December 16

Final Proposal

2009

This proposal outlines a new HVAC system design, which will replace the existing system with a geothermal system. In conjunction with a geothermal system, piezoelectric flooring and dye sensitive solar cells will also be incorporated into the Museum.

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The Walt Disney Family Museum in the Presidio of San Francisco

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Executive Summary

This proposal critiques the existing mechanical equipment as well as central chilled water and hot water plant. After a semester spent reviewing and analyzing the existing conditions, an overall conclusion can be drawn that while the systems are proficient and meet necessary standards and codes that govern HVAC systems, the Museum could be more sustainable in terms of energy consumption. Therefore, this report outlines more energy conscious technologies that will aid in moving the Museum towards energy independence versus dependence on secondary energy sources.

The existing central heating and cooling plant will be replaced by a geothermal system which will be composed of vertical piping loops that will utilize the ground as a heat source or heat sink depending upon the seasonal buiding loads. This system will naturally heat and cool the building's chilled water and hot water, therefore using less energy.

In conjunction with this system, piezoelectric flooring material is proposed based on the number of occupants constantly moving through the Museum. This technology will help produce electricity needed to fuel the interactive displays and lighting within the Museum.

Finally, a solar study will be performed to in order to determine the effiectiveness of using dye sensitive solar cells in place of the 640 ft^2 glass façade, located on the east side of the building. Incorporated into this solar study, research will be performed to understand the different types of vegitation that may be used in order to provide solar shading to the buiding in the summer time while allowing sunlight to heat the building during the winter months.

The proposed technologies previously mentioned were chosen because they are architectural passive solutions, meaning, these technologies may be implemented without disturbing the historical look and feel of the Museum. Due to the buildings standing in the Presidio as well as its National Historic Landmark standing, restrictions surround this structure that would otherwise not an issue for a newer building.

Building Summary

The Walt Disney Family Museum is historical renovation project located in the Presidio of San Francisco. The original idea behind the Museum came from Walt Disney's daughter, Diane Disney Miller, in order to properly display the life and work of the man behind the magic. The Walt Disney Family Foundation, a non-profit organization established by the Disney family in which Mrs. Miller plays an active role, approached Page and Turnbull, the project architects with the idea in September 2005.

With the Disney family's home located in Northern California, San Francisco was an ideal location for the Museum project. Walt Disney, a veteran of World War I, had an immense amount of respect for the American military and therefore, the Presidio, a former army post for over 200 years, serving the Spanish, Mexican and American armies, made an ideal location for the project.

The Museum, which is also identified as Building 104, occupies former army barracks, which were originally built in 1897, which housed various troops and army purposes until 1994. This building was the ideal home for the Museum, which showcases impressive views of the Golden Gate Bridge as well as the San Francisco Bay and also shares the neighborhood with other famous tenants, such as George Lucas Films.

The WDFM campus layout, locating each of the three buildings. (Right)

The WDFM consists of three buildings within the project. The original design objectives required that spaces be provided for a Museum consisting of galleries, exhibits, offices and a lecture hall. The project also needed a space for art archives, restorations areas and library space as well as all necessary utilities associated with the buildings. Therefore, three buildings were renovated within the campus. Building 104, the Museum building, houses the galleries, displays, lecture halls, learning areas and some offices for the Museum Staff. Building 122, houses the art archives and preservation spaces as well as more offices while Building 108 houses the MEP system.

While the entire space of Building 108, 1,174 ft^2, is dedicated solely to the MEP systems, Building 104 has five (5) levels within the building. Four of the five levels are gallery spaces, exhibits, lecture halls and office space while he sub-basement houses the four air handling units. Therefore, the Museum has 52,090 ft^2 of occupiable space, while 7,305 ft^2 dedicated to ductwork and air handling unit space.

Finally, it is important to take note that the WDFM campus falls under the category of National Historic Landmark (NHL). A structure labeled as a National Historic Landmark, as stated by the National Park service, has been determined "a nationally significant historic place designated by the Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States." While the Presidio encourages adaptive use of the buildings within the park, the preservation of the original structure, character and landscape must be maintained while abiding by the Secretary of Interiors Standards for Rehabilitation of Historic Properties.

