Peninsula Advanced Energy Community (PAEC)

Task 7.4: Final Technical and Economic Feasibility of Sustainability Features for the Atherton Civic Center Report

Summary Report of Sustainable Strategies

Prepared for

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WRNSSTUDIO

Clean Coalition
Making Clean Local Energy Accessible Now

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About the Authors

Town of Atherton

Atherton is a small, rural, and residential community, with no industrial land-use base. Native live oaks, white oaks, bays, redwoods, cedars, pines, and other ornamental trees cover the six square miles of town.

Atherton's population is 6,995, according to the 2011 census. In October of 2012, there were 5,052 registered voters and approximately 2,500 households. The median age is 48.2 years. Visit the Town of Atherton online at http://www.ci.atherton.ca.us/

WRNS Studios

With offices in San Francisco, New York, and Honolulu, WRNS Studio's staff of 135 works in creative studios across typologies: civic, education, workplace, residential, and urban mixed-use. Recognized for identity-rich, site-specific design at any scale, the firm brings to each new project a point of view informed by all the other work in which they engage. WRNS Studio is redefining what it means to be comfortable, healthy and inspired at school, work and at home. Problem solvers and creatives at heart, they tinker in models, garages, even under the hood of their design software. When WRNS talks about sustainability, they consider the ways in which wellness and resource conservation support economic, social and environmental health. With many clients focused on energy savings, WRNS targets all projects to exceed Title 24 by a minimum 20%. Every effort they undertake incorporates a level of sustainability that manifests both their own commitment to environmental responsibility as well as the mission of their client. Visit the WRNS Studios online at https://www.wrnsstudio.com/

Clean Coalition

The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

The Clean Coalition drives policy innovation to remove barriers to procurement and interconnection of distributed energy resources (DER) — such as local renewables, advanced inverters, demand response, and energy storage — and we establish market mechanisms that realize the full potential of integrating these solutions. The Clean Coalition also collaborates with utilities and municipalities to create near-term deployment opportunities that prove the technical and financial viability of local renewables and other DER. Visit us online at www.clean-coalition.org.

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I. Introduction

a. Peninsula Advanced Energy Community (PAEC)

The Peninsula Advanced Energy Community (PAEC) is a groundbreaking initiative to streamline policies and showcase projects that facilitate local renewables and other advanced energy solutions like energy efficiency, energy storage, and electric vehicle charging infrastructure. The PAEC will create pathways to cost-effective clean local energy and community resilience throughout San Mateo County and the City of Palo Alto; and beyond. The PAEC is a collaboration between the Clean Coalition, the California Energy Commission (CEC), Pacific Gas &Electric (PG&E), and an array of municipalities, emergency response jurisdictions, schools & universities, and corporate entities.

The PAEC initiative will play a key role in the state's ability to help meet its Climate and Energy goals by demonstrating that an Advanced Energy Community (AEC) is feasible — from both a technical and financial perspective — and can significantly accelerate the achievement of California's energy and environmental goals.

b. Atherton Civic Center

Atherton is about living under the oaks. It is a bucolic and beautiful place. It is also a town that has very little piped infrastructure for its storm water, and therefore requires major infiltration and flow management within all its project boundaries. The new civic center design devises its inspiration from the assets and challenges of the site, and seeks to be a place for the community to enjoy its beauty and learn from the strategies employed, moving forward towards a new civic space for the Town of Atherton – one that is safe, accessible, healthy, welcoming, and reflective of its place and community.

Figure 1: Satellite Image of Site Extents

The Town of Atherton's new Civic Center will sit on the existing five acre Civic Center site. The old buildings date from the1920's and include several temporary trailer offices. Many buildings are near, or at the end of, their useful life. The site itself is underutilized and split apart by several roads. The entire site will be remade to maximize use and provide an efficient functioning Town government. The new project will contain a new Library, a renovated Town Hall for library program, a new Police Station, and a new City Hall that will contain Council Chambers, City Administration offices, Community Development offices and an Emergency Operations Center. The existing Corporation yard will be updated to improve the working environment.

The Town of Atherton and the WRNS Studio Design consultants have developed a campus and building design strategy that demonstrate how time tested sustainable strategies working alongside innovative, and cutting edge technologies result in the highest resource efficiency and cost benefit. The campus design demonstrates key sustainable strategies that are cost effective, educational and beautiful, resulting in material, energy and water demand reduction, and improved resource use, comfort and well-being. Through the design analysis, key focus areas of carbon reduction, energy-water nexus, and ecosystem value were prioritized important parts to the story of the site and building design.

The Civic Center campus contains four buildings that help illustrate how diverse program and building types can be made efficient, productive and long lasting. The one story library program is housed in a new one story rammed earth building that works alongside the historically significant Town Hall. The building uses underfloor air distribution and is targeting zero net energy. The two story City Offices and Police Department, are joined to the Council Chambers and Emergency Operations Center, and will have a large percentage of photovoltaic panels on three of its most visible roof areas, and takes advantage of natural ventilation. The campus landscape and site are designed to maximize cost effective and educational strategies through distributed storm water plan and a thoughtful organization of planting types that respect the water balance of the area. A few campus systems that are being considered include an energy dashboard in each building which shows real time energy usage information, photovoltaic arrays on roofs and canopies resulting in a Zero Net Energy (ZNE) campus, well water and recycled water systems to demonstrate the regional water approach, and a solar emergency microgrid system for resiliency and safety, demonstrating resilience and carbon reduction.

It has been suggested to provide site specific signage that highlights the water conservation measures taken on site or a combination of site signage and pamphlet material that could be available at the new Community Development & Permit Center as an informational tool for designers, builders, and developers working in the town.

Figure 2: Site Plan for Civic Center

Figure 3: Site Plan with General Sustainable Strategies

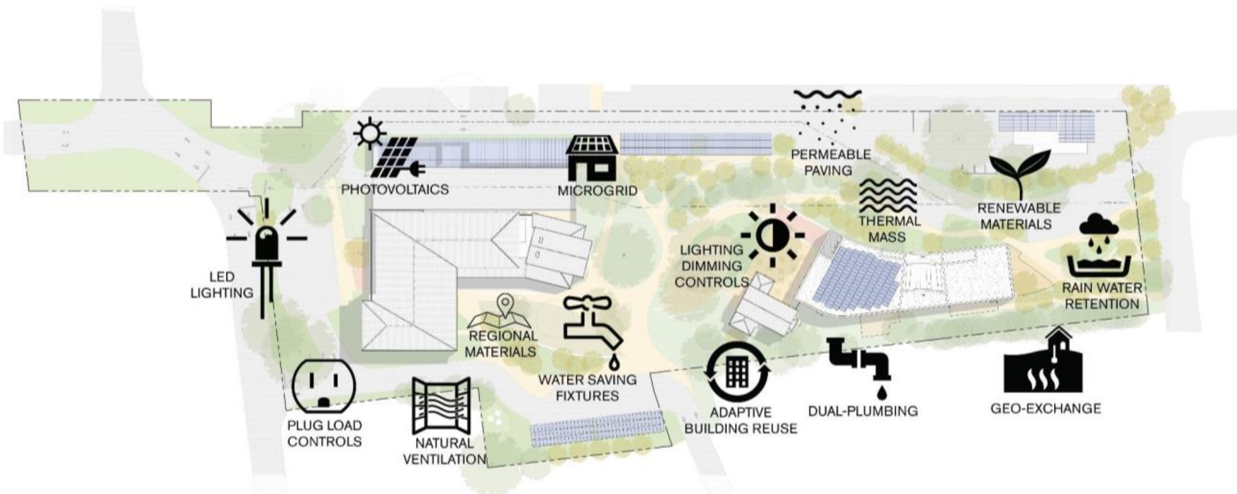


Figure 4: Perspective of Emergency Operations Center and City Hall

Figure 5: Perspective of Library from the South

II. Areas of Study

The purpose of this study is to identify key sustainable strategies that assist in the lowering of resource demand, inclusive of energy, water, material, and carbon. The goal of this study is to identify feasible, scalable and regional strategies that can be easily replicated, while serving as an educational tool for the broader community.

a. Architectural

The survey is performed manually by scanning for large structures or clusters of related structures that could provide suitable siting opportunities for solar photovoltaic (PV). The available surface area is measured, and the siting viability is estimated based on physical obstructions and shading. During the course of this project, the design team has consulted with the following Solar PV providers to determine what are best battery and Micro-Grid products on the market:

- SPIRAE (Microgrid controls)

- Geli (Microgrid controls)
- Pika Energy (Battery and PV inverter manufacturer)
- Ideal Power (Battery and PV inverter manufacturer)
- Apparent Energy (Battery and PV inverter manufacturer, microgrid controls, and project developer)
- LG Chem (Battery manufacturer)
- Switch Storage Solutions (Microgrid design)
- Tesla (Battery system manufacturer)
- SolarEdge (PV inverter and DC optimizer manufacturer)
- GILDEMEISTER Energy Solutions (Battery manufacturer)

Envelope Performance

The following envelope assumptions are held constant through all model iterations presented in this analysis:

i. Exterior Wall:

At new civic center and library: 2x6 metal stud wall with R-19 batt insulation and 1" of rigid insulation (U-0.071, R-14.1 overall); At historic council chambers: 2x4 wood stud wall with R-15 batt insulation (U-0.083, R-12 overall).

Roof: Civic center and historic building: Pitched roof with R-30 insulation at ceiling (U-0.032, R-31.25); Library: flat roof with R-30 insulation (U-0.032, R-31.25)

ii. Glazing:

Typical exterior glazing is specified as Solarban 72 low-e double pane glazing (U-0.40, SHGC-0.30, VLT 70%). Secure exterior windows at the police department are built to a more robust specification for bullet and impact resistance.

