ASHRAE TECHNOLOGY AWARDS APPLICATION FORM (Page 1)

APPLICATION MUST BE COMPLETE TO BE CONSIDERED FOR JUDGING

(Required for Society-Level Competition)

(For ASHRAE Staff Use Only)

I. Identification (0 Points)

Name of building or project: Seattle Academy of Arts and Sciences STREAM Building

II. Category - Check one and indicate New, Existing, or Existing Building Commissioning (EBCx)

☐ Commercial Buildings		☐ New	☐ Existing	☐ EBCx
Institutional Buildings:				
	☒ Educational Facilities	☒ New	☐ Existing	☐ EBCx
	☐ Other Institutional	☐ New	☐ Existing	☐ EBCx
☐ Health Care Facilities		☐ New	☐ Existing	☐ EBCx
☐ Industrial Facilities or Processes		☐ New	☐ Existing	☐ EBCx
☐ Public Assembly		☐ New	☐ Existing	☐ EBCx
☐ Residential (Single and Multi-Family)				

III. Project Description (0 Points)

1. Type of building or process: New science/robotics/engineering/arts/math building for college prep school
2. Size – gross floor area of building (ft. sq. or m. sq.): 34,000 SF
3. Function of major areas (such as offices, retail, food services, laboratories, guest/patient rooms, laundry, operating rooms, warehouse/storage, computer rooms, parking, manufacturing, process, etc., or industrial process description:

   Classroom laboratories, offices, student gathering spaces

4. Project Design Period: 06/2013 (Begin date (mm/yyyy)) to 10/2014 (End date (mm/yyyy))
5. Project Occupancy and Operation Period: 10/2015 (Begin date (mm/yyyy)) to ongoing (End date (mm/yyyy))
6. ASHRAE Standards referenced during design (this information will not be shared with the Judging Panel):

   ASHRAE 90.1-2007, 62.1-2007, 55-2004, 110

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1. **Name of Building or Project:** Seattle Academy of Arts and Sciences STREAM Building

2. **Entrant (ASHRAE member with significant role in project)**:

   a. Name: Marseille (Last) Thomas (First) James (Middle)

   Membership Number: 2026297

   Chapter: Puget Sound

   Region: Region XI

   b. Entrant's Design Firm/Company: WSP

   c. Address (including country):

   Seattle (City) WA (State) 98104 (Zip) USA (Country)

   d. Telephone: (O) 206-883-1220 e. Email: tom.marseille@wsp.com

   f. Entrant's Role in Project: Principal in Charge

   g. List the names of Design Team Members (A maximum of three may be listed below)

   1. Charles Gronek
   2.
   3.

3. **Certification of entrant (0 Points) (If multiple entrants, all must be listed on this form)**

   I certify the information submitted is correct, and that this entry satisfies the requirements of the ASHRAE Technology Award competition.

   Typed Name: Tom Marseille Title: Senior Vice President

   Signature: Thomas J Marseille Date: 4/26/19

4. **Building Owner's release (0 Points)**

   I certify that I am the owner or the authorized representative of this project, and hereby grant permission to ASHRAE to use all the enclosed data and information in the judging and subsequent publicity of this project.

   Typed Name: Rob Phillips Title: Head of School

   Signature: Date: 04.25.2019

   (Signatures must be on form submitted to ASHRAE)

   Company: Seattle Academy of Arts and Sciences

   Address: 1201 E Union

   Seattle, (City) WA (State) 98122 (Zip) USA (Country)

   Telephone: (O) 206.676.6842 Email: rphillips@seattleacademy.org

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5. Engineer of record: Required unless a written explanation is provided why the engineer of record will not grant his/her consent.

I consent to the presentation of this project for consideration in the ASHRAE Technology Awards Program.

Typed Name: Charles Gronek Title: Senior Associate

Signature: Date: 4/26/19

(Signatures must be on form submitted to ASHRAE)

Company: WSP
Address: 999 Third Ave
Seattle (City) WA (State) 98104 (Zip) USA (Country)
Telephone: (O) 206-883-1249 Email: charles.gronek@wsp.com

The topics below should be addressed on separate pages and formatted according to the requirements listed in the overview.

1. **Energy Efficiency (15 Points)**
2. **Indoor Air Quality (15 Points)**
3. **Innovation (15 Points)**
4. **Maintenance & Operation (15 Points)**
5. **Cost Effectiveness (15 Points)**
6. **Environmental Impact (15 Points)**
7. **Quality of Presentation (5 Points) (No response required)**

Return Completed Application to your Chapter Technology Transfer Committee Regional Vice-Chair.

