DEVELOPMENT OF A METHOD USING BIM TECHNOLOGY TO

DETERMINE THE UTILITY BILL AND TOTAL COST OF

OWNERSHIP OF A SINGLE-FAMILY HOME

A Senior Scholars Thesis

by

ASHLEY KAYE MCGARITY

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2010

Major: Environmental Design

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                                                       Charles Culp
Associate Dean for Undergraduate Research: Robert C. Webb

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ABSTRACT

Development of a Method Using BIM Technology to Determine the Utility Bill and Total
Cost of Ownership of a Single-Family Home. (April 2010)

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Building Information Modeling (BIM) Technology has been around for several years

and has proven to be very helpful in aiding engineers, architects, and contractors

with their projects. BIM is a set of computer programs that work together by sharing

information and allowing the user to see their building in 3D, and gain information

on scheduling, cost estimates, design problems, material selection, and much more.

Every project is different and requires BIM Technology to be used in a different

way. By creating a method to establish the utility bills and the mortgage of a single

family home, users will be able to know which programs to use and how to input

their information. This method will allow architects and builders more time to

concentrate on the design of the home and will allow clients to make appropriate

changes to the home to reflect their ideal utility bill and mortgage before the home is

built.

ACKNOWLEDGMENTS

also showed how much they value undergraduate research. I took the gesture not only as financial backing but also as a pat on the back. Also, the Undergraduate Research Scholar Program, provided financial assistance along with several educational seminars. Both forms of assistance were greatly appreciated and helped me focus on the topic I was researching.

Brazos County Affordable Housing and Stylecraft Builders provided me with a home plan and the homes' cost information. Without their cooperation this research may have not been successful. Both builders were eager to work with me. I appreciate the time spent answering my questions and agreeing to being a part of this research.

Once again I would like to thank you all for being a part of this research project and taking time away from your own endeavors to help me. Everything you have done is greatly appreciated.

NOMENCLATURE

B/CS   Bryan/College Station

BIM   Building Information Modeling

HVAC   Heating, Ventilation, & Air Conditioning

CAD   Computer Aided Design

AVG   Average

MIN   Minute

HR   Hour

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CHAPTER I

INTRODUCTION

My passion for residential architecture is what led me to start the Environmental Design program at Texas A&M. Throughout my education I have learned how to design, use different techniques, how to think outside the box, and about commercial architecture. As I entered my senior year I began to reflect on my studies and realized that I have not learned as much as I would like to about residential architecture. So, I decided to take part in the Research Track Option within the Architecture Department. By doing research I hoped to learn as much about residential architecture as I wanted; I would be free to point my studies in any direction. I chose to not only learn about the design aspect of residential architecture, but also cost estimating, total cost, energy usage (performance), and Building Information Modeling (BIM) programs. While learning I planned to devise a method using BIM to establish the total cost of ownership of a single-family home and predict what the utility bills will be. This research was intended to also allow me to get real world experience because I am not solely looking at the design. I planned to go through the process of establishing a total cost, energy bills, and how it will perform.

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This thesis follows the style of *Journal of Environment & Design*.

My plan has been to define a method using Building Information Technology (BIM) to establish the utility bill and the total cost of ownership of a single-family residence. Every project is different and requires BIM Technology to be used in a different way. By creating a method to establish the utility bills and the total cost of ownership of a single-family home, users will be able to know which programs to use and how to input their information. This method will allow architects and builders more time to concentrate on the design of the home and will allow clients to make appropriate changes to the home to reflect their ideal utility bill and ownership cost before the home is built.

Building Information Modeling (BIM) can be defined several ways. The National Building Information Model Standard defines Building Information Modeling as, "…a digital representation of physical and functional characteristics of a facility (Madsen, 2008)." They also state that it is intended to be a shared knowledge resource about a facility, and that it is a basis for decision making throughout the project (Madsen, 2008). BIM technology is very powerful and can be used on many different types of design projects and can provide a schedule, cost estimates, materials, 3D models, dimensions, and find design errors. The programs are capable of accomplishing all of those tasks plus more as long as the user spends time inputting information (Klemens, 1999). Architects and engineers benefit from using this technology because it allows their clients to get a better understanding of the building, by using the 3D models and clear drawings (Holness, 2006). The main goal of BIM is to provide better communication

among the parties involved in a project.   Steve Shirley, the president of the University

Mechanical & Engineering Contractors, Inc. stated, "It is all about pre-coordination with

sub-traders to bring everyone together on a project to ensure compliance (Murphy,

2009)." Tom Klemens stated in his article, "BIM facilitates better communication and

accuracy, reduces ambiguity, increases efficiency, and reduces work (Klemens, 1999)."

A nice quality of BIM is that these goals can be achieved with every project that uses

BIM, not just a select few. This is why it is valued by its users, not only because of what

it can do and produce, but because of its process (Madsen, 2008). BIM can be a very

powerful tool if it is utilized correctly.

In 2006, according to the 2006 AIA Firm Survey, 16% of AIA member-owned

architecture firms used BIM technology and 64% of the firms used BIM for billable

work (Riskus, 2007). Those percentages are good considering architecture is one of the

slowest industries to be advancing towards BIM. Also, according to a white paper

provided by Autodesk, Donald Powers Architects has seen a 30% productivity gain in

design and documentation by using Autodesk Revit (Autodesk, 2007). This resource

provides support to the claim I made that BIM does not have to be used on large projects

to be successful.

BIM makes cost estimating a very simple task, unlike the traditional way. By using BIM

to establish a cost estimate the architect is able to get an accurate estimate straight from

the model (Bedrick, 2005). BIM allows most of the basic building information that is

put into the models to be ran through this type of analyses. For example, all of the

information used in the traditional process like doors, windows, and walls can be

modeled in a BIM program (Tardiff, 2007a). The information used to form a BIM

model can be exported into a cost database and the database can produce an accurate

estimate faster than the traditional method (Bedrick, 2005). Cost databases usually have

several types of products with the prices that allow users to simply select the appropriate

item. By using a cost database and not the traditional method, the user is saving time

and money. This will allow more time to design.

In 2009 the buildings in the United States used 39% of the primary energy, 40% of all

raw materials, and contributed to 38% of the carbon dioxide emissions (Haymaker,

Flager, & A.A, 2009). Predictions show that the impact of buildings will increase as the

need increases unless some design changes are made. The design of a building plays a

very large role on how it will affect the surrounding environment and economy

throughout its lifecycle (Haymaker, 2009). BIM now provides a method for engineers

and architects to simulate their buildings' performance before it is built. Analysis

programs can analyze the architectural, mechanical, structural, acoustical, and lighting

systems within the 3D model built in a BIM program like Autodesk Revit (Flager &

Haymaker, 2009) Energy analysis programs were developed years before BIM

technology (Autodesk, 2005). The problem with the technology was that people did not

take advantage of it. Firms did not typically use the programs because they did not have

the time or the money to devote to learn them (Autodesk, 2005). At the time people did

not realize the benefits of using computer software to perform energy analysis because the negatives outweighed the benefits. With BIM software the users are allowed more time and can create "what if" situations to test out ideas (Madsen, 2008). Designers are no longer limited to one design idea because with BIM the user can run an analysis at anytime and decide on a good design. Also, the analysis process is much faster now, which allows more time to experiment (Madsen, 2008). The designer no longer has to work out complicated calculations or repeatedly enter data. Deke Smith, executive director of the buildingSMART alliance at the National Institute of Building Sciences stated, "It will be easier to create buildings that achieve zero carbon emissions, reduce construction and facility waste, and maximize building efficiency through alternative positioning and site-design analysis with BIM (Madsen, 2008)."

The HVAC (Heating, Ventilation, & Air Conditioning) loads can be analyzed by two different types of BIM programs: built-in or third-party analysis tool. Built-in analysis tools are built into the same program as the main model (Roth, 2009). This type of tool is easier to use because it is combined with the main model assuring that the user needs to learn fewer programs (Roth, 2009). Programs like Revit can support internal programs for BIM analysis and users can also use third party analysis tools. A third-party analysis tool is in a different program from the model. Some contractors are happy with the programs they use and do not want to change and may thus prefer a third-party program (Roth, 2009). Since many programs and methods were created prior to BIM, firms have established successful work methods without BIM. This is acceptable

because a majority of the BIM programs can share information with third-parties (Roth, 2009). Some third-party analysis tools were created specifically for HVAC systems. For example, the program Daikin has 3D templates of HVAC equipment that is capable of being transferred into a BIM model (Murphy, 2009). By being able to instantly input a 3D model into the main model, the designer can immediately decide if that system is going to work for the project they are working on. If it is not, another model can be placed or altered.

BIM technology has the extra dimension of time or 4D. This allows the user to input information for a project schedule (Klemens, 1999). An architect could input information such as start date, how long to allow for each scheduled task, and an end date to produce a schedule (Klemens, 1999). By being able to schedule time projects will more likely be completed on time and will be less likely to go over budget. Not only can the architect or other users schedule materials, start and end dates, or tasks, but 4D will also schedule nonstructural elements such as the construction equipment or operational equipment by adding it to the main model (Klemens, 1999). This would also guarantee the project would run smoothly. The firm OLBN (Online Business Network) worked on a project that proved how timely BIM actually is. OLBN was given the opportunity by GSA to work on a large project and the time allowed for the project was scheduled to be six weeks (Tardif, 2007b). This would have been an impossible task to complete within six weeks if the firm did not use BIM (Tardif, 2007b). BIM allowed them to work quickly, try different ideas, and even add "extras" (Tardif, 2007b). Also,

study was done to prove exactly how time efficient the technology was. Within the article BIM and Process Improvement, there was information about a study that involved three firms. The study compared the CAD process and the BIM process of the three firms (Bedrick, 2005). Diagrams were included that display the amount of time it took to do certain tasks and how many tasks were completed in one day (Bedrick, 2005). The study concluded that the BIM process was more beneficial because it was able to complete more tasks in a timely manner (Bedrick, 2005). Time is a large factor now when firms consider projects.

Autodesk stated in this white paper, "An ROI analysis is one of many ways to evaluate a proposed investment. It compares the gains anticipated from an investment against the cost of the investment (Autodesk, 2007)." An ROI (Return on Investment) will put a lot of prospective user's worries to rest. It is good to use when you want to find out how much you will gain, but becomes less accurate when it is used to figure out how much that gain is worth (Autodesk, 2007). This will allow users to see exactly how much they will or will not benefit from BIM. A ROI can be found by using a formula to establish the first year ROI that includes particular variables, such as the proposed systems cost, labor costs, the training time, expected percentage loss, and the percentage expected to gain (Autodesk, 2007). If an ROI and appropriate research are done I think a firm should be able to pick a provider of BIM software that will benefit them.

From researching BIM I have learned everything from the history of CAD to BIM, cost estimating with BIM, sustainability, energy analysis, and the benefits of BIM. I have identified a gap between BIM and residential use and mortgage calculations. I did not find much information that applied to residential homes and establishing the mortgage and energy bills. With my research I planned to define a method using BIM technology to calculate the utility bills and mortgage of a single-family home. By completing my research I expected to fill the gap that I have identified.

The scope of this research has been very specific to allow me to complete the research in the short amount of time that was available. I have focused on creating a method to be used for establishing the utility bill and the total cost of ownership of single-family homes. Background research was done to identify gaps that this method will fill. Actual house plans from builders were used to conduct this research. The programs, Autodesk Revit, Autodesk Green Building Studio, and SmartBIM Library are the BIM programs that I used to establish the desired method. A non-BIM program, Microsoft Excel, was also used to support the research study.

CHAPTER II

RESOURCES AND METHODS

The literature review summarizes background information about the proposed research. The topics covered in the literature review are a definition of BIM, its goals, the application of the programs, savings and cost estimating, energy analysis, HVAC system analysis, sustainability, standardization, the benefits of using BIM, and BIM software. Also, throughout the review I will compare BIM technology with CAD to illustrate the differences between the two and why BIM should be considered to be more efficient than CAD.

The next step was to find builders willing to work with me. I contacted two builders and asked them if they would be willing to provide a house plan between 1,500 and 3,000 square foot. Each participating builder would need to provide me with at least one house plan, the materials used to construct the home, and the cost estimates. This information could be on the floor plans, cut sheets, or on electronic files. Any other information about the home that the builder was willing to provide me was welcome and allowed me to learn more about the home. The two builders chosen to take part in this specific project were picked because they represent two different single-family home markets. One home is a production home and the other is an affordable home. Using different types of homes from builders in different markets illustrated that the created method can be applied to most homes no matter what market they represent.