Figure 6: Library Axonometric and Systems Strategy

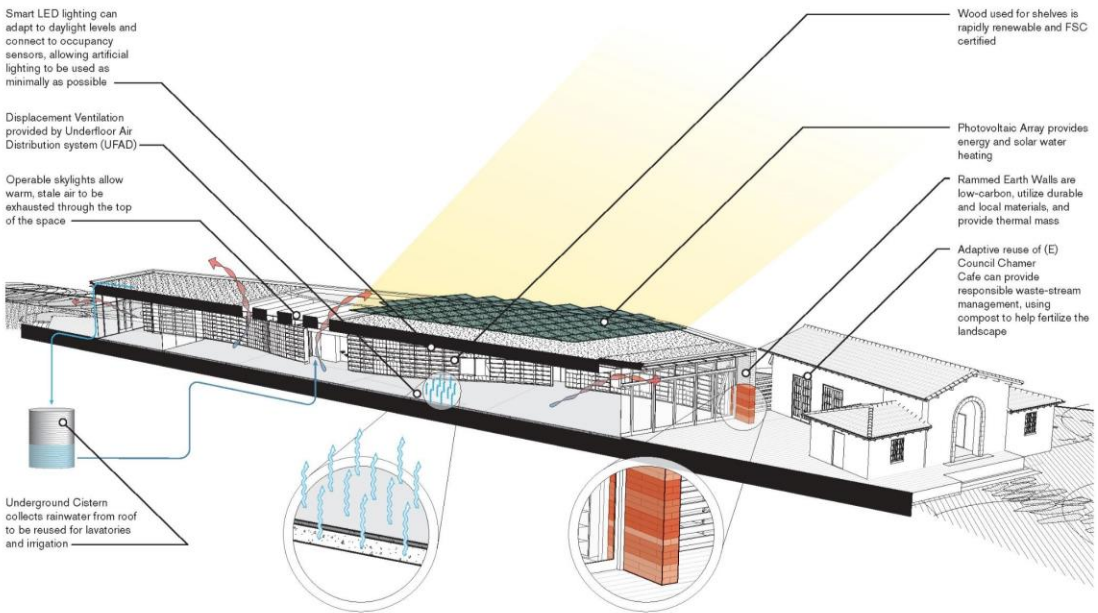
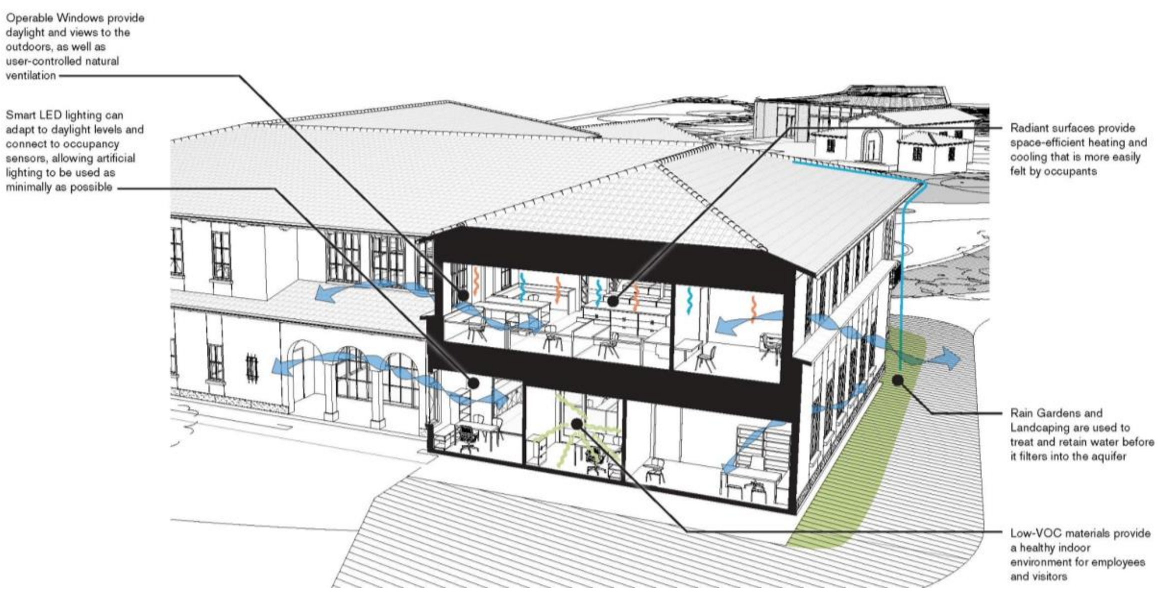


Figure 7: City Offices Sectional Axonometric and Systems Strategies



b. Project Design: Net-Positive Energy Performance

The project is aiming to be a sustainable beacon, representing the Town of Atherton's virtues (climate and place), and celebrating the Town's ideals and goals. The project is designed to achieve net-positive energy performance with energy offset provided by roof mounted PV panels. IES-VE 2015 has been used to perform various energy simulations in order to predict the building's annual energy consumption, and to benchmark the design against an ASHRAE 90.1-2007 baseline building. System concepts have been prioritized with the following thoughts in mind:

- Energy Reduction
  - Library EUI of 20 kBTU/sf/yr (assumed operating 57 hours/week)
  - City Hall/Council Chambers EUI of 20 kBTU/sf/yr (assumed operating 45 hours/week)
  - Police Station EUI of 35 kBTU/sf/yr (assumed operating 24/7 operation, 168 hours/week)
- Water Reduction
  - Target of 50% reduction in water use
- Maintenance and Operations
  - Capability to reduce maintenance cost over the life of the building
  - Simple to maintain
- Renewable Energy
  - Solar Thermal
  - Geoexchange[1] (alternate)
- Longevity
  - Long life span, understanding the building(s) have to stand the test of time
- Essential Services
  - The Police building must maintain up-time as an essential facility and will be designed with a seismic importance factor of 1.5
- Combustion and CO2 emissions
  - Reduce CO2 emissions drastically by deleting all forms of combustion on site
- Certification Strategies (potential)

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[1] Geothermal heat pumps, also known as geoexchange, ground-source or water-source heat pumps take advantage of the nearly constant temperature of the Earth to provide heating and cooling to buildings. Further reading includes: https://energy.gov/energysaver/geothermal-heat-pumps, https://www.nrel.gov/workingwithus/re-geo-heat-pumps.html, and https://www.geoexchange.org/geothermal-101/

- LEED® Platinum as a minimum
- Living Building Challenge Net Zero Energy Goal

Central Plant

Each building in the facility is served by a central chilled and hot water plant. The plant consists of a modular heat pump chiller which provides both heating and cooling from the single unit. The modular nature of the system allows it to operate at peak efficiency, regardless of load.

Civic Center, Police Station, and Historic Council Chambers

These building is served by a radiant ceiling system throughout the building. Ventilation is provided by dedicated air handlers.

Library

The library is served by an underfloor air distribution and displacement ventilation system. This system utilizes elevated supply air temperatures which significantly increases the amount of economizer hours and reduces energy usage.

Preliminary concepts for the projects are to provide:

HVAC:

- Base: Air-source heat pump (for cooling and heating with heat recovery)
- Alternate: Tied to a geoexchange grid and solar thermal heat input
- Variable volume underfloor air distribution cooling for Library
- Linear slot fan coils for Library heating
- Outside air handler for Police Station/Council Chambers (dedicated outside air) Radiant drywall or tile ceiling system for Police Station City Hall/Council Chambers
- Cooling and heating; radiant slabs in large open areas
- Exhaust systems as required by Code

Plumbing:

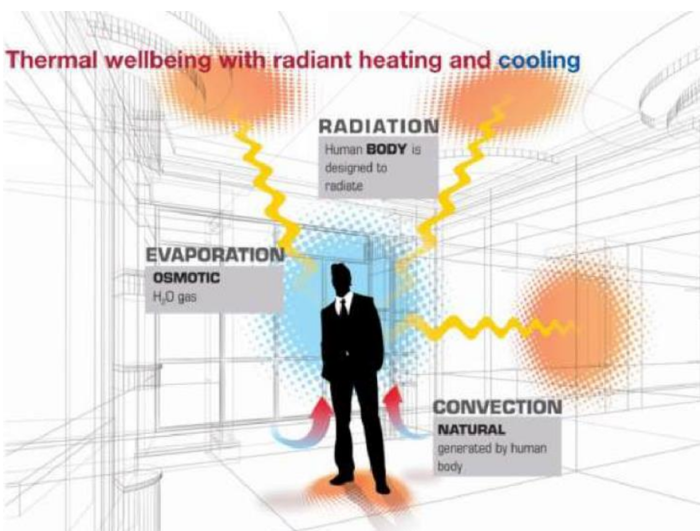
- Domestic cold water, hot water, sanitary sewer, storm for the facilities
- Base: Connection to the campus heat pump for primary heating and electric booster heat as needed
- Alternate: Solar thermal for Police Station showers
- Low flow fixtures

- 1.28 GPF waterclosets
- Waterless urinals with Betco Smartvalve Auto
- 0.5 GPM aerators
- Alternate: Alternate for water recycling (either storm, grey, or blackwater treatment for non-potable fixtures)

Heat Pump System

The system will comprise of an air-cooled (base) geoexchange (alternate) central heat pump system (120 Tons without thermal energy storage and 60 tons with thermal energy storage) as manufactured by Multistack or Aermec. This system will provide heating and cooling for all the buildings on the campus, and will be housed in an outdoor equipment yard located at the Library. Underground piping will be installed between the Library and Police Station/City Hall. Distribution piping will be PEX or HDPE pre-insulated underground chilled water and heating hot water (4-pipe) and will be no larger than a 4" supply return for Police Station/City Hall and 1-1/2" for the Heritage Building. Exterior valve boxes will be provided at each building for building isolation. There will not be any boilers, and there will be no requirement for any refrigeration machinery room controls.

Figure 8: Radiant Ceiling and Comfort Benefit



Thermal Energy Storage (TES)

A thermal energy storage tank (alternate) will be installed on site to reduce the peak energy demand through a process called demand shed. The heat pump will create cold water at night when electricity rates are low to charge the system. Throughout the next day, the tank will provide enough cooling capacity to offset the peak energy usage. It is estimated that three tanks are required at 12,000 gallons each for a total of 36,000 gallons. Each tank is 10’ in diameter and 22’ long.