For additional information, contact:

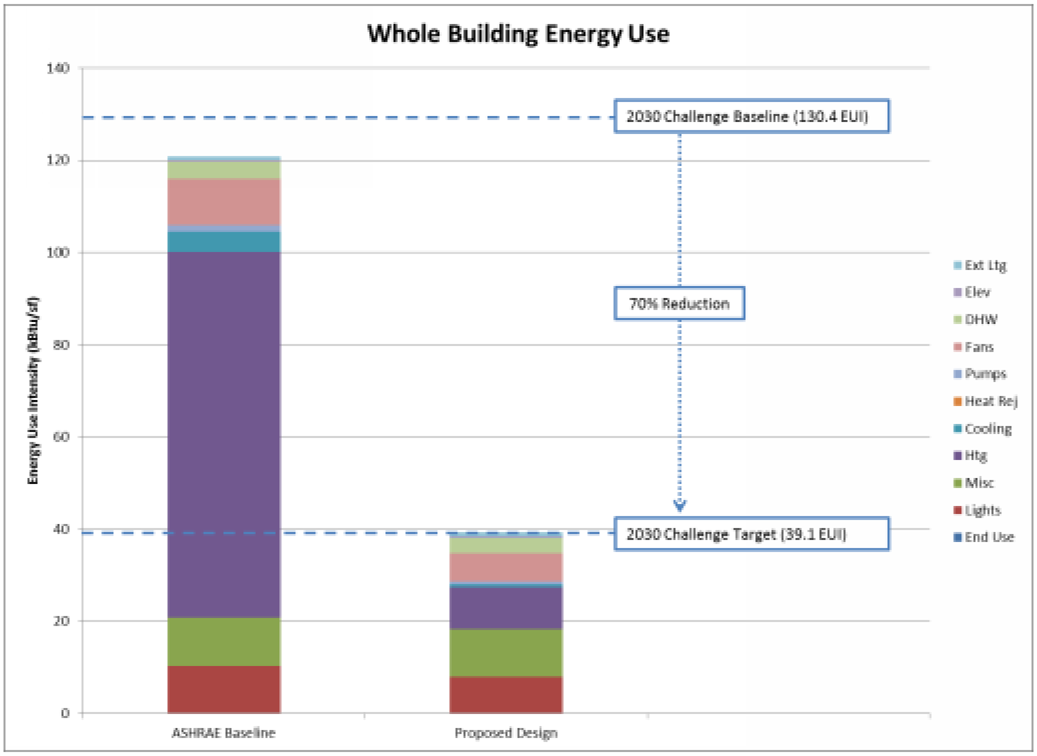
Candace DeVaughn
Chapter Programs Manager
678/539-1128
cdevaughn@ashrae.org

General

The Seattle Academy of Arts + Sciences STREAM (Science, Technology, Robotics, Engineering, Arts and Math) Building diverges from typical suburban school campus models by organizing the 34,000 square foot program vertically rather than horizontally on a site that is only 7,000 square feet. Located at the corner of 13th and East Spring within the Capitol Hill neighborhood, the five story STREAM building consists of seven laboratory and studio classrooms, a two-story learning commons, a robotics lab and staff offices. The purpose built lab and studio spaces all were designed to maximize both space and flexibility to meet current and future course needs. The design incorporates a mix of flexible formal and informal learning environments to encourage student-initiated projects, collaboration and innovation. Overall, the building serves as an expression of SAAS's commitment to urban ecological design.

Energy Efficiency

The STREAM Building addresses the challenge of reducing carbon emissions by meeting the energy performance target of the 2030 Challenge, beating baseline building performance by 70%. An integrated bundle of passive and active strategies used also enabled the STREAM building to achieve all available LEED V3.0 energy credits by reducing energy cost performance by 50% relative to the ASHRAE 90.1-2007 baseline. With an estimated Energy Use Intensity (EUI) of 39 kBtu/SF/Year the project significantly exceeds the baseline 100 EUI that is more typical for a STEM classroom building that includes wet labs.



