7. GREENCRAFT BUILDERS COLLEYVILLE HOUSE, COLLEYVILLE, TX

7.1 Executive Summary

Gate 2 - Prototype: Colleyville House, Greencraft Builders, Dallas, TX

Overview

Greencraft Builders LLC is a custom home builder that has been constructing Building America prototypes for three years. The partners involved in the effort are the builder (Greencraft), the architect (William Peck and Associates) and Building Science Corporation. The Colleyville house was constructed to the highest standards in efficiency, durability and sustainability. It is a quality demonstration of the type of construction that a Building America Prototype should endeavor to be.

Key Results

The Colleyville house was constructed to Building America standards by Greencraft Builders LLC. It will serve as a demonstration house for guests to tour and then it will be occupied by a family. This house incorporates many advanced technologies advocated by Building America and Building Science Corporation.

Gate Status

Table 7.1-1: Stage Gate Status Summary

"Must Meet" Gate Criteria	Status	Summary
Source Energy Savings	Pass	The Colleyville house meets the 50% minimum source energy savings threshold as defined by the 2009 Building America Benchmark.
Prescriptive-Based Code Approval	Pass	The Colleyville House meets the local building code – 2003 IBC.
Quality Control Requirements	Pass	Greencraft maintains quality control through constant communication and onsite reviews by the builder and the architect. Detailed drawing sets from the architect and documented specifications from BSC augments the quality service that Greencraft provides.

"Should Meet" Gate Criteria	Status	Summary
Neutral Cost Target	Pass	This home exceeds the neutral cost target when the cost of improvements is financed as part of a 30 year mortgage. This annual amortized cost is less than the energy savings of the homes compared to the BA Benchmark.
Quality Control Integration	Pass	Quality control is specified by documents between Greencraft and Building Science Corporation.
Gaps Analysis	Pass	BSC and Greencraft attempted to integrate XPS insulation on the slab edge but were unable to. Greencraft will try to include this and other characteristics in future homes.

Conclusions

The Colleyville house is a custom single detached home constructed by Greencraft Builders LLC, based out of Dallas, TX. This house began construction in May 2008 and finished

March 2009. It was commissioned by Building Science Corporation and the results of the performance testing were exemplary. This house exceeds the 50% energy savings threshold as defined by the Building America Benchmark. The Colleyville house is rated at a HERS 30 with 3.0 kW photovoltaics and HERS 39 without renewables. This house is expected to save $3152 annually due to the advanced technologies implemented in the construction of the home. Greencraft is a stalwart Building America partner and will continue to work closely with Building Science Corporation for the foreseeable future.

7.2 Introduction

7.2.1. Project Overview

Building Science Corporation has been collaborating with Greencraft Builders since 2005 and has forged a valuable working relationship. Greencraft has been successfully constructing highly efficient homes for years. They have been working with a local architect, William Peck and Associates, who specializes in energy efficient construction. Greencraft is based out of the Dallas Fort Worth area and specializes in mid to high market custom houses.

The Colleyville house is one of two 2009 prototypes. This is the largest and most expensive home that Greencraft has constructed as a part of the Building America program. It is a two-story single detached residence e with a total of 4886 sf. Construction began May 2008 and was finished March 2009. Please refer to the Appendix for the detailed floor plans. Below is a photo of the finished residence.

Figure 7.2-1: Colleyville House – 2009 Greencraft Prototype House

The house is on an uninsulated slab on grade post tensioned foundation due to expansive soils on site. The walls are 2x6 advanced framed with low density open celled spray foam in the cavity with 1" XPS as insulating sheathing. The roof is an unvented cathedralized attic with R-20 low density spray foam in the roof rafter cavities. A ground source heat pump provides heating and cooling and additional hot water heating. Supplemental dehumidification is installed to provide dehumidification separate from heating and cooling to maintain occupant comfort year round. Mechanical ventilation provides outside air to the home and is controlled by a fan cycler.

7.2.2. Project Information Summary Sheet

PROJECT SUMMARY	
Company	GreenCraft Builders L.L.C.
Company Profile	GreenCraft Builders L.L.C. is the culmination of more than 30 years of experience building and remodeling homes in the Dallas/Fort Worth metroplex. Since 2004, Chris Miles, principal of GreenCraft, has been recognized as a leader in the North Texas green building industry, first as a producer and project manager, and now as a builder with his company, GreenCraft Builders L.L.C.
Contact Information	Chris Miles GreenCraft Builders L.L.C. 105 West Main Street Lewisville, TX 75057 (214) 718-8424 http://www.greencraftbuilders.com/
Company Type	Custom Home Builder
Address	1708 Oak Knoll Drive
City, State	Colleyville, TX 76034
Climate Region	Mixed-Humid, IECC Zone 3A

SPECIFICATIONS	
Number of Houses	1
Municipal Address	1708 Oak Knoll Drive, Colleyville, TX 76034
House Style	Single Family Detached with attached garage
Number of Stories	2
Number of Bedrooms	4
Plan Number(s)	Arnett House
Floor Area	4886 ft^2
Estimated Energy Reduction	70.5% over BA Benchmark
Estimated Energy Savings	$3459 annual savings
Estimated Cost	$960,000 or $196/$ft^2$
Construction Start	May 2008
Construction Finish	March 2009

7.2.3. Targets and Goals

The Colleyville House has been designed as a Building America prototype house to meet a 50% reduction in whole house energy use when compared to the Building America Benchmark.

The Colleyville Eco House is a demonstration project for the US Department of Energy's "Building America" program to encourage homeowners and builders to live and build in a more fiscally and environmentally sensible manner.

A primary goal set for the project by Greencraft was to construct a prototype house that demonstrates key energy efficiency, durability, and sustainability features. Achieved certifications include:

- Building America Builders Challenge Program
- USGBC LEED®-H Gold
- Green Built™ North Texas
- NAHB National Green Building Program™ - Gold
- EPA Energy Star® for Homes

Specific goals of the 2009 Colleyville house are:

- To promote spray foam unvented roofs as an effective way to locate the HVAC system within the building enclosure, and to reduce building infiltration.
- To utilize full Optimum Value Engineering (OVE) Advanced Framing in the enclosure construction. This consists of 2x6 studs at 24"o.c. with two stud energy corners, single top plate and reduction in window framing. Also included is stacked framing with both the floor joists and roof trusses spaced at 24"o.c.
- To encourage supplemental dehumidification to provide annual comfort control separate from the HVAC system.

7.3 Whole-House Performance and Systems Engineering

7.3.1. Energy Analysis Summary

Table 7.3-1: Estimated Whole House Energy Use for the Colleyville House

ESTIMATED WHOLE HOUSE ENERGY USE		
Source (10^6 BTU/yr)	**Site (10^6 BTU/yr)**	**Area + Bsmt (sq ft)**
189	69	4886 + 0
	% Electric	**No. of Bedrooms**
	72%	4

With the enclosure and mechanical characteristics presented in Table 8.3-5 and Table 8.3-6, this plan achieves a performance level of 70.5 % reduction relative to the Building America Benchmark without renewable energy installations.

The table below shows the net whole house energy use with the 3.0 kW photovoltaic array included in the simulation. This shows that the renewable installation is expected to generate around 42 million BTUs of source energy annually.

Table 7.3-2: Estimated House Energy Net Generation for the Colleyville House

ESTIMATED HOUSE ENERGY NET GENERATION		
Source (10^6 BTU/yr)	**Site (10^6 BTU/yr)**	**Area + Bsmt (sq ft)**
147	55	4886 + 0
	% Electric	**No. of Bedrooms**
	65%	4

7.3.1.1. Parametric Energy Simulations

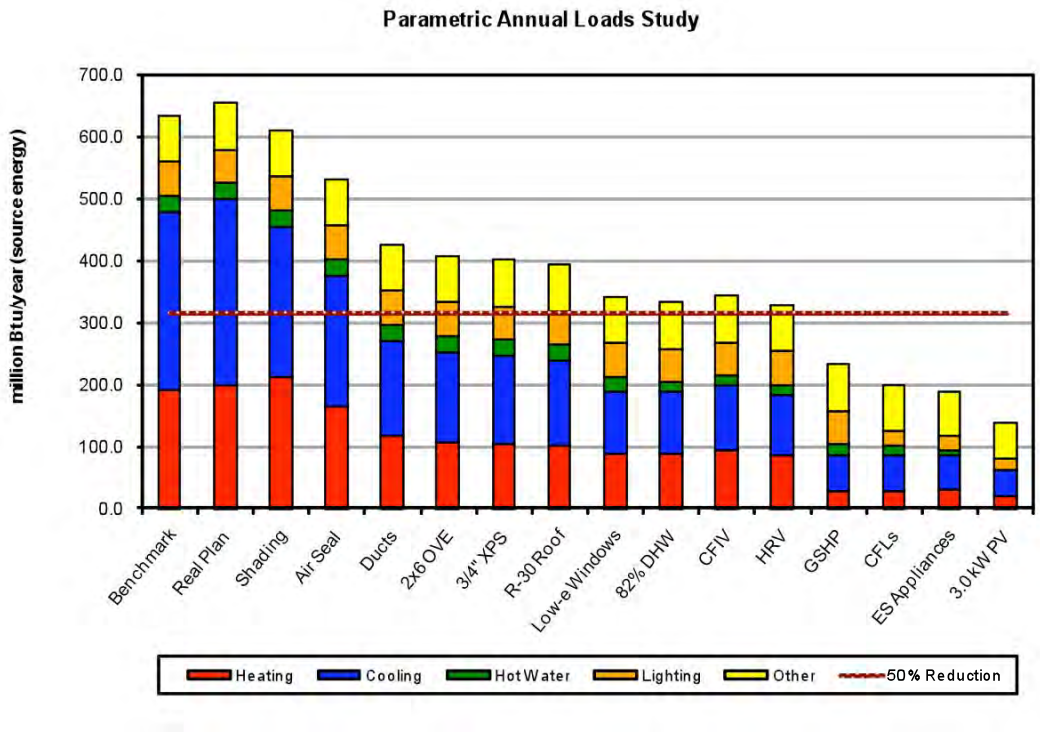


Figure 7.3-1: Parametric energy simulations for the Colleyville House

The Colleyville house exceeds the Building America Prototype energy threshold of 50% without PV contributions.

The following incremental improvements had the largest impact on the efficiency of the prototype vs. the benchmark (in order, not including renewable installations):

1. Ground Source Heat Pump
2. Ducts inside conditioned space and duct leakage to outside reduced to 1% of flow
3. Air Seal to 0.9 in^2 per 100 ft^2 of enclosure area
4. Vinyl framed double paned windows with LoE^3 spectrally selective coating

7.3.1.2. End-Use Site and Source Energy Summaries

Table 7.3-3: Summary of End-Use Site-Energy

	Annual Site Energy			
	Benchmark		Prototype	
End-Use	kWh	therms	kWh	therms
Space Heating	16656	0	2411	0
Space Cooling	24886		4782	
DHW	0	236	0	80
Lighting*	4717		1946	
Appliances + Plug	5695	114	5293	114
OA Ventilation**	112		178	
Total Usage	52064.75	350	14610	194
Site Generation			4090	
Net Energy Use	52065	350	14610	194

Table 7.3-4: Summary of End-Use Source-Energy and Savings

			Source Energy Savings	
	Estimated Annual Source Energy		% of End-Use	% of Total
	Benchmark	Prototype	Prototype	Prototype
End-Use	10^6 BTU/yr	10^6 BTU/yr	savings	savings
Space Heating	191.2	27.7	**86%**	**26%**
Space Cooling	285.7	54.9	**81%**	**36%**
DHW	25.8	8.7	**66%**	**3%**
Lighting*	54.2	22.3	**59%**	**5%**
Appliances + Plug	77.8	73.2	**6%**	**1%**
OA Ventilation**	1.3	2.0	**-60%**	**0%**
Total Usage	636	189	**70%**	**70%**
Site Generation	0	-42		**7%**
Net Energy Use	636	189	**70%**	**77%**

7.3.2. Discussion

7.3.2.1. Enclosure Design

Table 8.3-5 (below) summarizes the building enclosure assemblies used for this project.

Table 7.3-5: Enclosure Specifications

ENCLOSURE	SPECIFICATIONS
Ceiling	
Description -	Standing Seam metal roof - Unvented Cathedralized Attic
Insulation -	8.6” R-30 low density open cell spray foam in roof rafter cavity
Walls	
Description -	Advance Framed with ½”OSB at the corners for structural 2x6 wood studs 24” o.c., two stud corners single top plate Stacked framing with floor joists and roof trusses at 24”o.c.
Insulation -	R-20 low density open cell spray foam +1” R-5 XPS insulating sheathing
Foundation	
Description -	Slab on grade – Post Tensioned with Termimesh® barrier system Slab is 51% fly ash
Insulation -	Non insulated
Windows	
Description -	Double Pane Fiberglass Framed
Manufacturer -	Pella® Impervia®
U-value -	U = 0.28 Btu/hr-ft^2°F
SHGC -	SHGC = 0.24
Infiltration	
Specification -	2.5 in^2 leakage area per 100 ft^2 enclosure, 3149 CFM 50, 2.5 ACH 50
Performance test -	0.9 in^2 leakage area per 100 ft^2 enclosure, 1097 CFM 50, 0.9 ACH 50

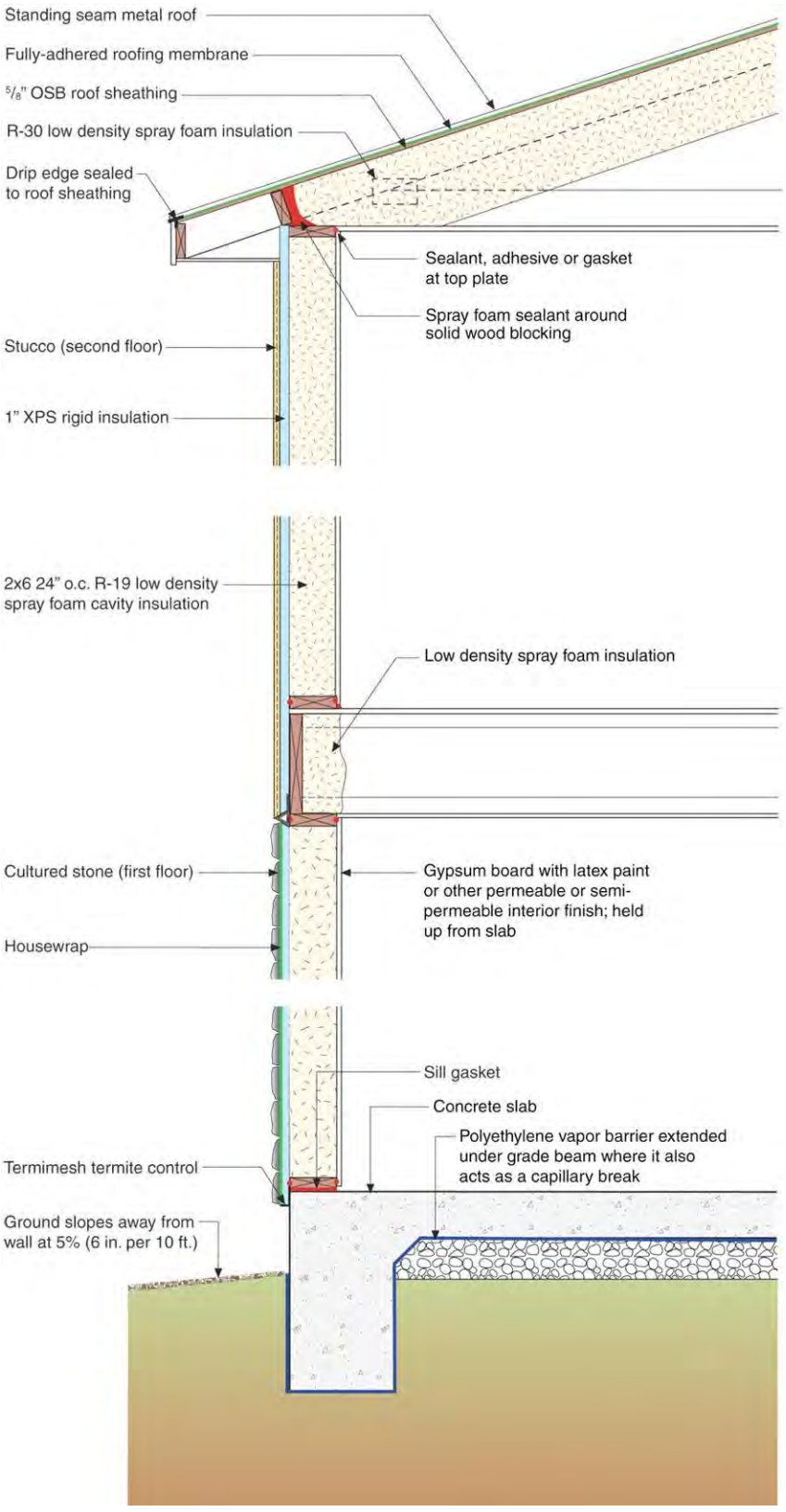


Figure 7.3-2: Enclosure Building Section

Greencraft has been constructing unvented cathedralized attics for years and prefers them versus a traditional vented attic. An unvented cathedralized attic allows the HVAC system to remain where it is initially designed to be, and to become a part of conditioned space. This does require rafter construction versus roof trusses but Greencraft has integrated this change into their framing without any trouble. Their framers are familiar with unvented cathedralized attic construction as well as OVE (Optimized Value Engineering) in general.

Figure 7.3-3: Unvented cathedralized attic with foam installed

Figure 7.3-4: Open cell low density spray foam in walls and unvented cathedralized attic

Greencraft installed a standing seam roof over a fully adhered membrane installed on the roof sheathing.

Figure 7.3-5: Fully adhered roofing membrane installed before standing seam roof

Figure 7.3-6: Standing seam metal roof

The entire structure is Advanced Framed. The roof rafters are spaced 24" on center and all framing is stack framed. The walls are 2x6 spaced 24" and are stacked below the roof rafters and above the rim joist framing to ensure proper stacked framing. The wall top plate can now be reduced from two to one. The corners are constructed of 2 stud rather than 3 or 4 to maximize the cavity space for insulation. The top plates of the walls are all single stud and 24" splices are used at the joints. The windows are framed with one

header set outboard of the structure. This allows for insulation at the headers. Reduced framing is utilized in the windows, resulting in a more efficient stud layout.

Figure 7.3-7: Advanced framed walls – 2x6 studs at 24" o.c.

Figure 7.3-8: Stacked framing with a 2x6 splice joining two single top plates

Another element of advanced framing is the omission of all cripple studs adjacent to window jack studs. These are not necessary from a structural perspective. Greencraft does install one cripple as a minimum and uses that cripple to measure up the sill stud first.

Figure 7.3-9: No cripples installed next to the jack studs

Figure 7.3-10: Two windows with no adjacent to jack studs

The windows are double paned fiberglass framed with state of the art LoE^3 coating to achieve one of the best performing windows in the residential construction industry. Fiberglass frames are much stronger and dimensionally stable than vinyl. This results in high quality operation and much improved durability.

The exterior walls have ¾" insulating sheathing. This reduces the energy losses from thermal bridging through the exterior studs. At the corners ½" OSB is installed for structural support. The OSB is installed 4' from the corner and then the wall resumes the ¾" XPS in the field. ¼" XPS is installed over the OSB to add insulation and to provide a smooth surface for continuing the construction of the exterior wall. DuPont™ Tyvek®

DrainWrap™ is installed as a housewrap on the entire enclosure. It serves as a water resistive membrane to drain water out from the wall assembly.

The exterior wall is clad half in stone and half in stucco. The transition between the two cladding systems is critical to be installed correctly in order to effectively control rainwater entry and air infiltration. The housewrap continually envelopes behind both wall claddings so there is no leakage at the joint between the stone and the fiber cement.

Figure 7.3-11: Fiberglass LoE^3 windows

Figure 7.3-12: Window with cladding installed

The foundation is post tensioned slab on grade, which is typical for this area. The concrete has 51% fly ash content. Insulation was not able to be installed due to the post tensioning, however BSC is focusing on integration XPS insulation in future prototype homes. A mesh based termite barrier system is installed at slab penetrations and at the slab edge behind the cultured stone.

Figure 7.3-13: Slab reinforcement before casting

Figure 7.3-14: 51% Fly Ash post tensioned slab on grade

Infiltration is controlled by the spray foam in the walls, rim joist and roof. All penetrations are foam sealed and all windows have a bead of foam sealing the rough openings. This resulted in a very tight building enclosure (0.9 tested leak ratio versus 1.5 specified leak ratio)

Figure 7.3-15: Low density open cell spray foam in unvented cathedralized attic (R-30) and walls (R-20)

Figure 7.3-16: Low density open cell spray foam in attic knee walls

7.3.2.2. Mechanical System Design

Table 8.3-6 (below) summarizes the mechanical systems used by this project.

Table 7.3-6: Mechanical system specifications

MECHANICAL SYSTEMS	SPECIFICATIONS
Heating (outdoor unit)	
Description -	4.1 COP Ground Source Heat Pump
Manufacturer & Model -	WaterFurnace® Envision™ Series
Cooling (outdoor unit)	
Description -	18.8 EER Ground Source Heat Pump
Manufacturer & Model -	WaterFurnace® Envision™ Series
Air Handler (indoor unit)	
Description -	Variable Speed Air Handler + High Efficiency Air Filter
Manufacturer & Model -	WaterFurnace® Envision™ Series + GeneralAire® AC22 filter
Domestic Hot Water	
Description -	Instantaneous Tankless Hot Water + Separate tank for GSHP DHW
Manufacturer & Model -	Rinnai® R94LSi (0.82 EF) + 30 Gal. A.O. Smith ® ProMax® tank
Distribution	
Description -	Duct board and R-6 flex duct run outs in conditioned attic
Leakage -	430 CFM 25 (18%) total, 30 CFM 25 (1.0%) to outside
Ventilation	
Description -	Central Fan Integrated Supply (CFIS) ventilation system 50 CFM 33% Duty Cycle: 10 minutes on; 20 minutes off Energy Recovery Ventilator Inline exhaust fan for all bathrooms

MECHANICAL SYSTEMS	SPECIFICATIONS
Manufacturer & Model -	Aprilaire® Model 8126 Ventilation Control System (VCS) Fantech FR 150 inline exhaust fan for all bathrooms
Dehumidification	
Description -	Supplemental dehumidification system
Manufacturer & Model -	GeneralAire® Model 1300 Whole House Dehumidifier
Return Pathways	
Description -	R-6 flex ducts to bedrooms and laundry room
PV System	
Description -	3 kW array
Manufacturer & Model -	Supplier: Meridian Solar | Manufacturer: Sharp® Corporation

Heating and cooling is provided by a WaterFurnace® ground source heat pump. A total of six wells were drilled 300 feet deep and 25 feet apart from one another. The overall system is rated at 4.1 COP heating and 18.8 EER cooling.

Figure 7.3-17: Well drilling

Figure 7.3-18: HVAC system located in the conditioned unvented cathedralized attic

The overall HVAC system cost was around $27,000 total. The indoor air handler is a variable speed unit from WaterFurnace®. All ductwork is located inside conditioned space in the unvented cathedralized attic. Total duct leakage was much improved versus the 2008 Greencraft Bannister house (18% vs. 38%). Duct leak to outside was well below the 5% requirement (1%).

The outside air ventilation design is Central Fan Integrated Supply (CFIS) ventilation that is controlled by the Aprilaire® Model 8126 VCS fan cycler that is installed at the supply plenum. A 6" insulated flex duct draws outside air from an exterior wall location and dumps it into the ERV. There is a mechanical damper on this duct that is controlled by the fan cycler to prevent over ventilation during periods of high operation. The fan cycler also turns on the air handler alone during periods of low operation to bring in outside air and mix the interior air. This ensures proper ventilation and maintains a homogenous indoor environment. The bathroom exhausts are all connected in parallel to a single exhaust duct that is powered via the Fantech FR 150 inline fan.

The figure below shows the HVAC design that integrates the air handler with the whole house dehumidification system.

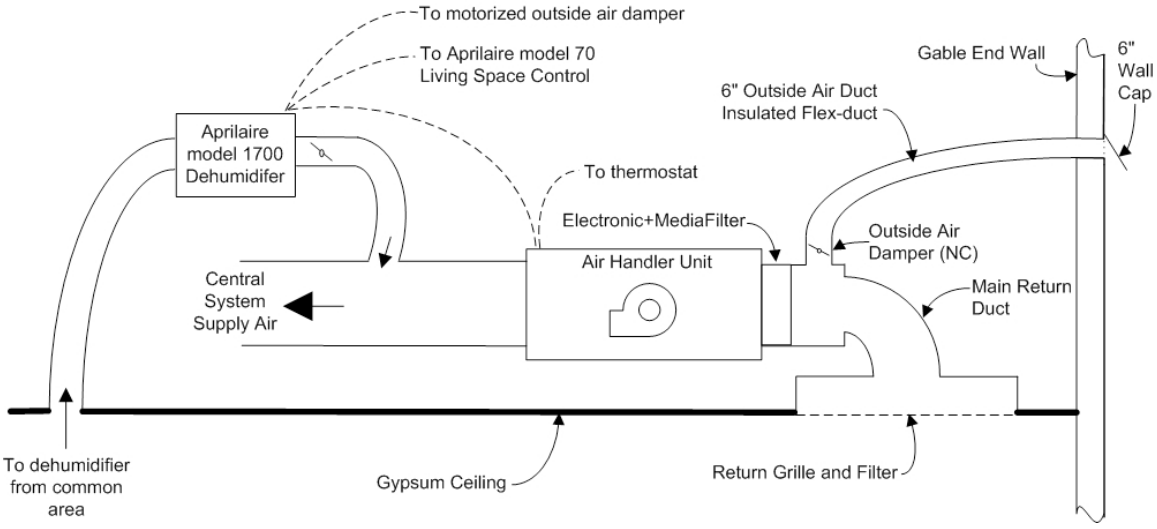


Figure 7.3-19: Central Fan Integrated Supply Ventilation Schematic with Supplemental Dehumidification

The photos below show both the fan cycling controls installed as well as the whole house dehumidification system and the central filtration system.

Figure 7.3-20: (L-R) GeneralAire® AC22 Filter and Aprilaire® 8126 VCS control panel on supply plenum

Figure 7.3-21: (L-R) GeneralAire® AC22 Filter, WaterFurnace® Air Handler and GeneralAire® Model 1300 whole house dehumidifier on top of air handler

The Colleyville house is in a Mixed-Humid climate, thus BSC recommends supplemental dehumidification to control humidity levels when air conditioning is not appropriate. Supplemental dehumidification is one of the key improvements to the prototype, and is necessary because of the very efficient enclosure. The sensible load has been reduced such that the ratio of sensible to latent load is very different than in a standard home. Supplemental dehumidification will provide the occupant with the ability to control indoor humidity levels all year round. This will have a beneficial impact on the comfort and durability of the structure by preventing high humidity levels and potential mold risks. Supplemental dehumidification is provided by a GeneralAire® Model 1300 whole house

dehumidifier that was installed on top of the air handler. The dehumidifier draws air from the main living space and supplies dehumidified air to the supply plenum. This allows for dehumidification to take place separate from air handler operation.

7.3.2.3. Lighting and Miscellaneous Electrical Loads

The Colleyville house has 100% fluorescent lighting, with around 10% pin based in the kitchen area and 90% compact fluorescent everywhere else. There are four LED lights installed as a demonstration of the technology. The refrigerator, clothes washer and dishwasher are all Energy Star rated.

7.3.2.4. Site-generated Renewable Energy

Meridian Solar installed a 3.0 kW PV system from Sharp® Corporation. It is expected to produce 4090 kWh annually, which converts to 47 million Btus source energy produced.

Figure 7.3-22: 3.0 kW Photovoltaic System

7.4 Construction Support

7.4.1. Construction Overview

Construction began in May 2008 and finished in March 2009. Greencraft did not come across any major enclosure or HVAC related problems during construction. The mechanical installation also is not experiencing any problems.

7.4.2. Educational Events and Training

This house, like all Greencraft Prototype homes, was a demonstration house that saw regular tours. It is estimated that over 6000 people visited the Colleyville house to learn about Building America construction. The majority of the audience was potential home buyers. The Colleyville house was also the sole show house at the 2009 Sunbelt Builder's Show. It is estimated that around 7,500 people have toured the house during its demonstration phase.

7.4.3. Systems Testing

Testing and commissioning of the building enclosure and mechanical systems was performed to ensure the house will operate as designed. The following tests will be performed:

- Air leakage
- Duct leakage
- Local air flows
- System external static pressure
- Outside air duct air flow
- Proper configuration of the GeneralAire® Model 1300 whole house dehumidifier

7.4.4. Monitoring

BSC installed U-10 HOBOs from Onset Corporation in four locations in the house:

- First Floor Thermostat
- First Floor Master Bedroom
- Second Floor Bed Two
- Second Floor Kids Area

7.5 Project Evaluation

The following sections evaluate the research project results based on the ability to integrate advanced systems with production building practices in prototype homes. References are made to the results from field tests and energy simulations, which are included as an appendix to this report.

7.5.1. Source Energy Savings

Requirement:	*Final production home designs must provide targeted whole house source energy efficiency savings based on BA performance analysis procedures and prior stage energy performance measurements.*
Conclusion:	***Pass***

The project is estimated to achieve a source energy savings of 70% prior to the additional of renewable energy strategies. The energy savings is increased to 77% with the addition of a 3 kW roof mounted photovoltaic system. The percentage savings were calculated with FSEC's Energy Gauge USA v. 2.8.02 and the 2009 Building America Benchmark defined the comparison home. This is achieved through the design and construction of a high quality enclosure and the installation of highly efficient mechanical systems.

7.5.2. Prescriptive-based Code Approval

Requirement:	*Must meet prescriptive or performance safety, health and building code requirements for new homes.*
Conclusion:	***Pass***

The city of Colleyville currently adopts the 2003 International Building Code. The Colleyville house meets this and all local building codes and has been designed and constructed to maintain a healthy living environment. Full advanced framing has been accepted by the local code officials for the past four years. Greencraft has been changing the way the code officials understand advanced framing and has served as a local example of exemplary construction.

7.5.3. Quality Control Requirements

Requirement:	*Must define critical design details, construction practices, training, quality assurance, and quality control practices required to successfully implement new systems with production builders and contractors.*
Conclusion:	***Pass***

Greencraft Builders LLC provides quality assurance and quality control through construction site management. A site/construction manager typically reviews the progress of construction on a regular basis. BSC worked with Greencraft to ensure proper quality control through implementation of quality construction practices into their building environment. Greencraft maintains excellent quality control from initial design to the finished building. The architect creates very detailed drawing sets with details that specifically outline a certain characteristic. The owner of Greencraft as well as a

superintendent both tour the homes regularly and will demand any deviations from the design to be remedies immediately.

Greencraft maintains constant communication within the company and between contractors or the architect. Contractors are made aware of their responsibility and their work is checked often.

7.5.4. Neutral Cost Target

Requirement:	*The incremental annual cost† of energy improvements, when financed as part of a 30 year mortgage, must be less than or equal to the annual reduction in utility bill costs relative to the BA benchmark house.*
Conclusion:	***Pass***

The Colleyville house achieves a positive cost target with respect to annual mortgage payments. This means that the annual energy savings is higher than the additional annual amortized mortgage cost.