After the two builders and two homes were identified and all the information was collected I learned how to use all of the BIM programs that are contributing to this research. To conduct this research effectively I learned how to use Autodesk Revit, SmartBIM Library, and Autodesk Green Building Studio. Each program has a specific role in the research. After I learned all of the programs I input one home's information at a time through all of the programs and then recorded the results. Small adjustments were made to the first process in order to complete the next house. I anticipated changing the way the information put into Autodesk Revit and the way I used all three programs. The method of use for each program was expected to affect the outcome of the study. After the second home's information was input and the results have been produced, a method was established to compute the expected utility bill and mortgage cost of a home.

As mentioned above the BIM programs that will be used to create the desired method are Autodesk Revit, SmartBIM Library, and Autodesk Green Building Studio. Autodesk Revit will produce a 3D model, schedules, and will keep track of how many windows, doors, and other building materials are used in the particular home. The model information will be able to transfer to the other BIM programs being used. SmartBIM Library was an additional source for finding building elements that need to be modeled into the homes. After the model was complete the schedules were exported to Microsoft Excel to analyze and organize the costs and create an estimate. Within Microsoft Excel I made changes to the created schedules, charts, and easily created a total from the costs

export. Autodesk Green Building Studio allowed me to input the model information automatically and then run an energy simulation. The results from the energy simulation provided information on how the home performs and aided in establishing the utility bill.

The BIM program Revit is able to keep track of all the materials used in a project, and the size, and quantity (Autodesk, 2005). Keeping track of all of that data is hard and can produce errors. Revit can provide accurate numbers because it keeps track of the buildings information throughout the whole process by using schedules (Autodesk, 2005). By using programs like Revit the amount of wasted material on site will be reduced. BIM is not limited to keeping track of the buildings information. The programs can also keep track of off-site fabrication and assembly (Holness, 2006). This is a unique tool that should ease the minds of architects. By keeping track of the off-site fabrication and assembly the on-site construction cost will be lower and the construction time will be lower (Holness, 2006). Not only does Revit keep track of materials and planning, it can also produce construction documents. By using Revit Architecture construction document confusion is eliminated and at the end of the project a set of accurate construction documents are produced because Revit has been in charge of rescheduling and making appropriate changes (Autodesk, 2005). Revit Architecture is a program that supports BIM technology and it allows for users to conduct analysis within the program and at anytime during the projects design (Autodesk, 2005). This is a good tool because users can make appropriate changes early on in the project rather than too

late. Not only can Revit provide an energy analysis, it also works directly with Autodesk Green Building Studio (Autodesk, 2005).

The BIM program, Green Building Studio will be used to conduct the energy analysis of the homes being studied during this research. Green Building Studio is a separate program that can perform an analysis on the building and will provide the user with a summary of the performance; it can also create a thermal model, apply local codes, and create a DOE-2 input (Autodesk, 2005). All of the listed results required are obtained from one program. The results can help the user when they are trying to decide how to orientate the building on the site (Autodesk, 2005). Being able to use the results to help orientate the building is a nice option that was not as easily available with the traditional method. Green Building Studio creates a DOE-2 input, which allows the building information to be easily plugged into more detailed engineering analysis programs such as eQuest, EnergyPlus, or Trane (Autodesk, 2005). The Green Building XML (gbXML) schema is developing into the primary schema for the building analysis industry (Roth, 2009). This schema is used by Green Building Studio as both input and output. Once the buildings information is exported as a gbXML the third-party program will analyze it to produce results for the user (Roth, 2009). By making sure that your data is translated into the appropriate schema you will be avoiding having to re-enter data. This function contributes to the efficient process of BIM.

After inputting each of the homes information into the appropriate BIM programs I will have created a useful method to establish the utility bill and the total cost of ownership of a single-family residential home. The method will be useful to those who are interested in both the professional field and education field.

CHAPTER III

RESULTS

To begin this research I created the first method using the affordable home provided by Brazos Valley Affordable Housing Corporation. The method was comprised of the following steps: create home in Autodesk Revit, input the building specifications and costs into the elements properties created in Autodesk Revit, input the homes information into Autodesk Green Building Studio, and summarize the results of the analyses as a total cost of ownership

The first step, create the affordable home in Autodesk Revit, took a total of eleven hours and nine minutes. Figure 1 illustrates the finished 3D model of the affordable home.

Figure 1. Affordable Home-3D Perspective
Source: Created in Autodesk Revit

I used the plans provided to me and other outside resources to adequately construct the

home. To establish this method it was necessary to construct the frame, interior and

exterior walls, ceiling, roof, windows, doors, decking, appliances, plumbing fixtures and

the site. Autodesk Revit is capable to do more, like electrical work, HVAC, and

plumbing, but for the purpose of this research it was not necessary. After the eleven

hours had passed and I had fully constructed the home, I started the next step.

Next, I input all the elements specifications and costs into their properties. By doing this

Autodesk Revit knows exactly what the element you created is and will allow you to

create accurate schedules. Autodesk Revit allows the user to create schedules that can

organize the different elements into categories of your choice. A benefit of these

schedules is that they help quantify the elements, know the costs, and focus on a specific

area. To get accurate costs and descriptions of the building elements I used the home

plans provided, Lowes website, and the books RSMeans Assemblies Cost Data 2009 and

RSMeans Building Construction Data 2008. By using all of these sources I was able to

get a valid estimate on the costs and descriptions of all of the elements needed to find the

total cost of the home and utility bill. After the correct information was in the schedules

I exported them directly to Microsoft Excel. In Microsoft Excel I was able to

personalize the schedules and create the total cost of the affordable home. Refer to the

Appendix for the schedules and the total cost of constructing the affordable home. The

total amount of time spent on gathering, inputting, and sorting all of the costs and

description was eight hours.

I computed the total cost of constructing the home to be $112,132.97 and the given total

cost was $86,290.00.

Table 1. Affordable: Mortgage Information

MORTGAGE: HOUSE #1, AFFORDABLE HOME	
Price of Home:	$112,133
Credit Rating:	Good (660-699)
Down payment:	20% $20,691
State:	Texas
County:	Brazos
Loan Type:	30-Year Fixed
Points:	Up to 1 Point
Home Type:	Single-Family Home
Use:	Primary Residence

Table 1. Continued

Lender:	Home Finance of America, Inc.
Interest Rate:	4.875%
APR:	5.129%
Monthly Payment:	$474.00
Lender Fees:	$2,553.00
Points:	0.875

Source: Calculator provided by Google, parameters set by me to accurately depict project

While computing my numbers I used the wall area while the original number was computed from the square footage of the house. Autodesk Revit provided me with accurate wall areas which made cost estimating more stream-lined and more efficient. After the cost information was compiled and recorded I proceeded to establish the monthly mortgage payment by using a mortgage calculator provided by Google. This

calculator allows you to choose preferences like what type of loan you want, credit

rating, and the use. After choosing the appropriate preferences the calculator estimated

that the monthly payment would be $474.00. Table 1 illustrates further details provided

by the mortgage calculator.

The final step in this first method was to export the home model's information into

Autodesk Green Building Studio. This step was not time consuming compared to the

other steps, but generated a lot of useful information. What I did was sign into my

online account with Autodesk Green Building Studio, create a new project, within

Autodesk Revit press export, and then within minutes the affordable homes' energy use

estimates were produced.

Table 2. Affordable: General Energy Analysis Information

ENERGY ANALYSIS: HOUSE #1, AFFORDABLE HOME		
Floor Area:	1,167 ft2	
Total Annual Energy Cost:	$1,760	
Annual Electric Cost:	$1,013	
Annual Fuel Cost:	$748	
Annual Peak Electric Demand:	3.10 kW	
Annual Electric Use:	7,790 kWh	
Annual Fuel Use:	54 MBtu	
Energy Use Intensity:	69.2 kBtu/ft2/year	

Source: Generated from Autodesk Green Building Studio

The program provided me with the annual usage of water and electricity, provided a 3D

image, and broke down the energy usage into charts and explanations. Overall, it took

me an hour to generate all the information, and organize it. The tables and figures

illustrate the energy results. Table 2 illustrates the general energy analysis information.

Figure 2 illustrates the annual fuel end use. Figure 3 illustrates the annual electric end

use.

Annual Fuel End Use

Hot Water ■ Space Heating ■ Pumps & Aux

15.20%

21.30%

63.60%
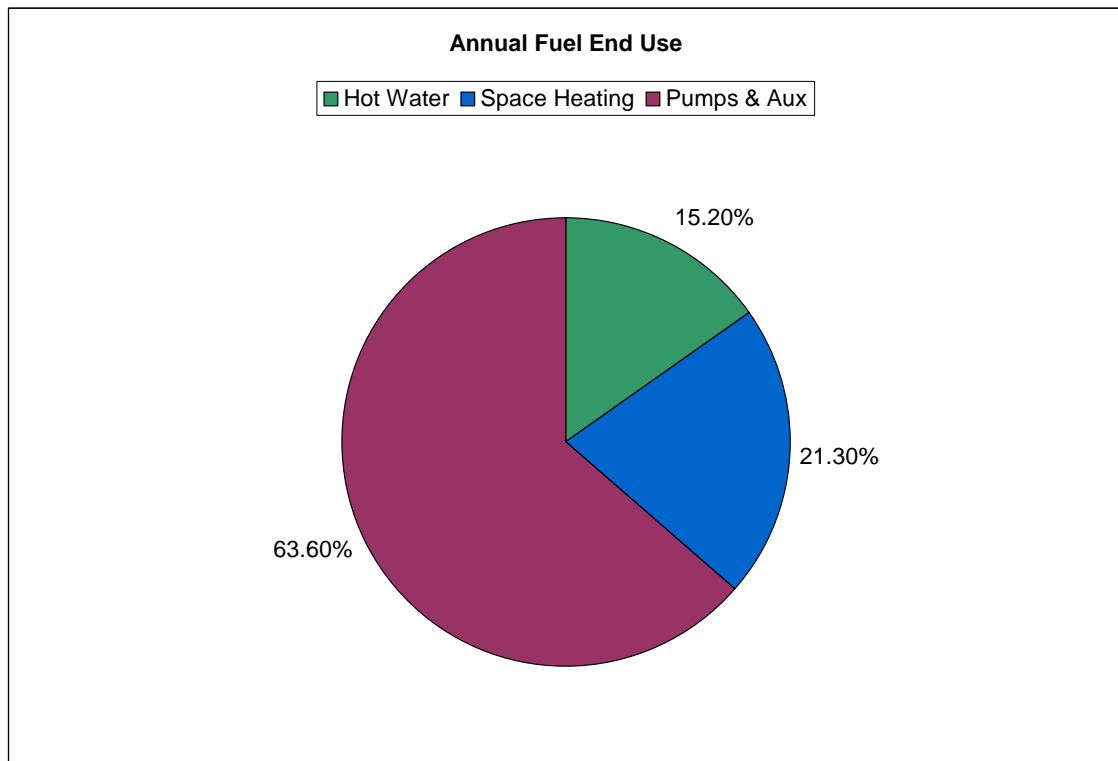
Figure 2. Affordable: Annual Fuel End Use
Source: Created in Autodesk Green Building Studio

Annual Electric End Use

☐ Lights ☐ Pump & Aux, Space Heating ☐ Fans ☐ Space Cooling ☐ Misc. Equip.

25.70%

23.50%

5.70%

9.80%

35.20%
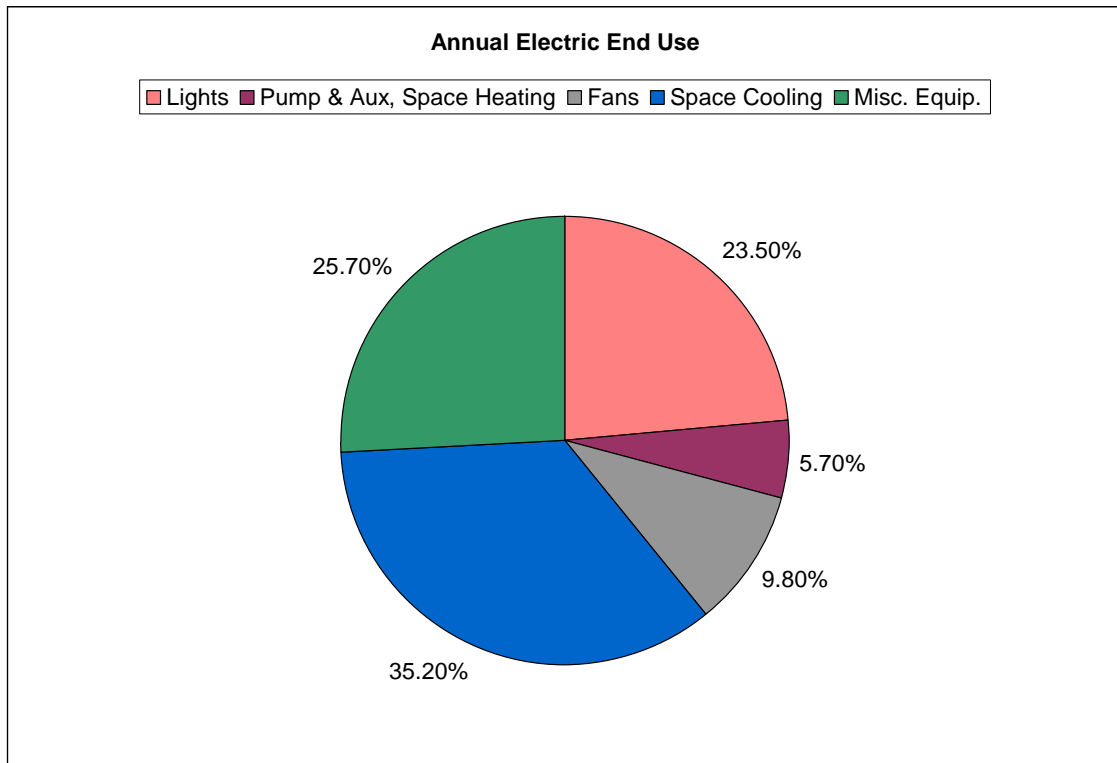
Figure 3. Affordable: Annual Electric End Use
Source: Created in Autodesk Green Building Studio

After I produced the annual energy usage and the monthly mortgage payments I was

able to compute the total cost of ownership and break it into amortized monthly

payments. I assumed the electricity and water rates had been fixed, so I divided the total

cost by twelve. Then I added energy, water, and monthly mortgage payment together to

establish the total cost of ownership per month. Table 3 illustrates the amortized

monthly payment. The first method took twenty hours and forty one minutes to

complete. Table 4 illustrates the total amount of time it took to complete the first

method.