Figure 9: Thermal Energy Storage

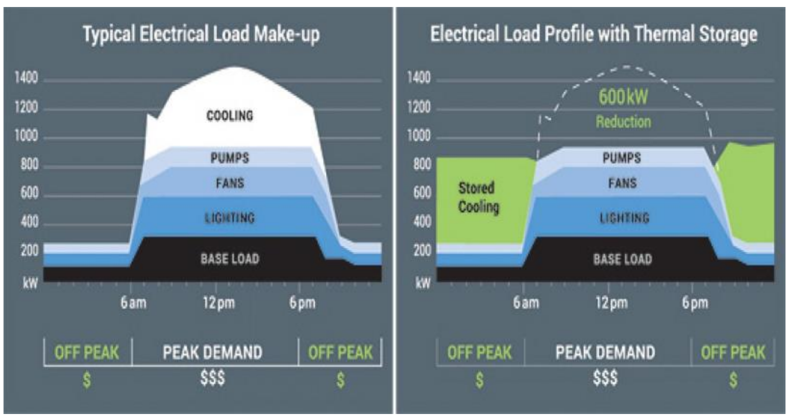


Figure 10: Campus Plant and Thermal Energy Storage

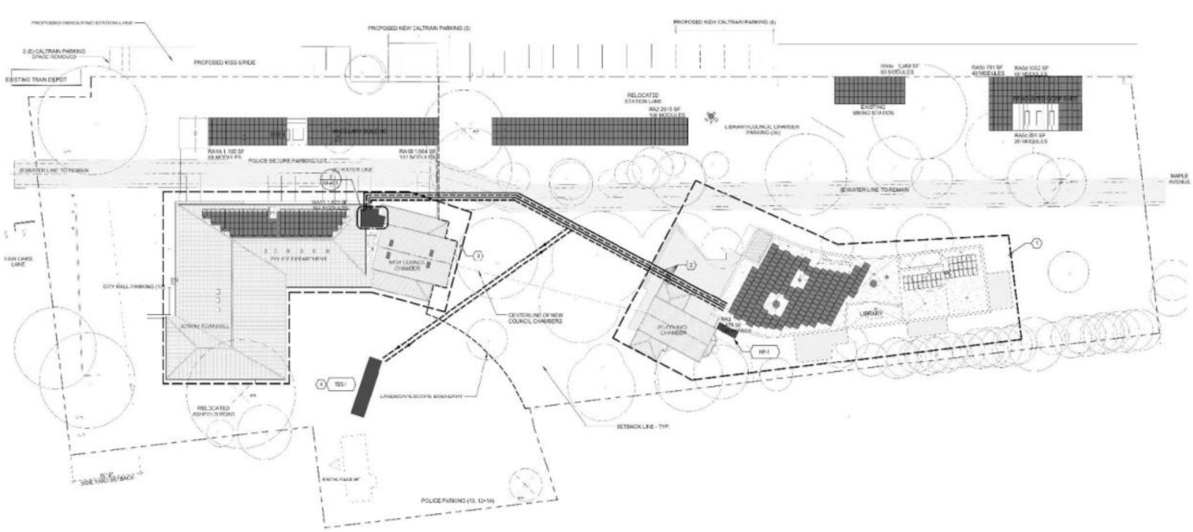
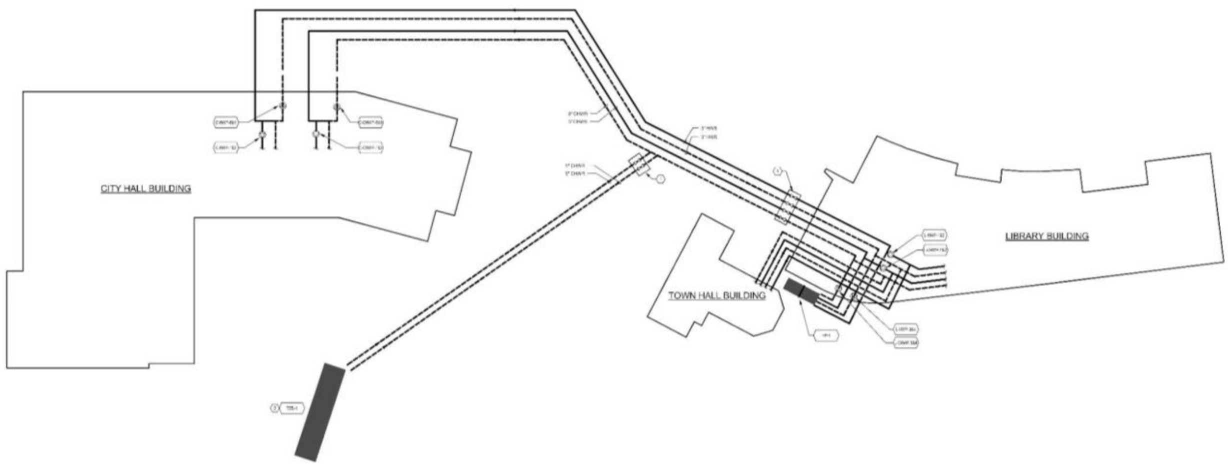


Figure 11: Campus Plant and Thermal Energy Storage



Controls

Controls will be provided through a new Direct Digital Control (DDC) BACnet system located at the Library. The "Front End" and programming will be done in the Library project and will be tied and integrated into a Building Dashboard at the Library for visitors to see and experience (touch, flip, etc.). A full 12 month Measurement and Verification Process will be completed. See Library and Heritage Building Description for additional information.

Control of the radiant ceiling systems will be achieved via the ceiling manufacturers control system including all wiring installation.

Domestic Hot Water

Base: Domestic Hot Water will be provided via a heat exchange storage tank with supplemental electric heating.

One water heater will service the Police Station side of the Facility and one water heater will service the City Hall portion of the Facility.

Alternate: Heating hot water will be provided for the entire campus via a solar thermal system pre-heat system and tank. This will pre-heat electric domestic hot water systems in each building. The solar thermal system will be the dimensions of the Library Building and will be located below any PV panels (Sun Drum system). The solar thermal system will also feed the geoexchange loop to heat the loop in winter.

Each system will include a domestic hot water return system including circulating pump.

Fixtures

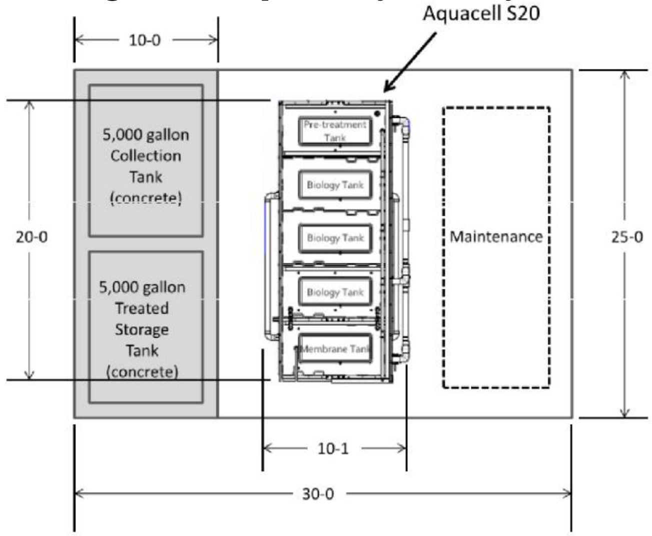
Plumbing fixtures will be high quality, commercial fixtures with metered water supply. Fixtures to be:

- 1.28 GPF water closets
- Waterless urinals with Betco SmartVALVE Auto
- 0.5 GPM aerators for all sinks

Alternate Water Recycling System

Water Recycle System (Alternate)
A complete water treatment system (blackwater system) would be desired as an add alternate to help support non-potable fixtures as well as landscaping irrigation needs. Wastewater is collected from all the plumbing fixtures on site, treated to California's water recycling criteria, and then reused for toilet flushing, irrigation and mechanical make-up water. The modular membrane bioreactor (MBR) system would yield more than 99.5%, of the water used on site (excluding irrigation) and may be able to offset the cost of the solar thermal system and potentially geoexchange system if heat can be pulled from the membrane bioreactor and water could be used to make up for cooling tower water. Below is a simple schematic of an Aqua Cell MBR system (Figure 1 and 2).

Figure 12: Aquacell System Layout



c. Electrical System Upgrades

The City of Atherton's desire for an energy efficient building is a challenge that can be met with collaboration, dedication, and attention to detail by all members of the ownership, design, and construction team. Creative thinking about how and when the building will be used, an embrace of creativity, innovation, and collaboration between owners and all members of the project design and construction team, and sustained attention to detail throughout project delivery are all essential.

A safe electrical system is the highest priority in any system design.

All systems installed shall meet or exceed all code requirements to ensure a safe working environment for all building occupants. All systems shall be properly installed, grounded/bonded, and tested to the strictest standards.

The electrical system shall also be flexible and shall allow for the building occupants to utilize their space effectively, without the use of make-shift workarounds, excessive use of plug strips or extension cords, or sub-optimal furniture arrangements that may result from inconvenient or hard to reach electrical outlets. The system shall be flexible enough to accommodate current and future needs without major changes to the electrical system.

The building will utilize electricity throughout the Mechanical, Lighting, Plumbing, Architectural, and Owner provided systems. As such, maximizing the efficiency of the electrical system will be critical to achieving maximum energy savings within the building.

i. Electrical System Summary

Electrical

City Hall/Police Station/Library: The entire campus is interconnected to a new main switchboard, with a 2000A Bus with a 1600A MCB, 480Y/277V, 3-phase, 4-wire electrical service fed from a new utility transformer via conduit provided by contractor and wire provided by utility.

Branch circuit panelboards provided to support all building loads, will be segregated by load type (e.g. receptacles, lighting, HVAC, etc).

Receptacle Controls: controlled receptacles provided per code in all office and office support areas, controlled via room lighting controls.

High efficiency LED lighting will be provided throughout, with office and open office areas utilizing a task/ambient lighting approach.

Lighting Load and Controls

An aggressive yet achievable building average lighting power density (LPD) target of 0.67 W/ft2 is assumed for the project. All regularly occupied spaces are simulated as having daylight responsive controls, which continuously adjust the electric light output in response to available daylight. The controls are continuous dimming with a 30 foot candle (fc) set point.

