between all parties in order to develop the most efficient sequence of operations. This requires the project team, subcontractors, material suppliers, safety officers, and anyone who plays a role in the process to be brought onboard as soon as possible so the schedule can adjusted to maximize efficiency. Because multiple trades will be working in a confined space, safety and quality control risks can be increased if the involved personnel are not aware of the potential hazards. For example, the mechanical and plumbing contractors may not be familiar with standard safety procedures for electrical work and vice-versa. This could result in a violation if multiple contractors are working in the same sleeping unit, so these practices must be communicated to all parties prior to installation. Minimizing the number of different subs in a single space or section of the room will be critical to maintaining an efficient pace without any injuries, accidents, or setbacks.

Analysis Goals

Mechanical, electrical, and fire protection rough-in are cumulatively scheduled from March 6th to July 17th, which totals 96 days. Although this duration includes the rough-in for the entire project, this analysis will explore implementing SIPS for individual room layout. By determining rough-in durations for each individual trade in a particular layout, a Short Interval Production Schedule (SIPS) can be created through analyzing and understanding the scope for each trade. Using these durations and knowledge of the work being done, a fast-paced schedule can be developed that allows multiple trades to work closely side-by-side without interfering with one another.

Process

The first step in this process was determining activity durations for electrical, mechanical, and fire protection. Once these durations were determined, work spaces where each activity would occur was analyzed and divided into three different zones. By scheduling rough-in operations to be completed in two separate zones of the same sleeping unit, two different trades could simultaneously complete their work. This sequencing would ultimately decrease total field installation time compared to original linear schedule in which only one trade would be working in a given room. Layouts separated by zones are shown below in Figure 30.

Figure 30 – Room Layout with Work Zones

Electrical

Electrical rough-in consisted of all outlet and junction box installation. Conduit layout and placement was accounted for and primarily this involved ENT flexible conduit with some EMT conduit branching from main raceways in the corridor. Conduit estimates includes all layout, hangers or supports, fittings, bending, and cutting. Once conduit was in place, conductors would be pulled and material take-offs for wiring include a three foot allowance for any terminations, fixtures, and receptacles. Duration for electrical rough-in are shown in Figure 31 and take-offs are shown in in Appendix O. Electrical work primarily took place in the interior partitions with a small amount of above ceiling rough-in, so the subcontractor would be instructed to complete in-wall work in zone 1 first. This is followed by above ceiling rough-in in zone 2 so HVAC could being their work. Since three electricians would be required to maintain a pace consistent with the other trades, HVAC would not begin until 90% of electrical rough in was completed to avoid unnecessary congestion.

Electrical			
Room	**Qty**	**Duration (hrs)**	**Adjusted Duration**
Unit A/A ADA Exterior	22	27.95	9.3
Unit A/A ADA Interior	18	30.52	10.2
Unit B	10	22.54	7.5

Figure 31 – Electrical Durations

Mechanical

Mechanical work consisted of two separate scopes, gas piping and HVAC, as well as two different crews. HVAC would complete their work first because it occupies the most plenum space and gas piping was only required in the interior rooms that were served by PTAC's. Also, because PTAC's maintained temperature controls for the rooms facing the courtyard, only exhaust ventilation was needed which significantly reduced rough in duration for HVAC.

HVAC

HVAC take offs included all rectangular and round duct for supply, return, and exhaust. This estimate includes all supports, hangers, and connection needed for this work. Also, flexible duct was taken off and this duration also included connections to other HVAC components. Since

Duct work took place primarily in zone 2 and 3 near the central corridor, this allowed gas piping rough-in to begin earlier than originally scheduled. HVAC durations for each layout are shown in Figure 32.

HVAC		
Room	**Qty**	**Duration (hrs)**
Unit A ADA Ext.	14	11.8
Unit A ADA Int.	11	8.6
Unit A Int.	7	0.7
Unit A Ext	8	8.4
Unit B	10	2.2

Figure 32 – HVAC Durations

Gas Piping

The interior courtyard rooms are served by gas-powered PTAC's. This meant that additional rough-in was needed for those rooms and had to be accounted for in the adjusted schedule. Piping takeoffs included one or three inch piping, elbows, tees, and other fittings. This work mostly took place in zones 1 and 2, so installation could begin as HVAC was completing their work in zones 2 and 3 towards the central corridor. These durations are shown in Figure 33.

HVAC Gas Piping		
Room	**Qty**	**Duration (hrs)**
Unit A	7	8.6
Unit A ADA	11	8.2

Figure 33 – Gas Piping Durations

Fire Protection

Silverado incorporated a wet pipe system for the habitable spaces. Takeoffs for this work included 1" CPVC piping, elbows, hangers, supports, and other fittings. Typically this work was also concentrated towards the central corridor, so it was phased after gas piping, which was always located in the opposite side of the room. Durations for this rough-in are shown in Figure 34.

Fire Protection Duration by Room		
Room	**Qty**	**Duration (hrs)**
Unit A ADA Ext.	14	10.0
Unit A ADA Int.	11	11.0
Unit A Int.	7	4.8
Unit A Ext	8	11.4
Unit B	10	10.5

Figure 34 – Fire Protection Durations

Results

After rough-in durations were determined for each layout by trade, rough-in for each room was phased based on which zone the work was being carried out. A SIPS for each layout as well as corresponding takeoffs can be found in Appendix O. Time saved per room was then calculated, and the cumulative schedule reduction totaled 118 labor hours or 14.75 days. This is shown in Figure 35.

Time Saved per Room Layout					
Layout	**No. of Room**	**Original total Duration**	**SIPS Duration**	**Time Saved per Room**	**Cumulative Time Saved**
Unit A ADA Ext.	14	32	30	2	28
Unit A ADA Int.	11	33	30	3	33
Unit A Int.	7	27	24	3	21
Unit A Ext.	8	34	32	2	16
Unit B	10	22	2	2	20
		Net-total			**118**

Figure 35 – Time Saved per Room

The benefit of SIPS is derived from the accelerated installation by increased phasing between each trade's rough-in. Separating work into individual zones and then analyzing where each process is being completed allowed more than one trade to work in the same room. Because of the increased number of workers in a small space, avoiding congestion between subcontractors is critical and can be minimized through early, thorough planning and frequent communication. Compared to the original linear room-to-room schedule, this adjusted SIPS schedule provided a significant savings from the reduced general conditions costs. This number totaled just under $31,000 for a conservative 14 days at $2,207 each day.

While this procedure on paper produces substantial time and cost savings, a possibility exists for issues between trades that are not familiar with each other's work or the SIPS process in general. Almost every project that implements SIPS has minor delays due the initial learning curve that SIPS usually encounters early in the process. Also, since there will be multiple trades in one space, material and equipment staging spaces for equipment will be limited.

On the other hand there are coordination benefits from working closely to the preceding and subsequent trades because communication between subs working in the same space is easier. Measures can be taken to reduce field issues with additional pre-installation meetings that relay the process which ensures that each trade understands their responsibilities and how their work impacts the other subs. Much of this planning can be done prior to field installation, which maximizes the schedule reduction that can be obtained.

Conclusion and Recommendation

Despite the fact the SIPS is typically utilized on larger project, implementation still results in multiple benefits from both cost savings and reduced schedule. The scope of the work remains the same, and the only major variable stems is the slightly increased number of workers operating in the same area. Coordination and planning is already required on any project, so several additional meetings between the four subcontractors involved is worthwhile for a potential savings of 14 days and $31,000 of general conditions savings.

Technical Analysis 4: Re-sequencing of the Project Schedule

Problem Identification

Construction for Silverado was operating on a strict September deadline that was set in stone due to financial constraints for the owner. Because of this restriction, several operations such as installing the CMU foundation walls and pouring the SOG occurred under harsh winter conditions. This meant that additional manpower, equipment, and facilities were needed in order to follow proper cold weather procedures. Also, this raised the chance that a worker could make a mistake due to the unfavorable or possibly unfamiliar conditions.

Background Research

In order to mitigate the additional risks and avoid extra expenses from cold weather pouring, the schedule could be re-sequenced so the SOG was poured during normal conditions. Hunzinger self-performed all concrete work and allotted $175,000 for “winter conditions” in addition to the estimated $67,147/month for general conditions costs.

The SOG was originally scheduled from Jan 9, 2013 to March 1, 2013, which totaled 40 working days in a harsh environment. With consistently cold temperatures, the chance for human error, equipment malfunction, or injury that could result in delays or other penalties is increased. ACI 306 defines cold weather as when the average daily temperature is less than 40ºF for three consecutive days, and does not exceed 50ºF for more than half of any 24 hour period. To allow for placement of concrete during “cold weather”, all snow or ice must be removed so the subgrade can thaw to the proper temperature. Portable heaters warm up the space inside the temporary enclosure so the ambient air temperature is conducive to pouring and curing of the individual section. After the concrete is placed, the slab still needs to be protected until it reaches the proper strength. For Silverado, this process included two enclosures, concrete buggies, glycol hoses, a vapor retarder, an accelerating admixture, and portable heaters to create and maintain proper pouring conditions. Hunzinger rarely pours the slab during the winter, so quality control was closely monitored because this was not a standard practice.

If the slab was rescheduled to be poured during the spring, then the additional costs and risks could avoided; however, all subsequent trades would be pushed back and the lost time would need to be made up with additional work crews or overtime. Pouring the slab would begin approximately mid-March when the weather falls under normal placement conditions

Process

Re-sequencing the project schedule accounted for several variable regarding work being done and their respective durations. The slab on grade was scheduled to be poured from Jan 9th to the March 1st. To avoid cold weather pouring conditions this operation would need to be postponed until March 11, which is a conservative date based on average daily temperatures in Milwaukee shown in Appendix P. This meant that Hunzinger would have to make up 43 days in order cover the lost time for postponing this activity.

The last activity that applied for the $175,000 allotted for winter conditions was erecting the foundation walls on December 26th, 2012, and about 60% or $105,000 of that fund was dedicated to pouring the slab. Because installing a stone base and fine grading still had to occur before the slab was poured, work still continued up until February 25th. This produced a gap between the adjusted pour date and the last completed task that had been completed 10 days prior. Although this meant a small break in construction activities, there would be little savings from general conditions because this time would then be used for delays due to inclement weather.

Figure 36 – Cold Weather Pour ***Courtesy of Hunzinger**

In order to make up for the 43 days, multiple measures were taken such as adding an extra concrete crew and working 12 hour days and weekends. Concrete was scheduled with a 40 day duration originally. Because the subcontractor would now be working in normal pouring conditions, it was feasible to add an additional crew to speed up the pouring process without major quality control risks. Subsequent work, however, would also need to be adjusted to maintain the proper work sequence and that no two scopes interfered with each other, which in turn would cause lower productivity rates and delays. Material delivery dates would also need to be modified to accommodate the adjusted schedule. The new construction dates for impacted trades, which include extra days for unworkable weather, are shown in Figure 37.

Activity	Original Start	Original Finish	Adjusted Start	Adjusted Finish
Pour Slab on Grade	9-Jan	1-Mar	11-Mar	25-Mar
Quad B Wall Panel Delivery	25-Jan		6-Mar	
Exterior Wall Panels and Sheathing	4-Feb	12-Mar	15-Mar	2-Apr
Mobilize Crane	4-Feb		14-Mar	
Interior Wall Panels	8-Feb	12-Mar	15-Mar	2-Apr
Quad C Wall Panel Delivery	8-Feb		15-Mar	
Quad B Truss Delivery	11-Mar		18-Mar	
Set Roof Trusses	14-Feb	2-Apr	19-Mar	5-Apr
Quad D Wall Panel Delivery	14-Feb		19-Mar	
Roof Sheathing	18-Feb	4-Apr	21-Mar	8-Apr
Quad C Truss Delivery	20-Feb		22-Mar	
Steel Columns and Beams	21-Feb	25-Feb	25-Mar	28-Mar
Quad A Wall Panel Delivery	25-Feb		28-Mar	
Full Height Interior Walls to Roof Sheathing	26-Feb	19-Mar	1-Apr	5-Apr
MEP roof Curbs & Penetrations	6-Mar	27-Mar	1-Apr	13-Apr
WE Energies Gas Service	12-Mar	14-Mar	3-Apr	5-Apr
Asphalt Roofing and Felt	14-Mar	31-May	4-Apr	31-May
Window Delivery Quad B	14-Mar		30-Mar	
RTU Screen Walls	18-Mar	22-Mar	9-Apr	18-Apr
Install Exterior Windows	26-Mar	24-May	8-Apr	24-May
Window Delivery Quad C	28-Mar		9-Apr	
HVAC Roof Curbs and Rails (EPDM Roofing)	2-Apr	9-Apr	8-Apr	6-May
EPDM Roofing	4-Apr	6-May	15-Apr	6-May

Figure 37 – Original and Adjusted Durations

In addition to adding another concrete crew, subcontractors would be working twelve hours week days from 7am to 7pm as well as eight hour on Saturday and Sunday because this time frame was still adhered to the City of Brookfield’s noise ordinance. Because this would be negotiated prior to construction, Hunzinger would be obligated to pay them time and a half for any overtime work and total overtime labor expenses are shown in Figure 38. The adjusted total accounted for all weekend as premium hours, but since those days would had already been accounted for in the original schedule, only the additional 50% was used to calculate the total labor expenses.

Activity	Crew	Overtime Hours	Standard Rate	Premium Rate	Total	Adjusted Total
Pour Slab on Grade (Crew 1)	C-6	72	$211.70	$317.55	$22,863.60	$16,089.20
Pour Slab on Grade (Crew 2)	C-6	72	$211.70	$317.55	$22,863.60	$16,089.20
Exterior Wall Panels and Sheathing	F-3	56	$204.85	$307.28	$17,207.40	$10,652.20
Interior Wall Panels	F-3	88	$204.85	$307.28	$27,040.20	$17,207.40
Set Roof Trusses	F-3	88	$204.85	$307.28	$27,040.20	$20,485.00
Roof Sheathing	2 Carp.	96	$90.40	$135.60	$13,017.60	$8,678.40
MEP roof Curbs & Penetrations	G-1	64	$275.60	$413.40	$26,457.60	$22,048.00
						$111,249.40

Figure 38 – Overtime Expenses

In addition to labor expenses, certain crews included equipment rentals that had to be estimated. This amount was produced by determining which crews needed extra equipment, and how many days that equipment was needed. The additional equipment costs are located in Figure 39.

Trade/Item	Qty	Unit	Days needed	Cost/Day	Total cost
Concrete C-6					
Gas engine vibrators	2	Ea	26	$54.56	$2,837.12
MEP Roof Curbs and Penetrations G-1					
1 Application Equipment	1	Ea	2	$182.16	$364.32
1 Tar Kettle/Pot	1	Ea	2	$94.71	$189.42
Crew Truck	1	Ea	2	$176.44	$352.88
					$3,743.74

Figure 39 – Equipment Costs

Results

Once added costs were calculated and compared to potential savings, the adjusted total for re-sequencing equaled $9,993. Although this is only about 1% of the total building cost, the end result would be the same in terms of making the September deadline. Savings originated from the 60% of the winter conditions budget, but was not sufficient enough to break even compared to the costs associated with the original project schedule.

Added Labor Expenses	Added Equipment Expenses	Potential Savings	Cost Impact
$111,249	$3,744	$105,000	-$9,993

Figure 40 – Cost and Savings Breakdown

Conclusion and Recommendation

From a quality control standpoint, re-sequencing the project schedule was not ideal because an additional concrete crew is utilized to make up a portion or 43 days. Working in normal pouring conditions was preferable to slab placement during the winter months, but the accelerated schedule and increased number of workers on site raised the chance for an accident, delay, or other setbacks. An additional crews amplifies jobsite congestion and increased coordination is needed to avoid issues and maintain and efficient operation. Because men would be working twelve hour days in addition to weekends, a higher possibility for human error exists which could translate into delays and added expenses to remedy the problem. Although the schedule was re-sequenced in a way subcontractors will not interfere with each other, accelerating the work at this pace will magnify any mistakes and result in a domino effect that impacts subsequent operations.

Evaluating the financial aspects of the re-sequencing confirmed that staying with the original schedule is best option. Although the difference in cost was only about $10,000, the goal of this analysis was to decide if the re-sequencing was cost effective as well as provide better working conditions for pouring the SOG. Since both aspects were negatively affected, re-sequencing was not a viable solution.

Conclusion

Silverado presented a unique challenge because of the strict completion date and harsh weather conditions that had the construction team had to overcome. After evaluating on-site prefabrication of the interior wall panels including plumbing rough-in, it was concluded that the procedure was too expensive and posed too many quality control and logistical concerns. Although it did save roughly 12.7 days in field installation time, this was not adequate to justify the increased cost and constructability concerns.

Installation of solar panels on the roof top proved to be more profitable and feasible to phase into the original project schedule. With a payback of 6.2 years and no additional modifications to the structural system, the only setback was potential safety and quality control issues from panel installation and the increased number of penetrations into the roof. The solar PV system did not make a significant contribution to a LEED certification, but this was not an original goal for the owner.

Implementing SIPS for electrical, mechanical, and fire protection rough-in was also a worthwhile endeavor. Total time saved equaled roughly 14 days of field installation time, which translated into just below $31,000 of general conditions savings. Though added coordination efforts were required, the reduction in schedule and cost savings validated the extra planning needed to utilize SIPS effectively.

Although pouring concrete in the middle of a cold Wisconsin winter involved additional efforts to maintain proper conditions, postponing slab installation until mid-March was not a worthwhile modification. Costs involved for overtime labor and an additional crew for concrete work did not justify the savings from the winter conditions budget. Because the schedule was accelerated via overtime work for subcontractors, potential quality control and safety risks combined with roughly $10,000 of additional expenses concluded that the re-sequenced schedule was not a cost effective means of reducing the project schedule and avoiding expenses associated with winter weather conditions.

