Bertschi Living Science Building
A Review by Matt Kabak, Eric Liang, & Mike Tran
University of San Diego Master of Science in Real Estate
April 29, 2014
Pre-5 Independent School
240 Students / 38 Faculty
LEED Gold Certified in 2008
Living Science Building completed
February 2011, Certified April 2013

SCHOOL VALUES:
Integrity | Inclusiveness | Respect
Commitment to Sustainability

Image Source: Google Maps
Bertschi Science Wing

- First built project to meet the standards of version 2.0 of the Living Building Challenge
- 4th Living Building in the world and 1st on the West Coast

Image Source: Google
Floor Plan

Image Source: Bertschi School
1. North, insulated glazing and operable windows providing daylighting and natural ventilation
2. 2x12 wood framed, cellulose insulated walls
3. SIPS panel roof
4. Hydronic radiant floor heating
5. Ventilation system with energy recovery
6. Operable skylight provides stack effect ventilation
7. Rain leaders to cisterns, exposed for education
8. Glass covered interior runnel transports excess rain water to potable cistern
9. Exterior runnel transports rain water for potable use to irrigation cistern and rain garden for infiltration

10. Irrigation Cistern
11. Rain Garden
12. Stormwater control valves divert water from other campus property to irrigation cistern and rain garden
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Image Source: Living Building Challenge
East EcoHouse

1. Church Building rain leader to cistern, exposed for education
2. Rain leader for classroom butterfly roof
3. Glass-covered interior runnel transports rain water to potable cistern
4. Potable water cistern
5. Potable tank hand pumped for water appregation
6. Energy Recovery Ventilator
7. Operable curtain wall window for ventilation
East EcoHouse

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Image Source: Living Building Challenge
West EcoHouse

1. North, insulated curtain wall glazing provides daylighting
2. Skylights provide additional toplighting for the Green Wall
3. Greywater filter tanks remove large particulate matter before sending to Green Wall
4. Green Wall treats all greywater onsite through closed-loop evapotranspiration
5. Vacuum flush toilet
6. Composting units (2) treat all blackwater on-site
7. Potable water treatment system (wall mounted) including micron filters and UV light for disinfection
8. Radiant floor hybrid hot water heater
9. Moss mat green roof
10. 2x12 wood-framed, cellulose insulated walls
THE STANDARD 2.1

• The Living Building Challenge is a green building certification program that defines the most advanced measure of sustainability in the built environment possible today.

• Acts to diminish the gap between current limits and ideal solutions.

• Projects that achieve this level of performance can claim to be the “greenest” anywhere, and will serve as role models for others that follow.
Living Building Challenge-Cont.

• A program of the International Living Future Institute, the Living Building Challenge (LBC) is widely considered the world’s most rigorous building performance standard.

• A Living Building generates all of its own energy through clean, renewable resources; captures and treats its own water; incorporates only non-toxic, appropriately sourced materials; and operates efficiently and for maximum beauty.

• A building must perform as designed for one full year of occupancy and pass a third-party audit before receiving certification as “Living.”
• Petals are subdivided into a total of twenty Imperatives, each of which focuses on a specific sphere of influence.

• This compilation of Imperatives can be applied to almost every conceivable project type, building (renovation or new construction), infrastructure, landscape or community development.
Design Process

• **Inspiration:** “Living Buildings are possible and necessary.”

• **Commitment:** “Ask what is possible. Ask for help to create the change you believe in.”

• **Collaboration:** Between architects, school, staff and students. (Kids requested/received a river in the classroom and a garden with a bamboo fountain to relieve their stress!)

• **Structural systems left exposed & Processes Labeled:** Students and visitors understand how the building works and Challenge imperatives such as net zero energy and water.

PETALS: ALL

Image Source: Bertschi School
Health Considerations: Design, Construction & Occupancy

- **Design:** Spaces provide healthy air (green wall of tropical plants aids air purification in eco-house) and day lighting (windows and skylights).

- **Construction:** Precautions to ensure classrooms not affected by construction debris, dust or noise.

- **Occupancy:** Red List Free Materials (massive undertaking creating transparency in industry). Reduced use of interior finishes; and selected products to eliminate any off-gassing.

- **Students play an active role:** Controlling lighting, natural ventilation, and caring for indoor plants.

Image Source: Bertschi School
Omission of Red List Material

The Living Building Challenge publishes a “Red List” of materials to be avoided in buildings seeking certification under the Living Building Challenge. What’s on it?