The project has a number of unique features for energy conservation. The primary efficiency measure was the use of variable volume lab exhaust. Each lab room in the building has a dedicated supply and exhaust valve that will increase or decrease the supply and exhaust airflow rates based on whether the space is being used. As a high school lab space, these fume hoods are used either all at one time, or not at all. Because of this, the airflow valves use two stage controls for simplicity and cost savings.

The remainder of the building includes many densely occupied spaces, with variable occupancy. Because of this, the fresh air system is controlled with demand control ventilation (DCV), which allows the ventilation air to be provided as needed to maintain CO2 levels in the space. As an additional efficiency measure, the dedicated outdoor air system that provides ventilation and lab makeup air includes heat pipe heat recovery to recover heat from the labs and toilet exhaust and use that to preheat the ventilation air. Diagram of the air system can be found in the Appendix of this submittal.

The primary heating in the building is from a highly efficient hydronic system, using a condensing gas boiler and variable primary flow pumping. Most of the heat is delivered from radiant ceiling panels in the classrooms and corridors, with a radiant floor in the main entry area. These panels were selected because they increased efficiency and comfort, while providing excellent flexibility for the classroom space and reduced maintenance. Diagrams of the hydronic system can be found in the Appendix of this submittal.

Most of the building uses passive cooling, further reducing energy consumption. Each classroom has manually operable windows to give the occupants control over their space. Additionally, there are motorized operable window louvers. These are controllable by the occupants during the day. At night, the control system can open or close these glazed louvers as needed to provide a night flush cooling cycle. The corridors in the building have motorized dampers on both ends, which open or close based on indoor temperature conditions. The corridors connect, either directly or through ventilation shafts, to louvers at the top of the building. This high/low configuration dramatically increases the effectiveness of the passive cooling system by using stack effect to increase the airflow.

A few spaces in the building could not have direct connections to the exterior, so air conditioning is provided to those spaces. A very efficient variable refrigerant flow heat pump system with heat recovery serves these few areas, which are primarily teachers offices and a robotics lab in the basement of the building.

Finally, a 13 kW photovoltaic array is installed on the roof of the building, providing both carbon free energy production and a learning experience for the students about renewable energy.

The project was simulated using eQuest for energy analysis.

Unfortunately, the project does not have energy consumption data available as it is on a campus with a shared electrical meter between multiple buildings.

Indoor Air Quality and Thermal Comfort

While occupant-managed natural ventilation strategies provide a healthy and comfortable indoor environment for much of the buildings' spaces with abundant amounts of fresh air, mechanical ventilation systems are still required on cold and hot days in spaces to maintain comfort and to serve interior faculty offices and the robotics lab located in the basement. To address this, a single dedicated outdoor air system was provided which includes 75% effective air-to-air recovery of heat from exhaust heat to temper incoming fresh outdoor air. As opposed to the majority of school buildings in Seattle and other parts of the country that recirculate a significant portion of the air used for HVAC), 100% of the buildings' air at the STREAM Building is fresh air from outdoors, whether delivered by an open window or a mechanical system.   The use of CO2 sensing technology enabled a demand control ventilation scheme to be employed to avoid over-ventilating spaces that were not occupied, reducing energy use.

The ventilation system was designed to exceed ASHRAE 62.1-2007 requirements by 30%. As a lab building, special pollutants were present. To deal with these, chemical storage cabinets with dedicated exhaust are provided. All chemical storage rooms are continuously exhausted. Some soldering was expected in the robotics lab, so dedicated stations were provided with fume capture hoods located above the working surface.

The project was very focused on thermal comfort. ASHRAE Standard 55 was a main driver in decisions about systems. The project maximized the use of radiant heating for the highly glazed areas to offset the potential effect of radiant asymmetry. The passively cooled spaces were designed to stay within the ASHRAE 55 expanded comfort range. The occupants were given control over their space, with operable windows and air speed control using overhead ceiling fans with multi-speed control. Thermal comfort and bulk airflow analysis was completed to ensure that the classrooms wouldn’t exceed comfortable conditions for more than a few hours per year.

Anecdotally, the building has been very comfortable for the occupants. The project opened during one of the warmest Septembers in Seattle history, with an extended stretch of above average days. There were no comfort related complaints during that time. The ceiling fans have been noted as a particularly nice feature, with everyone finding them key to maintaining comfort.

Innovation

To help the project exceed LEED Gold standards, the building utilizes power from a 13 kW photo-voltaic array and features a green roof atop a new breezeway, connecting the existing Arts building to the new STREAM building. An 11,900 gallon cistern collects rainwater from the roof for reuse for toilet flushing and landscape irrigation, reducing by an exemplary 99% of non-potable building water demand.