Appendix A: References

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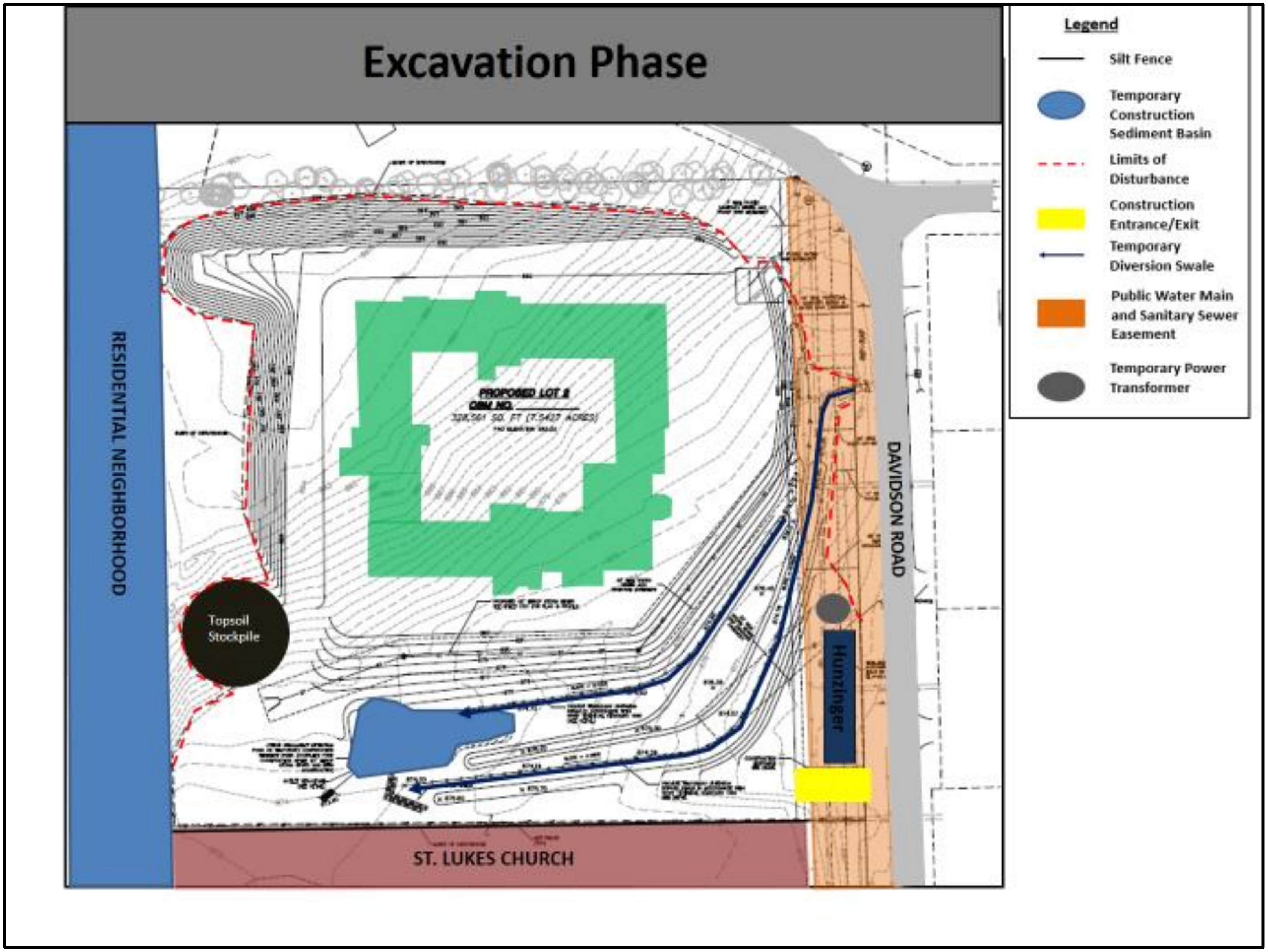
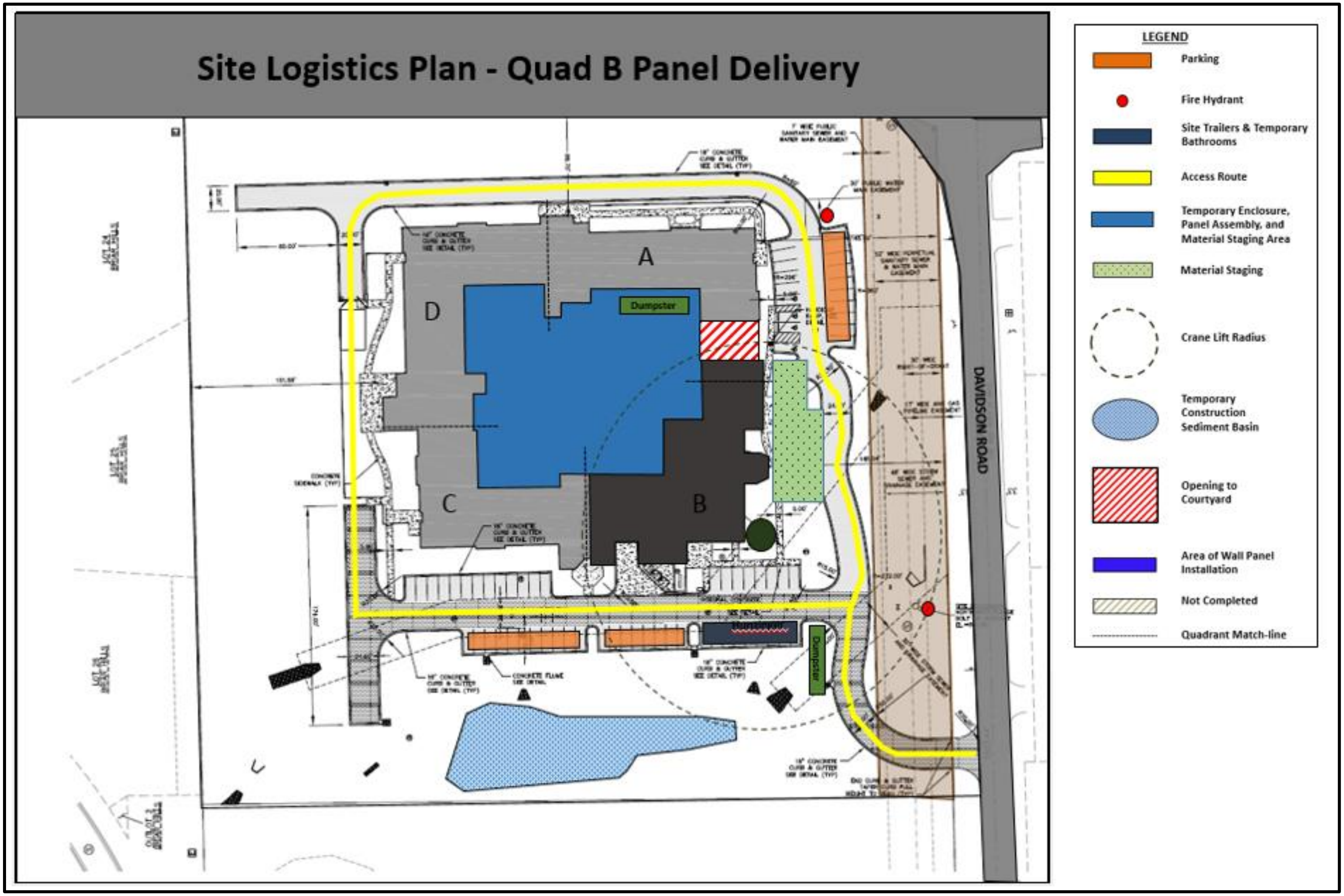
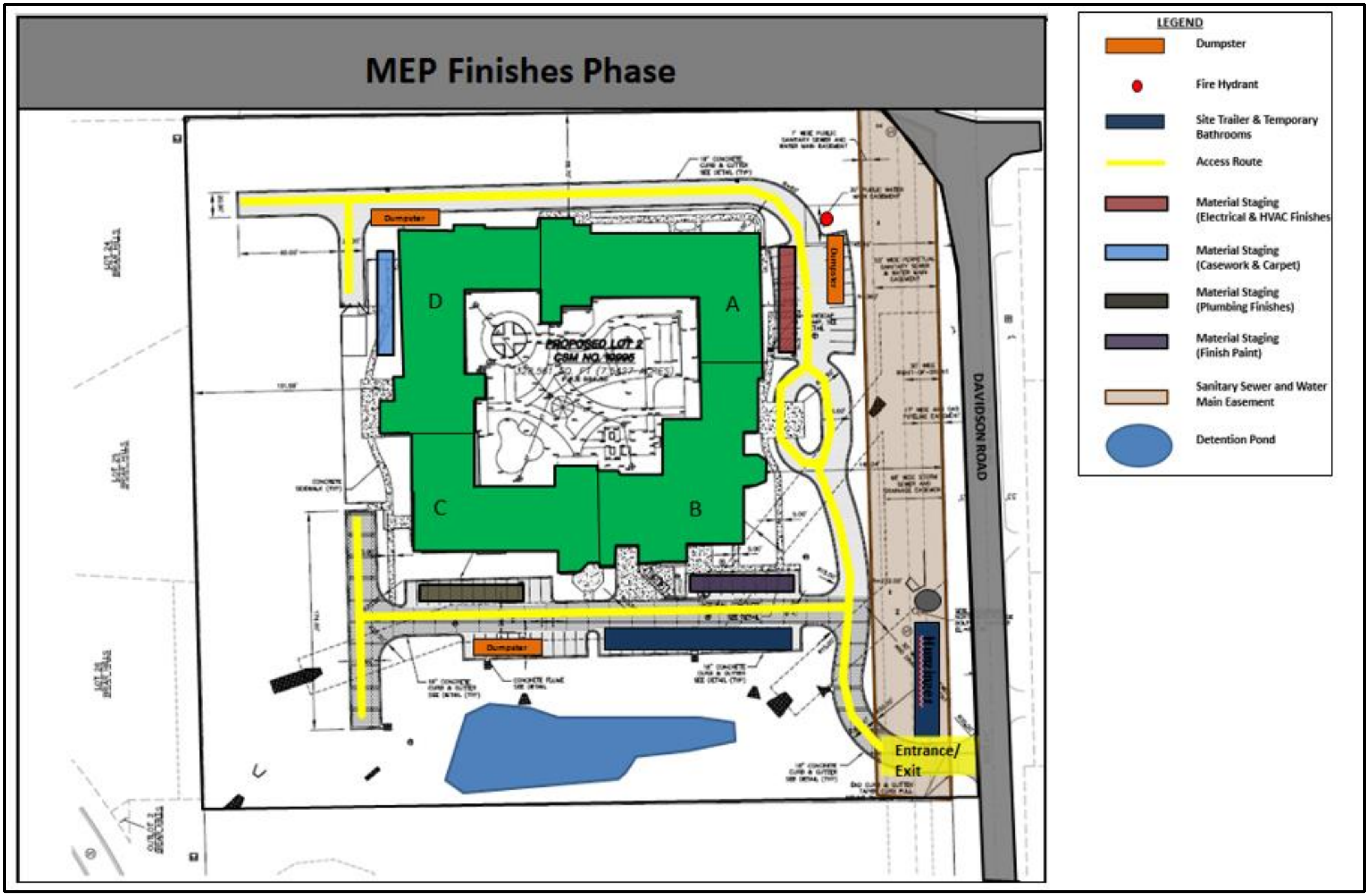
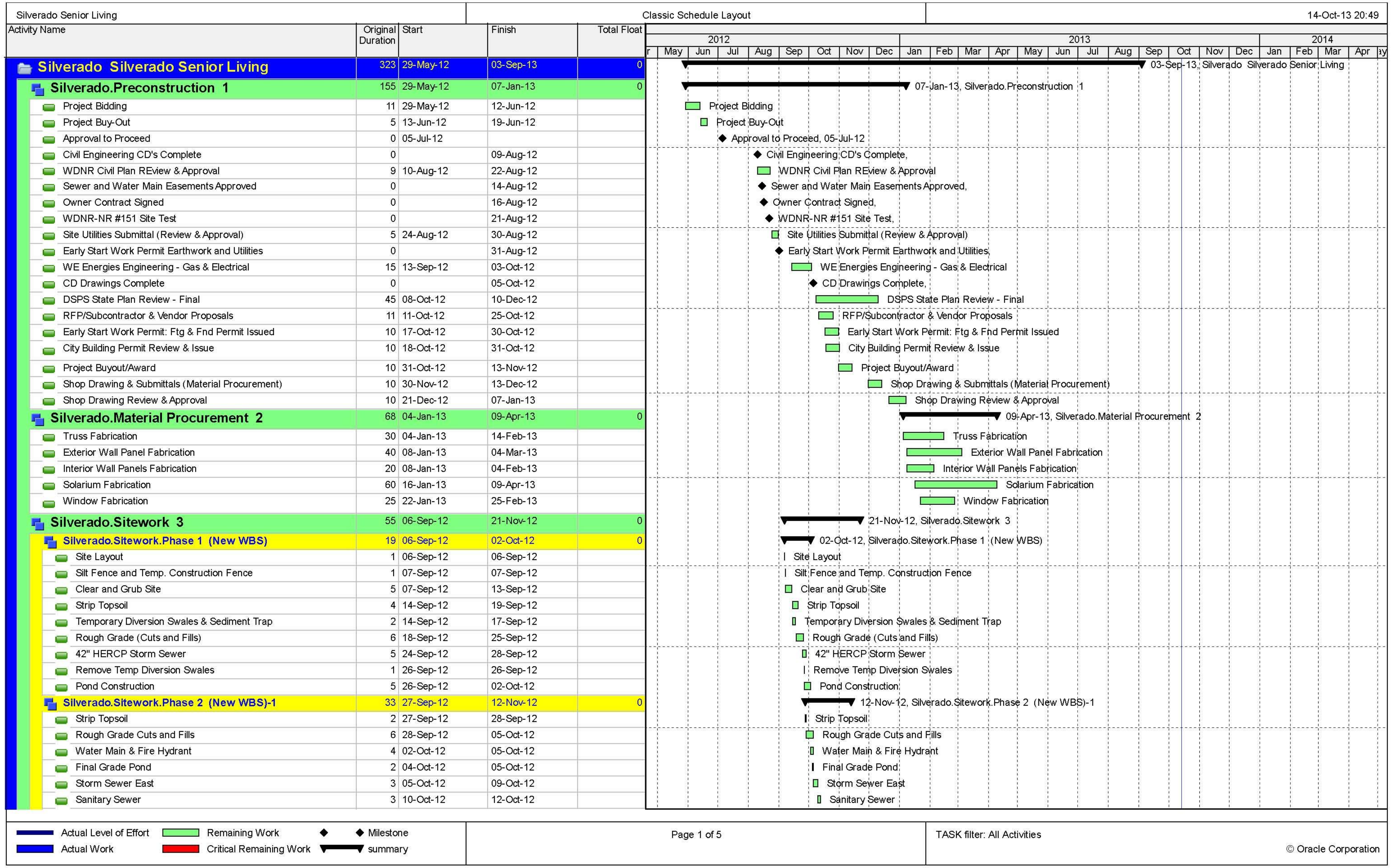
Appendix B: Site Logistics Plans


Excavation Phase
RESIDENTIAL NEIGHBORHOOD
Topsoil Stockpile
ST. LUKES CHURCH
DAVIDSON ROAD
Hunzinger
Legend
Silt Fence
Temporary Construction Sediment Basin
Limits of Disturbance
Construction Entrance/Exit
Temporary Diversion Swale
Public Water Main and Sanitary Sewer Easement
Temporary Power Transformer


Site Logistics Plan - Quad B Panel Delivery
A
B
C
D
Dumpster
Dumpster
DAVIDSON ROAD
LEGEND
Parking
Fire Hydrant
Site Trailers & Temporary Bathrooms
Access Route
Temporary Enclosure, Panel Assembly, and Material Staging Area
Material Staging
Crane Lift Radius
Temporary Construction Sediment Basin
Opening to Courtyard
Area of Wall Panel Installation
Not Completed
Quadrant Match-line


MEP Finishes Phase
LEGEND
Dumpster
Fire Hydrant
Site Trailer & Temporary Bathrooms
Access Route
Material Staging (Electrical & HVAC Finishes)
Material Staging (Casework & Carpet)
Material Staging (Plumbing Finishes)
Material Staging (Finish Paint)
Sanitary Sewer and Water Main Easement
Detention Pond
Dumpster
Dumpster
Dumpster
A
B
C
D
PROPOSED LOT 2
CSM NO. 10995
DAVIDSON ROAD
Hunzinger
Entrance/ Exit

Appendix C: Original Project Schedule



Silverado Senior Living | Classic Schedule Layout | 14-Oct-13 20:49

Activity Name	Original Duration	Start	Finish	Total Float
Silverado Silverado Senior Living	323	29-May-12	03-Sep-13	0
Silverado.Preconstruction 1	155	29-May-12	07-Jan-13	0
Project Bidding	11	29-May-12	12-Jun-12	
Project Buy-Out	5	13-Jun-12	19-Jun-12	
Approval to Proceed	0	05-Jul-12		
Civil Engineering CD's Complete	0		09-Aug-12	
WDNR Civil Plan REview & Approval	9	10-Aug-12	22-Aug-12	
Sewer and Water Main Easements Approved	0		14-Aug-12	
Owner Contract Signed	0		16-Aug-12	
WDNR-NR #151 Site Test	0		21-Aug-12	
Site Utilities Submittal (Review & Approval)	5	24-Aug-12	30-Aug-12	
Early Start Work Permit Earthwork and Utilities	0		31-Aug-12	
WE Energies Engineering - Gas & Electrical	15	13-Sep-12	03-Oct-12	
CD Drawings Complete	0		05-Oct-12	
DSPS State Plan Review - Final	45	08-Oct-12	10-Dec-12	
RFP/Subcontractor & Vendor Proposals	11	11-Oct-12	25-Oct-12	
Early Start Work Permit: Ftg & Fnd Permit Issued	10	17-Oct-12	30-Oct-12	
City Building Permit Review & Issue	10	18-Oct-12	31-Oct-12	
Project Buyout/Award	10	31-Oct-12	13-Nov-12	
Shop Drawing & Submittals (Material Procurement)	10	30-Nov-12	13-Dec-12	
Shop Drawing Review & Approval	10	21-Dec-12	07-Jan-13	
Silverado.Material Procurement 2	68	04-Jan-13	09-Apr-13	0
Truss Fabrication	30	04-Jan-13	14-Feb-13	
Exterior Wall Panel Fabrication	40	08-Jan-13	04-Mar-13	
Interior Wall Panels Fabrication	20	08-Jan-13	04-Feb-13	
Solarium Fabrication	60	16-Jan-13	09-Apr-13	
Window Fabrication	25	22-Jan-13	25-Feb-13	
Silverado.Sitework 3	55	06-Sep-12	21-Nov-12	0
Silverado.Sitework.Phase 1 (New WBS)	19	06-Sep-12	02-Oct-12	0
Site Layout	1	06-Sep-12	06-Sep-12	
Silt Fence and Temp. Construction Fence	1	07-Sep-12	07-Sep-12	
Clear and Grub Site	5	07-Sep-12	13-Sep-12	
Strip Topsoil	4	14-Sep-12	19-Sep-12	
Temporary Diversion Swales & Sediment Trap	2	14-Sep-12	17-Sep-12	
Rough Grade (Cuts and Fills)	6	18-Sep-12	25-Sep-12	
42" HERCP Storm Sewer	5	24-Sep-12	28-Sep-12	
Remove Temp Diversion Swales	1	26-Sep-12	26-Sep-12	
Pond Construction	5	26-Sep-12	02-Oct-12	
Silverado.Sitework.Phase 2 (New WBS)-1	33	27-Sep-12	12-Nov-12	0
Strip Topsoil	2	27-Sep-12	28-Sep-12	
Rough Grade Cuts and Fills	6	28-Sep-12	05-Oct-12	
Water Main & Fire Hydrant	4	02-Oct-12	05-Oct-12	
Final Grade Pond	2	04-Oct-12	05-Oct-12	
Storm Sewer East	3	05-Oct-12	09-Oct-12	
Sanitary Sewer	3	10-Oct-12	12-Oct-12	

Actual Level of Effort	Remaining Work	◆ Milestone	Page 1 of 5
Actual Work	Critical Remaining Work	summary	TASK filter: All Activities

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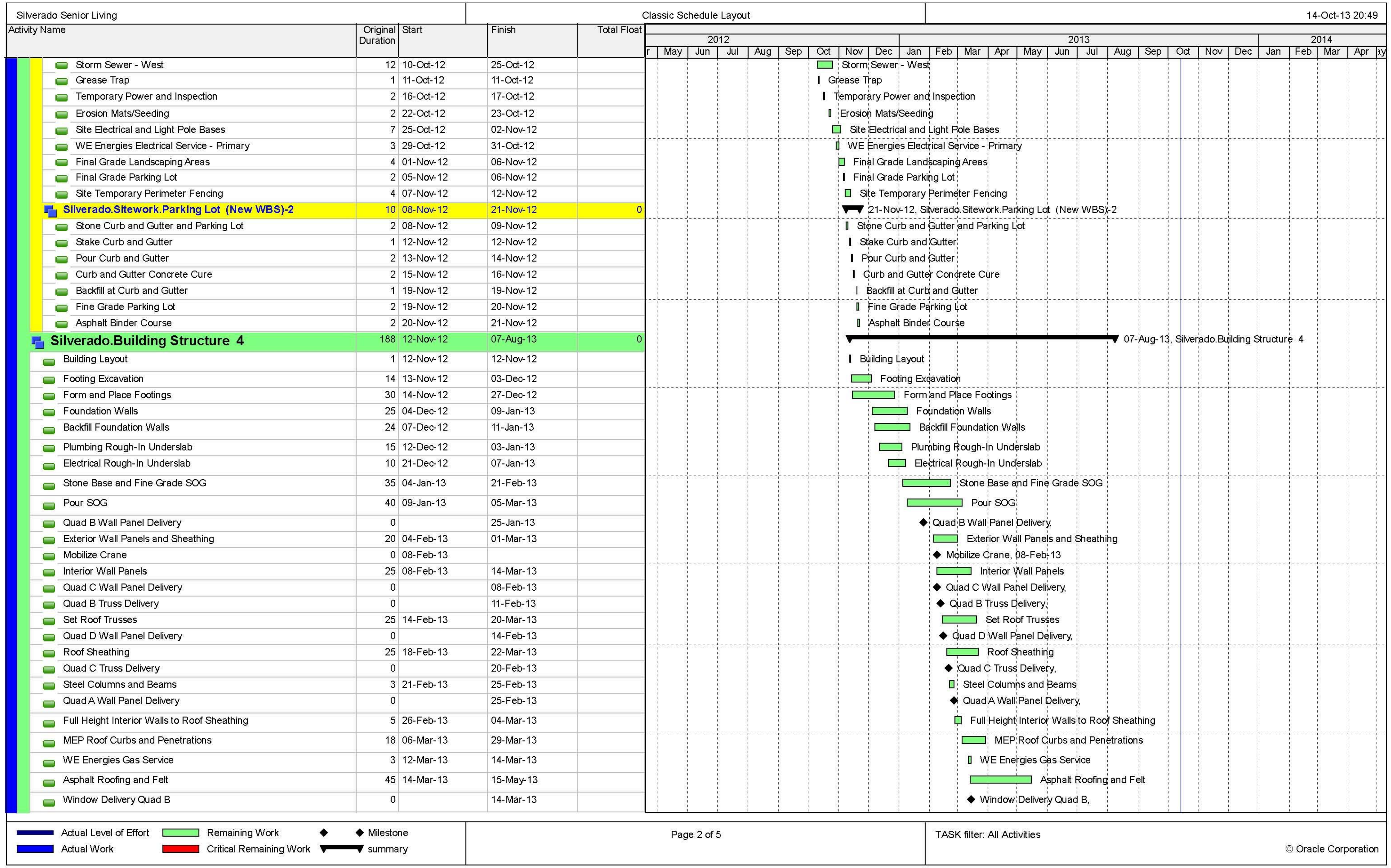

Silverado Senior Living | Classic Schedule Layout | 14-Oct-13 20:49

Activity Name	Original Duration	Start	Finish	Total Float
Storm Sewer - West	12	10-Oct-12	25-Oct-12	
Grease Trap	1	11-Oct-12	11-Oct-12	
Temporary Power and Inspection	2	16-Oct-12	17-Oct-12	
Erosion Mats/Seeding	2	22-Oct-12	23-Oct-12	
Site Electrical and Light Pole Bases	7	25-Oct-12	02-Nov-12	
WE Energies Electrical Service - Primary	3	29-Oct-12	31-Oct-12	
Final Grade Landscaping Areas	4	01-Nov-12	06-Nov-12	
Final Grade Parking Lot	2	05-Nov-12	06-Nov-12	
Site Temporary Perimeter Fencing	4	07-Nov-12	12-Nov-12	
Silverado.Sitework.Parking Lot (New WBS)-2	10	08-Nov-12	21-Nov-12	0
Stone Curb and Gutter and Parking Lot	2	08-Nov-12	09-Nov-12	
Stake Curb and Gutter	1	12-Nov-12	12-Nov-12	
Pour Curb and Gutter	2	13-Nov-12	14-Nov-12	
Curb and Gutter Concrete Cure	2	15-Nov-12	16-Nov-12	
Backfill at Curb and Gutter	1	19-Nov-12	19-Nov-12	
Fine Grade Parking Lot	2	19-Nov-12	20-Nov-12	
Asphalt Binder Course	2	20-Nov-12	21-Nov-12	
Silverado.Building Structure 4	188	12-Nov-12	07-Aug-13	0
Building Layout	1	12-Nov-12	12-Nov-12	
Footing Excavation	14	13-Nov-12	03-Dec-12	
Form and Place Footings	30	14-Nov-12	27-Dec-12	
Foundation Walls	25	04-Dec-12	09-Jan-13	
Backfill Foundation Walls	24	07-Dec-12	11-Jan-13	
Plumbing Rough-In Underslab	15	12-Dec-12	03-Jan-13	
Electrical Rough-In Underslab	10	21-Dec-12	07-Jan-13	
Stone Base and Fine Grade SOG	35	04-Jan-13	21-Feb-13	
Pour SOG	40	09-Jan-13	05-Mar-13	
Quad B Wall Panel Delivery	0		25-Jan-13	
Exterior Wall Panels and Sheathing	20	04-Feb-13	01-Mar-13	
Mobilize Crane	0	08-Feb-13		
Interior Wall Panels	25	08-Feb-13	14-Mar-13	
Quad C Wall Panel Delivery	0		08-Feb-13	
Quad B Truss Delivery	0		11-Feb-13	
Set Roof Trusses	25	14-Feb-13	20-Mar-13	
Quad D Wall Panel Delivery	0		14-Feb-13	
Roof Sheathing	25	18-Feb-13	22-Mar-13	
Quad C Truss Delivery	0		20-Feb-13	
Steel Columns and Beams	3	21-Feb-13	25-Feb-13	
Quad A Wall Panel Delivery	0		25-Feb-13	
Full Height Interior Walls to Roof Sheathing	5	26-Feb-13	04-Mar-13	
MEP Roof Curbs and Penetrations	18	06-Mar-13	29-Mar-13	
WE Energies Gas Service	3	12-Mar-13	14-Mar-13	
Asphalt Roofing and Felt	45	14-Mar-13	15-May-13	
Window Delivery Quad B	0		14-Mar-13	

Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
◆ Milestone
summary

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TASK filter: All Activities

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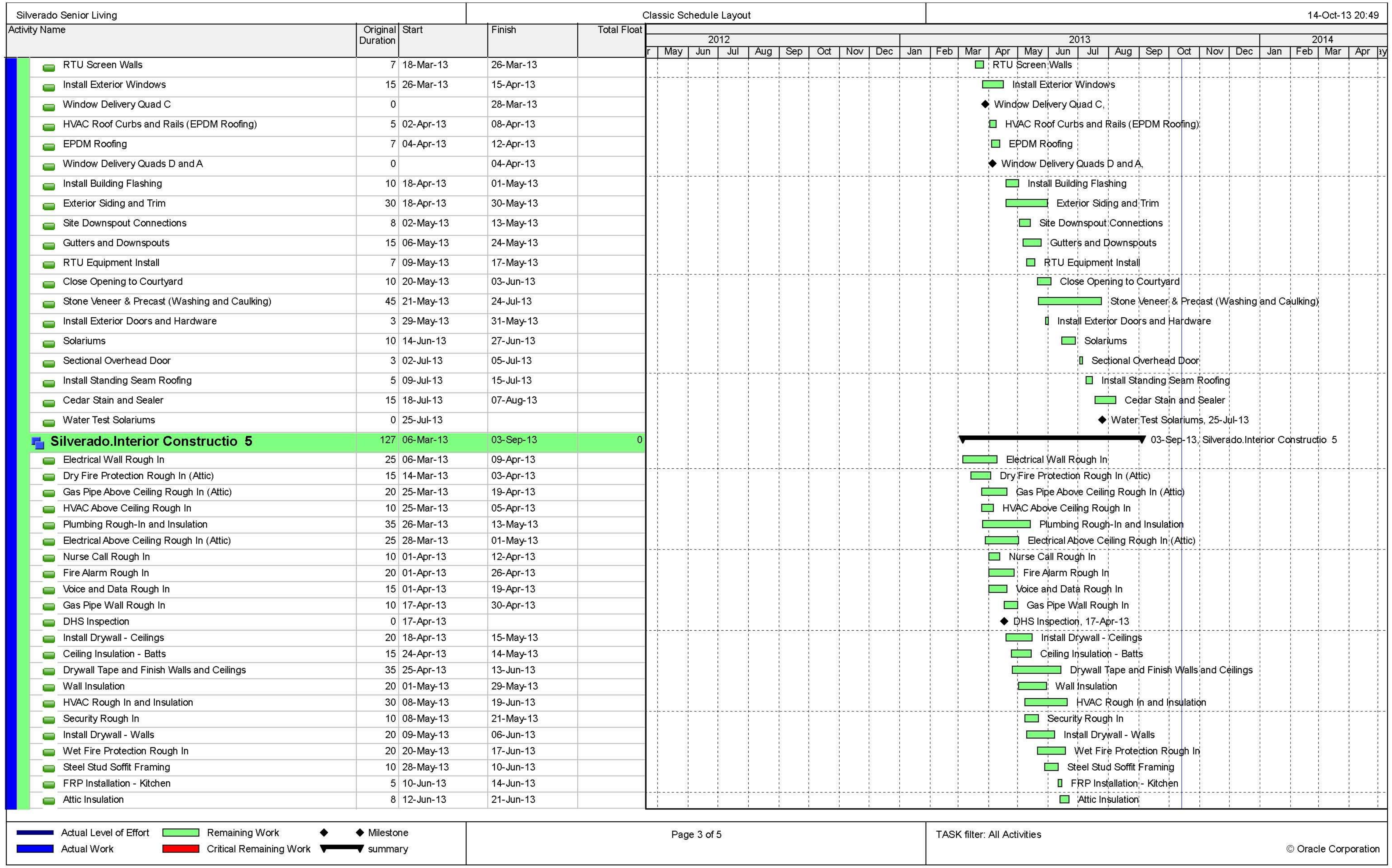