Table 3. Affordable: Amortized Payment of Single-Family Home

Amortized Payment of Affordable Single-Family Home	
Energy:	$146.67
Water:	$17.50
Payment:	$474.00
Total:	$638.17

Note: Numbers generated from Autodesk Green Building Studio & Google Mortgage
Calculator
Source: Created in Microsoft Excel

Table 4. Method #1, Total Time

METHOD #1: TOTAL TIME	
Revit:	11 hr. 9 min.
Schedules:	20 min.
Organizing/Cost:	8 hr.
Mortgage:	12min.
Green Building Studio:	1 hr.
Total:	20 hr. 41 min.

Note: Numbers generated from Autodesk Green Building Studio & Google Mortgage
Calculator
Source: Created in Microsoft Excel

In the first method I was able to successfully establish the utility bill and the total cost of ownership. The second method does not differ greatly from the first, but I did make some changes to the way I approached the second house. The adjustments I made were compiling all of the cost information before I began modeling the home in Autodesk Revit. Once all the cost information was collected I began modeling the home in Autodesk Revit and while I was creating elements I inputted their cost information. Next, I created schedules and exported them into Microsoft Excel. Then, I was able to export the model of the home into Autodesk Green Building Studio and analyze the results. Finally, the total cost of ownership and the utility bill was established.

In the second method I used the cost information provided to me by Stylecraft, RS Means Assemblies Cost Data and RS Means Building Construction Cost Data, and Lowe's. I also was able to use the cost information previously gathered for the first home.

Next, while I was modeling the second home into Autodesk Revit I entered the gathered cost information into the appropriate fields while creating new elements. This allowed me to prevent having to back track and later add the cost information. I modeled the same basic building elements as I did in the first house and added more elements when needed. Even though the construction of the both homes were the same the size of the second home was almost double the size of the first home, which meant more building elements were needed. The total time I spent modeling the second home was eight hours

and twenty minutes. Figure 4 illustrates a 3D image of the second home which was

provided to me by Stylecraft.

Figure 4. Production Home-3D Perspective
Source: Created in Autodesk Revit

After the home was finished I created schedules within Autodesk Revit exactly like I did

in the previous method except it only took me fifteen minutes to finish. Once the

schedules were complete I exported them into Microsoft Excel and organized them and

added in information where it was needed. Stylecraft had estimated that the total cost of

construction was about $200,000, but after organizing the schedules into new categories

and accounting for all the building elements I computed a total construction cost of

$327,068. The total amount of time it took me to export, organize, and gather cost

information was five hours. Refer to the Appendix for the schedules and the total cost of

constructing the production home.

Table 5. Production: Mortgage Information

MORTGAGE: HOUSE #2, STYLECRAFT	
Price of Home:	$327,068
Credit Rating:	Good (660-699)
Down payment:	20% $20,691
State:	Texas
County:	Brazos
Loan Type:	30-Year Fixed
Points:	Up to 1 Point
Home Type:	Single-Family Home
Use:	Primary Residence
Lender:	Home Finance of American, Inc.
Interest Rate:	4.875%
APR:	4.988%
Monthly Payment:	$1,427.00
Lender Fees:	$3,453.00
Points:	0.625

Source: Calculator provided by Google, parameters set by me to accurately depict project

Next, I used the total cost of constructing the production home to compute the mortgage.
Again, I used the mortgage calculator provided by Google and inputted the appropriate
information and the calculator produced a monthly mortgage rate of $1,427. See the
above, Table 5 for more details about the mortgage. It took me only three minutes to
produce a credible mortgage rate of the second home.

The final step of the second method was to export the second homes' model information
into Autodesk Green Building Studio. After exporting the information the program
provided me with the annual usage of water, electricity, and gas.

Table 6. Production: General Energy Analysis Information

ENERGY ANALYSIS: HOUSE #2, STYLECRAFT HOME	
Floor Area:	2,541 ft2
Total Annual Energy Cost:	$3,711
Annual Electric Cost:	$2,267
Annual Fuel Cost:	$1,443
Table 6. Continued	
Annual Peak Electric Demand:	7.10 kW
Annual Electric Use:	17,440 kWh
Annual Fuel Use:	105 MBtu
Energy Use Intensity:	64.6 kBtu/ft2/year

Source: Generated from Autodesk Green Building Studio

The steps I used to get these results were the same as the first method, but this time it took me seven minutes to produces performance results. The above tables and figures illustrate the second homes' energy performance.   Table 6 illustrates the general energy analysis information. Figure 5 illustrates the annual fuel end use. Figure 6 illustrates the annual electric end use.

Annual Fuel End Use

■ Hot Water ■ Space Heating ■ Pumps & Aux

11%

30%

59%
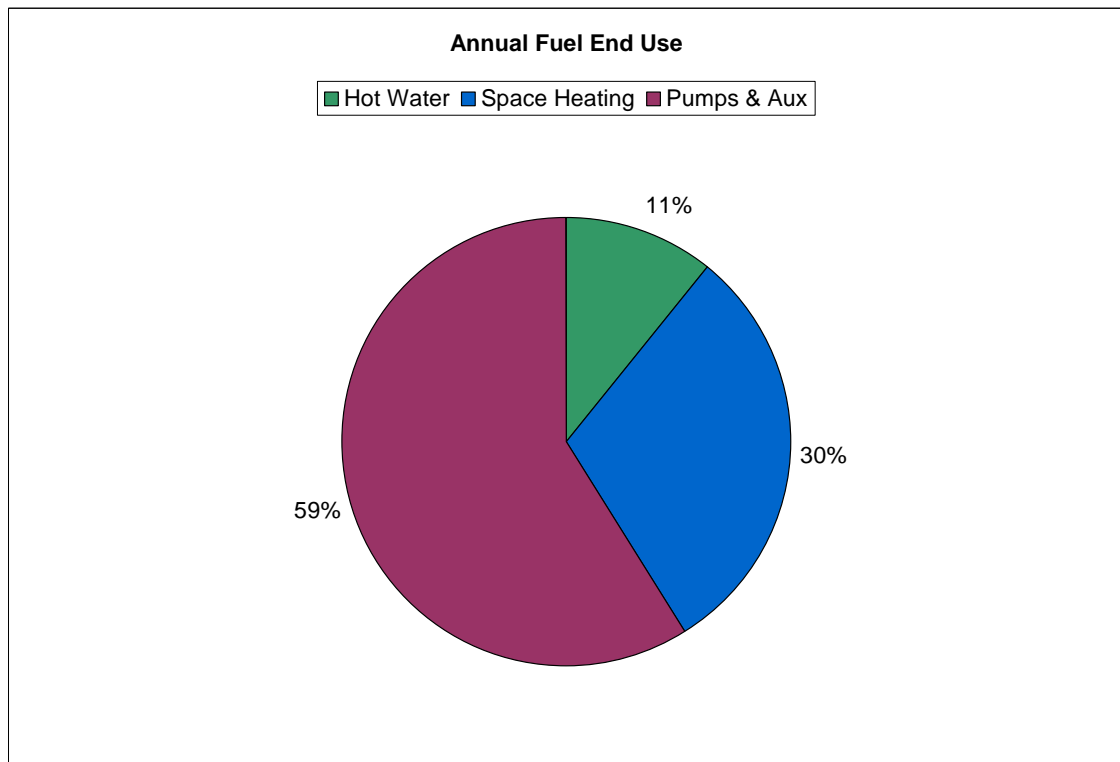
Figure 5. Production: Annual Fuel End Use
Source: Created in Autodesk Green Building Studio
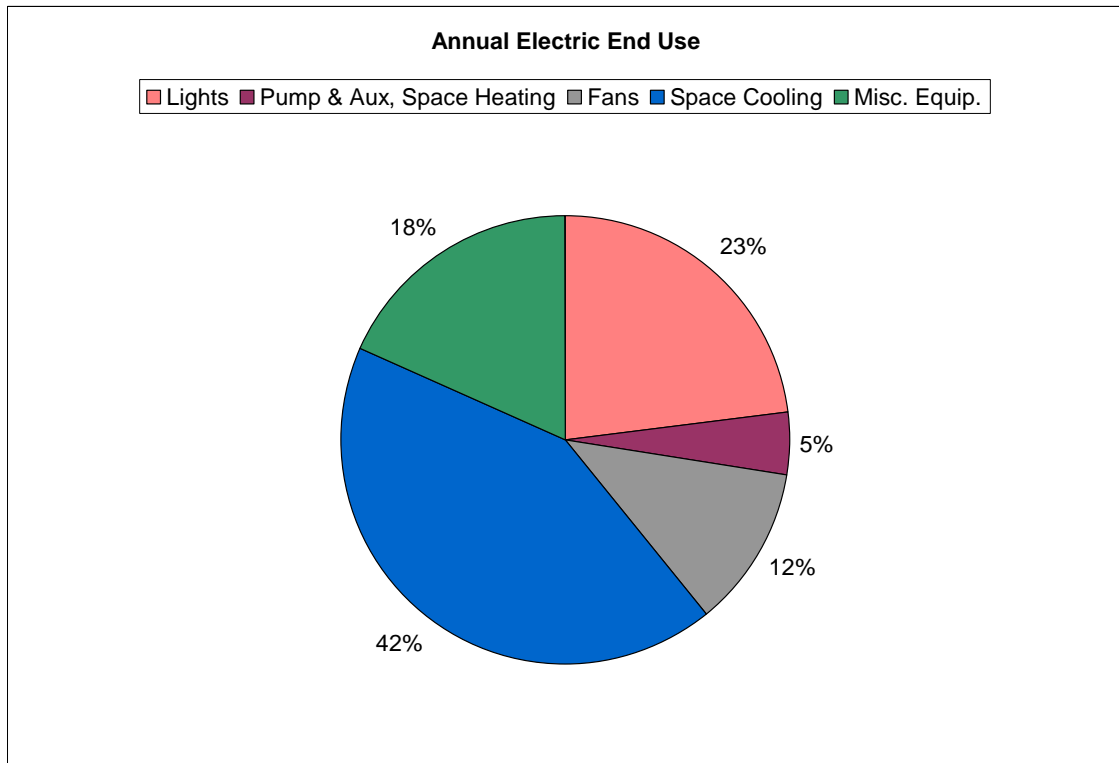
Figure 6. Production: Annual Electric End Use
Source: Created in Autodesk Green Building Studio

Once the energy costs and the mortgage had been established I again computed the total

cost of ownership and then amortized it into monthly payments. Like in the first method

I assumed the energy and water were fixed rates and divided the total cost by twelve.

After adding the monthly mortgage and the monthly energy and water fees I established

the total cost of ownership per month. See Table 7 for a detail view of the amortized

payment for the second home. The total time I spent completing the second method was

thirteen hours and forty five minutes. Table 8 illustrates the time it took to complete the

second method.

Table 7. Production: Amortized Payment of Single-Family Home

Amortized Payment of Stylecraft Single-Family Home	
Energy:	$309.17
Water:	$39.33
Payment:	$1,427.00
Total:	$1,775.50

Note: Numbers generated from Autodesk Green Building Studio & Google Mortgage
Calculator
Source: Created in Microsoft Excel

Table 8. Method #2, Total Time

METHOD #2: TOTAL TIME	
Revit:	8 hr. 20 min.
Schedules:	15 min.
Organizing/Cost:	5 hr.
Mortgage:	3 min.
Green Building Studio:	7 min.
Total:	13 hr. 45 min.

