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The Importance of Passive Sustainable Design

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The Importance of Passive Sustainable Design

Caite Raymond

The University of Akron

Honors Research Project

Sustainability is a topic regularly discussed within today's culture. Many people are worried about society's future due to pollution, excessive use of nonrenewable resources, and more. Some countries have already taken steps to become more sustainable in their daily lives, the United States being one of them. The U.S. promotes and incentivizes various aspects of sustainable living, specifically within building and construction. Even with all of the growing awareness and promotion, the historical context and more specifically the passive design techniques used in buildings have received little attention. It is imperative to increase this awareness, as well as increase the application of passive sustainable techniques to ensure that sustainable building is efficient and effective.

Historical Context

Ecological design, or sustainable design, is a term defined by Sim Van der Ryn and Stuart Cowan in 1996 as "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes."¹ Van der Ryn and Cowan stress that this involves processes that are compatible with nature as well as modeled on natural systems to create built environments that are integrated with nature in a symbiotic manner.²

Using concepts of ecological design has been around for hundreds of years. A prime example of this can be seen when looking at the Bedouin nomadic culture in the arid deserts of Jordan, which migrated to the area around the 14th century. The Bedouins live in tents woven of goat hair that are easily repaired as well as portable. These tents circulate the air by utilizing a

¹ Kibert, Charles J. *Sustainable Construction: Green Building Design and Delivery*. (3rd ed. Hoboken: John Wiley & Sons, 2013), 79.

² Kibert, *Sustainable Construction*, 81.

combination of the natural insulation properties of the goat hair which is placed in strategic holes towards the top of the tent to draw the hot air up and out.³

The modern movement towards sustainable design in architecture is fairly recent with only a few architects and designers developing the matter in the beginning of the 20th century. One architect, R. Buckminster Fuller, is seen as the founder of this movement in the United States. He is known for the aluminum Dymaxion car from 1933 as well as the autonomous Dymaxion house from the 1920s. One of his main contributions to the design world was the geodesic dome in the 1950s. The geodesic dome uses short segments following a framework made up of triangles or polygons. The dome is seen as one of the most lightweight, cost effective and strongest structures created. Fuller heavily emphasized the use of renewable energy, resource conservation, and the use of lightweight, ephemeral materials throughout his designs. Fuller also pushed the concept of deconstruction in architecture, or the idea of salvaging building materials before or instead of demolishing a building.⁴

Another important environmental architect was Frank Lloyd Wright. Wright's main goal was to create buildings specific to their site vis-à-vis the environment, inhabitants, and materials surrounding the building. Wright emphasized this by using an approach to architecture that worked with nature rather than imitated it. He encouraged integrating spaces to create a cohesive situation that fused the site, structure, and context to create a form that is whole. Various buildings can be seen around the United States designed by Wright, including his most famous Fallingwater in Pennsylvania.⁵

³ William McDonough and Michael Braungart. *Cradle to Cradle: Remaking the Way We Make Things*. (New York: North Point Press, 2002). 8.

⁴ Kilbert, *Sustainable Construction*, 83.

⁵ Kilbert, *Sustainable Construction*, 84.

Malcolm Wells, a well-respected architect, was very critical of the lack of awareness of biological foundations that he saw in the works of other architects. He asked “Why is it that every architect can recognize and appreciate beauty in the natural world yet fail to endow his own work with it?”⁶ His idea to show this type of solution was to leave the earth’s surface alone and submerge the built environment underground. Wells is known as the “father of gentle architecture” for his high expectations of buildings, specifically his earth-sheltered structures. He suggested that buildings should be able to consume their own waste, maintain themselves, provide natural habitats, and moderate their own climate. All these topics are very common in today’s discussions regarding sustainable architecture.

Publically, the push towards a more environmentally friendly lifestyle was started with a book called *Silent Spring* written by Rachael Carson in 1962. The book focused on nature’s vulnerability to human involvement as well as the extensive human dependence on nature. Carson touched on subjects such as food contamination, cancer, genetic mutilation, and the imminent extinction of species after species. The book directed the public’s attention towards conservation and sustainable living. In turn, the personal responsibility everyone had to creating a healthier world in which to live and strive became more apparent. This push from the general public made it increasingly necessary for architects and designers to create structures and spaces with the effects on the environment in mind.⁷

Integration

Integration of sustainable concepts into sustainable design has two parts. The first type of integration is that which occurs during the design process. This typically happens with a charrette or a large, intensive meeting that includes representatives from each discipline as well

⁶ Kilbert, *Sustainable Construction*, 87.

⁷ Stelmack, Annette K. *Sustainable Residential Interiors*. (2nd ed. Hoboken: John Wiley & Sons, 2014). 6.

as all stakeholders involved in the structure such as the designers, builders, building owners, and trade contractors. During the initial meeting the team establishes the project mission, goals, budget parameters, etc. together to ensure that everyone is aware of what is expected.

Throughout the design and building process each discipline has important information to add to the concept of the project and how it comes together. This type of integration has been shown to increase a level of personal investment from those involved as well as establish a team culture, which in turn leads to a higher quality project. This brain-storming process allows for an increase in problem solving as issues are identified more quickly and worked through with all aspects in mind. This type of integration throughout the design and building process allows for a more holistic outcome.⁸

Integrating the design of a building or space with the surrounding environment and its natural resources is the second essential part of integration. This site integration allows unique characteristics to heighten the effectiveness of the sustainable concepts used throughout the structure, to limit land usage, and to introduce key aspects of passive sustainable design. Limiting land usage could mean building more earth-sheltered structures, building smaller structures, or building higher structures. One of the main problems the world is facing today is overcrowding, and by limiting land usage this problem starts to diminish. To be able to limit land usage, it is crucial that consumers see they will not lose any functionality or storage. This concept is one that continually needs to be explained as well as shown to the average consumer who could potentially occupy the space. It is the designer's duty to express to the client that building a smaller scale home with more storage and multifunctional areas still allows for comfort and function. Creating multifunctional buildings also reduces the demand for additional construction that may be required in the future, which in turn limits land usage.

⁸ Kruger, *Green Building*, 58.

The weather conditions will vary by region and need to be considered when designing a structure. A building in a warmer climate would ideally limit the amount of heat gain; whereas a building in a colder climate would limit the amount of heat loss. A building in a more humid climate would have more moisture concerns than a building in a more arid climate. These types of needs can be more efficiently addressed when taking the site's climate into consideration.

Passive Sustainable Design

Passive sustainable design is defined as design that takes into consideration the effect of sunlight, wind, vegetation, and other natural resources occurring on the site when designing the building's heating, cooling, lighting, and ventilation systems. A building with a good passively designed system will in a sense "default to nature." This means that if the building is disconnected from all active energy sources that it will still be reasonably functional in regards to temperature, air flow, and light.⁹

A structure's roof is one of the main areas subjected to a high level of exposure and is therefore a major area where one deals with heat transmission. The roofs of structures, even in areas pretty mild in climate, can reach over 90° F in difference from air temperature, which can cause a lot of issues. The amount of heat being produced and retained can be transferred into the building itself causing a warmer built environment which uses a lot of energy to cool it back down. This amount of heat can also be damaging to the surrounding habitats, as the fluctuation in temperatures can cause changes in migration and hibernation patterns.¹⁰

There are two options possible for minimizing this heat production. Using a roofing material that has a high reflectivity for solar radiation is one way this can be done. Light-colored shingles are high in this reflectivity. Recently, self-washing white shingles have been

⁹ Kilbert, *Sustainable Construction*, 251.

¹⁰ Kilbert, *Sustainable Construction*, 263-265.

manufactured which have the highest reflectivity rating. Another is creating a natural environment on the roof, such as a green roof or a garden. A green roof is one that is partially or completely covered with vegetation typically native to the region. These roofs help delay and reduce storm runoff, insulate the building, and filter pollution and toxins from the water.¹¹

Another large surface area with exposure to climate is windows. Windows must be thermally resistant to ensure limited energy movement. Windows placed on the south side of a building need to maximize solar heat gain and should have a high solar heat gain coefficient, whereas, windows placed on the east and west sides of a building should have a lower coefficient since they receive less solar energy levels. Windows that have multiple panes and are filled with argon or krypton gas have higher thermal resistance. Low-E coatings added to windows also reduce long-wave radiation heat transfer. Typically it is most common to use windows with little heat transfer to ensure a stable temperature within the structure.¹²

It is fairly common when working toward passive sustainable design to orient a building so that the long side is on an east-west axis to minimize heat solar loads. When designing a building it is also common for the architect to use the aspect ratio which helps determine the length to width of the building with respect to solar heat gain. In the northern United States the aspect ratio suggests the building should be virtually square in shape. Materials such as brick, concrete, and adobe should be used in areas that require storing solar energy during the day to release during the night. Shading and overhangs are necessary to manipulate the solar loads. Integrating landscape into the design of a structure can also be used to help with cooling and insulation.¹³

¹¹ Kilbert, *Sustainable Construction*, 263-265.

¹² Kilbert, *Sustainable Construction*, 261-263.

¹³ Kilbert, *Sustainable Construction*, 252.

Natural Resources

Using natural resources is a common technique used by many sustainable architects due to the various benefits they may provide. Most natural resources are very complex, allow for a variety of uses, and are biodegradable. Abalones, for example, are marine snails with shells twice as tough as high-tech ceramics. Silk is five times stronger than steel and mussel adhesive maintains its strength even after long periods of being underwater. A more common material increasingly being used is bamboo, which though strong is still malleable as well as fast growing.¹⁴

Using natural resources common to the area limits the amount of transportation needed and, in turn, limits the use of fossil fuels. Using local resources also helps in the conservation of wildlife and preservation of land. By not importing “exotic” materials, especially woods, rainforests as well as other habitats are left unaffected instead of being cut down or destroyed in the interest in making a profit.

Due to the complexity of these natural substances, society has always tried to imitate or improve natural resources. It can certainly be argued that synthetic materials are beneficial, and to an extent they are. Synthetic materials allow for less loss of nonrenewable resources. For instance, the copper ore in the earth today is now at one-third of the originally dowry. Using synthetic materials can also help ensure less habitat destruction.¹⁵

In order for synthetic materials to be worthwhile in sustainable design it is imperative that they are created using a life-friendly manufacturing process. This means using clean energy to run machinery such as solar, wind, or water. This also means using only safe materials to create safe materials.

¹⁴ Kilbert, *Sustainable Construction*, 102.

¹⁵ Kilbert, *Sustainable Construction*, 100.

Recycling, Reusing, & Eliminating Waste

A practice that has become increasingly beneficial to the design world is the use of recycled or reused materials. By reusing or recycling materials we are limiting waste from other projects or aspects of life. Waste from demolition and renovation projects are thought to comprise as much as 50 percent of the nation's total waste. Deconstruction and design for disassembly are reusing concepts that are becoming increasingly more popular in today's construction to minimize this percentage.

The concept of deconstruction involves salvaging components, such as windows and doors, and reusing materials such as concrete for aggregate and metal, for a new construction or renovation project. Some companies have also started to donate these recycled materials to national organizations, such as Habitat for Humanity, and developing countries to help improve their standard of living.¹⁶

Design for disassembly is a concept that involves specifically making design and construction choices to allow for maximum reuse during deconstruction. This process involves various principles including minimizing the types of materials used, creating an open system with interchangeable parts, and providing spare parts. This type of process is implemented in three levels: the systems level, the product level, and materials level. Creating structures that are designed for disassembly allow for a closure in the materials loop, meaning the materials can be recycled indefinitely through natural or industrial processes.¹⁷

The concept of cradle-to-cradle ideology offers an elevated concept of recycling. Typically, products are created with the mindset that they will eventually be disposed. Even some products that are made to be recycled are in reality downcycled, meaning they are made

¹⁶ Kilbert, *Sustainable Construction*, 380-381.

¹⁷ Kilbert, *Sustainable Construction*, 379-380.

into lesser quality products and eventually become waste. With the cradle-to-cradle model all products are created with the intentions of either being reused in continuous cycles without losing quality or being decomposed into nutrients without negatively affecting the natural environment.¹⁸

Until cradle-to-cradle manufacturing has been fully adopted, there will always be waste of some sort or another. With sustainable design, the object is to minimize that waste as much as possible. Waste matter can be controlled and minimized in various ways, one of those being the regulation of waste matter based on absorption capacity. This can be done by comparing the critical loads of water, soil, and air with the perceived emission rates. Critical loads are defined as quantitative estimates of the exposure to pollutants which have been indicated to have harmful effects on the surrounding environment. Evaluating the absorption capacity can also be done by using a substance specific analysis, though not as accurately. With either test, there are noted limitations to knowing the complete potential of future impacts that may occur due to the expulsion of waste matter into the natural environment.¹⁹

Another way waste matter can be minimized is by reducing the amount of extra materials attained. This can easily be done by accurately quantifying when ordering material. This could mean checking and rechecking items' quantity as well as making systematic cuts in material such as wood.

Lastly, another way in which many architects and designers battle the expulsion of waste matter is to replenish renewable resources. Knowing that a project will produce a certain amount of carbon dioxide can be equalized by planting trees to take in the produced emissions. This can

¹⁸ McDonough, *Cradle to Cradle*.

¹⁹ Kilbert, *Sustainable Construction*, 97.

also be done by knowing how many trees were cut down to produce said structure and replenish those trees with new seedlings.

Harmful Materials

The biological impact to humans is one of the major reasons for such a large push towards sustainability. Cancer has become the second highest cause of death, killing 584,881 people in the United States in 2013.²⁰ The inhalation, absorption, and consumption of chemicals have continuously been proven to cause a great deal of damage to the human body. One of the most prevalent chemicals are VOCs, or volatile organic compounds, which are organic chemicals released into the air at ordinary room temperature and pressure. VOCs can be found in a variety of products including plastics, shower curtains, floorings, solvents, and paint. By using low or zero emission VOC products, one can decrease the amount of chemicals given off. Carbon filters can also be used to absorb the chemicals, but these must be replaced regularly. The reduction or elimination of these chemicals will not only improve the air quality inside the built environment, but will also improve the level of air pollution seen in the natural environment.²¹

Other harmful chemicals evident in construction that are slowly declining include radon, mercury, asbestos, lead, and cadmium. Though most of these are illegal in new construction, it is important that buildings with these materials be renovated to remove all traces of these harmful chemicals.

One way to enhance the quality of life and minimize the chemical content in the air is to increase the level of outdoor air placed into circulation within the building. Using natural air movement for ventilation can save on energy and increase the indoor air quality. Wind catchers can be placed on the roof of a structure. The catchers will automatically turn in the direction of

²⁰ Center for Disease Control and Prevention. *Mortality Rates for 2013*.

²¹ Kilbert, *Sustainable Construction*, 396.

the wind. Cool air is brought in, which sinks to the floor and pushes the warm air up to the ceiling where vents take the air out of the space.²²

Mold and mildew are also health concerns regarding indoor air quality within a structure. High humidity levels can act as a breeding ground for bacteria, which in turn can cause asthma and allergy problems, among others. Humidity should be maintained and regulated to levels between 30 to 50 percent to maximize comfort and health. Sick building syndrome has increasingly become more prevalent as people spend more time indoors. This syndrome indicates that more than 20 percent of the building's occupants have displayed symptoms of illness for more than two weeks. Illnesses such as respiratory tract infections, influenza, sinus congestion, and fatigue are most commonly seen. These problems or illnesses can be minimized by having adequate air ventilation, operable windows, and sufficient daylight. Creating designs that incorporate plants within the space also help with increasing indoor air quality.²³

Daylighting

Lack of exposure to daylight has increasingly become a problem. This has happened for two reasons. The first reason being that though structures are more open in width, they are larger in square footage with windows only on the exterior walls. The ease of switching on a lightbulb has reduced the need for natural light to see. This lack of daylight creates various problems, such as vitamin deficiencies, specifically vitamin D. 75 percent of teens and adults in the United States are suffering from vitamin D deficiency, meaning they have less than 20 nanograms per milliliter in their bodies.²⁴ This deficiency has been proven to put people at a higher risk for heart disease, diabetes, and cancer. Lack of daylight has also been linked to depression and exhaustion.

²² Kilbert, *Sustainable Construction*, 256.

²³ Kilbert, *Sustainable Construction*, 397.

²⁴ Ginde, Adit, Mark C. Liu, and Carlos A. Camargo Jr. "Demographic Differences and Trends of Vitamin D Insufficiency in the US Population, 1988-2004," *Arch Intern Med*. 2009.