Silverado Senior Living | Classic Schedule Layout | 14-Oct-13 20:49

Activity Name	Original Duration	Start	Finish	Total Float
RTU Screen Walls	7	18-Mar-13	26-Mar-13	
Install Exterior Windows	15	26-Mar-13	15-Apr-13	
Window Delivery Quad C	0		28-Mar-13	
HVAC Roof Curbs and Rails (EPDM Roofing)	5	02-Apr-13	08-Apr-13	
EPDM Roofing	7	04-Apr-13	12-Apr-13	
Window Delivery Quads D and A	0		04-Apr-13	
Install Building Flashing	10	18-Apr-13	01-May-13	
Exterior Siding and Trim	30	18-Apr-13	30-May-13	
Site Downspout Connections	8	02-May-13	13-May-13	
Gutters and Downspouts	15	06-May-13	24-May-13	
RTU Equipment Install	7	09-May-13	17-May-13	
Close Opening to Courtyard	10	20-May-13	03-Jun-13	
Stone Veneer & Precast (Washing and Caulking)	45	21-May-13	24-Jul-13	
Install Exterior Doors and Hardware	3	29-May-13	31-May-13	
Solariums	10	14-Jun-13	27-Jun-13	
Sectional Overhead Door	3	02-Jul-13	05-Jul-13	
Install Standing Seam Roofing	5	09-Jul-13	15-Jul-13	
Cedar Stain and Sealer	15	18-Jul-13	07-Aug-13	
Water Test Solariums	0	25-Jul-13		
Silverado.Interior Constructio 5	127	06-Mar-13	03-Sep-13	0
Electrical Wall Rough In	25	06-Mar-13	09-Apr-13	
Dry Fire Protection Rough In (Attic)	15	14-Mar-13	03-Apr-13	
Gas Pipe Above Ceiling Rough In (Attic)	20	25-Mar-13	19-Apr-13	
HVAC Above Ceiling Rough In	10	25-Mar-13	05-Apr-13	
Plumbing Rough-In and Insulation	35	26-Mar-13	13-May-13	
Electrical Above Ceiling Rough In (Attic)	25	28-Mar-13	01-May-13	
Nurse Call Rough In	10	01-Apr-13	12-Apr-13	
Fire Alarm Rough In	20	01-Apr-13	26-Apr-13	
Voice and Data Rough In	15	01-Apr-13	19-Apr-13	
Gas Pipe Wall Rough In	10	17-Apr-13	30-Apr-13	
DHS Inspection	0	17-Apr-13		
Install Drywall - Ceilings	20	18-Apr-13	15-May-13	
Ceiling Insulation - Batts	15	24-Apr-13	14-May-13	
Drywall Tape and Finish Walls and Ceilings	35	25-Apr-13	13-Jun-13	
Wall Insulation	20	01-May-13	29-May-13	
HVAC Rough In and Insulation	30	08-May-13	19-Jun-13	
Security Rough In	10	08-May-13	21-May-13	
Install Drywall - Walls	20	09-May-13	06-Jun-13	
Wet Fire Protection Rough In	20	20-May-13	17-Jun-13	
Steel Stud Soffit Framing	10	28-May-13	10-Jun-13	
FRP Installation - Kitchen	5	10-Jun-13	14-Jun-13	
Attic Insulation	8	12-Jun-13	21-Jun-13	

Actual Level of Effort	Remaining Work	◆ ◆ Milestone
Actual Work	Critical Remaining Work	summary

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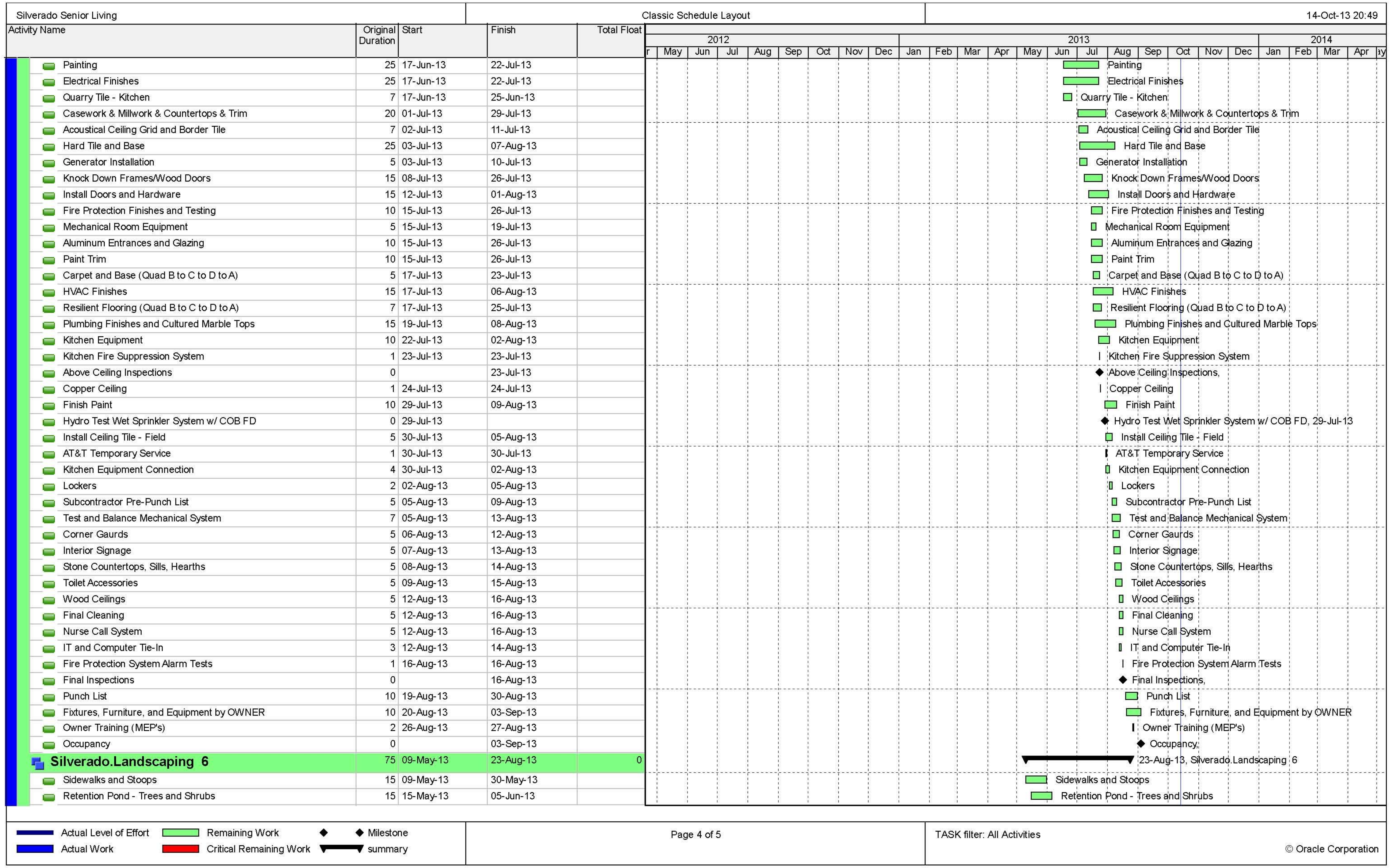
TASK filter: All Activities



Silverado Senior Living | Classic Schedule Layout | 14-Oct-13 20:49

Activity Name	Original Duration	Start	Finish	Total Float
Painting	25	17-Jun-13	22-Jul-13	
Electrical Finishes	25	17-Jun-13	22-Jul-13	
Quarry Tile - Kitchen	7	17-Jun-13	25-Jun-13	
Casework & Millwork & Countertops & Trim	20	01-Jul-13	29-Jul-13	
Acoustical Ceiling Grid and Border Tile	7	02-Jul-13	11-Jul-13	
Hard Tile and Base	25	03-Jul-13	07-Aug-13	
Generator Installation	5	03-Jul-13	10-Jul-13	
Knock Down Frames/Wood Doors	15	08-Jul-13	26-Jul-13	
Install Doors and Hardware	15	12-Jul-13	01-Aug-13	
Fire Protection Finishes and Testing	10	15-Jul-13	26-Jul-13	
Mechanical Room Equipment	5	15-Jul-13	19-Jul-13	
Aluminum Entrances and Glazing	10	15-Jul-13	26-Jul-13	
Paint Trim	10	15-Jul-13	26-Jul-13	
Carpet and Base (Quad B to C to D to A)	5	17-Jul-13	23-Jul-13	
HVAC Finishes	15	17-Jul-13	06-Aug-13	
Resilient Flooring (Quad B to C to D to A)	7	17-Jul-13	25-Jul-13	
Plumbing Finishes and Cultured Marble Tops	15	19-Jul-13	08-Aug-13	
Kitchen Equipment	10	22-Jul-13	02-Aug-13	
Kitchen Fire Suppression System	1	23-Jul-13	23-Jul-13	
Above Ceiling Inspections	0		23-Jul-13	
Copper Ceiling	1	24-Jul-13	24-Jul-13	
Finish Paint	10	29-Jul-13	09-Aug-13	
Hydro Test Wet Sprinkler System w/ COB FD	0	29-Jul-13		
Install Ceiling Tile - Field	5	30-Jul-13	05-Aug-13	
AT&T Temporary Service	1	30-Jul-13	30-Jul-13	
Kitchen Equipment Connection	4	30-Jul-13	02-Aug-13	
Lockers	2	02-Aug-13	05-Aug-13	
Subcontractor Pre-Punch List	5	05-Aug-13	09-Aug-13	
Test and Balance Mechanical System	7	05-Aug-13	13-Aug-13	
Corner Gaurds	5	06-Aug-13	12-Aug-13	
Interior Signage	5	07-Aug-13	13-Aug-13	
Stone Countertops, Sills, Hearths	5	08-Aug-13	14-Aug-13	
Toilet Accessories	5	09-Aug-13	15-Aug-13	
Wood Ceilings	5	12-Aug-13	16-Aug-13	
Final Cleaning	5	12-Aug-13	16-Aug-13	
Nurse Call System	5	12-Aug-13	16-Aug-13	
IT and Computer Tie-In	3	12-Aug-13	14-Aug-13	
Fire Protection System Alarm Tests	1	16-Aug-13	16-Aug-13	
Final Inspections	0		16-Aug-13	
Punch List	10	19-Aug-13	30-Aug-13	
Fixtures, Furniture, and Equipment by OWNER	10	20-Aug-13	03-Sep-13	
Owner Training (MEP's)	2	26-Aug-13	27-Aug-13	
Occupancy	0		03-Sep-13	
Silverado.Landscaping 6	75	09-May-13	23-Aug-13	0
Sidewalks and Stoops	15	09-May-13	30-May-13	
Retention Pond - Trees and Shrubs	15	15-May-13	05-Jun-13	

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

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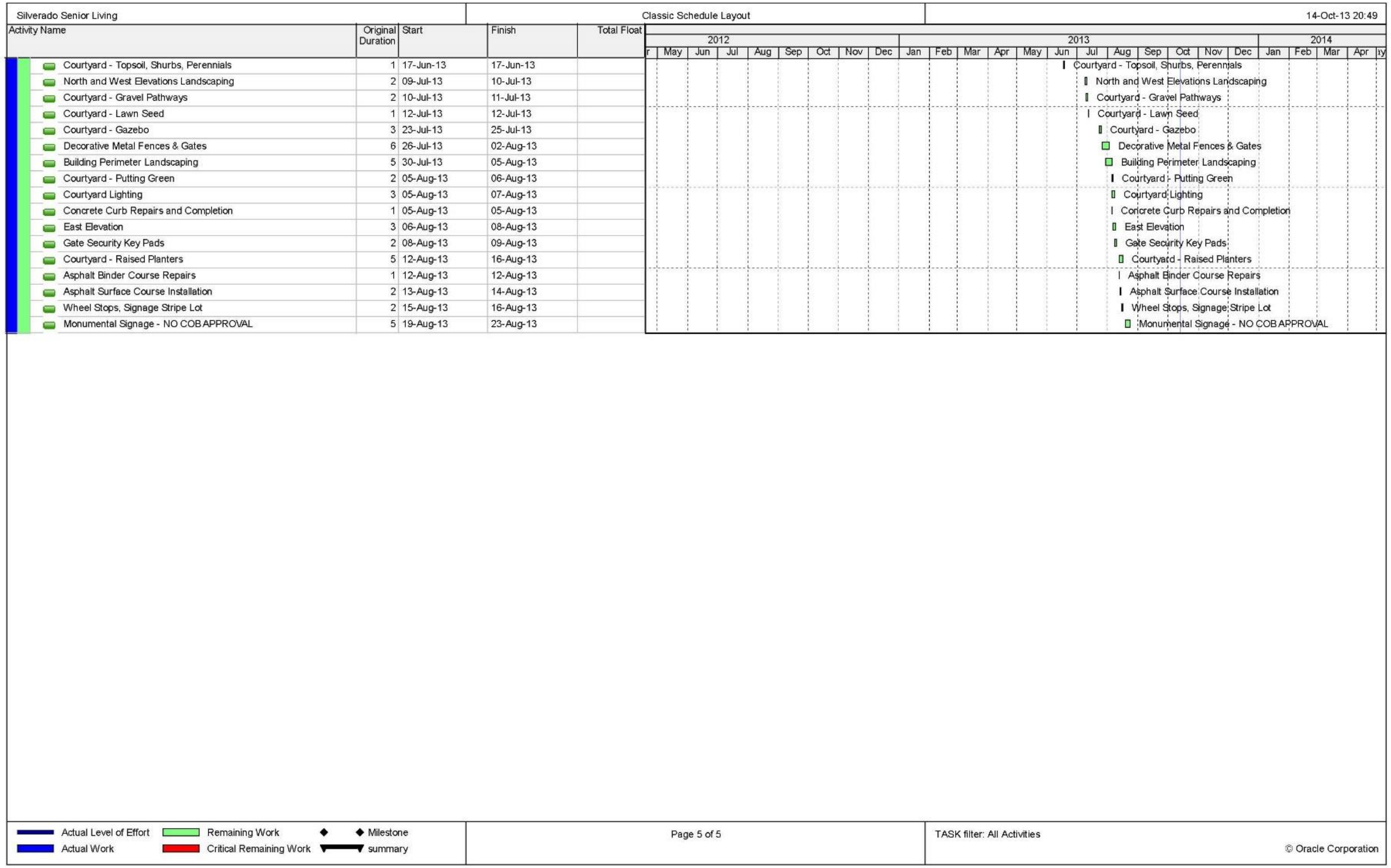
TASK filter: All Activities



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Activity Name	Original Duration	Start	Finish	Total Float
Courtyard - Topsoil, Shurbs, Perennials	1	17-Jun-13	17-Jun-13	
North and West Elevations Landscaping	2	09-Jul-13	10-Jul-13	
Courtyard - Gravel Pathways	2	10-Jul-13	11-Jul-13	
Courtyard - Lawn Seed	1	12-Jul-13	12-Jul-13	
Courtyard - Gazebo	3	23-Jul-13	25-Jul-13	
Decorative Metal Fences & Gates	6	26-Jul-13	02-Aug-13	
Building Perimeter Landscaping	5	30-Jul-13	05-Aug-13	
Courtyard - Putting Green	2	05-Aug-13	06-Aug-13	
Courtyard Lighting	3	05-Aug-13	07-Aug-13	
Concrete Curb Repairs and Completion	1	05-Aug-13	05-Aug-13	
East Elevation	3	06-Aug-13	08-Aug-13	
Gate Security Key Pads	2	08-Aug-13	09-Aug-13	
Courtyard - Raised Planters	5	12-Aug-13	16-Aug-13	
Asphalt Binder Course Repairs	1	12-Aug-13	12-Aug-13	
Asphalt Surface Course Installation	2	13-Aug-13	14-Aug-13	
Wheel Stops, Signage Stripe Lot	2	15-Aug-13	16-Aug-13	
Monumental Signage - NO COB APPROVAL	5	19-Aug-13	23-Aug-13	

Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
◆ Milestone
summary

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TASK filter: All Activities

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Appendix D: General Conditions Estimate

Description	Amount
Management and Staffing	$447,080.00
Temporary Utilities	$29,700.00
Equipment and Facilities	$123,454.00
Insurace, Permits, and Bonding	$205,537.66
Total	**$805,771.66**

Insurance, Permits, & Bonding				
Item	**Cost per Unit**		**Construction Cost**	**Cost**
Insurance - All Risk	0.45%	job	$7,612,506	$34,256.28
Performance Bond	1.50%	job	$7,612,506	$114,187.590
Permits	0.75%	job	$7,612,506	$57,093.80
Total				**$205,537.66**

Management & Staffing					
Role	Quantity	Unit	Base Cost per Hour	Total	Notes
Project Executive	400.0	hr	$129.00	$51,600.00	8 hrs/wk x 50 wks
Sr. Project Manager	2000.0	hr	$88.00	$176,000.00	40 hrs/wk x 50 wks
Senior Estimator	360.0	hr	$93.00	$33,480.00	40 hrs/wk x 50 wks
General Superintendant	200.0	hr	$88.00	$17,600.00	4 hrs/wk x 50 wks
Superintendant	2000.0	hr	$77.00	$154,000.00	40 hrs/wk x 50 wks
Safety Officer	200.0	hr	$72.00	$14,400.00	4 hrs/wk x 50 wks
Total	**5160.0**			**$447,080.00**	

Temporary Utilities				
Description	**Quantity**	**Unit**	**Cost per Unit**	**Total Cost**
Telephone Charges	12	Month	$300.00	$3,600.00
Broadband/Internet Charges	12	Month	$400.00	$4,800.00
Cell Phone Charges	12	Month	$225.00	$2,700.00
Electric Power	12	Month	$650.00	$7,800.00
Drinking Water/Water Cooler	12	Month	$75.00	$900.00
Temporary Toilets	12	Month	$375.00	$4,500.00
Trailer Heat/Propane	12	Month	$450.00	$5,400.00
Total				**$29,700.00**

Equipment and Facilities	
Description	**Total Cost**
Office Trailor	$5,496.00
Trailer Setup and Breakdown	$900.00
Trailer Utility Hook-ups	$4,400.00
Trailor Towing	$800.00
Field Office Supplies (Avg.)	$3,000.00
Field Office Printer/Copier	$7,800.00
Site Signage	$1,500.00
Postage/Federal Express	$1,200.00
First Aid & Safety Supplies	$3,600.00
Fire Extinguishers	$1,500.00
Fire Extinguisher Stands	$1,800.00
Trash Disposal/Dumpsters	$34,416.00
Blueprints Throughout Construction	$3,500.00
Weekly Cleaning	$19,392.00
Auto Mileage	$1,400.00
Superintendant Truck Fuel	$4,000.00
Misc Tools	$6,600.00
Cargo Box	$3,000.00
Warehouse Trucking	$10,060.00
Yard Work	$9,090.00
Total	**$123,454.00**

Appendix E: Quad B Delivery Wall Panel Take-Offs

Suspended Waste and Ventilation

Panel	Component	Quantiy	Units	Labor Hours	Total Hours
7	1 1/2" Diameter, PVC Schedule 40 Cleanout Tee	1.0	Ea.	0.533	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	10.5	LF	0.222	2.3
	1 1/4" Diameter PVC, Schedule 40 Piping	10.5	LF	0.19	2.0
	2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.271	0.4
	3" Diameter PVC, Schedule 40 Piping	1.3	LF	0.302	0.4
	1 1/2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.602	0.6
	1 1/4" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
	1 1/2" Diameter, PVC, Schedule 40 Cleanout Plug	1.0	Ea.	0.25	0.3
	2" Diameter PVC, Reducing Insert	1.0	Ea.	0.4	0.4
	3" Diameter PVC, Reducing Insert	1.0	Ea.	0.8	0.8
10	1 1/2" Diameter PVC, Schedule 40 Piping	12.7	LF	0.222	2.8
11	2" Diameter PVC, Schedule 40 Piping	12.7	LF	0.271	3.4
13	1 1/4" Diameter PVC, Schedule 40 Piping	6.8	LF	0.19	1.3
	2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
	2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.271	0.4
	2" Diameter PVC, Reducing Insert	1.0	Ea.	0.4	0.4
14	1 1/4" Diameter PVC, Schedule 40 Piping	7.1	LF	0.19	1.4
	2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
	2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.271	2.4
	3" Diameter PVC, Schedule 40 Piping	1.3	LF	0.302	0.4
	3" Diameter PVC, Schedule 40 Tee	1.0	Ea.	1.053	1.1
	3" Diameter PVC, Reducing Insert	1.0	Ea.	0.8	0.8
43	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
40	1 1/4" Diameter PVC, Schedule 40 Piping	5.9	LF	0.19	1.1
	3" Diameter, PVC Schedule 40 Cleanout Tee	1.0	Ea.	0.762	0.8
	3" Diameter, PVC, Schedule 40 Cleanout Plug	1.0	Ea.	0.444	0.4
	3" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	3" Diameter PVC, Reducing Insert	1.0	Ea.	0.8	0.8
46	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
47	1 1/4" Diameter PVC, Schedule 40 Piping	6.8	LF	0.19	1.3
	3" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
	3" Diameter PVC, Schedule 40 Piping	1.3	LF	0.302	0.4
	3" Diameter PVC, Reducing Insert	1.0	Ea.	0.8	0.8
51	1 1/4" Diameter PVC, Schedule 40 Piping	7.3	LF	0.19	1.4
55	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
60	2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.271	2.4