Incremental cost data was generated directly from Greencraft Builders LLC. The Neutral Cost Analysis Worksheet below shows that the Colleyville house does qualify. The house is expected to save $1056 a year compared to the additional amortized mortgage payments. The mortgage is assumed to be a 30 year plan at a rate of 7%. This is an important selling point that Greencraft uses with prospective home buyers.

Table 7.5-1: Colleyville House Neutral Cost Analysis

	Annual Electric Energy (Site)		Annual Gas Energy (Site)		
	Benchmark	Prototype House	Benchmark	Prototype House	Annual Utility Bill Reduction vs Benchmark
End Use	**(kWh/yr)**	**(kWh/yr)**	**(therms/yr)**	**(therms/yr)**	**($/yr)**
Space Heating	16656	2411	0	0	$1,852
Space Cooling	24886	4782	0	0	$2,614
DHW	0	0	236	80	$195
Lighting	4717	1946	0	0	$360
Appliances and MELs	5695	5293	114	114	$52
Ventilation	111	177	0	0	($9)
Total Usage	**52065**	**14609**	**350**	**194**	**$5,064**
Site Generation	0	4090	0	0	$532
Net Energy Use	**52065**	**10519**	**350**	**194**	**$5,596**
Added Annual Mortgage Cost w/o Site Gen.					**$3,135**
Net Cash Flow to Consumer w/o Site Gen.					**$1,929**
Added Annual Mortgage Cost with Site Gen.					**$4,540**
Net Cash Flow to Consumer with Site Gen.					**$1,056**

The annual savings from energy improvements, compared to the cost of the energy efficiency upgrades to the home compared to the incremental annual cost of energy improvements, when financed as part of a 30-year mortgage, results in a positive annual

cash flow. The addition of the 3kW PV array reduced the positive cash flow but is still shown to be economically viable. The analysis took into account the fees required for third party testing as well as the benefits back to the builder relative to the federal tax credit.

The estimated annual utility savings were based on local utility rates provided by Greencraft Builders LLC (Natural Gas $1.25/therm; Electricity $0.13/kWh).

7.5.5. Quality Control Integration

Requirement:	*Health, Safety, Durability, Comfort, and Energy related QA, QC, training, and commissioning requirements should be integrated within construction documents, contracts and BA team scopes of work.*
Conclusion:	***Pass***

Greencraft Builders LLC provides integrated quality control throughout the construction of the house to ensure that building specifications are met. This is achieved through periodic tours of the house during different levels of construction to check various building specifications. Any element of the house that is not to specifications is immediately remedied.

Details are generated in both the architectural and engineering documents to clearly outline the expected quality assurance. Please refer to the appendix for documents.

7.5.6. Gaps Analysis

Requirement:	*Should include prototype house gaps analysis, lessons learned, and evaluation of major technical and market barriers to achieving the targeted performance level.*
Conclusion:	***Pass***

A gap that was noted during the construction of the Prosper house was the lack of any slab insulation. BSC and Greencraft attempted to include exterior slab insulation but the post tensioned slab design did not work. BSC suggested that the slab be a stem wall in order to avoid the post tensioning that was blocking the continuity of the slab insulation. This was unable to be achieved in the Colleyville house but Greencraft would like to readdress this design in future prototype homes.

BSC is also recommending that the exterior insulating sheathing be increased from ¾" XPS to 1" XPS. Greencraft is also considering upgrading to 1" of foil-faced polyisocyanurate sheathing as a way to further reduce thermal bridging losses.

7.6 Conclusions/Remarks

Greencraft Builders constructed a 50% Prototype house in 2009 that incorporates advanced building technologies that positively impact the durability and efficiency of the residence as well as ensuring higher levels of comfort and health in the living space. Greencraft Builders is dedicated to energy efficient construction and the practice of integrating quality building science in their homes.

The home as currently designed achieves a 70% source energy consumption reduction when compared to the 2009 Building America Benchmark (above the required 50% BA goal for prototype homes). A 3 kW photovoltaic array produces electricity and increases the total savings to 77%. The building is expected to save around $5064 a year compared to the Building America benchmark without renewables or $5596 with the 3kW photovoltaic installed.

Significant aspects of the design include the low density spray foam unvented roof and supplemental dehumidification. The low density spray foam installed in the unvented roof, as well as in the walls will result in a very tight building enclosure. Supplemental dehumidification will ensure occupant comfort all year round and will control humidity levels separately from the HVAC system. Other important design elements include LoE3 vinyl windows, CFL lights and Energy Star® appliances.

This house received a lot of attention and was toured by about 6000 local interested homeowners. Greencraft always schedules a significant open house periods to advertise their quality construction practices and to serve as an building science educational tour. This house was also the 2009 demonstration house at the Sunbelt Builders show.

Gaps and lessons learned were identified throughout the design and construction process.

BSC and Greencraft Builders LLC intend to continue working together on this and future projects. The goal is to keep pushing for greater energy savings. Greencraft pursued a Zero Energy house (the Lewisville house, also a 2009 Prototype) after the Colleyville house and remains a stellar example of a quality custom home builder.

7.7 Appendices

7.7.1. BSC Project Case Study – Greencraft Colleyville House

7.7.2. Drawings and Specifications

7.7.3. Energy Modeling

7.7.4. Manual J Calculations

7.7.5. Field Testing

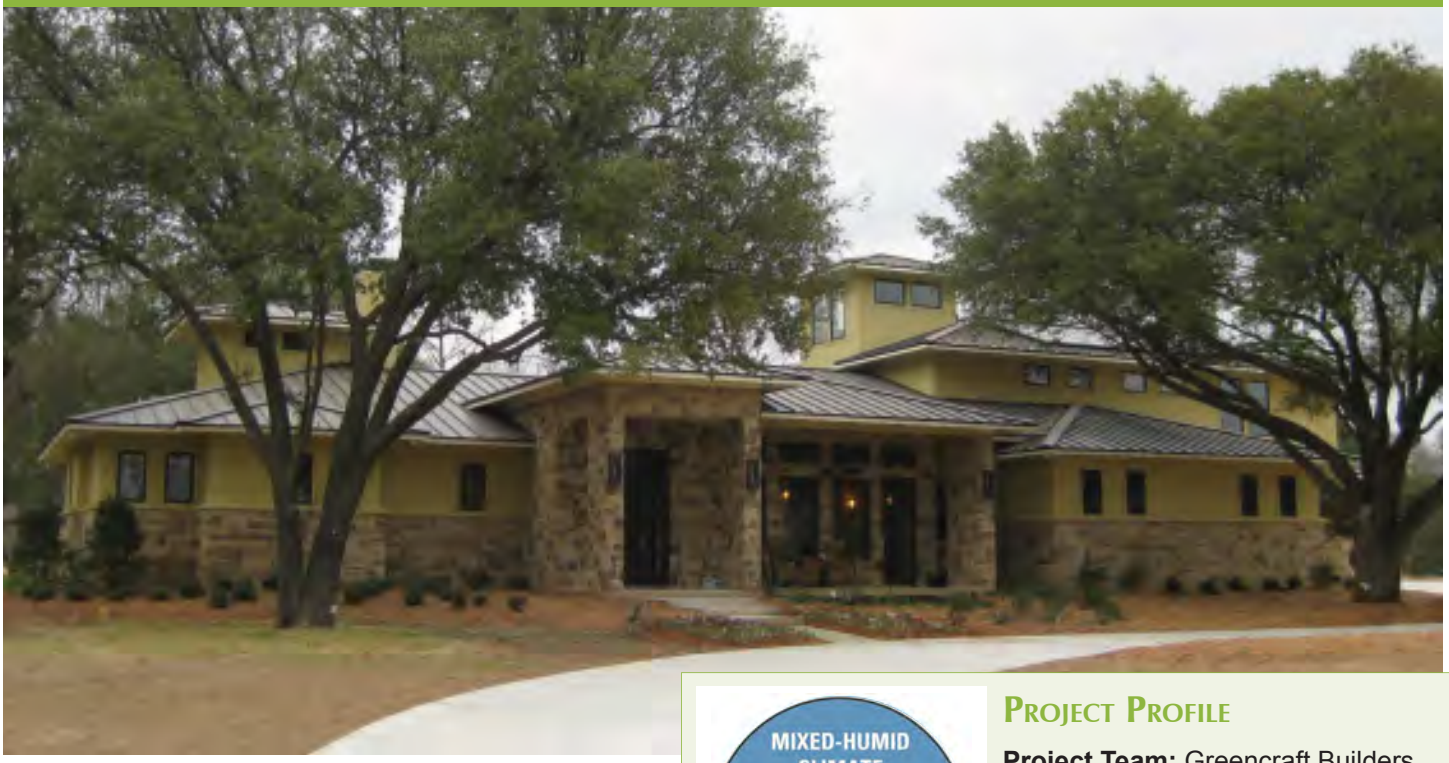
7.7.6. Builder’s Challenge Certificate

Appendix D.7.7.1
BSC Project Case Study—Greencraft Colleyville House

Case Study

Colleyville Eco House Prototype

Colleyville, Texas



Overview

BSC collaborated with Greencraft Builders, LLC in Colleyville, TX on a 2009 prototype house called the Colleyville House. This house demonstrates the energy efficiency and durability upgrades that Greencraft currently promotes in all of their products. The Colleyville house is located in Colleyville, TX, about 25 miles North West of Dallas. The house was designed by William Peck and Associates, an award winning architect specializing in sustainable energy efficient architecture.

BSC has been collaborating with Greencraft homes since 2005 and have forged a valuable working relationship. BSC provided consulting services for Greencraft and recommended numerous efficiency and durability improvements. One of the main features that separate this home from previous projects is the inclusion of a high efficiency ground source heat pump. Other key upgrades include an unvented roof with low density spray foam insulation and supplemental dehumidification. Also included are LoE^3 next generation spectrally selective glazing treatment

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Project Profile

Project Team: Greencraft Builders, LLC, Building Science Corporation

Address: 1708 Oak Knoll Drive, Colleyville, Texas

Description:
4,886 ft^2 two-story single family home

Completion Date:
March, 2009

Estimated Annual Energy Savings:
Average 70.5% projected source energy savings relative to the 2008 Building America Benchmark

Project Website:
http://colleyvilleecohouse.com/

Building Science Corporation
30 Forest Street
Somerville, MA 02143
www.buildingscience.com

Builder Profile

GreenCraft BUILDERS L.L.C.

GreenCraft Builders L.L.C. is the culmination of more than 30 years of experience building and remodeling homes in the Dallas/ Fort Worth metroplex. Since 2004, Chris Miles, principal of GreenCraft, has been recognized as a leader in the North Texas green building industry, first as a producer and project manager, and now as a builder with his company, GreenCraft Builders L.L.C.

Participating Programs & Certifications

U.S. Department of Energy's Building America Program

U.S. Green Building Council LEED® for Homes- Gold

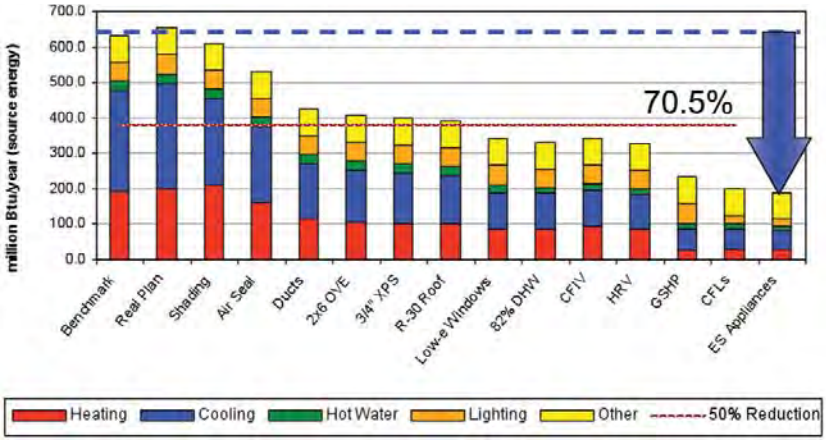
U.S. Environmental Protection Agency ENERGY STAR® Program

NAHB National Green Building Program™- Gold

GreenBuilt™ North Texas

Sole show house at the Sunbelt Builders Show

Parametric Study



and very low enclosure infiltration. A full CFL lighting package plus Energy Star® appliances help to achieve a HERS Index of 36.

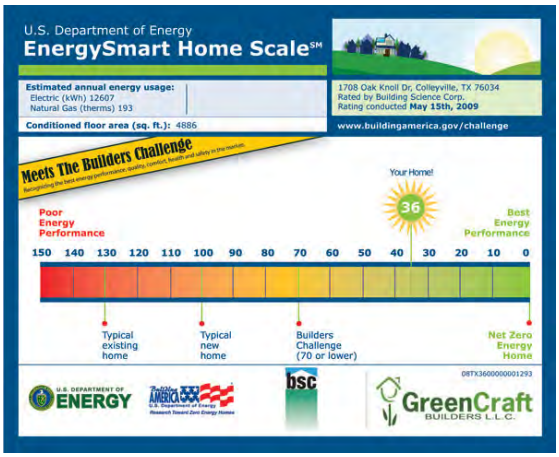
Construction

Greencraft constructs with full Advanced Framing in their walls, roof, and frame floor. This includes 2x6 studs at 24" o.c. plus two stud energy corners and single top plates. Greencraft employs stack framing so that wall and floor framing members are aligned to transfer loads efficiently through the structure.

The wall cavity is fully insulated with low density open cell spray foam to an R-20. The roof is an unvented cathedralized roof with R-30 low density open cell spray foam installed to the underside of the roof sheathing.

The Colleyville house was able to procure high quality fiberglass framed windows with state of the art LoE^3 spectrally selective glazing coating. This resulted in an NFRC full unit SHGC rating of 0.34 with a U-value of 0.29. This glazing coating, coupled with extensive overhangs in the floor plan, results in a greatly reduced cooling peak load and annual cooling energy use.

A high efficiency ground source heat pump (18.8 EER/4.1 COP) is installed along with a integrated supplemental dehumidification. All the equipment and ductwork is located in the unvented cathedralized attic to save living space. Jump ducts provide passive returns from the bedrooms. High efficiency exhaust ducts are installed at all the bathrooms and at the kitchen hood.



Enclosure Design

❶ **Roof Assembly:** Unvented roof with R-30 open cell spray foam and fully adhered waterproof membrane

❷ **Wall Assembly:** Fully advanced framed structure; R-24 wall with R-20 open cell spray foam and $^{3}/_{4}$" XPS sheathing

❸ **Window Specifications:** Vinyl framed double glazed windows: U=0.34, SHGC=0.29.

❹ **Air Sealing:** The design infiltration rate is 2.5 in^2 leakage area per 100 ft^2 of enclosure area. Low density open cell spray foam installed in wall and roof cavities. Low expanding open cell spray foam installed around windows and mechanical and electrical penetrations throughout the enclosure.

Foundation Assembly: Slab-on-grade foundation; ❺ uninsulated with Termimesh® termite mitigation system and sill seal ❻.

Mechanical Design

Heating and Cooling: 4.1 COP/18.8 EER ground source heat pump (see ❶ for piping).

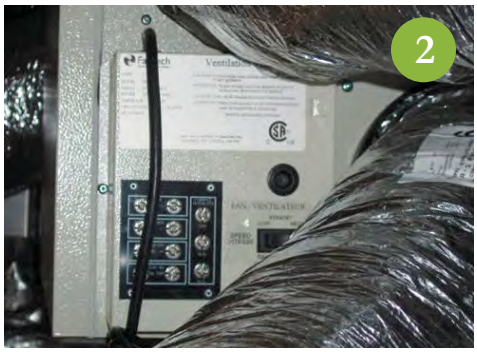
Ventilation: Fantech energy recovery ventilator (ERV) ❷.

Supplemental Dehumidification: GeneralAire whole-house dehumidifier integrated with HVAC system ❸.

DHW: 0.82 EF instantaneous water heater with an add-on storage tank for hot water from ground source heat pump.

Lighting: ENERGY STAR® CFLs

Appliances: ENERGY STAR® dishwasher, refrigerator and clothes washer.



Ventilation

Greencraft Builders, LLC utilizes Central Fan Integrated Supply ventilation that draws outside air via a 6" flex duct to the return plenum of the HVAC system. This allows for the introduction of outside air to the living space whenever space conditioning is already operating. The GeneralAire whole house dehumidifier draws air from the main living space and supplies dehumidified air to the supply plenum of the HVAC system. An Aprilaire® Ventilation Control System 8126 communicates with the air handler to employ fan cycling. Fan cycling will turn on the fan at a 33% duty cycle (10 minutes on, 20 minutes off) in order to provide outside air during periods of no space conditioning. A 6" mechanical damper is installed on the 6" outside air duct. This is controlled by the fan cycler and will close off the outside air duct during periods of consistent space conditioning to prevent over ventilation of the living space.

Bathroom exhaust fans plus a kitchen hood are installed to provide spot ventilation when necessary. These are all routed to the outside and are not recirculating fans. One of the bathroom fans is rated to provide ASHRAE 62.2 ventilation so that the house can be operated at that rate if needed.

Quality Control

- Design follows BSC Building America criteria
- Manual J8 analysis ensures right sized mechanical systems and ductwork

Moving Forward

The open house period of the Colleyville house has ended and now Greencraft is ready to start design on the Net Zero Energy Lewisville Eco House. One of the major design upgrades for this house will be the installation of a heat pump with integrated supplemental dehumidification. AAON Inc. has designed a residential heat pump that integrates modulating gas reheat to allow for dehumidification separate from cooling. This technology has been implemented successfully in commercial buildings for years and now will provide supplemental dehumidification in residential buildings.

Design and Construction Challenges

The construction of the Colleyville house presented a number of challenges to the builder. First, there was a new framing crew on the site and they had significant difficulty constructing a fully advanced framed structure. Greencraft had to hire another framing contractor halfway through construction to remedy errors and finish the job to meet specifications.

Second, the homeowners requested a dark metal roof for aesthetic purposes. Greencraft had to work to find an Energy Star® rated dark metal roofing material in a short period of time.

Third, the homeowners also requested a higher roof pitch to match the 10:12 roofs in the neighborhood. A 10:12 roof pitch greatly reduces the overhang potential for shading purposes so Greencraft compromised by increasing the roof pitch from the original 4:12 to 6:12. A 6:12 pitch still allowed for the specified overhangs to be constructed.

Fourth, a considerable amount of select fill had to be obtained to prepare the ground surface properly. This was due to the fact that the previous home on this site had a pier and beam foundation. The existing foundation was fully removed and that left large cavities that needed to be filled. Then, the resulting ground had to be compacted 95% to meet the structural demands and this had to be tested and verified in the field.

This case study has been prepared by Building Science Corporation for the Department of Energy's Building America Program, a private/public partnership that develops energy solutions for new and existing homes. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

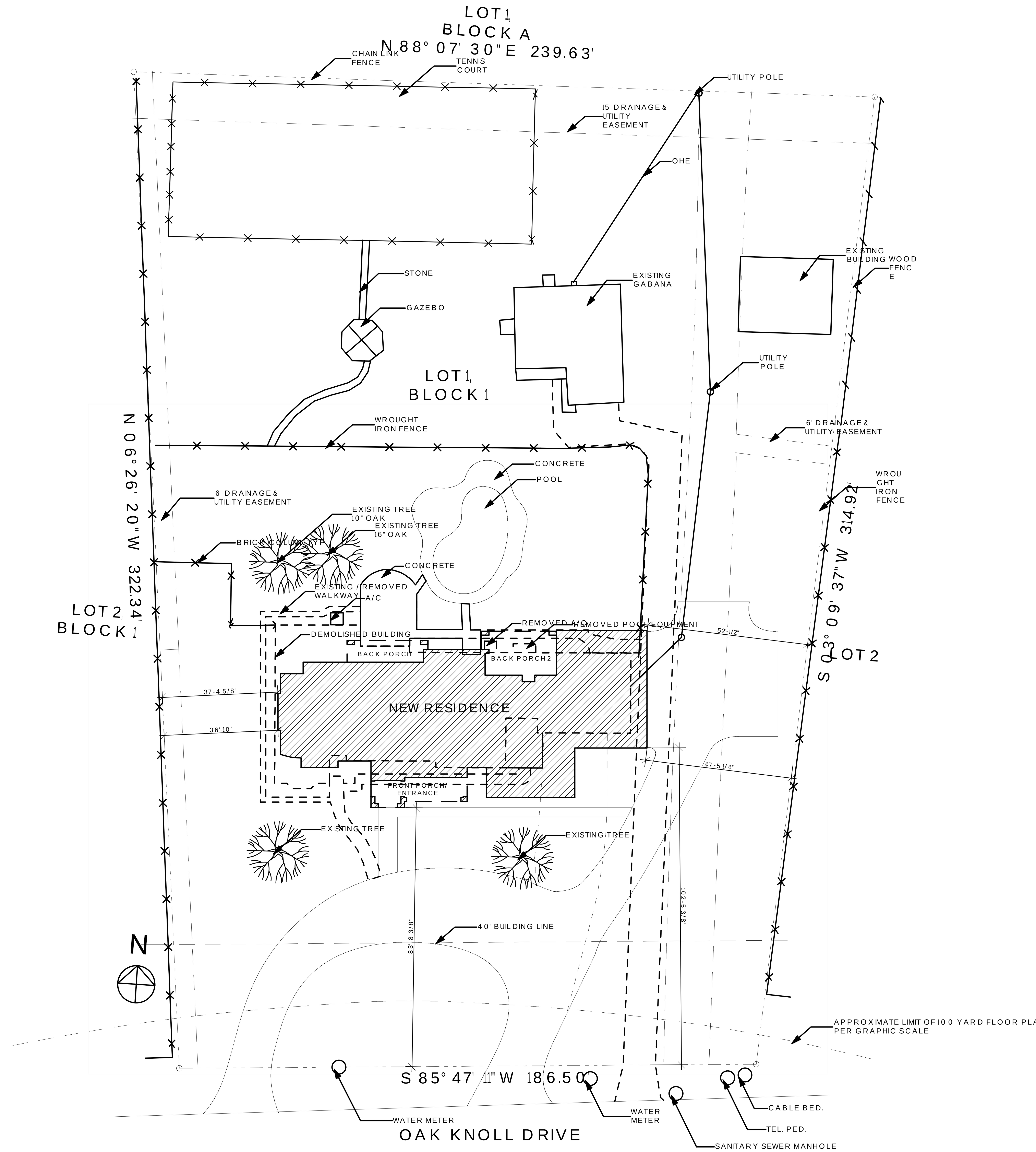
For more information about Building America go to www.buildingamerica.gov.

Building America U.S. Department of Energy Research Toward Zero Energy Homes

Building Science Corporation
30 Forest Street
Somerville, MA 02143
www.buildingscience.com

For more information about this or other case studies by Building Science Corporation and the Building America Program go to: www.buildingscienceconsulting.com/buildingamerica.

Appendix D.7.7.2
Drawings and Specifications



1 **SITE PLAN** 1" = 20'

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERMIN REVIEW UNDER THE AUTHORITY OF WILLIAM PECK & ASSOCIATES, ON THIS PLOT DATE AMD IS NOT TO BE USED BY AUTHORITIES HAVING JURSDICTION FOR THE PURPOSE OF ISSUING CONSTRUCTION PERMITS

These plans are intended to provide the basic construction information necessary to substantially complete this structure. These construction documents must be verified and checked by the builder or person in authority of this project. Any discrepancy, error, and/ or omissions, if any, are to be brought to the attention of the Designer prior to any construction or purchases being made. It is recommended that the owner or builder obtain complete engineering services for: foundation, HVAC, and structural, prior to construction of any kind. NOTE: All Federal, state, and Local codes, ordinances, and restrictions take precedence over any part of these construction documents which may conflict with same, and must be strictly obeyed and followed before and during construction.

ARNETT HOUSE

1708 OAK KNOLL DRIVE,
COLLEYVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

SITE PLAN

REVISIONS

DATE

Date: 05-23-08

Scale:

Drawn:

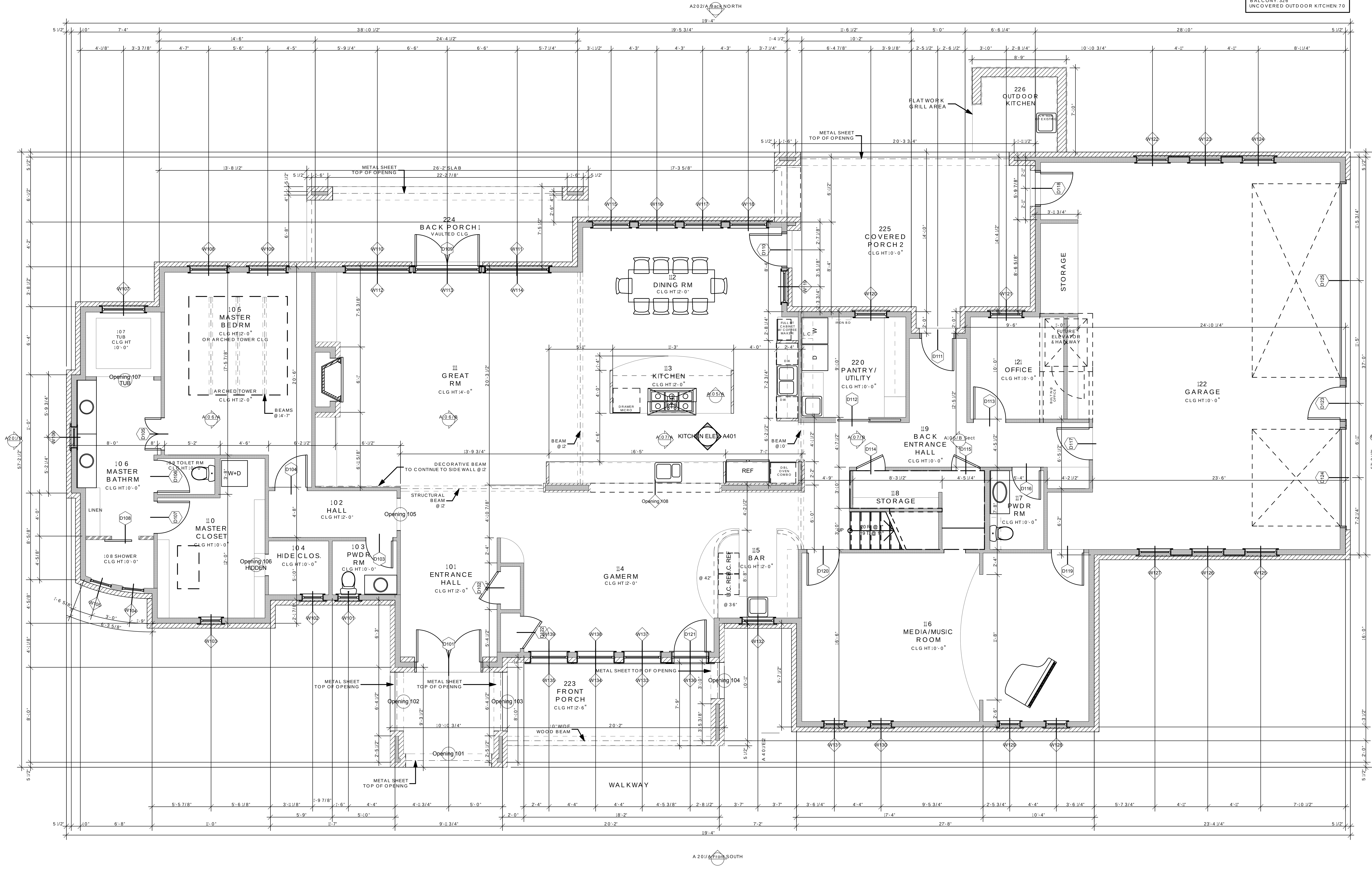
Job:

Sheet Number:

A-001

SHEET 1 OF 27

AREA SQUARE FOOTAGES:
1ST FLOOR: 3,452
2ND FLOOR: 1,336
3RD FLOOR: 97
TOTAL A/C: 4,885
GARAGE: 1,040
FRONT PORCH+ENTRANCE: 253
BACK PORCH 1: 177
COVERED PORCH 2: 342
BALCONY: 326
UNCOVERED OUTDOOR KITCHEN: 70



A FLOOR PLAN 1ST FLOOR 1/4" = 1'-0"

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WILLIAM PECK & ASSOCIATES INC. ARCHITECTS
Lewisville, Tx
(972) 221-1424

1st FLOOR PLAN

REVISIONS	
DATE	
Date:	05-23-08
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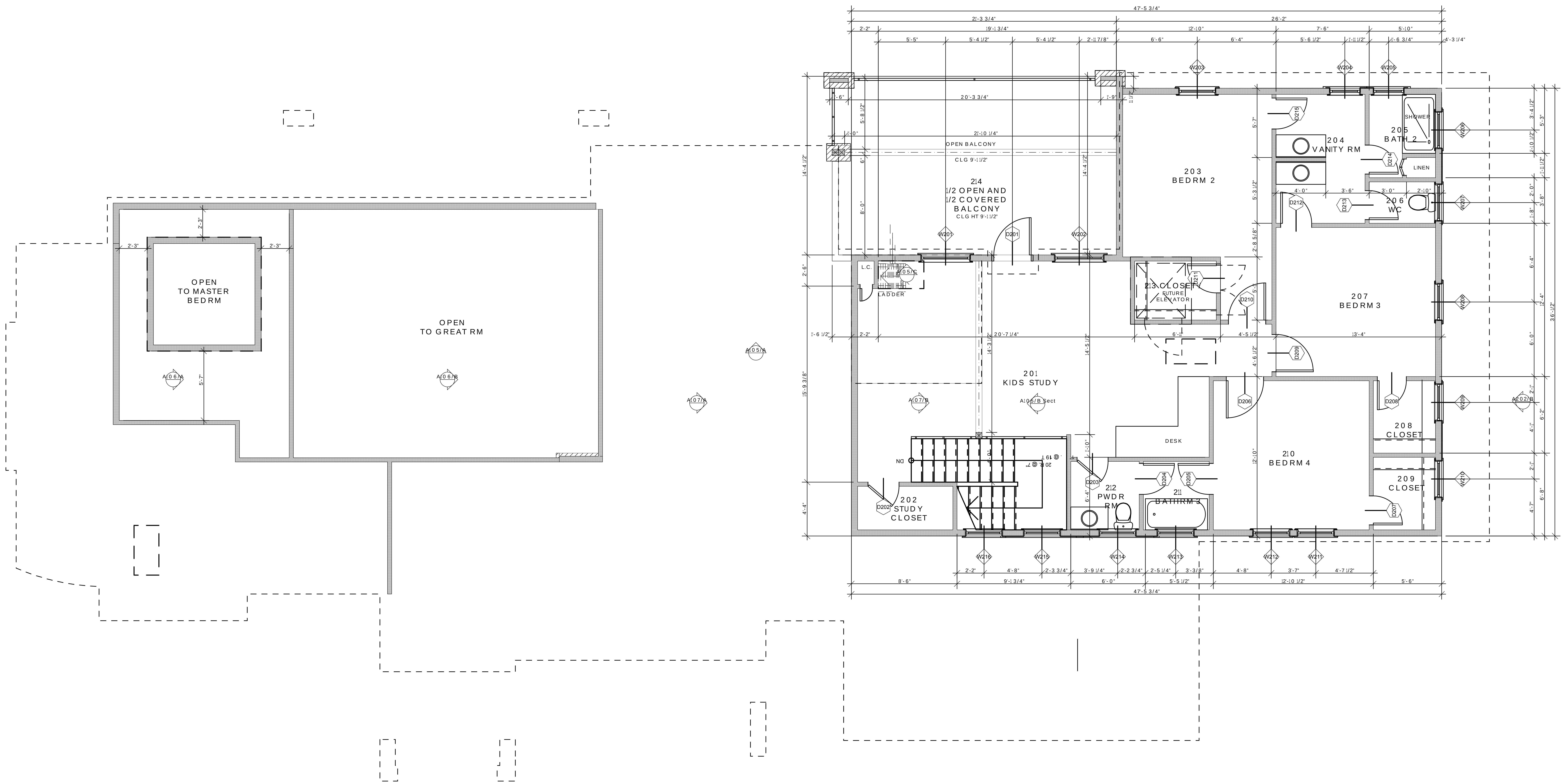
Job:	
Sheet Number:	A-101
SHEET 2	OF 27



A **FLOOR PLAN 2ND FLOOR** **1/4" = 1'-0"**

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COLLEYVILLE, TEXAS.