Note: Numbers generated from Autodesk Green Building Studio & Google Mortgage
Calculator
Source: Created in Microsoft Excel

CHAPTER IV

CONCLUSIONS

After finishing the second method I believe that I have successfully defined a method using Building Information Modeling Technology to establish the utility bill and total cost of ownership of a single-family home. I have concluded the best method should be conducted by following these steps:

1. first gather all cost information and organize it,

2. next build the home in Autodesk Revit and enter in the cost information as you work,

3. then create schedules and export them into Microsoft Excel,

4. after organizing all the schedules total up the costs to establish the total cost of construction and use that number to find the mortgage,

5. next export the model of the home's information into Autodesk Green Building Studio and analyze the results, and finally

6. add up the mortgage and energy costs to establish the total cost of ownership which can be amortized into monthly payments.

This method is truly user friendly and can easily be learned by someone who is willing to spend time and put in the effort to learn. To complete the first trial it took me twenty hours and forty one minutes. The second trail only took me thirteen hours forty five minutes. As you can see there is a drastic time decrease between the two. This can be

attributed to several different factors: learning curve, reused elements, and reworking of the method. The learning curve is addressing the fact that before I started this research I did not know how to use Autodesk Revit, SmartBIM Library, and Autodesk Green Building Studio. Even though I practiced with them before starting the first method, I still had to take extra time to figure out how to model certain elements and the steps I needed to take to make the programs function correctly. As I worked through the research I learned how to use the programs better, so my time decreased. This finding proves my statement above that everyone and anyone willing to try can learn this method. Also, another time saver was that I was able to reuse the charts and the cost information from the first method in the second method. I needed to make small changes here and there to adapt for the second house, but I did not have to completely start from scratch. This also shows that if a company was to start using this method the first time it might take a lot of extra time because you are starting from scratch, but when you run it a second and a third time the benefits will weigh in. In this particular research I was able to reuse the formatted charts in Microsoft Excel and general building elements that both homes shared. The final contributing factor to the decrease in time is the reworking of the first method. By finding and organizing all of the cost information before starting Autodesk Revit was a wonderful time saver. It prevented me from having to back track and search for elements throughout the fully built model. Since I inputted the cost information while I was creating elements I was able to address any problems before it was too late.

As you probably noticed the total cost of construction for both homes was not accurate.

This may be because I mainly used two RSMeans books to find the cost of materials and

labor. I used the wall areas to compute quantities, and made educated estimates. The

RSMeans books were very good sources for all the building elements in both homes.

Within the books they broke down the cost of materials and labor and explained about

the element. The numbers the books provided were high for the area of College Station,

so I multiplied every number I used by .85 to account for the difference in price. I chose

to use the books because it is a reputable source and is considered to have a good pricing

standard. One thing the books did not account for is the discount each builder gets,

which also explains why their prices are lower than mine. Overall, I think the total

construction cost of each home I computed is valid and is not too far off from the true

value. Another important factor that affects price is quantities. For this research I used

the area of the walls, floors, and roofs to establish the appropriate costs. The builders

used square footage to establish their costs. I think that using the area of the elements,

provided to you by Autodesk Revit, is a much easier and accurate than using square

footage. This may have caused the price to increase because Autodesk Revit accounted

for more than the builder would using square footage. The final factor in the price

increase is price estimating. I made several educated guesses and assumptions regarding

the costs. For example, Autodesk Green Building Studio provided me with the annual

rates and I decided to make the monthly payments be fixed because that is what several

energy companies in the area are doing now. Also, not all of the window and door sizes

were listed in the RSMeans books so I estimated the cost of materials and labor for those

elements by comparing them to similar products. All in all when it comes to construction and estimating costs I think that is it better to propose a high cost than a lower one. It is easier to convince people to pay less than it is to pay more.

While researching this topic and after analyzing my results I think that this method could help a lot of builders and people interested in building a home. Not only does it establish the utility bill and total cost of ownership, but it can also be used as a tool to make decisions. A builder or designer can create a base model home and than make changes to the design to see how much that would impact the cost or performance. This can be used as a tool to show people that paying more upfront will pay off in the end.

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APPENDIX

First Method, House #1, Schedules & Total Cost of Construction

Substructure

Standard Foundation
Strip Footings
Description: Load 2.6 KLF, Soil Capacity 3KSF, 16"x16"x8"
Count: 40
Linear
Feet: 212.8' (Each: 5.32')
Material: $1,744.96 ($8.20 per L.F.)
Labor: $2,225.89 ($10.46 per L.F.)
Total: **$3,970.85**
Substructure Total: $3,970.85

SHELL

Floor Construction
Wood Joist
Description: Wood Joist, Length: 23' - 9", 2"x8", 16" O.C.
Count: 41
Area: 1,394 S.F. (Each: 34 SF)
Material: $1,394 ($1.00 per S.F.)
Installation: $1,700.68 ($1.22 per S.F)
Total: **$3,094.68**

Description: Wood Joist, Length: 23' - 10 1/2", 2"x8", 16" O.C.
Count: 1
Area: 35 S.F.
Material: $35.00 ($1.00 per S.F.)
Installation: $42.70($1.22 per S.F)
Total: **$77.70**

Description: Wood Joist, Length: 23' - 8 1/4", 2"x8", 16" O.C.
Count: 1
Area: 35 S.F.
Material: $35.00 ($1.00 per S.F.)
Installation: $42.70($1.22 per S.F)

Total: **$77.70**

Description: Wood Joist, Length: 23' - 9", 2"x8", 16" O.C.
Count: 1
Area: 35 S.F.
Material: $35.00 ($1.00 per S.F.)
Installation: $42.70($1.22 per S.F)
Total: **$77.70**

Description: Wood Joist, Length: 54' - 8 1/4", 2"x8", 16" O.C.
Count: 6
Area: 480 S.F. (Each: 80 S.F.)
Material: $480 ($1.00 per S.F.)
Installation: $585.60 ($1.22 per S.F)
Total: **$1,065.60**

Description: Wood Joist, Length: 54' - 11 1/4", 2"x8", 16" O.C.
Count: 2
Area: 160 S.F. (Each: 80 S.F.)
Material: $160 ($1.00 per S.F.)
Installation: $195.20 ($1.22 per S.F)
Total: **$355.20**

Description: Wood Joist, Length: 54' - 10 1/2", 2"x8", 16" O.C.
Count: 2
Area: 160 S.F. (Each: 80 S.F.)
Material: $160 ($1.00 per S.F.)
Installation: $195.20 ($1.22 per S.F)
Total: **$355.20**

Description: Wood Joist, Length: 54' - 11 3/8", 2"x8", 16" O.C.
Count: 2
Area: 160 S.F. (Each: 80 S.F.)
Material: $160 ($1.00 per S.F.)
Installation: $195.20 ($1.22 per S.F)
Total: **$355.20**

Wood Joist Bridge Pieces
Description: Wood Joist, Length: 1' - 4", 2"x8", 16" O.C.
Count: 121
Area: 242 S.F. (Each: 2 SF)
Material: $242 ($1.00 per S.F.)
Installation: $295.25 ($1.22 per S.F)
Total: **$537.25**

Description:	Wood Joist, Length: 1' - 4 1/4", 2"x8", 16" O.C.
Count:	3
Area:	6 S.F. (Each: 2 SF)
Material:	$6 ($1.00 per S.F.)
Installation:	$7.32 ($1.22 per S.F)
Total:	**$13.32**

Description:	Wood Joist, Length: 1' - 3 1/4", 2"x8", 16" O.C.
Count:	29
Area:	58 S.F. (Each: 2 SF)
Material:	$58 ($1.00 per S.F.)
Installation:	$70.76 ($1.22 per S.F)
Total:	**$128.76**

Description:	Wood Joist, Length: 1' - 2 1/2", 2"x8", 16" O.C.
Count:	3
Area:	6 S.F. (Each: 2 SF)
Material:	$6 ($1.00 per S.F.)
Installation:	$7.32 ($1.22 per S.F)
Total:	**$13.32**

Roof Construction
Wood/Flat or Pitched Roof

Description:	Wood, Pitched, Rafter 2"x6", 16" O.C.
Area:	1,790 S.F.
Material:	$1,664.7 ($0.93 per S.F.)
Installation:	$1,986.9 ($1.11 per S.F.)
Total:	**$3,651.60**

Exterior Walls

Panel, Shingle, & Lap Siding

Description:	Hardy Board Siding, Length: 54' - 10 7/16", 2"x4" Studs, 16" O.C. Insulation,
Area:	383 S.F.
Material:	$965.16 ($2.52 per S.F.)
Installation:	$1,662.22 ($4.34 per S.F)
Total:	**$2,627.38**

Description:	Hardy Board Siding, Length: 23' - 10 7/16", 2"x4" Studs, 16" O.C. Insulation,
Area:	184 S.F.
Material:	$463.68 ($2.52 per S.F.)

Installation:	$798.56 ($4.34 per S.F)
Total:	**$1,262.24**

Description:	Hardy Board Siding, Length: 5' - 6", 2"x4" Studs, 16" O.C. Insulation,
Area:	41 S.F.
Material:	$103.32 ($2.52 per S.F.)
Installation:	$177.94 ($4.34 per S.F)
Total:	**$281.26**

Description:	Hardy Board Siding, Length: 23' - 10 7/16", 2"x4" Studs, 16" O.C. Insulation,
Area:	240 S.F.
Material:	$604.80 ($2.52 per S.F.)
Installation:	$1,041.60 ($4.34 per S.F)
Total:	**$1,646.40**

Description:	Hardy Board Siding, Length: 6' - 0", 2"x4" Studs, 16" O.C. Insulation,
Area:	40 S.F.
Material:	$100.80($2.52 per S.F.)
Installation:	$173.60 ($4.34 per S.F)
Total:	**$274.40**

Description:	Hardy Board Siding, Length: 54' - 10 7/16", 2"x4" Studs, 16" O.C. Insulation,
Area:	340 S.F.
Material:	$856.80 ($2.52 per S.F.)
Installation:	$1,475.60 ($4.34 per S.F)
Total:	**$2,332.40**

Exterior Windows
Aluminum Windows

Description:	Single Hung, Insulated Glass, 3'-4"x5'-0"
Count:	10
Manufacturer:	Pella
Material:	$2,975 ($297.50 per Window)
Installation:	$1,207 ($120.70 per Window)
Total:	**$4,182**

Description:	Single Hung, Insulated Glass, 2'x3'
Count:	1
Manufacturer:	Pella
Material:	$224.40 ($224.40 per Window)

Installation: $107.95 ($107.95 per Window)
Total: **$332.35**

Exterior Doors
Steel Doors
Description: Steel 18 Ga., Hollow Metal, w/frame, No Label, 3'-0"x7'-0"
Count: 2
Manufacturer: Therma-Tru
Material: $2,210 ($1,105 per Door)
Installation: $476.00 ($238 per Door)
Total: **$2,686.00**

Roof Coverings
Built-Up
Description: Asphalt base sheets & 3 Plies #15 asphalt felt, mopped on nailable deck
Area: 1,790 S.F.
Material: $1,485.7 ($0.83 per S.F.)
Labor: $2,541.8 ($1.42 S.F.)
Total: **$4,027.50**

Shingle & Tile
Description: Asphalt Roofing, Strip Shingle, 4" Slope, Inorganic
Area: 1,790 S.F.
Material: $912.90 ($0.51 per S.F.)
Labor: $1,467.8 ($0.82 per S.F)
Total: **$2,380.70**

Shell Total: **$31,835.86**

Interiors

Partitions
Drywall Partitions/Wood Stud Framing, Plumbing Wall
Description: Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 9' - 11 15/32", 2"x6", 16" O.C.
Count: 3
Area: 228 (Each: 76 S.F.)
Material: $576.84 ($2.53 per S.F.)
Labor: $1,000.92 ($4.39 per S.F)
Total: **$1,577.76**

Drywall Partitions/Wood Stud Framing

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 36' - 7 23/32", 2"x4", 16" O.C.
Count:	1
Area:	214 S.F.
Material:	$327.42 ($1.53 per S.F.)
Labor:	$725.46 ($3.39 per S.F)
Total:	**$1,052.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 9' - 11 15/32", 2"x4", 16" O.C.
Count:	1
Area:	56 S.F.
Material:	$85.68 ($1.53 per S.F.)
Labor:	$189.84 ($3.39 per S.F)
Total:	**$275.52**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 7' - 5 1/2", 2"x4", 16" O.C.
Count:	1
Area:	56 S.F.
Material:	$85.68 ($1.53 per S.F.)
Labor:	$189.84 ($3.39 per S.F)
Total:	**$275.52**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 3' - 1 1/2", 2"x4", 16" O.C.
Count:	1
Area:	22 S.F.
Material:	$33.66 ($1.53 per S.F.)
Labor:	$74.50 ($3.39 per S.F)
Total:	**$108.24**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 13' - 10 31/32", 2"x4", 16" O.C.
Count:	1
Area:	88 S.F.
Material:	$134.64 ($1.53 per S.F.)
Labor:	$298.32 ($3.39 per S.F)
Total:	**$432.96**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 28' - 9 1/2", 2"x4", 16" O.C.