Exterior lighting is estimated at 0.05 w/sq. ft, for a total of 2,000 watts.

LED Lighting

To ensure that the buildings use as little energy as possible, and to meet all requirements of the California Energy Code (CEC), LED lighting will be used throughout. LED lights offer increased energy performance over fluorescent lighting, as well as increased lamp life, meaning maintenance costs are reduced.

Traditionally, LED lighting has been more expensive than fluorescent, however now that there are more manufacturers available the costs have come down significantly. Also, due to the title 24 requirements for lighting controls, the ability to reduce the lighting is required in most spaces. When the cost of a dimming ballast is figured in to the light fixture cost, LED fixtures (which are capable of dimming without additional equipment) are cost competitive with dimming fluorescent.

d. Photovoltaic System Upgrades

Strategic PV locations have been considered in order to generate enough electricity to achieve the ZNE and the Living Building Challenge Net Positive Energy goals for the project. Due to different roofing materials and the use of parking lot shade structures many different mounting configurations are being designed. On this project we looked at installing the PV on the roofs of the Police Station, the Library, the Ancillary Building, the Corp Yard Building, on carport and canopy structures in the parking lots of the Police Station, and the Corp Yard. In total, roughly 367 KW of PV will be installed at the site.

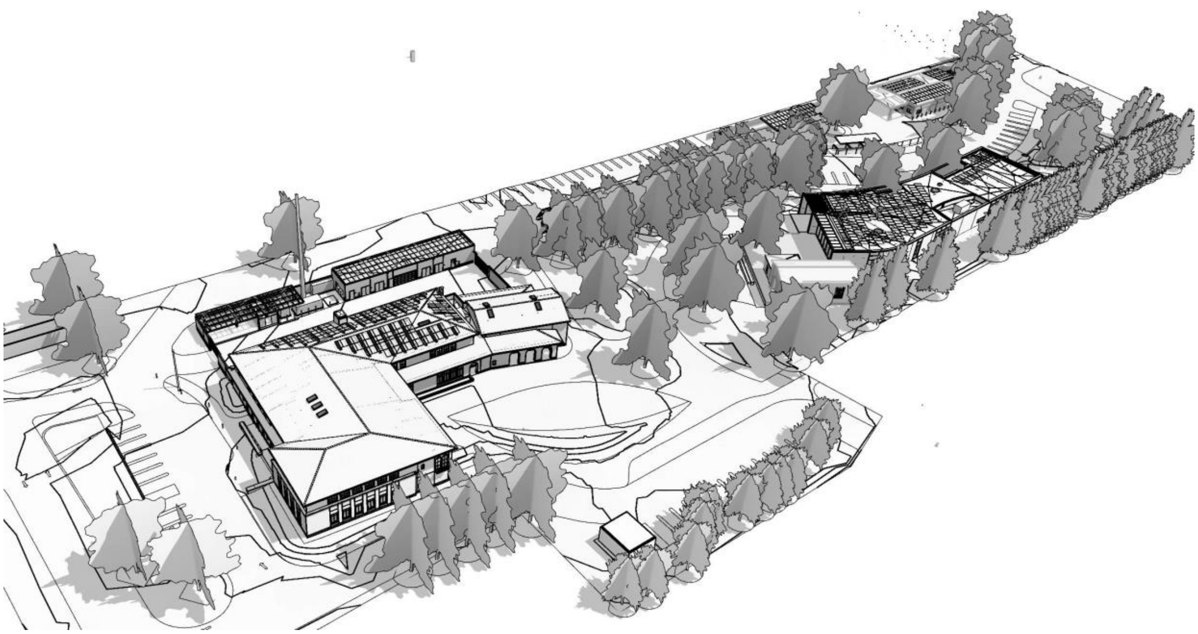
Since there are a limited number of locations where PV could be installed at the site, using the most efficient panels available is critical to ensure there is adequate energy generation to reach ZNE. High efficiency SunPower modules will be used for the arrays throughout the site to ensure that each square foot dedicated to photovoltaics is generating as much energy as possible.

To maximize the output of each individual panel in the system we recommend installing a SolarEdge DC Optimizer system. This system improves total output of the system by allowing each panel to maximize its production capability, independent of the performance of other panels in the system. This system reduces system performance degradation due to individual panel variation, shading, soiling and clouds. The SolarEdge system also improves safety: by providing a means of disconnection at each panel, security by providing electronic monitoring of each panel for theft detection, and reliability by providing real time information on individual panel performance. Based on life cycle cost analysis Integral Group has performed on past projects, a SolarEdge system can greatly increase the financial payback of a PV system.

Figure 13: Photovoltaic Distribution Campus Wide

Renewable Energy Production	
Proposed Building Use (kBTU)	1,188,575
PV Capacity for Net Zero Energy (KW)	244
PV Capacity for Net Positive Energy (KW)	257
PV Capacity for Net Positive with 10% Safety Factor Energy (KW)	282

Figure 14: Photovoltaic Mapping



e. Solar Emergency Microgrid (SEM)

A new solar emergency microgrid is proposed to backup both the library and police department buildings during a utility electrical power outage. By interconnecting the photovoltaic system on site with an energy storage (ES) system using rechargeable batteries, power can be continuously provided to parts or all of the buildings. The energy storage system will replace the planned diesel generators, eliminating concerns over fuel, diesel particulate and fumes. However, the police station shaded in red in figure 16 will also be backed up by a standard diesel generator with enough power capacity and fuel storage to supply the building for 4 days of normal operation.

Because the photovoltaics feed the battery system, the batteries can be recharged each day. By shedding unnecessary loads and sizing the PV and ES systems properly, the system can run indefinitely under good weather conditions. The battery system will be sized for the worst case solar production of a typical year. This system will be capable of providing back up power to the Library servers for 4 full days and support normal operations of key parts of the building for one day (see figure 16 shaded in red & orange, and figure 17 for a breakdown of areas supported by the SEM). It should be noted that in summer months these systems will be able to operate indefinitely during a power outage due to increased PV energy production. For additional reliability, the main switchboard will be designed with connection points to allow a mobile standby generator to be brought in from offsite. This will provide a third source of energy without requiring the town to own, maintain and regularly exercise a diesel generator onsite.

The solar emergency microgrid will provide standby power using clean renewable energy and will be one of the first in the country to serve and support critical building functionality in the event of a prolonged utility outage, allowing the buildings to continue to serve the community in a variety of ways. The police department shall be able to continue operations, including all of their dispatch and office functionality, to maintain emergency services if utility power is lost. Since the intent of the solar emergency microgrid is to maintain services during a major event, such as a large earthquake or flood, where utility power is anticipated to be out for an extended period of time, giving the police department the ability to continue to serve their community during such a crisis will be an invaluable resource to the community. A portion of the police department building will also serve as an emergency operations center, meaning that disaster recovery coordination efforts will take place in the building. It will be imperative that services to that portion of the building remain operational, so that first responders and organizers can continue to coordinate their efforts. In figure 16, the area depicted in red highlights the areas of the police station that will be backed up for a minimum of four days under a worst case weather scenario.

The library will also fulfill an important role during a major event. Because the library has large, open spaces inside, it can be used to house people who may be displaced. Power can be provided to members of the community to be used for lighting and charging cell phones.

Additionally, the solar emergency microgrid can be designed to bring up the rest of the campus during a utility outage during favorable weather conditions due to high generation of clean solar power.