Increasing the use of daylight also minimizes the energy needed to light the space. There are many ways to increase daylight when designing. The primary method incorporates a variety of window types throughout each room including clerestory windows, skylights, tubular daylight devices, and light shelves. Using light colored finishes and materials and having areas with sloped ceilings will also help spread the reflected light throughout the space.²⁵

Other Natural Resources

It is not hard to comprehend that residential and commercial buildings make up about 60 percent of the global energy use; especially when it is frequently discussed in public. One topic that is not considered as much is the high use of water. These buildings use around 25 percent of the global amount of water. The U.S. itself uses around 400 billion gallons of water per day. The average person often believes that the same quantity of water that was on the planet to begin with is still here today so water should not be a concern. Though this is partially true, the main concern is that the availability of potable water is dropping, and the amount of energy it takes to process the water and transport it to the various buildings from the treatment plants is increasing.²⁶

Water can be conserved in various ways. The easier options include installing low-flow faucets and showerheads as well as ultra-low or dual-flush toilets. Buying high efficiency washing machines and dishwashers will also save water. Reusing rainwater to water plants is another option. Though less common, there are systems that use rainwater and recycle greywater for use in toilets, instead of using potable water. Reducing the constant heating of hot water tanks as well as the water wasted as people wait for it to become hot is the main concern for residential water systems. This can be solved by installing a tank less water heater as well as locating

²⁵ Kilbert, *Sustainable Construction*, 405-407.

²⁶ Kruger, Abe and Carl Seville. *Green Building: Principles and Practices in Residential Construction*. (New York: Delmar, Cengage Learning, 2003). 416.

plumbing fixtures nearest to the water heater. Larger structures can use multiple water heaters to help with this aspect.²⁷

The Future

Creating smart sustainable buildings is becoming the future of design. This means sustainable buildings will be able to produce more energy than they consume. Ultimately these high performance buildings should only utilize one tenth of the energy that they consume now. This also means that buildings will be able to purify their own wastewater, which should also be only a tenth of the potable water they use now. By having each building deal with its own waste and maintenance systems, the land that is used for treatment and energy plants can be allocated for farming, parks, or housing.²⁸

A major consideration in regards to buildings is the affect it will have on future generations. Preserving the planet for future generations has progressively become a topic for consideration for most people. As technology continues to grow and the standards of living continue to rise many people are able to focus more time and thought towards creating a world that is safe as well as comfortable for future generations. More people are also focused on the health of ecosystems to allow plant and animal species to thrive and come back from the brink of extinction.

Literature Review Conclusion

Sustainable design has increasingly become more popular with about 50 percent of new construction buildings being fundamentally sustainable within the commercial sector.²⁹

Sustainable design allows for a better world ecologically in various ways. Incorporating aspects of passive sustainable design will allow for less use of nonrenewable resources, lower emissions,

²⁷ Kruger, *Green Building*, 418-419.

²⁸ Kilbert, *Sustainable Construction*, 495.

²⁹ Kilbert, *Sustainable Construction*, 483.

and reduce energy use. Passive sustainable design is also very beneficial for everyone's health by creating better indoor air quality and allowing more sunlight into the space. Sustainable design is the future of design, and to be able to do this efficiently and effectively one must increase the awareness of the historical context and utilize the aspects of passive sustainable concepts.

Design Project

Design Concept Statement

Evoke a sense of serenity and comfort by creating a safe, ecofriendly indoor environment without giving up the luxuries of the typical American home. Large windows maximize daylight to create the feeling of expansiveness while natural colors and materials blend the line between the indoor and outdoor environments.

Project Scope

Type: Single Family Residence

Square Footage: 1,350 sq ft

Building Footprint: 256 sq ft

Floors: Sixth with access to roof

Location: Akron, Ohio

Program

Passive sustainable design techniques can be used within any building in any part of the world. To show this, the single-family residence is hypothetically in Akron, Ohio with various passive techniques based upon the general site location. The three bedroom dwelling is large enough to accommodate for the average American family of two parents and two children.

Due to the humid continental climate of Akron, Ohio, the aspect ratio of the footprint should be close to 1:1 or relatively square. The 16'x16' building footprint matches this aspect ratio while also minimizing the land usage. The exterior of the building is white stucco which

will reflect light and minimize the heat island effect of the house. The roof is an extensive green roof that uses native vegetation such as Purple Prairie Clover, Common Yarrow, Blue Fescue, Fame Flower, and a large amount of various Stonecrops. This type of roof is low maintenance, will filter toxins from rain water, will minimize the heat island effect of the building, and insulate the building.

The number of windows on the South side of the building is maximized to ensure a high, but consistent daylight throughout the space. Windows or glass doors are also along the East and West sides of the building to allow daylight within the space. Few walls throughout the space allows for a larger spread of daylight as well as a more consistent air temperature. The main winds in Akron come from the Southwest, the South, or the West. The windows also allow for natural ventilation to flow more easily throughout the space.

Linoleum flooring is made from natural materials and is naturally anti-bacterial and biodegradable. This material was chosen specifically for the first floor because of its easy maintenance and durability. The dark color will absorb sunlight which will be transferred to the air and rise through the building to help with the natural air movement. The subfloor will be concrete which will also absorb the heat throughout the day and release the heat during the night. The product also has a low emission of VOCs, has 10-20% recycled content, and is made from rapidly renewable resources such as linseed oil and recycled wood flour.

Porcelain flooring is made by Mannington; a company which uses solar energy and waste and recycle management programs. This company also has programs in place to increase the bee population, maintain housing for birds to act as natural insect eradicators, and increase the use of recycled content. The product itself has a low emission of VOCs, can be cleaned with water, and does not readily support the growth of pathogens.

ECO by Cosentino was chosen for all countertops due to its high quantity of recycled content at 75% among other variables. Such recycled content includes mirrors, glass, porcelain, earthenware, and vitrified ash. This product was also chosen because its manufacturing process reuses 94% of its water for each cycle as well as its zero VOC emissions. ECO requires very low maintenance because it has a nonporous surface, is highly durable, and can be cleaned with mild soap and water. ECO has also received the Cradle to Cradle Certification verifying that the product can be recycled indefinitely.

All wood cabinetry is from Timberlake Cabinetry which has various manufacturing plants less than 300 miles away from Akron, Ohio, to save on transportation. More than 75% of the wood comes from sustainable forests in the United States. All cabinetry has low VOC emissions, uses recycled or recovered fiber content, and is manufactured using waste and recycle management problems.

All paint is Benjamin Moore in the Natura line or the Aura Bath & Spa due to their high quality. Both paint types are acrylic, require little maintenance, and have zero VOC emissions. The Aura Bath & Spa is used in all the bathrooms due to its resistance to high humidity levels and mildew. All colors are natural to blend the outdoor and indoor environments. The lighter colors used throughout the space also increase the reflectivity of light within the space.

LEED

Because this project was done by a single discipline, it is apparent that not all guidelines would correspond with LEED Certification. Thus, the following LEED credits have been looked at and applied to the project in regards to the U.S. Green Building Council LEED v4 for Homes Design and Construction.

LEED Credits		
Name	Amount of Credits	What Makes This Applicable
LT Credit: Compact Development	1-3	Small building footprint
SS Prerequisite: No Invasive Plants	Prerequisite	All plants used are native to Ohio
SS Credit: Heat Island Reduction	1-2	At least 50% of hardscaped surfaces have shading, a low solar reflectance, and vegetation covering
SS Credit: Rainwater Management	1-3	A vegetated roof was installed to help reduce rainwater runoff
WE Credit: Total Water Use	1-12	All indoor water using fixtures are low flow and high efficiency including fittings; the green roof does not require any watering
WE Credit: Indoor Water Use	1-6	All water using fixtures are low flow and high efficiency including fittings
WE Credit: Outdoor Water Use	1-4	All landscape is native to Ohio and does not require any extra watering
EA Prerequisite: Minimum Energy Performance	Prerequisite	All appliances are EnergyStar, the passive ventilation, heating, and cooling concepts used throughout improve the overall energy performance and reduce its greenhouse gas emissions
EA Credit: Annual Energy Use	1-29	Glazing is 15% of the floor area; there are no floors over unconditioned spaces,
EA Prerequisite: Home Size	Prerequisite and Bonus Credits	The square footage of the building is 48% less than the EnergyStar reference homes' conditioned floor area
EA Credit: Building Orientation for Passive Solar	3	South-facing glazing area is at least 50% greater than the sum of the east and west-facing glazing area; east-west axis is within 15 degrees of due east-west
EA Credit: Windows	1.5-3	The energy performance of windows is maximized through the Low-E film, gas filled panes, and solar heat gain coefficient

LEED Credits		
Name	Amount of Credits	What Makes This Applicable
EA Credit: Lighting	0.5-2	All fixtures are LED to minimize wattage and a daylighting system is to be installed
EA Credit: High-Efficiency Appliances	0.5-2	All appliances are EnergyStar efficient
MR Prerequisite: Certified Tropical Wood	Prerequisite	All wood used is nontropical, reused, or reclaimed
MR Prerequisite: Durability Management	Prerequisite	Water resistant flooring is used to help control moisture, products have long life spans and high durability
MR Credit: Environmentally Preferable Products	0.5-4	A percentage of building materials are local, use recycled and reclaimed content, and have reduced life-cycle impacts
EQ Prerequisite: Ventilation	Prerequisite	Natural ventilation concepts will help contribute to reduce moisture and exposure to pollutants
EQ Credit: Combustion Venting	1-2	No fireplaces or woodstoves were installed
EQ Credit: Enhanced Garage Pollutant Protection	1-2	No garage is attached to the structure
EQ Credit: Low-Emitting Products	0.5-3	All materials have low emission ratings

Attached Visuals

The attached visuals further explain the hypothetical residence based in Akron, Ohio. The set of working drawings show the construction and installation specifications needed for the project. The rendered drawings show a more realistic visualization to greater express the aesthetics of the residence. The finish boards show selected finishes for the various levels within the residence.

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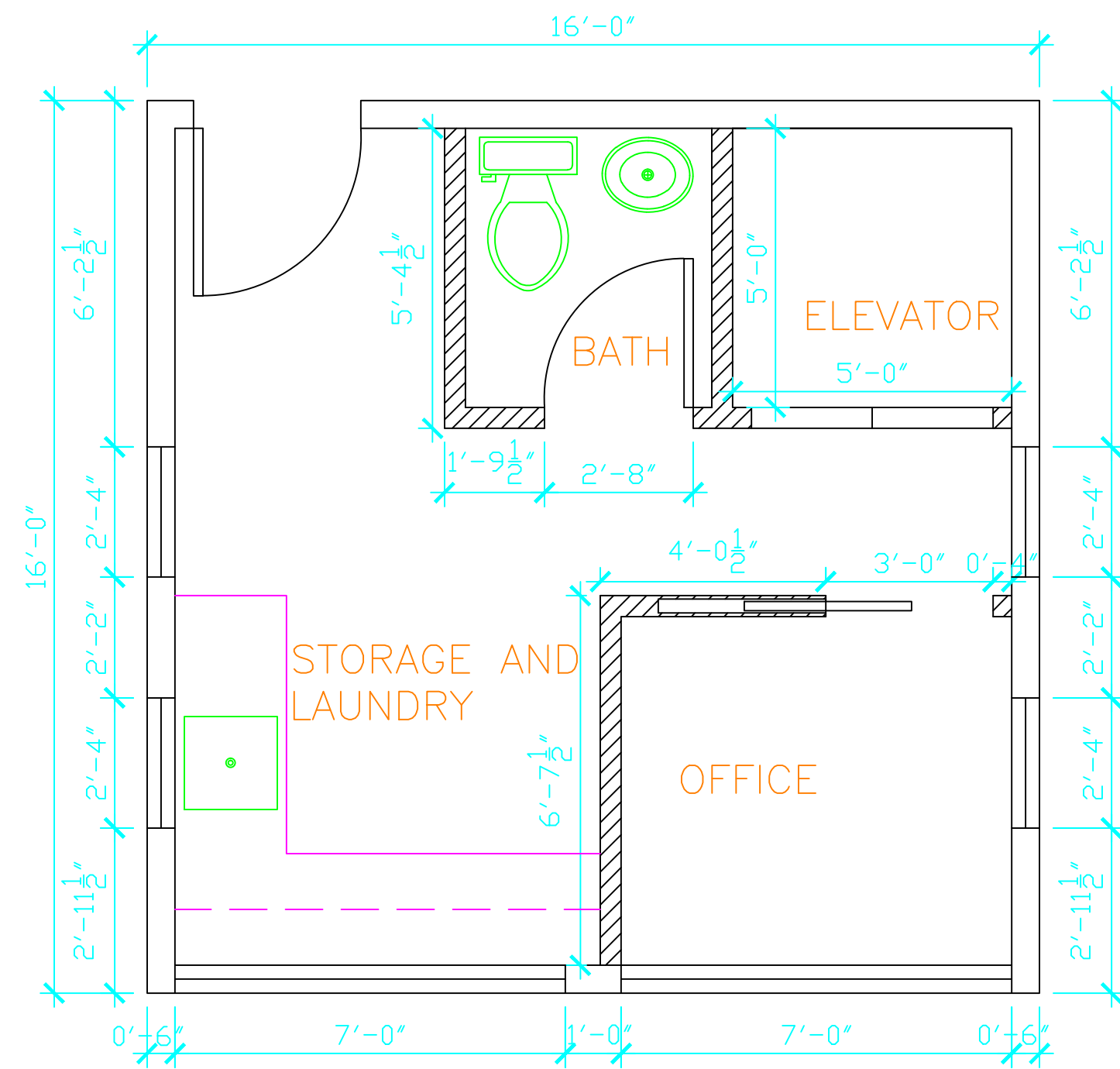
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PASSIVE SUSTAINABLE RESIDENCE
AKRON, OHIO