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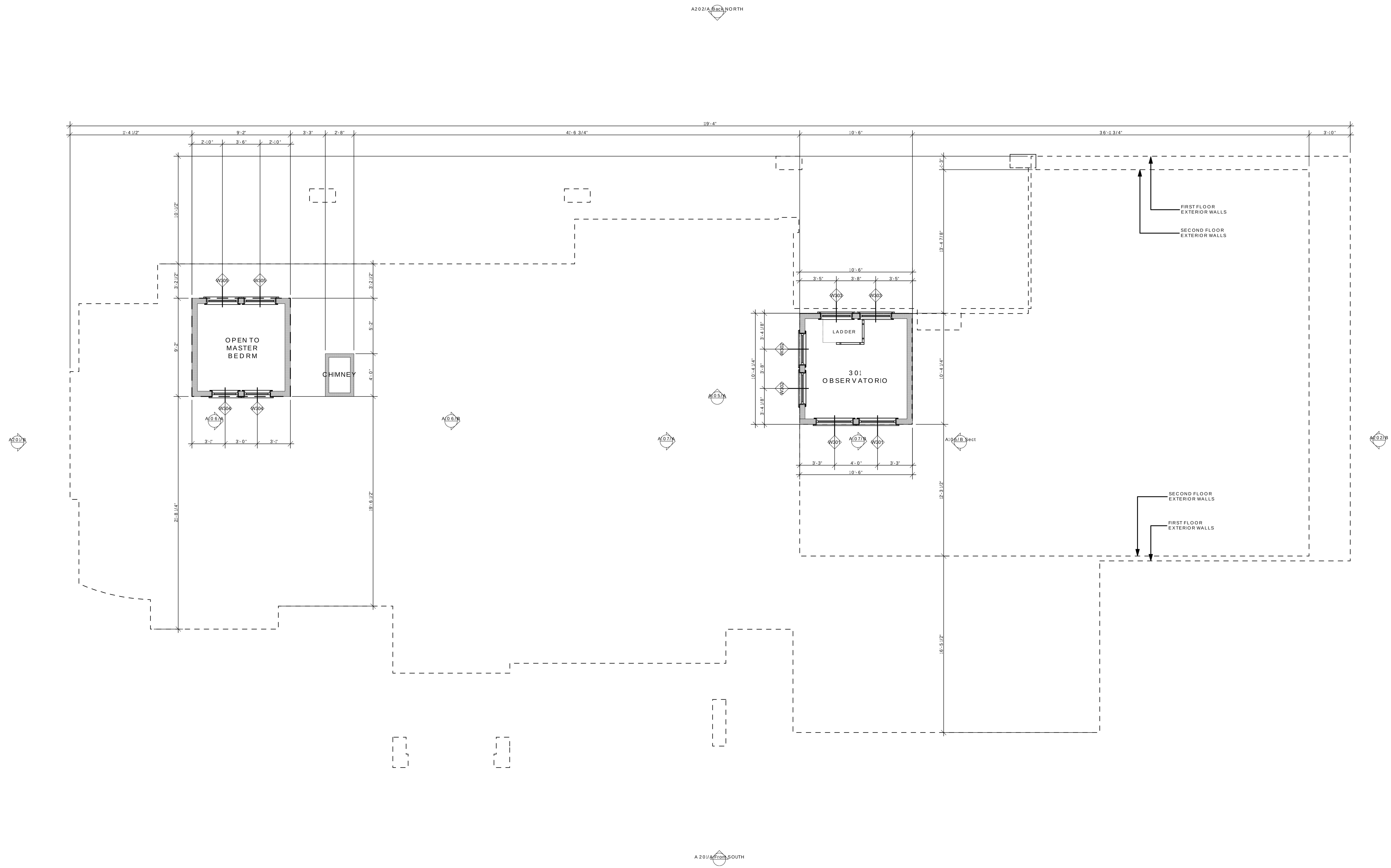
ARCHITECTS
Lewisville, Tx (972) 221-1424

2nd FLOOR PLAN

REVISIONS
DATE

Date: 05-23-08
Scale:
Drawn:
Job:
Sheet Number:
A-102
SHEET 3 OF 27



A

FLOOR PLAN ROOF

1/4" = 1'-0"

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Lewisville, Tx
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ROOF

REVISIONS	
DATE	
Date:	05-23-08
Scale:	
Drawn:	
Job:	
Sheet Number:	A-103
SHEET 4	OF 27

ROOM FINISH SCHEDULE

NO.	ROOM NAME	FLOOR						BASE				WALLS						CEILING					CROWN			CLG. HT.	REMARKS
		1	2	3	4	5	6	1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	1	2	3		
		CERAMIC TILE	HARDWOOD	VINYL LAMINATE	CARPET	STONE	CONCRETE	CERAMIC TILE BAS	WOOD / PAINTED	WOOD / STAINED		TEXTURE & PAINT	TILE	BULLNOSE CORNE				PAINTED GYPSUM	DECORATIVE BEA				4" STAINED	4" PAINTED			
101	ENTRANCE HALL																									12'	
102	HALL 1																									12'	
103	POWDER RM																									10'	
104	HIDE CLOSET																									10'	
105	MASTER BEDRM																									12' / TOWER	
106	MASTER BATHRM																									10'	
107	TUB																									10'	
108	WALK IN SHOWER																									10'	
109	MASTER TOILET RM																									10'	
110	MASTER CLOSET																									10'	
111	GREAT RM																									14'	
112	DINING RM																									12'	
113	KITCHEN																									12'	
114	GAMERM																									12'	
115	BAR																									12'	
116	MEDIA / MUSIC RM																									10'	
117	POWDER RM 2																									10'	
118	STORAGE																									UNDER STAIRS	
119	BACK ENTRANCE HALL																									10'	
120	PANTRY/ UTILITY RM																									10'	
121	OFFICE																									10'	
122	GARAGE																									10'	
123	FRONT PORCH																									10'	
124	BACK PORCH																									VAULTED	
125	COVERED PORCH 2																									10'	
201	KID'S STUDY																									9'	
202	STUDY CLOSET																									9'	
203	BEDRM 2																									9'	
204	VANITY RM																									9'	
205	BATHRM 2																									9'	
206	WC																									9'	
207	BEDRM 3																									9'	
208	CLOSET																									9'	
209	CLOSET																									9'	
210	BEDRM 4																									9'	
211	BATHRM 3																									9'	
212	PWDR RM																									9'	
213	CLOSET / FUT. ELEVATOR																									9'	
214	BALCONY																										

C **ROOM FINISH SCHEDULE**

DOOR AND FRAME SCHEDULE

DOOR								FRAME				FIRE RATING	HARDWARE		NOTES
MARK	SIZE		TYPE	EL	GLZ	LOUVER		MATL	EL	GLZ	HEAD		SET NO	KEYS. RM NO	
	W	HT				W	HT								
D101	6'-0"	8'-0"	GLASS		DBL										DOUBLE DOOR UNIT W/TRANSOM 1'-5"
D102	3'-0"	8'-0"	HOLLOW												COAT CLOSET
D103	2'-6"	8'-0"	SOLID												POWDER ROOM
D104	3'-0"	8'-0"	SOLID												MASTER BEDRM
D105	3'-0"	8'-0"	SOLID												BATHRM DBL DOOR
D106	3'-0"	8'-0"	SOLID												TOILETRM
D107	3'-0"	8'-0"	HOLLOW												MASTER CLOSET
D108	2'-6"	8'-0"	GLASS		SGL										SHOWER SLIDING D
D109	6'-0"	8'-0"	GLASS		DBL										FAMILY RM DBL DOOR
D110	3'-0"	8'-0"	GLASS		DBL										PORCH D W/TRANSOM 1'-5"
D111	3'-0"	8'-0"	GLASS		DBL										BACK HALL DOOR
D112	3'-0"	8'-0"	SOLID												PANTRY/UTILITY POCKET D
D113	3'-0"	8'-0"	SOLID												OFFICE DOOR
D114	2'-8"	8'-0"	HOLLOW												PANTRY D
D115	2'-8"	4'-6"	HOLLOW												UNDER STAIRS CLOSET
D116	2'-8"	8'-0"	SOLID												BATHRM DOOR
D117	3'-0"	8'-0"	SOLID												HALLWAY GARAGE INT DOOR
D118	3'-0"	8'-0"	SOLID												PORCH D TO GARAGE
D119	3'-0"	8'-0"	SOLID												MEDIA RM INT DOOR
D120	3'-0"	8'-0"	SOLID												MEDIA RM INT DOOR
D121	3'-0"	8'-0"	GLASS		DBL										FRONT PORCH GLASS DOOR
D122	3'-0"	8'-0"	HOLLOW												CLOSET DOOR
D123	3'-0"	6'-8"	SOLID												GARAGE D W/TRANSOM
D124	9'-0"	8'-0"	METAL												O.H. GARAGE D
D125	18'-0"	8'-0"	METAL												O.H. GARAGE D
D201	3'-0"	8'-0"	GLASS		DBL										BALCONY DOOR
D202	2'-6"	6'-8"	HOLLOW												CLOSET DOOR
D203	2'-6"	6'-8"	SOLID												BATHRM DOOR
D204	2'-6"	6'-8"	SOLID												BATHRM DOOR
D205	2'-6"	6'-8"	SOLID												BATHRM DOOR
D206	3'-0"	6'-8"	SOLID												BEDRM DOOR
D207	2'-4"	6'-8"	HOLLOW												CLOSET DOOR
D208	2'-4"	6'-8"	HOLLOW												CLOSET DOOR
D209	3'-0"	6'-8"	SOLID												BEDRM DOOR
D210	3'-0"	6'-8"	SOLID												BEDRM DOOR
D211	2'-4"	6'-8"	HOLLOW												CLOSET DOOR
D212	2'-6"	6'-8"	SOLID												BATHRM DOOR
D213	2'-4"	6'-8"	SOLID												TOILET RM DOOR
D214	2'-4"	6'-8"	SOLID												SHOWER RM DOOR
D215	2'-6"	6'-8"	SOLID												BATHRM DOOR
Opening 101	8'-0"	10'-8"	---	---	---	---	---	---	---	---	---	---	---	---	---
Opening 102	5'-5 1/2"	10'-0"	---	---	---	---	---	---	---	---	---	---	---	---	---
Opening 103	5'-5 1/2"	10'-0"	---	---	---	---	---	---	---	---	---	---	---	---	---
Opening 104	3'-4 1/2"	8'-6"	---	---	---	---	---	---	---	---	---	---	---	---	---
Opening 105	3'-0"	8'-0"	---	---	---	---	---	---	---	---	---	---	---	---	---
Opening 106	2'-0"	6'-8"	---	---	---	---	---	---	---	---	---	---	---	---	---
Opening 107	5'-4"	8'-0"	---	---	---	---	---	---	---	---	---	---	---	---	---

B **DOOR SCHEDULE**

WINDOW SCHEDULE

MARK	Quantity	Library Part Name	SIZE		HEADER HT	MATERIAL	GENERAL NOTES:
			WIDTH	HEIGHT			
Opening 108	1	W Rectangular Open...	12'-0"	6'-0"	10'-0"	Wood 08-Pine	---
W101	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W102	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W103	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W104	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W105	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W106	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W107	1	W Fixed	4'-0"	4'-6"	8'-6"	ALU CLAD. WOOD WINDOW	MASTER TUB
W108	1	W1 Casement	3'-6"	6'-9"	9'-3"	ALU CLAD. WOOD WINDOW	MASTER BEDRM WINDOW
W109	1	W1 Casement	3'-6"	6'-9"	9'-3"	ALU CLAD. WOOD WINDOW	MASTER BEDRM WINDOW
W110	1	W Fixed	6'-0"	6'-6"	8'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W111	1	W Fixed	6'-0"	6'-6"	8'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W112	1	W Fixed	6'-0"	3'-0"	12'-0"	ALU CLAD. WOOD WINDOW	GREAT RM
W113	1	W Fixed	6'-0"	3'-0"	12'-0"	ALU CLAD. WOOD WINDOW	GREAT RM
W114	1	W Fixed	6'-0"	3'-0"	12'-0"	ALU CLAD. WOOD WINDOW	GREAT RM
W115	1	W Fixed	3'-6"	6'-6"	9'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W116	1	W Fixed	3'-6"	6'-6"	9'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W117	1	W Fixed	3'-6"	6'-6"	9'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W118	1	W Fixed	3'-6"	6'-6"	9'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W119	1	W1 Casement	3'-0"	6'-0"	9'-4"	ALU CLAD. WOOD WINDOW	DINING RM
W120	1	W1 Casement	3'-0"	5'-0"	8'-4"	ALU CLAD. WOOD WINDOW	PANTRY/UTILITY
W121	1	W1 Casement	3'-0"	5'-0"	8'-4"	ALU CLAD. WOOD WINDOW	PANTRY/UTILITY
W122	1	W Awning 1	3'-0"	2'-0"	8'-5"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W123	1	W Awning 1	3'-0"	2'-0"	8'-5"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W124	1	W Awning 1	3'-0"	2'-0"	8'-5"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W125	1	W Awning 1	3'-0"	2'-0"	8'-5"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W126	1	W Awning 1	3'-0"	2'-0"	8'-5"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W127	1	W Awning 1	3'-0"	2'-0"	8'-5"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W128	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W129	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W130	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W131	1	W1 Casement	2'-0"	3'-6"	8'-8"	ALU CLAD. WOOD WINDOW	POWDER RM W/O MULLION
W132	1	W1 Casement	3'-0"	5'-0"	8'-6"	ALU CLAD. WOOD WINDOW	HIDDEN CLOSET W/O MULLION
W133	1	W Fixed	3'-6"	6'-6"	8'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W134	1	W Fixed	3'-6"	6'-6"	8'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W135	1	W Fixed	3'-6"	6'-6"	8'-0"	ALU CLAD. WOOD WINDOW	DINING RM
W136	1	W Fixed	3'-6"	1'-6"	10'-6"	ALU CLAD. WOOD WINDOW	DINING RM
W137	1	W Fixed	3'-6"	1'-6"	10'-6"	ALU CLAD. WOOD WINDOW	DINING RM
W138	1	W Fixed	3'-6"	1'-6"	10'-6"	ALU CLAD. WOOD WINDOW	DINING RM
W139	1	W Fixed	3'-6"	1'-6"	10'-6"	ALU CLAD. WOOD WINDOW	DINING RM
W201	1	W1 Casement	4'-0"	6'-0"	8'-0"	ALU CLAD. WOOD WINDOW	STUDY RM
W202	1	W1 Casement	4'-0"	6'-0"	8'-0"	ALU CLAD. WOOD WINDOW	STUDY RM
W203	1	W1 Casement	3'-0"	5'-6"	7'-8"	ALU CLAD. WOOD WINDOW	BEDRM W
W204	1	W Awning 1	2'-6"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W205	1	W Awning 1	2'-6"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W206	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W207	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W208	1	W1 Casement	3'-0"	5'-6"	7'-8"	ALU CLAD. WOOD WINDOW	BEDRM W
W209	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W210	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W211	1	W1 Casement	3'-0"	5'-6"	7'-8"	ALU CLAD. WOOD WINDOW	BEDRM W
W212	1	W1 Casement	3'-0"	5'-6"	7'-8"	ALU CLAD. WOOD WINDOW	BEDRM W
W213	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W214	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W215	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W216	1	W Awning 1	3'-0"	2'-0"	7'-8"	ALU CLAD. WOOD WINDOW	W/ 1 VERTICAL MULLION
W301	2	W1 Casement	3'-6"	2'-6"	6'-6"	ALU CLAD. WOOD WINDOW	OBSERVATORIO
W302	2	W1 Casement	3'-0"	5'-6"	6'-6"	ALU CLAD. WOOD WINDOW	BEDRM W
W303	2	W1 Casement	3'-0"	3'-6"	6'-8"	ALU CLAD. WOOD WINDOW	OBSERVATORIO
W304	2	W Fixed	2'-6"	1'-6"	7'-10"	ALU CLAD. WOOD WINDOW	BEDRM TOWER, HEADER TO 1ST FLOOR 19'-10"
W305	2	W1 Casement	3'-0"	3'-0"	7'-8"	ALU CLAD. WOOD WINDOW	REMOTE CONTROL, HEADER HT 19'-8" TO 1ST FLOOR

A **WINDOW SCHEDULE**

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ARNETT HOUSE

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Lewisville, Tx
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SCHEDULES

REVISIONS

DATE

Date: 05-23-08

Scale:

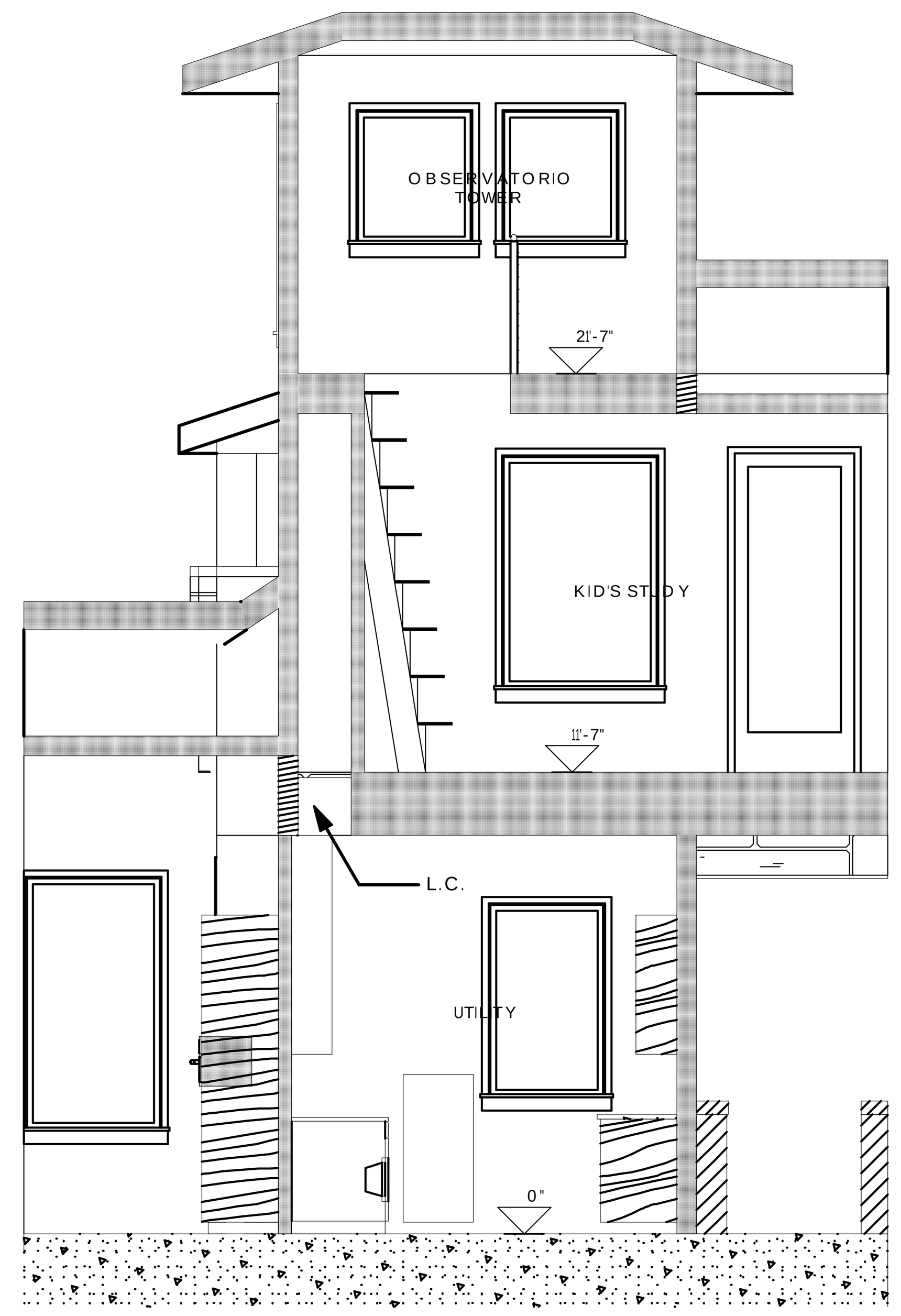
Drawn:

Job:

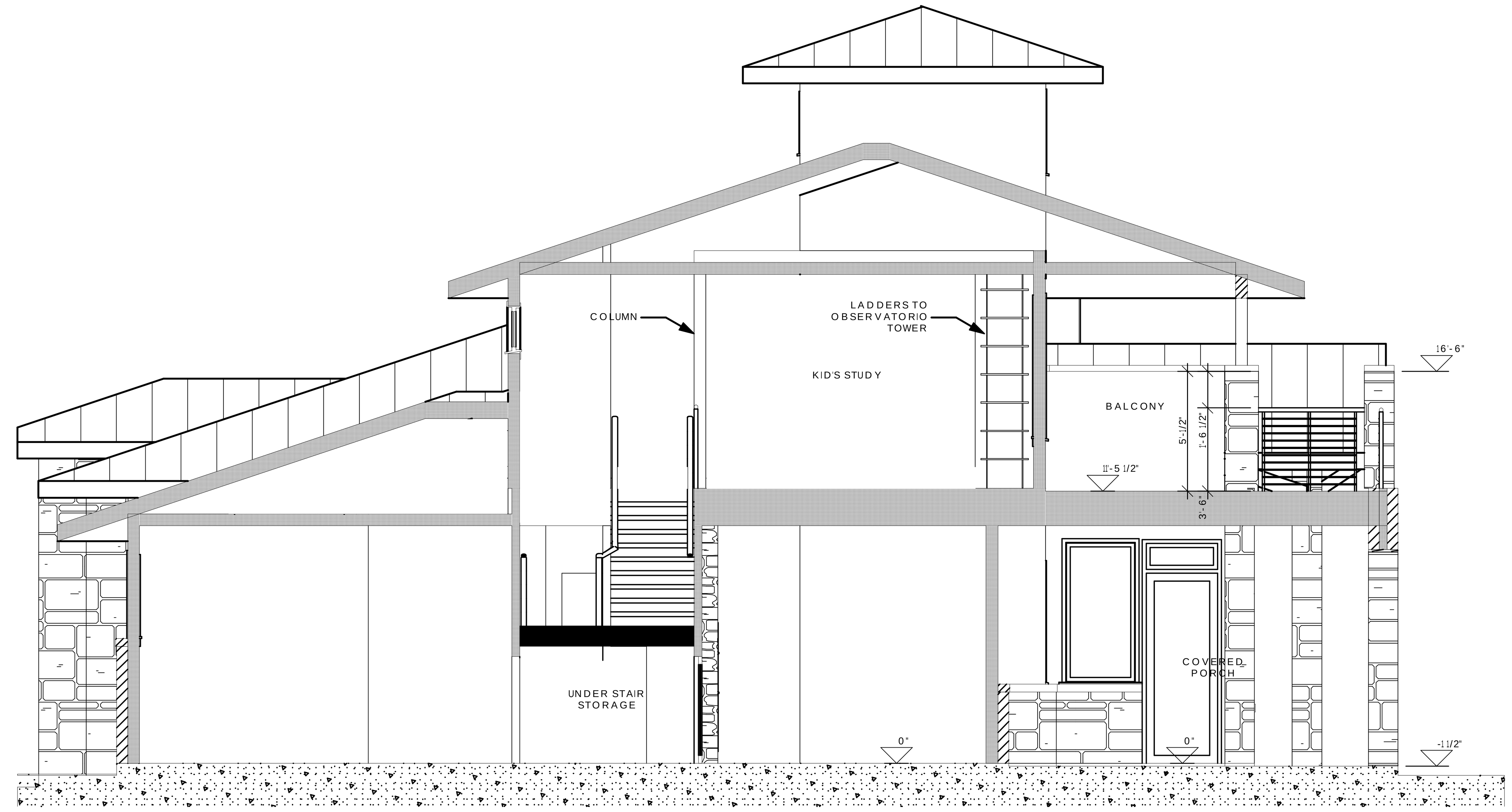
Sheet Number:

A-104

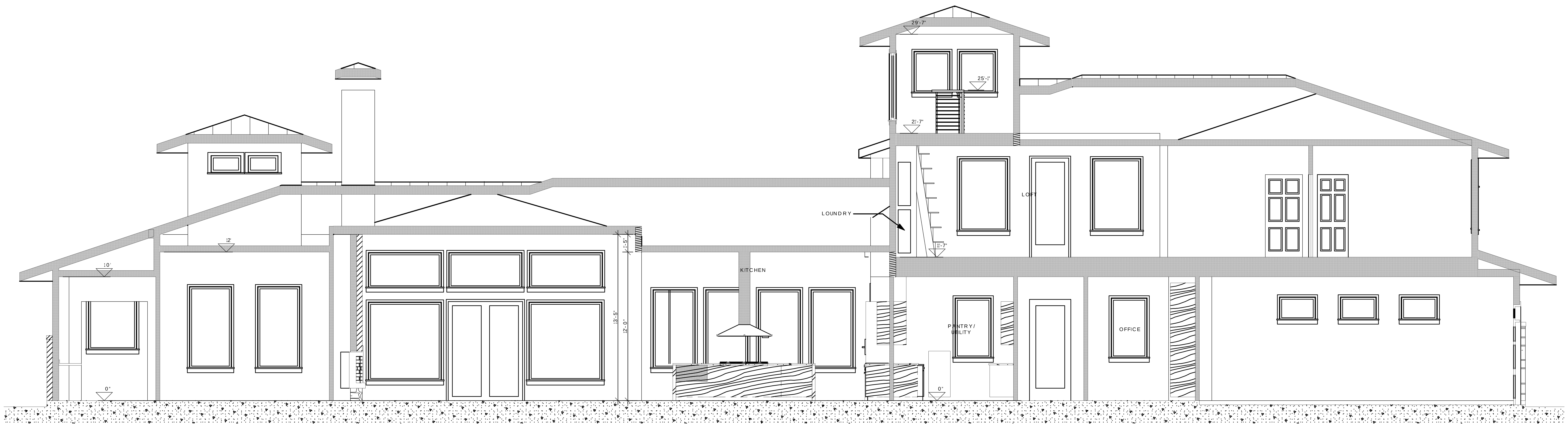
SHEET 5 OF 27



C A105/C 1/4" = 1'-0"



B A105/B 1/4" = 1'-0"



A A105/A 1/4" = 1'-0"

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SECTIONS

REVISIONS
DATE

Date: 05-23-08
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Drawn:
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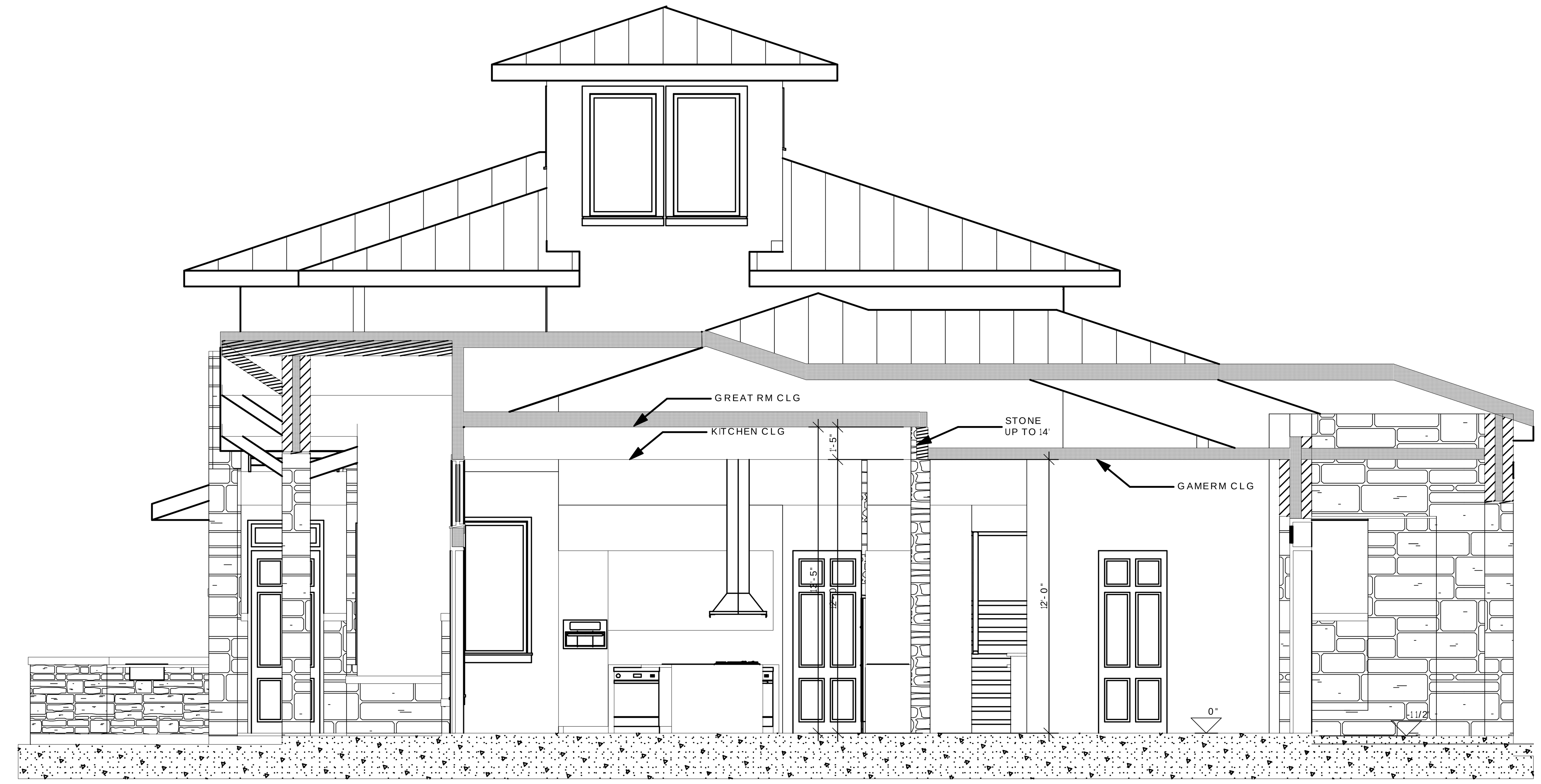
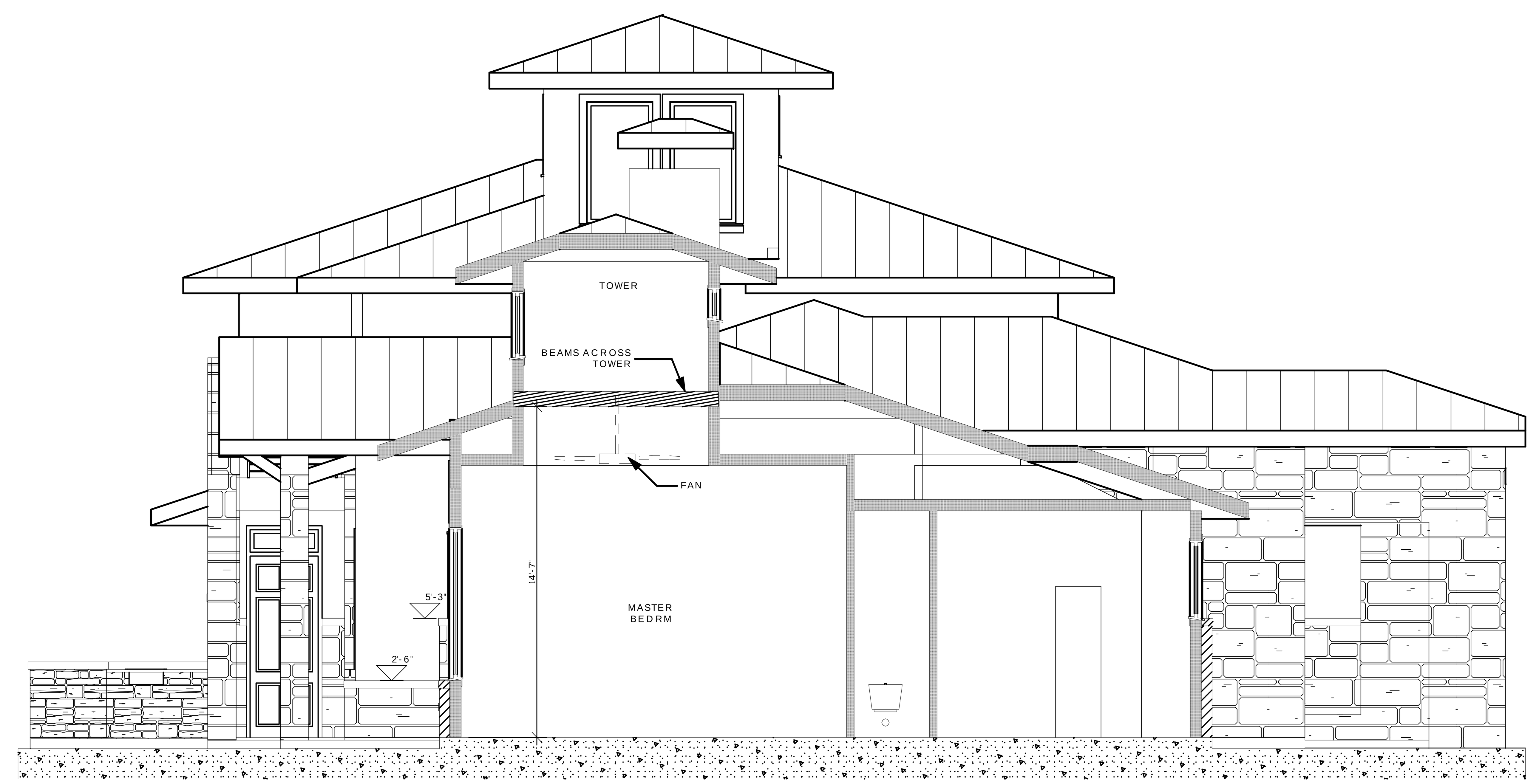
A-105