Given the effective use of passive cooling strategies via natural ventilation when combined with solar heat gain control, the school decided no mechanical cooling would be required in classrooms in order to maintain comfortable conditions.

The ventilation strategy for science labs took all fume hoods out of the classrooms themselves and placed them in adjacent lab prep/support rooms with glass separation that enabled demonstrations to be viewed by students in classrooms. With hoods so located, they could be stacked over multiple classroom floors, simplifying organization of shafts, allowing for consolidated variable air volume hood operation with fewer valves required, reducing first costs and long term O&M.

Operation & Maintenance

By effectively using daylight to illuminate classroom spaces, the use of artificial lighting in classroom and circulations spaces was dramatically reduced. Occupancy sensors further reduce the energy consumed by artificial lighting. Together these strategies significantly extend the service life of fixtures and lamps.

Space heating in classrooms and circulation areas was provided by hydronic radiant ceiling panels, enabling a high degree of thermal comfort. The radiant panels further (1) enable a more efficient use of classroom perimeter space for programmatic needs, (2) are easier to keep clean and maintain than if more traditional perimeter fin tube radiation/convectors were employed, and (3) have fewer parts to maintain than unit ventilators or a fully forced air heating and ventilating system.

The dedicated outdoor air system's heat recovery of exhaust air is achieved using low maintenance heat pipes.

Cost Effectiveness

The project used a life cycle cost analysis methodology to enable the School to make choices on appropriate MEP strategies based on both initial and long term costs.

The project included a General Contractor/Construction Manager (GC/CM) delivery model, which meant a contractor was on board from the beginning of design. This enabled the project team to benefit by having accurate and relevant early cost and constructability input during the entire design process. A robust and true value engineering approach and process could be employed to address budget challenges that came up. As an example, this tightly integrated project team enabled the School to make an informed decision to eliminate a proposed basement welding shop based on understanding both the technical coordination challenges and accompanying cost implications.

The elimination of mechanical cooling in all spaces except internal faculty offices and occupied portions of the basement saved significant money that could be applied elsewhere.