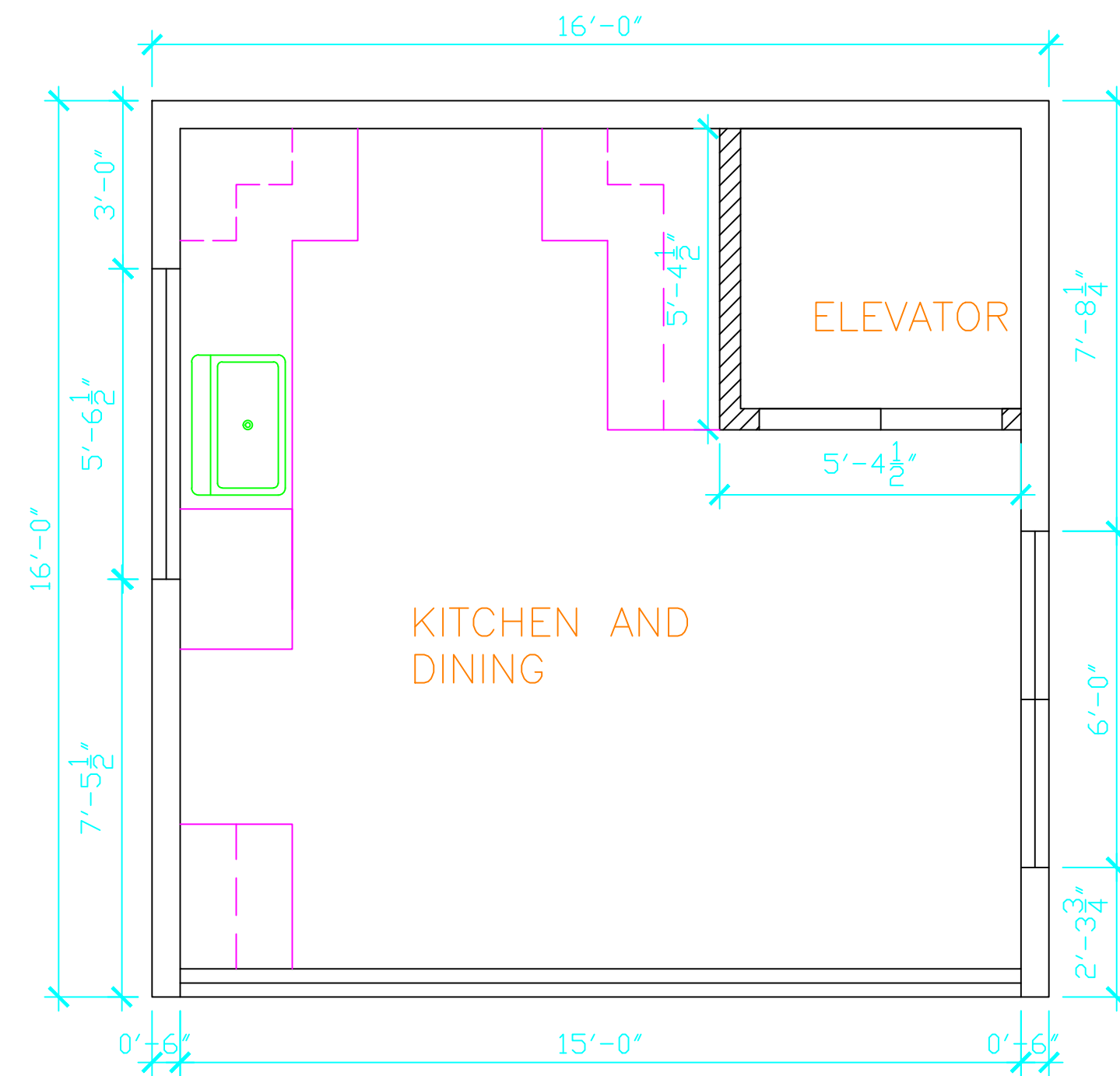
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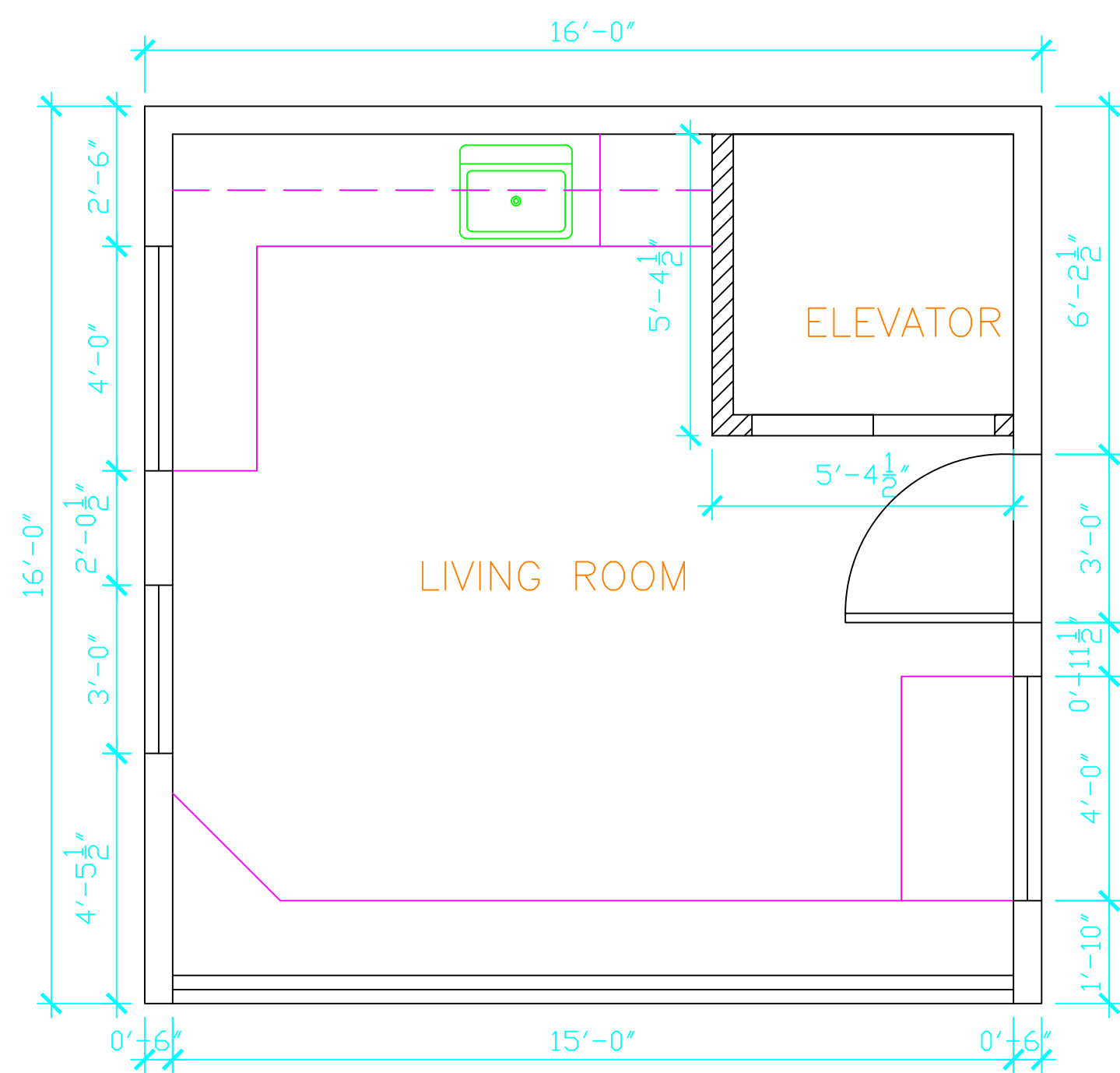
- A1 – PARTITION PLAN
 - A2 – PARTITION PLAN
 - A3 – FURNITURE PLAN
 - A4 – FURNITURE PLAN
 - A5 – REFLECTED CEILING PLAN
 - A6 – REFLECTED CEILING PLAN
 - A7 – ELEVATIONS
 - A8 – FINISH SCHEDULE
 - A9 – EXTERIOR ELEVATIONS
-



1 FIRST FLOOR
A1 3/8" = 1'-0"

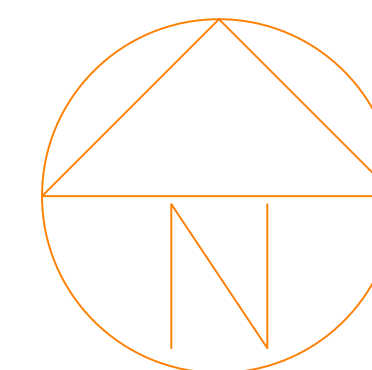


2 SECOND FLOOR
A1 3/8" = 1'-0"



3 THIRD FLOOR
A1 3/8" = 1'-0"

LEGEND
 NEW WALLS



General Notes

PARTITION PLAN

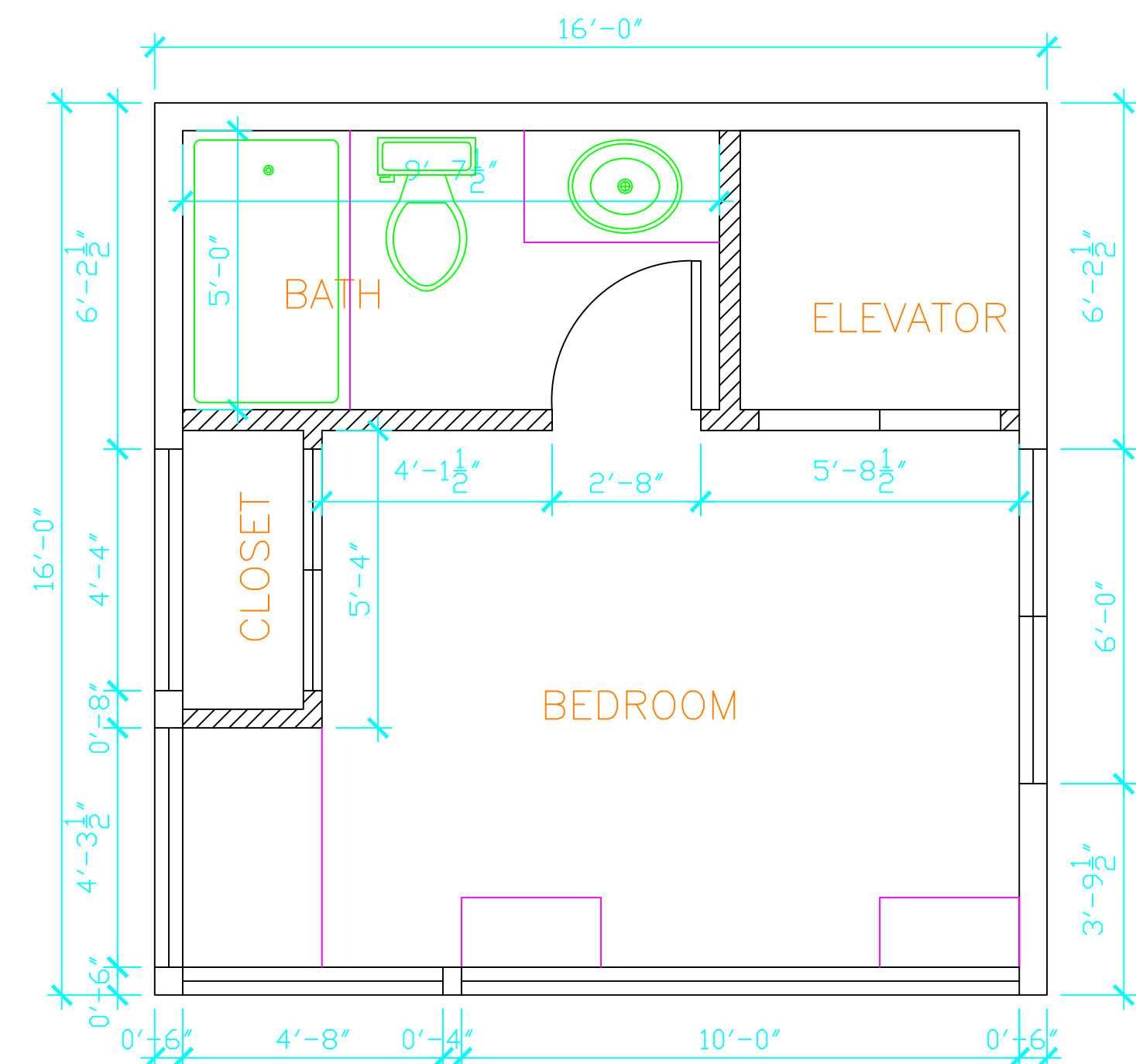
DRAWING TITLE

No.	Revision/Issue	Date

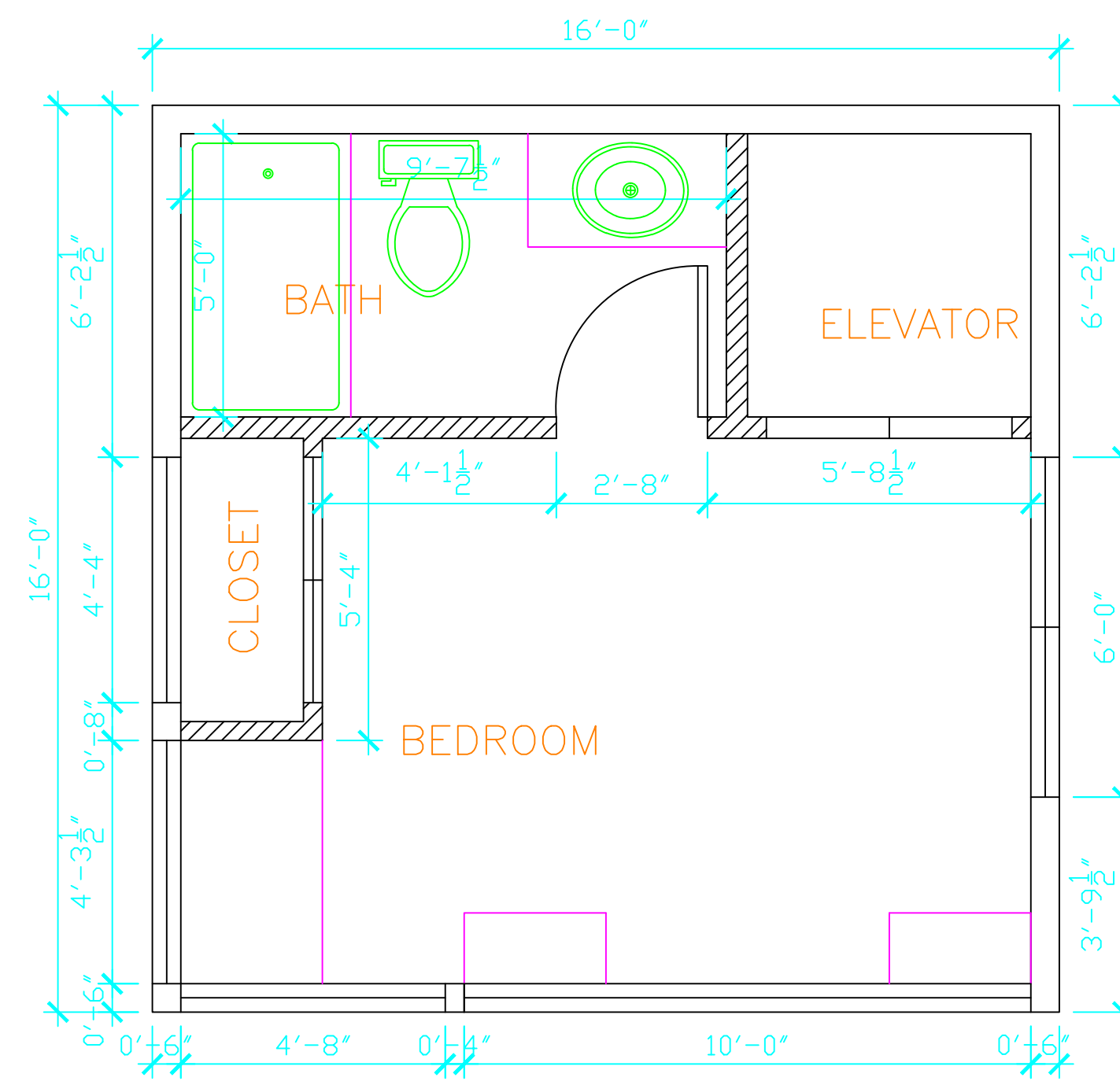
PROJECT NAME
 PASSIVE SUSTAINABLE
 RESIDENCE
 AKRON, OHIO

DESIGNER AND CLASS
 CAITE RAYMOND
 HONORS RESEARCH PROJECT
 SPONSOR: AMANDA RURA

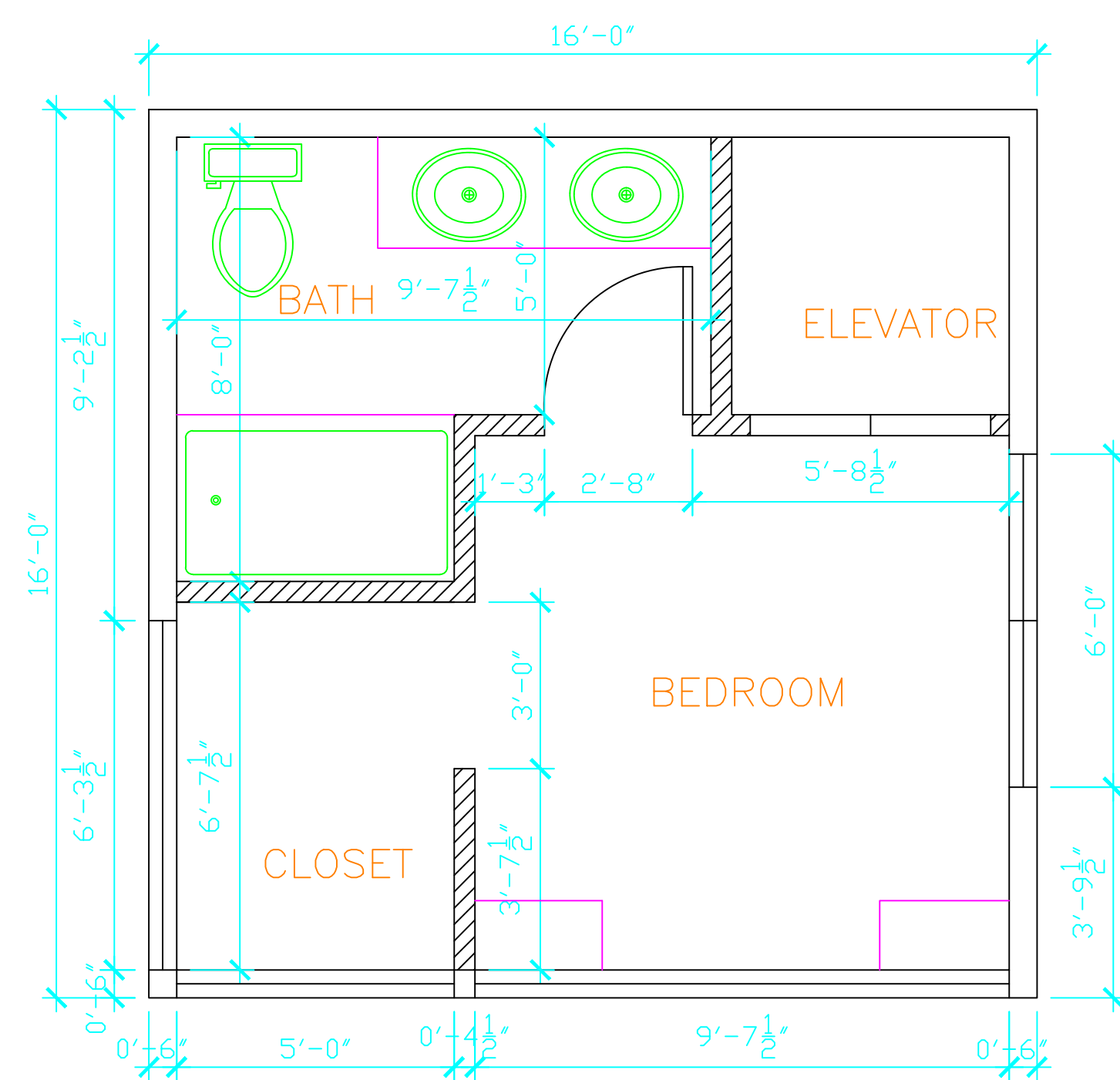
Project HONORS	Sheet A1
Date 3/20/16	A1
Scale 3/8" = 1'-0"	