SHEET 6 OF 27



B — A106/B — 1/4" = 1'-0"



A — A106/A — 1/4" = 1'-0"

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SECTIONS

REVISIONS
DATE

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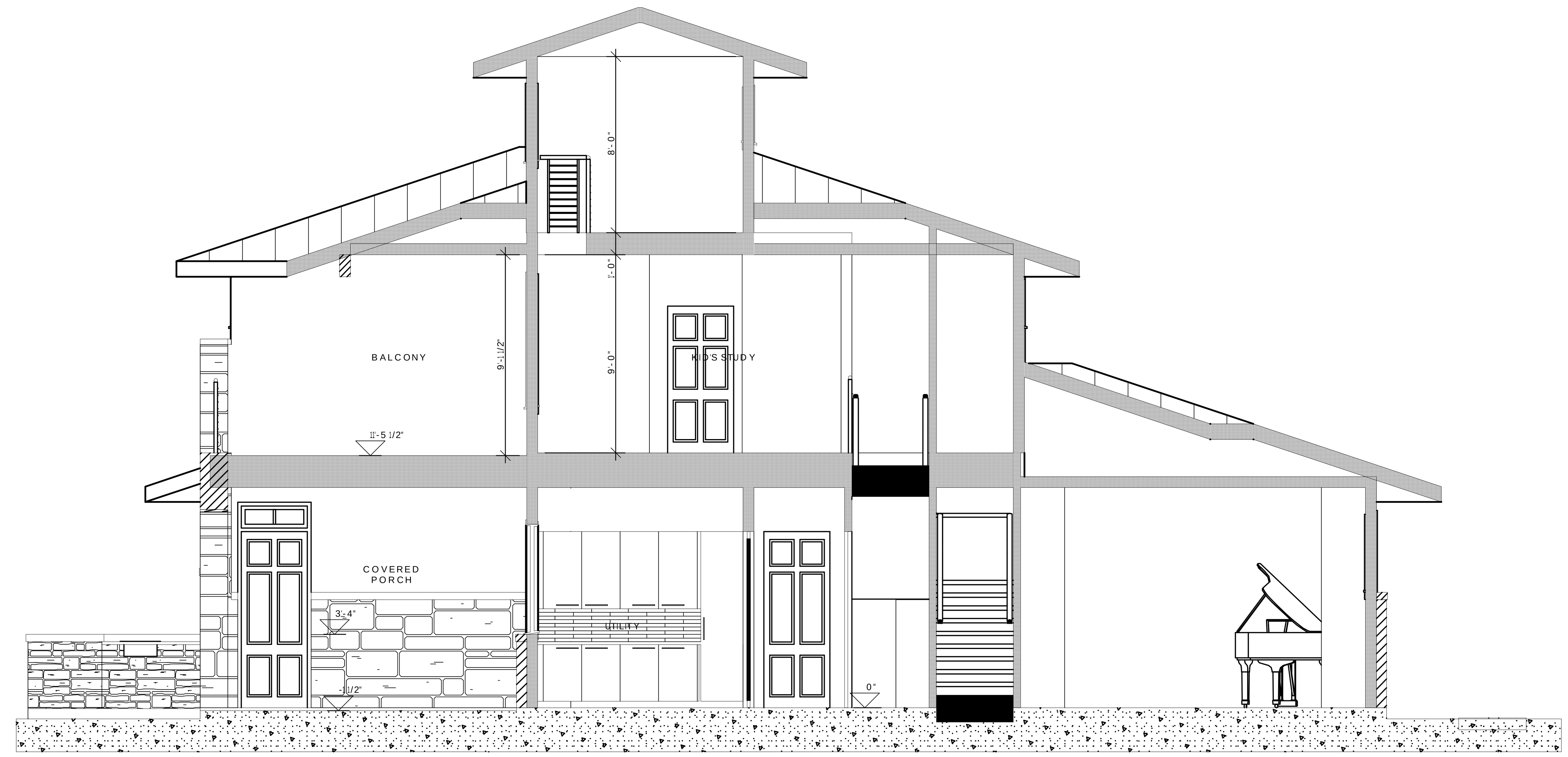
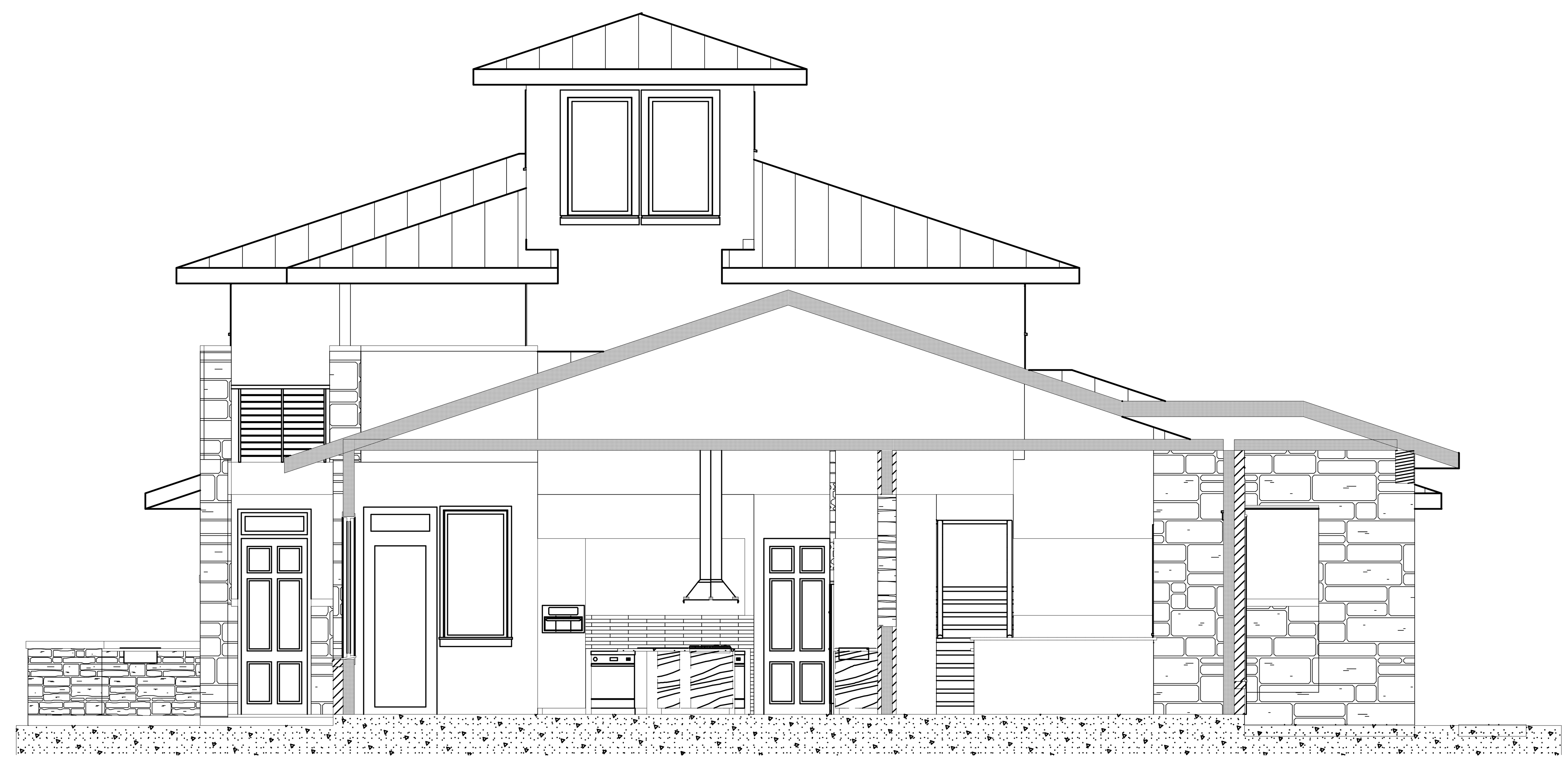


B A107/B 1/4" = 1'-0"



A A107/A 1/4" = 1'-0"

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERMIN REVIEW UNDER THE AUTHORITY OF WILLIAM PECK & ASSOCIATES, ON THIS PLOT DATE AMD IS NOT TO BE USED BY AUTHORITIES HAVING JURSDICTION FOR THE PURPOSE OF ISSUING CONSTRUCTION PERMITS

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SECTIONS

REVISIONS
DATE

Date: 05-23-08
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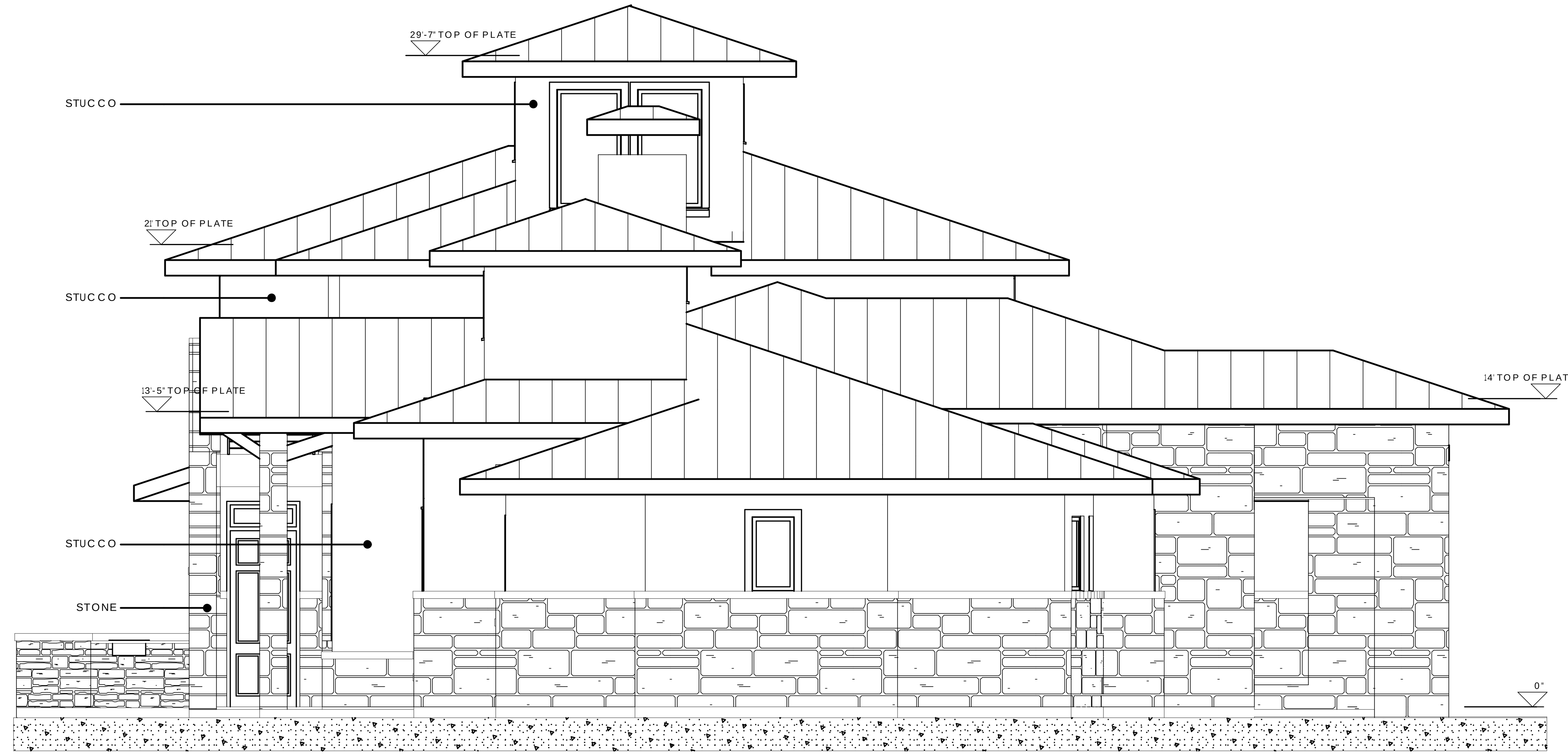

2 A 201/B Left 1/4" = 1'-0"

1 A 201/A Front 1/4" = 1'-0"

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Lewisville, Tx

FRONT& LEFT ELEVATIONS

REVISIONS	
DATE	

Date: 05-23-08
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Drawn:
Job:
Sheet Number:
A-201
SHEET 9 OF 27

2 A 202/B Right 1/4" = 1'-0"

1 A 202/A Back 1/4" = 1'-0"

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NORTH & EAST ELEVATIONS

REVISIONS

DATE

Date: 05-23-08

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Drawn:

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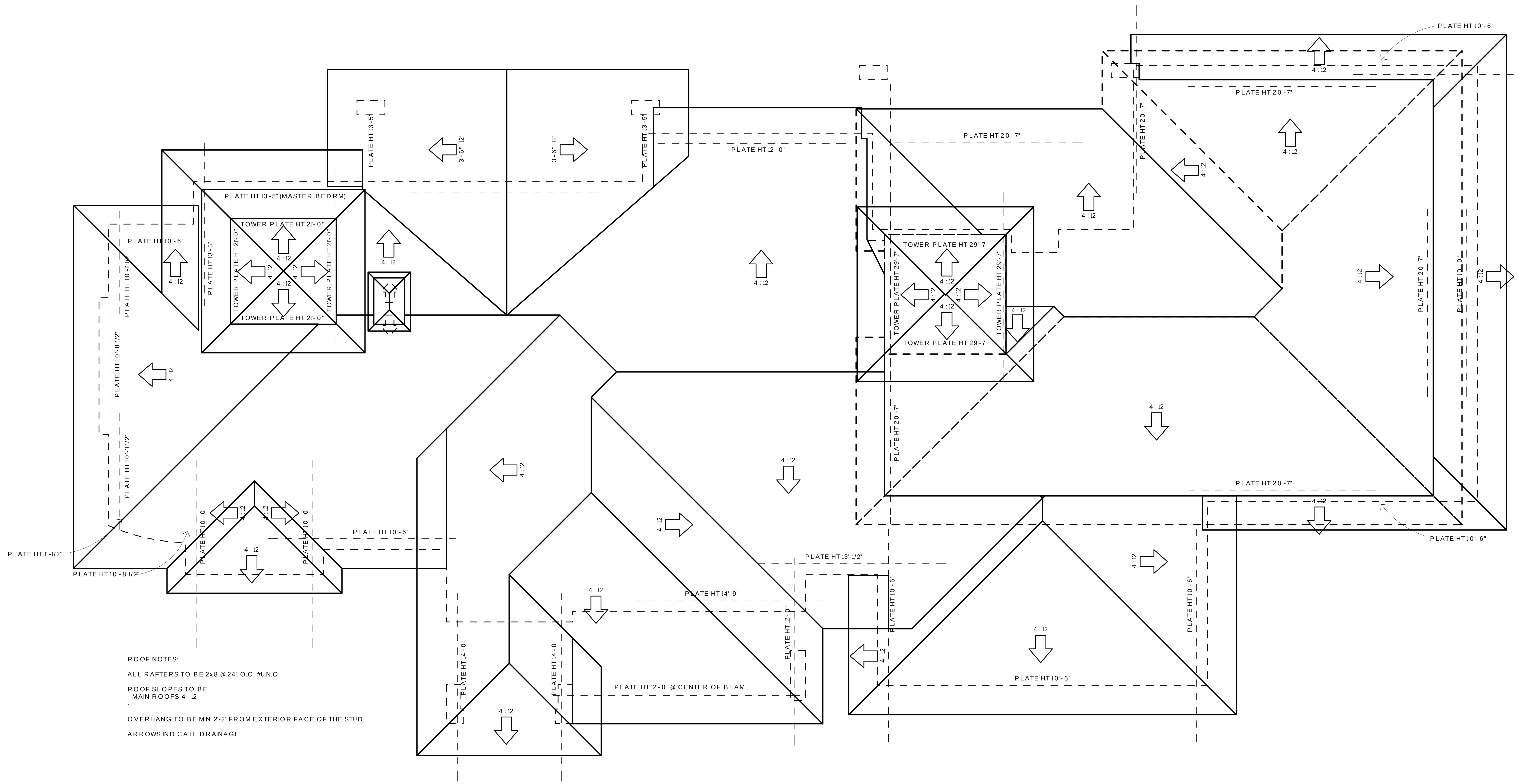

ROOF NOTES:

ALL RAFTERS TO BE 2x8 @ 24" O.C., #U.N.O.

ROOF SLOPES TO BE:
- MAIN ROOFS 4' : 12'
-

OVERHANG TO BE MIN. 2'-2" FROM EXTERIOR FACE OF THE STUD.

ARROWS INDICATE DRAINAGE.

1 ROOF PLAN 3/16" = 1'-0"

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ROOF PLAN

REVISIONS	
DATE	
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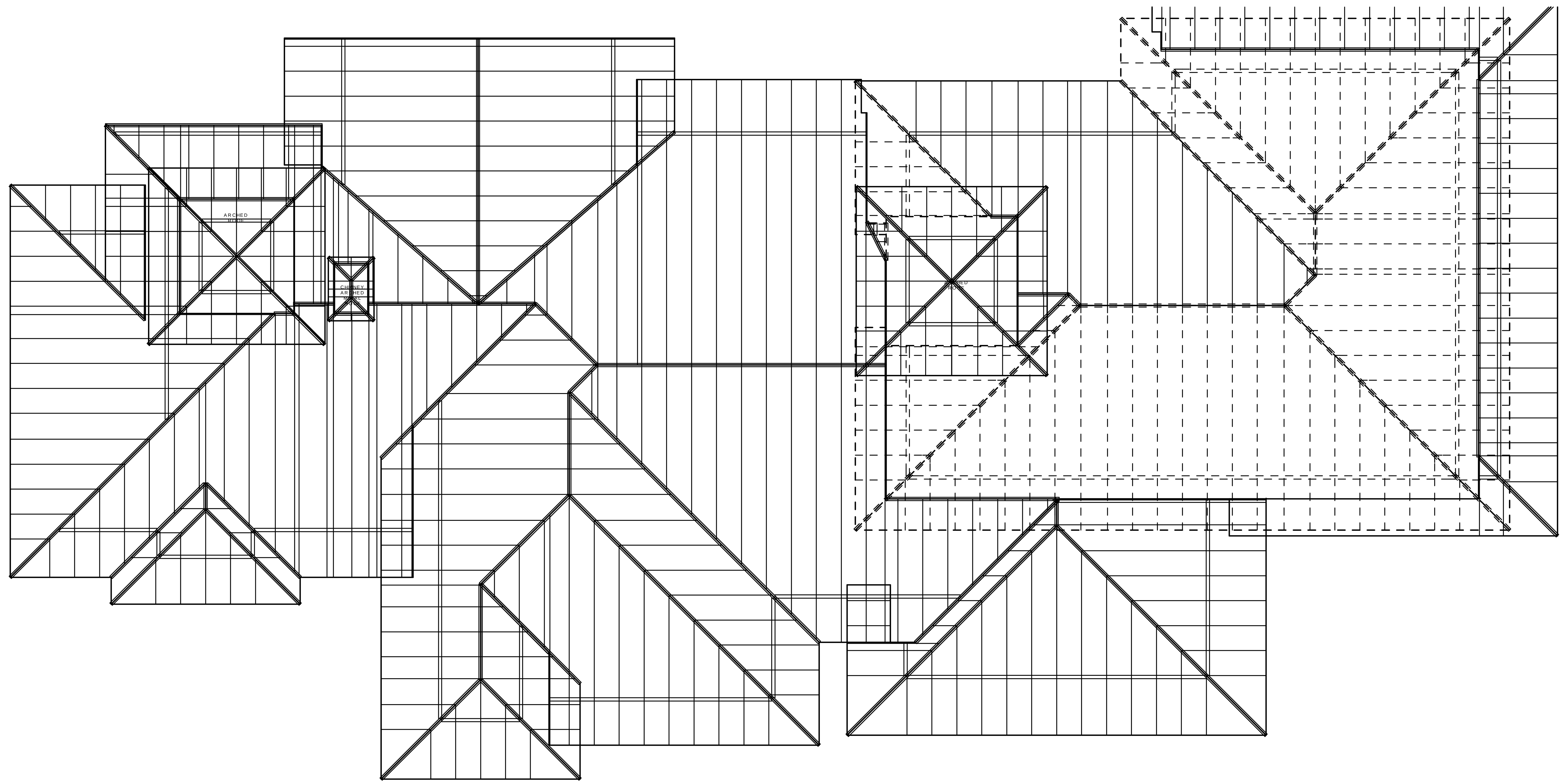
SHEET 11	OF 27



1 **Roof Framing** 3/16" = 1'-0"

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REVISIONS
DATE

Roof Framing

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Drawn:
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Sheet Number:
A-302
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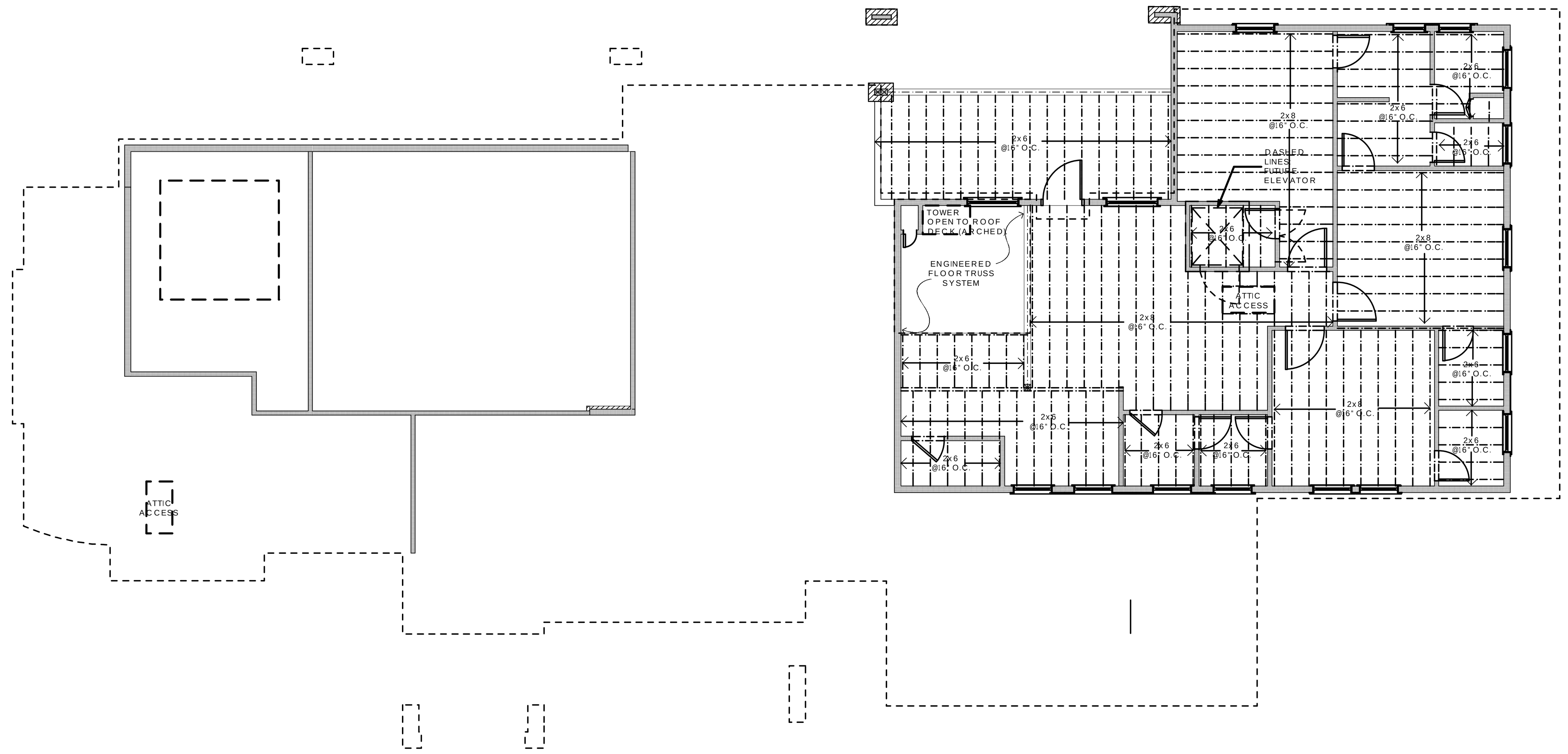
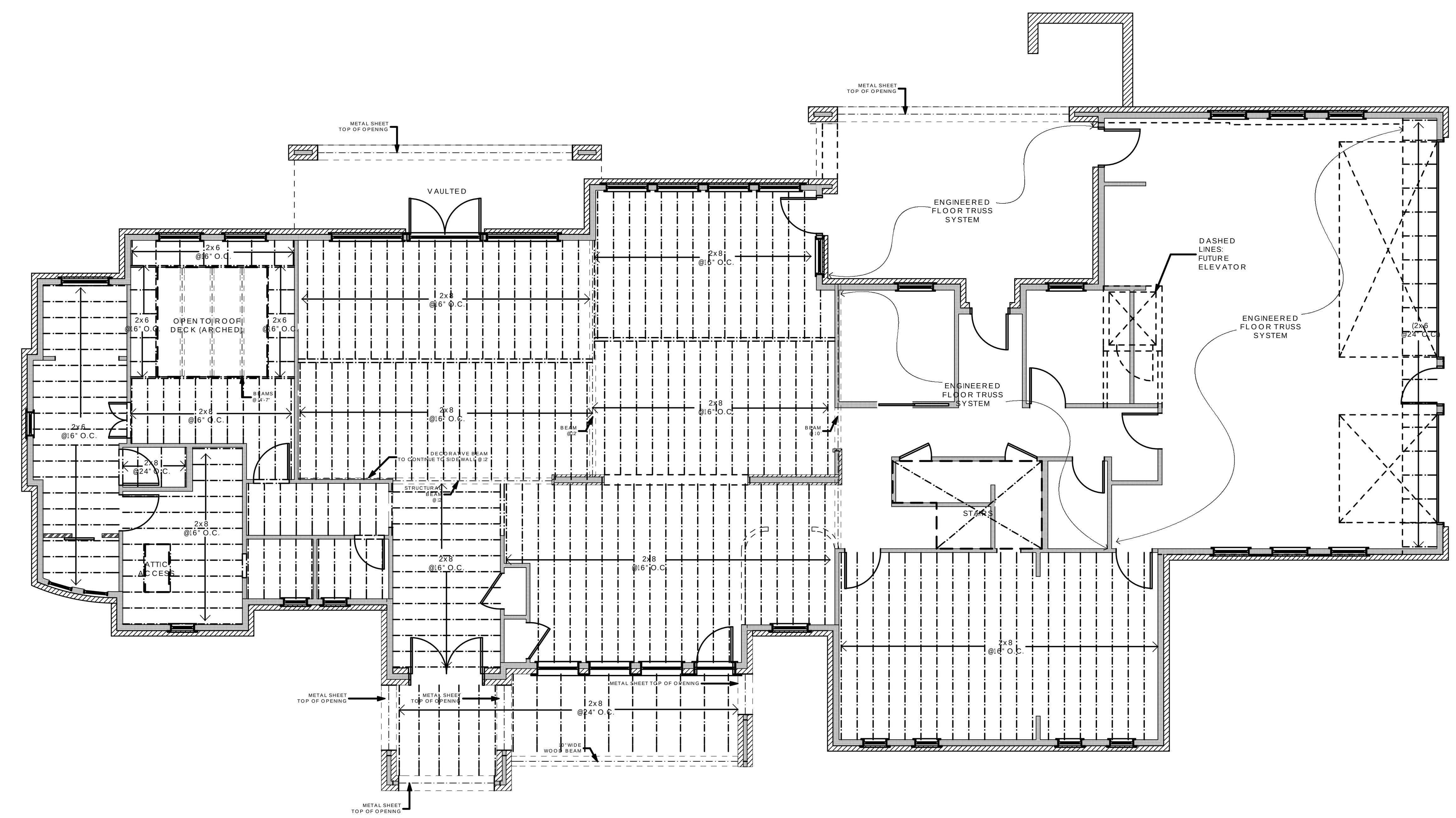