Figure 15: Solar Emergency Microgrid Diagram

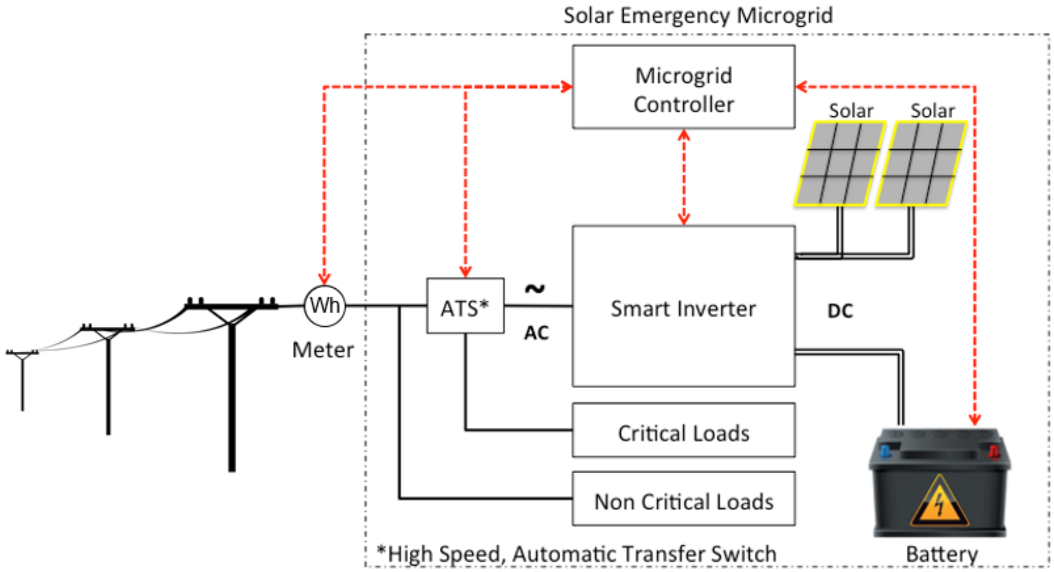
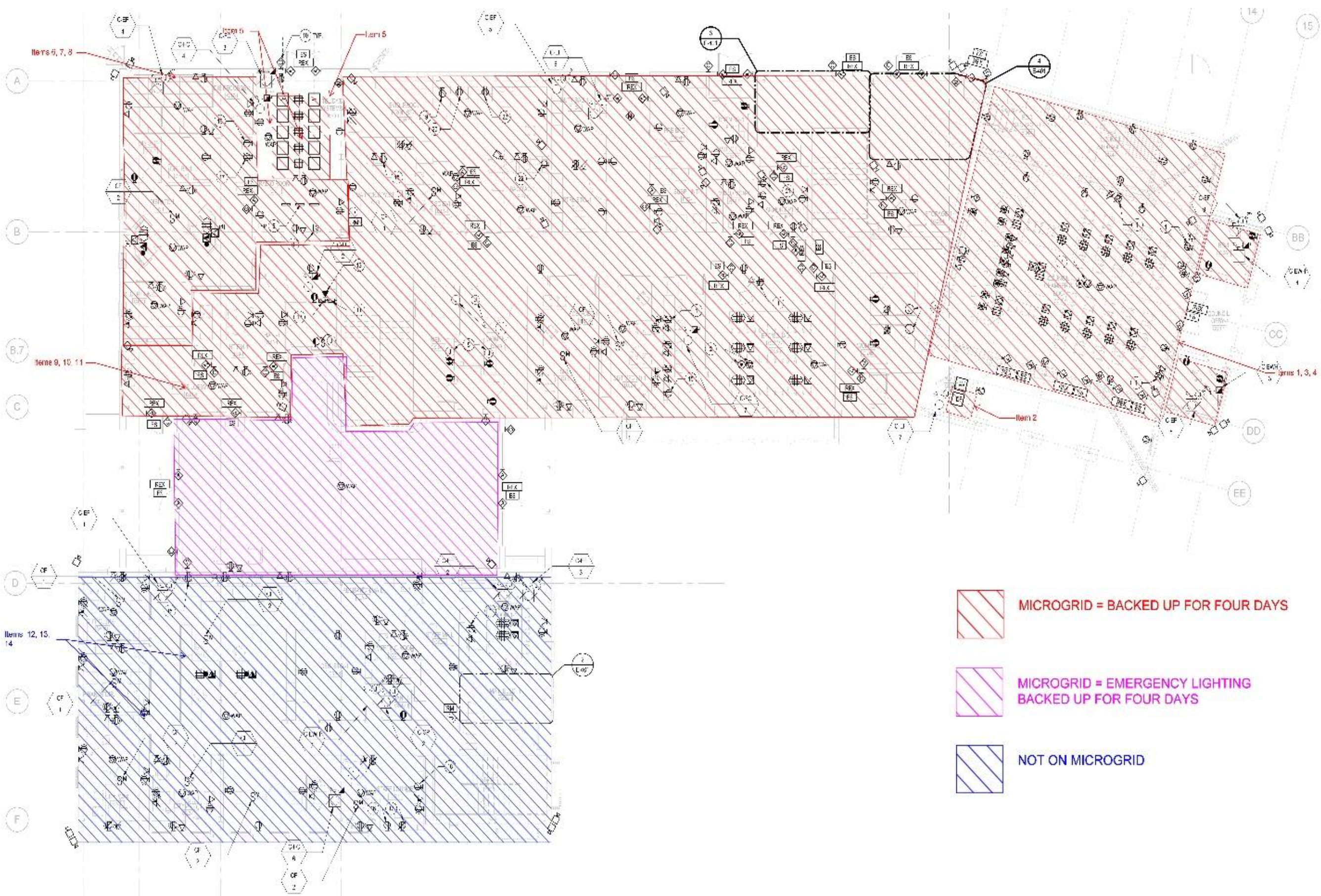


Figure 16: Solar Emergency Microgrid Diagram of Critical Zones Library and Town Hall Multi-use Space

Figure 17: Solar Emergency Microgrid Diagram of Critical Zones City Hall and Police Station



f. Electrical Vehicle Charging

Electric vehicle chargers will be installed on the new campus to promote the adoption of electric vehicles. A total of six Level 2 chargers will be installed at the site. This will include two column mounted chargers under the PV canopy array along Station Lane, two single pole-mounted chargers located at the Ashfield road parking area and two single pole-mounted chargers at the corporation yard.

The new Town of Atherton's Civic Center electric vehicle charger design is adequately planned with six Level 2 chargers. However, the Town of Atherton will continue to evaluate the need for additional electric vehicle chargers on an on-going basis.

g. Site Water Management and Landscape

In accordance with the Town of Atherton Drainage Requirements, proposed improvements cannot block overland flow from adjacent properties. All proposed stormwater facilities and drainage structures will be sized to mitigate the runoff and run-on from the site and neighboring properties for the design and 100 year storm. This will require that much of the site stay at existing grades in order to allow overland flow to continue to pass through the site uninterrupted as it does today.

Pervious pavement will be used at proposed parking spaces and drive aisles. Runoff from parking and hardscape areas above the San Francisco Public Utilities Commission (SFPUC) water main and setback will sheet flow to adjacent pervious pavement or rain gardens. The media profile beneath the porous layer of concrete will be sized to detain 2 inches of rainfall over the contributing impervious area as required by the Town of Atherton.

For the runoff from proposed hardscape areas bordering to the new buildings, there will be proposed rain gardens and/or suspended pavement systems adjacent to each hardscape area. All systems will be required to detain the 2 inches of rainfall over the contributing impervious areas. The rain gardens will be sized to allow temporary ponding of no more than 6 inches for a period of time no longer than 48 hours. Over-excavation to a minimum depth of 3 feet will be required at the location of each rain garden to ensure adequate infiltration of site stormwater runoff. Earthwork estimates above did not include over-excavation for stormwater treatment facilities (additional cut of +/- 300 cu. yd). Over-excavated soils will be replaced by site topsoil and/or an amended soil mixture with an infiltration rate of 5-10 inches per hour. Rain gardens may be planted with a variety of water tolerant plantings, from grasses to bushes and trees. The supporting media located within suspended pavement systems, which can include structural soil or proprietary cell blocks like Silva Cells, will be sized to accommodate proposed tree root growth and runoff mitigation volumes (assume +/- 4,000 sq. ft of suspended pavement).
Overflow from the stormwater infiltration areas will enter a piped network that will connect to the existing storm drain system where available. The existing storm drain system will be utilized as much as possible, with new pipes and structures being held to a minimum. Drain inlet locations on site are known and shown on plans. The shallow existing storm drain system connects to the Atherton Channel located northeast of the site. See “Stormwater Approach” for proposed infrastructure.

Roof Runoff Harvesting / Treatment

Roof runoff from the new Library building and the existing Town Hall will be captured and stored in a cistern near the new Library. It is assumed that gravity lines will be used to collect and convey water to the proposed cistern using an underground network of pipes that bubble up into the cistern (pipes retain water within them at all times). The cistern is estimated at 10,000 gallons and will include necessary filtration, disinfection, and pressurization equipment. A back-up connection to the municipal potable water distribution system will be required.

Raised flow through planters will also be provided adjacent to the western side of City Hall to treat any roof runoff not being harvesting for reuse (+/- 200 sq. ft). The tanks could be of modular types that are fastened to the exterior walls, or they could also be consolidated into a single tank adjacent to the Library. The harvested rainwater will be reused within the non-potable system at the Library. This system will be used for irrigating the landscape around the Library and Town Hall as well as flushing toilets within the Library (the Library is assumed to be dual plumbed).