1 FOURTH FLOOR
A2 3/8" = 1'-0"

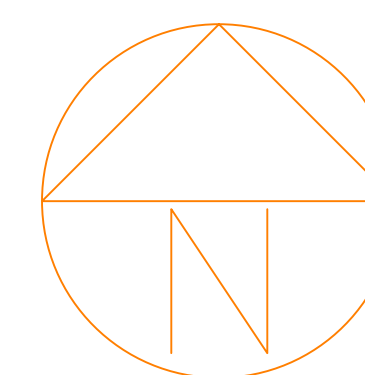


2 FIFTH FLOOR
A2 3/8" = 1'-0"



3 SIXTH FLOOR
A2 3/8" = 1'-0"

LEGEND
 NEW WALLS



General Notes

PARTITION PLAN

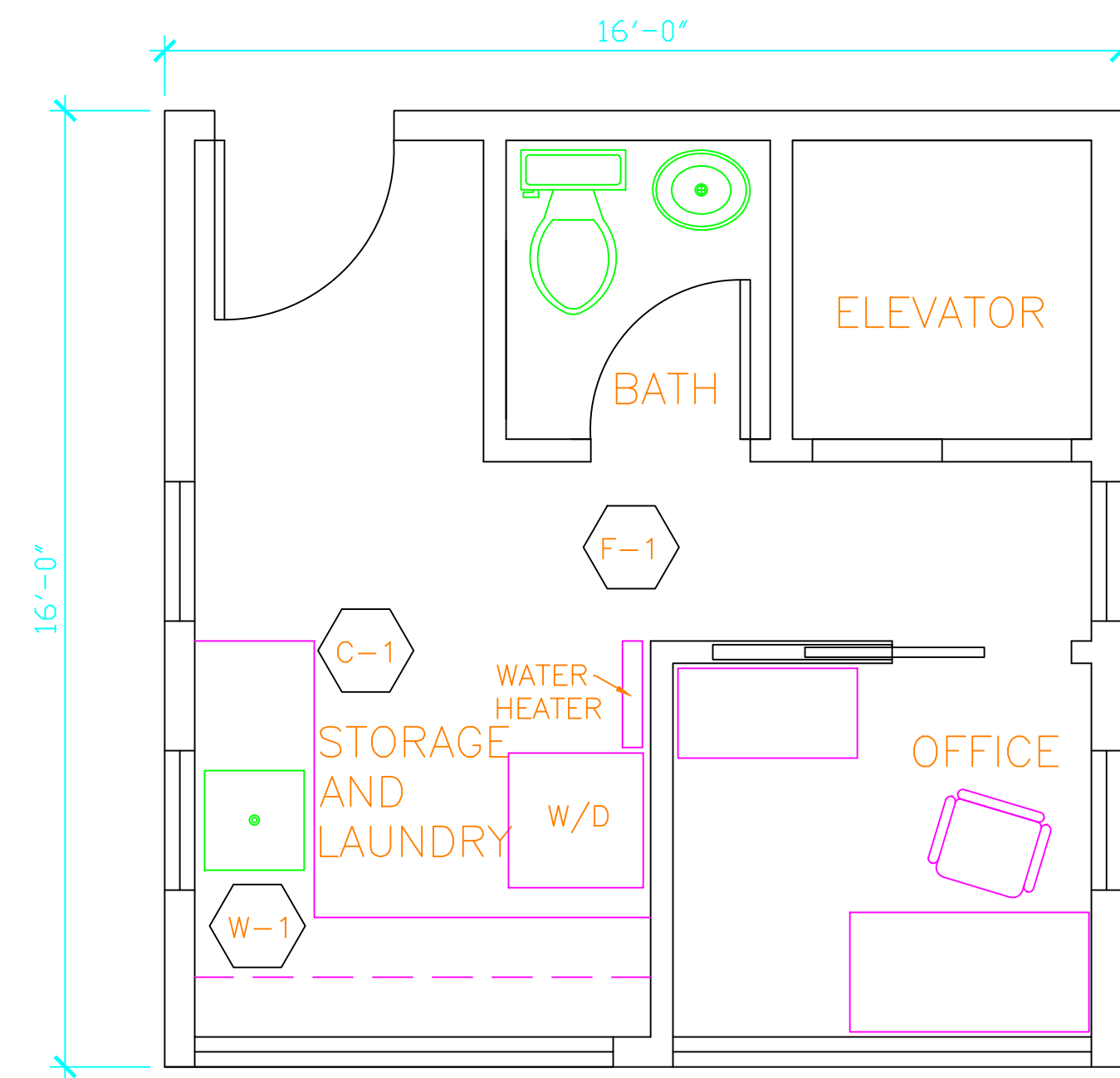
DRAWING TITLE

No.	Revision/Issue	Date

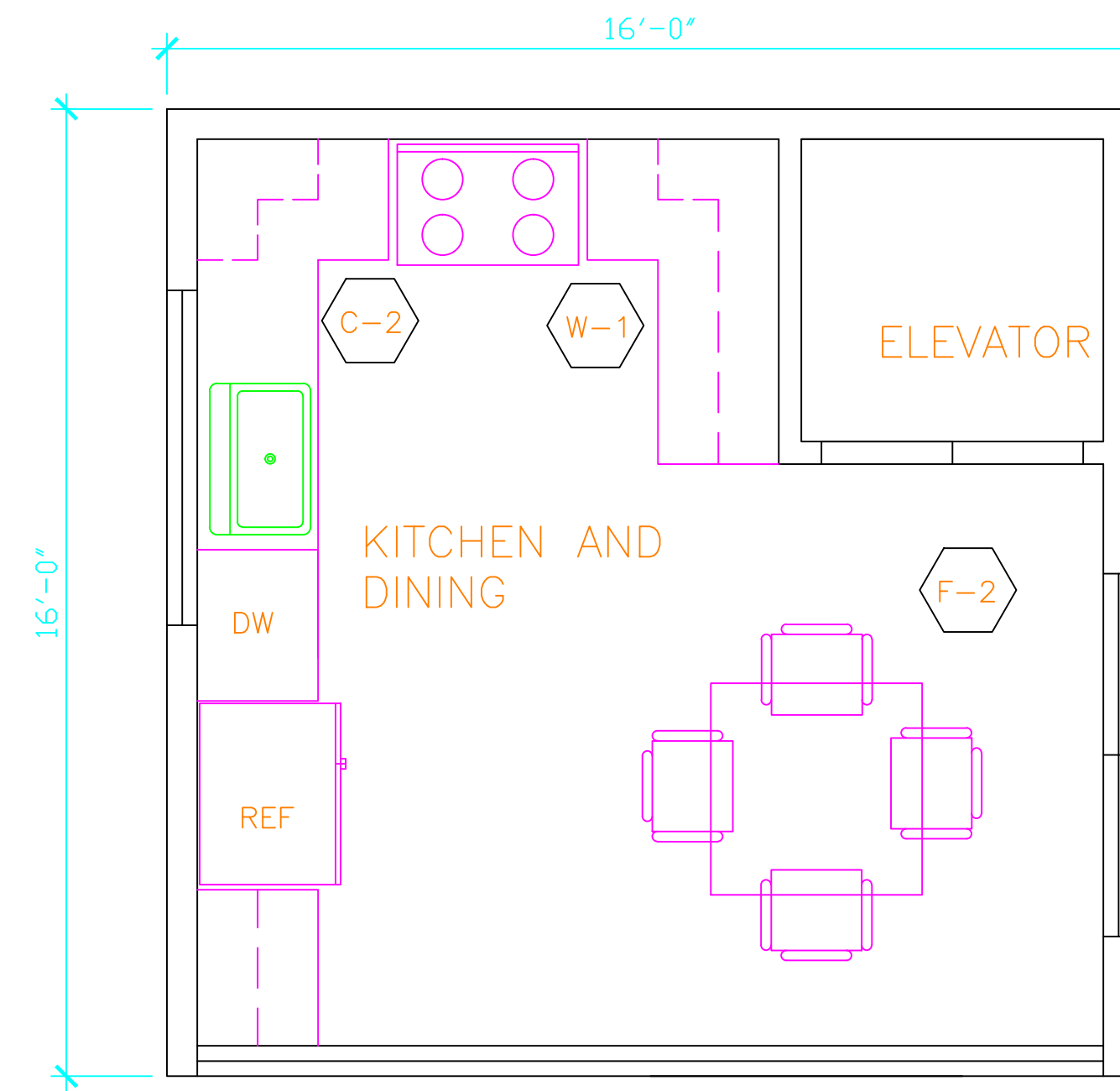
PROJECT NAME
 PASSIVE SUSTAINABLE
 RESIDENCE
 AKRON, OHIO

DESIGNER AND CLASS
 CAITE RAYMOND
 HONORS RESEARCH PROJECT
 SPONSOR: AMANDA RURA

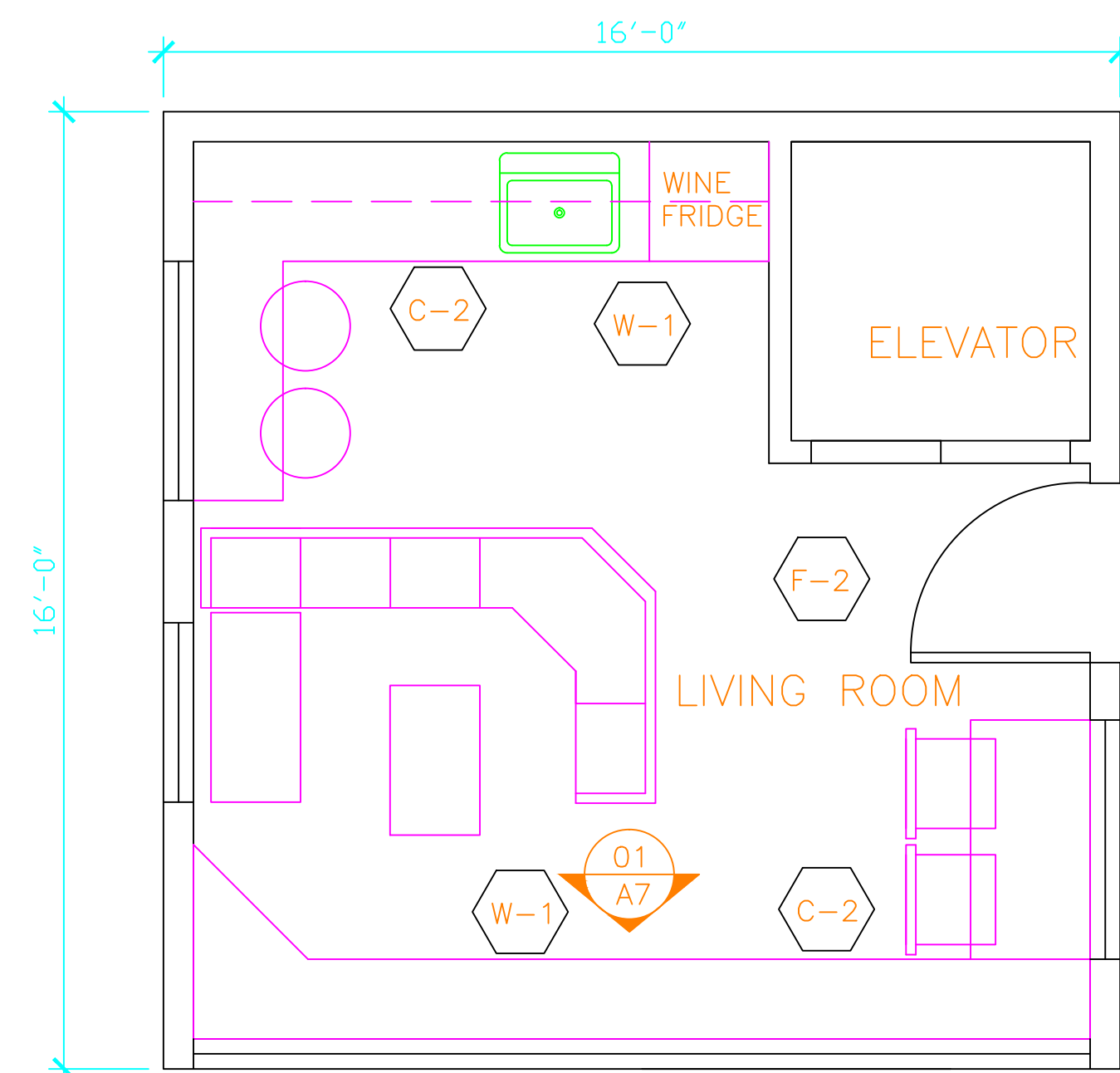
Project HONORS	Sheet A2
Date 3/20/16	A2
Scale 3/8" = 1'-0"	



1 FIRST FLOOR
A3 3/8" = 1'-0"



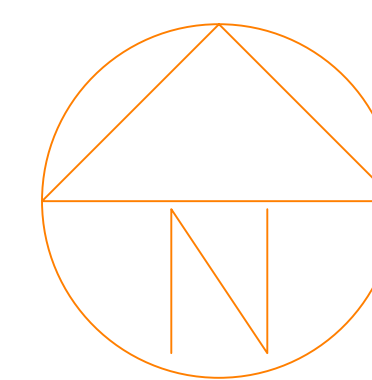
2 SECOND FLOOR
A3 3/8" = 1'-0"