70	1 1/2" Diameter, PVC Schedule 40 Cleanout Tee	1.0	Ea.	0.533	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	15.8	LF	0.222	3.5
	1 1/2" Diameter, PVC, Schedule 40 Cleanout Plug	1.0	Ea.	0.25	0.3
	1 1/4" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
	1 1/4" Diameter PVC, Schedule 40 Piping	8.3	LF	0.19	1.6
	2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.271	2.4
91	2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.271	0.4
	1 1/2" Diameter PVC, Schedule 40 Piping	10.1	LF	0.222	2.2
	1 1/2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.602	0.6
	1 1/2 Diameter PVC, Reducing Insert	1.0	Ea.	0.364	0.4
154	2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.271	0.4
	1 1/2" Diameter PVC, Schedule 40 Piping	9.3	LF	0.222	2.1
	1 1/2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.602	0.6
	1 1/2 Diameter PVC, Reducing Insert	1.0	Ea.	0.364	0.4
232	2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.271	0.4
	2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
	1 1/4" Diameter PVC, Schedule 40 Piping	6.8	LF	0.19	1.3
	2" Diameter PVC, Reducing Insert	1.0	Ea.	0.4	0.4
238	1 1/2" Diameter PVC, Schedule 40 Piping	26.0	LF	0.222	5.8
	3" Diameter PVC, Schedule 40 Piping	8.7	LF	0.302	2.6
234	1 1/4" Diameter PVC, Schedule 40 Piping	13.6	LF	0.19	2.6
	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
	2" Diameter PVC, Schedule 40 Piping	2.6	LF	0.271	0.7
	2" Diameter PVC, Reducing Insert	2.0	Ea.	0.4	0.8
	2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
248	1 1/4" Diameter PVC, Schedule 40 Piping	6.8	LF	0.19	1.3
	1 1/2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.222	0.3
	1 1/2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.602	0.6
	1 1/2 Diameter PVC, Reducing Insert	1.0	Ea.	0.364	0.4
243	1 1/4" Diameter PVC, Schedule 40 Piping	6.8	LF	0.19	1.3
	2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.271	0.4
	2" Diameter PVC, Reducing Insert	2.0	Ea.	0.4	0.8
	2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5
246	1 1/4" Diameter PVC, Schedule 40 Piping	6.8	LF	0.19	1.3
	1 1/2" Diameter PVC, Schedule 40 Piping	1.3	LF	0.222	0.3
	1 1/2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.602	0.6
	1 1/2 Diameter PVC, Reducing Insert	1.0	Ea.	0.364	0.4
					81.6

Supply/Return Piping

Panel	Component	Quantiy	Units	Labor Hours	Total Hours
91	3/4" CPVC Piping, socket joint, incl. clamps and supports	8.4	LF	0.157	1.3188
	3/4" CPVC 90 Deg. Elbow	1	Ea.	0.308	0.308
	1/2" CPVC Piping, socket joint, incl. clamps and supports	8.4	LF	0.148	1.2432
	1/2" CPVC 90 Deg. Elbow	3	Ea.	0.25	0.75
40	3/4" CPVC Piping, socket joint, incl. clamps and supports	8.4	LF	0.157	1.3188
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
7	3/4" CPVC Piping, socket joint, incl. clamps and supports	8.4	LF	0.157	1.3188
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC Piping, socket joint, incl. clamps and supports	25.2	LF	0.148	3.7296
	1/2" CPVC 90 Deg. Elbow	6	Ea.	0.25	1.5
	1 -1/2" CPVC Piping, socket joint, incl. clamps and supports	8.4	LF	0.222	1.8648
	1-1/2" CPVC 90 Deg. Elbow	2	Ea.	0.661	1.322
47	3/4" CPVC Piping, socket joint, incl. clamps and supports	3	LF	0.157	0.471
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
70	1/2" CPVC Piping, socket joint, incl. clamps and supports	33.6	LF	0.148	4.9728
	1/2" CPVC 90 Deg. Elbow	8	Ea.	0.25	2
71	1/2" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.148	2.664
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
63	3/4" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.157	2.826
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12	LF	0.148	1.776
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
11	3/4" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.157	2.826
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12	LF	0.148	1.776
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
13	3/4" CPVC Piping, socket joint, incl. clamps and supports	12.4	LF	0.157	1.9468
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
14	1/2" CPVC Piping, socket joint, incl. clamps and supports	36	LF	0.148	5.328
	1/2" CPVC 90 Deg. Elbow	8	Ea.	0.25	2
12	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
154	3/4" CPVC Piping, socket joint, incl. clamps and supports	3	LF	0.157	0.471
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
232	3/4" CPVC Piping, socket joint, incl. clamps and supports	3	LF	0.157	0.471
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
234	3/4" CPVC Piping, socket joint, incl. clamps and supports	3	LF	0.157	0.471
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
252	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
240	1/2" CPVC Piping, socket joint, incl. clamps and supports	13.3	LF	0.148	1.9684
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
246	1/2" CPVC Piping, socket joint, incl. clamps and supports	13.3	LF	0.148	1.9684
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
					67.7064

Appendix F: Quad C Delivery Wall Panel Take-Offs

Suspended Waste and Ventilation

Panel	Item Number	Component	Quantiy	Units	Labor Hours	Total Hours
473	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
438	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
467	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
416	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
451	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
443	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
364	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
356	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
346	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
396	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
334	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
322	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
369	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
294	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
277	22 11 13.74 1930	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	22 11 13.74 1900	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	22 05 76.20 5030	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	22 11 13.76 3717	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	22 11 13.76 3250	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
						74.1

Supply/Return Piping

Panel	Component	Quantiy	Units	Labor Hours	Total Hours
473	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
477	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
438	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
437	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
E67	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
467	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
466	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
416	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
451	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1

450	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
443	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
447	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
E63	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
356	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
362	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
357	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
346	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
345	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
396	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
400	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
395	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
334	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
329	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
336	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
322	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
321	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
326	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1

374	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
369	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
376	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
272	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1 -1/2" CPVC Piping, socket joint, incl. clamps and supports	8.4	LF	0.222	1.8648
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
	1-1/2" CPVC 90 Deg. Elbow	2	Ea.	0.661	1.322
304	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
294	1/2" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.148	2.664
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
298	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
E96	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
					154.48335

Appendix G: Quad A Delivery Wall Panel Take-Offs

Suspended Waste and Ventilation

Panel	Component	Quantiy	Units	Labor Hours	Total Hours
517	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
	1 1/4" Diameter PVC, Schedule 40 Piping	6.9	LF	0.19	1.3
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
544	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
	1 1/4" Diameter PVC, Schedule 40 Piping	6.9	LF	0.19	1.3
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
547	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
551	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
598	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
569	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
624	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
638	1 1/2" Diameter PVC, Schedule 40 Piping	9.7	LF	0.222	2.2
	2" Diameter PVC, Schedule 40 Piping	1.4	LF	0.271	0.4
	2" Diameter PVC, Reducing Insert	1.0	Ea.	0.4	0.4
	2" Diameter PVC, Schedule 40 Tee	1.0	Ea.	0.541	0.5

693	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
709	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
646	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
658	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
719	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
729	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
668	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
740	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1

679	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
676	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
755	1 1/4" Diameter PVC, Schedule 40 Piping	6.9	LF	0.19	1.3
	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
874	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
816	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
828	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
876	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
906	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
859	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
920	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1

952	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
942	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
945	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
955	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
1004	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
969	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
981	3" Diameter PVC, Schedule 40 Piping	3.6	LF	0.302	1.1
	1 1/2" Diameter PVC, Schedule 40 Piping	10.8	LF	0.222	2.4
	3" Diameter, PVC Schedule 40 Cleanout Tee	2	Ea.	0.762	1.5
	3" Diameter PVC, Reducing Insert	2	Ea.	0.8	1.6
	3" Diameter PVC, Schedule 40 Tee	2	Ea.	1.053	2.1
1027	3" Diameter PVC, Schedule 40 Piping	1.8	LF	0.302	0.5
	1 1/2" Diameter PVC, Schedule 40 Piping	5.9	LF	0.222	1.3
	3" Diameter, PVC Schedule 40 Cleanout Tee	1	Ea.	0.762	0.8
	3" Diameter PVC, Reducing Insert	1	Ea.	0.8	0.8
	3" Diameter PVC, Schedule 40 Tee	1	Ea.	1.053	1.1
991	1 1/2" Diameter PVC, Schedule 40 Piping	8.7	LF	0.222	1.9
					149.2

Supply/Return Piping

Panel	Component	Quantiy	Units	Labor Hours	Total Hours
739	3/4" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.157	2.826
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
740	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
679	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
680	3/4" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.157	2.826
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
676	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
729	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
735	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
731	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
668	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
670	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
674	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
718	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
719	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
709	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1

646	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
650	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
705	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
702	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
695	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
699	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
693	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
624	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
628	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
623	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
569	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
578	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
572	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
602	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
597	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
598	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25

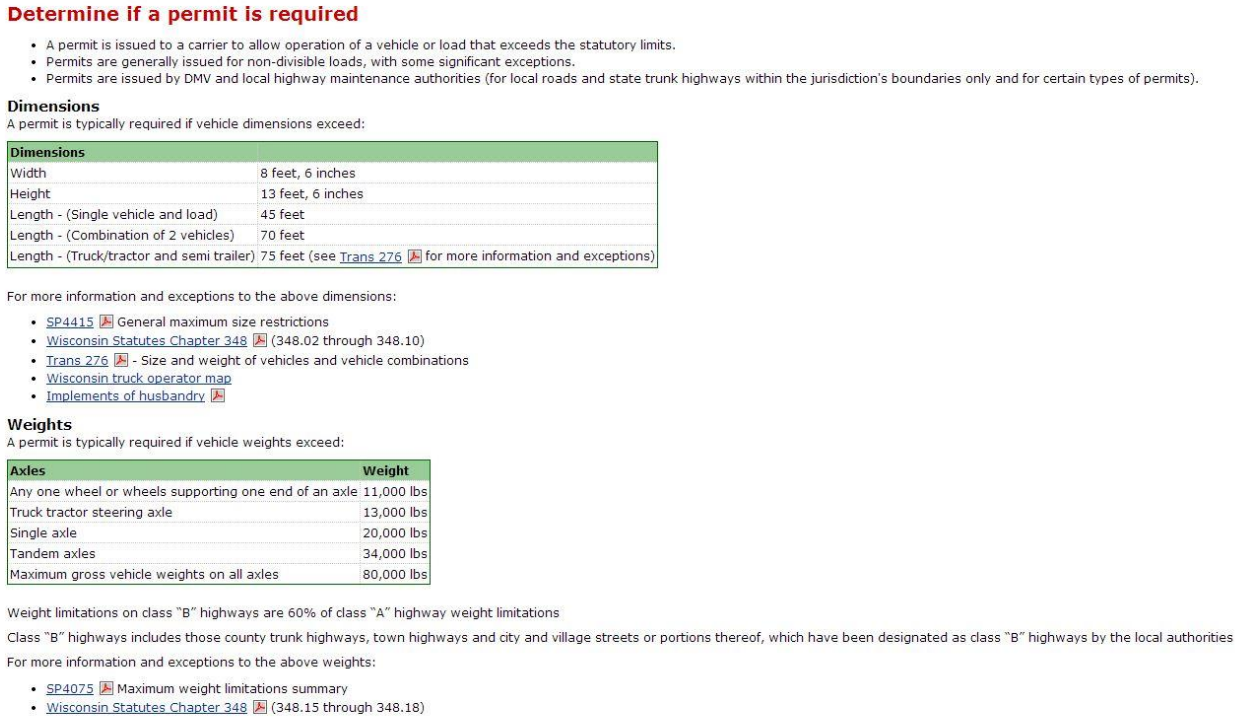
618	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
573	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
551	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
556	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
547	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1 -1/2" CPVC Piping, socket joint, incl. clamps and supports	8.4	LF	0.222	1.8648
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
	1-1/2" CPVC 90 Deg. Elbow	2	Ea.	0.661	1.322
544	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
512	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
518	1/2" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.148	2.664
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
510	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
664	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
757	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
769	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
752	1/2" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.148	2.664
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
749	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
755	1/2" CPVC Piping, socket joint, incl. clamps and supports	16.8	LF	0.148	2.4864
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
878	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
874	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
816	1/2" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.148	2.664
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5

828	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
827	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
832	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
822	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
896	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
895	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
900	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
906	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
903	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
853	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
854	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
858	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
910	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
919	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
920	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
932	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
931	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
936	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1

945	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
949	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
955	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
952	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
872	3/4" CPVC Piping, socket joint, incl. clamps and supports	3	LF	0.157	0.471
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
959	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
969	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
968	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
1004	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
1003	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
1008	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
981	3/4" Tee, CPVC, Sched. 80, Socket	4	Ea.	0.462	1.848
	1/2" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.396	0.792
	3/4" CPVC Piping, socket joint, incl. clamps and supports	20.3	LF	0.157	3.1871
	1/2" CPVC Piping, socket joint, incl. clamps and supports	27.7	LF	0.148	4.0996
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	5	Ea.	0.25	1.25
980	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
987	1/2" CPVC Piping, socket joint, incl. clamps and supports	18	LF	0.148	2.664
	1/2" CPVC 90 Deg. Elbow	2	Ea.	0.25	0.5
1027	3/4" Tee, CPVC, Sched. 80, Socket	2	Ea.	0.462	0.924
	1/2" Tee, CPVC, Sched. 80, Socket	1	Ea.	0.396	0.396
	3/4" CPVC Piping, socket joint, incl. clamps and supports	11.85	LF	0.157	1.86045
	1/2" CPVC Piping, socket joint, incl. clamps and supports	12.8	LF	0.148	1.8944
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
1026	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
1028	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
1010	3/4" CPVC Piping, socket joint, incl. clamps and supports	5.6	LF	0.157	0.8792
	3/4" CPVC 90 Deg. Elbow	2	Ea.	0.308	0.616
985	1/2" CPVC Piping, socket joint, incl. clamps and supports	10.4	LF	0.148	1.5392
	1/2" CPVC 90 Deg. Elbow	4	Ea.	0.25	1
					378.25435

Appendix H: Trucking Limitations, Maps, and Diagrams

Permit Information and Limitations



Determine if a permit is required

- A permit is issued to a carrier to allow operation of a vehicle or load that exceeds the statutory limits.
- Permits are generally issued for non-divisible loads, with some significant exceptions.
- Permits are issued by DMV and local highway maintenance authorities (for local roads and state trunk highways within the jurisdiction's boundaries only and for certain types of permits).

Dimensions

A permit is typically required if vehicle dimensions exceed:

Dimensions	
Width	8 feet, 6 inches
Height	13 feet, 6 inches
Length - (Single vehicle and load)	45 feet
Length - (Combination of 2 vehicles)	70 feet
Length - (Truck/tractor and semi trailer)	75 feet (see Trans 276 for more information and exceptions)

For more information and exceptions to the above dimensions:

- SP4415 General maximum size restrictions
- Wisconsin Statutes Chapter 348 (348.02 through 348.10)
- Trans 276 - Size and weight of vehicles and vehicle combinations
- Wisconsin truck operator map
- Implements of husbandry

Weights

A permit is typically required if vehicle weights exceed:

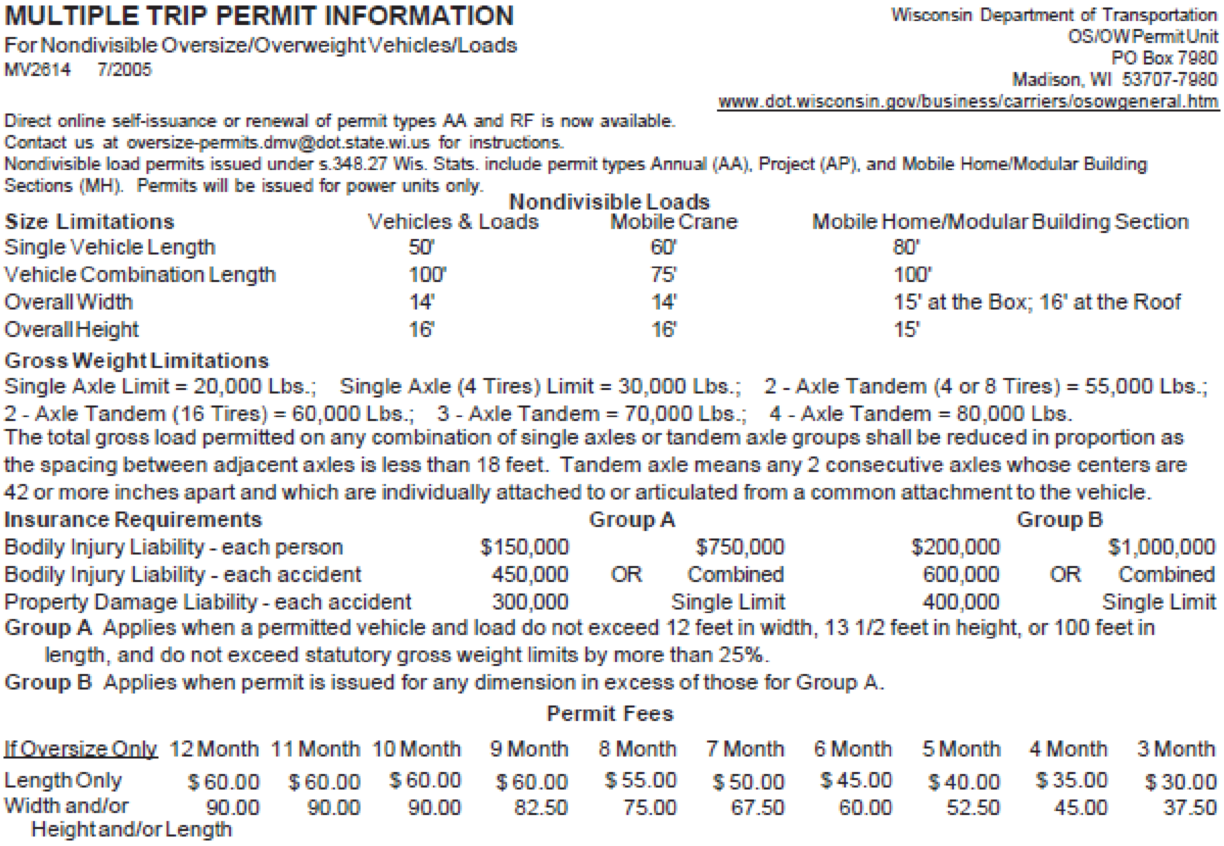
Axles	Weight
Any one wheel or wheels supporting one end of an axle	11,000 lbs
Truck tractor steering axle	13,000 lbs
Single axle	20,000 lbs
Tandem axles	34,000 lbs
Maximum gross vehicle weights on all axles	80,000 lbs

Weight limitations on class "B" highways are 60% of class "A" highway weight limitations

Class "B" highways includes those county trunk highways, town highways and city and village streets or portions thereof, which have been designated as class "B" highways by the local authorities

For more information and exceptions to the above weights:

- SP4075 Maximum weight limitations summary
- Wisconsin Statutes Chapter 348 (348.15 through 348.18)



MULTIPLE TRIP PERMIT INFORMATION

For Nondivisible Oversize/Overweight Vehicles/Loads
MV2614 7/2005

Wisconsin Department of Transportation
OS/OW Permit Unit
PO Box 7980
Madison, WI 53707-7980
www.dot.wisconsin.gov/business/carriers/osowgeneral.htm

Direct online self-issuance or renewal of permit types AA and RF is now available.
Contact us at oversize-permits.dmv@dot.state.wi.us for instructions.
Nondivisible load permits issued under s.348.27 Wis. Stats. include permit types Annual (AA), Project (AP), and Mobile Home/Modular Building Sections (MH). Permits will be issued for power units only.

	Nondivisible Loads		
Size Limitations	Vehicles & Loads	Mobile Crane	Mobile Home/Modular Building Section
Single Vehicle Length	50'	60'	80'
Vehicle Combination Length	100'	75'	100'
Overall Width	14'	14'	15' at the Box; 16' at the Roof
Overall Height	16'	16'	15'

Gross Weight Limitations

Single Axle Limit = 20,000 Lbs.; Single Axle (4 Tires) Limit = 30,000 Lbs.; 2 - Axle Tandem (4 or 8 Tires) = 55,000 Lbs.; 2 - Axle Tandem (16 Tires) = 60,000 Lbs.; 3 - Axle Tandem = 70,000 Lbs.; 4 - Axle Tandem = 80,000 Lbs.

The total gross load permitted on any combination of single axles or tandem axle groups shall be reduced in proportion as the spacing between adjacent axles is less than 18 feet. Tandem axle means any 2 consecutive axles whose centers are 42 or more inches apart and which are individually attached to or articulated from a common attachment to the vehicle.

Insurance Requirements		Group A			Group B	
Bodily Injury Liability - each person	$150,000		$750,000	$200,000		$1,000,000
Bodily Injury Liability - each accident	450,000	OR	Combined	600,000	OR	Combined
Property Damage Liability - each accident	300,000		Single Limit	400,000		Single Limit

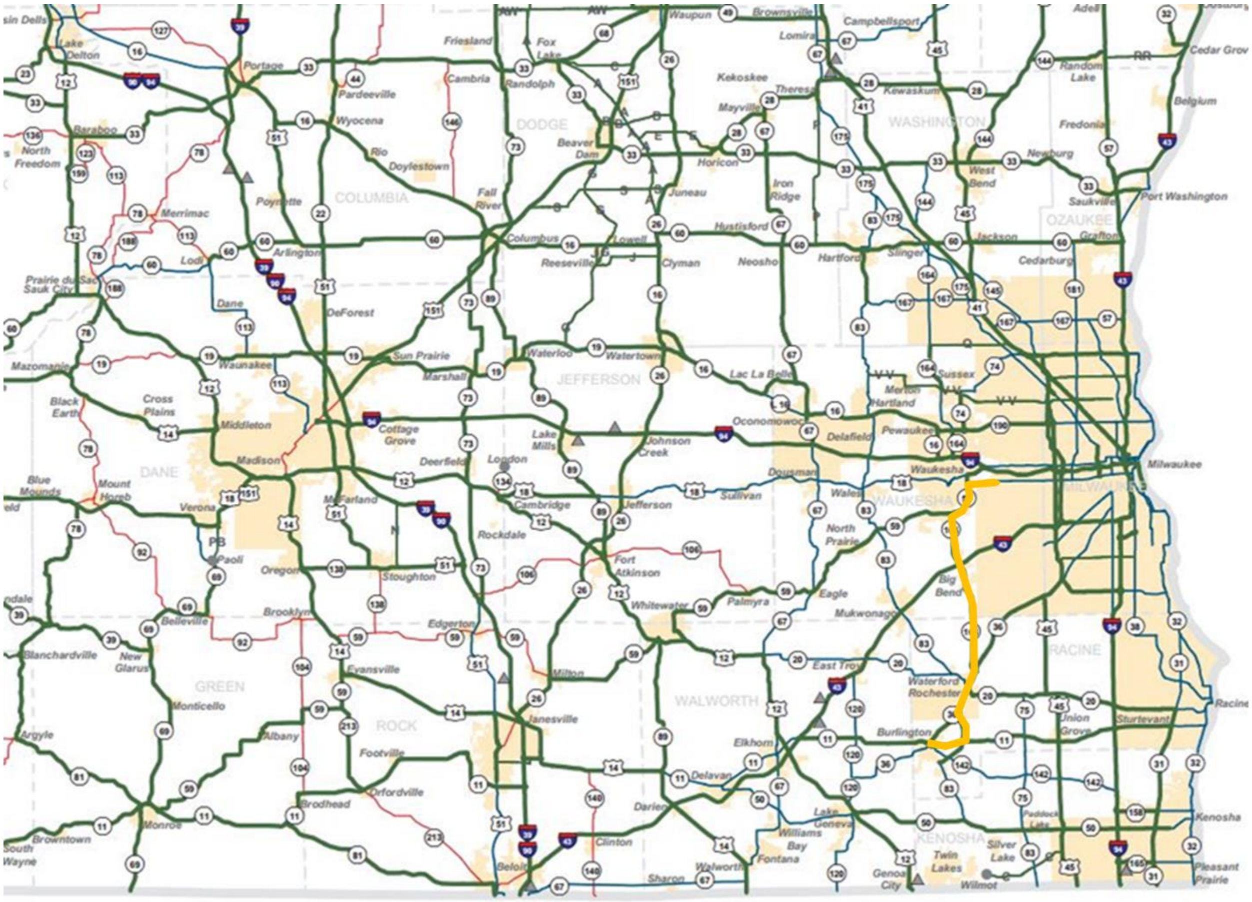
Group A Applies when a permitted vehicle and load do not exceed 12 feet in width, 13 1/2 feet in height, or 100 feet in length, and do not exceed statutory gross weight limits by more than 25%.