2 **Ceiling Joists 2nd Floor** 1/8" = 1'-0"



1 **Ceiling Joists 1st Floor** 1/8" = 1'-0"

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CEILING JOISTS

REVISIONS
DATE

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A-303
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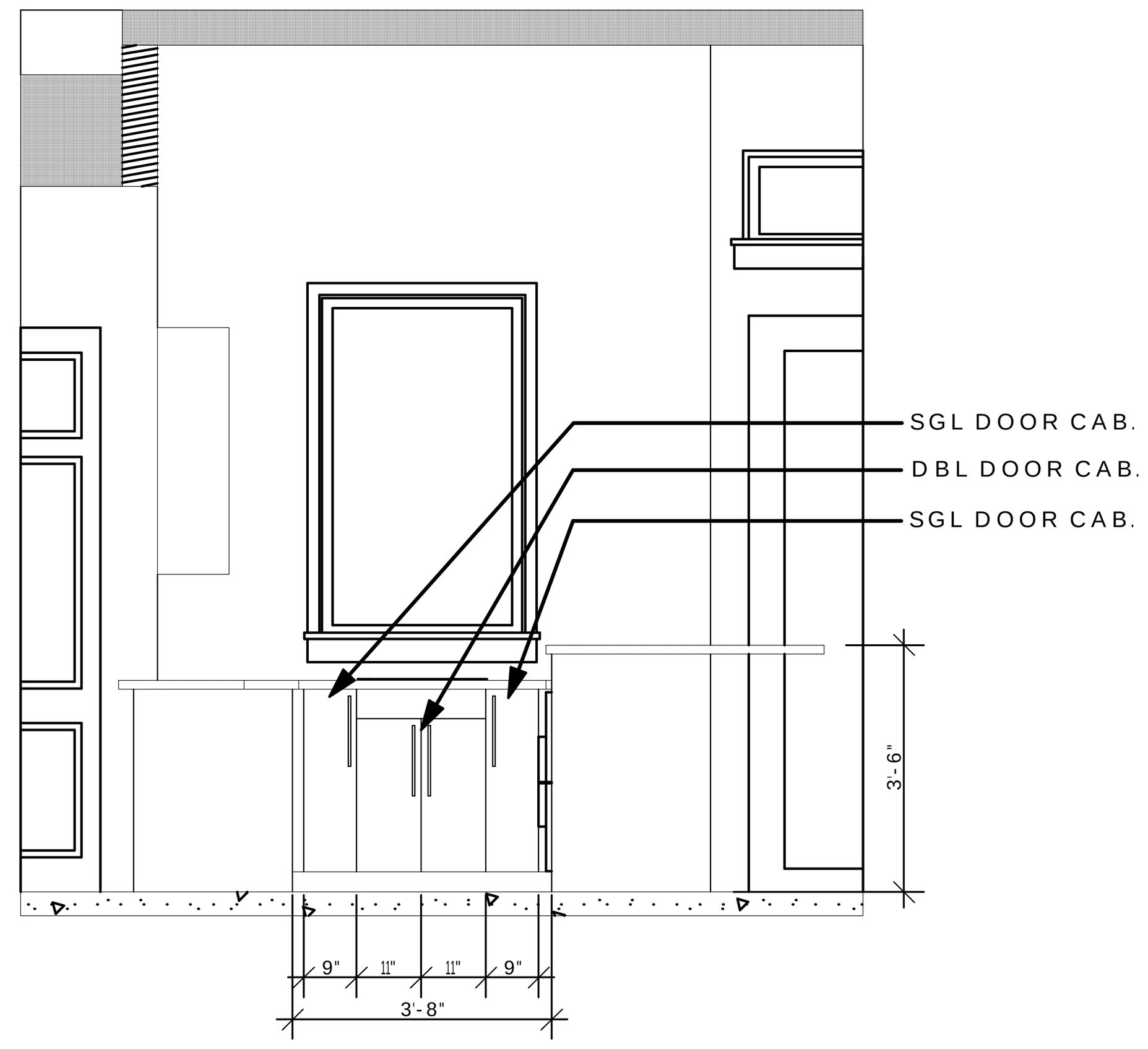
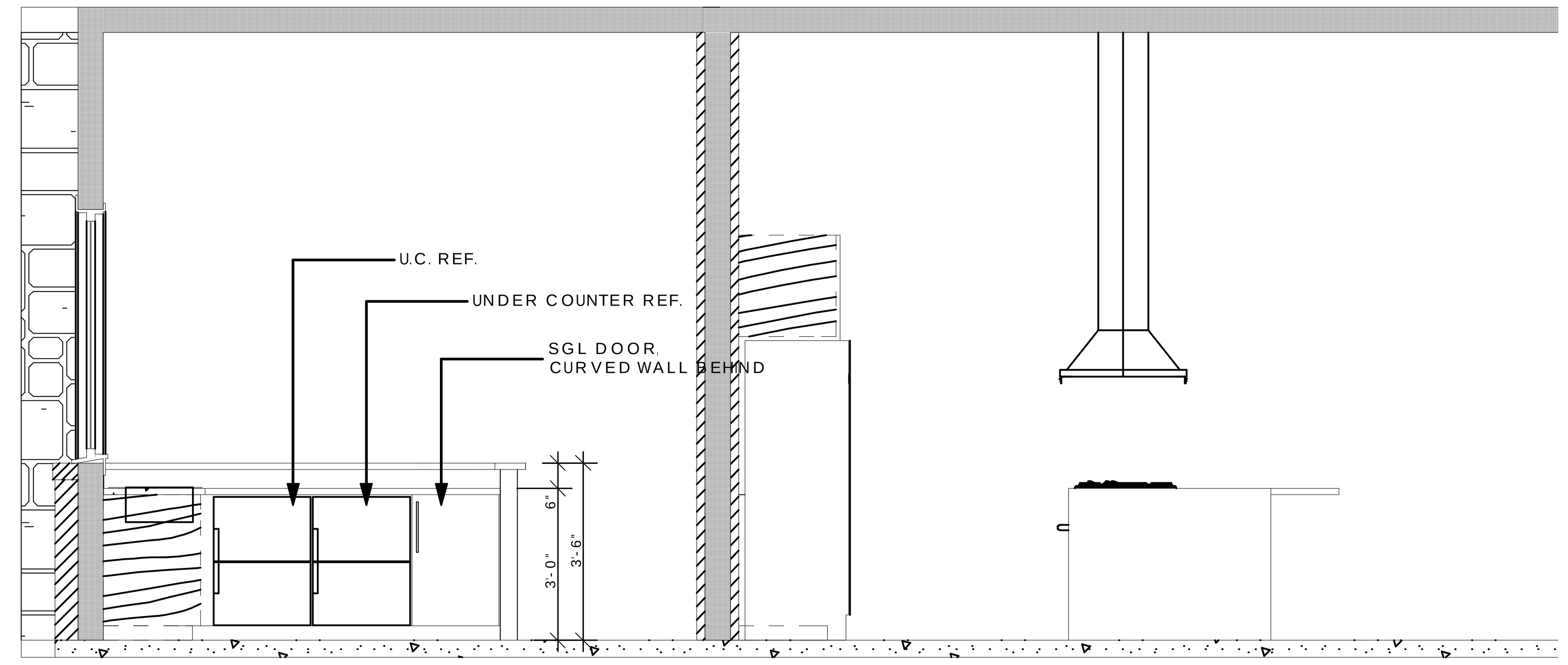
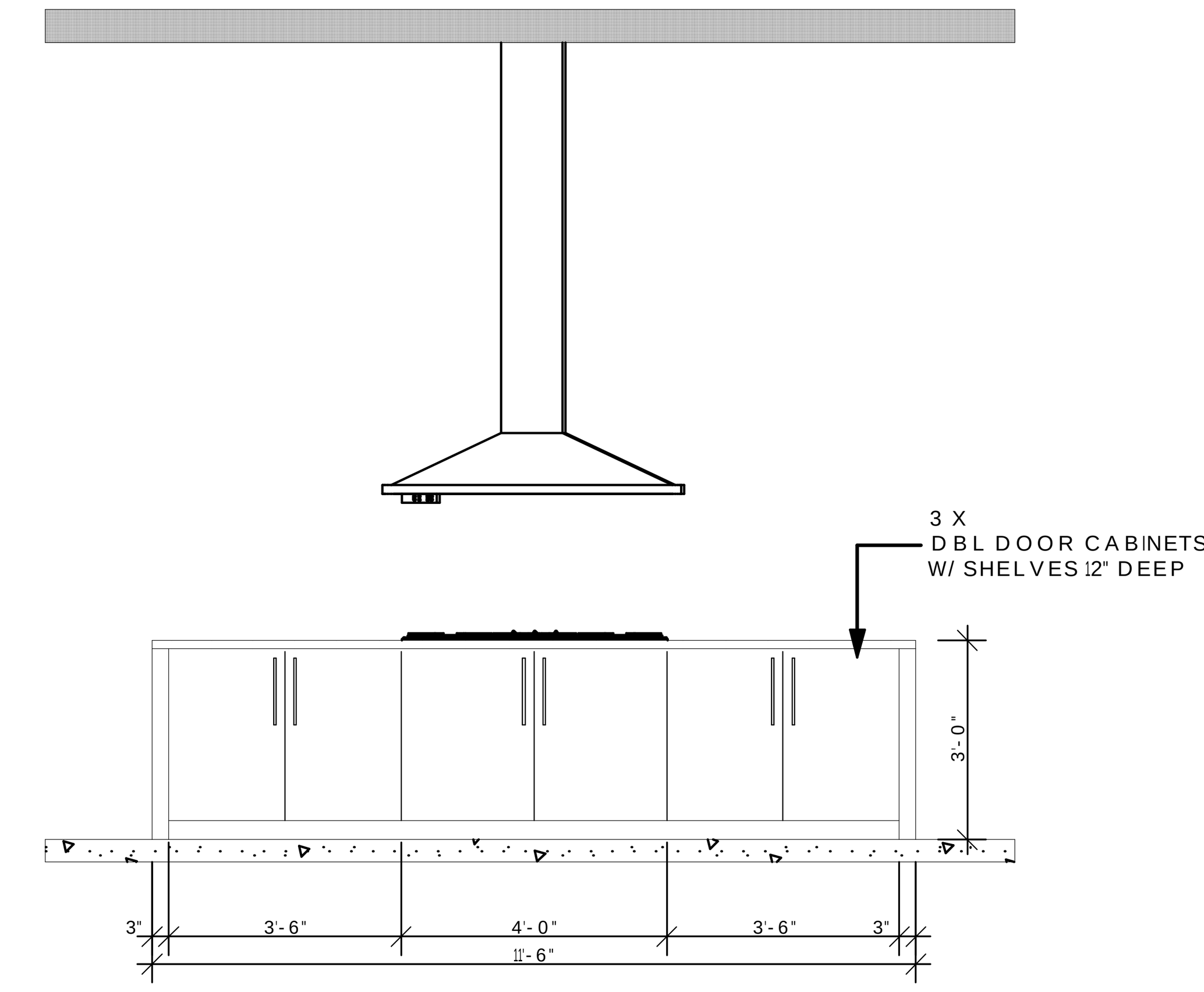


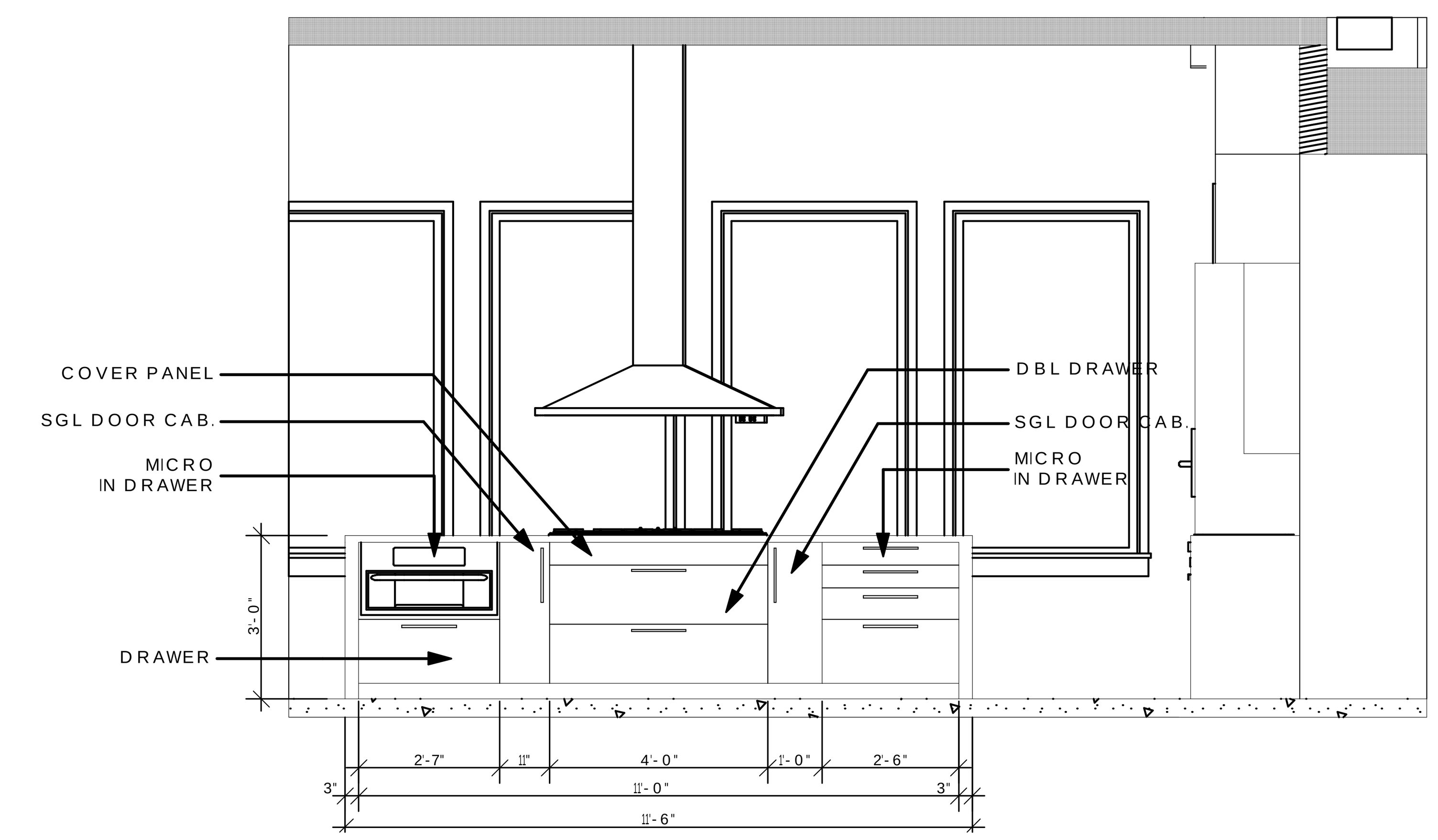
6 A 401/G BAR 3/8" = 1'-0"



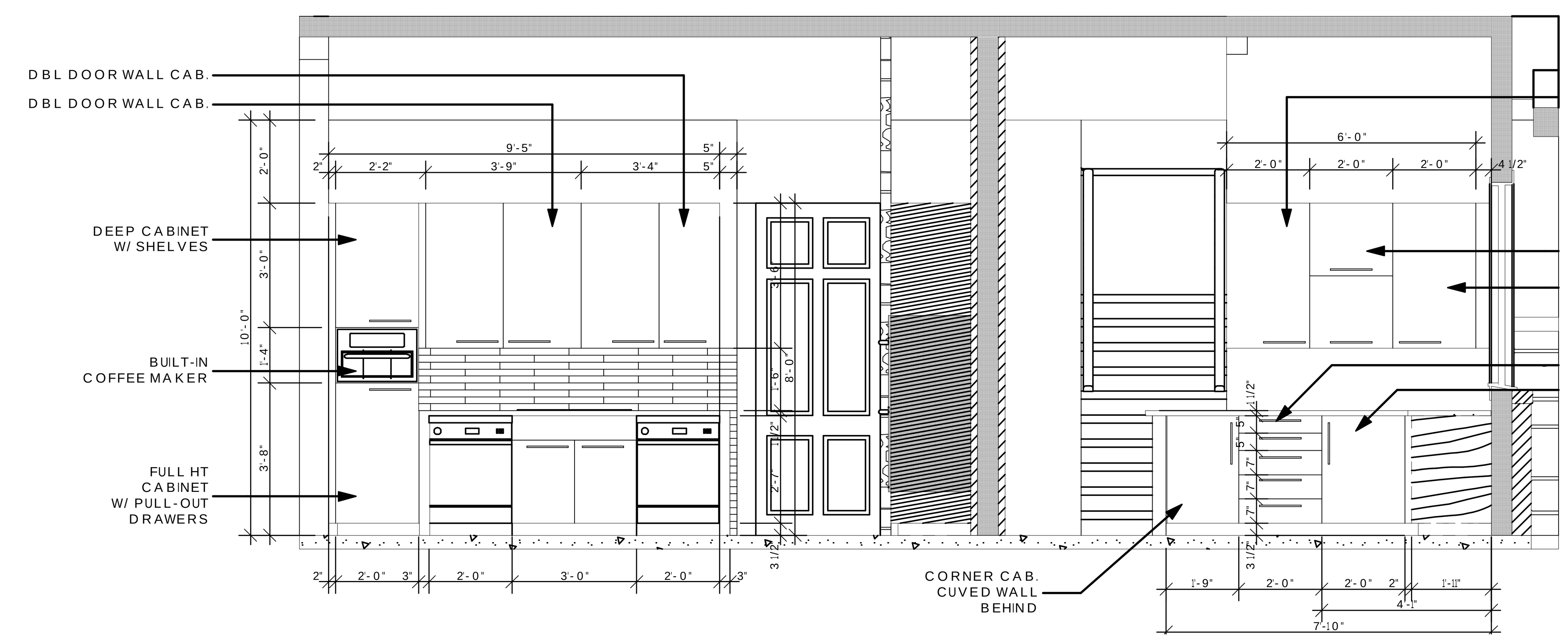
5 A 401/F KITCHEN & BAR 3/8" = 1'-0"



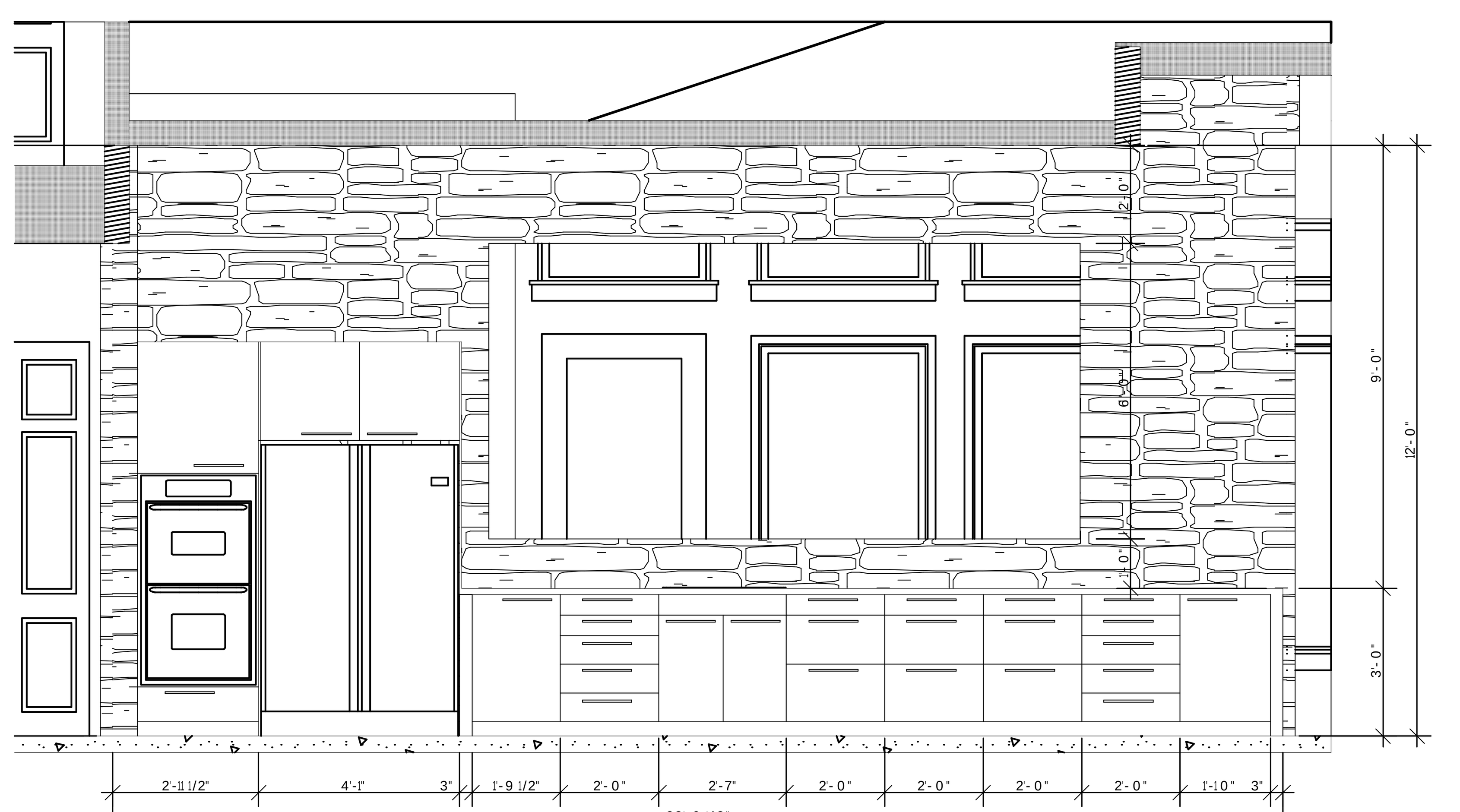
3 A 401/D KITCHEN ELEVATION 3/8" = 1'-0"



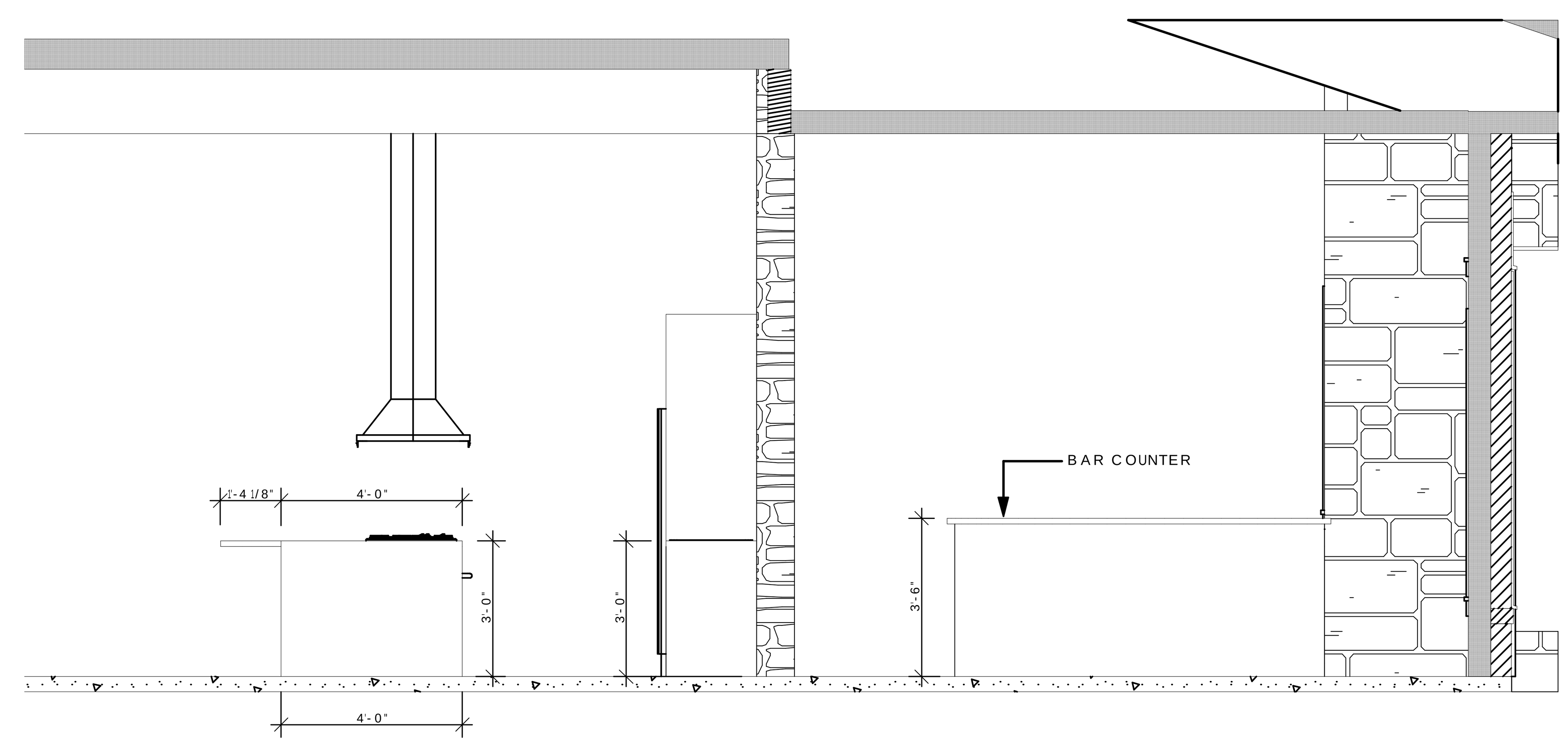
4 A 401/E KITCHEN ISLAND ELEVATION 3/8" = 1'-0"



2 A 401/C KITCHEN & BAR 3/8" = 1'-0"



1 A 401/B KITCHEN ELEVATION 3/8" = 1'-0"



7 3/8" = 1'-0"

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REVISIONS
DATE

INTERIOR
DETAILS

Date: 05-23-08
Scale:
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Job:
Sheet Number:
A-401
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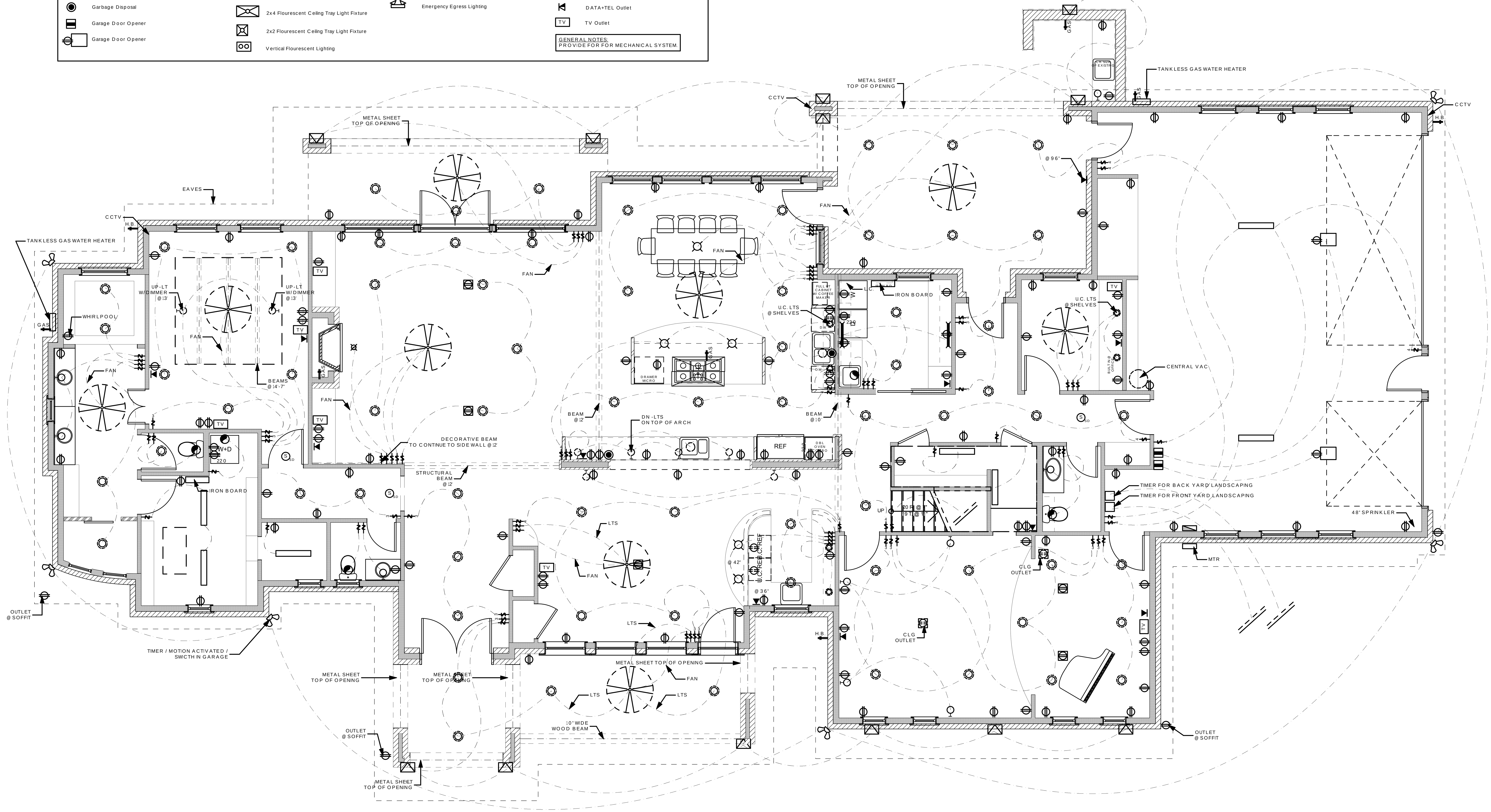
FIXTURE LEGEND

- 120 V Receptacle
- 120 V Receptacle Water Proof (W.P.)
- Ground Fault Interupter-120 V Receptacle (GFI)
- 220 V Receptacle
- Floor Outlet
- Switch
- 4-Way Switch
- 3-Way Switch
- Garbage Disposal
- Garage Door Opener
- Garage Door Opener
- Incandescent Pendant Light Fixture
- Monopoint Directional Fixture
- Recessed Can Light Fixture
- Recessed Can Light Fixture (spot light)
- Wall Mounted Incandescant Fixture
- Incandescant Wall Sconce
- Flourescent Light Fixture
- 1x4 Flourescent Light Fixture
- 2x4 Flourescent Ceiling Tray Light Fixture
- 2x2 Flourescent Ceiling Tray Light Fixture
- Vertical Flourescent Lighting
- Exterior Flood Lighting
- Built-In Column Accent Lighting
- Incandescent Pendant Light Fixture
- Junction Box - 10'-0" Above Finished Floor (10'-0" AFF)
- Bath Exhaust Fan - Broan Model 686 Ductless
- Thermostat Control
- Smoke Detector
- Exit Sign
- Emergency Egress Lighting
- Return Air Filter Grill
- Supply Diffuser
- Condensing and Air Handling Units
- Gas Supply (GAS)
- Hose Bib (H.B.)
- Electrical Panel
- Door Bell (D.B.)
- Telephone Outlet
- DATA+TEL Outlet
- TV Outlet (TV)