3 THIRD FLOOR
A3 3/8" = 1'-0"

NOTES

1. SEE FINISH MATERIALS SCHEDULE FOR KEY ON SHEET A-8
2. ALL SHELIVING AGAINST GLAZING ARE OPEN GLASS SHELVES



General Notes

FURNITURE PLAN

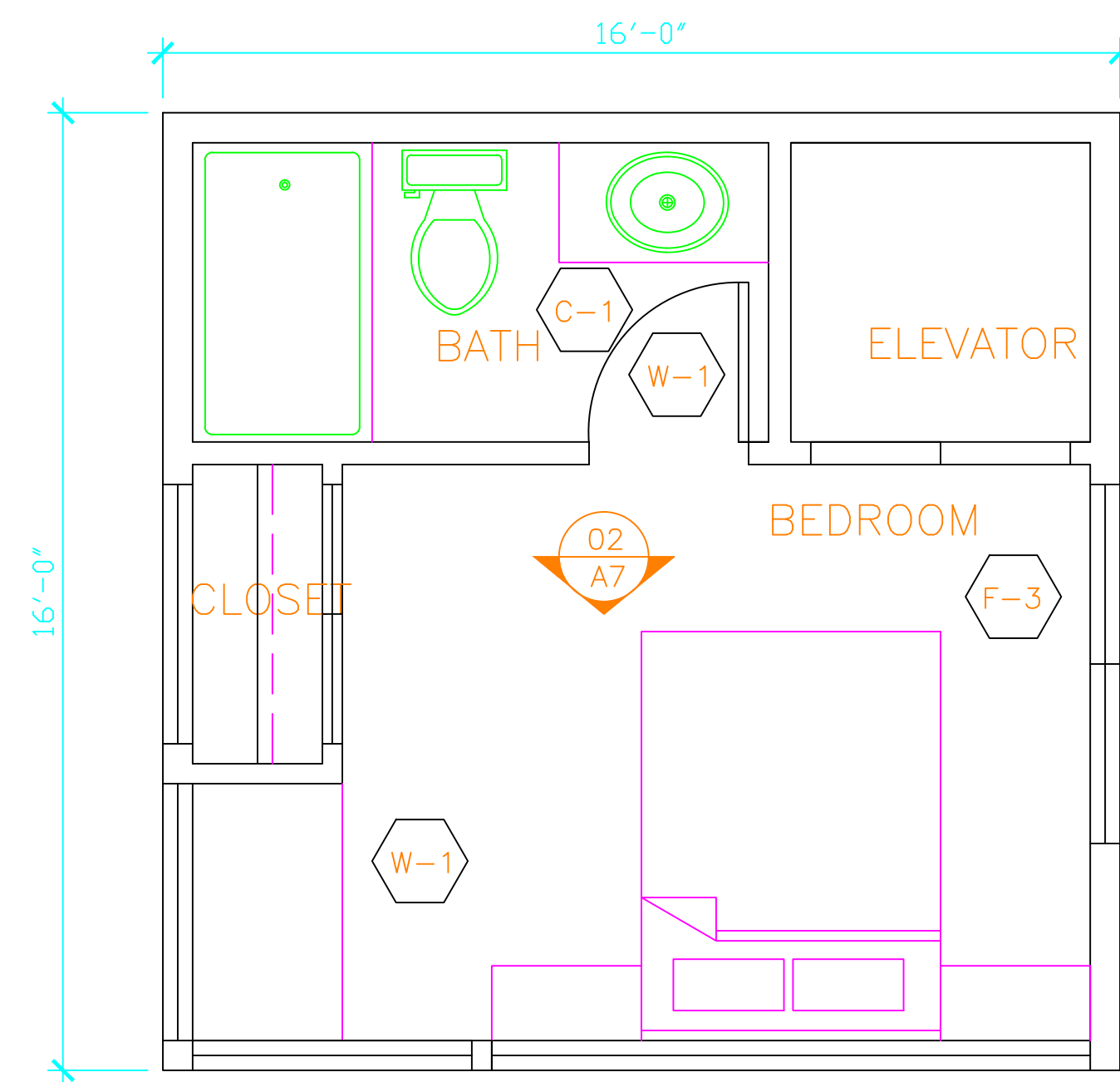
DRAWING TITLE

No.	Revision/Issue	Date

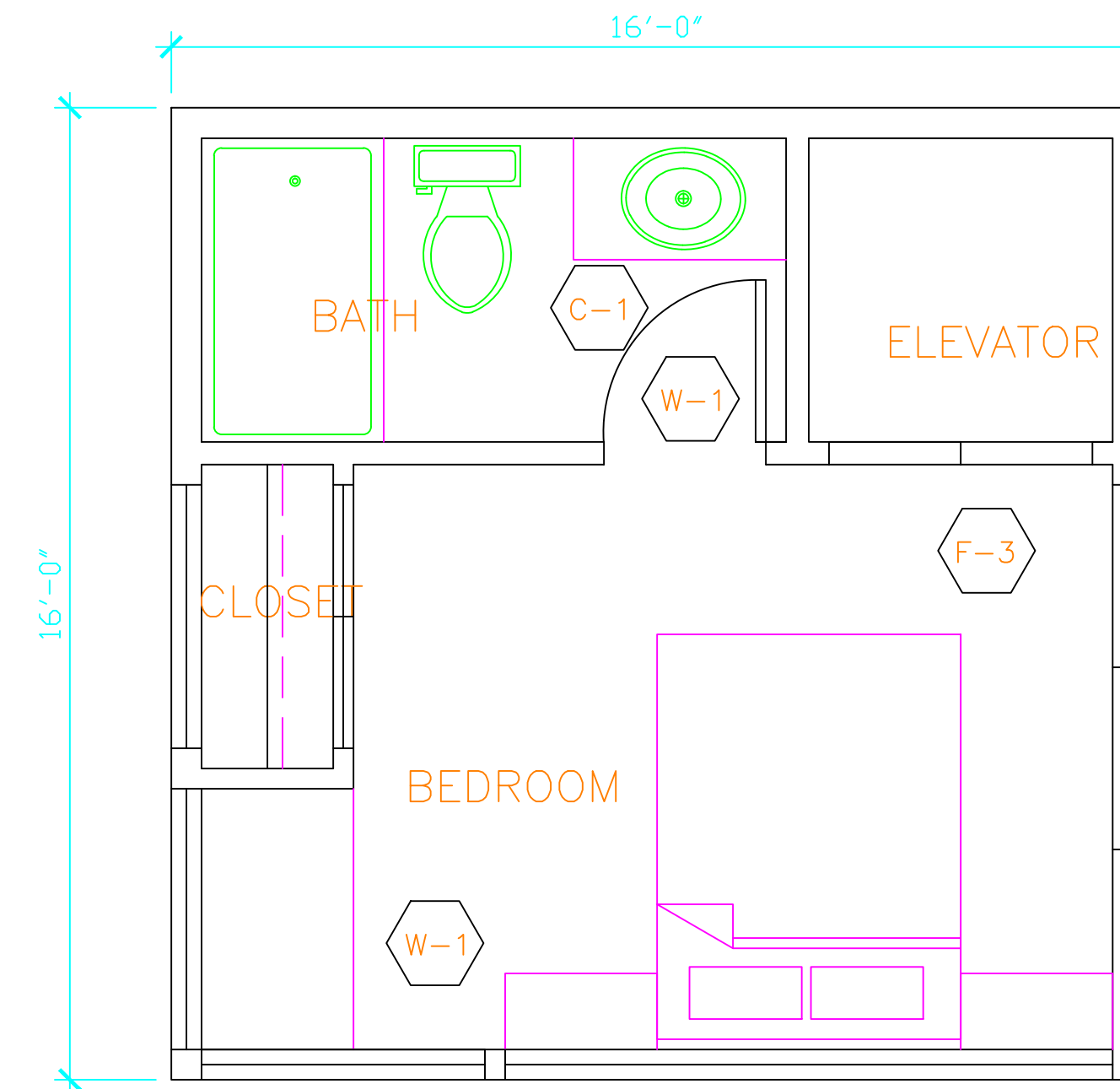
PROJECT NAME
PASSIVE SUSTAINABLE RESIDENCE
AKRON, OHIO

DESIGNER AND CLASS
CAITE RAYMOND
HONORS RESEARCH PROJECT
SPONSOR: AMANDA RURA

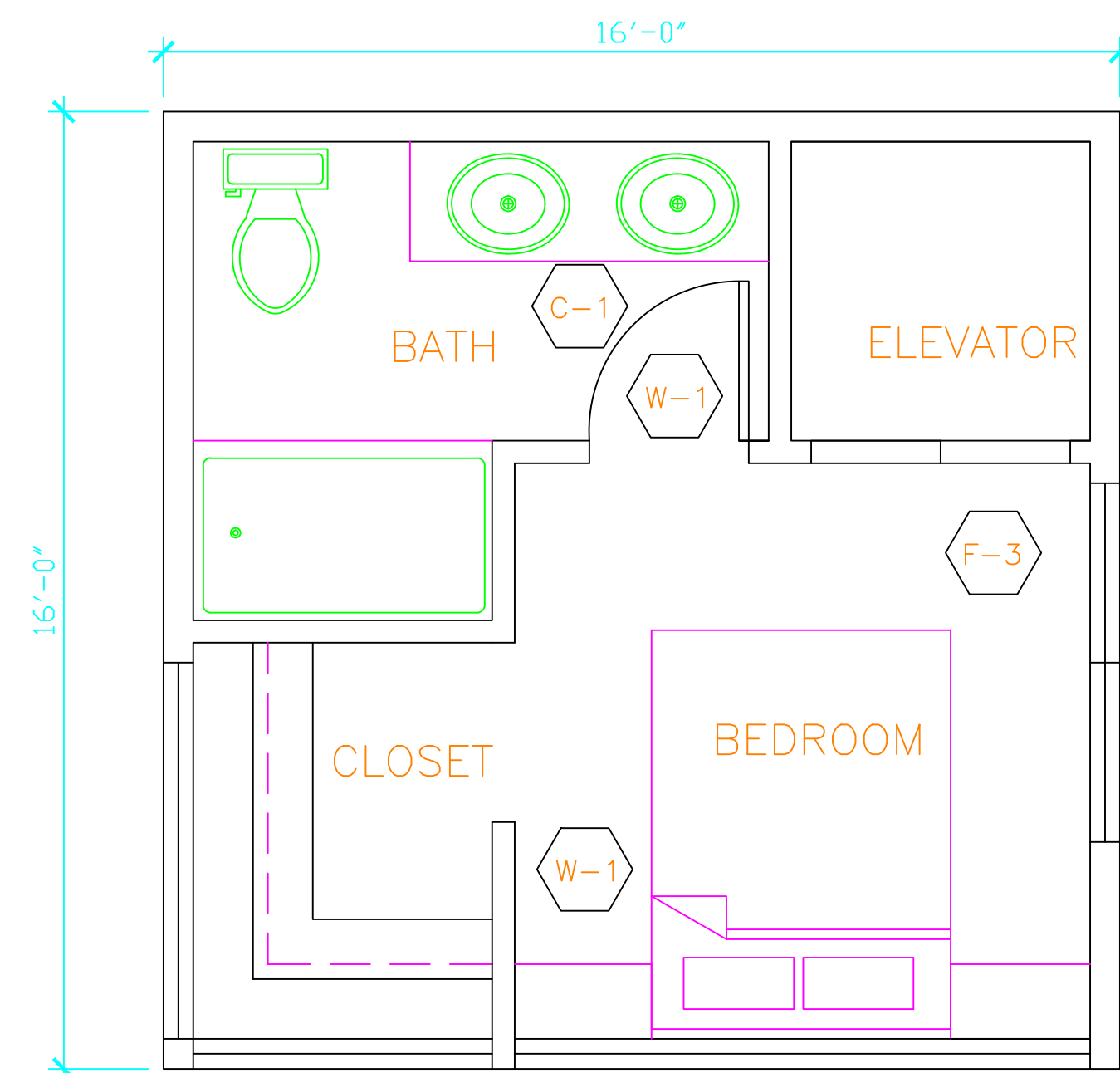
Project	HONORS	Sheet	A3
Date	3/20/16		
Scale	3/8" = 1'-0"		



1 FOURTH FLOOR
A4 3/8" = 1'-0"



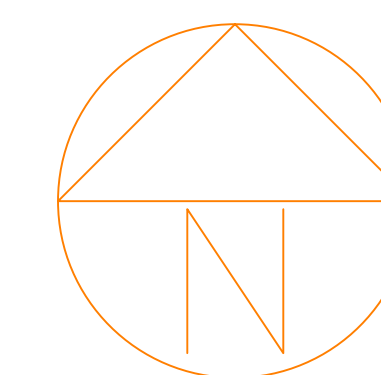
2 FIFTH FLOOR
A4 3/8" = 1'-0"



3 SIXTH FLOOR
A4 3/8" = 1'-0"

NOTES

1. SEE FINISH MATERIALS SCHEDULE FOR KEY ON SHEET A-8
2. ALL SHELIVING AGAINST GLAZING ARE OPEN GLASS SHELVES



General Notes

FURNITURE PLAN

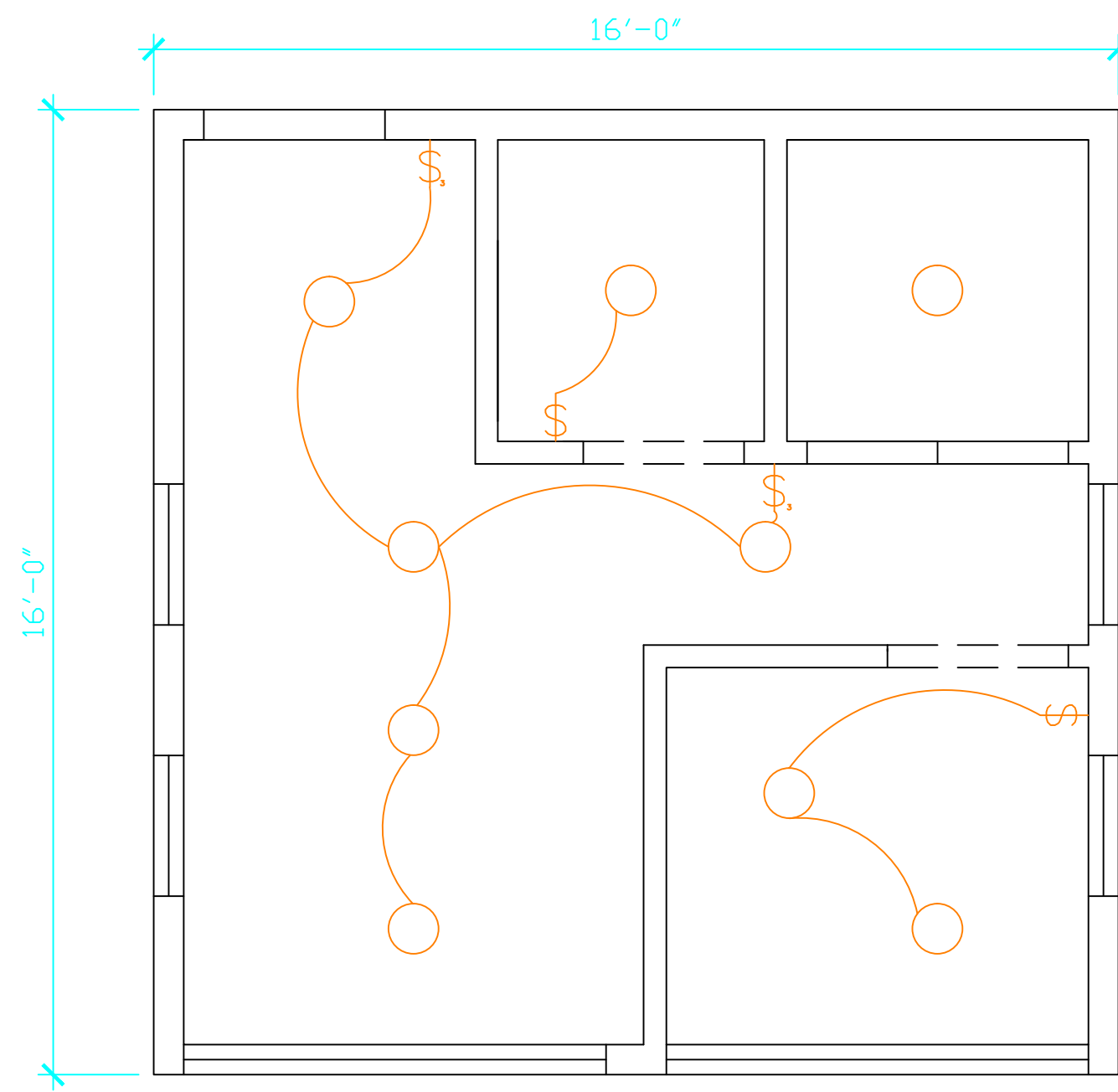
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No.	Revision/Issue	Date