Group B Applies when permit is issued for any dimension in excess of those for Group A.

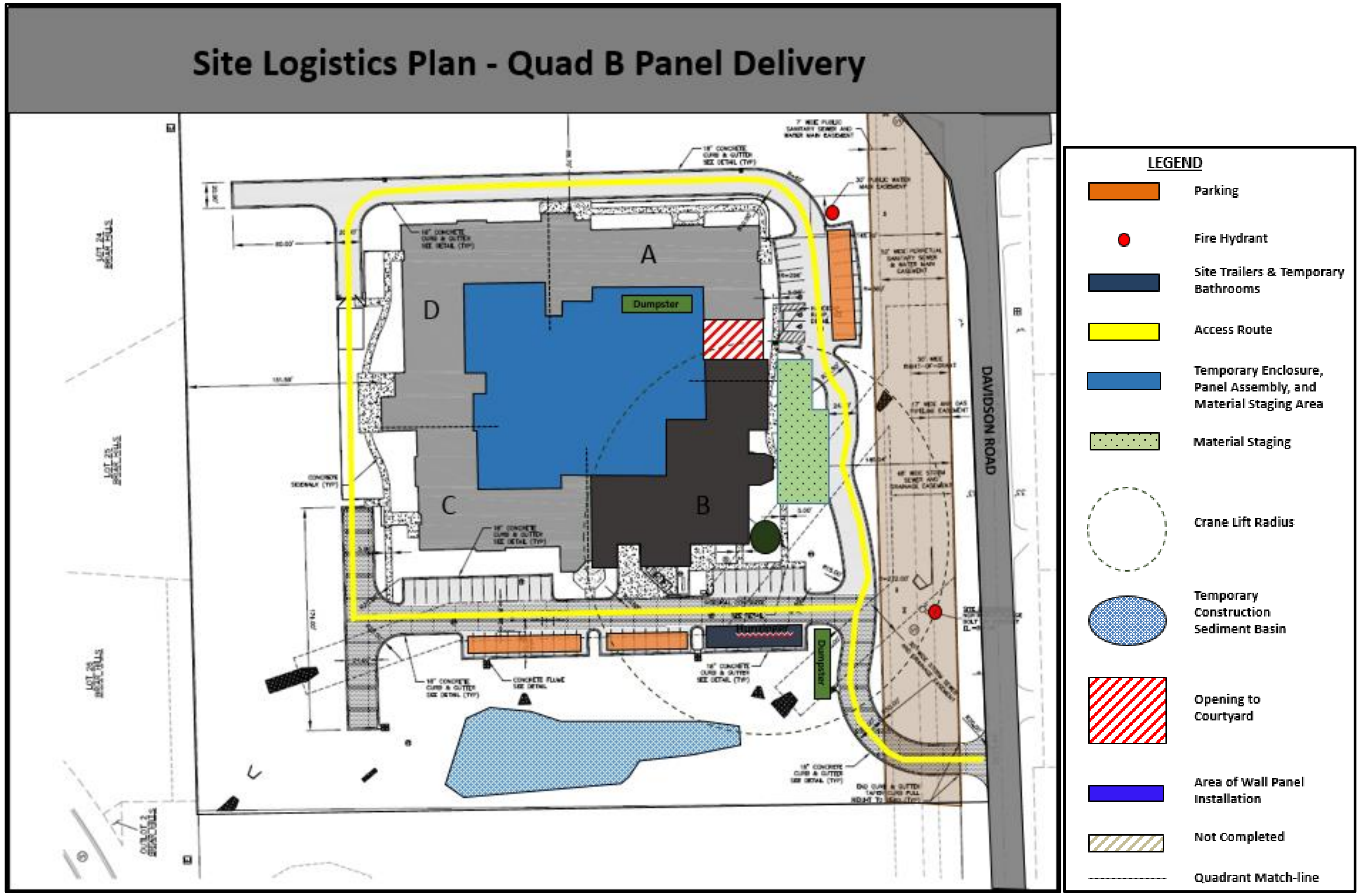
Permit Fees

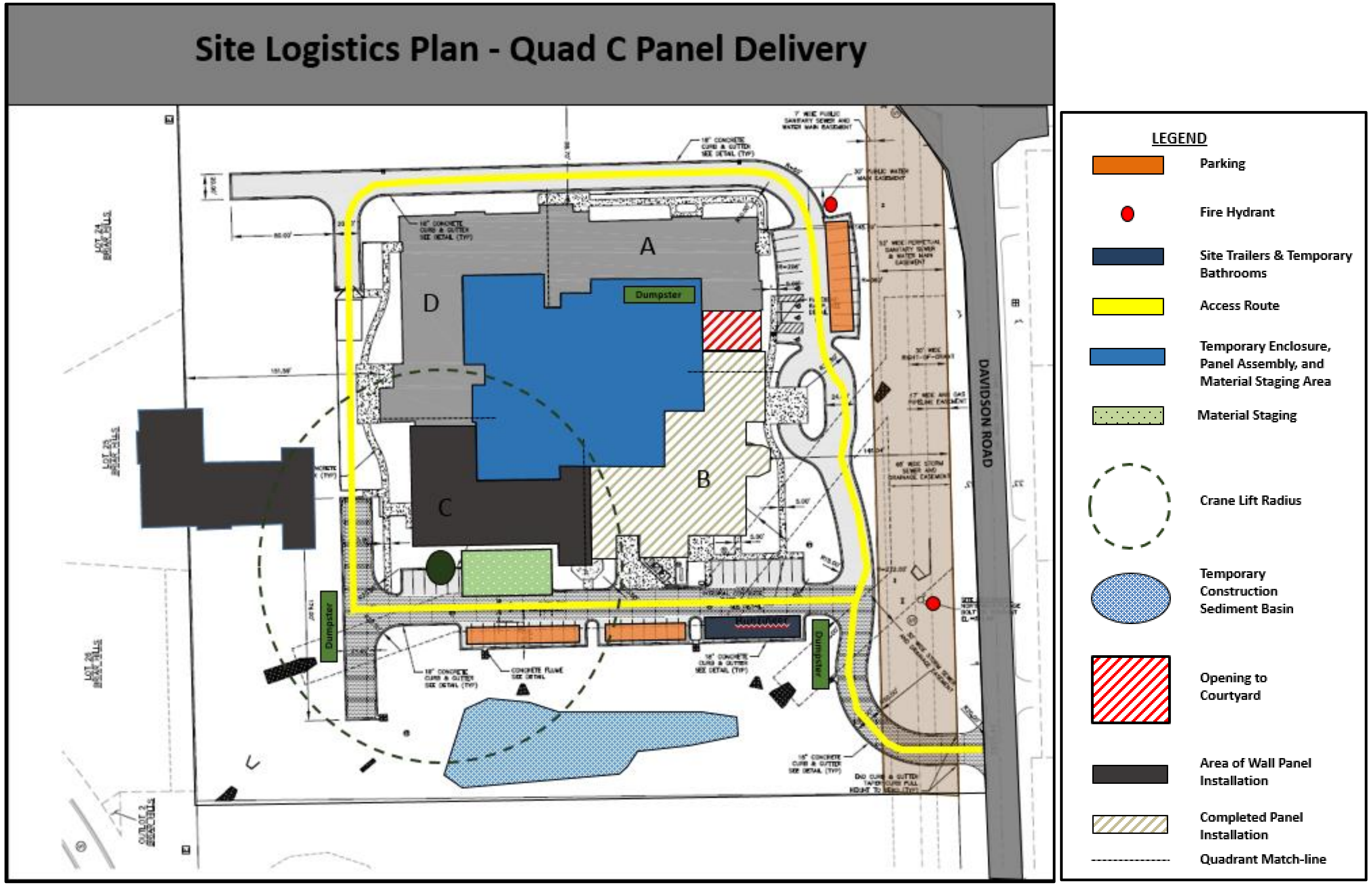
If Oversize Only	12 Month	11 Month	10 Month	9 Month	8 Month	7 Month	6 Month	5 Month	4 Month	3 Month
Length Only	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 55.00	$ 50.00	$ 45.00	$ 40.00	$ 35.00	$ 30.00
Width and/or Height and/or Length	90.00	90.00	90.00	82.50	75.00	67.50	60.00	52.50	45.00	37.50

Route to Silverado from Great Lakes Components



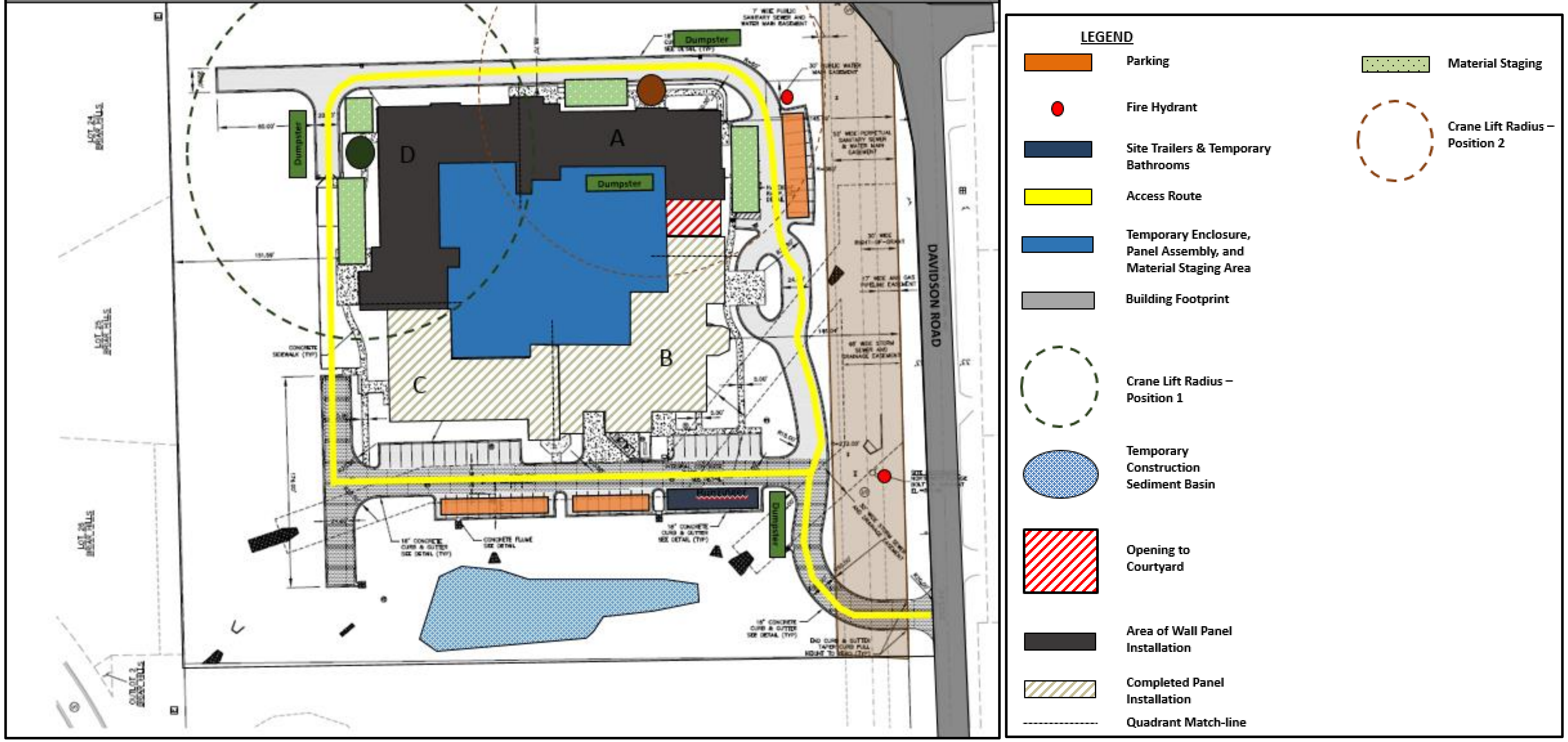
Appendix I: Site Plans for Prefabrication Phases


Site Logistics Plan - Quad B Panel Delivery
A
B
C
D
Dumpster
Dumpster
DAVIDSON ROAD
LEGEND
Parking
Fire Hydrant
Site Trailers & Temporary Bathrooms
Access Route
Temporary Enclosure, Panel Assembly, and Material Staging Area
Material Staging
Crane Lift Radius
Temporary Construction Sediment Basin
Opening to Courtyard
Area of Wall Panel Installation
Not Completed
Quadrant Match-line

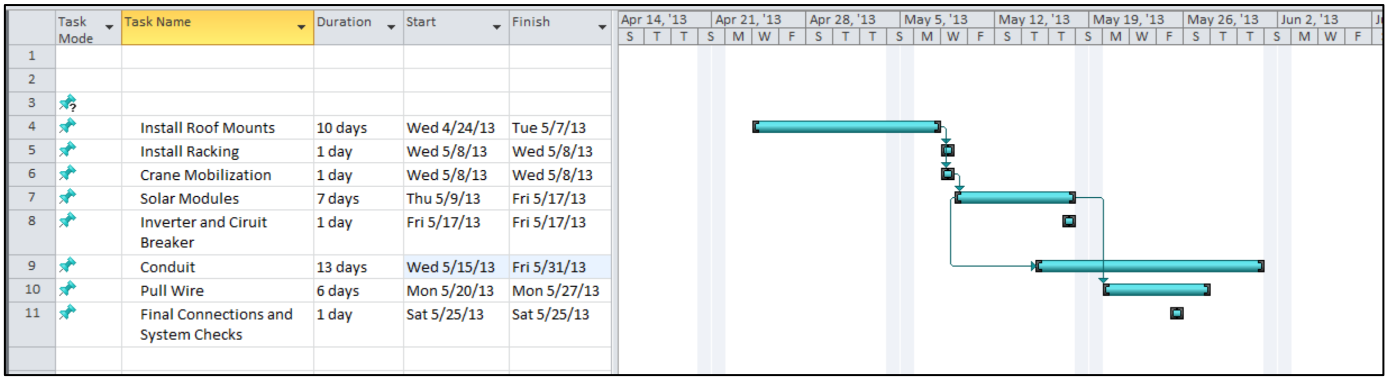


Site Logistics Plan - Quad C Panel Delivery

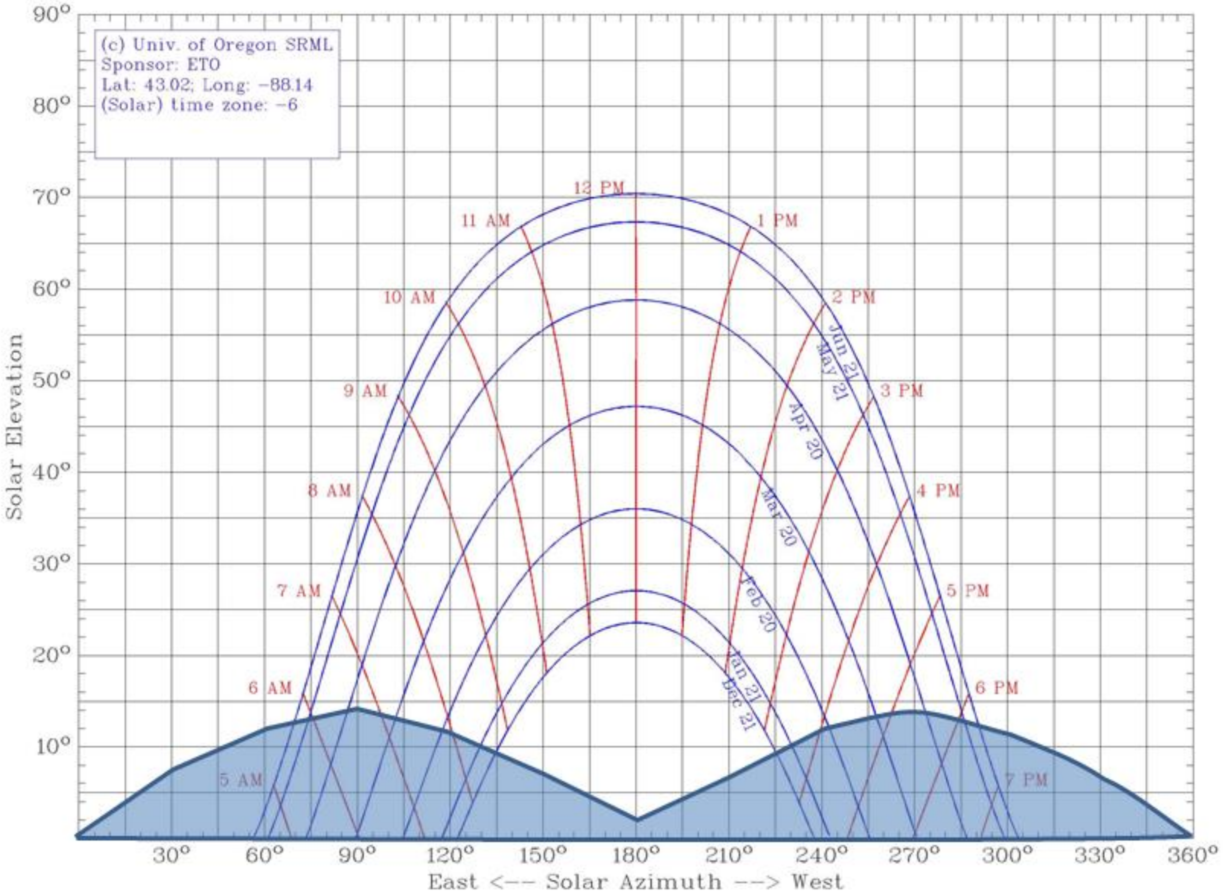
Site Logistics Plan - Quad D Panel Delivery

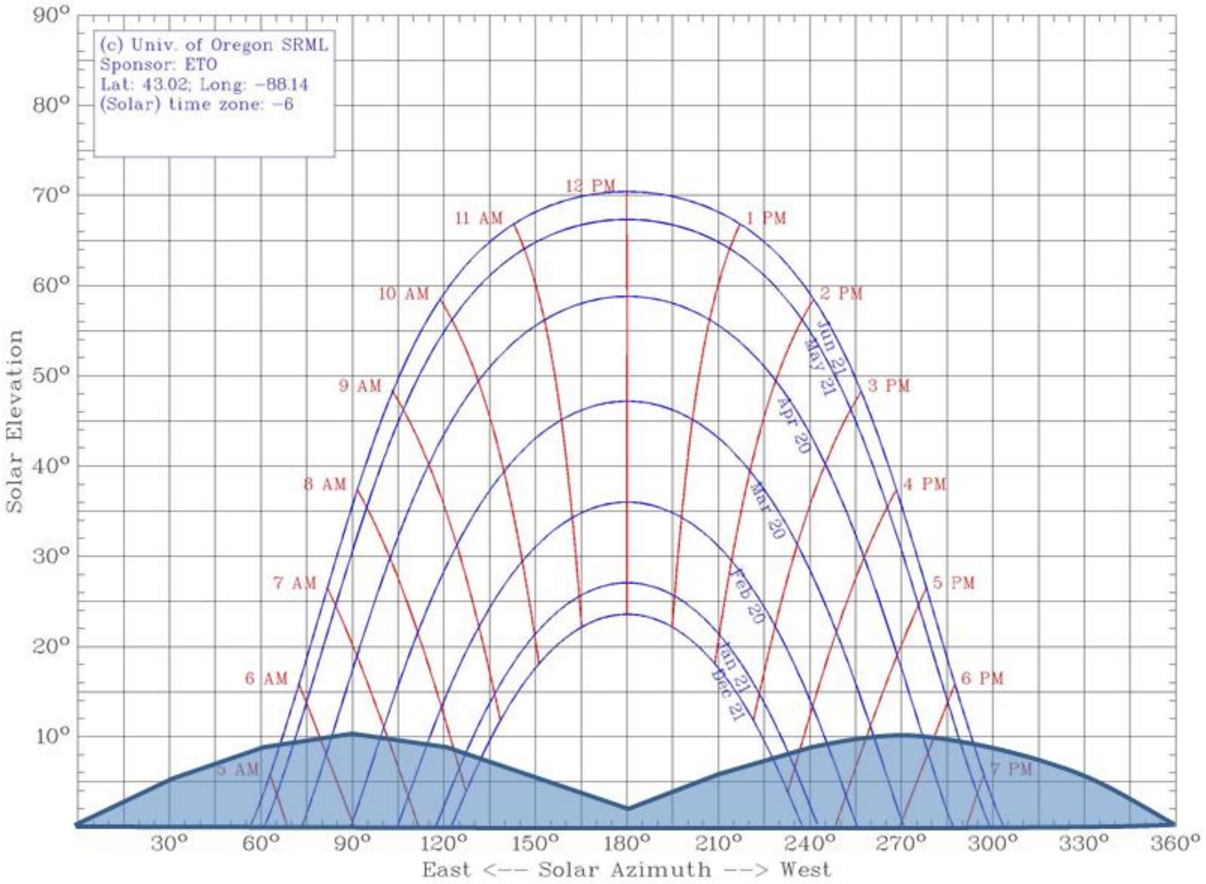


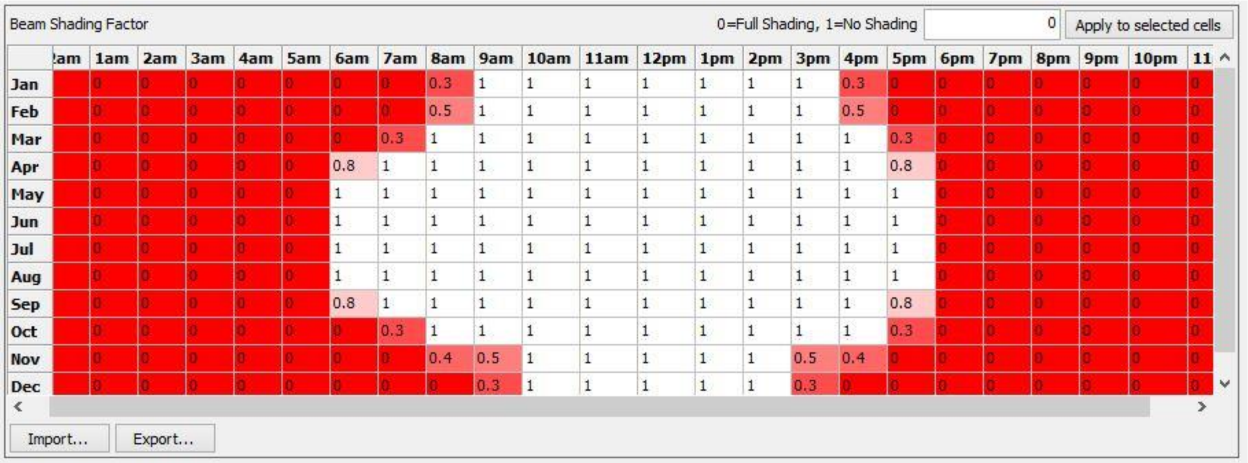
Appendix J: Panel Shading Charts and Installation Schedule



	Task Mode	Task Name	Duration	Start	Finish
1					
2					
3					
4		Install Roof Mounts	10 days	Wed 4/24/13	Tue 5/7/13
5		Install Racking	1 day	Wed 5/8/13	Wed 5/8/13
6		Crane Mobilization	1 day	Wed 5/8/13	Wed 5/8/13
7		Solar Modules	7 days	Thu 5/9/13	Fri 5/17/13
8		Inverter and Ciruit Breaker	1 day	Fri 5/17/13	Fri 5/17/13
9		Conduit	13 days	Wed 5/15/13	Fri 5/31/13
10		Pull Wire	6 days	Mon 5/20/13	Mon 5/27/13
11		Final Connections and System Checks	1 day	Sat 5/25/13	Sat 5/25/13







	am	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11
Jan		0	0	0	0	0	0	0	0.3	1	1	1	1	1	1	1	0.3	0	0	0	0	0	0	0
Feb		0	0	0	0	0	0	0	0.5	1	1	1	1	1	1	1	0.5	0	0	0	0	0	0	0
Mar		0	0	0	0	0	0	0.3	1	1	1	1	1	1	1	1	1	0.3	0	0	0	0	0	0
Apr		0	0	0	0	0	0.8	1	1	1	1	1	1	1	1	1	1	0.8	0	0	0	0	0	0
May		0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Jun		0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Jul		0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Aug		0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Sep		0	0	0	0	0	0.8	1	1	1	1	1	1	1	1	1	1	0.8	0	0	0	0	0	0
Oct		0	0	0	0	0	0	0.3	1	1	1	1	1	1	1	1	1	0.3	0	0	0	0	0	0
Nov		0	0	0	0	0	0	0	0.4	0.5	1	1	1	1	1	0.5	0.4	0	0	0	0	0	0	0
Dec		0	0	0	0	0	0	0	0	0.3	1	1	1	1	1	0.3	0	0	0	0	0	0	0	0

Appendix K: Solar Panel and Inverter Specifications

SHARP.
solar electricity

250 WATT

MULTI-PURPOSE MODULE

ND-250QCS

MULTI-PURPOSE 250 WATT MODULE FROM THE WORLD'S TRUSTED SOURCE FOR SOLAR.