While this historical project required a large amount of research and dedication that required the design team to work within the limits of redeveloping a NHL, the Walt Disney Family Museum contributes to the community of the Presidio and more importantly, reaches its ultimate goal of properly displaying the life and legacy of Walt Disney to the world.

Existing Mechanical System

Building 108 houses the thermal plant where the heating and cooling system for the Museum is located. This concept of a central plant was ideal because it allows the major HVAC components to be consolidated into one centralized location for maintenance and repairs without disturbing the visitors or employees within the Museum. Also within the Museum, sound and vibration was also a sensitive issue, therefore, the central plant eliminates these disturbances as well.

From an energy standpoint, the usage should be lower due to the three larger, high efficiency chillers versus smaller, distributed compressor chillers throughout the buildings. The electrical distribution within the buildings is also minimized, as all the major HVAC loads are located within this centralized plant.

The system consists of a central chilled water plant, heating water plant, condenser water loop as well as distributed air system. The following sections explain each of these components more in depth.

Central Chilled Water Plant

The central chilled water plant consists of three (3) 254 ton maximum capacity, electric powered, water cooled screw chillers. The chillers evaporatively cool the chilled glycol and water mixture to 40°F using R-134A refrigerant. The chilled water is then pumped to the buildings for use by the coils. One primary chilled inline water pump with a 435 GPM capacity pumps the chilled water to Buildings 104 and Building 122 for use, while a secondary chilled water pump with a variable frequency drive as well as a 435 GPM capacity returns the water. Both primary and secondary pumps have additional pumps on standby for use when needed. Pressure gauges, thermometers and flow meters ensure the chilled water is leaving the plant at the right temperature, pressure and velocity for proper use by the buildings.

After the buildings receive the water, the coils chill the air by using the chilled water, that air is supplied to the appropriate spaces. Then, the water is pumped back into the chiller system to reduce the temperature once again for reuse.

Condenser Water System

In order to process the chilled water in the central chiller plant, a cooling tower uses a heat rejection process to reduce the temperature of the condenser water. The cooling tower, like the chillers, is located in Building 108 and has a total capacity of 260 tons. The process begins with the screw compressor within each of the chillers, which increases the pressure of the refrigerant and after passing through the condenser, transfers heat to the condenser water. The condenser water then goes through a heat rejection process via the cooling towers, which reduce the temperature to 80°F. The flow is measured by a globe value then enters through a check valve before it entering the condenser pump. The water continues through the condenser pump that has a 740 GPM capacity while another pump with the same capacity is on standby and used if necessary. After leaving the pump, the water is measured by a pressure gauge, pressure cock and goes through a "Y" type strainer to filter debris and particles out of the water. Chemical feed pumps are used to clean the condenser water in order to prevent mold and other particle build-up. This process is continued while the chillers are in operation to meet the building's demands.

Hot Water Plant

To provide hot water to the buildings, two natural gas fueled, condensing type boilers, each with a 860 MBtu output capacity, which provide heating for the system. Water enters the boiler, at 60 GPM and is heated to 170°F which is then pumped to the buildings by an inline, primary hot water pump with a 60 GPM capacity on a variable frequency drive. Both the boiler system and hot water system pump have equal components on standby for use if the building demands are measured necessary. The hot water is then pumped to Building 104 and Building 122 for use by the air distribution systems.

Generator

Also located within Building 108, a radiator cooled, diesel fuel fired standby generator provides power to emergency loads. This generator is rated 500kW/625kVA, 120/208V, 3-phase, 4 wire. Emergency power is provided to air handling system equipment used to maintain the environmental control in the gallery and display areas, sump pumps and sewage ejector pumps, fire management system as well as other components of the building.

The generator is also provided with a separate fuel oil tank, which can provide power to emergency loads for 72 hours.

Air Distribution System

Within Building 104, all air supplied to the spaces is conditioned by the 4-AHUs that are located in the sub-basement of the building. The AHUs can supply a maximum of 88,000 cfm of total airflow with the minimum outside airflow totaling 15,800 cfm. The air supplied to the spaces ranges from 54°F to 70°F depending on the loads as well as the outdoor air temperatures. AHUs 1, 2,and 3 service the entire Museum building while AHU 4 is dedicated solely to the Lecture Hall space. After the air handling units condition the air needed by the spaces, the supply air is distributed to the spaces through pressure independent modules and VAV boxes.