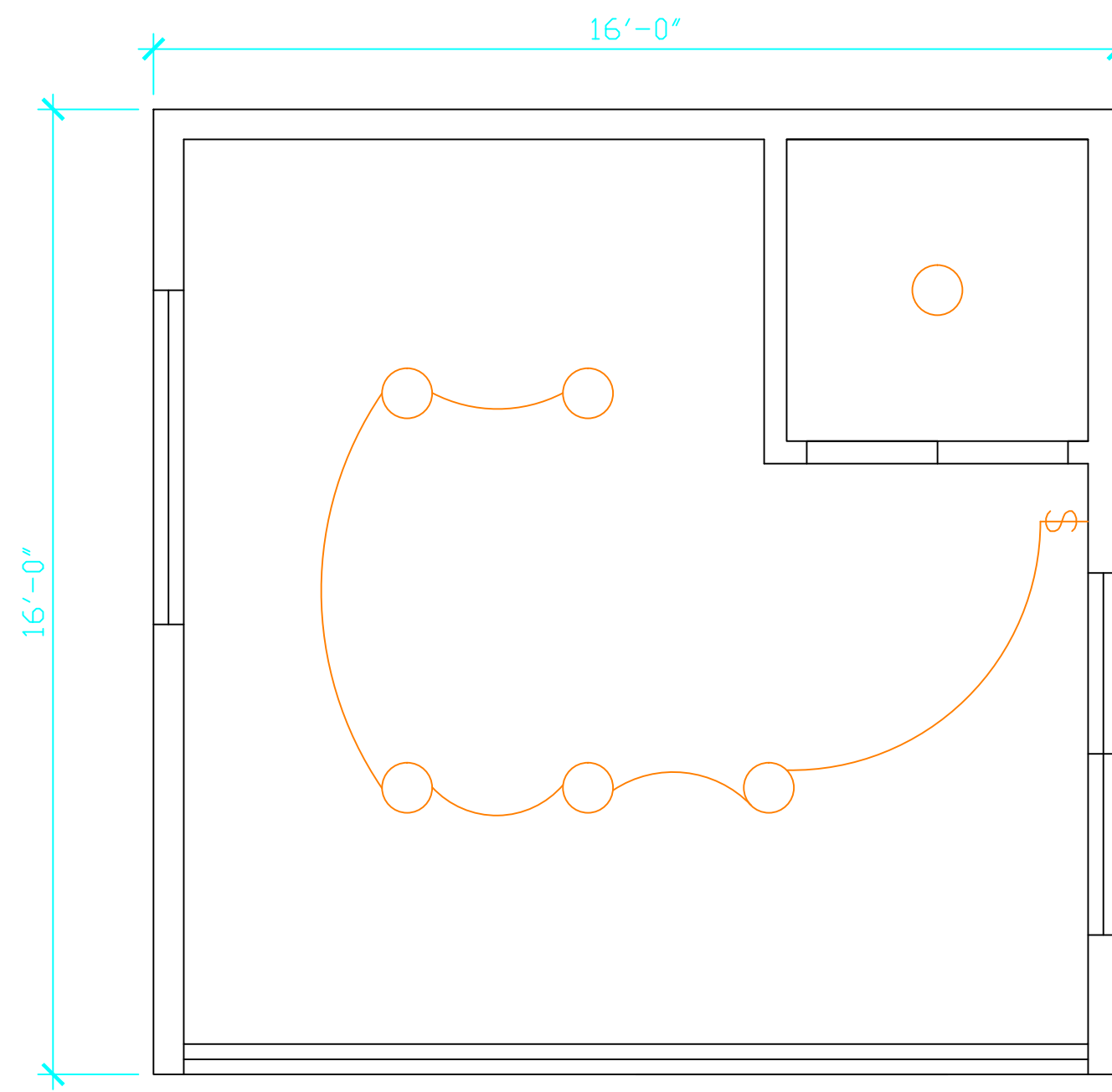
PROJECT NAME
PASSIVE SUSTAINABLE
RESIDENCE
AKRON, OHIO

DESIGNER AND CLASS
CAITE RAYMOND
HONORS RESEARCH PROJECT
SPONSOR: AMANDA RURA

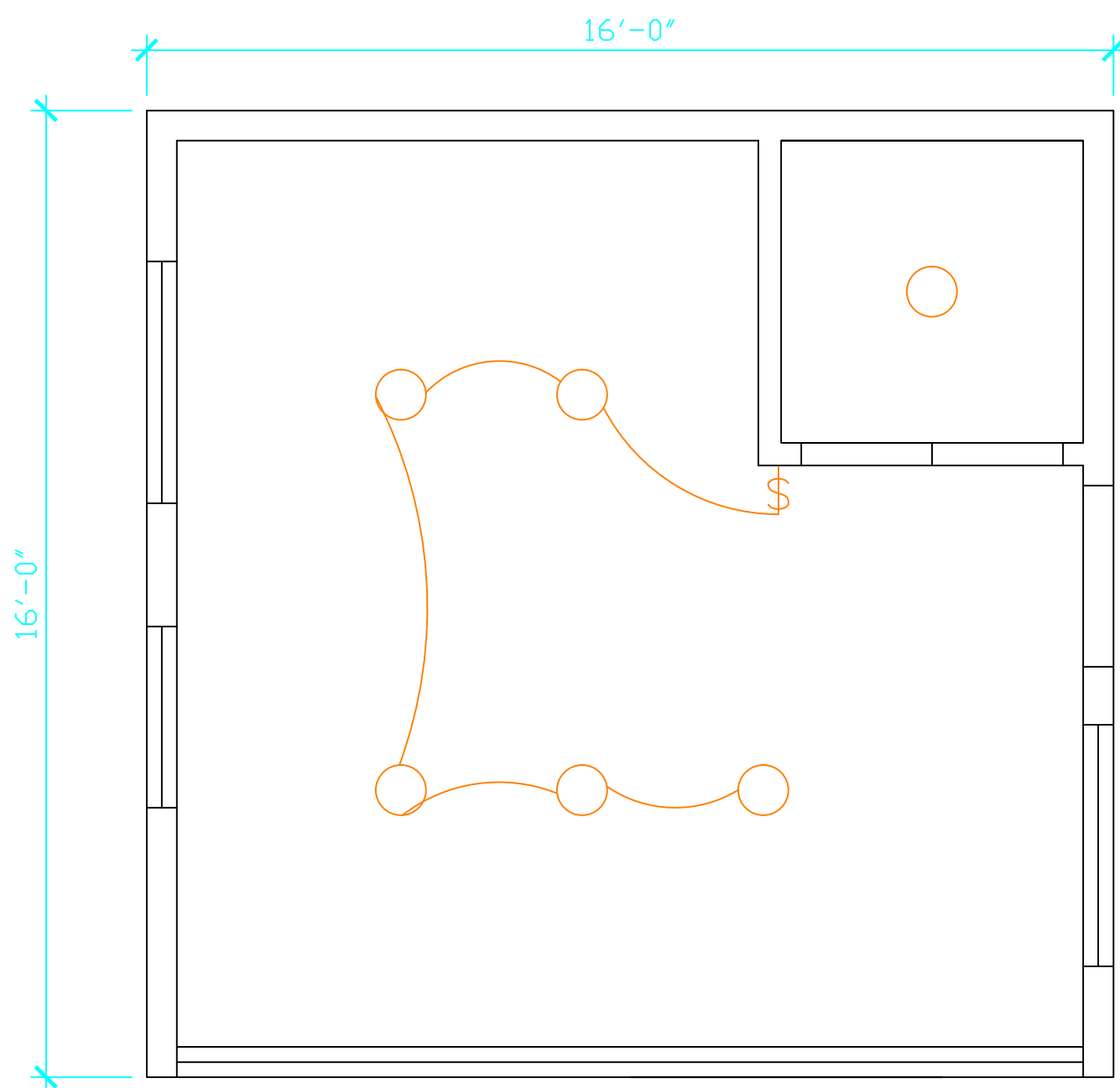
Project HONORS	Sheet A4
Date 3/20/16	A4
Scale 3/8" = 1'-0"	



1 FIRST FLOOR
A5 3/8" = 1'-0"



2 SECOND FLOOR
A5 3/8" = 1'-0"



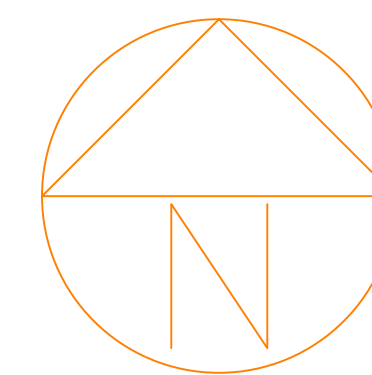
3 THIRD FLOOR
A5 3/8" = 1'-0"

POWER/VOICE/DATA LEGEND

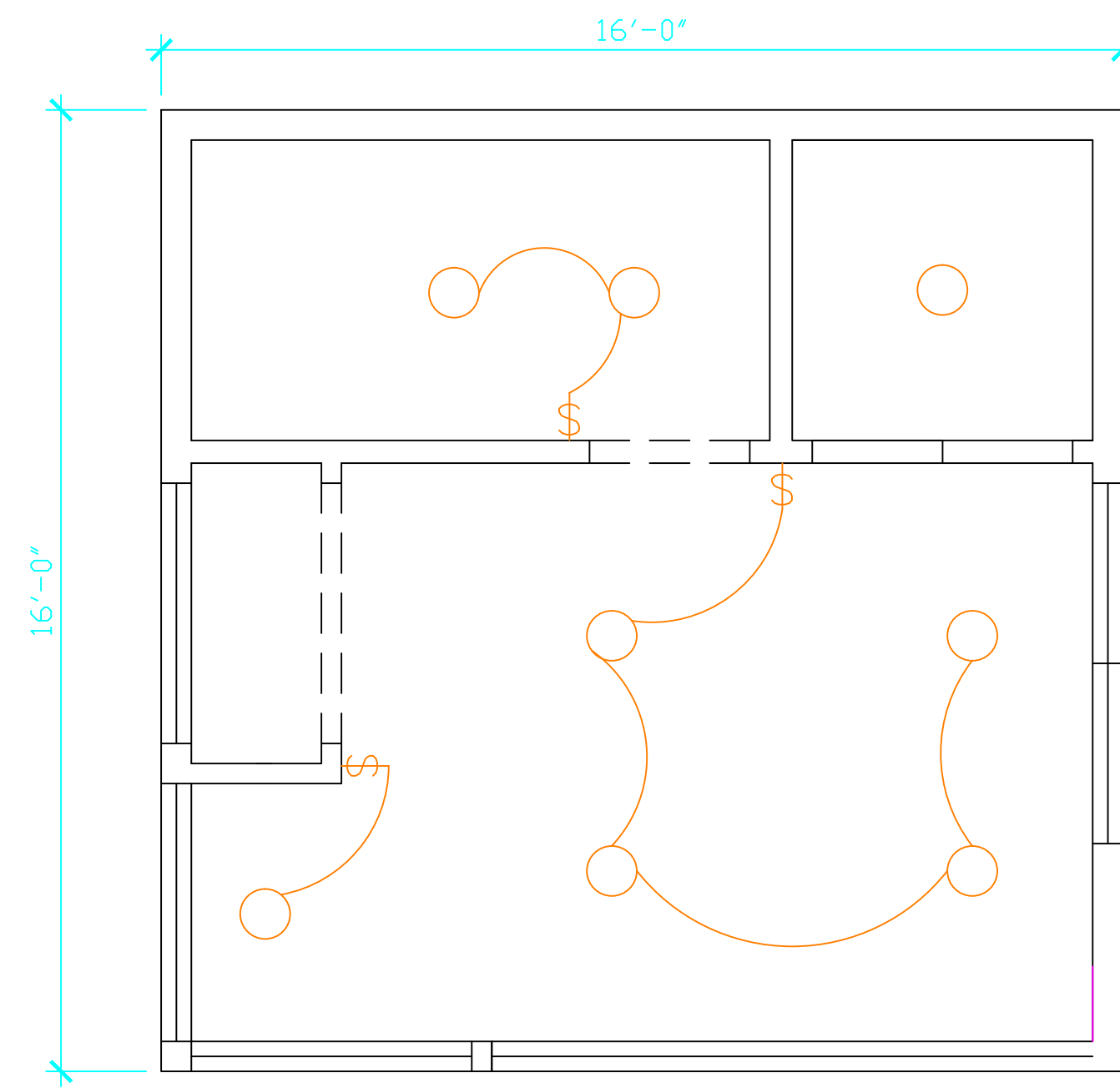
- RECESSED LIGHTING
- \$ TOGGLE SWITCH
- ⌘ THREE WAY SWITCH

NOTES

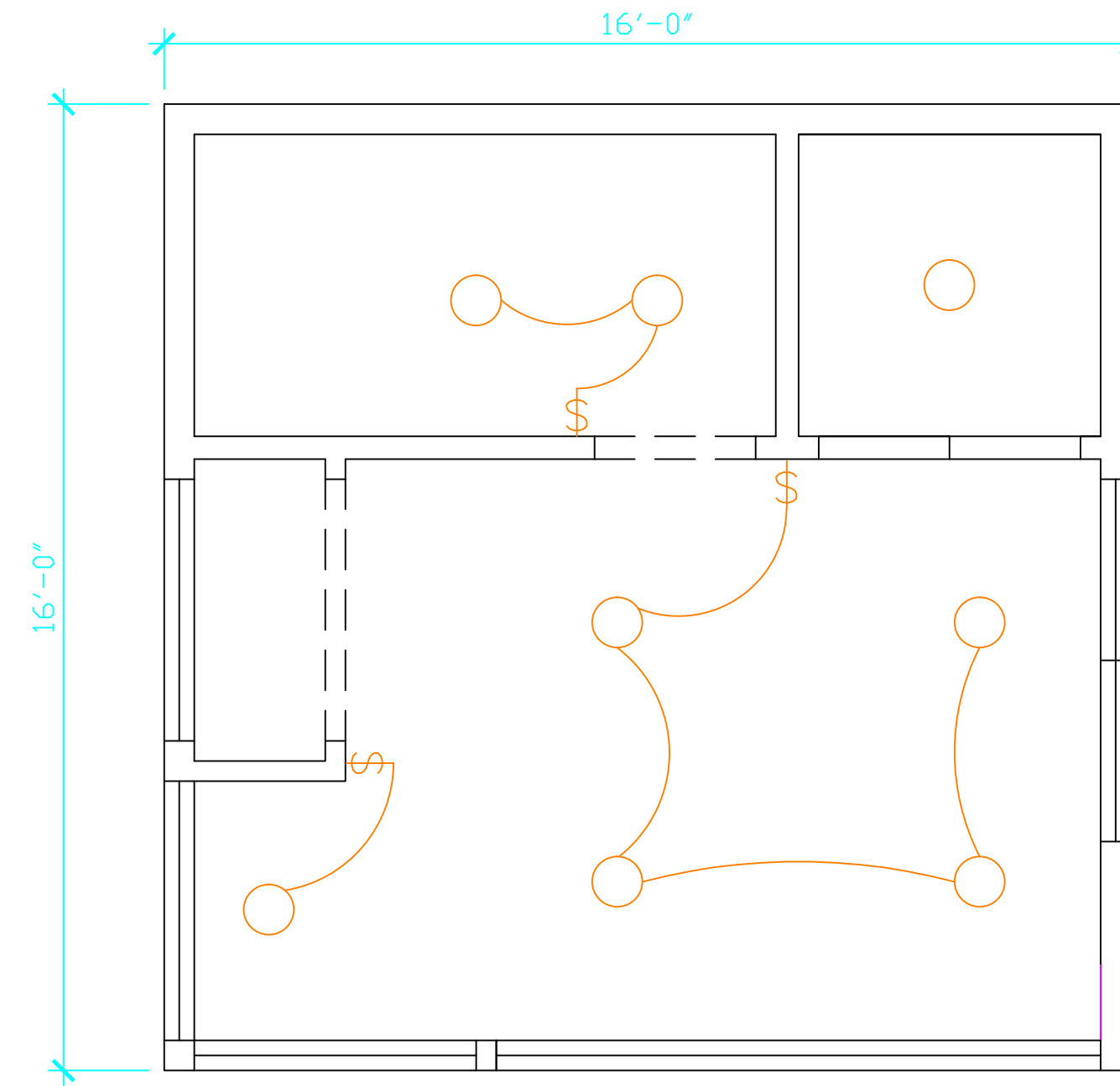
1. ALL LIGHTS ARE 594WB WHITE EYEBALL WITH BAFFLE, WHITE FLANGE, LED FROM COOPER INDUSTRIES
2. DAYLIGHTING SYSTEMS ARE TO BE INSTALLED
3. ALL CEILINGS ARE GYPSUM BOARD AND PAINTED BENJAMIN MOORE CHANTILLY LACE 2121-70