Figure 18: Site Plan and Water Use Optional Strategy Diagrams

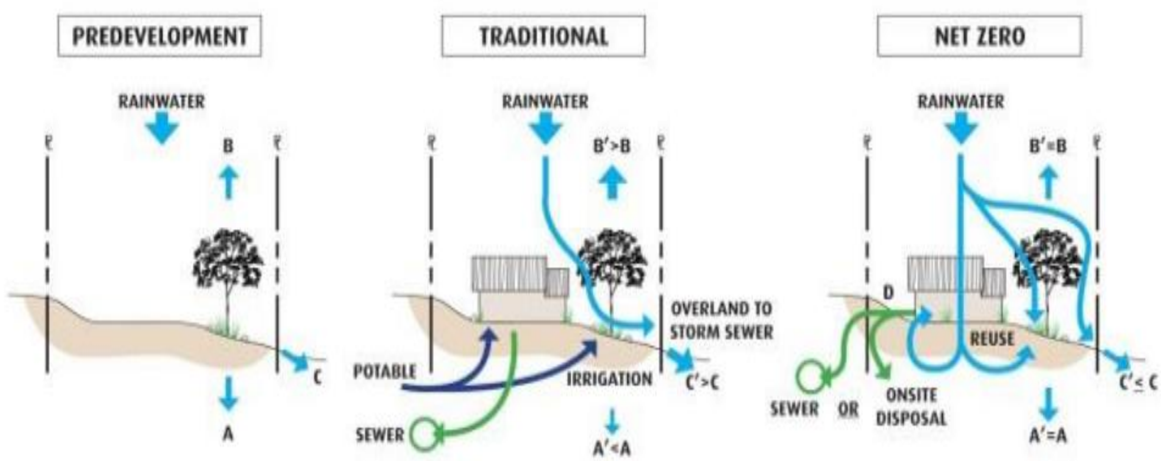


Figure 19: Site Plan and Water Capture Strategy

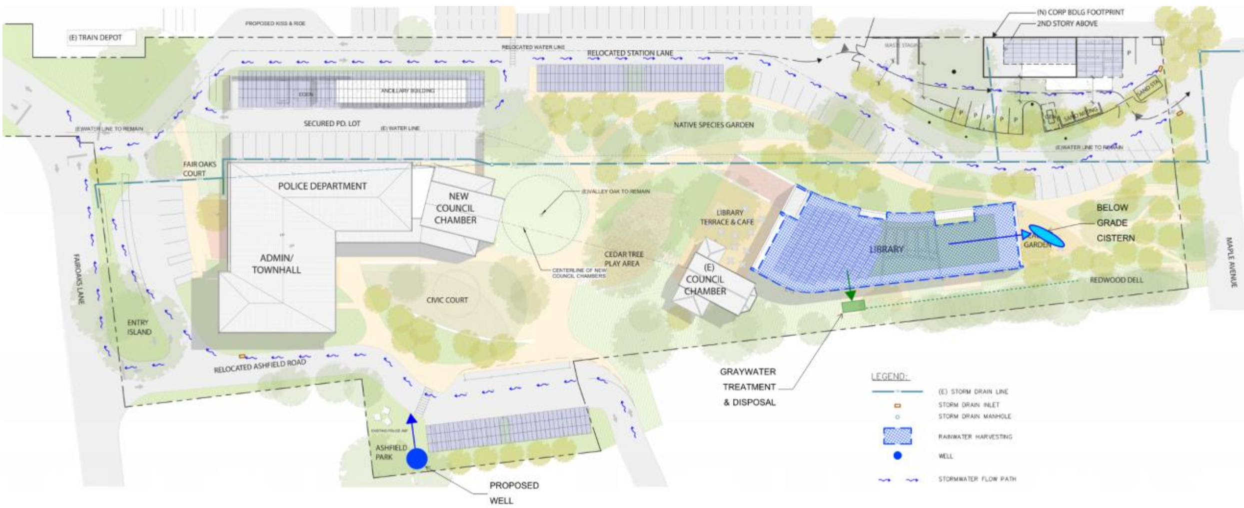


Figure 20: Site Plan and Water Distribution Strategy

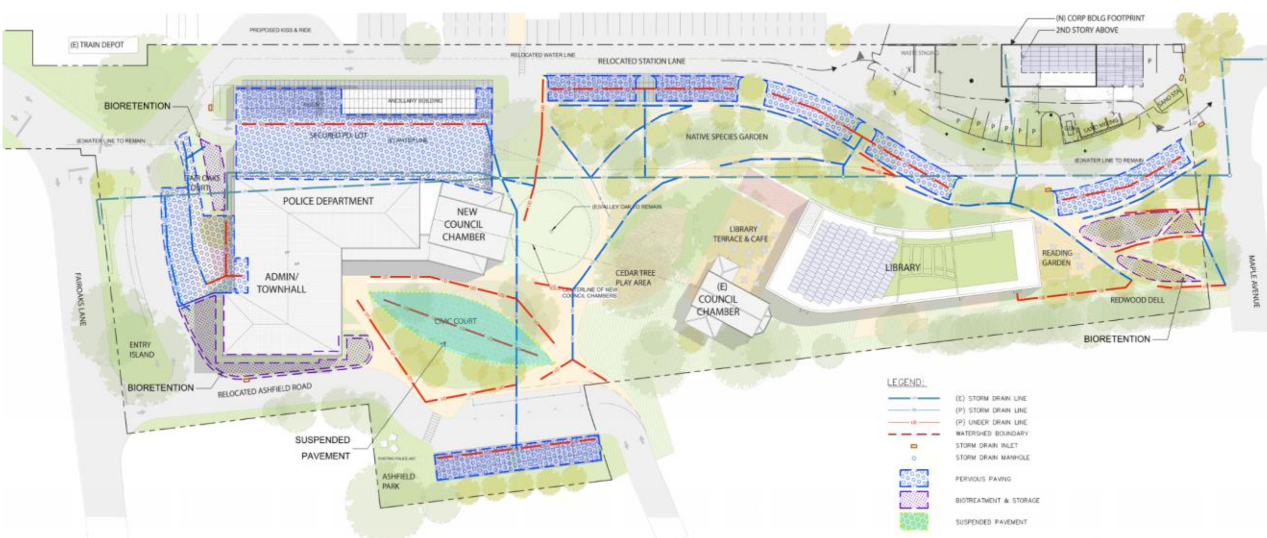
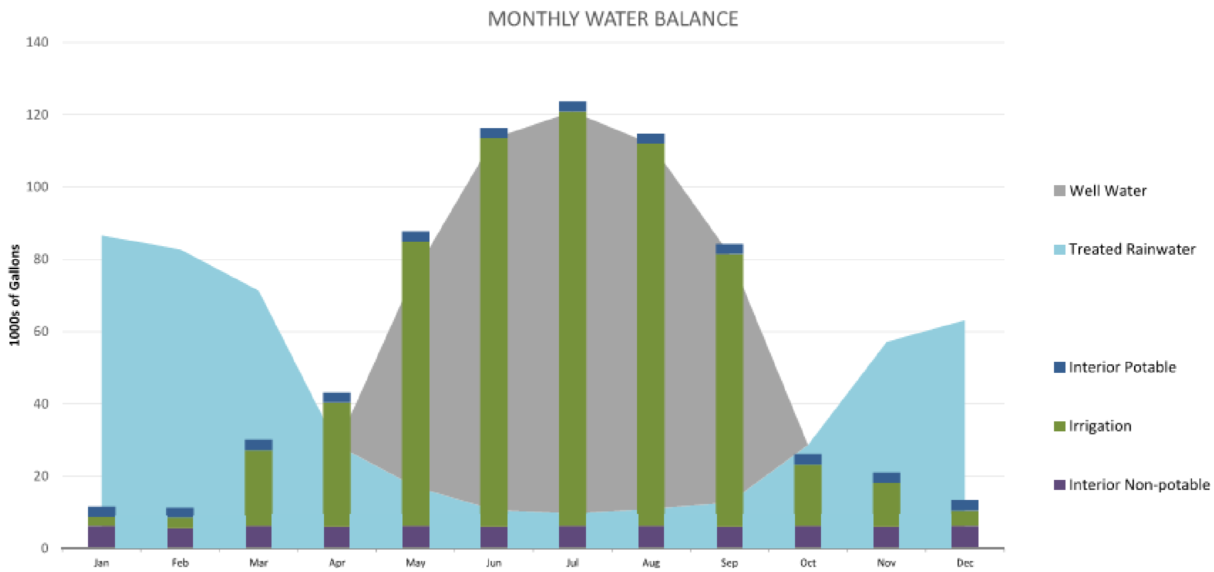


Figure 21: Well Water Scenario



<u>Potential Strategy: Net Zero Non-potable Water at the Library</u>

There is a desire to understand the cost differential for the Library to be constructed with facilities to meet its own non-potable water demands from onsite non-potable sources. The water demands to be met include toilet flushing water and irrigation water. In order to meet this goal it is anticipated that both the rainwater and greywater collection and treatment systems will need to be expanded.

The rainwater tank sizes will increase to approximately 20,000 gallons. Roof leaders and a piped network will route rainwater from the southeastern half of the Police Station/City Hall building to the cistern at the Library. A small sump pump and pressure line will be required to convey runoff from the Police Station and City Hall due to the piping distance to the collection tank.

The graywater system will be upsized to a 500 gallon surge tank, pump, treatment filter, and UV disinfection system. Dual collection plumbing will be required within the Police Station / City Hall to collect graywater from the lavatory sinks and showers. This graywater will be pumped to the Library treatment/reuse system.

Figure 22: Water Balance Scenario

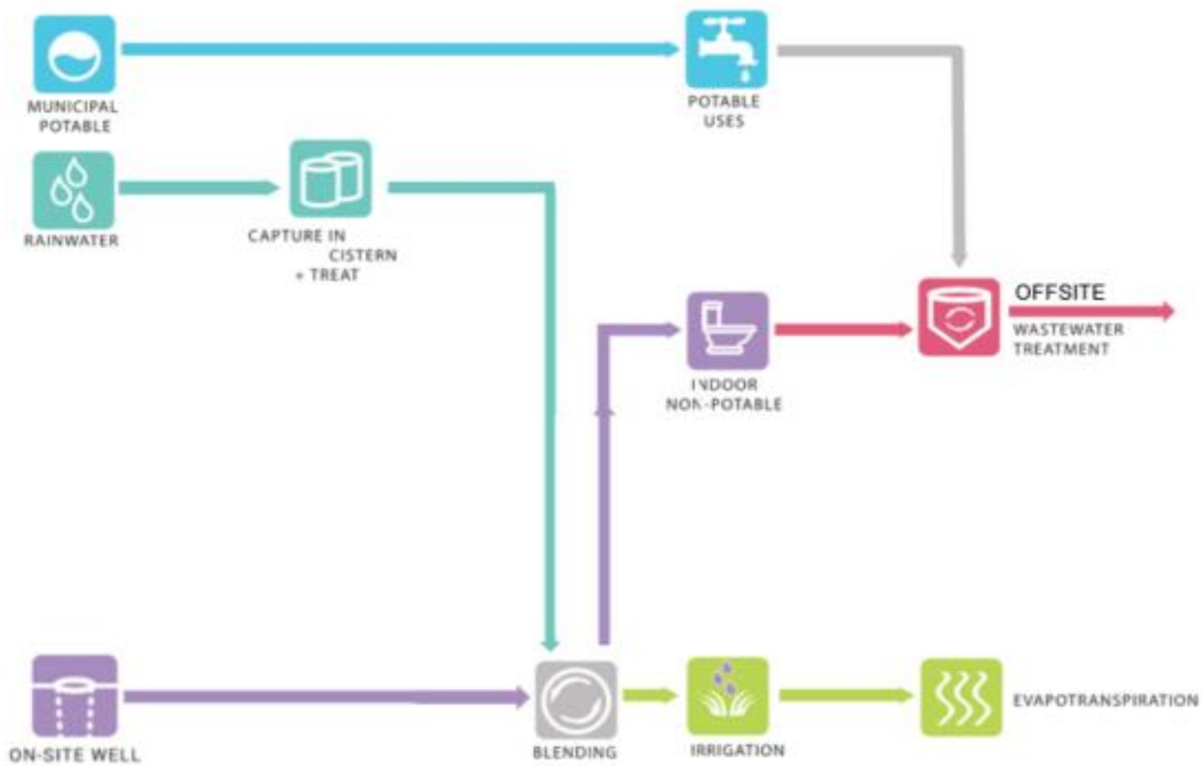
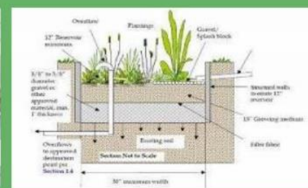


Figure 23: Native California Planting Design Low-water use Landscaping

Figure 24: Landscaping Exhibit

FLOW-THRU PLANTERS



FLOW-THROUGH PLANTERS ARE LANDSCAPE FEATURES THAT ALSO PROVIDE STORMWATER RUNOFF CONTROL AND TREATMENT. FLOW-THROUGH PLANTERS ARE SEALED ON ALL SIDES AND FITTED WITH AN UNDERDRAIN. WATER IS DETAINED THROUGH THE PERCOLATION PROCESS AND IS RETAINED IN THE AVAILABLE VOID SPACE. THEY ARE IDEAL FOR RECIEVEING RUNOFF FROM DOWNSPOUTS AND CAN BE INCORPORATED INTO FOUNDATION WALLS.