- Asbestos
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethlene
- Chlorofluorocarbons (CFCs)
- Chloroprene (Neoprene)
- Formaldehyde
- Halogenated Flame Retardants
- Hydrochlorofluorocarbons (HCFCs)
- Lead
- Mercury
- Petrochemical Fertilizers and Pesticides
- Phthalates
- Polyvinyl Chloride (PVC)
- Wood treatments containing creosote, arsenic or pentachlorophenol

- **Sourcing, researching and determining accurate ingredients** for all products was tremendously challenging.

- **Education required to help subcontractors and manufacturers** understand the requirements and reasoning behind LBC Imperatives 11 and 14.

- **Mechanical and electrical** have so many parts, **difficult to source Red List information**. Sheer amount of data presented huge difficulties to keep project on time/budget.

- **Can be costly and difficult to find substitute products;** however there were many successful Red List substitutions.

- **Discovered discrepancies between LBC criteria and building codes.**
Construction Materials

- All wood is **Forest Stewardship Council (FSC) certified** (responsibly managed & local sources).
- **Natural, nontoxic and appropriately sourced materials.**
- **Materials were reduced**, including elimination of unnecessary finishes and synthetic materials.
- **Materials were reused** or reclaimed for use; wherever possible.
- **98-100% of waste** from the construction process was diverted from landfills.
- **Carbon emission offset** from construction processes; set aside 3 acres of undeveloped land for habitat preservation.

Image Source: Living Building Challenge
Low-E Windows & Skylights

- **Low E-Advantages**: Limits UV rays, without blocking visible light, reduces energy consumption by retaining in-room heat, reduces sound levels.

- **Maximizes natural light** and views onto the garden and the open sky.

- **Adds a sense of space** and a connection to nature from within the building.

- **Operable windows** allow fresh air to circulate and provide cooling, saves energy and improves indoor experience for the students.

- **Skylights** Continuous band (about 3 ft. wide 20 ft. long) with operable shades which may be closed for insulation or opened to allow light.

Image Source: Bertschi School
In-Floor Heat

The Science Classroom is heated with a hydronic radiant floor.

• **Step 1**: Electricity from solar panels powers a hybrid water heater.
• **Step 2**: The heated water is pumped through tubes in the floor and heats the concrete.

• **Step 3**: Radiant heat is even and efficient. The large mass of the concrete floor, once heated, provides a continuous source of heat rising from the floor into the occupied zone of the room. Works even better than expected.

Image Source: Bertschi School

• Image of heated floor taken with an infrared camera.
• The heated water tubes are visible as a warmer area of the concrete shown by the infrared wavelength.
Rainwater Collection

1. Collects water from metal Butterfly Roof from the Science building and adjacent church roof.

2. Two water sources combine to flow into classroom runnel.

3. Water fills up the EcoHouse interior cistern.

4. Once its full, water then flows into exterior runnel.

5. Water is collected at the end and flows through underground pipe to irrigate and then to irrigation cistern.

6. Once irrigation cistern is full, water backflows to runnel and overflows to rain garden.

Image Source: Bertschi School
**Rainwater Cisterns**

- Two concrete underground cisterns and lined with non-toxic materials.

- **Interior Cistern**
  - 2200 Gallon capacity
  - Converts to potable water through treatment equipment on site.
  - Can be hand pumped to water plants in EcoHouse.
  - Flows to external cistern when full.

- **Exterior Cistern**
  - Also called irrigation cistern
  - 2500 Gallon capacity
  - Main Purpose:
    - Toilet flushing, irrigation
  - Flows back to runnel and overflows to rain garden when full.

*Image Source: Bertschi School*
Exterior Runnel

- Source of waterflow:
  - Overflow from Interior Cistern
  - Green Roofs
  - Stairway Drain

- At the end of runnel, water flows to the Irrigation Cistern.
- When irrigation cistern is full, water overflows to rain garden.
- Porous concrete similar to soil to control stormwater runoff.
Ethnobotanical Garden

- The site provides urban agriculture.
- It has a collection of native plant species that are significant to Columbian people who lived in this region.
- Each Plant has a marker with their common name and a QR code that links to information about that plant.
- Great variety of mosses, grapes, and berries.
- Teaches students how native people use them as foods and medicines.

Image Source: Bertschi School
Hand Pump

- Water comes from the potable interior water cistern.
- Similar to the traditional hand-pump in many rural places.
- Used to water plants in the EcoHouse for plant studies.
- Also used for other water-related experiments.
- Water First program teaches students how people travel great distances everyday to utilize this system for basic needs.