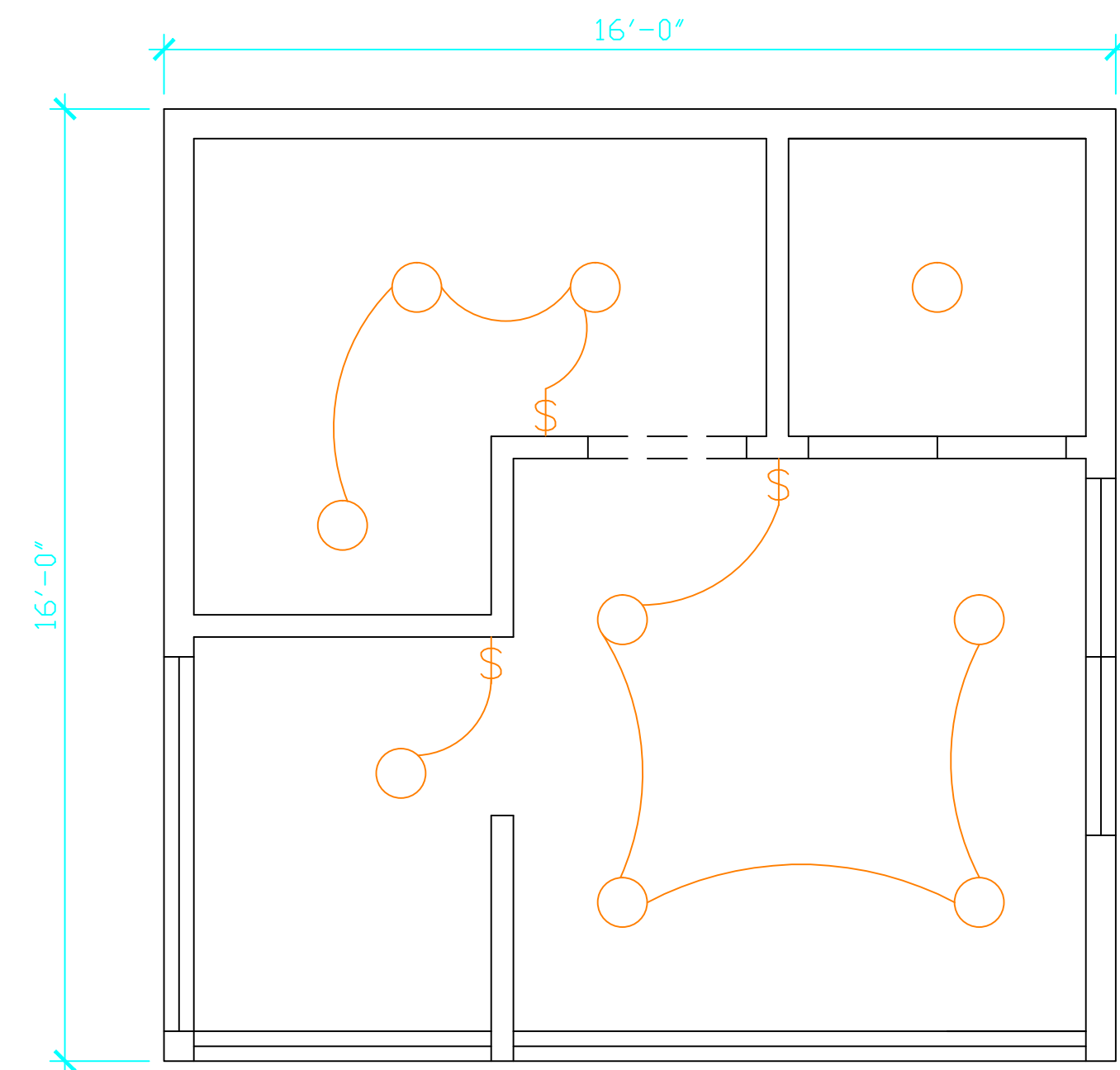
General Notes		
REFLECTED CEILING PLAN		
DRAWING TITLE		
No.	Revision/Issue	Date
PROJECT NAME		
PASSIVE SUSTAINABLE RESIDENCE AKRON, OHIO		
DESIGNER AND CLASS		
CAITE RAYMOND HONORS RESEARCH PROJECT SPONSOR: AMANDA RURA		
Project	Sheet	
Date	A5	
Scale	3/8" = 1'-0"	



1 FOURTH FLOOR
A6 3/8" = 1'-0"



2 FIFTH FLOOR
A6 3/8" = 1'-0"



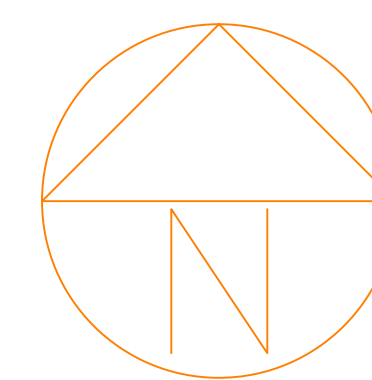
3 SIXTH FLOOR
A6 3/8" = 1'-0"

POWER/VOICE/DATA LEGEND

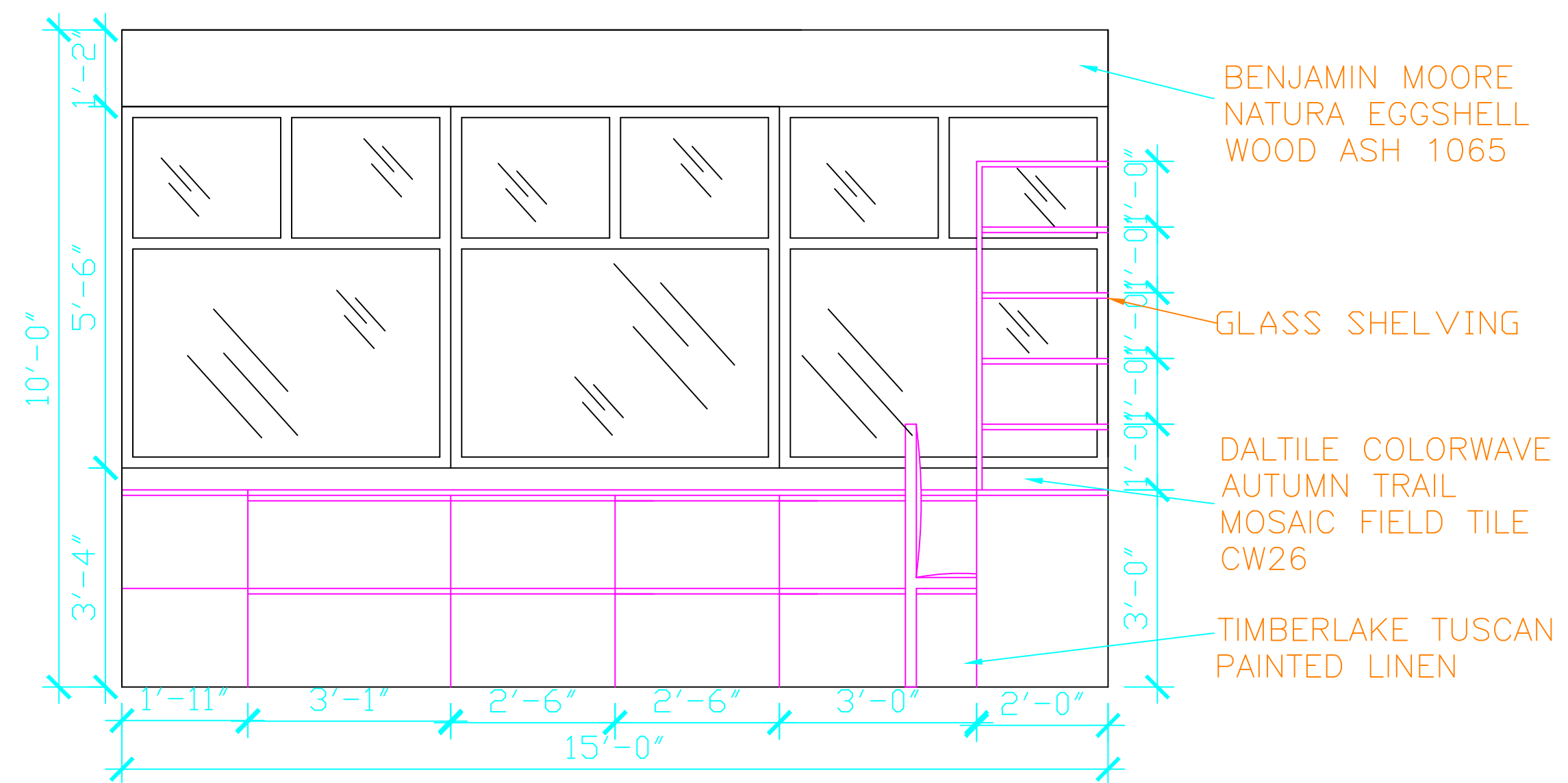
- RECESSED LIGHTING
- \$ TOGGLE SWITCH
- ⌘ THREE WAY SWITCH

NOTES

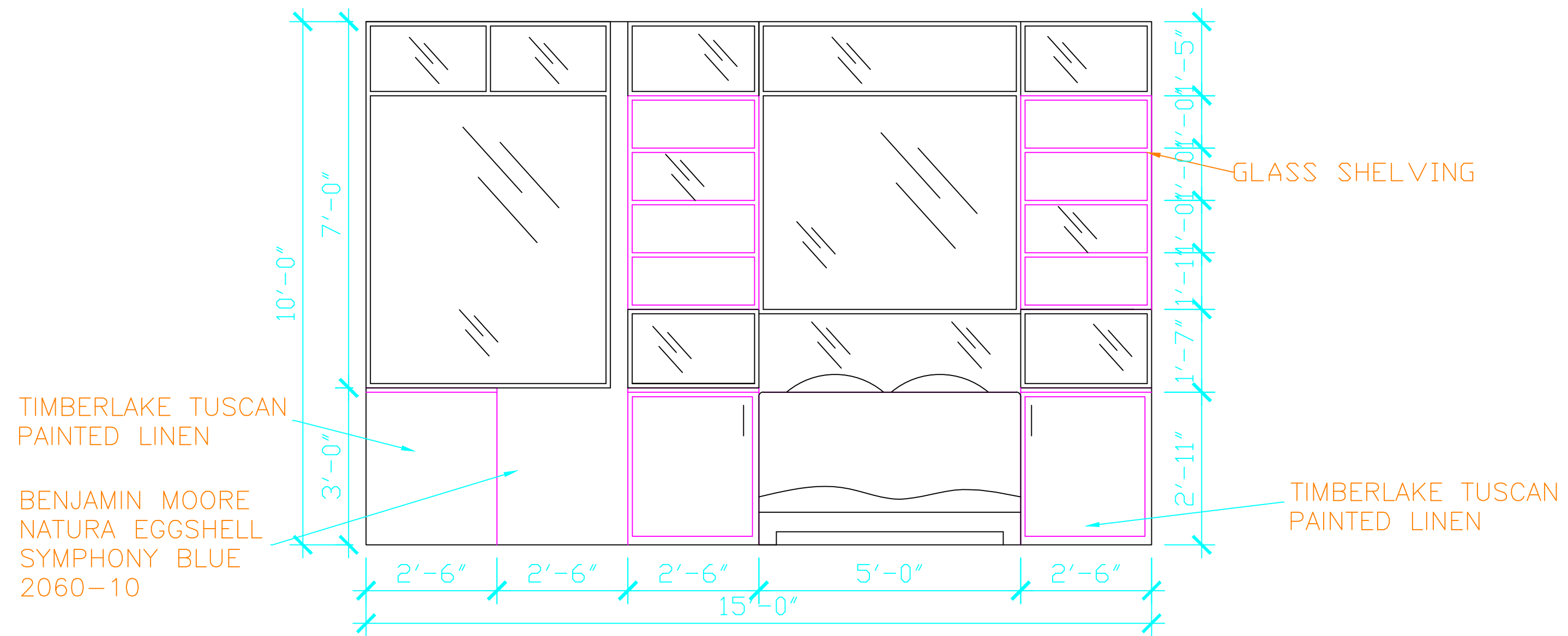
1. ALL LIGHTS ARE 594WB WHITE EYEBALL WITH BAFFLE, WHITE FLANGE, LED FROM COOPER INDUSTRIES
2. DAYLIGHTING SYSTEMS ARE TO BE INSTALLED
3. ALL CEILINGS ARE GYPSUM BOARD AND PAINTED BENJAMIN MOORE CHANTILLY LACE 2121-70



General Notes		
REFLECTED CEILING PLAN		
DRAWING TITLE		
No.	Revision/Issue	Date
PROJECT NAME		
PASSIVE SUSTAINABLE RESIDENCE AKRON, OHIO		
DESIGNER AND CLASS		
CAITE RAYMOND HONORS RESEARCH PROJECT SPONSOR: AMANDA RURA		
Project	Date	Sheet
HONORS	3/20/16	A6
Scale		
3/8" = 1'-0"		



1 LIVING ROOM SOUTH WALL
A7 1/2" = 1'-0"



2 FIFTH FLOOR
A7 1/2" = 1'-0"

NOTES

- SEE FINISH MATERIALS SCHEDULE FOR KEY ON SHEET A-8

General Notes

ELEVATIONS

DRAWING TITLE

No.	Revision/Issue	Date

PROJECT NAME
PASSIVE SUSTAINABLE
RESIDENCE
AKRON, OHIO

DESIGNER AND CLASS
CAITE RAYMOND
HONORS RESEARCH PROJECT
SPONSOR: AMANDA RURA

Project HONORS	Sheet A7
Date 3/20/16	
Scale 1/2" = 1'-0"	

FINISH MATERIALS SCHEDULE							
KEY	MATERIAL	MANUFACTURER	FINISH/COLOR	SIZE	SPECIFICATIONS	LOCATION	REMARKS
C-1	RECYCLED SURFACES COUNTERTOP	COSENTINO	WHITE DIAMOND - POLISHED	-	ECD BY COSENTINO WHITE DIAMOND	1ST LEVEL STORAGE AND LAUNDRY, 4TH LEVEL BATHROOM, 5TH LEVEL BATHROOM, 6TH LEVEL BATHROOM	-
C-2	RECYCLED SURFACES COUNTERTOP	COSENTINO	LUNA - POLISHED	-	ECD BY COSENTINO LUNA	2ND LEVEL KITCHEN, 3RD LEVEL LIVING ROOM	-
F-1	LINOLEUM FLOORING	ARMSTRONG	MARMORETTE - OBSIDIAN - LOW GLOSS	6'-7" x 98'-0"	LINDART MARMORETTE OBSIDIAN LS096	1ST LEVEL STORAGE AND LAUNDRY, BATH, AND OFFICE	-
F-2	PORCELAIN TILE FLOORING	MANNINGTON	SILICA	18" X 18"	MANNINGTON STRATA SILICA ST0T12	2ND LEVEL KITCHEN, 3RD LEVEL LIVING ROOM	-
F-3	PORCELAIN TILE FLOORING	MANNINGTON	RAIN	6' x 36'	MANNINGTON HAVEN RAIN HA1T36	4TH LEVEL BATHROOM, 5TH LEVEL BATHROOM, 6TH BATHROOM	-
P-1	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - MINERAL ICE	-	BENJAMIN MOORE NATURA EGGSHELL MINERAL ICE 2132-70	1ST LEVEL WALLS, 4TH LEVEL WALLS, 5TH LEVEL WALLS, 6TH LEVEL WALLS	ALL PAINT IN THE BATHROOM IS AURA BATH & SPA - MATTE
P-2	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - WOODCLIFF LAKE	-	BENJAMIN MOORE NATURA EGGSHELL WOODCLIFF LAKE 980	1ST LEVEL WALLS	ALL PAINT IN THE BATHROOM IS AURA BATH & SPA - MATTE
P-3	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - DEEP SPACE	-	BENJAMIN MOORE NATURA EGGSHELL DEEP SPACE 2125-20	1ST LEVEL WALLS, 2ND LEVEL WALLS, 3RD LEVEL WALLS	ALL PAINT IN THE BATHROOM IS AURA BATH & SPA - MATTE
P-4	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - SWEET CAROLINE	-	BENJAMIN MOORE NATURA EGGSHELL SWEET CAROLINE 478	2ND LEVEL AND 3RD LEVEL WALLS	-
P-5	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - WOOD ASH	-	BENJAMIN MOORE NATURA EGGSHELL WOOD ASH 1065	2ND LEVEL AND 3RD LEVEL WALLS	-
P-6	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - CHANTILLY LACE	-	BENJAMIN MOORE NATURA EGGSHELL CHANTILLY LACE 2121-70	ALL CEILINGS	ALL PAINT IN THE BATHROOM IS AURA BATH & SPA - MATTE
P-7	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - SYMPHONY BLUE	-	BENJAMIN MOORE NATURA EGGSHELL SYMPHONY BLUE 2060-10	4TH LEVEL WALLS, 5TH LEVEL WALLS, 6TH LEVEL WALLS	ALL PAINT IN THE BATHROOM IS AURA BATH & SPA - MATTE
P-8	PAINT	BENJAMIN MOORE	EGGSHELL FINISH - FANTASY BLUE	-	BENJAMIN MOORE NATURA EGGSHELL FANTASY BLUE 716	4TH LEVEL WALLS, 5TH LEVEL WALLS, 6TH LEVEL WALLS	ALL PAINT IN THE BATHROOM IS AURA BATH & SPA - MATTE
T-1	GLASS TILE	DALTILE	WILLOW WATER RANDOM BLOCK	11 3/4" x 11 3/4" x 5/16"	DALTILE COLORWAVE WILLOW WATER RANDOM BLOCK CW21	1ST LEVEL BATHROOM	-
T-2	GLASS TILE	DALTILE	WILLOW WATER INTERLOCKING MOSAIC	12" x 18" x 5/16"	DALTILE COLORWAVE WILLOW WATER INTERLOCKING MOSAIC CW21	1ST LEVEL STORAGE AND LAUNDRY	-
T-3	GLASS TILE	DALTILE	AUTUMN TRAIL MOSAIC FIELD TILE	11 7/8" x 11 7/8" x 5/16"	DALTILE COLORWAVE AUTUMN TRAIL MOSAIC FIELD TILE CW26	2ND LEVEL KITCHEN, 3RD LEVEL LIVING ROOM	-
T-4	GLASS TILE	DALTILE	WINTER BLUES BRICK JOINT MOSAIC	12 7/8" x 11 7/8" x 5/16"	DALTILE COLORWAVE WINTER BLUES BRICK JOINT MOSAIC CW27	4TH LEVEL BATHROOM, 5TH LEVEL BATHROOM, 6TH BATHROOM	-
W-1	CABINETY	TIMBERLAKE	TUSCAN PAINTED LINEN	-	TIMBERLAKE TUSCAN PAINTED LINEN	ALL LEVELS	-