Count:	1
Area:	157 S.F.
Material:	$240.21 ($1.53 per S.F.)
Labor:	$532.23 ($3.39 per S.F)
Total:	**$772.44**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 9' - 9 15/32", 2"x4", 16" O.C.
Count:	2
Area:	82 S.F. (Each: 41 S.F.)
Material:	$125.46 ($1.53 per S.F.)
Labor:	$277.98 ($3.39 per S.F)
Total:	**$403.44**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 7' - 0 31/32", 2"x4", 16" O.C.
Count:	1
Area:	53 S.F.
Material:	$81.09 ($1.53 per S.F.)
Labor:	$179.67 ($3.39 per S.F)
Total:	**$260.76**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 9' - 9 15/32", 2"x4", 16" O.C.
Count:	1
Area:	75 S.F.
Material:	$114.75 ($1.53 per S.F.)
Labor:	$254.25 ($3.39 per S.F)
Total:	**$369.00**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 8", 2"x4", 16" O.C.
Count:	1
Area:	50 S.F.
Material:	$76.50 ($1.53 per S.F.)
Labor:	$169.50 ($3.39 per S.F)
Total:	**$246.00**

**Interior
Doors**
Wood Door/Wood Frame

Description:	Hollow Core/Flush, Lauan, 2'-8"x6'-8", Pine, Depth: 3-5/8"
Count:	8
Manufacturer:	Masonite

Material: $1,135.60($141.95 per Door)
Labor: $1,740.80 ($217.60 per Door)
Total: **$2,876.40**

Bi-Fold
Description: Bi-Fold, Closet Door, Louvered, Pine, 5'-0" Wide
Count: 3
Manufacturer: Masonite
Material: $576.30 ($192.10 per Door)
Labor: $141.54 ($47.18 per Door)
Total: **$717.84**

Bath & Toilet Accessories
Grab Bar
Description: 1-1/4" diam. 12" long
Count: 2
Manufacturer: Moen
Material: $55.26 (Each: $27.63)
Labor: $35.46 (Each: $17.43)
Total: **$90.72**

Toilet Tissue Dispenser
Description: Surface Mounted, Single Roll
Count: 2
Manufacturer: Pfister
Material: $36.56 (Each: $18.28)
Labor: $28.06 (Each: $14.03)
Total: **$64.62**

Towel Bar
Description: 18" Long
Count: 2
Manufacturer: Moen
Material: $73.96 (Each: $36.98)
Labor: $36.56 (Each: $18.28)
Total: **$110.52**

Medicine Cabinet
Description: Sliding Mirror Door, 20"x16"x4-3/4", Unlighted
Count: 2
Manufacturer: Kohler
Material: $189 (Each: $94.35)

Labor:	$120.70 (Each: $60.35)
Total:	**$309.70**

Fabricated Cabinets & Counters
Lower
Cabinets

Description:	House, Base, Hard wood, 1 Top Drawer & 1 Door Below, 12" Wide
Count:	1
Manufacturer:	Continental Cabinets
Material:	$318.75 ($212.50 per L.F.)
Labor:	$51.00 ($34.00 per L.F.)
Total:	**$369.75**

Description:	House, Base, Hard wood, 4 Drawer, 24" Wide
Count:	3
Manufacturer:	Continental Cabinets
Material:	$1,147.50 ($382. 50 per L.F.)
Labor:	$113.49 ($37.83 per L.F.)
Total:	**$1,260.99**

Upper
Cabinets

Description:	Wall, Hard wood, 30" High w/1 Door x 12" Wide
Count:	1
Manufacturer:	Continental Cabinets
Material:	$269.03 ($179.35 per L.F.)
Labor:	$57.38 ($38.25 per L.F.)
Total:	**$326.41**

Description:	Wall, Hard wood, 30" High w/2 Door x 48" Wide
Count:	3
Manufacturer:	Continental Cabinets
Material:	$1,122.00 ($374 per L.F.)
Labor:	$137.70 ($45.90 per L.F.)
Total:	**$1,259.70**

Kitchen Counter Top

Description:	Laminate, Stock Economy
Count:	1
Manufacturer:	VT Industries
Material:	$105.56 ($8.12 per L.F.)
Labor:	$182.39 ($14.03 per L.F.)
Total:	**$287.95**

Wall Finishes - Painting
Painting
Walls

Description:	Exterior, Siding, Brush Work, 2 Coats
Area:	1,228 S.F.
Material:	$171.92 ($0.14 per S.F.)
Labor:	$699.96 ($0.57 per S.F.)
Total:	**$871.88**

Description:	Interior, Plaster & Drywall, Brush Work, 2 Coats, Primer
Area:	2,642 S.F.
Material:	$369.88 ($0.14 per S.F.)
Labor:	$1,928.66 ($0.73 per S.F.)
Total:	**$2,298.54**

Painting
Trim

Description:	Wood Trim, Enamel, Primer
Area:	200 S.F.
Material:	$20.00 ($0.10 per L.F.)
Labor:	$90.00 ($0.45 per L.F.)
Total:	**$110.00**

Floor
Finishes
Tile &
Covering

Description:	Carpet, Tufted, Nylon, Roll Goods, 12" Wide, 26 oz, Brown
Area:	916 S.F.
Material:	$3,975.44 ($4.34 per S.F.)
Labor:	$549.60 ($0.60 per S.F.)
Total:	**$4,525.04**

Description:	Vinyl, Tile, Minimum, White
Area:	265 S.F.
Material:	$731.40 ($2.76 per S.F.)
Labor:	$201.40 ($0.76 per S.F.)
Total:	**$932.80**

Ceiling Finishes
Drywall
Ceiling

Description:	1/2" F.R. Drywall, Painted & Textured, 1"x3" Wood, 16" O.C.
Area:	1268 S.F.
Material:	$951.00 ($0.75 per S.F.)
Labor:	$3,296.80 ($2.60 per S.F.)
Total:	**$4,247.80**

Interiors
Total: **$26,435.18**

Services

Plumbing Fixtures
Water Closet Systems

Description:	Floor Mount Toilet, 1 Piece
Count:	2
Manufacturer:	AquaSource
Material:	$1,555.55 (Each: $777.75)
Labor:	$1,122 (Each: 561)
Total:	**$2,677.55**

Lavatory Systems

Description:	Lavatory w/Trim, Vanity Top, P.E.on C.I. 20"x18"
Count:	2
Manufacturer:	Franke
Material:	$852.44 (Each: $426.22)
Labor:	$1,059.78 (Each: $529.89)
Total:	**$1,912.22**

Kitchen Sink Systems

Description:	Stainless Steel, 33"x22" Double Bowl
Count:	2
Manufacturer:	Franke
Material:	$2,082.50 (Each: $1,041.25)
Labor:	$1,249.50 (Each: $624.75)
Total:	**$3,332.00**

Bathtub Systems

Description:	Bathtub, Recessed, Porcelain Enamel on Cast Iron, 72"x36"
Count:	2
Manufacturer:	Aqua Glass

Material:	$4,122.50 (Each: $2,061.25)
Labor:	$1,462 (Each: $731)
Total:	**$5,584.50**

Electric Water Heaters

Description:	Electric Water Heater, 100 degree Fahrenheit, 50 Gallon, 9 kw, 37 GPH
Count:	1
Manufacturer:	Whirlpool
Material:	$4,228.04 (Each: $4,228.04)
Labor:	$866.41 (Each: $866.41)
Total:	**$5,094.45**

HVAC
Air Handling
Unit

Description:	Built-Up, w/Cooling/Heating Coil Section, Filters, Mixing Box, Single Zone, 1600 CFM
Count:	1
Manufacturer:	Frigidaire
Material:	$2,550 (Each: $2,550)
Labor:	$480.25 (Each: $480.25)
Total:	**$3,030.25**

Electrical
Electrical Service/Distribution

Description:	Service Installation, Includes Breakers, Metering 20' Conduit & 3 Phase, 4 Wire 60 A
Count:	1
Material:	$843.80 (Each: $843.80)
Labor:	$734.32 (Each: $734.32)
Total:	**$1,578.12**

Lighting & Branch Wiring

Description:	Receptacles & Wall Switches, Receptacle Duplex
Count:	13
Material:	$487.89 (Each: $37.53)
Labor:	$2,038.53 (Each: $156.81)
Total:	**$2,526.42**

Safety Switch

Description:	Safety Switch, 30A Fused, 1 Phase, 115V or 230V
Count:	13
Material:	$1,787.89 (Each: $137.53)

Labor:	$2,015.52 (Each: $155.04)
Total:	**$3,803.41**

Ceiling Fan

Description:	Paddle Fan, Variable Speed, Economy Model
Count:	4
Manufacturer:	Harbor Breeze
Material:	$357.00 (Each: $89.25)
Labor:	$124.12 (Each: $31.03)
Total:	**$481.12**

Services Total:	**$30,020.04**

Equipment & Furnishings

Laundry/Dry Cleaning
Dryer

Description:	Gas Fired, Residential, 16lb Capacity
Count:	1
Manufacturer:	Whirlpool
Material:	$586.50 (Each: $586.50)
Labor:	$165.75 (Each: $165.75)
Total:	**$752.25**

Washer

Description:	Residential,4 Cycle
Count:	1
Manufacturer:	Whirlpool
Material:	$748.00 (Each: $748)
Labor:	$165.75 (Each: $165.75)
Total:	**$913.75**

Residential Equipment
Range

Description:	Built-In, Single Oven, 30" Wide, Economy
Count:	1
Manufacturer:	GE

Material:	$646.00 (Each: $646)
Labor:	$79.48 (Each: $79.48)
Total:	**$725.48**

Dishwasher

Description:	Built-In, 4 Cycles, Deluxe
Count:	1
Manufacturer:	GE
Material:	$956.25 (Each: $956.25)
Labor:	$484.50 (Each: $484.50)
Total:	**$1,440.75**

Garbage Disposer

Description:	Sink Type, Economy
Count:	1
Manufacturer:	GE
Material:	$62.48 (Each: $62.48)
Labor:	$96.90 (Each: $96.90)
Total:	**$159.38**

Refrigerator

Description:	No Frost, 10 to 12 CF, Economy
Count:	1
Manufacturer:	Whirlpool
Material:	$416.50 (Each: $416.50)
Labor:	$66.73 (Each: $66.73)
Total:	**$483.23**

Equipment & Furnishings Total:	**$4,474.84**

Building Site Work

Fence & Guardrails

Description:	Chain Link, 2" Post, 1-5/8" Rail, 9 Gauge Galvanized Wire, 5' High
Linear Feet:	180'
Material:	$2,188.80($12.16 per L.F.)

Labor: $707.40 ($3.93 per L.F.)
Total: **$2,896.20**

Average Lot
Total: **$12,500.00**

Building Site Work Total: **$15,396.20**

Assemblies Total	
Substructure:	$3,970.85
Shell:	$31,835.86
Interiors:	$26,435.18
Services:	$30,020.04
Equipment & Furnishings:	$4,474.84
Building Site work:	$15,396.20
Total Cost:	$112,132.97

Second Method, House #2, Schedules & Total Cost of Construction

SHELL

Floor Construction
Cast in Place Beam & Slab

	2 Way Slab, 9" Thick, 15'x15' Bay, 200 P.S.F, Min. Col.
Description:	Size: 14"
Area:	2929 S.F.
Material:	$16,050.92 ($5.48 per S.F.)
Installation:	$25,892.36 ($8.84 per S.F)
Total:	**$41,943.28**

Roof Construction
Wood/Flat or Pitched Roof

Description:	Wood, Pitched, Rafter 2"x6", 16" O.C.
Area:	5,275 S.F.
Material:	$4,905.75 ($0.93 per S.F.)
Installation:	$5,855.25 ($1.11 per S.F.)
Total:	**$10,761.00**

Exterior Walls
Brick Veneer/Wood Stud

Description:	Brick Face, Length: 65' - 2 15/16", 2"x4" Studs, 16" O.C.
Area:	670 S.F.
Material:	$6,009.90 ($8.97 per S.F.)
Installation:	$9,681.50 ($14.45 per S.F)
Total:	**$15,691.40**

Description:	Brick Face, Length: 7' - 8", 2"x4" Studs, 16" O.C.
Area:	66 S.F.
Material:	$592.02 ($8.97 per S.F.)
Installation:	$953.70 ($14.45 per S.F)
Total:	**$1,545.72**

Description:	Brick Face, Length: 7' - 8", 2"x4" Studs, 16" O.C.
Area:	670 S.F.
Material:	$6,009.90 ($8.97 per S.F.)
Installation:	$9,681.50 ($14.45 per S.F)
Total:	**$15,691.40**

Description:	Brick Face, Length: 4', 2"x4" Studs, 16" O.C.
Area:	49 S.F.