GENERAL NOTES:
PROVIDE FOR FOR MECHANICAL SYSTEM



1 Electrical Plan 1st Floor 1/4" = 1'-0"

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ELECTRICAL/1

REVISIONS

DATE

Date: 05-23-08

Scale:

Drawn:

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Sheet Number:

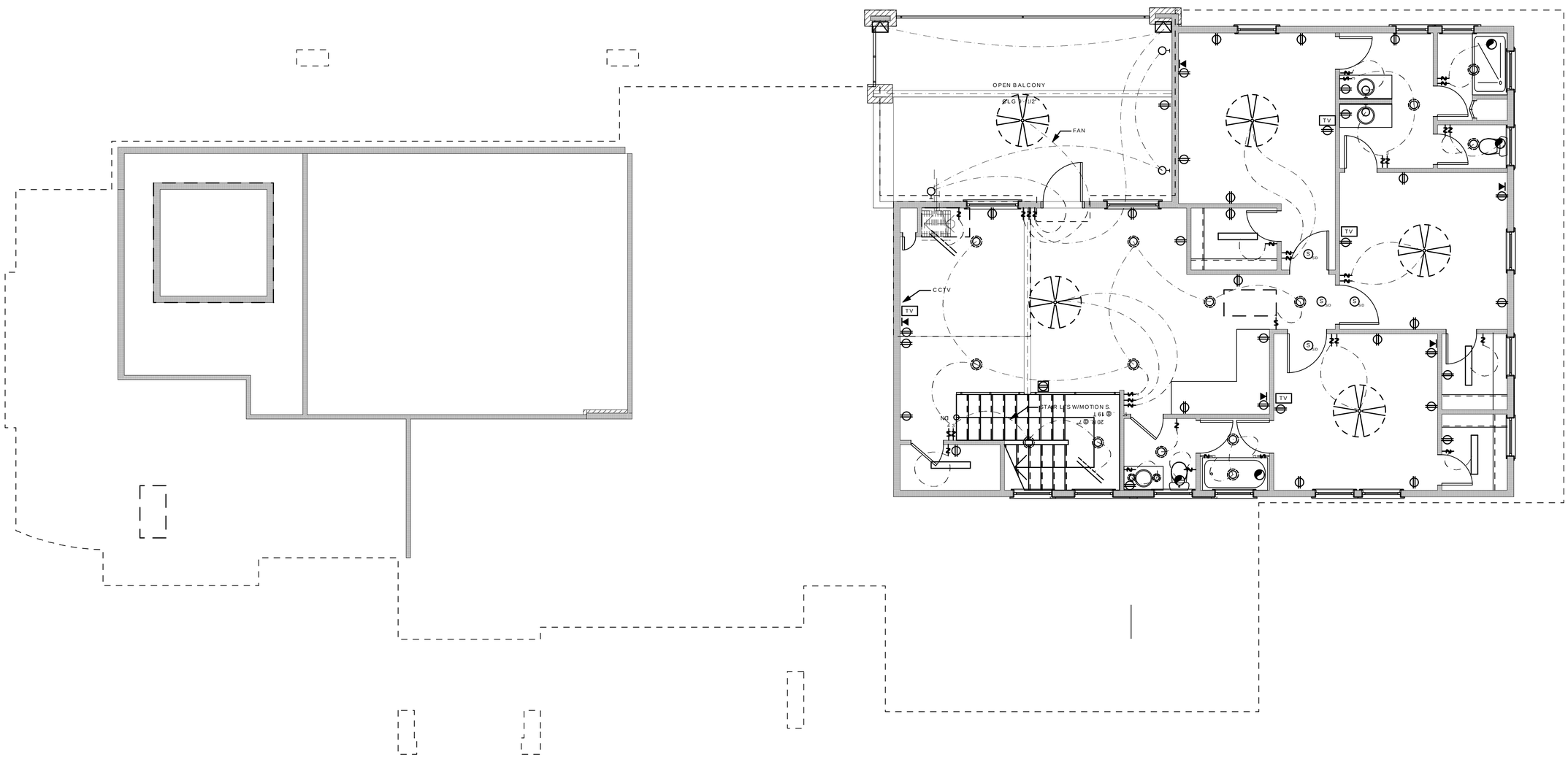
E-01

SHEET 19 OF 27

FIXTURE LEGEND

- 120 V Receptacle
- 120 V Receptacle Water Proof
- G.F.I. — Ground Fault Interupter-120 V Receptacle
- 220 — 220 V Receptacle
- Floor Outlet
- Switch
- 4-Way Switch
- 3-Way Switch
- Garbage Disposal
- Garage Door Opener
- Garage Door Opener
- Incandescent Pendant Light Fixture
- Monopoint Directional Fixture
- Recessed Can Light Fixture
- Recessed Can Light Fixture (spot light)
- Wall Mounted Incandescant Fixture
- Incandescant Wall Sconce
- Flourescent Light Fixture
- 1x4 Flourescent Light Fixture
- 2x4 Flourescent Ceiling Tray Light Fixture
- 2x2 Flourescent Ceiling Tray Light Fixture
- Vertical Flourescent Lighting
- Exterior Flood Lighting
- Built-In Column Accent Lighting
- Incandescent Pendant Light Fixture
- J — 10'-0" AFF — Junction Box - 10'-0" Above Finished Floor
- Bath Exhaust Fan - Broan Model 686 Ductless
- T — Thermostat Control
- S — SD — Smoke Detector
- Exit Sign
- Emergency Egress Lighting
- Return Air Filter Grill
- Supply Diffuser
- AC — Condensing and Air Handling Units
- GAS — Gas Supply
- H.B. — Hose Bib
- Electrical Panel
- D.B. — Door Bell
- Telephone Outlet
- DATA+TEL Outlet
- TV — TV Outlet

GENERAL NOTES:
PROVIDE FOR FOR MECHANICAL SYSTEM.



1 **Electrical Plan 2nd Floor** **1/4" = 1'-0"**

ARNETT HOUSE

1708 OAK KNOLL DRIVE,
COLLEYVILLE, TEXAS.

WILLIAM PECK & ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx
(972) 221-1424

ELECTRICAL/2

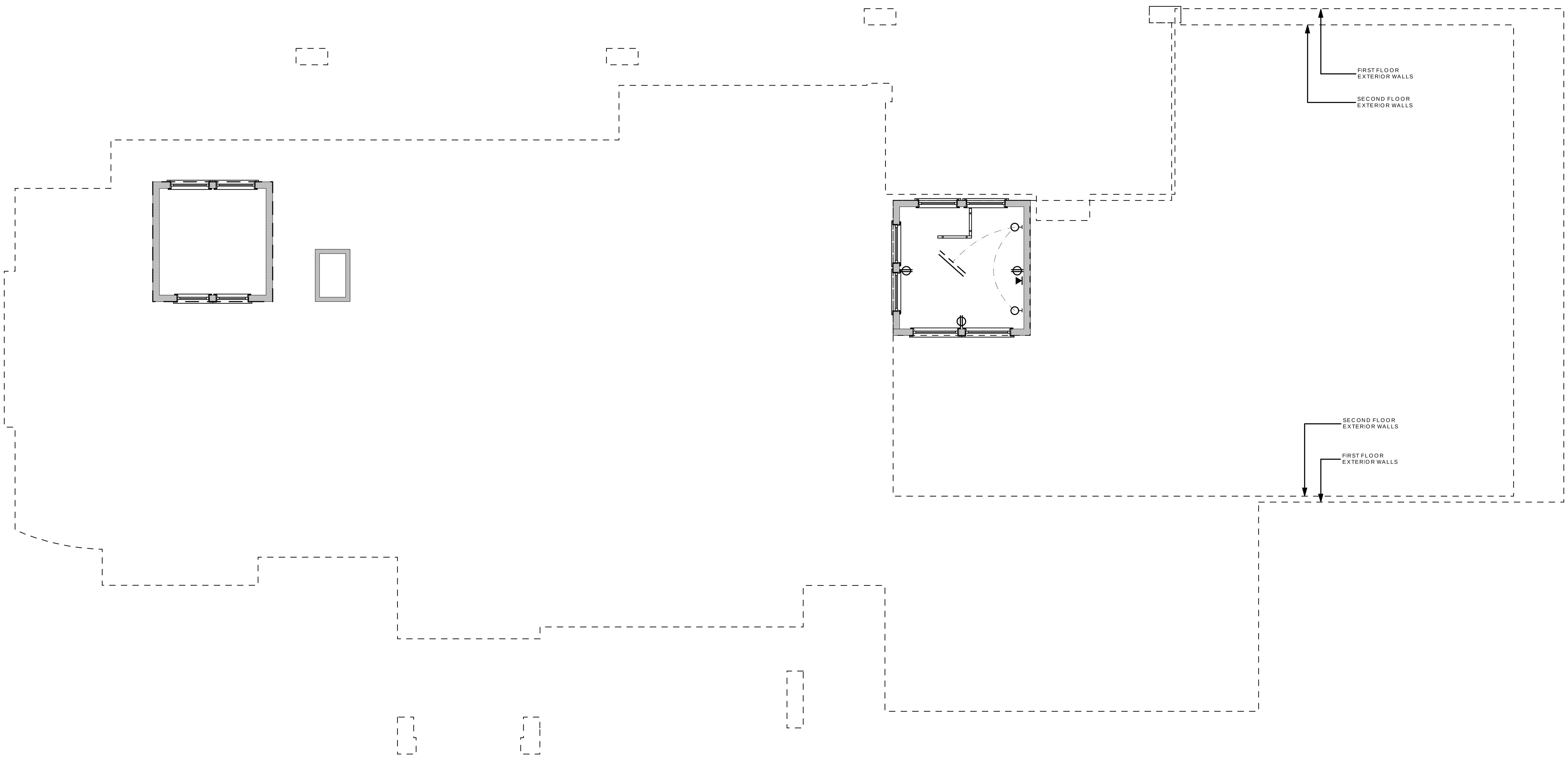
REVISIONS
DATE

Date: 05-23-08
Scale:
Drawn:
Job:
Sheet Number: E-02
SHEET 20 OF 27

FIXTURE LEGEND

120 V Receptacle	Incandescent Pendant Light Fixture	Exterior Flood Lighting	Return Air Filter Grill
120 V Receptacle Water Proof (W.P.)	Monopoint Directional Fixture	Built-In Column Accent Lighting	Supply Diffuser
Ground Fault Interupter-120 V Receptacle (GFI)	Recessed Can Light Fixture	Incandescent Pendant Light Fixture	Condensing and Air Handling Units (UNIT)
220 V Receptacle (220)	Recessed Can Light Fixture (spot light)	Junction Box - 10'-0" Above Finished Floor (J, 10'-0" AFF)	Gas Supply (GAS)
Floor Outlet	Wall Mounted Incandescant Fixture	Bath Exhaust Fan - Broan Model 686 Ductless	Hose Bib (H.B.)
Switch	Incandescant Wall Sconce	Thermostat Control	Electrical Panel
4-Way Switch	Flourescent Light Fixture	Smoke Detector (SD)	Door Bell (D.B.)
3-Way Switch	1x4 Flourescent Light Fixture	Exit Sign	Telephone Outlet
Garbage Disposal	2x4 Flourescent Ceiling Tray Light Fixture	Emergency Egress Lighting	DATA+TEL Outlet
Garage Door Opener	2x2 Flourescent Ceiling Tray Light Fixture		TV Outlet (TV)
Garage Door Opener	Vertical Flourescent Lighting		

GENERAL NOTES:
PROVIDE FOR FOR MECHANICAL SYSTEM.



1 **Electrical Plan Roof Floor** 1/4" = 1'-0"

ARNETT HOUSE

1708 OAK KNOLL DRIVE,
COLLEYVILLE, TEXAS.

WILLIAM PECK &
ASSOCIATES INC.
ARCHITECTS
Lewisville, Tx (972) 221-1424

Electrical Tower

REVISIONS
DATE

Date: 05-23-08
Scale:
Drawn:
Job:
Sheet Number:
E-03
SHEET 21 OF 27

Appendix D.7.7.3
Energy Modeling

February 25, 2009

Chris Miles
GreenCraft Builders LLC
105 W. Main Street
Lewisville, Texas
214-718-8424

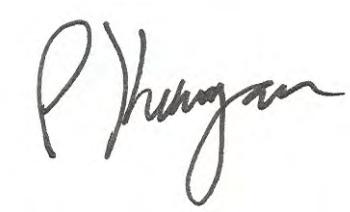
Building America Performance Analysis of the Colleyville House

Dear Mr. Miles,

BSC has completed initial energy analysis for the 2009 Greencraft Colleyville house in Texas. The analysis shows that the plan has a source energy consumption reduction of 70.5% relative to the Building America Benchmark Protocol. The following is a detailed explanation of the analysis and results as well as a discussion on the various attributes of the plan.

BSC will be performance testing the 2008 Colleyville house the second week in March 2009.

Sincerely,



Philip Kerrigan Jr., PE
Building Science Corporation

Daniel Bergey
Building Science Corporation

1. Building Plan and Specifications

The building characteristics used in this analysis are listed below. Details of the analysis are included later in the report.

Floor area (ft^2)	Surface Area (ft^2)	Volume (ft^3)	Glazing Ratio (%)
4886	12598	76929	18.9%

Specifications

Building Enclosure

Ceiling	R-30 spray foam at roof deck to create Conditioned attic Icynene®
Walls	2x6, 24" oc framing with 3/4" XPS with R-19 Spray foam Icynene®
Foundation	51% Flyash concrete monolithic slab with Termimesh termite control
Windows	Pella ® fiberglass LoE^3 (U=0.28, SHGC=0.24)
Infiltration	2.5 sq in leakage area per 100 sf envelope

Mechanical systems

Heat	WaterFurnace COP 5 GSHP
Cooling	WaterFurnace 4 ton downstairs, 2 ton upstairs 6 wells 25' apart 300 ft deep
DHW	30 gal LowBoy gets hot water from GSHP Rinnai R94LSi Instantaneous Hot Water EF=0.82 for auxillary DHW
Ducts	R-4.2 flex runouts in unvented attic or in floor joists
Leakage	none to outside (5% or less)
Dehumidification	GeneralAire Model 1300 whole house dehumidifier
Ventilation	ERV Fantech SER Series AirCycler^{TM} FR-V Supply-only system integrated with AHU 33% Duty Cycle: 10 minutes on; 20 minutes off, 50 CFM average flow
Return Pathways	Jump ducts at bedrooms and laundry

Other Loads

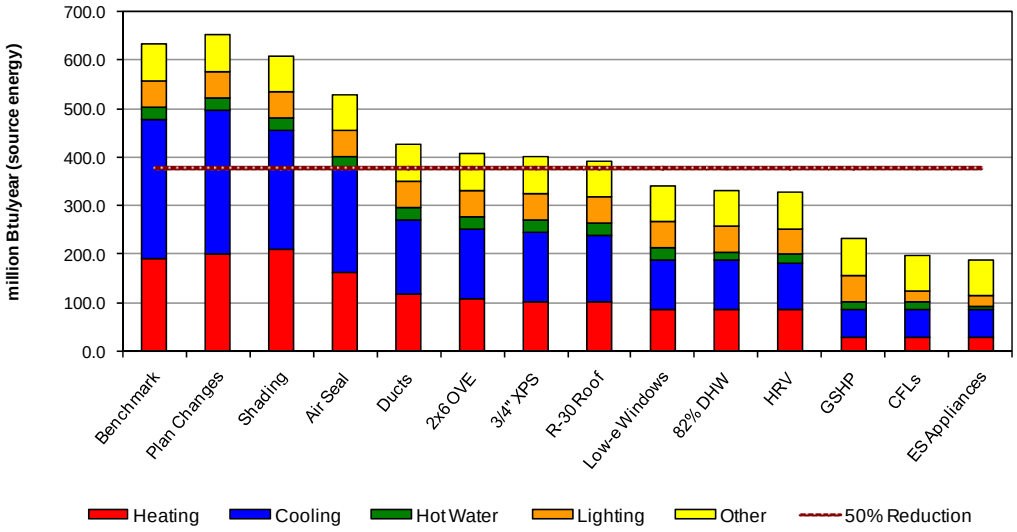
Lighting	CFL lighting package all screw base
Appliances	Energy Star fridge, DW, clothes washer

2. Energy Analysis

Baseline Energy Efficiency Package: A whole house hourly energy consumption parametric simulation was completed comparing the incremental energy consumption reduction for various energy efficiency strategies compared to the Building America Benchmark Protocol created by the Department of Energy. The simulation was run using EnergyGauge USA USRCBB v2.8.01 software developed by the Florida Solar Energy Center (FSEC).

Each parametric step shows an increment over source energy use (IOSEU) over the Building America Benchmark Protocol for the change to the model. This can be used to evaluate the relative effects of each performance upgrade made to the model. Due to rounding error, the sum of incremental improvements does not precisely match the total improvement for all measures. Each step is described below and the results are discussed.

Parametric Annual Loads Study



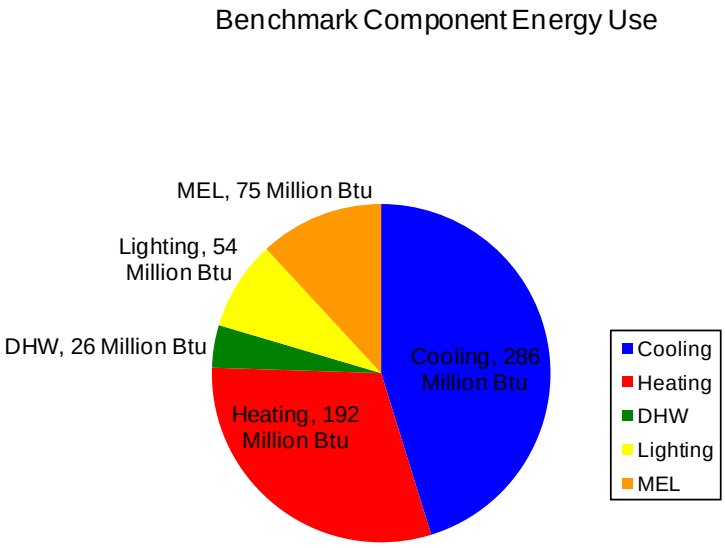
1. Plan Changes: This step reflects the difference in window distribution between the Benchmark and the planned house.
2. 1+ Shading: This step accounts for the shading provided by roof overhangs. Taken together with the previous step, the savings is 3.7% of Benchmark energy usage.
3. 2 + Air Seal: This step brings the modeled house to Building America targets for air infiltration. The IOSEU for this step was 12.5%.
4. 3 + Ducts to interior: In this step, all ductwork was well sealed and brought to the interior, greatly reducing leakage to outside. The IOSEU for this step was 16.6%.
5. 4 + 2x6 OVE Framing: Advanced framing on 24" centers saves labor while reducing thermal bridging in the walls. 2x6 walls provide space for R-19 cavity insulation, resulting in an IOSEU of 3.2%.
6. 5 + Insulating Sheathing: ¾" of XPS sheathing was added to the exterior of all exposed walls, for an IOSEU of 1.0%.
7. 6 + R-30 attic insulation: The ceiling insulation was increased from R-25 to R-30. This upgrade results in an IOSEU of 1.2%.
8. 7 + U=0.28, SHGC=0.24 Windows: All windows were set to those to be installed, for an IOSEU of 8%.
9. 8 + 0.82 EF Instantaneous gas hot water: A gas hot water tank with an EF rating of 0.56 was replaced with a high efficiency instantaneous gas hot water system. This resulted in an IOSEU of 1.5% for this step.
10. 9 + HRV: A heat recovery ventilator was added to the central air system. The IOSEU for this step was 0.7%.

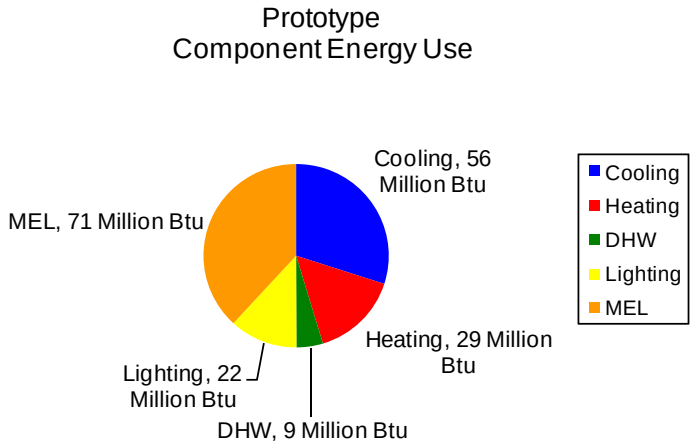
11. 10 + GSHP: A ground source heat pump with a COP of 5.0 was modeled. The IOSEU for this step was 17.5%.
12. 11 + CFLs: All light fixtures in the modeled house were provided with compact fluorescent bulbs. The IOSEU was 5.3%.
13. 12 + ES Appliances: The dishwasher, clothes washer, and refrigerator were replaced with Energy Star rated models. The IOSEU for this step was 1.9%
14. 10+ 80% Compact fluorescent lighting: The lighting scheme was changed from a 14% CFL lighting package to an 80% CFL package for all hard wired lights. This resulted in a IOSEU of 4.2% for this step.

		Total Source Energy Savings (H/C/DHW/Lights/Appliances/Plug)						
Parametric Run ID	Description of change	% over BA Bmrk	Incr. Over Bmrk	Annual energy cost	Item Savings	HERS Score	Heating Load	Cooling Load
							kBtuh	kBtuh
0	Benchmark			$5,602		142	174.4	197.7
1	Windows as-designed	-3.2%	-3.2%	$5,777	($175)	142	170.4	178.6
2	Porches and overhangs	3.7%	6.9%	$5,399	$378	130	175.7	188.2
3	Air Seal (2.5 Leakage Ratio)	16.2%	12.5%	$4,708	$691	114	130.2	147.2
4	Ducts 5% leakage and in cond. space	32.8%	16.6%	$3,795	$913	92	96.8	83.9
5	R-19 OVE Walls	35.7%	3.0%	$3,632	$163	89	90.7	80.1
6	3/4" XPS	36.8%	1.0%	$3,575	$58	87	89.4	79.4
7	R-30 Roof	38.0%	1.2%	$3,506	$69	85	88	78
8	Windows Low-e (U=0.28, SHGC=0.24)	46.0%	8.0%	$3,064	$442	74	73.4	56.5
9	0.82 EF Inst. DHW	47.5%	1.5%	$2,968	$96	70	73.4	56.5
10	HRV	48.1%	0.7%	$2,931	$37	69	72.4	55.5
11	WaterFurnace GSHP COP=5	63.3%	17.5%	$2,094	$965	53	72.4	55.5
12	CFL Lighting	68.6%	5.3%	$1,802	$292	48	72.4	55.5
13	ES Appliances	70.5%	1.9%	$1,680	$122	47	72.4	55.5

3. Energy Components

The pie charts below reflect the component energy use for benchmark and the BA characteristics model. Because most of the savings were in heating and cooling, the plug loads, which are dependent on occupant behavior, and not on the building design, form a larger fraction of the total load.





4. End Use Site and Source Energy

GreenCraft: Colleyville House

ESTIMATED WHOLE HOUSE ENERGY USE		
Source (10^6 BTU/yr)	**Site (10^6 BTU/yr)**	**Area + Bsmt (sq ft)**
189	69	4886 + 0
	% Electric	**No. of Bedrooms**
	72%	4

Table 1. Summary of End-Use Site-Energy

	Annual Site Energy			
	Manual Benchmark		Prototype	
End-Use	kWh	therms	kWh	therms
Space Heating	16656	0	2411	0
Space Cooling	24886		4782	
DHW	0	236	0	80
Lighting*	4717		1946	
Appliances + Plug	5695	114	5293	114
OA Ventilation**	112		178	
Total Usage	52064.75	350	14610	194
Site Generation	0		0	
Net Energy Use	52065	350	14610	194

*Lighting end-use includes both interior and exterior lighting

**This OA Ventilation energy consumption is for fan energy only, space conditioning is included in Space Heating and Cooling

Table 2. Summary of End-Use Source-Energy and Savings

	Estimated Annual Source Energy		Source Energy Savings	
			% of End-Use	% of Total
	Manual Benchmark	**Prototype**	**Prototype**	**Prototype**
End-Use	10^6 BTU/yr	10^6 BTU/yr	**savings**	**savings**
Space Heating	191.2	27.7	**86%**	**26%**
Space Cooling	285.7	54.9	**81%**	**36%**
DHW	25.8	8.7	**66%**	**3%**
Lighting*	54.2	22.3	**59%**	**5%**
Appliances + Plug	77.8	73.2	**6%**	**1%**
OA Ventilation**	1.3	2.0	**-60%**	**0%**
Total Usage	636	189	**70%**	**70%**
Site Generation	0	0		**0%**
Net Energy Use	636	189	**70%**	**70%**

Notes:

The "% of End-Use" columns show prototype energy savings in each end-use category.

The "% of Total" columns show component savings contribution to the overall savings.

Appendix D.7.7.4
Manual J Calculations

Rhvac - Residential & Light Commercial HVAC Loads
Wolverton Co. Inc.
Waxahachie, TX 75165

Elite Software Development, Inc.
Colleyville Eco House (Arnett)
Page 1

Load Preview Report

Scope	Has AED	Net Ton	Rec Ton	ft.²/Ton	Area	Sen Gain	Lat Gain	Net Gain	Sen Loss	Sys Htg CFM	Sys Clg CFM	Sys Act CFM	Duct Size
Building		4.78	5.13	912	4,682	46,192	11,172	57,364	87,459	949	1,774	1,774	
System 1	Yes	3.37	3.69	972	3,585	33,181	7,215	40,396	68,298	799	1,353	1,353	18
Ventilation						3,919	2,614	6,533	7,837				
Zone 1					3,585	29,262	4,601	33,863	60,461	799	1,353	1,353	18
1-Master Bath					208	2,233	342	2,575	6,359	84	103	103	1-6
2-Master Bedroom					252	1,972	576	2,548	3,490	46	91	91	1-6
3-Master Closet					150	783	130	913	2,445	32	36	36	1-4
4-Hidden Closet					36	290	49	339	912	12	13	13	1-4
5-Powder Bath					36	290	49	339	912	12	13	13	1-4
6-Living					525	4,781	685	5,466	7,290	96	221	221	2-6
7-Entry					144	1,133	147	1,280	2,924	39	52	52	1-4
8-Dining Room					285	3,416	503	3,919	6,633	88	158	158	1-8
9-Kitchen					320	1,445	0	1,445	245	3	67	67	1-5
10-Game Room					320	2,579	225	2,804	5,152	68	119	119	1-6
11-Bar					96	519	78	597	1,402	19	24	24	1-4
12-Utility					160	773	147	920	2,652	35	36	36	1-4
13-Office					160	1,093	228	1,321	4,026	53	51	51	1-4
14-East Pwdr Bath					48	192	49	241	823	11	9	9	1-4
15-Stairs / Hall					216	612	57	669	1,400	19	28	28	1-4
16-Media Room					448	2,949	840	3,789	8,118	107	136	136	1-7
17-Observation					100	2,845	261	3,106	3,273	43	132	132	1-7
18-Upper Master Bedroom					81	1,357	235	1,592	2,405	32	63	63	1-5
System 2	Yes	1.41	1.45	759	1,097	13,012	3,956	16,968	19,160	150	421	421	10
Ventilation						3,919	2,614	6,533	7,837				
Zone 1					1,097	9,093	1,342	10,435	11,323	150	421	421	10
19-Bedroom 4					234	2,423	364	2,787	2,682	35	112	112	1-6
20-Bedroom 3					156	1,402	264	1,666	1,113	15	65	65	1-5
21-Bath 2					143	1,601	127	1,728	1,932	26	74	74	1-5
22-Bedroom 2					168	1,372	338	1,710	1,922	25	63	63	1-5
23-Kids Study					330	1,806	191	1,997	2,859	38	84	84	1-5
24-Upstairs Bath					66	489	58	547	815	11	23	23	1-4

Total Building Summary Loads

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
4A-6-o: Glazing-Double pane low-e (e = 0.20 or less), high performance, operable window, e=0.05 on surface 2, any frame, u-value 0.33, SHGC 0.33	808.5	13,346	0	14,354	14,354
10D-w: Glazing-French door, double pane low-e glass (e = 0.10), wood frame, u-value 0.49, SHGC 0.32	84	2,059	0	1,583	1,583
11N: Door-Metal - Polystyrene Core	63	1,103	0	794	794
12C1-0bw: Wall-Frame, R-13.3 open cell 1/2 lb. spray foam insulation in 2 x 4 stud cavity, no board insulation, brick finish, wood studs	4232.5	19,055	0	8,381	8,381
18B1-21o: Partition Roof/Ceiling (STD=15, WTD=15)-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Spray Foam Insulation, White or Light Color Asphalt Shingle, Any Wood Shake, Dark or Medium Color Tile, Slate or Concrete, Light or Unpainted Metal, Light or Silver Membrane, Light Tar and Gravel, R-21 open cell 1/2 lb. spray foam in 2 x 6 joist cavity	4314	3,301	0	3,301	3,301
22A-ph: Floor-Slab on grade, No edge insulation, no insulation below floor, any floor cover, passive, heavy moist soil	303	20,573	0	0	0
open cell foam: Partition Floor (STD=15, WTD=15)-Over open crawl space or garage, Custom, over garage with open cell foam	701	536	0	536	536
Subtotals for structure:		59,973	0	28,949	28,949
People:	10		2,000	2,300	4,300
Equipment:			0	1,200	1,200
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 219, Summer CFM: 219		11,811	3,943	5,906	9,849
Ventilation: Winter CFM: 290, Summer CFM: 290		15,675	5,229	7,837	13,066
Total Building Load Totals:		87,459	11,172	46,192	57,364

Check Figures

Total Building Supply CFM:	1,774	CFM Per Square ft.:	0.379
Square ft. of Room Area:	4,682	Square ft. Per Ton:	912
Volume (ft³) of Cond. Space:	52,455		

Building Loads

Total Heating Required Including Ventilation Air:	87,459 Btuh	87.459	MBH
Total Sensible Gain:	46,192 Btuh	81	%
Total Latent Gain:	11,172 Btuh	19	%
Total Cooling Required Including Ventilation Air:	57,364 Btuh	4.78	Tons (Based On Sensible + Latent)
		5.13	Tons (Based On 75% Sensible Capacity)

Notes

Calculations are based on 8th edition of ACCA Manual J.