Using breakthrough technology, made possible by nearly 50 years of proprietary research and development, Sharp's ND-250QCS solar module incorporates an advanced surface texturing process to increase light absorption and improve efficiency. Common applications include commercial and residential grid-tied roof systems as well as ground mounted arrays. Designed to withstand rigorous operating conditions, this module offers high power output per square foot of solar array.

This module is ideal for large commercial applications, demonstrating financial astuteness and environmental stewardship.

ENGINEERING EXCELLENCE

High module efficiency for an outstanding balance of size and weight to power and performance.

5% POSITIVE POWER TOLERANCE

Count on Sharp to deliver all the watts you pay for with a positive-only power tolerance of +5%.

RELIABLE

25-year limited warranty on power output and 10-year limited warranty on materials or workmanship.

HIGH PERFORMANCE

This module uses an advanced surface texturing process to increase light absorption and improve efficiency.

Sharp multi-purpose modules offer industry-leading performance for a variety of applications.

Tempered glass, EVA lamination and weatherproof backskin provide long-life and enhanced cell performance.

SHARP: THE NAME TO TRUST

When you choose Sharp, you get more than well-engineered products. You also get Sharp's proven reliablity, outstanding customer service and the assurance of both our 10-year warranty on materials or workmanship as well as the 25-year limited warranty on power output. With over 50 years experience in solar and over 4.3 GW of installed capacity, Sharp has a proven legacy as a trusted name in solar.

BECOME POWERFUL

3-PH TRANSFORMERLESS STRING INVERTERS

PVI **14TL**
PVI **20TL**
PVI **23TLM**
PVI **28TLM**

FEATURES
- 600 or 1000 VDC
- Best-in-class efficiency
- Three-phase transformerless inverters
- Quick and easy installation
- Dual MPP tracking zones
- Wide MPPT range
- Lightweight, compact design
- Modbus communications
- User-interactive LCD
- Wall mount configuration

OPTIONS
- Integrated DC fused string combiner
- DC arc-fault protection
- Web-based monitoring

SOLECTRIA RENEWABLES

3-PH TRANSFORMERLESS STRING INVERTERS

Solectria Renewables' PVI 14TL, PVI 20TL, PVI 23TLM, and PVI 28TLM are compact, transformerless three-phase inverters with a dual MPP tracker. These inverters come standard with AC and DC disconnect, user-interactive LCD and 8-fuse string combiner. Its small and lightweight design make for quick and easy installation and maintenance. These inverters include an enhanced DSP control, comprehensive protection functions, and advanced thermal design enabling highest reliability and uptime. They also come with a standard 10 year warranty with options for 15 and 20 years.

Built for the real world

250 WATT

ND-250QCS

Module output cables: 12 AWG PV Wire (per UL Subject 4703)

ELECTRICAL CHARACTERISTICS

Maximum Power (Pmax)*	250 W
Tolerance of Pmax	+5%/-0%
PTC Rating	223.6 W
Type of Cell	Polycrystalline silicon
Cell Configuration	60 in series
Open Circuit Voltage (Voc)	38.3 V
Maximum Power Voltage (Vpm)	29.8 V
Short Circuit Current (Isc)	8.90 A
Maximum Power Current (Ipm)	8.40 A
Module Efficiency (%)	15.3%
Maximum System (DC) Voltage	600 V (UL)/1000V (IEC)
Series Fuse Rating	15 A
NOCT	47.5°C
Temperature Coefficient (Pmax)	-0.485%/°C
Temperature Coefficient (Voc)	-0.36%/°C
Temperature Coefficient (Isc)	0.053%/°C

*Illumination of 1 kW/m² (1 sun) at spectral distribution of AM 1.5 (ASTM E892 global spectral irradiance) at a cell temperature of 25°C.

MECHANICAL CHARACTERISTICS

Dimensions (A x B x C to the right)	39.1" x 64.6" x 1.8"/994 x 1640 x 46 mm
Cable Length (G)	43.3"/1100 mm
Output Interconnect Cable	12 AWG with *SMK Locking Connector
Hail Impact Resistance	1" (25 mm) at 52 mph (23 m/s)
Weight	41.9 lbs / 19.0 kg
Max Load	50 psf (2400 Pascals)
Operating Temperature (cell)	-40 to 194°F / -40 to 90°C

*Intertek recognized for mating with MC-4 connectors (part numbers PV-KST4; PV-KBT4)

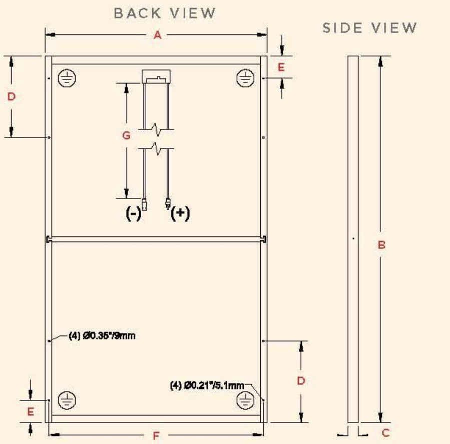
CERTIFICATIONS

UL 1703, ULC/ORD-C1703, IEC 61215, IEC 61730, CEC, FSEC

WARRANTY

25-year limited warranty on power output
Contact Sharp for complete warranty information

DIMENSIONS



A	B	C	D	E
39.1"/994 mm	64.6"/1640 mm	1.8"/46 mm	14.4"/365 mm	3.9"/100 mm
F	G			
37.7"/958 mm	43.3"/1100 mm			

Contact Sharp for tolerance specifications

ISO QUALITY & ENVIRONMENTAL MANAGEMENT

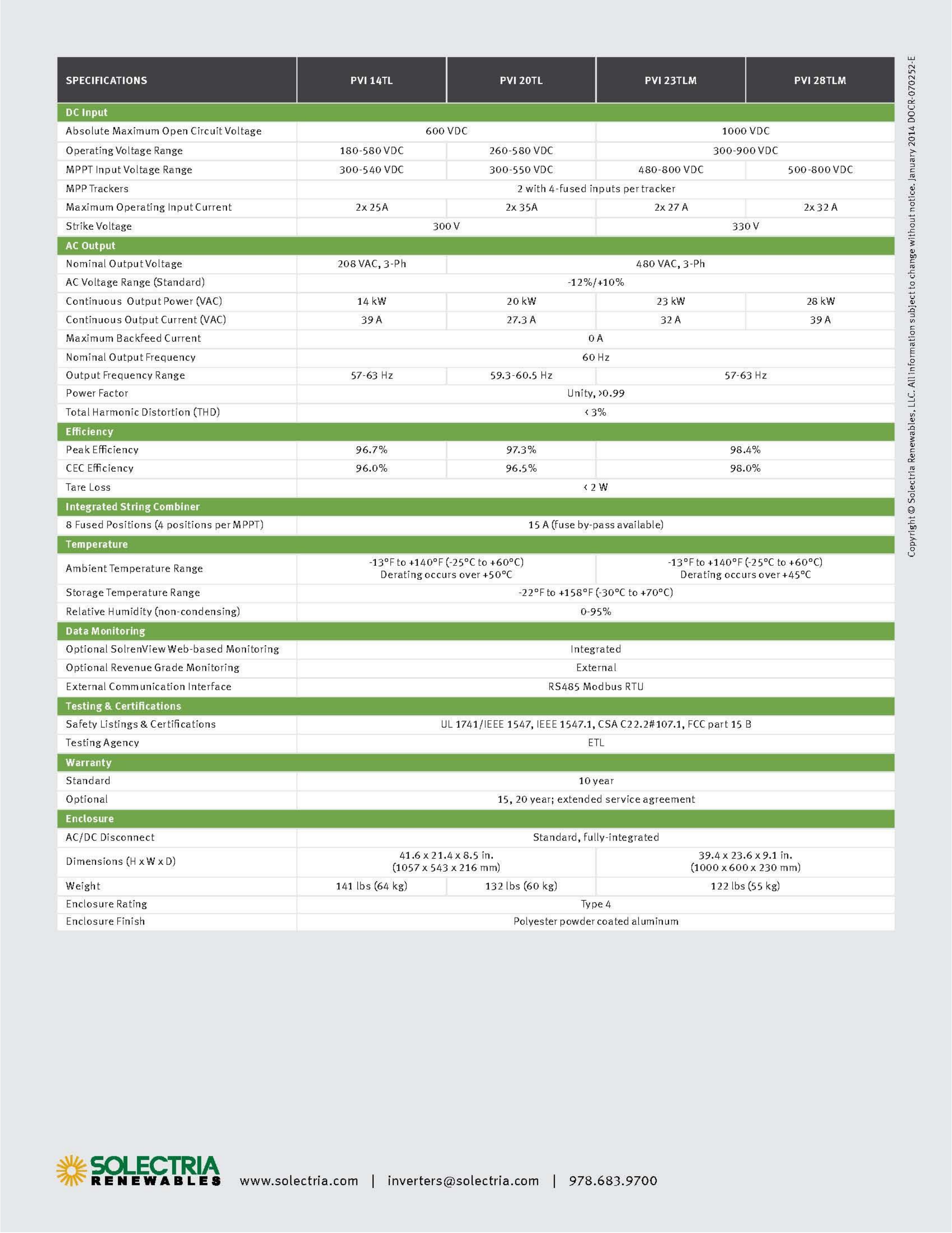
Sharp solar modules are manufactured in ISO 9001:2000 AND ISO 14001:2004 certified facilities.

"BUY AMERICAN"

Sharp solar modules are manufactured in the United States and Japan, and qualify as "American" goods under the "Buy American" clause of the American Recovery and Reinvestment Act (ARRA).

SHARP ELECTRONICS CORPORATION
5700 NW Pacific Rim Boulevard, Camas, WA 98607
1-800-SOLAR-06 • Email: sharpsolar@sharpusa.com
www.sharpusa.com/solar

Printed in U.S.A. on recycled paper. 12F-111*PC 08-12



SPECIFICATIONS	PVI 14TL	PVI 20TL	PVI 23TLM	PVI 28TLM
DC Input				
Absolute Maximum Open Circuit Voltage	600 VDC		1000 VDC	
Operating Voltage Range	180-580 VDC	260-580 VDC	300-900 VDC	
MPPT Input Voltage Range	300-540 VDC	300-550 VDC	480-800 VDC	500-800 VDC
MPP Trackers	2 with 4-fused inputs per tracker			
Maximum Operating Input Current	2x 25A	2x 35A	2x 27 A	2x 32 A
Strike Voltage	300 V		330 V	
AC Output				
Nominal Output Voltage	208 VAC, 3-Ph	480 VAC, 3-Ph		
AC Voltage Range (Standard)	-12%/+10%			
Continuous Output Power (VAC)	14 kW	20 kW	23 kW	28 kW
Continuous Output Current (VAC)	39 A	27.3 A	32 A	39 A
Maximum Backfeed Current	0 A			
Nominal Output Frequency	60 Hz			
Output Frequency Range	57-63 Hz	59.3-60.5 Hz	57-63 Hz	
Power Factor	Unity, >0.99			
Total Harmonic Distortion (THD)	< 3%			
Efficiency				
Peak Efficiency	96.7%	97.3%	98.4%	
CEC Efficiency	96.0%	96.5%	98.0%	
Tare Loss	< 2 W			
Integrated String Combiner				
8 Fused Positions (4 positions per MPPT)	15 A (fuse by-pass available)			
Temperature				
Ambient Temperature Range	-13°F to +140°F (-25°C to +60°C) Derating occurs over +50°C		-13°F to +140°F (-25°C to +60°C) Derating occurs over +45°C	
Storage Temperature Range	-22°F to +158°F (-30°C to +70°C)			
Relative Humidity (non-condensing)	0-95%			
Data Monitoring				
Optional SolrenView Web-based Monitoring	Integrated			
Optional Revenue Grade Monitoring	External			
External Communication Interface	RS485 Modbus RTU			
Testing & Certifications				
Safety Listings & Certifications	UL 1741/IEEE 1547, IEEE 1547.1, CSA C22.2#107.1, FCC part 15 B			
Testing Agency	ETL			
Warranty				
Standard	10 year			
Optional	15, 20 year; extended service agreement			
Enclosure				
AC/DC Disconnect	Standard, fully-integrated			
Dimensions (H x W x D)	41.6 x 21.4 x 8.5 in. (1057 x 543 x 216 mm)		39.4 x 23.6 x 9.1 in. (1000 x 600 x 230 mm)	
Weight	141 lbs (64 kg)	132 lbs (60 kg)	122 lbs (55 kg)	
Enclosure Rating	Type 4			
Enclosure Finish	Polyester powder coated aluminum			

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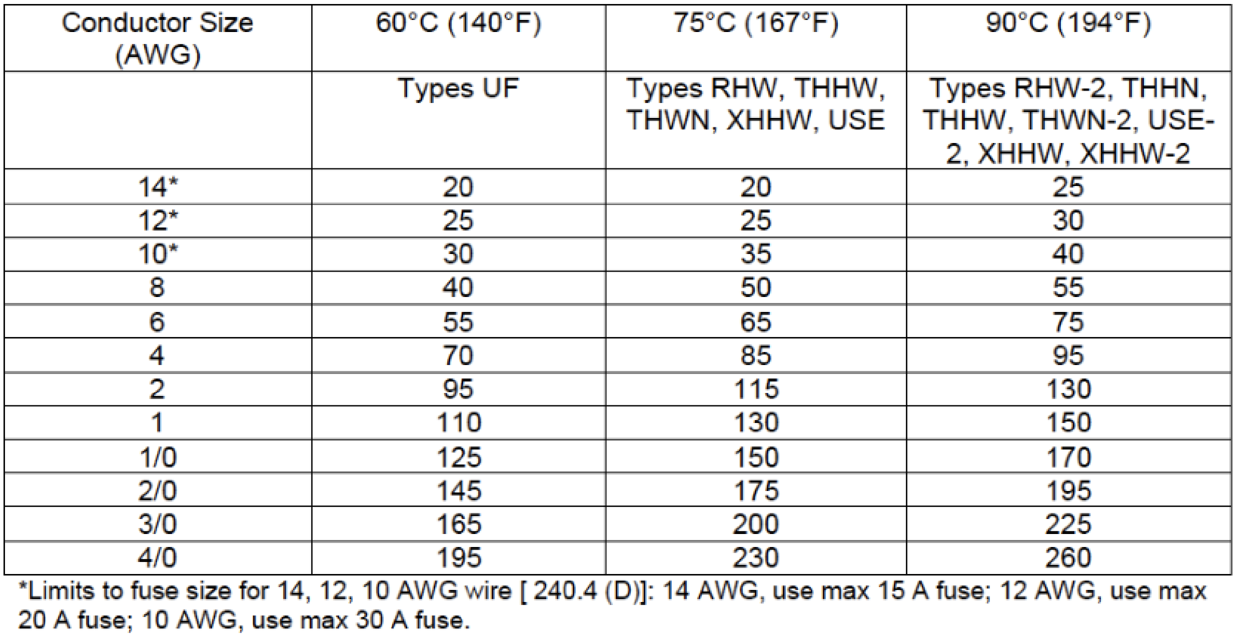
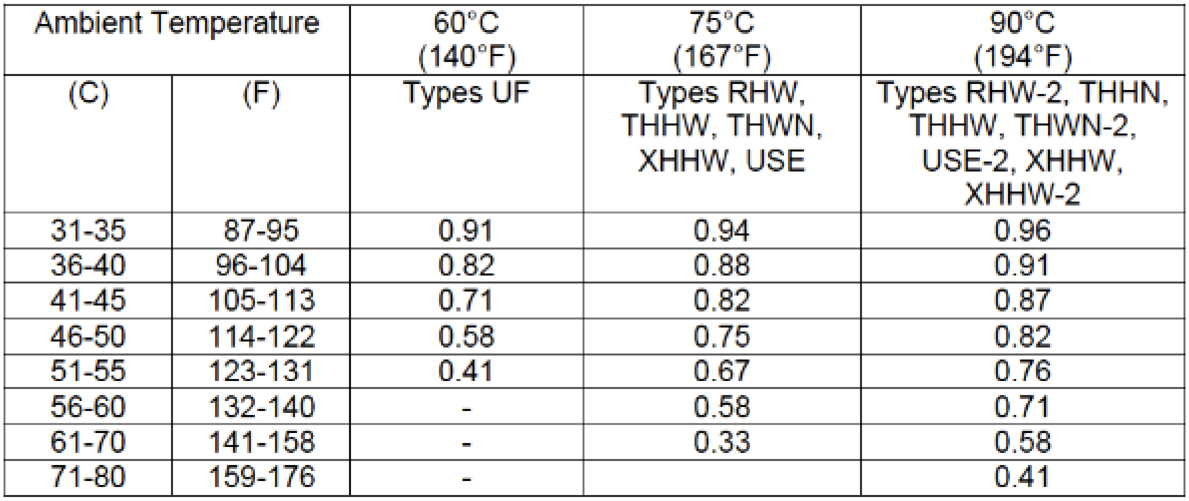
Appendix L: Conductor Sizing and Voltage Drop Tables



Conductor Size (AWG)	60°C (140°F)	75°C (167°F)	90°C (194°F)
	Types UF	Types RHW, THHW, THWN, XHHW, USE	Types RHW-2, THHN, THHW, THWN-2, USE-2, XHHW, XHHW-2
14*	20	20	25
12*	25	25	30
10*	30	35	40
8	40	50	55
6	55	65	75
4	70	85	95
2	95	115	130
1	110	130	150
1/0	125	150	170
2/0	145	175	195
3/0	165	200	225
4/0	195	230	260

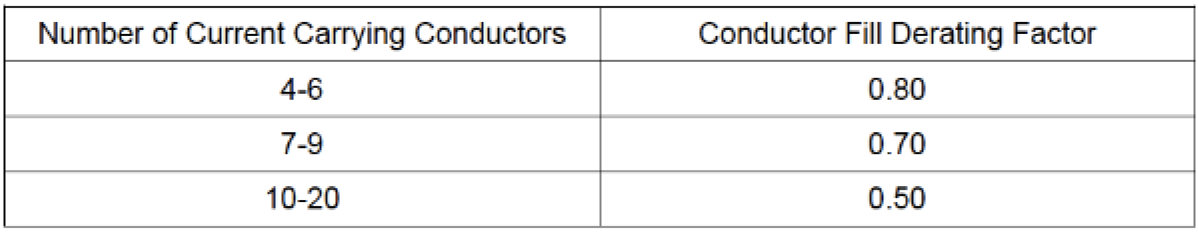
*Limits to fuse size for 14, 12, 10 AWG wire [240.4 (D)]: 14 AWG, use max 15 A fuse; 12 AWG, use max 20 A fuse; 10 AWG, use max 30 A fuse.