Five fan coil units are also located throughout the building on the basement level and first floor level. These units provide 8,935 cfm to spaces when determined necessary.

The buildings also have exhaust fans located in restrooms, kitchens and also in telecommunications closets.

Conclusion of the Mechanical Systems Analysis

Within the Walt Disney Family Museum campus, the mechanical system provides the appropriate amount of heating and cooling to meet the calculated loads, however, the system lacks environmental efficiency and sustainable design. However, the historical nature of the building as well as the constraints of the Museum's budget have left the system meeting the HVAC needs but lacking green quality. Therefore, with a closer look at the budget costs as well as long-term benefits of a greener mechanical system, the WDFM could have been pursued to agree to a more environmentally friendly design.

The overall construction cost of the system average about $94.00 per square foot while the total cost to install the mechanical system totaled over $2.5 million dollars. The total energy cost each year total $209,877.80 that equals $6.05 per square foot, which seems somewhat high but due to the large loads within the building needed to properly display the exhibits and galleries; however, this number is appropriate. However, if green systems were implemented concerning day lighting as well as renewable energy systems, this operating cost could be reduced.

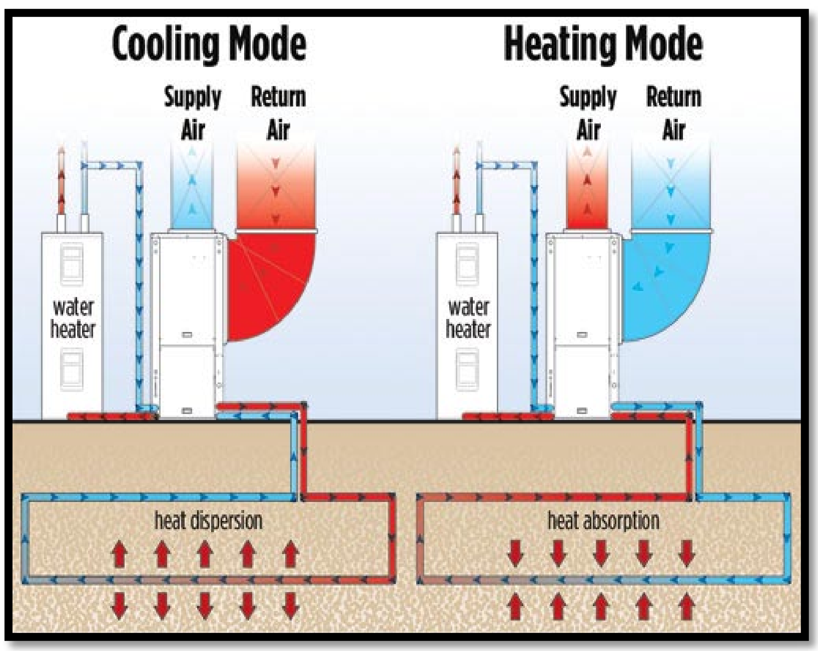
The occupants receive a substantial amount of ventilation air as well as supply air within the Museum. The system has appropriate controls within the variable air volume system (VAV), which senses the need for more air at desired temperatures. Other controls within the building include monitoring of occupants and CO_2 levels that contribute to the HVAC system. The lighting system is also controlled although by occupancy sensor, however, a scheduled lighting system usually overrides the occupant controls.

Therefore, while the system meets basic HVAC needs of the space and the occupants, further consideration should be given to environmental concerns. Green should not be quantified by how much recycling the Museum processes every month, however, energy reduction as well as renewable energy resources that could be implemented in the Museum should define "going green". Further thought and ideas into this concept will be discussed in the upcoming mechanical project proposal.