Total Building Summary Loads (cont'd)

Notes

All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

System 1 Summary Loads

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
4A-6-o: Glazing-Double pane low-e (e = 0.20 or less), high performance, operable window, e=0.05 on surface 2, any frame, u-value 0.33, SHGC 0.33	637.5	10,524	0	10,590	10,590
10D-w: Glazing-French door, double pane low-e glass (e = 0.10), wood frame, u-value 0.49, SHGC 0.32	84	2,059	0	1,583	1,583
11N: Door-Metal - Polystyrene Core	63	1,103	0	794	794
12C1-0bw: Wall-Frame, R-13.3 open cell 1/2 lb. spray foam insulation in 2 x 4 stud cavity, no board insulation, brick finish, wood studs	3143.5	14,152	0	6,227	6,227
18B1-21o: Partition Roof/Ceiling (STD=15, WTD=15)-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Spray Foam Insulation, White or Light Color Asphalt Shingle, Any Wood Shake, Dark or Medium Color Tile, Slate or Concrete, Light or Unpainted Metal, Light or Silver Membrane, Light Tar and Gravel, R-21 open cell 1/2 lb. spray foam in 2 x 6 joist cavity	3217	2,463	0	2,463	2,463
22A-ph: Floor-Slab on grade, No edge insulation, no insulation below floor, any floor cover, passive, heavy moist soil	303	20,573	0	0	0
Subtotals for structure:		50,874	0	21,657	21,657
People:	7		1,400	1,610	3,010
Equipment:			0	1,200	1,200
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 177, Summer CFM: 177		9,587	3,201	4,795	7,996
Ventilation: Winter CFM: 145, Summer CFM: 145		7,837	2,614	3,919	6,533
System 1 Load Totals:		68,298	7,215	33,181	40,396

Check Figures

Supply CFM:	1,353	CFM Per Square ft.:	0.378
Square ft. of Room Area:	3,585	Square ft. Per Ton:	972
Volume (ft³) of Cond. Space:	42,582		

System Loads

Total Heating Required Including Ventilation Air:	68,298 Btuh	68.298	MBH
Total Sensible Gain:	33,181 Btuh	82	%
Total Latent Gain:	7,215 Btuh	18	%
Total Cooling Required Including Ventilation Air:	40,396 Btuh	3.37	Tons (Based On Sensible + Latent)
		3.69	Tons (Based On 75% Sensible Capacity)

Notes

Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

System 2 Summary Loads

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
4A-6-o: Glazing-Double pane low-e (e = 0.20 or less), high performance, operable window, e=0.05 on surface 2, any frame, u-value 0.33, SHGC 0.33	171	2,822	0	3,764	3,764
12C1-0bw: Wall-Frame, R-13.3 open cell 1/2 lb. spray foam insulation in 2 x 4 stud cavity, no board insulation, brick finish, wood studs	1089	4,903	0	2,154	2,154
18B1-21o: Partition Roof/Ceiling (STD=15, WTD=15)-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Spray Foam Insulation, White or Light Color Asphalt Shingle, Any Wood Shake, Dark or Medium Color Tile, Slate or Concrete, Light or Unpainted Metal, Light or Silver Membrane, Light Tar and Gravel, R-21 open cell 1/2 lb. spray foam in 2 x 6 joist cavity	1097	838	0	838	838
open cell foam: Partition Floor (STD=15, WTD=15)-Over open crawl space or garage, Custom, over garage with open cell foam	701	536	0	536	536
Subtotals for structure:		9,099	0	7,292	7,292
People:	3		600	690	1,290
Equipment:			0	0	0
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 41, Summer CFM: 41		2,224	742	1,111	1,853
Ventilation: Winter CFM: 145, Summer CFM: 145		7,837	2,614	3,919	6,533
System 2 Load Totals:		19,160	3,956	13,012	16,968

Check Figures

Supply CFM:	421	CFM Per Square ft.:	0.383
Square ft. of Room Area:	1,097	Square ft. Per Ton:	759
Volume (ft³) of Cond. Space:	9,873		

System Loads

Total Heating Required Including Ventilation Air:	19,160 Btuh	19.160	MBH
Total Sensible Gain:	13,012 Btuh	77	%
Total Latent Gain:	3,956 Btuh	23	%
Total Cooling Required Including Ventilation Air:	16,968 Btuh	1.41	Tons (Based On Sensible + Latent)
		1.45	Tons (Based On 75% Sensible Capacity)

Notes

Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

System 1, Zone 1 Summary Loads (Average Load Procedure for Rooms)

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
4A-6-o: Glazing-Double pane low-e (e = 0.20 or less), high performance, operable window, e=0.05 on surface 2, any frame, u-value 0.33, SHGC 0.33	637.5	10,524	0	10,590	10,590
10D-w: Glazing-French door, double pane low-e glass (e = 0.10), wood frame, u-value 0.49, SHGC 0.32	84	2,059	0	1,583	1,583
11N: Door-Metal - Polystyrene Core	63	1,103	0	794	794
12C1-0bw: Wall-Frame, R-13.3 open cell 1/2 lb. spray foam insulation in 2 x 4 stud cavity, no board insulation, brick finish, wood studs	3143.5	14,152	0	6,227	6,227
18B1-21o: Partition Roof/Ceiling (STD=15, WTD=15)-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Spray Foam Insulation, White or Light Color Asphalt Shingle, Any Wood Shake, Dark or Medium Color Tile, Slate or Concrete, Light or Unpainted Metal, Light or Silver Membrane, Light Tar and Gravel, R-21 open cell 1/2 lb. spray foam in 2 x 6 joist cavity	3217	2,463	0	2,463	2,463
22A-ph: Floor-Slab on grade, No edge insulation, no insulation below floor, any floor cover, passive, heavy moist soil	303	20,573	0	0	0
Subtotals for structure:		50,874	0	21,657	21,657
People:	7		1,400	1,610	3,010
Equipment:			0	1,200	1,200
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 177, Summer CFM: 177		9,587	3,201	4,795	7,996
System 1, Zone 1 Load Totals:		60,461	4,601	29,262	33,863

Check Figures

Supply CFM:	1,353	CFM Per Square ft.:	0.378
Square ft. of Room Area:	3,585	Square ft. Per Ton:	1,185
Volume (ft³) of Cond. Space:	42,582		

Zone Loads

Total Heating Required:	60,461 Btuh	60.461	MBH
Total Sensible Gain:	29,262 Btuh	86	%
Total Latent Gain:	4,601 Btuh	14	%
Total Cooling Required:	33,863 Btuh	2.82	Tons (Based On Sensible + Latent)
		3.03	Tons (Based On 75% Sensible Capacity)

Notes

Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

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System 2, Zone 1 Summary Loads (Average Load Procedure for Rooms)

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
4A-6-o: Glazing-Double pane low-e (e = 0.20 or less), high performance, operable window, e=0.05 on surface 2, any frame, u-value 0.33, SHGC 0.33	171	2,822	0	3,764	3,764
12C1-0bw: Wall-Frame, R-13.3 open cell 1/2 lb. spray foam insulation in 2 x 4 stud cavity, no board insulation, brick finish, wood studs	1089	4,903	0	2,154	2,154
18B1-21o: Partition Roof/Ceiling (STD=15, WTD=15)-Roof Joists Between Roof Deck and Ceiling or Foam Encapsulated Roof Joists, Spray Foam Insulation, White or Light Color Asphalt Shingle, Any Wood Shake, Dark or Medium Color Tile, Slate or Concrete, Light or Unpainted Metal, Light or Silver Membrane, Light Tar and Gravel, R-21 open cell 1/2 lb. spray foam in 2 x 6 joist cavity	1097	838	0	838	838
open cell foam: Partition Floor (STD=15, WTD=15)-Over open crawl space or garage, Custom, over garage with open cell foam	701	536	0	536	536
Subtotals for structure:		9,099	0	7,292	7,292
People:	3		600	690	1,290
Equipment:			0	0	0
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 41, Summer CFM: 41		2,224	742	1,111	1,853
System 2, Zone 1 Load Totals:		11,323	1,342	9,093	10,435

Check Figures

Supply CFM:	421	CFM Per Square ft.:	0.383
Square ft. of Room Area:	1,097	Square ft. Per Ton:	1,246
Volume (ft³) of Cond. Space:	9,873		

Zone Loads

Total Heating Required:	11,323 Btuh	11.323	MBH
Total Sensible Gain:	9,093 Btuh	87	%
Total Latent Gain:	1,342 Btuh	13	%
Total Cooling Required:	10,435 Btuh	0.87	Tons (Based On Sensible + Latent)
		0.88	Tons (Based On 75% Sensible Capacity)

Notes

Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

Detailed Room Loads - Room 1 - Master Bath (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	26.0	ft.	System Number:	1	
Room Width:	8.0	ft.	Zone Number:	1	
Area:	208.0	sq.ft.	Supply Air:	103	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	3.0	AC/hr
Volume:	2,080.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	15	CFM
Runout Air:	103	CFM	Percent of Supply.:	15	%
Runout Duct Size:	6	in.	Actual Summer Vent.:	11	CFM
Runout Air Velocity:	526	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	526	ft./min.	Actual Winter Infil.:	19	CFM
Actual Loss:	0.174	in.wg./100 ft.	Actual Summer Infil.:	19	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
W -Wall-12C1-0bw 26 X 10	250	0.090	4.5	1,125	2.0	0	495
N -Wall-12C1-0bw 8 X 10	64	0.090	4.5	288	2.0	0	127
S -Wall-12C1-0bw 8 X 10	70	0.090	4.5	315	2.0	0	139
S -Gls-4A-6-o shgc-0.33 73%S (2)	10	0.330	16.5	166	16.0	0	160
W -Gls-4A-6-o shgc-0.33 0%S	10	0.330	16.5	165	39.9	0	399
N -Gls-4A-6-o shgc-0.33 100%S	16	0.330	16.5	264	15.1	0	241
UP-Roof-Part-18B1-21o 26 X 8	208	0.051	0.8	159	0.8	0	159
Floor-22A-ph 42 ft..Per.	42	1.358	67.9	2,852	0.0	0	0
Subtotals for Structure:				5,334		0	1,720
Infil.: Win.: 19.0, Sum.: 19.0	420		2.440	1,025	1.221	342	513
Room Totals:				6,359		342	2,233

Detailed Room Loads - Room 2 - Master Bedroom (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	18.0	ft.	System Number:	1	
Room Width:	14.0	ft.	Zone Number:	1	
Area:	252.0	sq.ft.	Supply Air:	91	CFM
Ceiling Height:	12.0	ft.	Supply Air Changes:	1.8	AC/hr
Volume:	3,024.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	8	CFM
Runout Air:	91	CFM	Percent of Supply.:	9	%
Runout Duct Size:	6	in.	Actual Summer Vent.:	10	CFM
Runout Air Velocity:	465	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	465	ft./min.	Actual Winter Infil.:	10	CFM
Actual Loss:	0.136	in.wg./100 ft.	Actual Summer Infil.:	10	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 14 X 12	120	0.090	4.5	540	2.0	0	238
W -Wall-12C1-0bw 4 X 12	48	0.090	4.5	216	2.0	0	95
N -Gls-4A-6-o shgc-0.33 100%S (2)	48	0.330	16.5	792	15.0	0	722
UP-Roof-Part-18B1-21o 18 X 14	252	0.051	0.8	193	0.8	0	193
Floor-22A-ph 18 ft..Per.	18	1.358	67.9	1,222	0.0	0	0
Subtotals for Structure:				2,963		0	1,248
Infil.: Win.: 9.8, Sum.: 9.8	216		2.440	527	1.222	176	264
People: 200 lat/per, 230 sen/per:	2					400	460
Room Totals:				3,490		576	1,972

Detailed Room Loads - Room 3 - Master Closet (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	15.0	ft.	System Number:	1	
Room Width:	10.0	ft.	Zone Number:	1	
Area:	150.0	sq.ft.	Supply Air:	36	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	1.4	AC/hr
Volume:	1,500.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	6	CFM
Runout Air:	36	CFM	Percent of Supply.:	16	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	4	CFM
Runout Air Velocity:	415	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	415	ft./min.	Actual Winter Infil.:	7	CFM
Actual Loss:	0.193	in.wg./100 ft.	Actual Summer Infil.:	7	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 10 X 10	89	0.090	4.5	401	2.0	0	176
E -Wall-12C1-0bw 2 X 10	20	0.090	4.5	90	2.0	0	40
W -Wall-12C1-0bw 4 X 10	40	0.090	4.5	180	2.0	0	79
S -Gls-4A-6-o shgc-0.33 66%S	11	0.330	16.5	182	16.2	0	178
UP-Roof-Part-18B1-21o 15 X 10	150	0.051	0.8	115	0.8	0	115
Floor-22A-ph 16 ft..Per.	16	1.358	67.9	1,086	0.0	0	0
Subtotals for Structure:				2,054		0	588
Infil.: Win.: 7.2, Sum.: 7.2	160		2.444	391	1.219	130	195
Room Totals:				2,445		130	783

Detailed Room Loads - Room 4 - Hidden Closet (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	6.0	ft.	System Number:	1	
Room Width:	6.0	ft.	Zone Number:	1	
Area:	36.0	sq.ft.	Supply Air:	13	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	2.2	AC/hr
Volume:	360.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	2	CFM
Runout Air:	13	CFM	Percent of Supply.:	16	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	1	CFM
Runout Air Velocity:	154	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	154	ft./min.	Actual Winter Infil.:	3	CFM
Actual Loss:	0.028	in.wg./100 ft.	Actual Summer Infil.:	3	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 6 X 10	55	0.090	4.5	248	2.0	0	109
S -Gls-4A-6-o shgc-0.33 73%S	5	0.330	16.5	83	16.0	0	80
UP-Roof-Part-18B1-21o 6 X 6	36	0.051	0.8	28	0.8	0	28
Floor-22A-ph 6 ft..Per.	6	1.358	67.9	407	0.0	0	0
Subtotals for Structure:				766		0	217
Infil.: Win.: 2.7, Sum.: 2.7	60		2.433	146	1.217	49	73
Room Totals:				912		49	290

Detailed Room Loads - Room 5 - Powder Bath (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	6.0	ft.	System Number:	1	
Room Width:	6.0	ft.	Zone Number:	1	
Area:	36.0	sq.ft.	Supply Air:	13	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	2.2	AC/hr
Volume:	360.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	2	CFM
Runout Air:	13	CFM	Percent of Supply.:	16	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	1	CFM
Runout Air Velocity:	154	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	154	ft./min.	Actual Winter Infil.:	3	CFM
Actual Loss:	0.028	in.wg./100 ft.	Actual Summer Infil.:	3	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 6 X 10	55	0.090	4.5	248	2.0	0	109
S -Gls-4A-6-o shgc-0.33 73%S	5	0.330	16.5	83	16.0	0	80
UP-Roof-Part-18B1-21o 6 X 6	36	0.051	0.8	28	0.8	0	28
Floor-22A-ph 6 ft..Per.	6	1.358	67.9	407	0.0	0	0
Subtotals for Structure:				766		0	217
Infil.: Win.: 2.7, Sum.: 2.7	60		2.433	146	1.217	49	73
Room Totals:				912		49	290

Detailed Room Loads - Room 6 - Living (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	21.0	ft.	System Number:	1	
Room Width:	25.0	ft.	Zone Number:	1	
Area:	525.0	sq.ft.	Supply Air:	221	CFM
Ceiling Height:	14.0	ft.	Supply Air Changes:	1.8	AC/hr
Volume:	7,350.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	2		Actual Winter Vent.:	17	CFM
Runout Air:	111	CFM	Percent of Supply.:	8	%
Runout Duct Size:	6	in.	Actual Summer Vent.:	24	CFM
Runout Air Velocity:	563	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	563	ft./min.	Actual Winter Infil.:	16	CFM
Actual Loss:	0.199	in.wg./100 ft.	Actual Summer Infil.:	16	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 25 X 14	148	0.090	4.5	666	2.0	0	293
N -Gls-4A-6-o shgc-0.33 100%S (2)	84	0.330	16.5	1,386	15.0	0	1,264
N -Gls-4A-6-o shgc-0.33 100%S	76	0.330	16.5	1,254	15.1	0	1,144
N -Gls-10D-w shgc-0.32 100%S	42	0.490	24.5	1,029	18.8	0	791
UP-Roof-Part-18B1-21o 21 X 25	525	0.051	0.8	402	0.8	0	402
Floor-22A-ph 25 ft..Per.	25	1.358	67.9	1,698	0.0	0	0
Subtotals for Structure:				6,435		0	3,894
Infil.: Win.: 15.8, Sum.: 15.8	350		2.443	855	1.220	285	427
People: 200 lat/per, 230 sen/per:	2					400	460
Room Totals:				7,290		685	4,781

Detailed Room Loads - Room 7 - Entry (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	16.0	ft.	System Number:	1	
Room Width:	9.0	ft.	Zone Number:	1	
Area:	144.0	sq.ft.	Supply Air:	52	CFM
Ceiling Height:	12.0	ft.	Supply Air Changes:	1.8	AC/hr
Volume:	1,728.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	7	CFM
Runout Air:	52	CFM	Percent of Supply.:	13	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	6	CFM
Runout Air Velocity:	601	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	601	ft./min.	Actual Winter Infil.:	8	CFM
Actual Loss:	0.399	in.wg./100 ft.	Actual Summer Infil.:	8	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 9 X 12	66	0.090	4.5	297	2.0	0	131
W -Wall-12C1-0bw 6 X 12	72	0.090	4.5	324	2.0	0	143
S -Door-11N 6 X 7	42	0.350	17.5	735	12.6	0	529
UP-Roof-Part-18B1-21o 16 X 9	144	0.051	0.8	110	0.8	0	110
Floor-22A-ph 15 ft..Per.	15	1.358	67.9	1,019	0.0	0	0
Subtotals for Structure:				2,485		0	913
Infil.: Win.: 8.1, Sum.: 8.1	180		2.439	439	1.222	147	220
Room Totals:				2,924		147	1,133

Detailed Room Loads - Room 8 - Dining Room (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	15.0	ft.	System Number:	1	
Room Width:	19.0	ft.	Zone Number:	1	
Area:	285.0	sq.ft.	Supply Air:	158	CFM
Ceiling Height:	12.0	ft.	Supply Air Changes:	2.8	AC/hr
Volume:	3,420.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	16	CFM
Runout Air:	158	CFM	Percent of Supply.:	10	%
Runout Duct Size:	8	in.	Actual Summer Vent.:	17	CFM
Runout Air Velocity:	453	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	453	ft./min.	Actual Winter Infil.:	17	CFM
Actual Loss:	0.087	in.wg./100 ft.	Actual Summer Infil.:	17	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 19 X 12	137	0.090	4.5	617	2.0	0	271
W -Wall-12C1-0bw 5 X 12	60	0.090	4.5	270	2.0	0	119
E -Wall-12C1-0bw 7 X 12	45	0.090	4.5	203	2.0	0	89
N -Gls-4A-6-o shgc-0.33 100%S (4)	91	0.330	16.5	1,500	15.0	0	1,368
E -Gls-4A-6-o shgc-0.33 100%S	18	0.330	16.5	297	15.1	0	271
E -Gls-10D-w shgc-0.32 100%S	21	0.490	24.5	515	18.9	0	396
UP-Roof-Part-18B1-21o 15 X 19	285	0.051	0.8	218	0.8	0	218
Floor-22A-ph 31 ft..Per.	31	1.358	67.9	2,105	0.0	0	0
Subtotals for Structure:				5,725		0	2,732
Infil.: Win.: 16.8, Sum.: 16.8	372		2.441	908	1.220	303	454
People: 200 lat/per, 230 sen/per:	1					200	230
Room Totals:				6,633		503	3,416

Detailed Room Loads - Room 9 - Kitchen (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	16.0	ft.	System Number:	1	
Room Width:	20.0	ft.	Zone Number:	1	
Area:	320.0	sq.ft.	Supply Air:	67	CFM
Ceiling Height:	12.0	ft.	Supply Air Changes:	1.0	AC/hr
Volume:	3,840.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	1	CFM
Runout Air:	67	CFM	Percent of Supply.:	1	%
Runout Duct Size:	5	in.	Actual Summer Vent.:	7	CFM
Runout Air Velocity:	490	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	490	ft./min.	Actual Winter Infil.:	0	CFM
Actual Loss:	0.195	in.wg./100 ft.	Actual Summer Infil.:	0	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
UP-Roof-Part-18B1-21o 16 X 20	320	0.051	0.8	245	0.8	0	245
Subtotals for Structure:				245		0	245
Infil.: Win.: 0.0, Sum.: 0.0	0		0	0	0	0	0
Equipment:						0	1,200
Room Totals:				245		0	1,445

Detailed Room Loads - Room 10 - Game Room (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	16.0	ft.	System Number:	1	
Room Width:	20.0	ft.	Zone Number:	1	
Area:	320.0	sq.ft.	Supply Air:	119	CFM
Ceiling Height:	12.0	ft.	Supply Air Changes:	1.9	AC/hr
Volume:	3,840.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	12	CFM
Runout Air:	119	CFM	Percent of Supply.:	10	%
Runout Duct Size:	6	in.	Actual Summer Vent.:	13	CFM
Runout Air Velocity:	608	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	608	ft./min.	Actual Winter Infil.:	12	CFM
Actual Loss:	0.232	in.wg./100 ft.	Actual Summer Infil.:	12	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 20 X 12	135	0.090	4.5	608	2.0	0	267
E -Wall-12C1-0bw 3 X 12	36	0.090	4.5	162	2.0	0	71
S -Gls-4A-6-o shgc-0.33 100%S (3)	84	0.330	16.5	1,386	15.0	0	1,263
S -Gls-10D-w shgc-0.32 100%S	21	0.490	24.5	515	18.9	0	396
UP-Roof-Part-18B1-21o 16 X 20	320	0.051	0.8	245	0.8	0	245
Floor-22A-ph 23 ft..Per.	23	1.358	67.9	1,562	0.0	0	0
Subtotals for Structure:				4,478		0	2,242
Infil.: Win.: 12.5, Sum.: 12.5	276		2.442	674	1.221	225	337
Room Totals:				5,152		225	2,579

Detailed Room Loads - Room 11 - Bar (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	12.0	ft.	System Number:	1	
Room Width:	8.0	ft.	Zone Number:	1	
Area:	96.0	sq.ft.	Supply Air:	24	CFM
Ceiling Height:	12.0	ft.	Supply Air Changes:	1.3	AC/hr
Volume:	1,152.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	3	CFM
Runout Air:	24	CFM	Percent of Supply.:	14	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	3	CFM
Runout Air Velocity:	275	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	275	ft./min.	Actual Winter Infil.:	4	CFM
Actual Loss:	0.086	in.wg./100 ft.	Actual Summer Infil.:	4	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 8 X 12	86	0.090	4.5	387	2.0	0	170
S -Gls-4A-6-o shgc-0.33 73%S	10	0.330	16.5	165	15.9	0	159
UP-Roof-Part-18B1-21o 12 X 8	96	0.051	0.8	73	0.8	0	73
Floor-22A-ph 8 ft..Per.	8	1.358	67.9	543	0.0	0	0
Subtotals for Structure:				1,168		0	402
Infil.: Win.: 4.3, Sum.: 4.3	96		2.438	234	1.219	78	117
Room Totals:				1,402		78	519

Detailed Room Loads - Room 12 - Utility (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	16.0	ft.	System Number:	1	
Room Width:	10.0	ft.	Zone Number:	1	
Area:	160.0	sq.ft.	Supply Air:	36	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	1.3	AC/hr
Volume:	1,600.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	6	CFM
Runout Air:	36	CFM	Percent of Supply.:	18	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	4	CFM
Runout Air Velocity:	410	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	410	ft./min.	Actual Winter Infil.:	8	CFM
Actual Loss:	0.188	in.wg./100 ft.	Actual Summer Infil.:	8	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 16 X 10	145	0.090	4.5	653	2.0	0	287
E -Wall-12C1-0bw 2 X 10	20	0.090	4.5	90	2.0	0	40
N -Gls-4A-6-o shgc-0.33 100%S	15	0.330	16.5	248	15.1	0	226
Floor-22A-ph 18 ft..Per.	18	1.358	67.9	1,222	0.0	0	0
Subtotals for Structure:				2,213		0	553
Infil.: Win.: 8.1, Sum.: 8.1	180		2.439	439	1.222	147	220
Room Totals:				2,652		147	773

Detailed Room Loads - Room 13 - Office (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	16.0	ft.	System Number:	1	
Room Width:	10.0	ft.	Zone Number:	1	
Area:	160.0	sq.ft.	Supply Air:	51	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	1.9	AC/hr
Volume:	1,600.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	10	CFM
Runout Air:	51	CFM	Percent of Supply.:	19	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	5	CFM
Runout Air Velocity:	579	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	579	ft./min.	Actual Winter Infil.:	13	CFM
Actual Loss:	0.372	in.wg./100 ft.	Actual Summer Infil.:	13	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-12C1-0bw 10 X 10	100	0.090	4.5	450	2.0	0	198
N -Wall-12C1-0bw 16 X 10	145	0.090	4.5	653	2.0	0	287
W -Wall-12C1-0bw 2 X 10	20	0.090	4.5	90	2.0	0	40
N -Gls-4A-6-o shgc-0.33 100%S	15	0.330	16.5	248	15.1	0	226
Floor-22A-ph 28 ft..Per.	28	1.358	67.9	1,901	0.0	0	0
Subtotals for Structure:				3,342		0	751
Infil.: Win.: 12.6, Sum.: 12.6	280		2.443	684	1.221	228	342
Room Totals:				4,026		228	1,093

Detailed Room Loads - Room 14 - East Pwdr Bath (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	8.0	ft.	System Number:	1	
Room Width:	6.0	ft.	Zone Number:	1	
Area:	48.0	sq.ft.	Supply Air:	9	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	1.1	AC/hr
Volume:	480.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	2	CFM
Runout Air:	9	CFM	Percent of Supply.:	22	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	1	CFM
Runout Air Velocity:	102	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	102	ft./min.	Actual Winter Infil.:	3	CFM
Actual Loss:	0.013	in.wg./100 ft.	Actual Summer Infil.:	3	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-12C1-0bw 6 X 10	60	0.090	4.5	270	2.0	0	119
Floor-22A-ph 6 ft..Per.	6	1.358	67.9	407	0.0	0	0
Subtotals for Structure:				677		0	119
Infil.: Win.: 2.7, Sum.: 2.7	60		2.433	146	1.217	49	73
Room Totals:				823		49	192

Detailed Room Loads - Room 15 - Stairs / Hall (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	12.0	ft.	System Number:	1	
Room Width:	18.0	ft.	Zone Number:	1	
Area:	216.0	sq.ft.	Supply Air:	28	CFM
Ceiling Height:	20.0	ft.	Supply Air Changes:	0.4	AC/hr
Volume:	4,320.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	3	CFM
Runout Air:	28	CFM	Percent of Supply.:	12	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	3	CFM
Runout Air Velocity:	324	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	324	ft./min.	Actual Winter Infil.:	3	CFM
Actual Loss:	0.119	in.wg./100 ft.	Actual Summer Infil.:	3	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-12C1-0bw 7 X 10	49	0.090	4.5	221	2.0	0	97
E -Door-11N 3 X 7	21	0.350	17.5	368	12.6	0	265
UP-Roof-Part-18B1-21o 12 X 18	216	0.051	0.8	165	0.8	0	165
Floor-22A-ph 7 ft..Per.	7	1.358	67.9	475	0.0	0	0
Subtotals for Structure:				1,229		0	527
Infil.: Win.: 3.2, Sum.: 3.2	70		2.443	171	1.214	57	85
Room Totals:				1,400		57	612

Detailed Room Loads - Room 16 - Media Room (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	16.0	ft.	System Number:	1	
Room Width:	28.0	ft.	Zone Number:	1	
Area:	448.0	sq.ft.	Supply Air:	136	CFM
Ceiling Height:	10.0	ft.	Supply Air Changes:	1.8	AC/hr
Volume:	4,480.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	19	CFM
Runout Air:	136	CFM	Percent of Supply.:	14	%
Runout Duct Size:	7	in.	Actual Summer Vent.:	15	CFM
Runout Air Velocity:	510	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	510	ft./min.	Actual Winter Infil.:	24	CFM
Actual Loss:	0.133	in.wg./100 ft.	Actual Summer Infil.:	24	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 28 X 10	250	0.090	4.5	1,125	2.0	0	495
E -Wall-12C1-0bw 16 X 10	160	0.090	4.5	720	2.0	0	317
W -Wall-12C1-0bw 10 X 10	100	0.090	4.5	450	2.0	0	198
S -Gls-4A-6-o shgc-0.33 73%S (3)	30	0.330	16.5	495	15.9	0	477
UP-Roof-Part-18B1-21o 16 X 28	448	0.051	0.8	343	0.8	0	343
Floor-22A-ph 54 ft..Per.	54	1.358	67.9	3,667	0.0	0	0
Subtotals for Structure:				6,800		0	1,830
Infil.: Win.: 24.4, Sum.: 24.4	540		2.441	1,318	1.220	440	659
People: 200 lat/per, 230 sen/per:	2					400	460
Room Totals:				8,118		840	2,949

Detailed Room Loads - Room 17 - Observation (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	10.0	ft.	System Number:	1	
Room Width:	10.0	ft.	Zone Number:	1	
Area:	100.0	sq.ft.	Supply Air:	132	CFM
Ceiling Height:	8.0	ft.	Supply Air Changes:	9.9	AC/hr
Volume:	800.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	8	CFM
Runout Air:	132	CFM	Percent of Supply.:	6	%
Runout Duct Size:	7	in.	Actual Summer Vent.:	14	CFM
Runout Air Velocity:	492	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	492	ft./min.	Actual Winter Infil.:	14	CFM
Actual Loss:	0.124	in.wg./100 ft.	Actual Summer Infil.:	14	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 10 X 8	53	0.090	4.5	239	2.0	0	105
S -Wall-12C1-0bw 10 X 8	53	0.090	4.5	239	2.0	0	105
E -Wall-12C1-0bw 10 X 8	80	0.090	4.5	360	2.0	0	158
W -Wall-12C1-0bw 10 X 8	53	0.090	4.5	239	2.0	0	105
N -Gls-4A-6-o shgc-0.33 100%S (2)	27	0.330	16.5	446	15.0	0	406
W -Gls-4A-6-o shgc-0.33 0%S (2)	27	0.330	16.5	446	39.9	0	1,076
S -Gls-4A-6-o shgc-0.33 81%S (2)	27	0.330	16.5	446	15.6	0	422
UP-Roof-Part-18B1-21o 10 X 10	100	0.051	0.8	77	0.8	0	77
Subtotals for Structure:				2,492		0	2,454
Infil.: Win.: 14.5, Sum.: 14.5	320		2.441	781	1.222	261	391
Room Totals:				3,273		261	2,845

Detailed Room Loads - Room 18 - Upper Master Bedroom (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	9.0	ft.	System Number:	1	
Room Width:	9.0	ft.	Zone Number:	1	
Area:	81.0	sq.ft.	Supply Air:	63	CFM
Ceiling Height:	8.0	ft.	Supply Air Changes:	5.8	AC/hr
Volume:	648.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	6	CFM
Runout Air:	63	CFM	Percent of Supply.:	9	%
Runout Duct Size:	5	in.	Actual Summer Vent.:	7	CFM
Runout Air Velocity:	460	ft./min.	Percent of Supply:	11	%
Runout Air Velocity:	460	ft./min.	Actual Winter Infil.:	13	CFM
Actual Loss:	0.173	in.wg./100 ft.	Actual Summer Infil.:	13	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 9 X 8	49.5	0.090	4.5	223	2.0	0	98
E -Wall-12C1-0bw 9 X 8	72	0.090	4.5	324	2.0	0	143
W -Wall-12C1-0bw 9 X 8	72	0.090	4.5	324	2.0	0	143
S -Wall-12C1-0bw 9 X 8	66	0.090	4.5	297	2.0	0	131
N -Gls-4A-6-o shgc-0.33 100%S (2)	22.5	0.330	16.5	372	15.0	0	338
S -Gls-4A-6-o shgc-0.33 100%S (2)	6	0.330	16.5	100	15.0	0	90
UP-Roof-Part-18B1-21o 9 X 9	81	0.051	0.8	62	0.8	0	62
Subtotals for Structure:				1,702		0	1,005
Infil.: Win.: 13.0, Sum.: 13.0	288		2.441	703	1.222	235	352
Room Totals:				2,405		235	1,357