Table 310.16



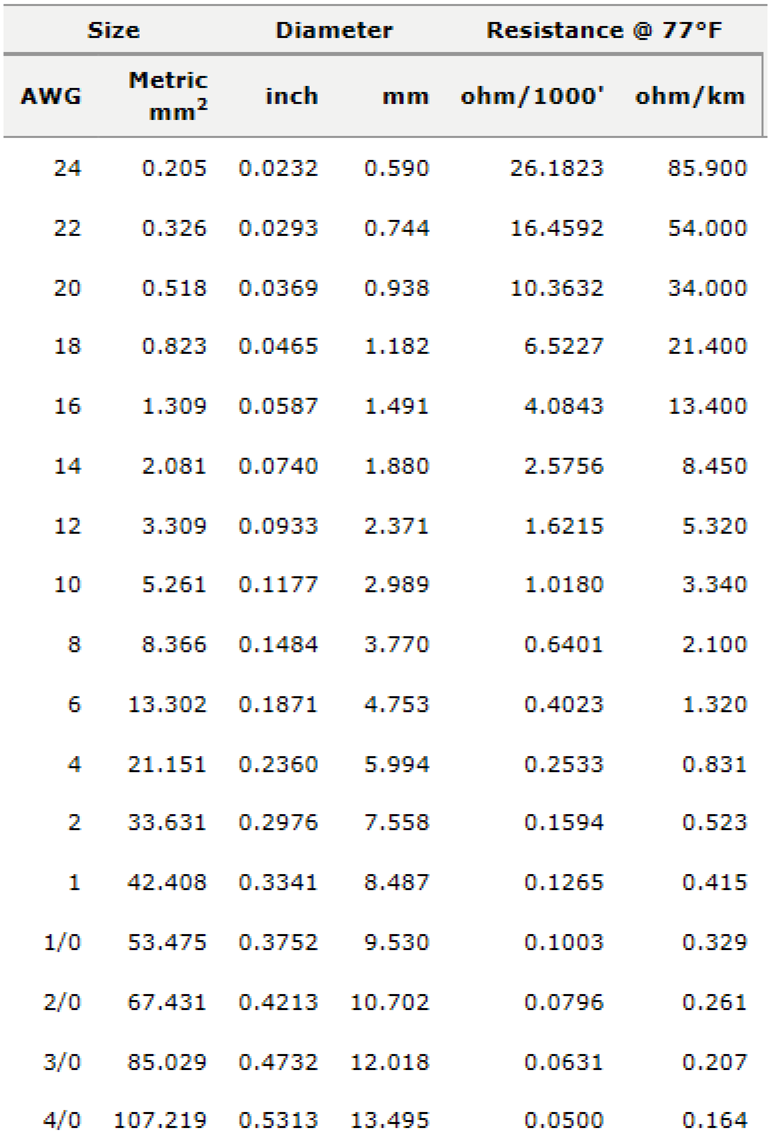
Ambient Temperature		60°C (140°F)	75°C (167°F)	90°C (194°F)
(C)	(F)	Types UF	Types RHW, THHW, THWN, XHHW, USE	Types RHW-2, THHN, THHW, THWN-2, USE-2, XHHW, XHHW-2
31-35	87-95	0.91	0.94	0.96
36-40	96-104	0.82	0.88	0.91
41-45	105-113	0.71	0.82	0.87
46-50	114-122	0.58	0.75	0.82
51-55	123-131	0.41	0.67	0.76
56-60	132-140	-	0.58	0.71
61-70	141-158	-	0.33	0.58
71-80	159-176	-		0.41

Table 310.16



Number of Current Carrying Conductors	Conductor Fill Derating Factor
4-6	0.80
7-9	0.70
10-20	0.50

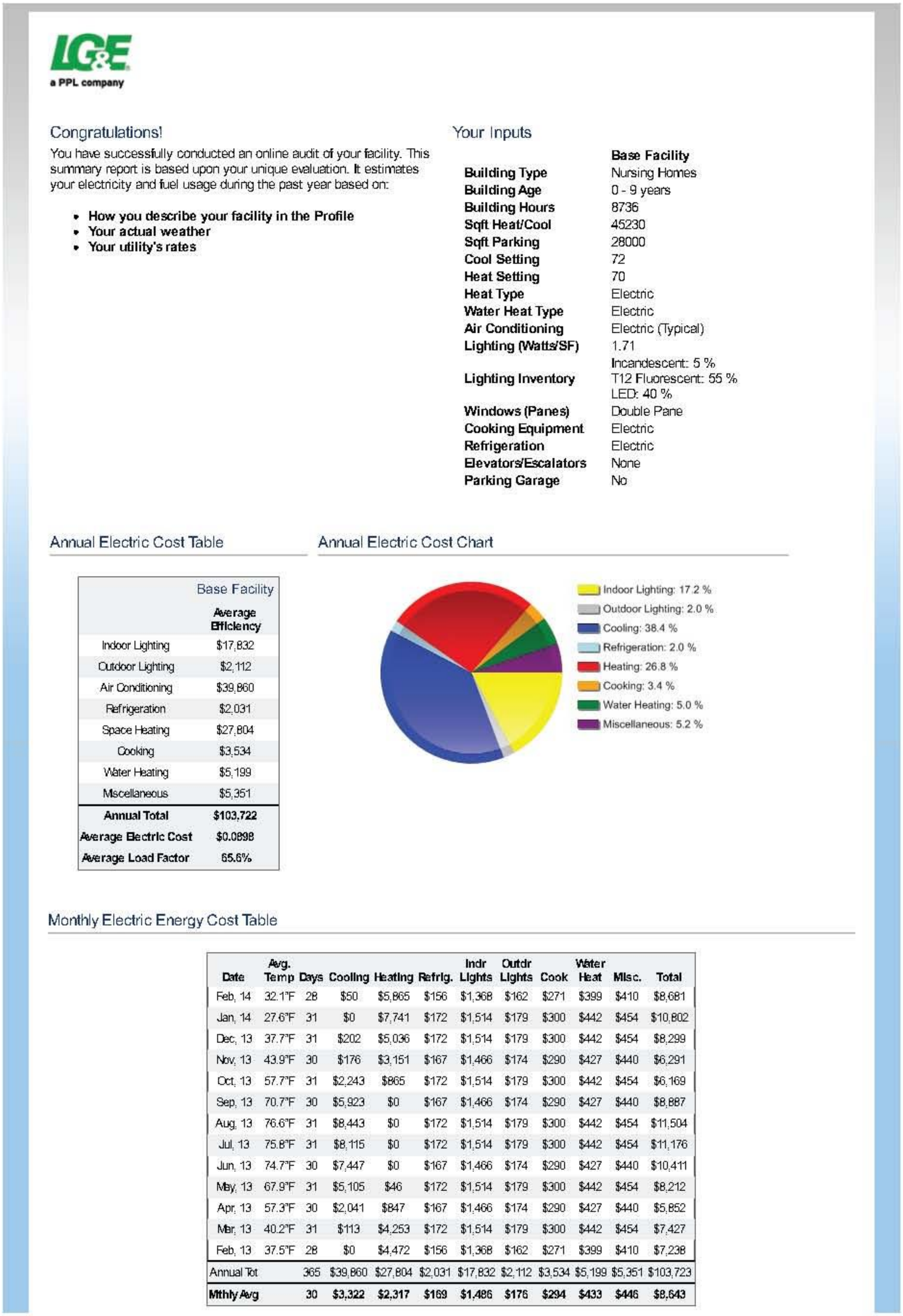
Table 310.15



Size		Diameter		Resistance @ 77°F	
AWG	Metric mm^2	inch	mm	ohm/1000'	ohm/km
24	0.205	0.0232	0.590	26.1823	85.900
22	0.326	0.0293	0.744	16.4592	54.000
20	0.518	0.0369	0.938	10.3632	34.000
18	0.823	0.0465	1.182	6.5227	21.400
16	1.309	0.0587	1.491	4.0843	13.400
14	2.081	0.0740	1.880	2.5756	8.450
12	3.309	0.0933	2.371	1.6215	5.320
10	5.261	0.1177	2.989	1.0180	3.340
8	8.366	0.1484	3.770	0.6401	2.100
6	13.302	0.1871	4.753	0.4023	1.320
4	21.151	0.2360	5.994	0.2533	0.831
2	33.631	0.2976	7.558	0.1594	0.523
1	42.408	0.3341	8.487	0.1265	0.415
1/0	53.475	0.3752	9.530	0.1003	0.329
2/0	67.431	0.4213	10.702	0.0796	0.261
3/0	85.029	0.4732	12.018	0.0631	0.207
4/0	107.219	0.5313	13.495	0.0500	0.164

Wire Resistance values by size

Appendix M: LEED Checklist and Energy Consumption Report



LG&E
a PPL company

Congratulations!

You have successfully conducted an online audit of your facility. This summary report is based upon your unique evaluation. It estimates your electricity and fuel usage during the past year based on:

- **How you describe your facility in the Profile**
- **Your actual weather**
- **Your utility's rates**

Your Inputs

	Base Facility
Building Type	Nursing Homes
Building Age	0 - 9 years
Building Hours	8736
Sqft Heat/Cool	45230
Sqft Parking	28000
Cool Setting	72
Heat Setting	70
Heat Type	Electric
Water Heat Type	Electric
Air Conditioning	Electric (Typical)
Lighting (Watts/SF)	1.71
Lighting Inventory	Incandescent: 5 % T12 Fluorescent: 55 % LED: 40 %
Windows (Panes)	Double Pane
Cooking Equipment	Electric
Refrigeration	Electric
Elevators/Escalators	None
Parking Garage	No

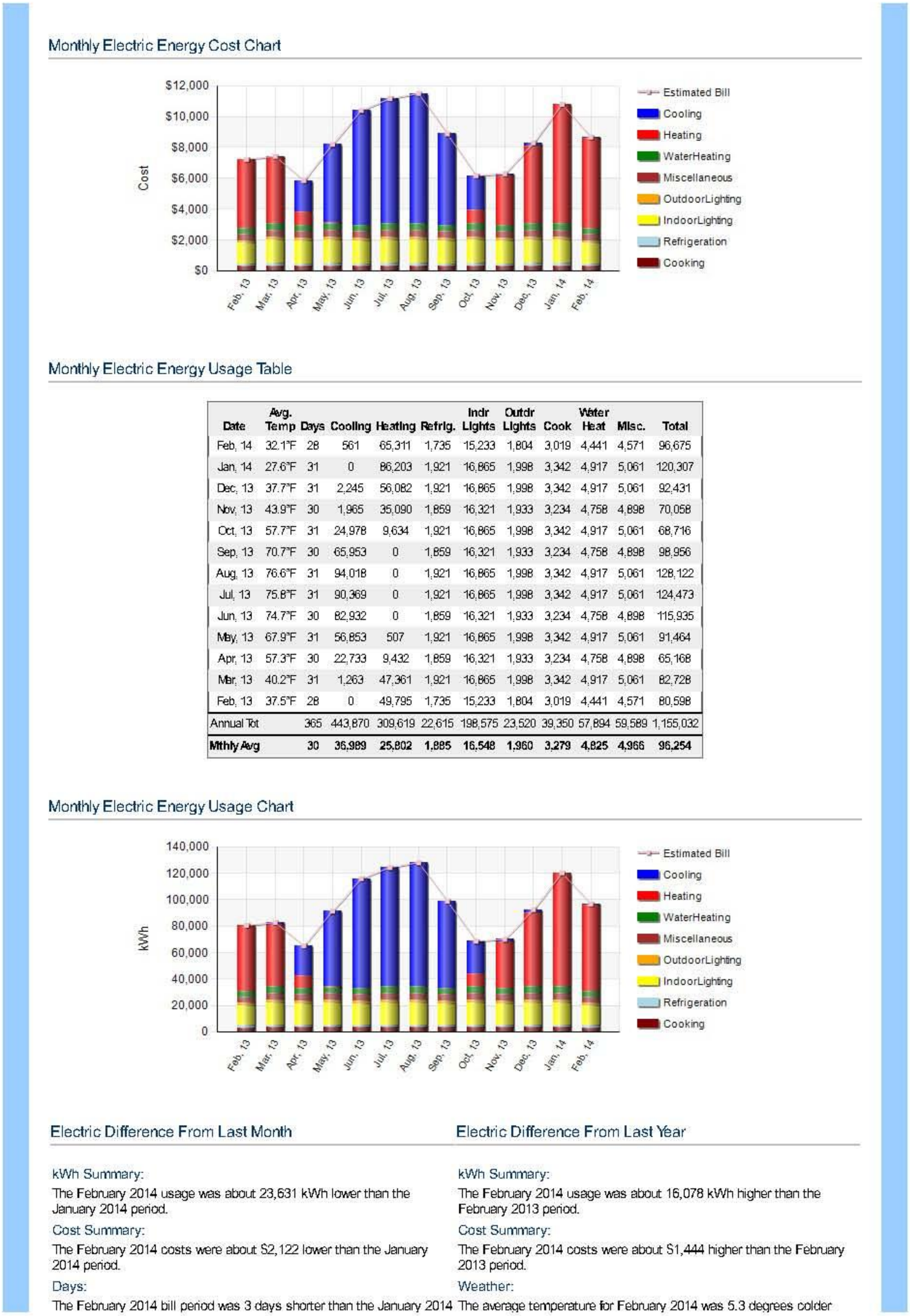
Annual Electric Cost Table

	Base Facility
	Average Efficiency
Indoor Lighting	$17,832
Outdoor Lighting	$2,112
Air Conditioning	$39,860
Refrigeration	$2,031
Space Heating	$27,804
Cooking	$3,534
Water Heating	$5,199
Miscellaneous	$5,351
Annual Total	**$103,722**
Average Electric Cost	**$0.0898**
Average Load Factor	**65.6%**

Annual Electric Cost Chart

Monthly Electric Energy Cost Table

Date	**Avg. Temp**	**Days**	**Cooling**	**Heating**	**Refrig.**	**Indr Lights**	**Outdr Lights**	**Cook**	**Water Heat**	**Misc.**	**Total**
Feb, 14	32.1°F	28	$50	$5,865	$156	$1,368	$162	$271	$399	$410	$8,681
Jan, 14	27.6°F	31	$0	$7,741	$172	$1,514	$179	$300	$442	$454	$10,802
Dec, 13	37.7°F	31	$202	$5,036	$172	$1,514	$179	$300	$442	$454	$8,299
Nov, 13	43.9°F	30	$176	$3,151	$167	$1,466	$174	$290	$427	$440	$6,291
Oct, 13	57.7°F	31	$2,243	$865	$172	$1,514	$179	$300	$442	$454	$6,169
Sep, 13	70.7°F	30	$5,923	$0	$167	$1,466	$174	$290	$427	$440	$8,887
Aug, 13	76.6°F	31	$8,443	$0	$172	$1,514	$179	$300	$442	$454	$11,504
Jul, 13	75.8°F	31	$8,115	$0	$172	$1,514	$179	$300	$442	$454	$11,176
Jun, 13	74.7°F	30	$7,447	$0	$167	$1,466	$174	$290	$427	$440	$10,411
May, 13	67.9°F	31	$5,105	$46	$172	$1,514	$179	$300	$442	$454	$8,212
Apr, 13	57.3°F	30	$2,041	$847	$167	$1,466	$174	$290	$427	$440	$5,852
Mar, 13	40.2°F	31	$113	$4,253	$172	$1,514	$179	$300	$442	$454	$7,427
Feb, 13	37.5°F	28	$0	$4,472	$156	$1,368	$162	$271	$399	$410	$7,238
Annual Tot		365	$39,860	$27,804	$2,031	$17,832	$2,112	$3,534	$5,199	$5,351	$103,723
Mthly Avg		**30**	**$3,322**	**$2,317**	**$169**	**$1,486**	**$176**	**$294**	**$433**	**$446**	**$8,643**



Monthly Electric Energy Cost Chart

Monthly Electric Energy Usage Table

Date	Avg. Temp	Days	Cooling	Heating	Refrig.	Indr Lights	Outdr Lights	Cook	Water Heat	Misc.	Total
Feb, 14	32.1°F	28	561	65,311	1,735	15,233	1,804	3,019	4,441	4,571	96,675
Jan, 14	27.6°F	31	0	86,203	1,921	16,865	1,998	3,342	4,917	5,061	120,307
Dec, 13	37.7°F	31	2,245	56,082	1,921	16,865	1,998	3,342	4,917	5,061	92,431
Nov, 13	43.9°F	30	1,965	35,090	1,859	16,321	1,933	3,234	4,758	4,898	70,058
Oct, 13	57.7°F	31	24,978	9,634	1,921	16,865	1,998	3,342	4,917	5,061	68,716
Sep, 13	70.7°F	30	65,953	0	1,859	16,321	1,933	3,234	4,758	4,898	98,956
Aug, 13	76.6°F	31	94,018	0	1,921	16,865	1,998	3,342	4,917	5,061	128,122
Jul, 13	75.8°F	31	90,369	0	1,921	16,865	1,998	3,342	4,917	5,061	124,473
Jun, 13	74.7°F	30	82,932	0	1,859	16,321	1,933	3,234	4,758	4,898	115,935
May, 13	67.9°F	31	56,853	507	1,921	16,865	1,998	3,342	4,917	5,061	91,464
Apr, 13	57.3°F	30	22,733	9,432	1,859	16,321	1,933	3,234	4,758	4,898	65,168
Mar, 13	40.2°F	31	1,263	47,361	1,921	16,865	1,998	3,342	4,917	5,061	82,728
Feb, 13	37.5°F	28	0	49,795	1,735	15,233	1,804	3,019	4,441	4,571	80,598
Annual Tot		365	443,870	309,619	22,615	198,575	23,520	39,350	57,894	59,589	1,155,032
Mthly Avg		**30**	**36,989**	**25,802**	**1,885**	**16,548**	**1,960**	**3,279**	**4,825**	**4,966**	**96,254**

Monthly Electric Energy Usage Chart

Electric Difference From Last Month

kWh Summary:

The February 2014 usage was about 23,631 kWh lower than the January 2014 period.

Cost Summary:

The February 2014 costs were about $2,122 lower than the January 2014 period.

Days:

The February 2014 bill period was 3 days shorter than the January 2014

Electric Difference From Last Year

kWh Summary:

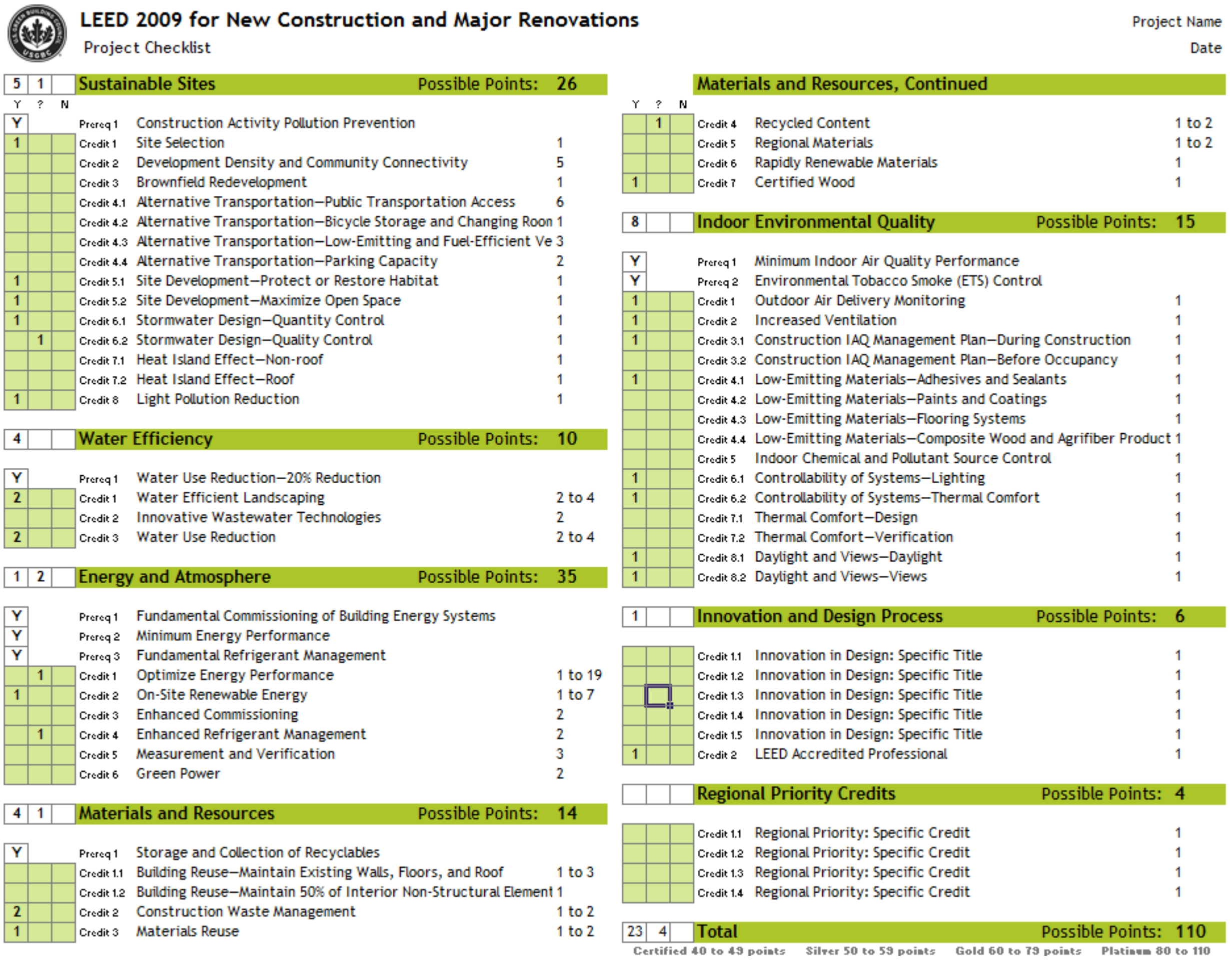
The February 2014 usage was about 16,078 kWh higher than the February 2013 period.

Cost Summary:

The February 2014 costs were about $1,444 higher than the February 2013 period.

Weather:

The average temperature for February 2014 was 5.3 degrees colder



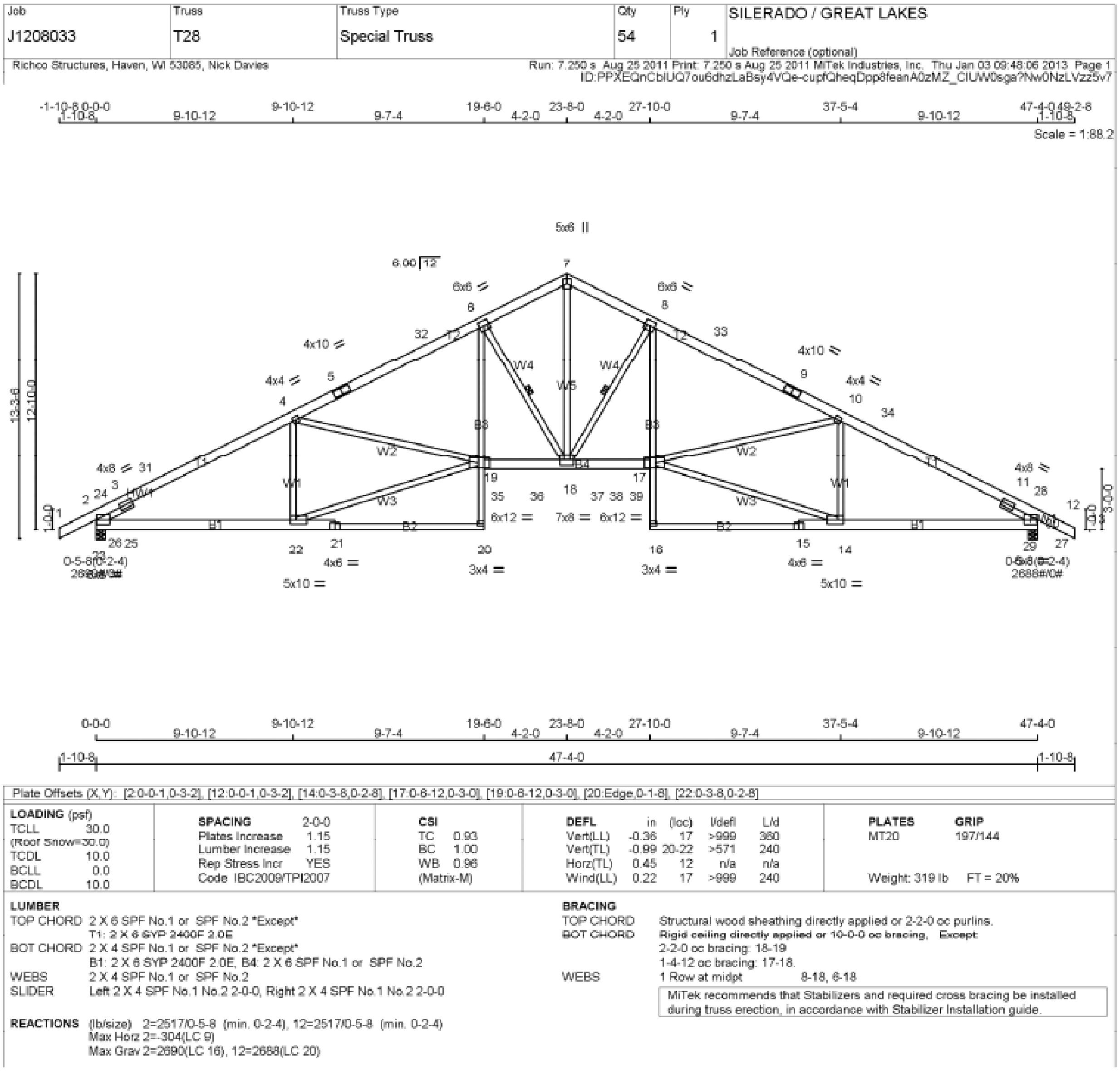
LEED 2009 for New Construction and Major Renovations
Project Checklist