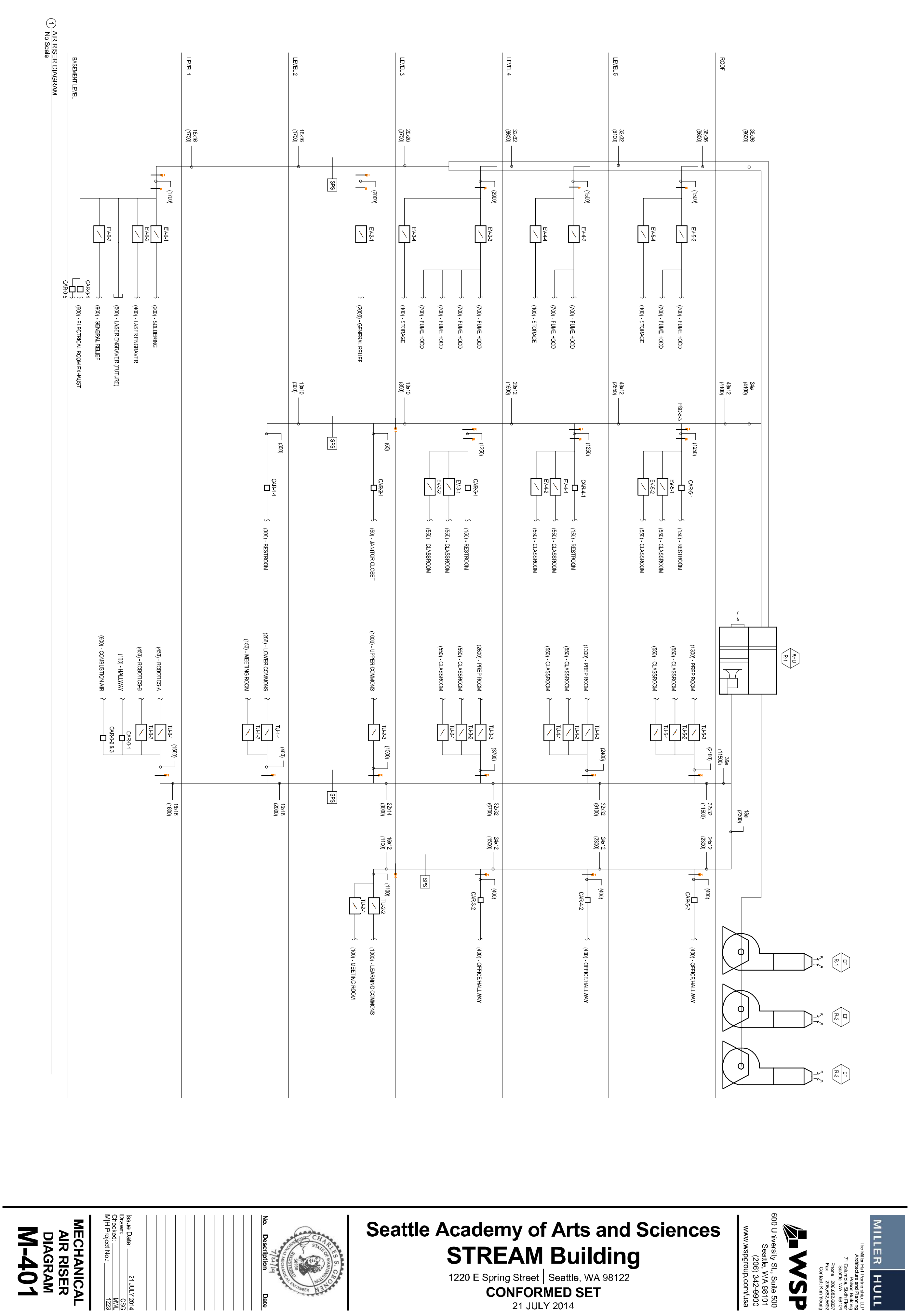
Environmental Impact

Seattle Academy students are keenly aware of environmental issues and their accompanying corporate and individual role and responsibility, and the school therefore early on saw the opportunity to make STREAM an effective environmental learning tool. An eco-charrette with students at project onset established guiding sustainability principles that were then incorporated in this high performance building.

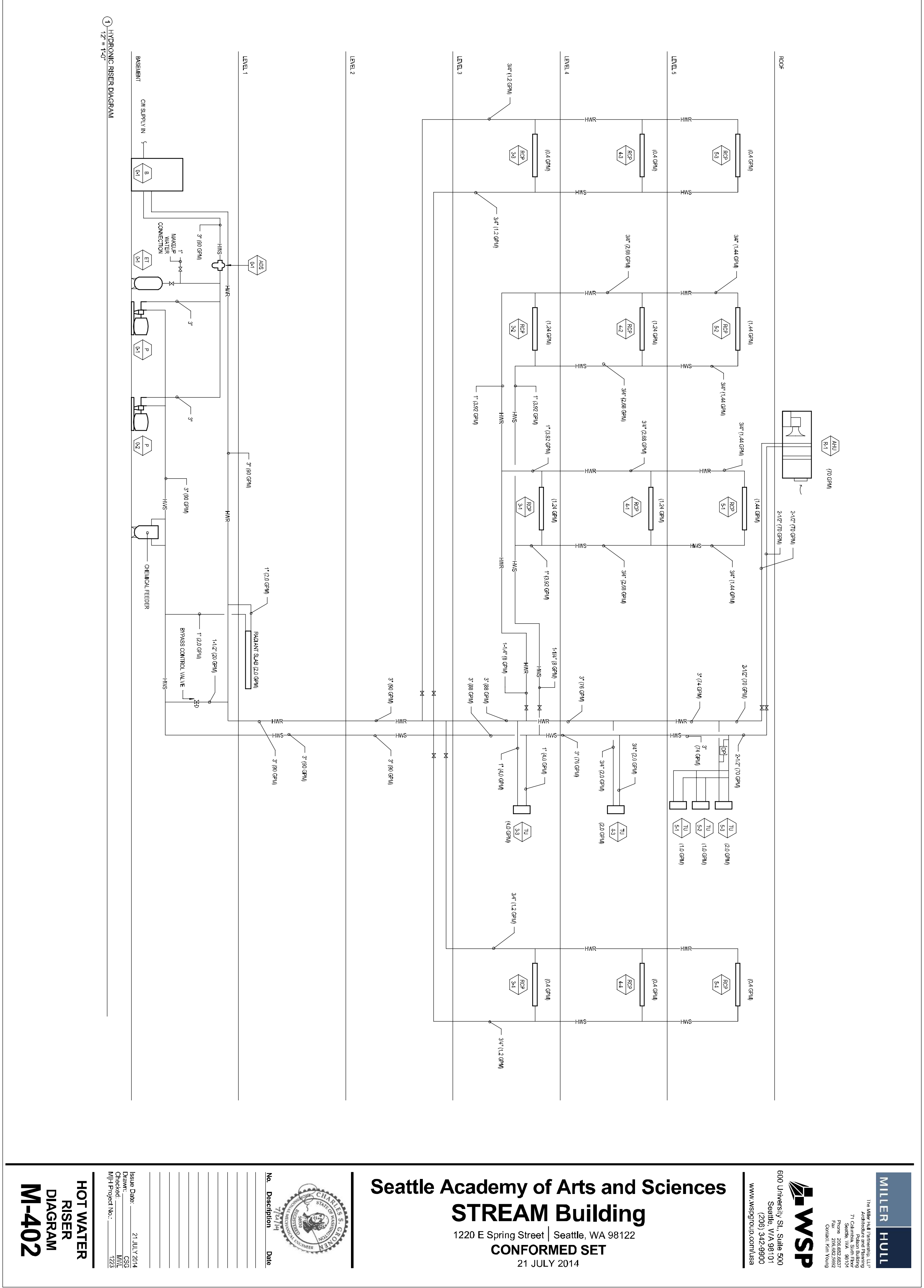
As a starting point in the design process, the team recognized that the most energy efficient HVAC strategy is to decrease the need for heating and cooling required. In response, the building envelope was designed to be as thermally efficient as possible, with strategic use, but not overuse, or glazing. On classroom floors, the south façade included glazing that brings in abundant daylight, but which is controlled by exterior sunshades and interior automated blinds to reduce glare and heat gain, typically the major cooling load building perimeter spaces in Seattle.