RAIN GARDENS

BIORETENTION IS A WATER QUALITY AND QUANTITY CONTROL PRACTICE THAT USES CHEMICAL, BIOLOGICAL, AND PHYSICAL PROPERTIES OF PLANTS, MICROBES, AND SOILS FOR REMOVAL OF POLLUTANTS FROM STORMWATER RUNOFF. ROOF AND SURFACE RUNOFF CAN BE ROUTED TO THESE FEATURES FOR TREATMENT AND INFILTRATION.

PERVIOUS PAVING

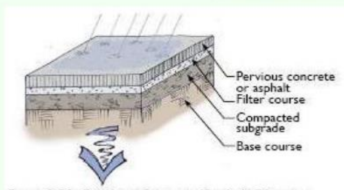
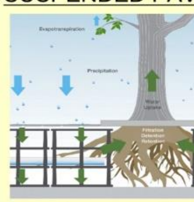


Figure 2-32: **Pervious Concrete/Asphalt Diagram**

Figure 2-36: The difference between drainage on pervious asphalt and impervious asphalt is evident in this photo.

PERMEABLE PAVERS QUICKLY DRAIN INTO A GRAVEL LAYER BELOW SURFACE WHERE STORMWATER IS STORED AND ALLOWED TO PERCOLATE INTO THE SUBSOIL. INFILTRATION INTO THE SOIL PROVIDES PRELIMINARY WATER QUALITY TREATMENT AND ULTIMATELY REDUCES RUNOFF FROM THE SITE. THESE PAVERS SHOULD BE PLACED TO AVOID UNDERGROUND UTILITY CONFLICTS.

SUSPENDED PAVEMENT



Suspended pavement provides a continuous base course under pavements while providing a material for tree root growth. Drainage can be routed into a structural soil retention area beneath the pavement where it is then temporarily stored. Water leaves the reservoir via soil infiltration, root uptake and/or subdrains. Because the reservoir creates a large rooting volume, trees have the potential to develop full canopies, allowing increased interception of precipitation. Tree roots take up excess nutrients and water in the soil reservoir and can enhance infiltration into the subsoil. Together, trees and structural soils can create a zero runoff site.

SELF RETAINING AREAS

LANDSCAPED AREAS WITH HIGHLY POROUS UNCOMPACTED SOILS ARE UTILIZED TO RETAIN A MAJORITY OF WATER THAT FALLS ON IT TREATING WATER THROUGH ADSORBTION AND MINIMIZING RUNOFF BY EMULATING THE NATURAL UNALTERED CONDITION

h. Carbon

In our preliminary studies, we have found that the traditional office building results in approximately 792 tons of carbon to create (assumed 20,000 sq. ft), The Atherton Library is targeted to be approximately 454 tons of carbon, almost half.

Some key points about the campus design that contributes to reduced carbon footprint:

- Reuse of Town Hall is a savings in embodied carbon
- Use of rammed earth – reduction in cement. The 18" rammed earth walls will have a 5" rigid insulation core and two 7" this rammed earth shells. The mix will have clay, sand and 4% cement and 4% slag; this is a fairly low carbon wall relative to massive walls - it would be similar to a 12" concrete wall with 50% slag
- Mineral wool for insulation in lieu of traditional insulation
- Concrete – high slag content. Target 60-70% slag replacement for all concrete
- Framing for Library is structural steel beams (95% recycled content), metal deck, and load bearing rammed earth shear walls. Steel braced frames for lateral resistance in transverse direction, rammed walls in longitudinal

The structural approach for City Hall is structural steel beams and columns (95% recycled content), metal deck with normal weight concrete topping at floors only. The skin will be metal studs at 24" off center. Ideally, we could use engineered wood (lower carbon footprint and thermal bridging).

Figure 25: Global Warming Potential

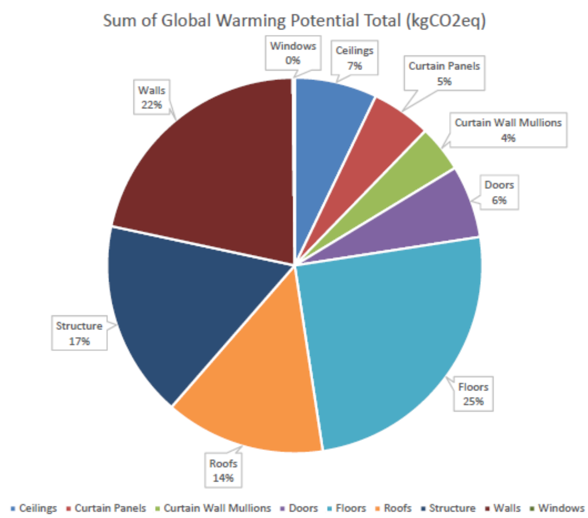


Figure 26: Rammed Earth Photo, Stanford Windhover Centre

© *Matthew Millman*

j. Resiliency

A civic center is a symbol of the town's permanence and commitment to its citizens. It is therefore most appropriate to think of permanence and durability in tune with resiliency. Recent disasters in the last five years have highlighted the importance public community spaces play in providing refuge, community support and leadership. The Atherton Civic Center will exhibit this leadership in resiliency in the following ways:

- Structural Integrity - Information will be provided in the final version given that the design is being updated.
- Material Integrity - Information will be provided in the final version given that the design is being updated.

For the library, the rammed-earth walls are designed to not get damaged and rock and re-center under their own weight. The transverse steel frames have yielding/re-centering grade beams like the city offices.

III. Summary

The following table shows the energy use of the proposed projects relative to baseline energy use averages of the same building types.

Table 1: Campus EUI Comparison

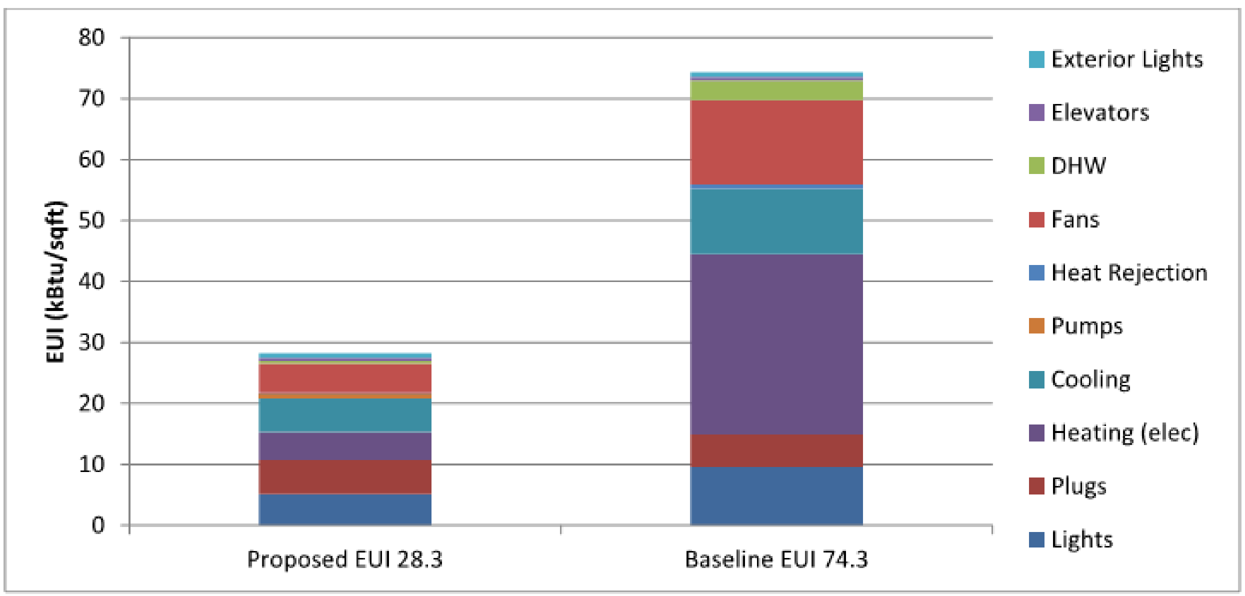


Table 2 below shows the approximate break down of each building's energy consumption. As the central plant serves all three buildings, it is not possible to fully disaggregate the HVAC energy consumption.

Table 2: EUI breakdown by Building

	Library	Civic Center	Town Hall
Energy Consumption (kBTU)	283,725.3	885,207.0	40,187.0
EUI (kBTU/SF-yr)	28.6	33.2	21.9

<u>Utility Rate</u>

The utility rates for this project are assumed at 0.17/KWh, which reflects the current average PG&E E19P electricity rate.

There are no gas appliances in the project.