Image Source: Bertschi School
Green Roof

- 522 sq. ft. of moss mat green roof system for rainwater that falls onto flat roof.
- Moss selected due to shading from adjacent building and supports wide variation in moisture levels.
- Benefits: Stormwater retention, energy savings, return of green space, oxygen production, and aesthetics.

Image Source: Xero Flor & Bertschi School
Grey Water

1. Cistern potable water or city water flows to the classroom sinks.

2. Used water (grey water) drains into grey water tank below the sinks to filter larger particulates.

3. When grey water tank is full, tank pumps the water to green wall.

4. Plants on green wall absorb grey water and nutrients from the soil for photosynthesis and perform evapotranspiration to release energy-rich oxygen and water vapor into the air.

5. Water not absorbed by the wall is cycled back onto the wall.
Students need to monitor the usage since a limited amount can be absorbed each day.

Image Source: Bertschi School
Green Wall

• Grey water is injected into the soil on 165 sq. ft. green wall to provide water and nutrient sources for plants.

• The 4 types of plants are chosen for tolerance of water-variety and indoor conditions.

• Needs to be healthy throughout the years to treat grey water produced by students.

• Needs to be closely monitored and maintained by students.

• Green wall provides oxygen, natural air conditioning, and air purification.
Composting Toilet

- **Features**
  - One composting unisex restroom with one toilet
  - Vacuum flush Envirolet system
    - Toilet, vacuum/pulverizing unit, two composting waste storage tanks
  - Two tanks allow for about 50 flushes per day
    - Each flush = 1 pint of water
  - Empty every 6-12 months

- **Challenges**
  - Space constraint did not allow for under-toilet composing
  - Uses more energy than typical gravity composting system
  - Issues with moving compost horizontally
    - Requires more service

Image Source: Envirolet & Bertschi School
Salmon Tank

- 4th Grade Field Trip to Issaquah Fish Hatchery
- Allows students to learn about salmon life cycle.
- Germinate salmon roe and allow them to grow (12 Week)
- Release fry to complete life cycle

Lake Washington → Puget Sound → Ocean → Back to spawn in Lake Washington

PETALS: HEALTH BEAUTY

Image Source: Bertschi School
Power Generation

- 20.1 kW solar array (90 panels)
- Net-metering – allows for grid credits and peak energy grid draw
- 2012: 20,000 kWh
  - 14,000 kWh for avg. household
- Enphase Energy Monitoring
Monitoring Systems

- Monitored by staff and students
- 4th and 5th graders monitor and record energy weekly
- Energy meters
- Water cistern levels
- Testing the water pH Cisterns capacity readouts

Image Source: Bertschi School
Costs: How was this funded?

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Other Features Considered and Rejected

• Geothermal Heat-too expensive
• Solar Water Heat-Distance from Classroom to Solar Array Would have Made It Inefficient (Solar Panels on adjacent building due to Northern Exposure of Living Building)
• Basement-for traditional composting toilet-too expensive. Would have been better, the current compost system requires lots of maintenance
Key Takeaways

• Example of a bar-raising, small scale Living Building project.
• Tough road to make real and positive change to an industry that has taken for granted the negative health impacts of their products.
• Red List compliance - difficult to find products that meet such rigorous, health and transparency standards.
• International Response - requests for tours from across the globe.
• Educational tool for architects, engineers, and other elementary students.
Acknowledgement

The authors are grateful to Jessie Kaarbo, Interim Front Office Manager of the Bertschi School for her valuable information and insightful explanations about the Bertschi School’s sustainable features, processes, and history.
Resources

• Bertschi School [http://www.bertschi.org/](http://www.bertschi.org/)
• EnPhase Energy: [https://enlighten.enphaseenergy.com/pv/public_systems/8Qc56878](https://enlighten.enphaseenergy.com/pv/public_systems/8Qc56878)
• Envirolet Composting Toilets: [http://www.envirolet.com/](http://www.envirolet.com/)
• International Living Building Institute/Living Building Challenge 2.0 [https://ilbi.org/lbc/LBC%20Documents/LBC2-0.pdf](https://ilbi.org/lbc/LBC%20Documents/LBC2-0.pdf)
• Email Correspondence: Kaarbo, Jessie, Interim Front Office Manager, Bertschi School, April 14-24, 2014