General Notes

FINISH SCHEDULE

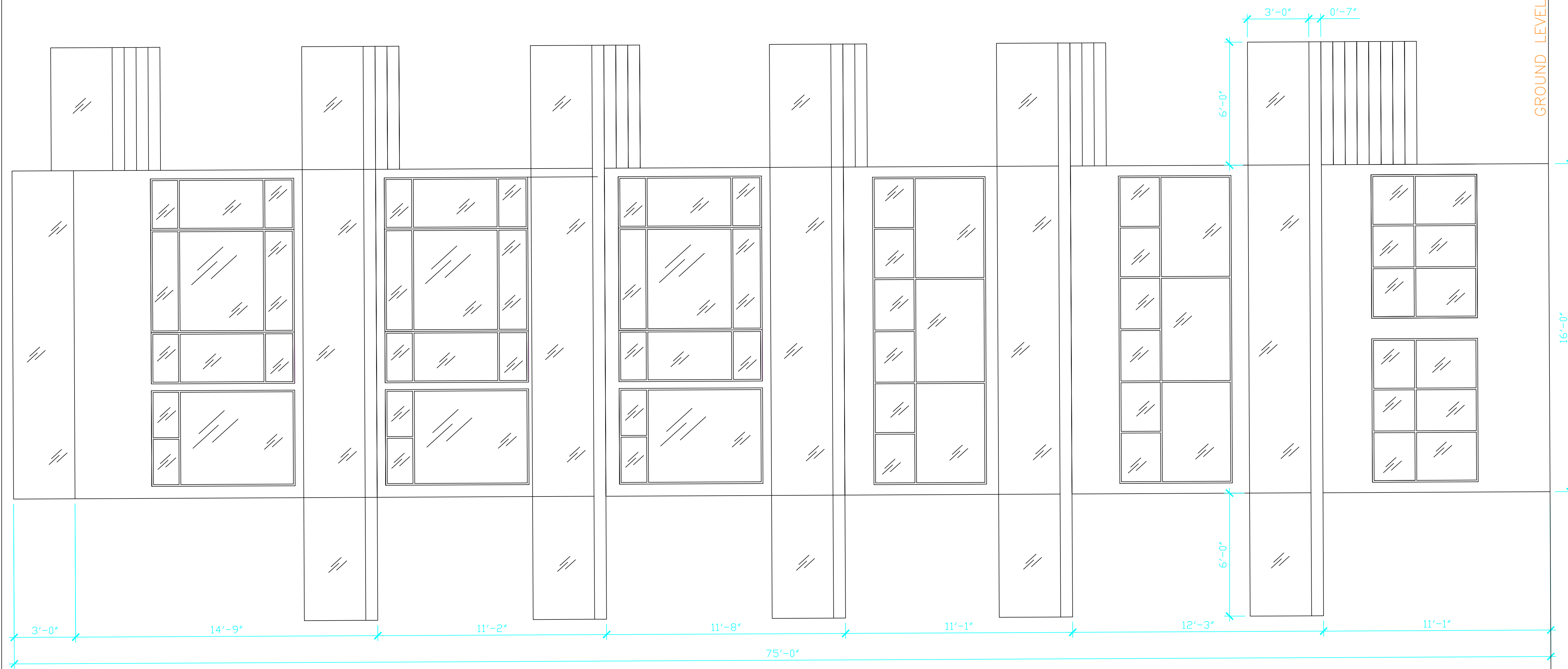
DRAWING TITLE

No.	Revision/Issue	Date
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PROJECT NAME
PASSIVE SUSTAINABLE
RESIDENCE
AKRON, OHIO

DESIGNER AND CLASS
CAITE RAYMOND
HONORS RESEARCH PROJECT
SPONSOR: AMANDA RURA

Project	HONORS	Sheet	A8
Date	3/20/16		
Scale	NONE		



1 EXTERIOR ELEVATION OF SOUTH WALL
 A9 3/8" = 1'-0"

General Notes

EXTERIOR ELEVATION

DRAWING TITLE

No.	Revision/Issue	Date

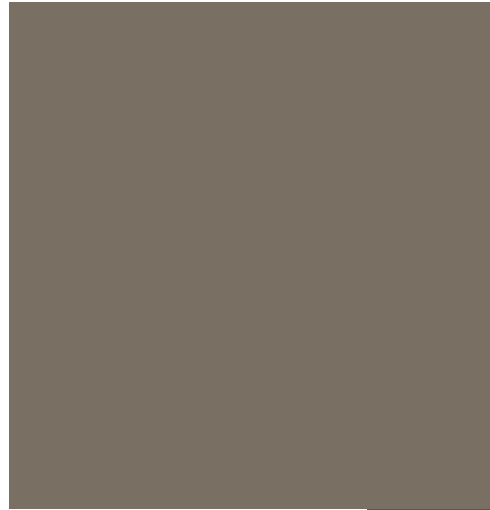
PROJECT NAME
 PASSIVE SUSTAINABLE
 RESIDENCE
 AKRON, OHIO

DESIGNER AND CLASS
 CAITE RAYMOND
 HONORS RESEARCH PROJECT
 SPONSOR: AMANDA RURA

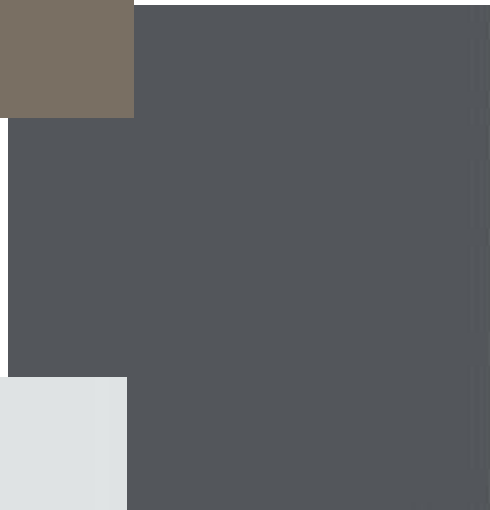
Project HONORS	Sheet A9
Date 3/20/16	
Scale 3/8" = 1'-0"	

FIRST FLOOR

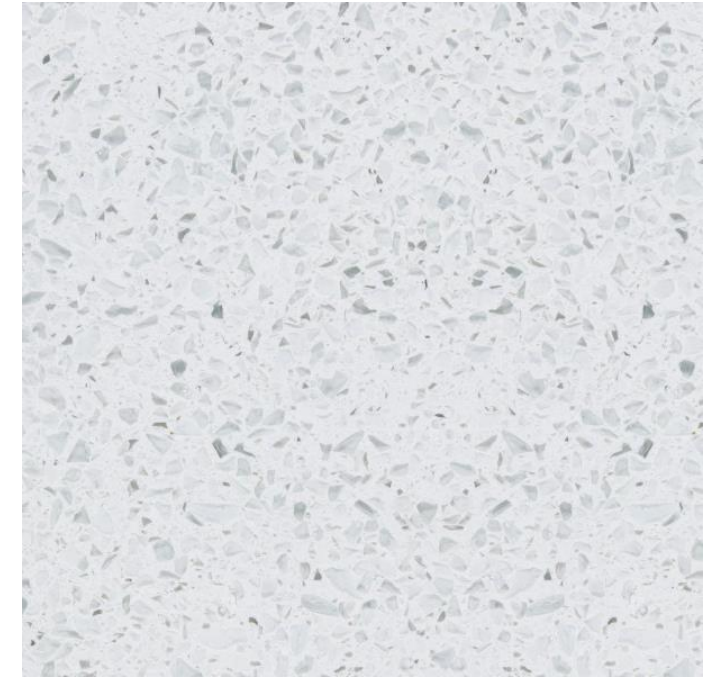
BENJAMIN MOORE
WOODCLIFF LAKE



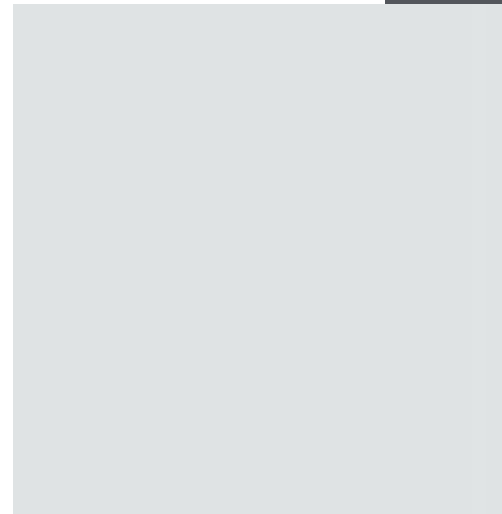
BENJAMIN MOORE
DEEP SPACE



ARMSTRONG LINOART
MARMORETTE OBSIDIAN



ECO BY COSENTINO
WHITE DIAMOND



BENJAMIN MOORE
MINERAL ICE



DALTILE COLORWAVE
WILLOW WATER INTERLOCKING MOSAIC



TIMBERLAKE TUSCAN
PAINTED LINEN

DALTILE COLORWAVE
WILLOW WATER RANDOM BLOCK

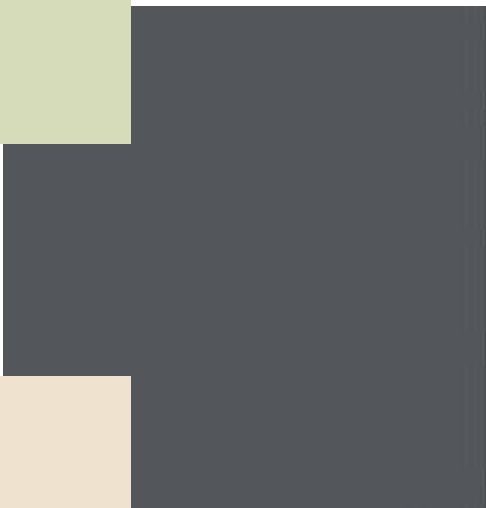


SECOND AND THIRD FLOORS

BENJAMIN MOORE
SWEET CAROLINE



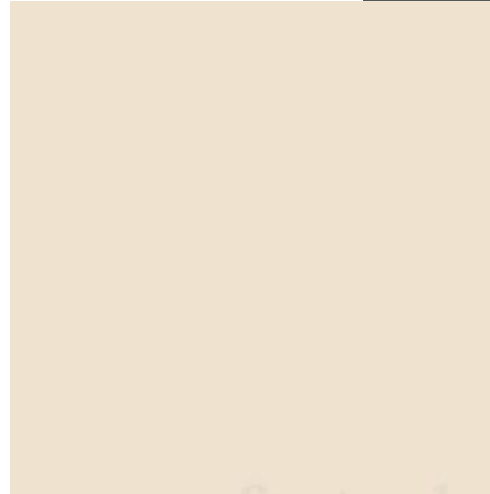
BENJAMIN MOORE
DEEP SPACE



MANNINGTON STRATA SILICA



ECO BY COSENTINO LUNA



BENJAMIN MOORE
WOOD ASH

TIMBERLAKE TUSCAN
PAINTED LINEN

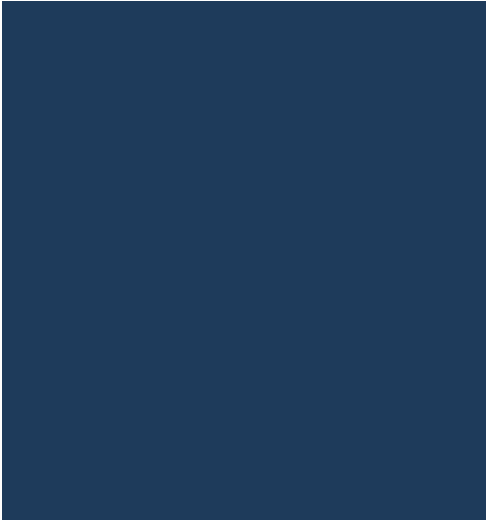


DALTILE COLORWAVE
AUTUMN TRAIL MOSAIC FIELD

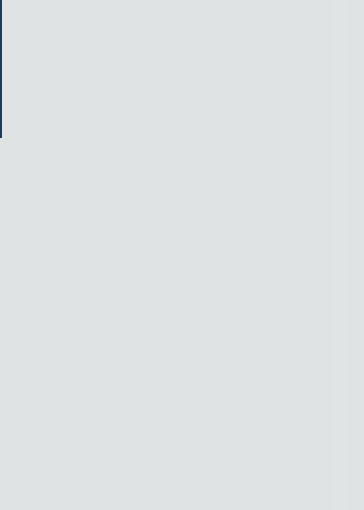


FOURTH, FIFTH, AND SIXTH FLOORS

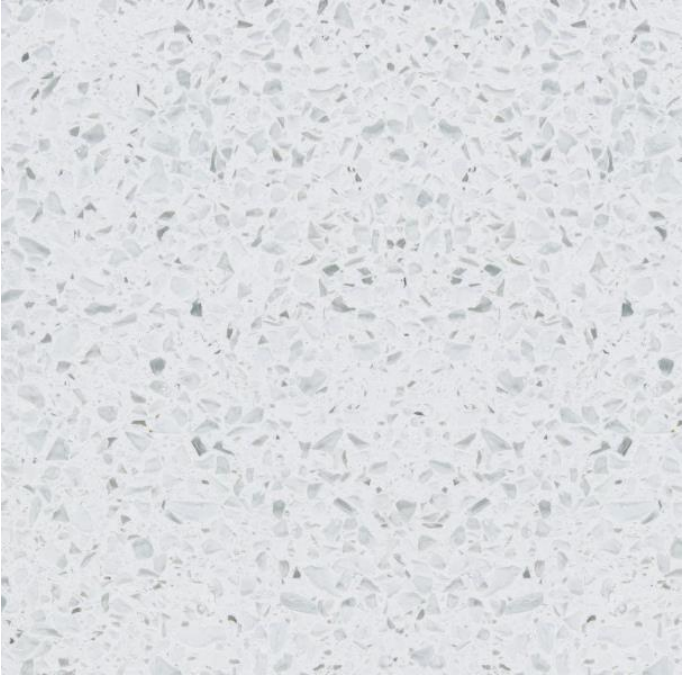
BENJAMIN MOORE
SYMPHONY BLUE



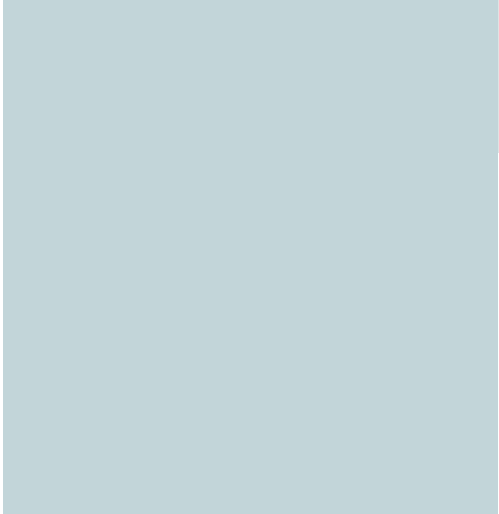
BENJAMIN MOORE
MINERAL ICE



MANNINGTON HAVEN RAIN



ECO BY COSENTINO
WHITE DIAMOND



BENJAMIN MOORE
FANTASY BLUE

TIMBERLAKE TUSCAN
PAINTED LINEN



DALTILE COLORWAVE
WINTER BLUES BRICK JOINT MOSAIC



INTERIOR RENDERING: BEDROOM



EXTERIOR RENDERINGS