Material:	$439.53 ($8.97 per S.F.)
Installation:	$708.05 ($14.45 per S.F)
Total:	**$1,147.58**

Description: Brick Face, Length: 13' - 8 15/16", 2"x4" Studs, 16" O.C.
Area: 155 S.F.
Material: $1,390.35 ($8.97 per S.F.)
Installation: $2,239.75 ($14.45 per S.F)
Total: **$3,630.10**

Description: Brick Face, Length: 2 '- 6", 2"x4" Studs, 16" O.C.
Area: 19 S.F.
Material: $170.43 ($8.97 per S.F.)
Installation: $274.55 ($14.45 per S.F)
Total: **$444.98**

Description: Brick Face, Length: 2' - 3 1/16", 2"x4" Studs, 16" O.C.
Area: 33 S.F.
Material: $296.01 ($8.97 per S.F.)
Installation: $476.85 ($14.45 per S.F)
Total: **$772.86**

Description: Brick Face, Length: 1' - 10 17/32", 2"x4" Studs, 16" O.C.
Area: 25 S.F.
Material: $224.25 ($8.97 per S.F.)
Installation: $361.25 ($14.45 per S.F)
Total: **$585.50**

Description: Brick Face, Length: 1' - 10 17/32", 2"x4" Studs, 16" O.C.
Area: 33 S.F.
Material: $296.01 ($8.97 per S.F.)
Installation: $476.85 ($14.45 per S.F)
Total: **$772.86**

Description: Brick Face, Length: 14' - 8", 2"x4" Studs, 16" O.C.
Area: 108 S.F.
Material: $968.76 ($8.97 per S.F.)
Installation: $1,560.60 ($14.45 per S.F)
Total: **$2,529.36**

Description: Brick Face, Length: 25' - 9 15/16", 2"x4" Studs, 16" O.C.
Area: 277 S.F.
Material: $2,484.69 ($8.97 per S.F.)
Installation: $4,002.65 ($14.45 per S.F)

Total: **$6,487.34**

Description: Brick Face, Length: 2' - 0", 2"x4" Studs, 16" O.C.
Area: 27 S.F.
Material: $242.19 ($8.97 per S.F.)
Installation: $390.15 ($14.45 per S.F)
Total: **$632.34**

Description: Brick Face, Length: 10' - 9 1/16", 2"x4" Studs, 16" O.C.
Area: 105 S.F.
Material: $941.85 ($8.97 per S.F.)
Installation: $1,517.25 ($14.45 per S.F)
Total: **$2,459.10**

Description: Brick Face, Length: 2' - 0 1/8", 2"x4" Studs, 16" O.C.
Area: 25 S.F.
Material: $224.25 ($8.97 per S.F.)
Installation: $361.25 ($14.45 per S.F)
Total: **$585.50**

Description: Brick Face, Length: 12' - 9", 2"x4" Studs, 16" O.C.
Area: 145 S.F.
Material: $1,300.65 ($8.97 per S.F.)
Installation: $2,095.25 ($14.45 per S.F)
Total: **$3,395.90**

Description: Brick Face, Length: 1' - 6", 2"x4" Studs, 16" O.C.
Area: 29 S.F.
Material: $260.13 ($8.97 per S.F.)
Installation: $419.05 ($14.45 per S.F)
Total: **$679.18**

Description: Brick Face, Length: 5' - 2 1/16", 2"x4" Studs, 16" O.C.
Area: 47 S.F.
Material: $421.59 ($8.97 per S.F.)
Installation: $679.15 ($14.45 per S.F)
Total: **$1,100.74**

Description: Brick Face, Length: 9' - 1 17/32", 2"x4" Studs, 16" O.C.
Area: 71 S.F.
Material: $636.87 ($8.97 per S.F.)
Installation: $1,025.95 ($14.45 per S.F)
Total: **$1,663.82**

Description:	Brick Face, Length: 10' - 4", 2"x4" Studs, 16" O.C.
Area:	69 S.F.
Material:	$618.93 ($8.97 per S.F.)
Installation:	$997.05 ($14.45 per S.F)
Total:	**$1,615.98**

Description:	Brick Face, Length: 6' - 1 15/32", 2"x4" Studs, 16" O.C.
Area:	48 S.F.
Material:	$430.56 ($8.97 per S.F.)
Installation:	$693.60 ($14.45 per S.F)
Total:	**$1,124.16**

Description:	Brick Face, Length: 3' -0", 2"x4" Studs, 16" O.C.
Area:	29 S.F.
Material:	$260.13 ($8.97 per S.F.)
Installation:	$419.05 ($14.45 per S.F)
Total:	**$679.18**

Description:	Brick Face, Length: 13' - 0 3/32", 2"x4" Studs, 16" O.C.
Area:	63 S.F.
Material:	$565.11 ($8.97 per S.F.)
Installation:	$910.35 ($14.45 per S.F)
Total:	**$1,475.46**

Description:	Ashlar, Length: 10' - 7 19/32", 2"x4" Studs, 16" O.C.
Area:	132 S.F.
Material:	$1,548.36 ($11.73 per S.F.)
Installation:	$1,234.20 ($9.35 per S.F)
Total:	**$2,782.56**

Description:	Ashlar, Length: 9' - 2 15/16", 2"x4" Studs, 16" O.C.
Area:	118 S.F.
Material:	$1,384.14 ($11.73 per S.F.)
Installation:	$1,103.30 ($9.35 per S.F)
Total:	**$2,487.44**

Description:	Ashlar, Length: 19' - 6 1/32", 2"x4" Studs, 16" O.C.
Area:	142 S.F.
Material:	$1,665.66 ($11.73 per S.F.)
Installation:	$1,327.70 ($9.35 per S.F)
Total:	**$2,993.36**

Description:	Ashlar, Length: 2' - 5 31/32", 2"x4" Studs, 16" O.C.
Area:	23 S.F.

Material:	$269.79 ($11.73 per S.F.)
Installation:	$215.05 ($9.35 per S.F)
Total:	**$484.84**

Description:	Ashlar, Length: 1' - 0", 2"x4" Studs, 16" O.C.
Area:	22 S.F.
Material:	$258.06 ($11.73 per S.F.)
Installation:	$205.70 ($9.35 per S.F)
Total:	**$463.76**

Description:	Ashlar, Length: 5' - 7 31/32", 2"x4" Studs, 16" O.C.
Area:	43 S.F.
Material:	$504.39 ($11.73 per S.F.)
Installation:	$402.05 ($9.35 per S.F)
Total:	**$906.44**

Exterior Windows
Aluminum Windows

Description:	Single Hung, Insulated Glass, 36"x72"
Count:	10
Manufacturer:	Pella
Material:	$4,000 ($400.00 per Window)
Installation:	$1300 ($130.00 per Window)
Total:	**$5,300**

Description:	Single Hung, Insulated Glass, 24"x84"
Count:	5
Manufacturer:	Pella
Material:	$1,250 ($250.00 per Window)
Installation:	$600 ($120.00 per Window)
Total:	**$1,850.00**

Description:	Single Hung, Insulated Glass, 32"x72"
Count:	2
Manufacturer:	Pella
Material:	$664 ($332.00 per Window)
Installation:	$250 ($125.00 per Window)
Total:	**$914.00**

Description:	Single Hung, Insulated Glass, 36"x84"
Count:	2
Manufacturer:	Pella
Material:	$840 ($420.00 per Window)
Installation:	$280 ($140.00 per Window)

Total: **$1,120.00**

Description: Single Hung, Insulated Glass, 30"x72"
Count: 2
Manufacturer: Pella
Material: $600 ($300.00 per Window)
Installation: $246 ($123.00 per Window)
Total: **$846.00**

Description: Single Hung, Insulated Glass, 42"x72"
Count: 1
Manufacturer: Pella
Material: $418.20 ($418.20 per Window)
Installation: $138 ($138.00 per Window)
Total: **$556.20**

Description: Single Hung, Insulated Glass, 42"x42"
Count: 1
Manufacturer: Pella
Material: $200 ($200.00 per Window)
Installation: $115 ($115.00 per Window)
Total: **$315.00**

Description: Single Hung, Insulated Glass, 48"x60"
Count: 1
Manufacturer: Pella
Material: $225 ($225.00 per Window)
Installation: $123 ($123.00 per Window)
Total: **$348.00**

Description: Single Hung, Insulated Glass, 18"x48"
Count: 1
Manufacturer: Pella
Material: $200 ($200.00 per Window)
Installation: $115 ($115.00 per Window)
Total: **$315.00**

Exterior Doors
Steel Doors
Description: Steel 18 Ga., Hollow Metal, w/frame, No Label, 3'-0"x7'-0"
Count: 2
Manufacturer: Therma-Tru
Material: $2,210 ($1,105 per Door)
Installation: $476.00 ($238 per Door)

Total:	**$2,686.00**

Roof Coverings
Built-Up

Description:	Asphalt base sheets & 3 Plies #15 asphalt felt, mopped on nailable deck
Area:	5,275 S.F.
Material:	$4,378.25 ($0.83 per S.F.)
Labor:	$7,490.50 ($1.42 S.F.)
Total:	**$11,868.75**

Shingle &
Tile

Description:	Asphalt Roofing, Strip Shingle, 4" Slope, Inorganic
Area:	5,275 S.F.
Material:	$2,690.25 ($0.51 per S.F.)
Labor:	$4,325.50 ($0.82 per S.F)
Total:	**$7,015.75**

Shell Total:	**$160,667.84**

Interiors

Partitions
Drywall Partitions/Wood Stud Framing, Plumbing Wall

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 7 25/32", 2"x6", 16" O.C.
Area:	25 S.F.
Material:	$63.25 ($2.53 per S.F.)
Labor:	$109.75 ($4.39 per S.F)
Total:	**$173.00**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 9' - 8", 2"x6", 16" O.C.
Area:	104 S.F.
Material:	$263.12 ($2.53 per S.F.)
Labor:	$456.56 ($4.39 per S.F)
Total:	**$719.68**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 9' - 11", 2"x6", 16" O.C.
Area:	109 S.F.
Material:	$275.77 ($2.53 per S.F.)

Labor:	$478.51 ($4.39 per S.F)
Total:	**$754.28**

Drywall Partitions/Wood Stud Framing

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 7 1/2", 2"x4", 16" O.C.
Count:	2
Area:	28 S.F. (Each: 14 S.F.)
Material:	$42.84 ($1.53 per S.F.)
Labor:	$94.92 ($3.39 per S.F)
Total:	**$137.76**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 11' - 5 5/32", 2"x4", 16" O.C.
Count:	1
Area:	104 S.F.
Material:	$159.12 ($1.53 per S.F.)
Labor:	$352.56 ($3.39 per S.F)
Total:	**$511.68**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 18' - 10 5/32", 2"x4", 16" O.C.
Count:	1
Area:	150 S.F.
Material:	$229.50 ($1.53 per S.F.)
Labor:	$508.50 ($3.39 per S.F)
Total:	**$738.00**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 13' - 7 5/32", 2"x4", 16" O.C.
Count:	1
Area:	127 S.F.
Material:	$194.31 ($1.53 per S.F.)
Labor:	$430.53 ($3.39 per S.F)
Total:	**$624.84**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 19' - 6 15/16", 2"x4", 16" O.C.
Count:	1
Area:	189 S.F.
Material:	$289.17 ($1.53 per S.F.)
Labor:	$640.71($3.39 per S.F)
Total:	**$929.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 12' - 11", 2"x4", 16" O.C.
Count:	1
Area:	142 S.F.
Material:	$217.26 ($1.53 per S.F.)
Labor:	$481.38 ($3.39 per S.F)
Total:	**$698.64**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 5 1/2", 2"x4", 16" O.C.
Count:	1
Area:	56 S.F.
Material:	$85.68 ($1.53 per S.F.)
Labor:	$189.84 ($3.39 per S.F)
Total:	**$275.52**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 0 1/2", 2"x4", 16" O.C.
Count:	1
Area:	16 S.F.
Material:	$24.48 ($1.53 per S.F.)
Labor:	$54.24 ($3.39 per S.F)
Total:	**$78.52**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 3' - 1 1/2", 2"x4", 16" O.C.
Count:	1
Area:	34 S.F.
Material:	$52.02 ($1.53 per S.F.)
Labor:	$115.26 ($3.39 per S.F)
Total:	**$167.28**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 3' - 3", 2"x4", 16" O.C.
Count:	1
Area:	18 S.F.
Material:	$27.54 ($1.53 per S.F.)
Labor:	$61.02 ($3.39 per S.F)
Total:	**$88.56**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 5 15/32", 2"x4", 16" O.C.
Count:	1
Area:	39 S.F.