Model Iterations to investigate potential energy performance improvement

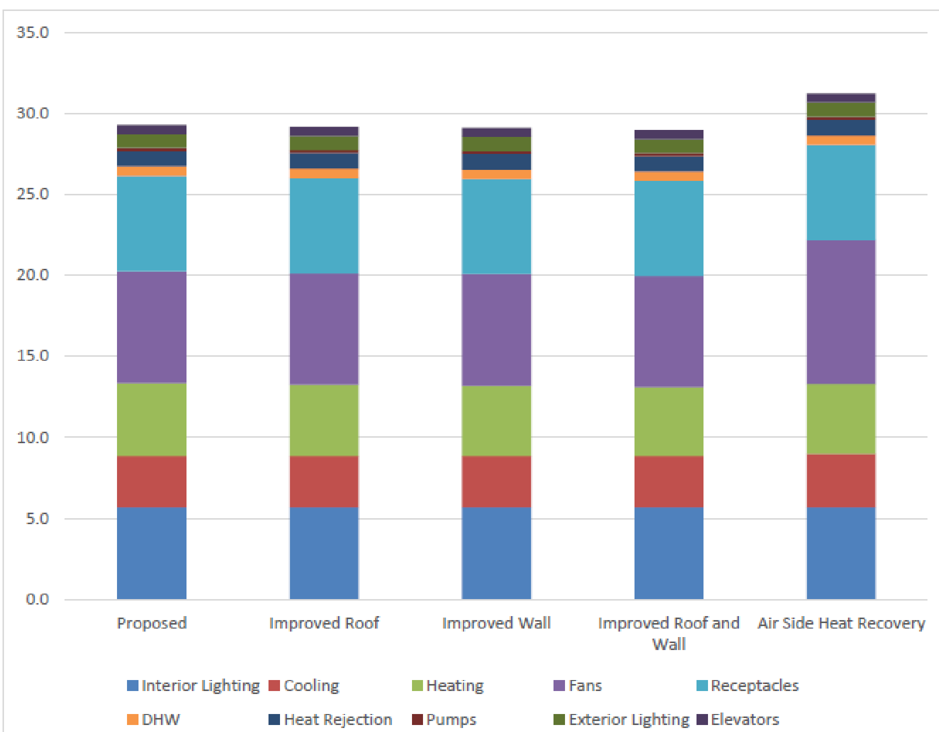
The following additional energy conservation measures were evaluated in order to determine their effectiveness in the proposed building:

- Improved roof insulation – The roof R-value is increased from R-30 to R-40
- Improved wall insulation – The wall R-value is increased by adding an additional inch of rigid insulation, increasing the R-value from 14.1 to 19.2 (*Note – historic building walls are not improved)
- Improved wall and roof insulation – Roof increased to R-40 and wall increased to R-19.2 (*Note – historic building walls are not improved)
- Air side heat recovery added to air handlers – 70% sensible effectiveness air-to-air heat exchanger

Table 3: EUI Comparison of Model Iterations (Interface)

	Proposed	Improved Roof	Improved Wall	Improved Roof and Wall	Air Side Heat Recovery
Interior Lighting	5.7	5.7	5.7	5.7	5.7
Cooling	3.2	3.1	3.2	3.1	3.3
Heating	4.5	4.4	4.3	4.3	4.3
Fans	6.9	6.9	6.9	6.9	8.9
Receptacles	5.9	5.9	5.9	5.9	5.9
DHW	0.6	0.6	0.6	0.6	0.6
Heat Rejection	1.0	1.0	1.0	0.9	1.0
Pumps	0.2	0.2	0.2	0.2	0.2
Exterior Lighting	0.9	0.9	0.9	0.9	0.9
Elevators	0.6	0.6	0.6	0.6	0.6
Total	**29.3**	**29.2**	**29.1**	**29.0**	**31.2**

Table 4: EUI Comparison of Model Iterations (Interface)



The results show that while the envelope improvements do reduce the energy consumption of the building, the impact is small. The scenario with the lowest energy consumption is the improved wall and roof option, but total energy is only reduced by about 1%.

The results show that air side heat recovery is not effective means of reducing energy consumption in the mild Atherton climate. The increased fan energy required for the system is not offset by heating and cooling savings.

a. Scorecard of Sustainability Features (see Exhibit or attached)

Sustainability Scorecard

Reference Appendix A: PAEC Scorecard of Sustainability Features.

Data

The spreadsheet columns relay to particular areas of concern, including cost, operations and maintenance cost, retention effectiveness and quality of effectiveness. The rows include various methods for the stormwater management including Rain gardens, infiltration planters, pervious pavement (pavers and poured), rainwater harvesting, and green roofs.

Table 5: Stormwater Alternative Analysis

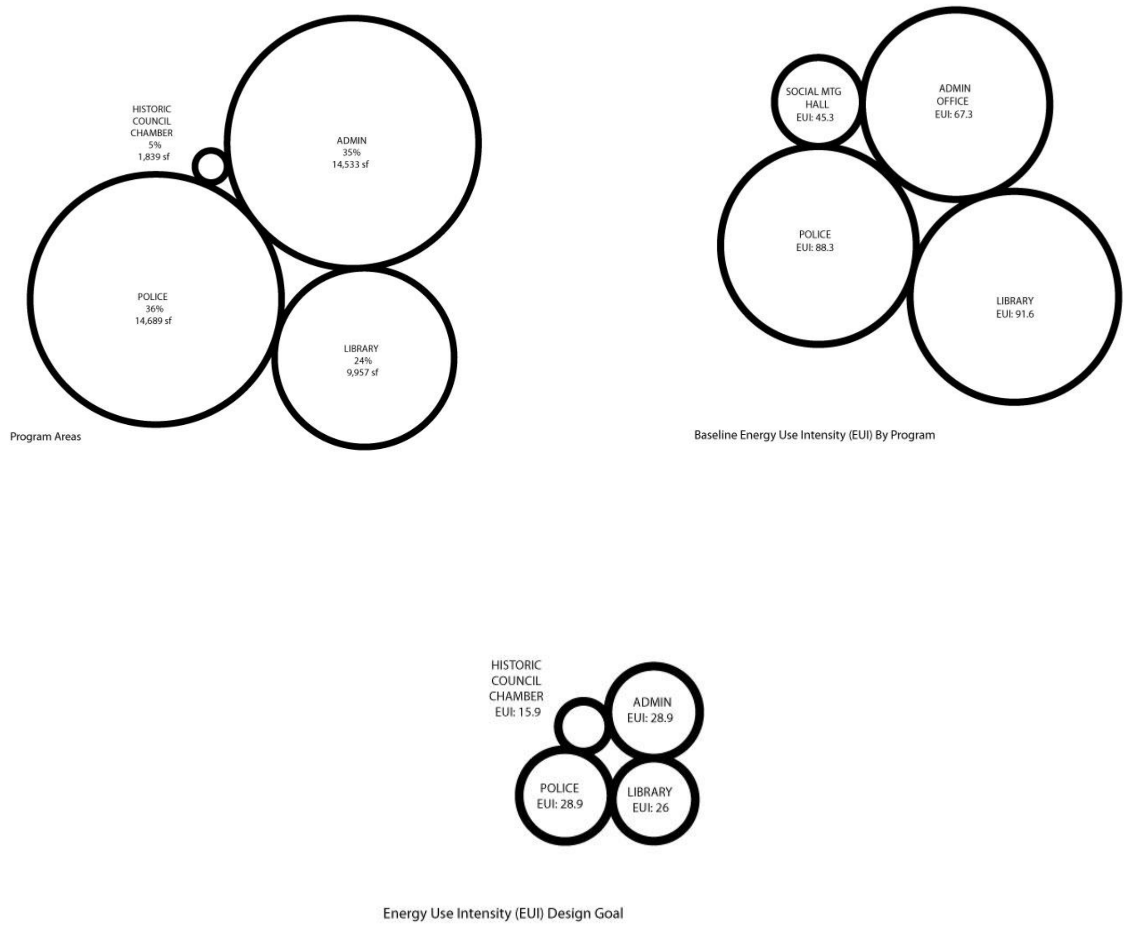
Stormwater Alternatives	Cost	O&M Cost (Annually)	Retention Effectiveness	Quality Effectiveness
Rain Garden	Low	Medium	High	High
Infiltration Planters	Medium	Medium	High	High
Pervious Pavement	Medium	Very Low	Very High	High
Rain Water Harvesting	High	High	High	Very High
Green Roof	High	Low	Medium	High

b. Mapping of Program and Energy

The following aerial is specific to the Atherton Civic Center. Reducing energy use was a primary goal in the design of the architecture, building envelope and building engineering systems. Opportunities for energy savings were analyzed through a comparison of the relative size and baseline energy use data per building use. Design opportunities for energy reduction are most notable in efficient mechanical and electrical systems design, programmatic combinations or shared use spaces to reduce demand, and high performance building envelopes for thermal, daylight and ventilation. The target EUI's reflect the commitment to designing energy efficiency into the operations of each facility while contributing to the comfort and safety of the occupants and visitors.

Figure 27: An Aerial View of the Site (north is up)

Figure 28: Graphic Representation of Program to Energy Use Mapping



<u>Integrated Design Assessment</u>

The Town of Atherton staff, Civic Center design team, Civic Center Advisory Committee including Budget and Library subcommittees, collaborated with the town of Atherton throughout the design phase of the project. The initial program and conceptual design phase meetings, beginning in April of 2015, introduced site and community specific opportunities for sustainable practices and energy saving measures. Opportunities for public integration with the design process for the civic center is currently ongoing as the construction documents phase of the design currently underway.

The Town Staff hosted public meetings to present the design and gather public feedback occurred at phase of the design. These meetings were well attended and provided informative updates and feedback between the design team and community. Monthly Civic Center Advisory Committee meetings and frequent subcommittee and Town Council meetings have been open to the public to continue to create a valuable discourse on the design and sustainability goals of the project.

IV. Atherton Civic Center Next Steps

The project is currently in Construction Documents phase. The design includes many cost savings alternates to evaluate options which will be finalized at the completion of the bidding phase. The following milestones are currently scheduled leading towards project completion:

- 50% Construction Documents: June 2017
- Permitting and Approvals: September 2017 – January 2018
- Bid Documents: January 2018
- 100% Construction Documents: January 2018
- Bidding Phase: January 2018 – March 2018
- Construction Kick-off: March 2018
- Project Completion: May 2020

V. Conclusion

The Town of Atherton's Civic Center Project provides a unique showcase opportunity that includes building replacements and upgrades while highlighting a public development project that is centered on a net positive energy design. Because the project consists of public buildings in a town where nearly all buildings are exclusively residential, the project naturally stands apart as a community space which is designed to be exemplary in terms of its approach to energy savings and capture.

Partnering with the PAEC, the project team has been able to identify multiple strategies to reduce overall energy demand, provide innovative means to capture and store solar energy, and provide a resilient facility design.

The peninsula corridor is a unique region in the country with progressive collaborators focused on the future of advanced energy technologies. These showcased project technologies and energy measures demonstrate how to leverage energy savings, collection, energy storage, a SEM, and electric vehicle charging into a net positive energy design. The Town of Atherton's Civic Center project is well suited to become a showcase civic project while providing significant energy, environmental, economic, and security benefits. Furthermore, it will provide regional access to advanced energy technologies and measures that are intended to benefit a local community, California, and beyond.

VI. Appendices

Appendix A: The PAEC Scorecard of Sustainability Features is available as a separate Excel spreadsheet.