Detailed Room Loads - Room 19 - Bedroom 4 (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	13.0	ft.	System Number:	2	
Room Width:	18.0	ft.	Zone Number:	1	
Area:	234.0	sq.ft.	Supply Air:	112	CFM
Ceiling Height:	9.0	ft.	Supply Air Changes:	3.2	AC/hr
Volume:	2,106.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	34	CFM
Runout Air:	112	CFM	Percent of Supply.:	31	%
Runout Duct Size:	6	in.	Actual Summer Vent.:	39	CFM
Runout Air Velocity:	571	ft./min.	Percent of Supply:	34	%
Runout Air Velocity:	571	ft./min.	Actual Winter Infil.:	9	CFM
Actual Loss:	0.205	in.wg./100 ft.	Actual Summer Infil.:	9	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 18 X 9	129	0.090	4.5	581	2.0	0	255
E -Wall-12C1-0bw 13 X 9	102	0.090	4.5	459	2.0	0	202
S -Gls-4A-6-o shgc-0.33 66%S (2)	33	0.330	16.5	544	16.2	0	534
E -Gls-4A-6-o shgc-0.33 0%S (2)	15	0.330	16.5	248	39.9	0	598
UP-Roof-Part-18B1-21o 13 X 18	234	0.051	0.8	179	0.8	0	179
Floor-Part-open cell foam 18 X 13	234	0.051	0.8	179	0.8	0	179
Subtotals for Structure:				2,190		0	1,947
Infil.: Win.: 9.1, Sum.: 9.1	279		1.763	492	0.882	164	246
People: 200 lat/per, 230 sen/per:	1					200	230
Room Totals:				2,682		364	2,423

Detailed Room Loads - Room 20 - Bedroom 3 (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	12.0	ft.	System Number:	2	
Room Width:	13.0	ft.	Zone Number:	1	
Area:	156.0	sq.ft.	Supply Air:	65	CFM
Ceiling Height:	9.0	ft.	Supply Air Changes:	2.8	AC/hr
Volume:	1,404.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	14	CFM
Runout Air:	65	CFM	Percent of Supply.:	22	%
Runout Duct Size:	5	in.	Actual Summer Vent.:	22	CFM
Runout Air Velocity:	476	ft./min.	Percent of Supply:	34	%
Runout Air Velocity:	476	ft./min.	Actual Winter Infil.:	4	CFM
Actual Loss:	0.184	in.wg./100 ft.	Actual Summer Infil.:	4	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
E -Wall-12C1-0bw 12 X 9	91.5	0.090	4.5	412	2.0	0	181
E -Gls-4A-6-o shgc-0.33 0%S	16.5	0.330	16.5	272	39.9	0	658
UP-Roof-Part-18B1-21o 12 X 13	156	0.051	0.8	119	0.8	0	119
Floor-Part-open cell foam 13 X 12	156	0.051	0.8	119	0.8	0	119
Subtotals for Structure:				922		0	1,077
Infil.: Win.: 3.5, Sum.: 3.5	108		1.769	191	0.880	64	95
People: 200 lat/per, 230 sen/per:	1					200	230
Room Totals:				1,113		264	1,402

Detailed Room Loads - Room 21 - Bath 2 (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	11.0	ft.	System Number:	2	
Room Width:	13.0	ft.	Zone Number:	1	
Area:	143.0	sq.ft.	Supply Air:	74	CFM
Ceiling Height:	9.0	ft.	Supply Air Changes:	3.5	AC/hr
Volume:	1,287.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	25	CFM
Runout Air:	74	CFM	Percent of Supply.:	33	%
Runout Duct Size:	5	in.	Actual Summer Vent.:	26	CFM
Runout Air Velocity:	543	ft./min.	Percent of Supply:	34	%
Runout Air Velocity:	543	ft./min.	Actual Winter Infil.:	7	CFM
Actual Loss:	0.239	in.wg./100 ft.	Actual Summer Infil.:	7	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 13 X 9	102	0.090	4.5	459	2.0	0	202
E -Wall-12C1-0bw 11 X 9	84	0.090	4.5	378	2.0	0	166
E -Gls-4A-6-o shgc-0.33 0%S (2)	15	0.330	16.5	248	39.9	0	598
N -Gls-4A-6-o shgc-0.33 100%S (2)	15	0.330	16.5	248	15.1	0	226
UP-Roof-Part-18B1-21o 11 X 13	143	0.051	0.8	109	0.8	0	109
Floor-Part-open cell foam 13 X 11	143	0.051	0.8	109	0.8	0	109
Subtotals for Structure:				1,551		0	1,410
Infil.: Win.: 7.1, Sum.: 7.1	216		1.764	381	0.884	127	191
Room Totals:				1,932		127	1,601

Detailed Room Loads - Room 22 - Bedroom 2 (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	14.0	ft.	System Number:	2	
Room Width:	12.0	ft.	Zone Number:	1	
Area:	168.0	sq.ft.	Supply Air:	63	CFM
Ceiling Height:	9.0	ft.	Supply Air Changes:	2.5	AC/hr
Volume:	1,512.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	25	CFM
Runout Air:	63	CFM	Percent of Supply.:	39	%
Runout Duct Size:	5	in.	Actual Summer Vent.:	22	CFM
Runout Air Velocity:	465	ft./min.	Percent of Supply:	34	%
Runout Air Velocity:	465	ft./min.	Actual Winter Infil.:	8	CFM
Actual Loss:	0.176	in.wg./100 ft.	Actual Summer Infil.:	8	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
N -Wall-12C1-0bw 12 X 9	91.5	0.090	4.5	412	2.0	0	181
W -Wall-12C1-0bw 14 X 9	126	0.090	4.5	567	2.0	0	249
N -Gls-4A-6-o shgc-0.33 100%S	16.5	0.330	16.5	272	15.0	0	248
UP-Roof-Part-18B1-21o 14 X 12	168	0.051	0.8	129	0.8	0	129
Floor-Part-open cell foam 12 X 14	168	0.051	0.8	129	0.8	0	129
Subtotals for Structure:				1,509		0	936
Infil.: Win.: 7.6, Sum.: 7.6	234		1.765	413	0.880	138	206
People: 200 lat/per, 230 sen/per:	1					200	230
Room Totals:				1,922		338	1,372

Detailed Room Loads - Room 23 - Kids Study (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	15.0	ft.	System Number:	2	
Room Width:	22.0	ft.	Zone Number:	1	
Area:	330.0	sq.ft.	Supply Air:	84	CFM
Ceiling Height:	9.0	ft.	Supply Air Changes:	1.7	AC/hr
Volume:	2,970.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	37	CFM
Runout Air:	84	CFM	Percent of Supply.:	44	%
Runout Duct Size:	5	in.	Actual Summer Vent.:	29	CFM
Runout Air Velocity:	613	ft./min.	Percent of Supply:	34	%
Runout Air Velocity:	613	ft./min.	Actual Winter Infil.:	11	CFM
Actual Loss:	0.303	in.wg./100 ft.	Actual Summer Infil.:	11	CFM

Item Description	Area Quantity	-U- Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
W -Wall-12C1-0bw 15 X 9	135	0.090	4.5	608	2.0	0	267
N -Wall-12C1-0bw 21 X 9	141	0.090	4.5	635	2.0	0	279
N -Gls-4A-6-o shgc-0.33 100%S (2)	48	0.330	16.5	792	15.0	0	722
UP-Roof-Part-18B1-21o 15 X 22	330	0.051	0.8	252	0.8	0	252
Subtotals for Structure:				2,287		0	1,520
Infil.: Win.: 10.6, Sum.: 10.6	324		1.765	572	0.883	191	286
Room Totals:				2,859		191	1,806

Detailed Room Loads - Room 24 - Upstairs Bath (Average Load Procedure)

General

Calculation Mode:	Htg. & clg.		Occurrences:	1	
Room Length:	6.0	ft.	System Number:	2	
Room Width:	11.0	ft.	Zone Number:	1	
Area:	66.0	sq.ft.	Supply Air:	23	CFM
Ceiling Height:	9.0	ft.	Supply Air Changes:	2.3	AC/hr
Volume:	594.0	cu.ft.	Required Vent.:	0	CFM
Number of Registers:	1		Actual Winter Vent.:	10	CFM
Runout Air:	23	CFM	Percent of Supply.:	46	%
Runout Duct Size:	4	in.	Actual Summer Vent.:	8	CFM
Runout Air Velocity:	259	ft./min.	Percent of Supply:	34	%
Runout Air Velocity:	259	ft./min.	Actual Winter Infil.:	3	CFM
Actual Loss:	0.077	in.wg./100 ft.	Actual Summer Infil.:	3	CFM

Item Description	Area Quantity	-U-Value	Htg HTM	Sen Loss	Clg HTM	Lat Gain	Sen Gain
S -Wall-12C1-0bw 11 X 9	87	0.090	4.5	392	2.0	0	172
S -Gls-4A-6-o shgc-0.33 100%S (2)	12	0.330	16.5	198	15.0	0	180
UP-Roof-Part-18B1-21o 6 X 11	66	0.051	0.8	50	0.8	0	50
Subtotals for Structure:				640		0	402
Infil.: Win.: 3.2, Sum.: 3.2	99		1.768	175	0.879	58	87
Room Totals:				815		58	489

System 1 Room Load Summary

No	Room Name	Area SF	Htg Sens Btuh	Min Htg CFM	Run Duct Size	Run Duct Vel	Clg Sens Btuh	Clg Lat Btuh	Min Clg CFM	Act Sys CFM
---Zone 1---										
1	Master Bath	208	6,359	84	1-6	526	2,233	342	103	103
2	Master Bedroom	252	3,490	46	1-6	465	1,972	576	91	91
3	Master Closet	150	2,445	32	1-4	415	783	130	36	36
4	Hidden Closet	36	912	12	1-4	154	290	49	13	13
5	Powder Bath	36	912	12	1-4	154	290	49	13	13
6	Living	525	7,290	96	2-6	563	4,781	685	221	221
7	Entry	144	2,924	39	1-4	601	1,133	147	52	52
8	Dining Room	285	6,633	88	1-8	453	3,416	503	158	158
9	Kitchen	320	245	3	1-5	490	1,445	0	67	67
10	Game Room	320	5,152	68	1-6	608	2,579	225	119	119
11	Bar	96	1,402	19	1-4	275	519	78	24	24
12	Utility	160	2,652	35	1-4	410	773	147	36	36
13	Office	160	4,026	53	1-4	579	1,093	228	51	51
14	East Pwdr Bath	48	823	11	1-4	102	192	49	9	9
15	Stairs / Hall	216	1,400	19	1-4	324	612	57	28	28
16	Media Room	448	8,118	107	1-7	510	2,949	840	136	136
17	Observation	100	3,273	43	1-7	492	2,845	261	132	132
18	Upper Master Bedroom	81	2,405	32	1-5	460	1,357	235	63	63
	Ventilation		7,837				3,919	2,614		
	System 1 total	3,585	68,298	799			33,181	7,215	1,353	1,353

System 1 Main Trunk Size:	18	in.
Velocity:	766	ft./min
Loss per 100 ft.:	0.083	in.wg

Cooling System Summary

	Cooling Tons	Sensible/Latent Split	Sensible Btuh	Latent Btuh	Total Btuh
Net Required:	3.37	82% / 18%	33,181	7,215	40,396
Recommended:	3.69	75% / 25%	33,181	11,060	44,241

Equipment Data

	Heating System	Cooling System
Type:	Natural Gas Furnace	Standard Air Conditioner
Model:		
Indoor Model:		
Brand:		
Efficiency:	0 AFUE	0 SEER
Sound:		
Capacity:	0 Btuh	0 Btuh
Sensible Capacity:	n/a	0 Btuh
Latent Capacity:	n/a	0 Btuh
ARI Reference No.:	n/a	

System 2 Room Load Summary

No	Room Name	Area SF	Htg Sens Btuh	Min Htg CFM	Run Duct Size	Run Duct Vel	Clg Sens Btuh	Clg Lat Btuh	Min Clg CFM	Act Sys CFM
---Zone 1---										
19	Bedroom 4	234	2,682	35	1-6	571	2,423	364	112	112
20	Bedroom 3	156	1,113	15	1-5	476	1,402	264	65	65
21	Bath 2	143	1,932	26	1-5	543	1,601	127	74	74
22	Bedroom 2	168	1,922	25	1-5	465	1,372	338	63	63
23	Kids Study	330	2,859	38	1-5	613	1,806	191	84	84
24	Upstairs Bath	66	815	11	1-4	259	489	58	23	23
	Ventilation		7,837				3,919	2,614		
	System 2 total	1,097	19,160	150			13,012	3,956	421	421

System 2 Main Trunk Size:	10	in.
Velocity:	771	ft./min
Loss per 100 ft.:	0.185	in.wg

Cooling System Summary

	Cooling Tons	Sensible/Latent Split	Sensible Btuh	Latent Btuh	Total Btuh
Net Required:	1.41	77% / 23%	13,012	3,956	16,968
Recommended:	1.45	75% / 25%	13,012	4,337	17,349

Equipment Data

	Heating System	Cooling System
Type:	Natural Gas Furnace	Standard Air Conditioner
Model:		
Indoor Model:		
Brand:		
Efficiency:	0 AFUE	0 SEER
Sound:		
Capacity:	0 Btuh	0 Btuh
Sensible Capacity:	n/a	0 Btuh
Latent Capacity:	n/a	0 Btuh
ARI Reference No.:	n/a	

Appendix D.7.7.5
Field Testing

March 25, 2009

Chris Miles
GreenCraft Builders LLC
105 W. Main Street
Lewisville, Texas
214-718-8424

Building America Performance Testing of the Colleyville House

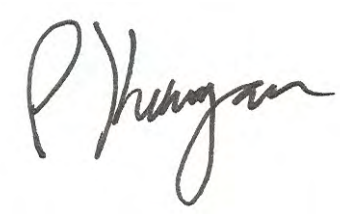
Dear Mr. Miles,

BSC visited the Colleyville house on March 10, 2009 and performed a full battery of performance tests for commissioning the house as a Building America building. Overall, the house tested very well and complies with Building America Specifications.

Monitoring devices were also installed. Temperature and Relative Humidity HOBOs were installed in various areas of the house. It will be recording and saving data every half hour for a year.

If you have any questions you can email me at phil@buildingscience.com. The data will have to be downloaded in one year.

Sincerely,



Philip Kerrigan Jr., PE

Building Science Corporation

Building Plan and Specifications

Building Science Corporation tested the Colleyville House (a 2007 Building America Research house) on March 10, 2009. This prototype reaches 69% vs. the Building America Benchmark without PVs and 76% with PV renewables. This prototype was given a full battery of tests, including multipoint blower door measurements; duct leakage (total and to the outside), and individual register flows. Overall, the Colleyville house tested extraordinarily well. In addition to meeting Building America performance criteria the house employs many conservative design elements (salvaged wood floors, recycled material countertop) and is certified LEED Platinum.

Figure 1: Greencraft Colleyville House at 1708 Oak Knoll Drive, Colleyville, TX

The building dimensions for the Colleyville house are listed below.

Address	Town, State	Floor area (ft^2)	Surface (ft^2)	Volume (ft^3)	Glazing Ratio (%)
1708 Oak Knoll Drive	Colleyville, TX	4886	12598	76929	18.9%

The summary of our blower door data was as follows:

$CFM\ 50_{measured}$	$CFM\ 50_{goal}$	Pass/Fail	ACH 50	EqLA	ELA	Leak Ratio
CFM @ 50 Pa	CFM @ 50 Pa	2.5 in^2	(cfm50/vol/hr)	(in^2@10 Pa)	(in^2@4 Pa)	(EqLA/surf/100)
1097	3149	Pass	0.9	113.0	60.3	0.9

- Duct airtightness tests were run on the prototype; it met our requirement of 5% or less of nominal air handler flow duct leakage to outside (CFM 25), at 1.0% (30 CFM). Total duct leakage was on the order of 18% (430 CFM 50).
- A GeneralAire model 1300 whole house dehumidifier was installed and configured correctly.
- An Aprilaire Model 8126 Ventilation Control System was installed for outside air ventilation.
- An Energy Star Compact Fluorescent Lighting package was installed as well as an Energy Star refrigerator, dishwasher and clothes washer.

Construction

Construction of the Colleyville House was well documented and they have a website solely dedicated to this project.

http://www.colleyvilleecohouse.com/

GreenCraft Builders LLC. was the builder for this project, headed by Chris Miles. The house had guided tours throughout the construction process and over 4000 people were able to explore the project and get educated on the advanced technologies involved.

Below are the characteristics of the house

Specifications

Building Enclosure

Ceiling	R-30 spray foam at roof deck to create Conditioned attic Icynene®
Walls	2x6, 24" oc framing with 3/4" XPS with R-19 Spray foam Icynene®
Foundation	51% Flyash concrete monolithic slab with Termimesh termite control
Windows	Pella ® fiberglass LoE^3 (U=0.28, SHGC=0.24)
Infiltration	2.5 sq in leakage area per 100 sf envelope

Mechanical systems

Heat	WaterFurnace COP 5 GSHP
Cooling	WaterFurnace 4 ton downstairs, 2 ton upstairs 6 wells 25' apart 300 ft deep
DHW	30 gal LowBoy gets hot water from GSHP Rinnai R94LSi Instantaneous Hot Water EF=0.82 for auxillary DHW
Ducts	R-4.2 flex runouts in unvented attic or in floor joists
Leakage	none to outside (5% or less)
Dehumidification	GeneralAire Model 1300 whole house dehumidifier
Ventilation	ERV Fantech SER Series AirCycler^{TM} FR-V Supply-only system integrated with AHU 33% Duty Cycle: 10 minutes on; 20 minutes off, 50 CFM average flow
Return Pathways	Jump ducts at bedrooms and laundry

Other Loads

Lighting	CFL lighting package all screw base
Appliances	Energy Star fridge, DW, clothes washer

Walls

The house was cladded with Hardie Color Plus siding and stone over Tyvek® DrainWrap™ (with the corrugated grooves) over ¾" unskinned XPS sheathing over a wood framed wall with 2x6 24" OVE framing. The OVE framing includes a single top plate and two stud energy corners as well as windows framed at 2' intervals.

Figure 2: Walls wrapped with Tyvek® DrainWrap™

Roof

The roof was constructed with an unvented cathedralized attic. Icynene® was sprayed to the underside of the roof sheathing to R-30. A fully adhered roof membrane was installed over the roof sheathing, see photo below.

Figure 3: Fully adhered roof membrane installed over roof sheathing as underlayment for standing seam metal roof

Greencraft chose to construct an unvented cathedralized attic rather than the vented roof in a cathedralized attic installed at the 2007 Bannister house. This is due to cost concerns, mainly from a labor standpoint.

Figure 4: Standing seam metal roof

Foundation

Termimesh was installed as a physical termite barrier before the concrete pour. Below are some photos.

Termimesh protection around plumbing

Termimesh installation

Lattimore Concrete poured the concrete foundation for the Colleyville House. The concrete for the foundation of the house and porches consisted of 51% fly ash. This installation increases the strength of the concrete to 6000 psi (twice the normal strength).

51% fly ash concrete pour

Finished slab

Other efficiency improvements include:

Recycled glass material countertop
Bamboo countertop
Low VOC paint
3kW Photovoltaic installation

Mechanical Systems

A 5.0 COP ground source heat pump from WaterFurnace with a variable speed air handler is installed for heating and cooling. The ductwork is assembled with flex with duct board.

The duct work is located in conditioned space as the photos show below.

	
Ductwork coming from mixing box	Ductwork in cathedralized attic

The ventilation system is a supply only central fan integrated supply (CFIS) system.

	
8” outside air duct with mechanical damper at return plenum	Inline fan connecting three bathrooms and the laundry room to the outside via a single duct

The dehumidification system installed is a GeneralAire model 1300 whole house dehumidifier that draws directly from the main living space and dumps into the supply plenum of the HVAC system. This configuration allows for whole house dehumidification to run separate from heating and cooling because it is not fully coupled to the duct system (intake is from main living space). This prevents short circuiting as can happen when the dehumidifier is ducted to both supply and central return, which would require the air handle to run whenever there is a call for dehumidification.

Figure 5: GeneralAire Model 1300 installed on top of air handler

Temperature and Relative Humidity Monitoring

BSC installed a monitoring system in the Colleyville house to observe conditions for one year. Building Science Corporation requests monthly utility bills for comparison to our computer models.

Purpose

Questions to be answered are:

1. How do the temperatures and humidity levels compare in the various living areas and unvented attic?
2. Is interior relative humidity effectively controlled with the Aprilaire supplemental dehumidification system?

Monitoring Instrumentation in Bedrooms and Attic

BSC installed temperature/RH sensors called HOBO's to keep track of temperatures and relative humidities; they are 1-¾" x 2-¼" x ¾". A sample picture is shown here. Two types of HOBO's will be installed:

- Temperature/Relative Humidity loggers will be located in the bedrooms, near the thermostat, and upstairs.
- An Onset Hobo Pro outdoor weather monitor, measuring temperature and relative humidity, will be installed under an exterior roof soffit.

BUILDING LEAKAGE TEST

Date of Test: 3/10/09
Test File: BD with Attic closed and Cupola Open

Technician: P. Kerrigan

Customer: GreenCraft Builders
P.O. 147
Lewisville, TX 75067
Phone 214-718-8424

Building Address: 1708 Oak Knoll Drive
Colleyville, TX

Test Results

1. Airflow at 50 Pascals: (50 Pa = 0.2 w.c.)	1097 CFM (+/- 1.4 %) 0.86 ACH 0.22 CFM per ft2 floor area
2. Leakage Areas:	127.4 in2 (+/- 4.3 %) Canadian EqLA @ 10 Pa 72.4 in2 (+/- 7.2 %) LBL ELA @ 4 Pa
3. Minneapolis Leakage Ratio:	0.09 CFM50 per ft2 surface area
4. Building Leakage Curve:	Flow Coefficient (C) = 114.7 (+/- 11.7 %) Exponent (n) = 0.577 (+/- 0.032) Correlation Coefficient = 0.99218
5. Test Settings:	Test Standard: = CGSB Test Mode: = Depressurization Equipment = Model 3 Minneapolis Blower Door

Infiltration Estimates

1. Estimated Average Annual Infiltration Rate:		144.5 CFM 0.11 ACH 28.9 CFM per person (using bedrooms + 1)
2. Estimated Design Infiltration Rate:	Winter:	124.5 CFM 0.10 ACH
	Summer:	78.4 CFM 0.06 ACH
3. Recommended Whole Building Mechanical Ventilation Rate: (based on ASHRAE 62.2)		63.0 CFM

Cost Estimates

1. Estimated Cost of Air Leakage for Heating:	$ 0 per year heating
2. Estimated Cost of Air Leakage for Cooling:	$ 0 per year cooling

BUILDING LEAKAGE TEST Page 2

Date of Test: 3/10/09 Test File: BD with Attic closed and Cupola Open

Building Conditions

Inside Temperature:	75 deg F	Heating Fuel:	Heat Pump
Outside Temperature:	73 deg F	Heating Fuel Cost:	
# of Stories	2.0	HSPF:	5.00
		Heating Degree Days:	2407
Wind Shield:	M	Cooling Fuel Cost:	
# of Occupants	4.0	Cooling SEER:	16.0
		Cooling Degree Days:	1693
# of Bedrooms:	4.0		
Volume:	76929 ft3	Ventilation Weather Factor:	0.89
Surface Area:	12598 ft2	Energy Climate Factor:	18.0
Floor Area:	4886 ft2		
Design Winter Wind Speed:	13.0 mph	Design Winter Temp Diff:	48 deg F
Design Summer Wind Speed:	7.0 mph	Design Summer Temp Diff:	24 deg F

Comments

BUILDING LEAKAGE TEST Page 3

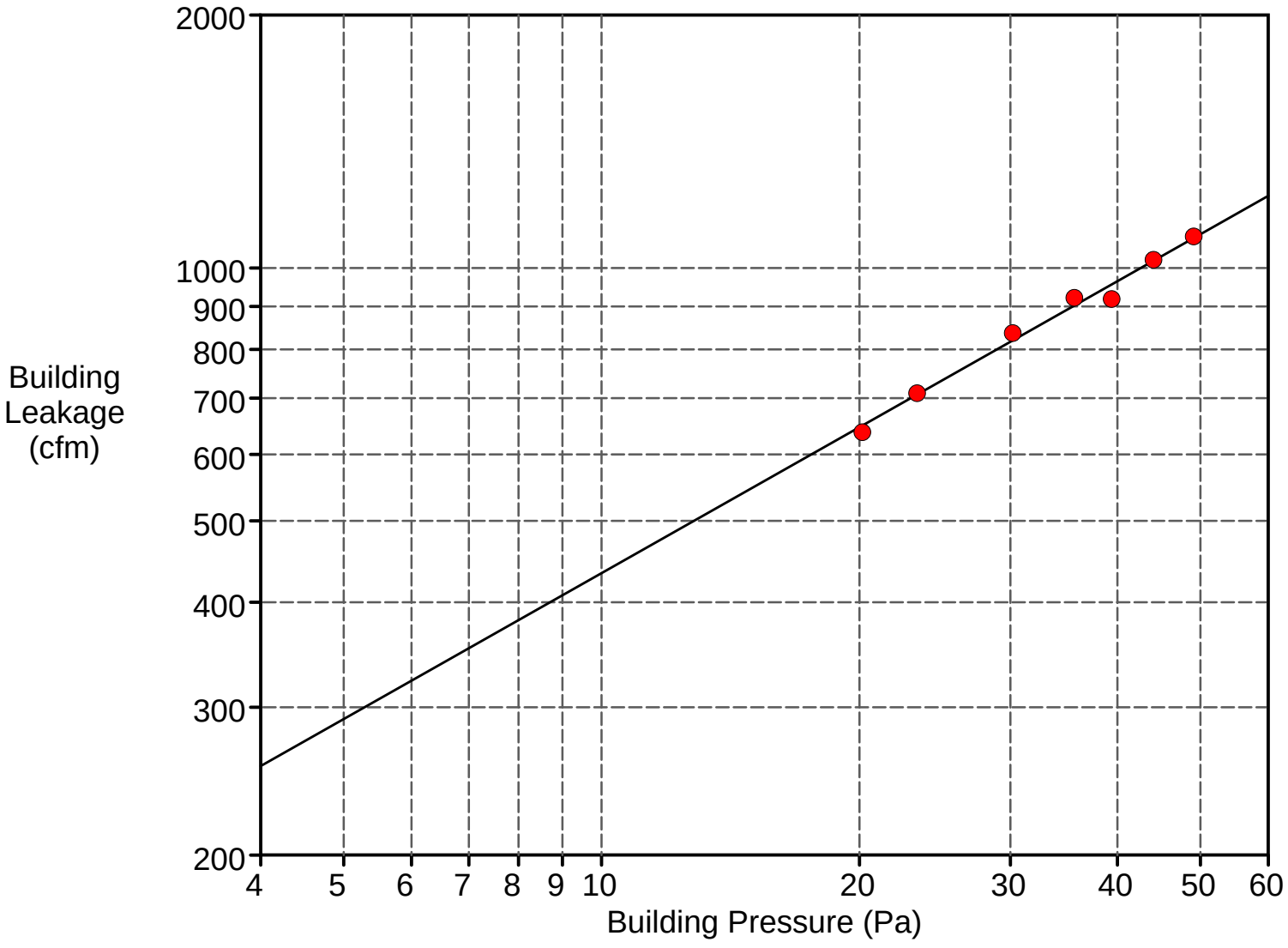
Date of Test: 3/10/09 Test File: BD with Attic closed and Cupola Open

Data Points:

Nominal Building Pressure (Pa)	Fan Pressure (Pa)	Nominal Flow	Temperature Adjusted Flow	% Error	Fan Configuration	Baseline Std Dev (Pa)
0.5	n/a					+/- 0.19
-48.5	38.0	1092	1090	0.4	Ring A	
-43.5	33.4	1025	1023	0.3	Ring A	
-38.8	26.8	920	918	-3.9	Ring A	
-35.1	242.6	923	922	2.1	Ring B	
-29.6	200.4	838	837	2.0	Ring B	
-22.8	144.7	711	709	0.3	Ring B	
-19.6	117.2	639	638	-1.8	Ring B	
0.6	n/a					+/- 0.06

Building Leakage Curve

Date of Test: 3/10/09 Test File: BD with Attic closed and Cupola Open



Appendix D.7.7.6
Builder’s Challenge Certificate

U.S. Department of Energy

EnergySmart Home Scale℠

Estimated annual energy usage:
Electric (kWh) 12607
Natural Gas (therms) 193

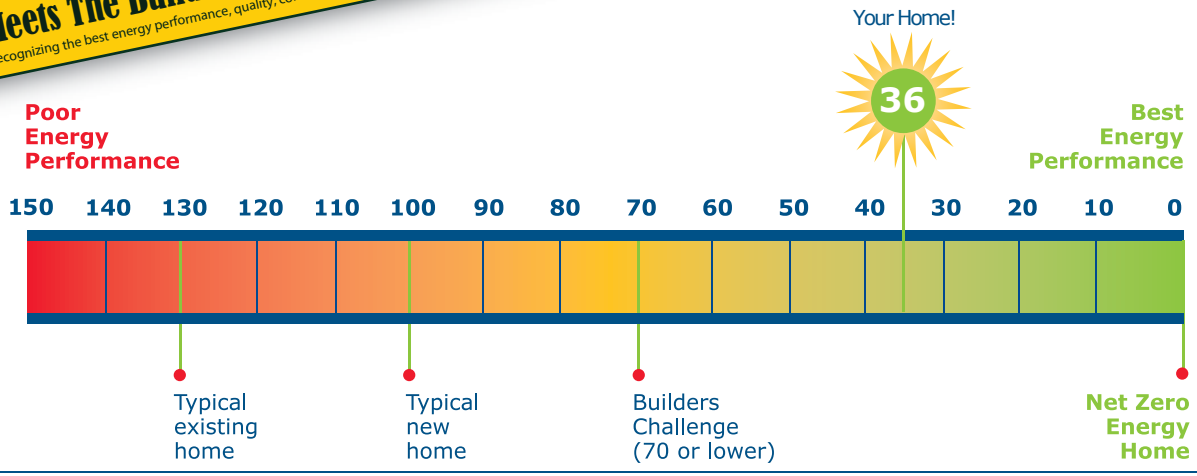
Conditioned floor area (sq. ft.): 4886

1708 Oak Knoll Dr, Colleyville, TX 76034
Rated by Building Science Corp.
Rating conducted **May 15th, 2009**

www.buildingamerica.gov/challenge

Meets The Builders Challenge

Recognizing the best energy performance, quality, comfort, health and safety in the market.



U.S. DEPARTMENT OF ENERGY

Building America U.S. Department of Energy Research Toward Zero Energy Homes

bsc

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GreenCraft BUILDERS L.L.C.