The project takes advantage of the mild Pacific Northwest climate by providing operable windows configured to effectively provide natural ventilation and passive cooling. Temperatures locally range between 50 to 75 degrees for over half of the occupied hours each year, so fresh air introduced through open windows can be highly effective. The strategy at STREAM included automated glazed louvers, manually operable window openings, manual transoms over classroom doors and motorized dampers at the top of ventilation “chimneys” serving circulation spaces. Together, these promote natural ventilation for passive cooling. Automated controls provide a passive night-flush cooling to remove heat precooling classrooms, circulation, and break-out spaces for the next day. The extent and location of operable windows and type of shading were analyzed and optimized using a thermal comfort model.

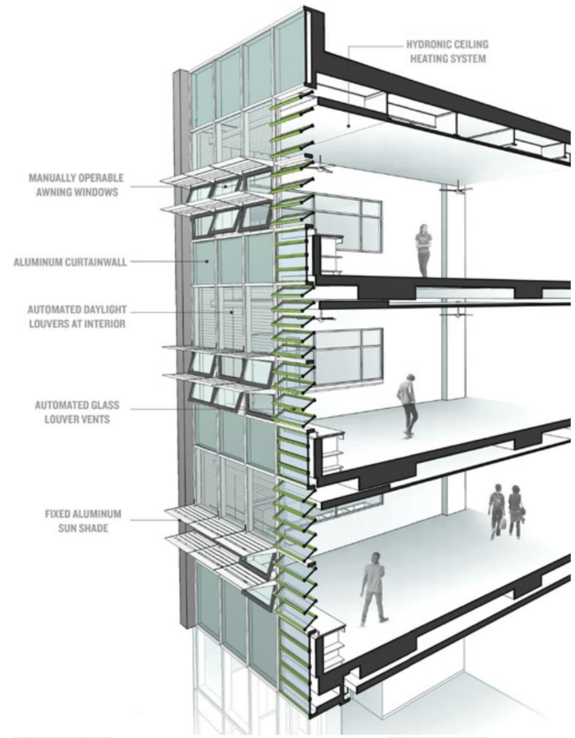
Appendix A: HVAC Air-Side Diagram



Appendix B: HVAC Water-Side Diagram



Appendix C: Passive Mode Diagrams



PERFORMANCE

Achieves **2030 Challenge target 70%** energy savings

50% energy savings over ASHRAE 90.1 baseline

100% outside air system **improves indoor air quality**

Passive cooling through natural ventilation - no mechanical air conditioning in classroom spaces