Material:	$59.67 ($1.53 per S.F.)
Labor:	$132.21 ($3.39 per S.F)
Total:	**$191.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 6 25/32", 16" O.C.
Count:	1
Area:	70 S.F.
Material:	$107.10 ($1.53 per S.F.)
Labor:	$237.30 ($3.39 per S.F)
Total:	**$344.40**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 8 13/16", 2"x4", 16" O.C.
Count:	1
Area:	27 S.F.
Material:	$41.31 ($1.53 per S.F.)
Labor:	$91.53 ($3.39 per S.F)
Total:	**$132.84**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 6 13/16", 2"x4", 16" O.C.
Count:	1
Area:	27 S.F.
Material:	$41.31 ($1.53 per S.F.)
Labor:	$91.53 ($3.39 per S.F)
Total:	**$132.84**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 3' - 9 3/8", 16" O.C.
Count:	1
Area:	18 S.F.
Material:	$27.54 ($1.53 per S.F.)
Labor:	$61.02 ($3.39 per S.F)
Total:	**$88.56**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 13' - 7 25/32", 2"x4", 16" O.C.
Count:	1
Area:	148 S.F.
Material:	$226.44 ($1.53 per S.F.)
Labor:	$501.72 ($3.39 per S.F)
Total:	**$728.16**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 7' - 5", 2"x4", 16" O.C.
Count:	1
Area:	82 S.F.
Material:	$125.46 ($1.53 per S.F.)
Labor:	$277.98 ($3.39 per S.F)
Total:	**$403.44**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 3 13/16", 2"x4", 16" O.C.
Count:	1
Area:	17 S.F.
Material:	$26.01 ($1.53 per S.F.)
Labor:	$57.63 ($3.39 per S.F)
Total:	**$83.64**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 6 5/16", 2"x4", 16" O.C.
Count:	1
Area:	41 S.F.
Material:	$62.73 ($1.53 per S.F.)
Labor:	$138.99 ($3.39 per S.F)
Total:	**$201.72**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 3 3/32", 2"x4", 16" O.C.
Count:	1
Area:	12 S.F.
Material:	$18.36 ($1.53 per S.F.)
Labor:	$40.68 ($3.39 per S.F)
Total:	**$59.04**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 8' - 2 3/8", 2"x4", 16" O.C.
Count:	1
Area:	69 S.F.
Material:	$105.57 ($1.53 per S.F.)
Labor:	$233.91 ($3.39 per S.F)
Total:	**$339.48**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 3' - 1 15/32", 2"x4", 16" O.C.
Count:	1
Area:	33 S.F.

Material:	$50.49 ($1.53 per S.F.)
Labor:	$111.87 ($3.39 per S.F)
Total:	**$162.36**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 9' - 11", 2"x4", 16" O.C.
Count:	1
Area:	94 S.F.
Material:	$143.82 ($1.53 per S.F.)
Labor:	$318.66 ($3.39 per S.F)
Total:	**$462.48**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 5' - 8", 2"x4", 16" O.C.
Count:	1
Area:	57 S.F.
Material:	$87.21 ($1.53 per S.F.)
Labor:	$193.23 ($3.39 per S.F)
Total:	**$280.44**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 5' - 6", 2"x4", 16" O.C.
Count:	1
Area:	43 S.F.
Material:	$65.79 ($1.53 per S.F.)
Labor:	$145.77 ($3.39 per S.F)
Total:	**$211.56**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 8", 2"x4", 16" O.C.
Count:	1
Area:	14 S.F.
Material:	$21.42 ($1.53 per S.F.)
Labor:	$47.46 ($3.39 per S.F)
Total:	**$68.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 22' - 4 5/32", 16" O.C.
Count:	1
Area:	221 S.F.
Material:	$338.13 ($1.53 per S.F.)
Labor:	$749.19 ($3.39 per S.F)
Total:	**$1,087.32**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 11' - 8 3/8", 2"x4", 16" O.C.
Count:	1
Area:	125 S.F.
Material:	$191.25 ($1.53 per S.F.)
Labor:	$423.75 ($3.39 per S.F)
Total:	**$615.00**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 4 3/4", 2"x4", 16" O.C.
Count:	1
Area:	24 S.F.
Material:	$36.72 ($1.53 per S.F.)
Labor:	$81.36 ($3.39 per S.F)
Total:	**$118.08**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 3 1/2", 16" O.C.
Count:	1
Area:	25 S.F.
Material:	$38.25 ($1.53 per S.F.)
Labor:	$84.75 ($3.39 per S.F)
Total:	**$123.00**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 4 3/4", 2"x4", 16" O.C.
Count:	1
Area:	10 S.F.
Material:	$15.30 ($1.53 per S.F.)
Labor:	$33.90 ($3.39 per S.F)
Total:	**$49.20**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 9 25/32", 2"x4", 16" O.C.
Count:	1
Area:	44 S.F.
Material:	$67.32 ($1.53 per S.F.)
Labor:	$149.16 ($3.39 per S.F)
Total:	**$216.48**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 11 5/8", 2"x4", 16" O.C.
Count:	1
Area:	23 S.F.

Material:	$35.19 ($1.53 per S.F.)
Labor:	$77.97 ($3.39 per S.F)
Total:	**$113.16**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 3", 2"x4", 16" O.C.
Count:	1
Area:	14 S.F.
Material:	$21.42 ($1.53 per S.F.)
Labor:	$47.46 ($3.39 per S.F)
Total:	**$68.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 0 1/2", 2"x4", 16" O.C.
Count:	1
Area:	9 S.F.
Material:	$13.77 ($1.53 per S.F.)
Labor:	$30.51 ($3.39 per S.F)
Total:	**$44.28**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 8' - 7 3/8", 16" O.C.
Count:	1
Area:	94 S.F.
Material:	$143.82 ($1.53 per S.F.)
Labor:	$318.66 ($3.39 per S.F)
Total:	**$462.48**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 7 5/8" 2"x4", 16" O.C.
Count:	1
Area:	15 S.F.
Material:	$22.95 ($1.53 per S.F.)
Labor:	$50.85 ($3.39 per S.F)
Total:	**$73.80**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 11 1/8", 2"x4", 16" O.C.
Count:	1
Area:	19 S.F.
Material:	$29.07 ($1.53 per S.F.)
Labor:	$64.41 ($3.39 per S.F)
Total:	**$93.48**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 11 1/8", 16" O.C.
Count:	1
Area:	17 S.F.
Material:	$26.01 ($1.53 per S.F.)
Labor:	$57.63 ($3.39 per S.F)
Total:	**$83.64**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 5' - 8", 2"x4", 16" O.C.
Count:	1
Area:	58 S.F.
Material:	$88.74 ($1.53 per S.F.)
Labor:	$196.62 ($3.39 per S.F)
Total:	**$285.36**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 3' - 11 1/2", 2"x4", 16" O.C.
Count:	1
Area:	22 S.F.
Material:	$33.66 ($1.53 per S.F.)
Labor:	$74.58 ($3.39 per S.F)
Total:	**$108.24**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 11", 2"x4", 16" O.C.
Count:	1
Area:	21 S.F.
Material:	$32.13 ($1.53 per S.F.)
Labor:	$71.19 ($3.39 per S.F)
Total:	**$103.32**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 3", 2"x4", 16" O.C.
Count:	1
Area:	73 S.F.
Material:	$111.69 ($1.53 per S.F.)
Labor:	$247.47 ($3.39 per S.F)
Total:	**$359.16**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 6' - 3", 2"x4", 16" O.C.
Count:	1
Area:	31 S.F.

Material:	$47.43 ($1.53 per S.F.)
Labor:	$105.09 ($3.39 per S.F)
Total:	**$152.52**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 14' - 4 9/32", 16" O.C.
Count:	1
Area:	152 S.F.
Material:	$232.56 ($1.53 per S.F.)
Labor:	$515.28 ($3.39 per S.F)
Total:	**$747.84**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 2 1/2", 2"x4", 16" O.C.
Count:	1
Area:	16 S.F.
Material:	$24.48 ($1.53 per S.F.)
Labor:	$54.24 ($3.39 per S.F)
Total:	**$78.72**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 5' - 4 1/16", 2"x4", 16" O.C.
Count:	1
Area:	39 S.F.
Material:	$59.67 ($1.53 per S.F.)
Labor:	$132.21 ($3.39 per S.F)
Total:	**$191.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 2 1/2", 2"x4", 16" O.C.
Count:	1
Area:	24 S.F.
Material:	$36.72 ($1.53 per S.F.)
Labor:	$81.36 ($3.39 per S.F)
Total:	**$118.08**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 6", 2"x4", 16" O.C.
Count:	1
Area:	12 S.F.
Material:	$18.36 ($1.53 per S.F.)
Labor:	$40.68 ($3.39 per S.F)
Total:	**$59.04**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 11' - 2 1/8", 2"x4", 16" O.C.
Count:	1
Area:	35 S.F.
Material:	$53.55 ($1.53 per S.F.)
Labor:	$118.65 ($3.39 per S.F)
Total:	**$172.22**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 11' - 7 21/32", 2"x4", 16" O.C.
Count:	1
Area:	124 S.F.
Material:	$189.72 ($1.53 per S.F.)
Labor:	$420.36 ($3.39 per S.F)
Total:	**$610.08**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 0' - 5 3/4", 16" O.C.
Count:	1
Area:	3 S.F.
Material:	$4.59 ($1.53 per S.F.)
Labor:	$10.17 ($3.39 per S.F)
Total:	**$14.76**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 5' - 9 1/2", 2"x4", 16" O.C.
Count:	1
Area:	48 S.F.
Material:	$73.44 ($1.53 per S.F.)
Labor:	$162.72 ($3.39 per S.F)
Total:	**$236.16**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 1", 2"x4", 16" O.C.
Count:	2
Area:	38 S.F. (Each: 19 S.F.)
Material:	$58.14 ($1.53 per S.F.)
Labor:	$128.82 ($3.39 per S.F)
Total:	**$186.96**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 23' - 2 29/32", 2"x4", 16" O.C.
Count:	1
Area:	110 S.F.

Material:	$168.30 ($1.53 per S.F.)
Labor:	$372.90 ($3.39 per S.F)
Total:	**$541.20**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 0' - 3 1/2", 2"x4", 16" O.C.
Count:	1
Area:	7 S.F.
Material:	$10.71 ($1.53 per S.F.)
Labor:	$23.73 ($3.39 per S.F)
Total:	**$34.44**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 8 23/32", 2"x4", 16" O.C.
Count:	1
Area:	19 S.F.
Material:	$29.07 ($1.53 per S.F.)
Labor:	$64.41 ($3.39 per S.F)
Total:	**$93.48**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 8 23/32", 16" O.C.
Count:	1
Area:	15 S.F.
Material:	$22.95 ($1.53 per S.F.)
Labor:	$50.85 ($3.39 per S.F)
Total:	**$73.80**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 0' - 6 1/2", 2"x4", 16" O.C.
Count:	1
Area:	6 S.F.
Material:	$9.18 ($1.53 per S.F.)
Labor:	$20.34 ($3.39 per S.F)
Total:	**$29.52**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 4' - 6 31/32", 2"x4", 16" O.C.
Count:	1
Area:	48 S.F.
Material:	$73.44 ($1.53 per S.F.)
Labor:	$162.72 ($3.39 per S.F)
Total:	**$236.16**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 0 11/16", 2"x4", 16" O.C.
Count:	1
Area:	14 S.F.
Material:	$21.42 ($1.53 per S.F.)
Labor:	$47.46 ($3.39 per S.F)
Total:	**$68.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 8 31/32", 2"x4", 16" O.C.
Count:	1
Area:	14 S.F.
Material:	$21.42 ($1.53 per S.F.)
Labor:	$47.46 ($3.39 per S.F)
Total:	**$68.88**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 2' - 1 3/8", 2"x4", 16" O.C.
Count:	1
Area:	15 S.F.
Material:	$22.95 ($1.53 per S.F.)
Labor:	$50.85 ($3.39 per S.F)
Total:	**$73.80**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 1' - 11 1/4", 2"x4", 16" O.C.
Count:	1
Area:	20 S.F.
Material:	$30.60 ($1.53 per S.F.)
Labor:	$67.80 ($3.39 per S.F)
Total:	**$98.40**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 12' - 9 1/2", 2"x4", 16" O.C.
Count:	1
Area:	44 S.F.
Material:	$67.32 ($1.53 per S.F.)
Labor:	$149.16 ($3.39 per S.F)
Total:	**$216.48**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 13' - 0 1/2", 2"x4", 16" O.C.
Count:	1
Area:	40 S.F.