Redesign of the Mechanical Systems

As part of the mechanical system redesign, a ground coupled heat exchanger with vertical boreholes containing the ground loop piping is proposed to replace a large portion of the central chilled water and heating plant. The ground water piping system will be composed of polyethylene piping loops, which are connected to the central plant for distribution to the buildings. This type of system could reduce the cost of heating and cooling hot and chilled water as well as energy used to reduce the condenser water temperature. The excavating for this type of system could have been constructed when the sub-basement level was being built. While this system has higher upfront costs, the energy savings over the 40-year lease period that the Museum contracted will be sure to prove the system's worth.

Aside from the excavation costs and the area needed as a heat source/heat sink, the upfront costs of the system include the cost of vertical piping as well as a separate set of group water heat pumps. However, this cost can be offset by the reduction in energy usage over the building's life cycle, the hopeful elimination of the chillers and boilers. This will also lead to a reduction in maintenance costs as well. If the system is properly design, the need for Building 108 could potentially be found unnecessary, saving the Museum both money and opening Building 108 up for other uses.



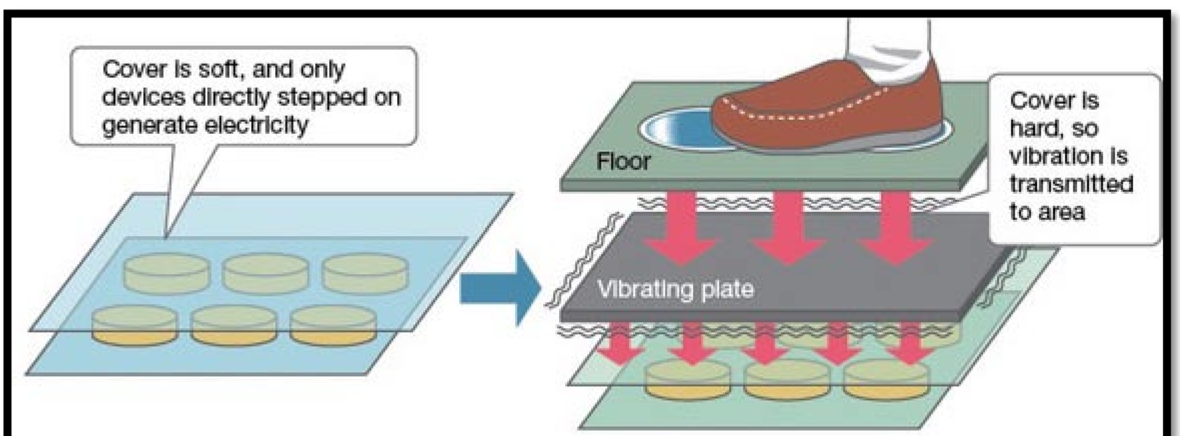
Geothermal System Conceptual Figure (Above)

This system will help the Museum produce energy savings for space cooling, space heating and heat rejection that is currently being processed by the central plant. A variable flow design with space temperature controls could also reduce the amount of pumping power needed by shutting off the flow to heat pumps when loads do not require heating or cooling.

A closer look at the capacity of the system as well as the feasibility of the soil type, the cost of the system as well as the projected saving will also need to be determined.