Project Name
Date

Y	?	N			
5	1			**Sustainable Sites**	Possible Points: 26
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
			Credit 2	Development Density and Community Connectivity	5
			Credit 3	Brownfield Redevelopment	1
			Credit 4.1	Alternative Transportation—Public Transportation Access	6
			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Roon	1
			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Ve	3
			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
	1		Credit 6.2	Stormwater Design—Quality Control	1
			Credit 7.1	Heat Island Effect—Non-roof	1
			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1
4				**Water Efficiency**	Possible Points: 10
Y			Prereq 1	Water Use Reduction—20% Reduction	
2			Credit 1	Water Efficient Landscaping	2 to 4
			Credit 2	Innovative Wastewater Technologies	2
2			Credit 3	Water Use Reduction	2 to 4
1	2			**Energy and Atmosphere**	Possible Points: 35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
	1		Credit 1	Optimize Energy Performance	1 to 19
1			Credit 2	On-Site Renewable Energy	1 to 7
			Credit 3	Enhanced Commissioning	2
	1		Credit 4	Enhanced Refrigerant Management	2
			Credit 5	Measurement and Verification	3
			Credit 6	Green Power	2
4	1			**Materials and Resources**	Possible Points: 14
Y			Prereq 1	Storage and Collection of Recyclables	
			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
			Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Element	1
2			Credit 2	Construction Waste Management	1 to 2
1			Credit 3	Materials Reuse	1 to 2
				Materials and Resources, Continued	
Y	?	N			
	1		Credit 4	Recycled Content	1 to 2
			Credit 5	Regional Materials	1 to 2
			Credit 6	Rapidly Renewable Materials	1
1			Credit 7	Certified Wood	1
8				**Indoor Environmental Quality**	Possible Points: 15
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
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 4.1	Low-Emitting Materials—Adhesives and Sealants	1
			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Product	1
			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
1			Credit 6.2	Controllability of Systems—Thermal Comfort	1
			Credit 7.1	Thermal Comfort—Design	1
			Credit 7.2	Thermal Comfort—Verification	1
1			Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1
1				**Innovation and Design Process**	Possible Points: 6
			Credit 1.1	Innovation in Design: Specific Title	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1
				Regional Priority Credits	Possible Points: 4
			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1
23	4			**Total**	Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

Appendix N: Structural Breadth Truss Submittals and Span Tables



Job	Truss	Truss Type	Qty	Ply	SILERADO / GREAT LAKES
J1208033	T28	Special Truss	54	1	Job Reference (optional)

Richco Structures, Haven, WI 53085, Nick Davies
Run: 7.250 s Aug 25 2011 Print: 7.250 s Aug 25 2011 MiTek Industries, Inc. Thu Jan 03 09:48:06 2013 Page 1
ID:PPXEQnCbIUQ7ou6dhzLaBsy4VQe-cupfQheqDpp8feanA0zMZ_CIUW0sga?Nw0NzLVzz5v7

Plate Offsets (X,Y): [2:0-0-1,0-3-2], [12:0-0-1,0-3-2], [14:0-3-8,0-2-8], [17:0-6-12,0-3-0], [19:0-6-12,0-3-0], [20:Edge,0-1-8], [22:0-3-8,0-2-8]

LOADING (psf)		SPACING		CSI		DEFL	in	(loc)	l/defl	L/d	PLATES	GRIP
TCLL	30.0	Plates Increase	1.15	TC	0.93	Vert(LL)	-0.36	17	>999	360	MT20	197/144
(Roof Snow=30.0)		Lumber Increase	1.15	BC	1.00	Vert(TL)	-0.99	20-22	>571	240		
TCDL	10.0	Rep Stress Incr	YES	WB	0.96	Horz(TL)	0.45	12	n/a	n/a		
BCLL	0.0	Code IBC2009/TPI2007		(Matrix-M)		Wind(LL)	0.22	17	>999	240	Weight: 319 lb	FT = 20%
BCDL	10.0											

SPACING 2-0-0

LUMBER

TOP CHORD	2 X 6 SPF No.1 or SPF No.2 *Except* T1: 2 X 6 SYP 2400F 2.0E
BOT CHORD	2 X 4 SPF No.1 or SPF No.2 *Except* B1: 2 X 6 SYP 2400F 2.0E, B4: 2 X 6 SPF No.1 or SPF No.2
WEBS	2 X 4 SPF No.1 or SPF No.2
SLIDER	Left 2 X 4 SPF No.1 No.2 2-0-0, Right 2 X 4 SPF No.1 No.2 2-0-0

BRACING

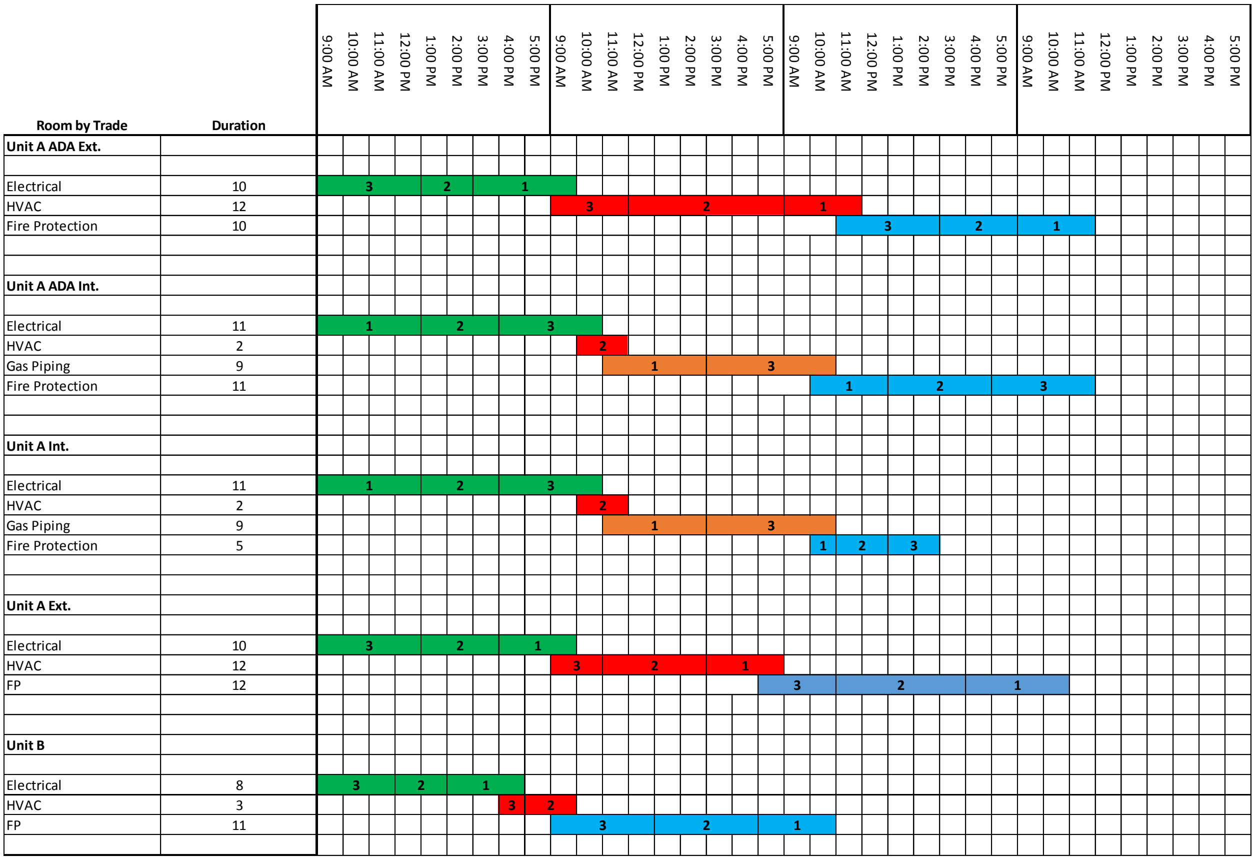
TOP CHORD	Structural wood sheathing directly applied or 2-2-0 oc purlins.
BOT CHORD	Rigid ceiling directly applied or 10-0-0 oc bracing, Except: 2-2-0 oc bracing: 18-19 1-4-12 oc bracing: 17-18.
WEBS	1 Row at midpt 8-18, 6-18

MiTek recommends that Stabilizers and required cross bracing be installed during truss erection, in accordance with Stabilizer Installation guide.

REACTIONS (lb/size) 2=2517/0-5-8 (min. 0-2-4), 12=2517/0-5-8 (min. 0-2-4)
Max Horz 2=-304(LC 9)
Max Grav 2=2690(LC 16), 12=2688(LC 20)

Appendix O: SIPS Schedules and Takeoffs

SIPS schedule for each room layout



Room by Trade	Duration
Unit A ADA Ext.	
Electrical	10
HVAC	12
Fire Protection	10
Unit A ADA Int.	
Electrical	11
HVAC	2
Gas Piping	9
Fire Protection	11
Unit A Int.	
Electrical	11
HVAC	2
Gas Piping	9
Fire Protection	5
Unit A Ext.	
Electrical	10
HVAC	12
FP	12
Unit B	
Electrical	8
HVAC	3
FP	11

Electrical Takeoffs

Electrical

Unit A/A ADA (22 Ext. Rooms)

Reference	Activity	Qty	Unit	Crew	Labor Hours	Total Duration
RS MEANS	Outlet Boxes 4" Steel	22	Ea	1 Electrician	0.4	8.8
RS MEANS	Sheet Metal Junction Boxes	4	Ea	1 Electrician	1	4
RS MEANS	1/2" Steel EMT Conduit	24	LF	1 Electrician	0.047	1.128
RS MEANS	1/2" Steel EMT Connector to Box	22	Ea	1 Electrician	0.067	1.474
RS MEANS	1/2" ENT Conduit	155	LF	1 Electrician	0.03	4.65
RS MEANS	1/2" ENT Conduit Connector to Box	22	Ea	1 Electrician	0.035	0.77
RS MEANS	#12 Copper Wire THWN/THHN	9.8	CLF	1 Electrician	0.727	7.1246
				Total Duration		**27.95**

Electrical

Unit A/A ADA (18 Int. Rooms)

Reference	Activity	Qty	Unit	Crew	Labor Hours	Total Duration
RS MEANS	Outlet Boxes 4" Steel	22	Ea	1 Electrician	0.4	8.8
RS MEANS	Sheet Metal Junction Boxes	4	Ea	1 Electrician	1	4
RS MEANS	1/2" Steel EMT Conduit	34.6	LF	1 Electrician	0.047	1.6262
RS MEANS	1/2" Steel EMT Connector to Box	22	Ea	1 Electrician	0.067	1.474
RS MEANS	1/2" ENT Conduit	185.3	LF	1 Electrician	0.03	5.559
RS MEANS	1/2" ENT Conduit Connector to Box	22	Ea	1 Electrician	0.035	0.77
RS MEANS	#12 Copper Wire THWN/THHN	11.4	CLF	1 Electrician	0.727	8.2878
				Total Duration		**30.52**

Electrical

Unit B (10 Rooms)

Reference	Activity	Qty	Unit	Crew	Labor Hours	Total Duration
RS MEANS	Outlet Boxes 4" Steel	16	Ea	1 Electrician	0.4	6.4
RS MEANS	Sheet Metal Junction Boxes	3	Ea	1 Electrician	1	3
RS MEANS	1/2" Steel EMT Conduit	23.4	LF	1 Electrician	0.047	1.0998
RS MEANS	1/2" Steel EMT Connector to Box	16	Ea	1 Electrician	0.067	1.072
RS MEANS	1/2" ENT Conduit	148.3	LF	1 Electrician	0.03	4.449
RS MEANS	1/2" ENT Conduit Connector to Box	16	Ea	1 Electrician	0.035	0.56
RS MEANS	#12 Copper Wire THWN/THHN	8.2	CLF	1 Electrician	0.727	5.9614
				Total Duration		**22.54**

HVAC Takeoffs

HVAC						
Unit A ADA (11 Int. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	FSK vapor barrier wrap, 1 1/2" thick	154.6	SF	Q-14	0.05	7.73
RS MEANS	6" Diameter Round Duct, Galv. Steel, 26 Ga.	8.2	LF	Q-9	0.057	0.4674
RS MEANS	6" Diameter, Connector	1	Ea	Q-9	0.057	0.057
RS MEANS	6" Flex Duct	5	Ea	Q-9	0.062	0.31
				Total Duration		**8.56**

HVAC						
Unit A ADA (14 Ext. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	14x5 Rectangular Duct, Galv. Steel, Under 200 lbs	55.27	Lbs	Q-10	0.102	5.63754
RS MEANS	12x6 Rectangular Duct, Galv. Steel, Under 200 lbs	18.14	Lbs	Q-11	0.102	1.85028
RS MEANS	FSK vapor barrier wrap, 1 1/2" thick	75.1	SF	Q-14	0.05	3.755
RS MEANS	6" Diameter Round Duct, Galv. Steel, 26 Ga.	3.3	LF	Q-9	0.057	0.1881
RS MEANS	6" Flex Duct	5	Ea	Q-9	0.062	0.31
RS MEANS	6" Diameter, Connector	1	Ea	Q-9	0.057	0.057
				Total Duration		**11.80**

HVAC						
Unit B (10 Rooms)						
Reference	**Activity**	**Sty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	12x6 Rectangular Duct, Galv. Steel, Under 200 lbs	15.7	Lbs	Q-11	0.102	1.6014
RS MEANS	6" Diameter Round Duct, Galv. Steel, 26 Ga.	3.3	LF	Q-9	0.057	0.1881
RS MEANS	6" Flex Duct	5	Ea	Q-9	0.062	0.31
RS MEANS	6" Diameter, Connector	1	Ea	Q-9	0.057	0.057
				Total Duration		**2.16**

HVAC						
Unit A (7 Int. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	6" Diameter Round Duct, Galv. Steel, 26 Ga.	5.2	LF	Q-9	0.057	0.2964
RS MEANS	6" Flex Duct	5	Ea	Q-9	0.062	0.31
RS MEANS	6" Diameter, Connector	1	Ea	Q-9	0.057	0.057
				Total Duration		**0.66**

HVAC						
Unit A (8 Ext. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	14x5 Rectangular Duct, Galv. Steel, Under 200 lbs	55.27	Lbs	Q-10	0.102	5.63754
RS MEANS	12x6 Rectangular Duct, Galv. Steel, Under 200 lbs	21.4	Lbs	Q-11	0.102	2.1828
RS MEANS	6" Flex Duct	5	Ea	Q-9	0.062	0.31
RS MEANS	6" Diameter, Connector	1	Ea	Q-9	0.057	0.057
RS MEANS	6" Diameter Round Duct, Galv. Steel, 26 Ga.	3.3	LF	Q-9	0.057	0.1881
				Total Duration		**8.38**

Gas Piping Takeoffs

HVAC Gas Piping with 1/2" to 1 1/2" Piping						
Unit A ADA (11 Int. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	3" Gas Piping, Steel, Schedule 40	31.5	LF	Q-4	0.123	3.8745
RS MEANS	90^0 Elbow	2	Ea	Q-6	1	2
RS MEANS	3" Tee	2	Ea	Q-6	1.143	2.286
				Total Duration		8.1605

HVAC Gas Piping with 2" to 3" Piping						
Unit A ADA (11 Int. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	1" Gas Piping, Steel, Schedule 40	31.5	LF	Q-4	0.107	3.3705
RS MEANS	90^0 Elbow	2	Ea	Q-6	1	2
RS MEANS	3" Tee	2	Ea	Q-6	1.143	2.286
				Total Duration		7.6565

HVAC Gas Piping with 2" to 3" Piping						
Unit A/A ADA (9 Int. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	3" Gas Piping, Steel, Schedule 40	34.7	LF	Q-4	0.123	4.2681
RS MEANS	90^0 Elbow	2	Ea	Q-6	1	2
RS MEANS	3" Tee	2	Ea	Q-6	1.143	2.286
				Total Duration		8.55

HVAC Gas Piping with 1/2" to 1 1/2" Piping						
Unit A/A ADA (9 Int. Rooms)						
Reference	**Activity**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	1" Gas Piping, Steel, Schedule 40	34.7	LF	Q-4	0.107	3.7129
RS MEANS	90^0 Elbow	2	Ea	Q-6	1	2
RS MEANS	3" Tee	2	Ea	Q-6	1.143	2.286
				Total Duration		8.00

Fire Protection Takeoffs

Fire Protection						
Unit A ADA (14 Ext. Rooms)						
Reference	**Acitivtiy**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	1" CPVC Pipe	32.2	LF		0.174	5.6028
RS MEANS	1" CPVC Tee	5	Ea.		0.526	2.63
RS MEANS	1" 90^{o} Elbow	5	Ea.		0.352	1.76
				Total Duration		**9.99**

Fire Protection						
Unit A ADA (11 Int. Rooms)						
Reference	**Acitivtiy**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	1" CPVC Pipe	38.1	LF		0.174	6.6294
RS MEANS	1" CPVC Tee	5	Ea.		0.526	2.63
RS MEANS	1" 90^{o} Elbow	5	Ea.		0.352	1.76
				Total Duration		**11.02**

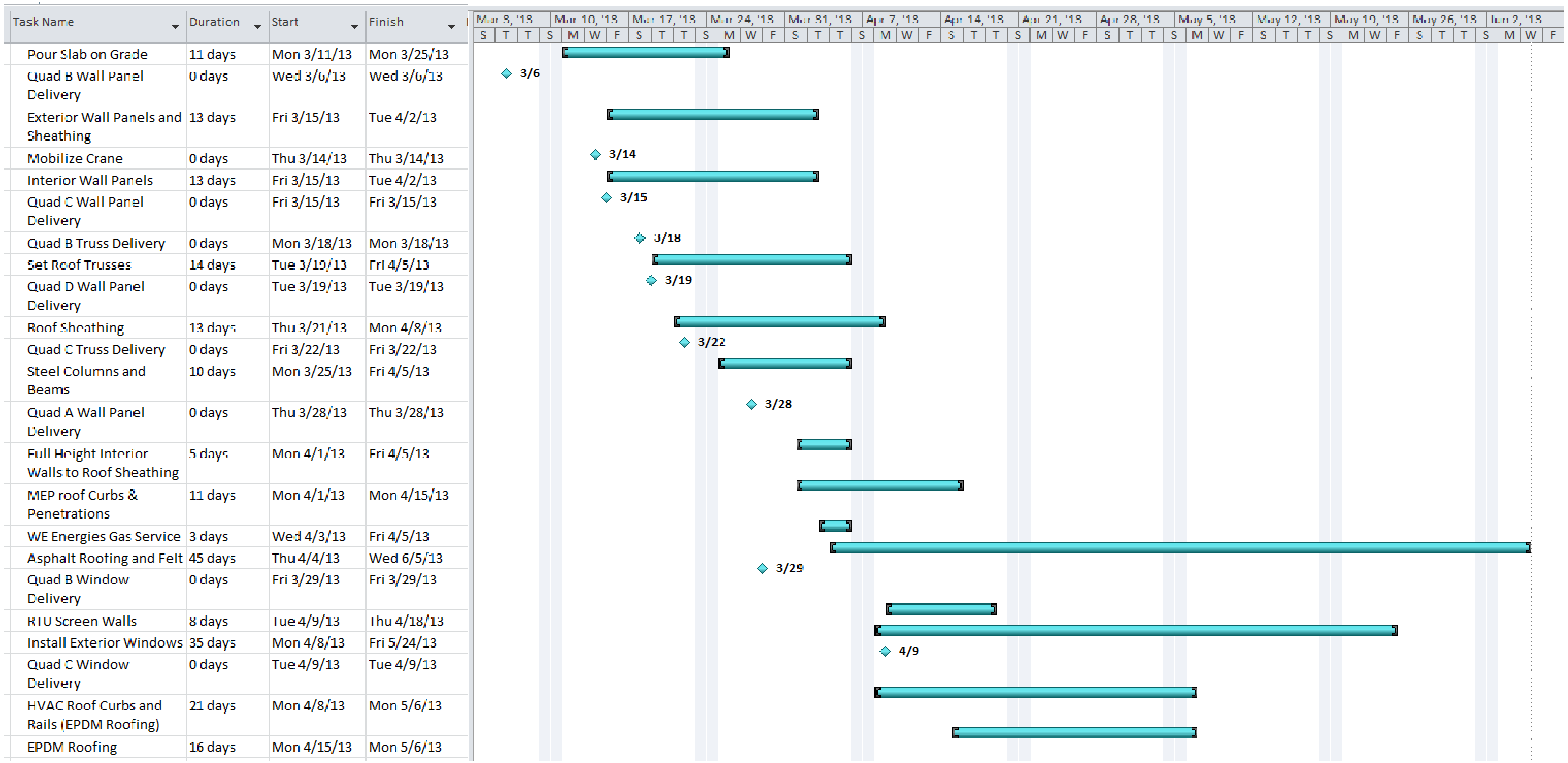
Fire Protection						
Unit B (10 Rooms)						
Reference	**Acitivtiy**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	1" CPVC Pipe	13.67	LF		0.174	2.37858
RS MEANS	1" CPVC Tee	2	Ea.		0.526	1.052
RS MEANS	1" 90^{o} Elbow	4	Ea.		0.352	1.408
				Total Duration		**4.84**

Fire Protection						
Unit A (7 Int. Rooms)						
Reference	**Acitivtiy**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	1" CPVC Pipe	40	LF		0.174	6.96
RS MEANS	1" CPVC Tee	5	Ea.		0.526	2.63
RS MEANS	1" 90^{o} Elbow	5	Ea.		0.352	1.76
				Total Duration		**11.35**

Fire Protection						
Unit A (8 Rooms)						
Reference	**Acitivtiy**	**Qty**	**Unit**	**Crew**	**Labor Hours**	**Total Duration**
RS MEANS	1" CPVC Pipe	35.3	LF		0.174	6.1422
RS MEANS	1" CPVC Tee	5	Ea.		0.526	2.63
RS MEANS	1" 90^{o} Elbow	5	Ea.		0.352	1.76
				Total Duration		**10.53**

Appendix P: Re-sequencing the Project Schedule

Re-sequenced Project Schedule



Task Name	Duration	Start	Finish
Pour Slab on Grade	11 days	Mon 3/11/13	Mon 3/25/13
Quad B Wall Panel Delivery	0 days	Wed 3/6/13	Wed 3/6/13
Exterior Wall Panels and Sheathing	13 days	Fri 3/15/13	Tue 4/2/13
Mobilize Crane	0 days	Thu 3/14/13	Thu 3/14/13
Interior Wall Panels	13 days	Fri 3/15/13	Tue 4/2/13
Quad C Wall Panel Delivery	0 days	Fri 3/15/13	Fri 3/15/13
Quad B Truss Delivery	0 days	Mon 3/18/13	Mon 3/18/13
Set Roof Trusses	14 days	Tue 3/19/13	Fri 4/5/13
Quad D Wall Panel Delivery	0 days	Tue 3/19/13	Tue 3/19/13
Roof Sheathing	13 days	Thu 3/21/13	Mon 4/8/13
Quad C Truss Delivery	0 days	Fri 3/22/13	Fri 3/22/13
Steel Columns and Beams	10 days	Mon 3/25/13	Fri 4/5/13
Quad A Wall Panel Delivery	0 days	Thu 3/28/13	Thu 3/28/13
Full Height Interior Walls to Roof Sheathing	5 days	Mon 4/1/13	Fri 4/5/13
MEP roof Curbs & Penetrations	11 days	Mon 4/1/13	Mon 4/15/13
WE Energies Gas Service	3 days	Wed 4/3/13	Fri 4/5/13
Asphalt Roofing and Felt	45 days	Thu 4/4/13	Wed 6/5/13
Quad B Window Delivery	0 days	Fri 3/29/13	Fri 3/29/13
RTU Screen Walls	8 days	Tue 4/9/13	Thu 4/18/13
Install Exterior Windows	35 days	Mon 4/8/13	Fri 5/24/13
Quad C Window Delivery	0 days	Tue 4/9/13	Tue 4/9/13
HVAC Roof Curbs and Rails (EPDM Roofing)	21 days	Mon 4/8/13	Mon 5/6/13
EPDM Roofing	16 days	Mon 4/15/13	Mon 5/6/13

Average Temperatures in Milwaukee


Monthly Averages for
Milwaukee, WI (53207)
[English | Metric]

Monthly Averages ▼

Table Display | Graph Display

Temperature (°F)
☑ Avg Higl ☐ Record Hig
☑ Avg Lov ☐ Record Lo

Precipitation
● Avg Precip.