Material:	$61.20 ($1.53 per S.F.)
Labor:	$135.60 ($3.39 per S.F)
Total:	**$196.80**

Description:	Face: 1/2" Reg. Drywall, Base: 3/8" Reg. Drywall, Length: 3' - 4 1/2", 2"x4", 16" O.C.
Count:	1
Area:	8 S.F.
Material:	$12.24 ($1.53 per S.F.)
Labor:	$27.12 ($3.39 per S.F)
Total:	**$39.36**

Interior Doors

Wood Door/Wood Frame

Description:	Hollow Core/Flush, Lauan, 18"x80", Pine, Depth: 3-5/8"
Count:	5
Manufacturer:	Masonite
Material:	$604.75 ($120.95 per Door)
Labor:	$953.00 ($190.60 per Door)
Total:	**$1,557.75**

Description:	Hollow Core/Flush, Lauan, 28"x80", Pine, Depth: 3-5/8"
Count:	4
Manufacturer:	Masonite
Material:	$543.80 ($135.95 per Door)
Labor:	$802.40 ($200.60 per Door)
Total:	**$1,346.20**

Description:	Hollow Core/Flush, Lauan, 32"x80", Pine, Depth: 3-5/8"
Count:	7
Manufacturer:	Masonite
Material:	$993.65 ($141.95 per Door)
Labor:	$1,523.20 ($217.60 per Door)
Total:	**$2,516.85**

Description:	Hollow Core/Flush, Lauan, 36"x80", Pine, Depth: 3-5/8"
Count:	2
Manufacturer:	Masonite
Material:	$300.00 ($150.00 per Door)

Labor:	$451.20 ($225.60 per Door)
Total:	**$751.20**

Description:	Hollow Core/Flush, Lauan, 32"x80", Pine, Depth: 3-5/8"
Count:	7
Manufacturer:	Masonite
Material:	$993.65 ($141.95 per Door)
Labor:	$1,523.20 ($217.60 per Door)
Total:	**$2,516.85**

Double Closet Door

Description:	Double Door, Closet Door, Pine, 5'-0" Wide
Count:	3
Manufacturer:	Masonite
Material:	$576.30 ($192.10 per Set)
Labor:	$300.54 ($100.18 per Set)
Total:	**$876.84**

Description:	Double Door, Closet Door, Pine, 2'-0" Wide
Count:	1
Manufacturer:	Masonite
Material:	$130.10
Labor:	$50.18
Total:	**$180.28**

Garage Door

Description:	Overhead, Sectional, Includes Hardware, Fiberglass, 7'x8'
Count:	2
Manufacturer:	ReliaBilt
Material:	$1,997.50 ($998.75 per Door)
Labor:	$173.40 ($86.70 per Door)
Total:	**$2,170.90**

Bath & Toilet Accessories
Grab Bar

Description:	1-1/4" diam. 12" long
Count:	4
Manufacturer:	Moen
Material:	$110.52 (Each: $27.63)

Labor: $69.72 (Each: $17.43)
Total: **$180.24**

Toilet Tissue Dispenser
Description: Surface Mounted, Single Roll
Count: 3
Manufacturer
: Pfister
Material: $54.84 (Each: $18.28)
Labor: $42.09 (Each: $14.03)
Total: **$96.93**

Towel Bar
Description: 18" Long
Count: 2
Manufacturer
: Moen
Material: $73.96 (Each: $36.98)
Labor: $36.56 (Each: $18.28)
Total: **$110.52**

Medicine Cabinet
Description: Sliding Mirror Door, 20"x16"x4-3/4", Unlighted
Count: 2
Manufacturer
: Kohler
Material: $189 (Each: $94.35)
Labor: $120.70 (Each: $60.35)
Total: **$309.70**

Fabricated Cabinets & Counters
Lower Cabinets
Description: House, Base, Hard wood, 1 Top Drawer & 1 Door Below
Count: 3'-0"
Manufacturer
: Continental Cabinets
Material: $637.50 ($212.50 per L.F.)
Labor: $102.00 ($34.00 per L.F.)
Total: **$739.50**

Description: House, Base, Hard wood, 4 Drawer

Count:	3'-0"
Manufacturer:	Continental Cabinets
Material:	$1,147.50 ($382. 50 per L.F.)
Labor:	$113.49 ($37.83 per L.F.)
Total:	**$1,260.99**

Description:	House, Base, Hard wood, 1 Door, 2 Drawer
Count:	13'-0"
Manufacturer:	Continental Cabinets
Material:	$2,866.50 ($220.50 per L.F.)
Labor:	$520.00 ($40.00 per L.F.)
Total:	**$3,386.50**

Description:	House, Base, Hard wood, 2 Door,1 Drawer
Count:	23'-0"
Manufacturer:	Continental Cabinets
Material:	$5,186.50 ($225.50 per L.F.)
Labor:	$1,035.00 ($45.00 per L.F.)
Total:	**$6,221.50**

Upper Cabinets

Description:	Wall, Hard wood, 30" High w/1 Door x 12" Wide
Count:	7'-0"
Manufacturer:	Continental Cabinets
Material:	$1,255.45 ($179.35 per L.F.)
Labor:	$267.75 ($38.25 per L.F.)
Total:	**$1,523.20**

Description:	Wall, Hard wood, 30" High w/2 Door x 48" Wide
Count:	3'-0"
Manufacturer:	Continental Cabinets
Material:	$1,122.00 ($374.00 per L.F.)
Labor:	$137.70 ($45.90 per L.F.)
Total:	**$1,259.70**

Counter Top

Description:	Granite, Stock Economy

Count:	41'-0"
Manufacturer:	VT Industries
Material:	$332.92 ($8.12 per L.F.)
Labor:	$575.23 ($14.03 per L.F.)
Total:	**$908.15**

Wall Finishes - Painting

Painting Walls

Description:	Interior, Plaster & Drywall, Brush Work, 2 Coats, Primer
Area:	7,178 S.F.
Material:	$1,004.92 ($0.14 per S.F.)
Labor:	$5,239.94 ($0.73 per S.F.)
Total:	**$6,244.86**

Painting Trim

Description:	Wood Trim, Enamel, Primer
Area:	437 L.F.
Material:	$43.70 ($0.10 per L.F.)
Labor:	$196.65 ($0.45 per L.F.)
Total:	**$240.35**

Floor Finishes

Tile & Covering

Description:	Carpet, Tufted, Nylon, Roll Goods, 12" Wide, 26 oz, Brown
Area:	684 S.F.
Material:	$2,968.56 ($4.34 per S.F.)
Labor:	$410.40 ($0.60 per S.F.)
Total:	**$3,378.96**

Description:	Ceramic, Tile, White
Area:	637 S.F.
Material:	$2,790.06 ($4.38 per S.F.)
Labor:	$2,363.27 ($3.71 per S.F.)
Total:	**$5,153.33**

Description:	Oak Strip, Sanded & Finished
Area:	870 S.F.
Material:	$3,227.70 ($3.71 per S.F.)

Labor:	$3,140.70 ($3.61 per S.F.)
Total:	**$6,368.40**

Ceiling Finishes
Drywall
Ceiling

Description:	1/2" F.R. Drywall, Painted & Textured, 1"x3" Wood, 16" O.C.
Area:	2730 S.F.
Material:	$2,047.50 ($0.75 per S.F.)
Labor:	$7,098.00 ($2.60 per S.F.)
Total:	**$9,145.50**

Interiors
Total: **$76,578.90**

Services

Plumbing Fixtures
Water Closet Systems

Description:	Floor Mount Toilet, 1 Piece
Count:	3
Manufacturer:	AquaSource
Material:	$2,333.25 (Each: $777.75)
Labor:	$1,683.00 (Each: $561.00)
Total:	**$4,016.25**

Lavatory
Systems

Description:	Lavatory w/Trim, Vanity Top, P.E. on C.I. 20"x18"
Count:	4
Manufacturer:	Franke
Material:	$1,704.88 (Each: $426.22)
Labor:	$2,119.56 (Each: $529.89)
Total:	**$3,824.44**

Kitchen Sink Systems

Description:	Stainless Steel, 33"x22" Double Bowl
Count:	1
Manufacturer:	Franke
Material:	$1,041.25
Labor:	$624.75
Total:	**$1,666.00**

Bathtub Systems

Description:	Bathtub, Recessed, Porcelain Enamel on Cast Iron, 72"x36"
Count:	2
Manufacturer:	Aqua Glass
Material:	$4,122.50 (Each: $2,061.25)
Labor:	$1,462 (Each: $731)
Total:	**$5,584.50**

Electric Water Heaters

Description:	Electric Water Heater, 100 degree Fahrenheit, 50 Gallon, 9 kw, 37 GPH
Count:	2
Manufacturer:	Whirlpool
Material:	$8,456.08 (Each: $4,228.04)
Labor:	$1,732.82 (Each: $866.41)
Total:	**$10,188.90**

HVAC
Air Handling Unit

Description:	Built-Up, w/Cooling/Heating Coil Section, Filters, Mixing Box, Single Zone, 1600 CFM
Count:	1
Manufacturer:	Frigidaire
Material:	$2,550 (Each: $2,550)
Labor:	$480.25 (Each: $480.25)
Total:	**$3,030.25**

Electrical
Electrical Service/Distribution

Description:	Service Installation, Includes Breakers, Metering 20' Conduit & 3 Phase, 4 Wire 60 A
Count:	1
Material:	$843.80 (Each: $843.80)
Labor:	$734.32 (Each: $734.32)
Total:	**$1,578.12**

Lighting & Branch Wiring

Description:	Receptacles & Wall Switches, Receptacle Duplex
Count:	54
Material:	$2,026.62 (Each: $37.53)
Labor:	$8,467.74 (Each: $156.81)

Total: **$10,494.36**

Safety Switch
Description: Safety Switch, 30A Fused, 1 Phase, 115V or 230V
Count: 68
Material: $9,352.04 (Each: $137.53)
Labor: $10,542.72 (Each: $155.04)
Total: **$19,894.76**

Ceiling Fan
Description: Paddle Fan, Variable Speed, Economy Model
Count: 6
Manufacturer: Harbor Breeze
Material: $535.50 (Each: $89.25)
Labor: $186.18 (Each: $31.03)
Total: **$721.68**

Services Total: **$60,999.26**

Equipment & Furnishings

Laundry/Dry Cleaning
Dryer
Description: Gas Fired, Residential, 16lb Capacity
Count: 1
Manufacturer: Whirlpool
                         $586.50 (Each:
Material: $586.50)
                         $165.75 (Each:
Labor: $165.75)
Total: **$752.25**

Washer
Description: Residential,4 Cycle
Count: 1
Manufacturer: Whirlpool
Material: $748.00 (Each: $748)
                         $165.75 (Each:
Labor: $165.75)
Total: **$913.75**

Residential Equipment

Range

Description:	Built-In, Single Oven, 30" Wide, Economy
Count:	1
Manufacturer:	GE
Material:	$646.00 (Each: $646)
Labor:	$79.48 (Each: $79.48)
Total:	**$725.48**

Dishwasher

Description:	Built-In, 4 Cycles, Deluxe
Count:	1
Manufacturer:	GE
Material:	$956.25 (Each: $956.25)
Labor:	$484.50 (Each: $484.50)
Total:	**$1,440.75**

Garbage Disposer

Description:	Sink Type, Economy
Count:	1
Manufacturer:	GE
Material:	$62.48 (Each: $62.48)
Labor:	$96.90 (Each: $96.90)
Total:	**$159.38**

Refrigerator

Description:	No Frost, 10 to 12 CF, Economy
Count:	1
Manufacturer:	Whirlpool
Material:	$416.50 (Each: $416.50)
Labor:	$66.73 (Each: $66.73)
Total:	**$483.23**

Fireplace

Description:	Fireplace, Prefabricated, Freestanding or Wall hung
Count:	1
Manufacturer:	EverTrue
Material:	$1,083.75
Labor:	$323.00

Total: **$1,406.75**

Equipment & Furnishings Total: **$5,881.59**

Building Site Work

Fence & Guardrails
Fence
	Chain Link, 2" Post, 1-5/8" Rail, 9 Gauge Galvanized
Description:	Wire, 5' High
Linear Feet:	276'-0"
Material:	$3,356.16 ($12.16 per L.F.)
Labor:	$1,084.68 ($3.93 per L.F.)
Total:	**$4,440.84**

Average Lot
Total: **$18,500.00**

Building Site Work Total: **$22,940.84**

Assemblies Total

Substructure:	Not Applicable
Shell:	$160,667.84
Interiors:	$76,578.90
Services:	$60,999.26
Equipment & Furnishings:	$5,881.59
Building Site work:	$22,940.84
Total Cost:	$327,068.43

CONTACT INFORMATION

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