Electrical Breath

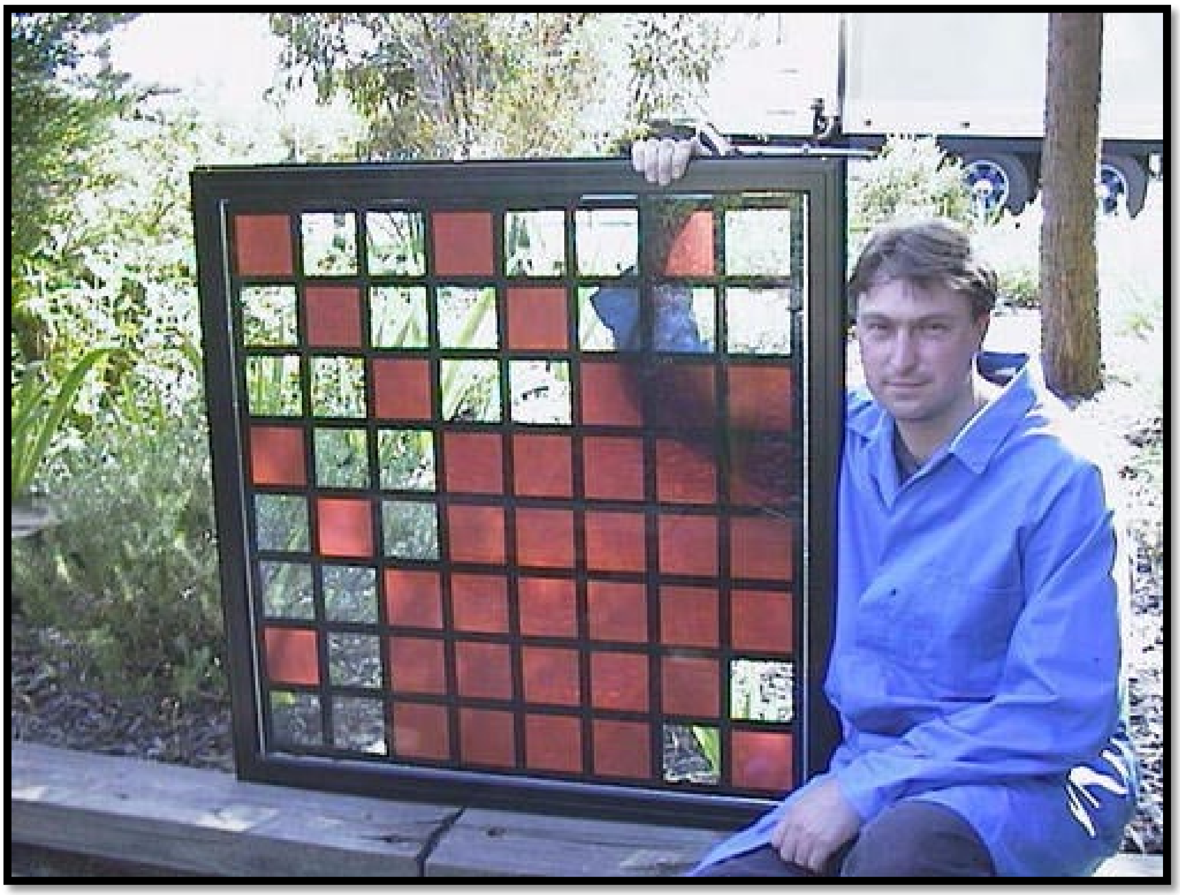
In conjunction with the geothermal system, loads will have to be determined within the building. While these loads will hopefully decreased in size, or at less energy will be used in heating and cooling the HVAC system in order to meet demands. However, in a strive to create a greener, more sustainable redevelopment project for others to model after, loads need to be addressed in other alternative methods as well. Therefore, Hatsuden-yuka™, a Japanese piezoelectric floor material used to convert vibrations and movements into electricity is being proposed for the Museum, a space in which the occupants are constantly moving. This type of technology was originally proposed for nightclubs; however, it is now proposed for subway stations in Tokyo, Japan and is suitable for high pedestrian traffic areas. Hopefully, the energy generated from this technology will help provide energy to the lighting throughout the building as well as the interactive displays and gallery exhibits.



Piezoelectric cells proposed for use by the Museum occupants (Above)

Solar Breadth

The East façade of the Museum building consists of two walls of floor-to-floor glass, approximately 10' high by 32' long for a total area of 320 ft^2 on each floor. Therefore, within this area, dye sensitized solar cells (DSSC) are proposed as an alternative energy solution which will capture solar energy within the windows and convert the solar energy into electricity for usage throughout the Museum. A solar study will be conducted in order to determine the efficiency and contribution of this technology. Also within this breadth, an analysis of the different types of vegetation will be conducted along with the solar shading, beneficial and detrimental based on the season and the type of landscaping most appropriate.