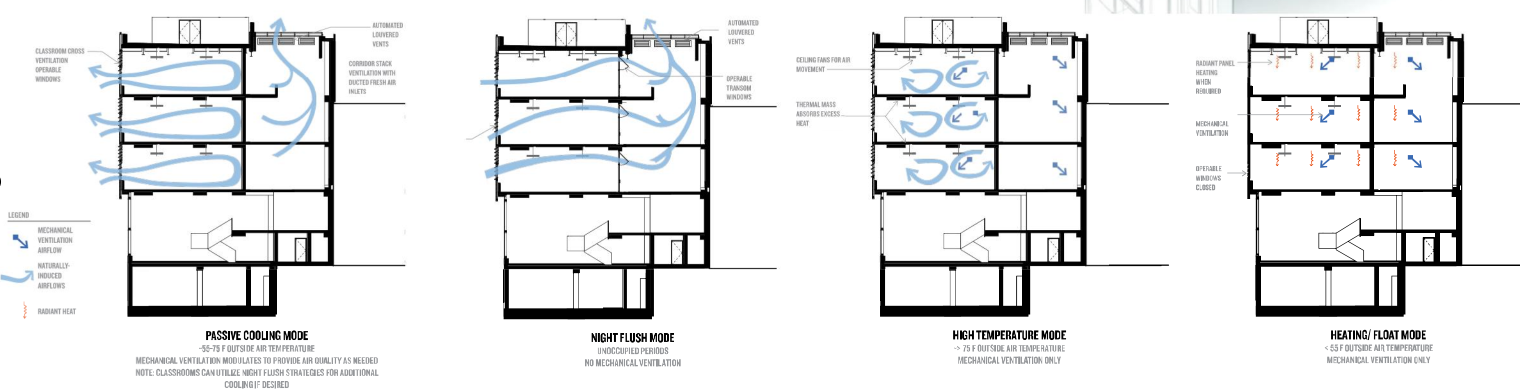
Non-potable building water needs served by **reclaimed rainwater**

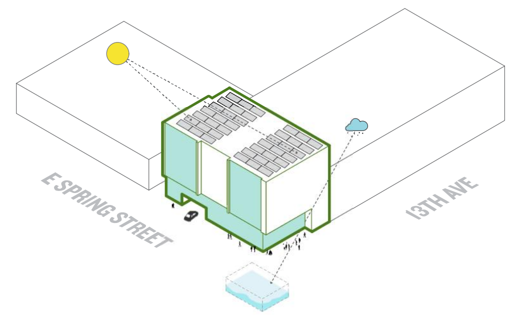
50% of **stormwater managed on site**

Vertical green wall integrates Green Factor requirements on tight urban site

100% daylit classroom spaces - 30 fc on desktops throughout

Glare control with automated interior blinds on daylight glazing - no direct beam sunlight





An 11,900 gallon cistern collects rainwater from the roof, reused for irrigation and flushing. Rooftop photovoltaic panels demonstrate renewable energy potential to the school community.

Seattle Academy of Arts and Sciences | Thermal Comfort Study - Results

The results of the thermal comfort study are different if only the traditional school year is considered, from September until June, instead of the whole year. The graphs shown to the right contrast the results for the whole year against only the ten expected school months.

BASELINE

The baseline case consists of:

- Manually operated south and west glazing
- South shading
- Night flushing operation
- South opaque panel
- Mechanical ventilation, with tempering in winter
- 25 total occupants

In the peak zone, 178 occupied hours or 7% of occupied hours are uncomfortable for 80% of people if the whole year is considered for the baseline case. This is reduced to 74 hours, or 3% if the school year is considered.

BASELINE + CEILING FANS

This case models the effect of ceiling fans on improving the thermal comfort of the baseline.

The addition of ceiling fans increases the comfort levels, allowing only 98 occupied hours or 4% of occupied hours uncomfortable for 80% of people if the whole year is considered. This is reduced to 33 hours, or 1% if the school year is considered.

MAXIMUM PERFORMANCE

After testing a number of design options a "maximum performance case" was considered, which includes:

- Ceiling fans
- Improved glazing performance
- Removal of glazing at below desk level
- Opaque operable louvre, 50% effective free area

This case shows only 37 occupied hours, or 1%, of occupied hours uncomfortable for 80% of people if the whole year is considered. This is reduced to 8 hours, or 0.5% if the school year is considered.