Dye Sensitive Solar Cells (DSSC) for use within the Museum's façade (Above)

Development Plan and Integrated Systems Approach

From previous studies and technical reports based on the Museum's existing heating, ventilation and air conditioning systems, an overall conclusion can be drawn that while the systems are meeting the baseline heating, cooling and ventilation needs of the building's loads and occupants, the system is not sustainable. Sustainable meaning, throughout the remainder of this thesis project, the support and means to independently fuel the building as an individual structure, not entirely dependent on secondary energy sources such as natural gas or electricity. However, this proposal is meant to move the Museum towards more natural, grid independent energy state; unfortunately, the building will never be 100% free from secondary energy sources because much more significant energy conversion technology would have to be implemented, which may jeopardize the Museum's status as a National Historic Landmark. Therefore, these proposed technologies are within the scope of the historical redevelopment guidelines offered forth by the Presidio Trust.

The first step within moving towards a more sustainable structure will result in an immense amount of research. Information and technology specifications must be gathered in order to determine if these types of technologies will result in a beneficial energy outcome.

Next, a solar study will be conducted in order to determine if the dye sensitive solar window cells will contribute towards energy reduction within the building. At this same time, vegetation tree types will be researched as well as the existing landscape, in order to determine the benefits of a new solar landscaping plan.

Following the solar analysis, research will be conducted based on the number of Museum visitors that enter each day. This study will determine where and how much of the Hatsuden-yuka™ flooring material will be needed.

After both of these technologies or their equal alternatives are integrated into the current Museum building, a new load analysis will be performed using

Trane Trace 700. The Trane energy analysis will show the energy needed to meet the demands within the building based on the existing loads as well as the new technologies within the building.

Next, the geothermal system will have to be sized to appropriately meet the needs of the building. After the system is sized, research and design specifications will need to be created in order to properly place the system into the site. Once the system is sized, designed and in place within the site, another energy modeling analysis will need to be created in order to determine the systems effectiveness. In conjunction with the energy modeling analysis, a cost analysis of the system as well as the life cycle costs of the new HVAC and adjunct technologies versus the older systems will be performed.

Therefore, after extensive research, energy modeling and cost analysis of the newly proposed systems, a comparison will be performed against the existing systems in order to determine the potential effectiveness of these building systems.

References

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Building and Plant Energy & Emissions Analysis, Technical Report Two, Alyse Sutara, The Pennsylvania State University, Fall 2009

Existing Mechanical Systems Analysis, Technical Report Three, Alyse Sutara, The Pennsylvania State University, Fall 2009

Sustainable Urban Design, Energy Research Group, The University College of Dublin, 2000

ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality

ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings

Proposed Spring Calendar

In the following section, a calendar of due dates has been created as a project timeline. This schedule is flexible, however, the beginning of the proposal as well as the due date are firm. Changes may be made to the proposal based on the feasibility of the project as well.

January 2010

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11 • Classes Begin	12	13	14 • Discussion Board Log-In	15 • CPEP Update • Progress Schedule Up-	16
17	18	19 • Updated Pro-posal • New Event	20	21	22	23
24	25	26 • Solar Study Complete	27	28	29 • Question posted to	30
31	1	2 • Analyze DSSC Use	3	4	5	6

February 2010

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
31	1	2 • Analyze DSSC Use	3	4	5	6
7	8	9 • Updated Progress Schedule	10	11 • Vegetation Types Defined	12	13
14	15	16 • Progress Sub-mission • Advisor Meet-ing	17	18 • Electricity use from piezo-electric cells calculated	19	20
21	22	23 • Updated Progress Schedule	24	25	26 • Go-No Go Checks	27
28	1	2	3	4 • Cost & Energy Analysis of Breadths	5	6

March 2010

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
28	1	2	3	4 • Cost & Energy Analysis of Breadths	5	6
7	8 • Spring Break	9 • Spring Break	10 • Spring Break	11 • Spring Break	12 • Spring Break	13
14	15	16 • Progress Re-port	17	18 • Geothermal Loop Sized	19	20
21	22	23 • Presentation Outline	24	25 • Analysis Com-plete of Old Vs New Sys-	26	27
28	29	30 • Final Report Draft • Outline Up-	31	1	2	3

April 2010

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
28	29	30 • Outline Up- • Final Report Draft	31	1	2	3
4	5	6 • Slides Com-plete for Pre- • Final Report Due	7	8	9	10
11	12	13 • Presentation Week	14 • Presentation Week	15 • Presentation Week	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30 • Final CPEP Site	1