What Makes a Building Green?

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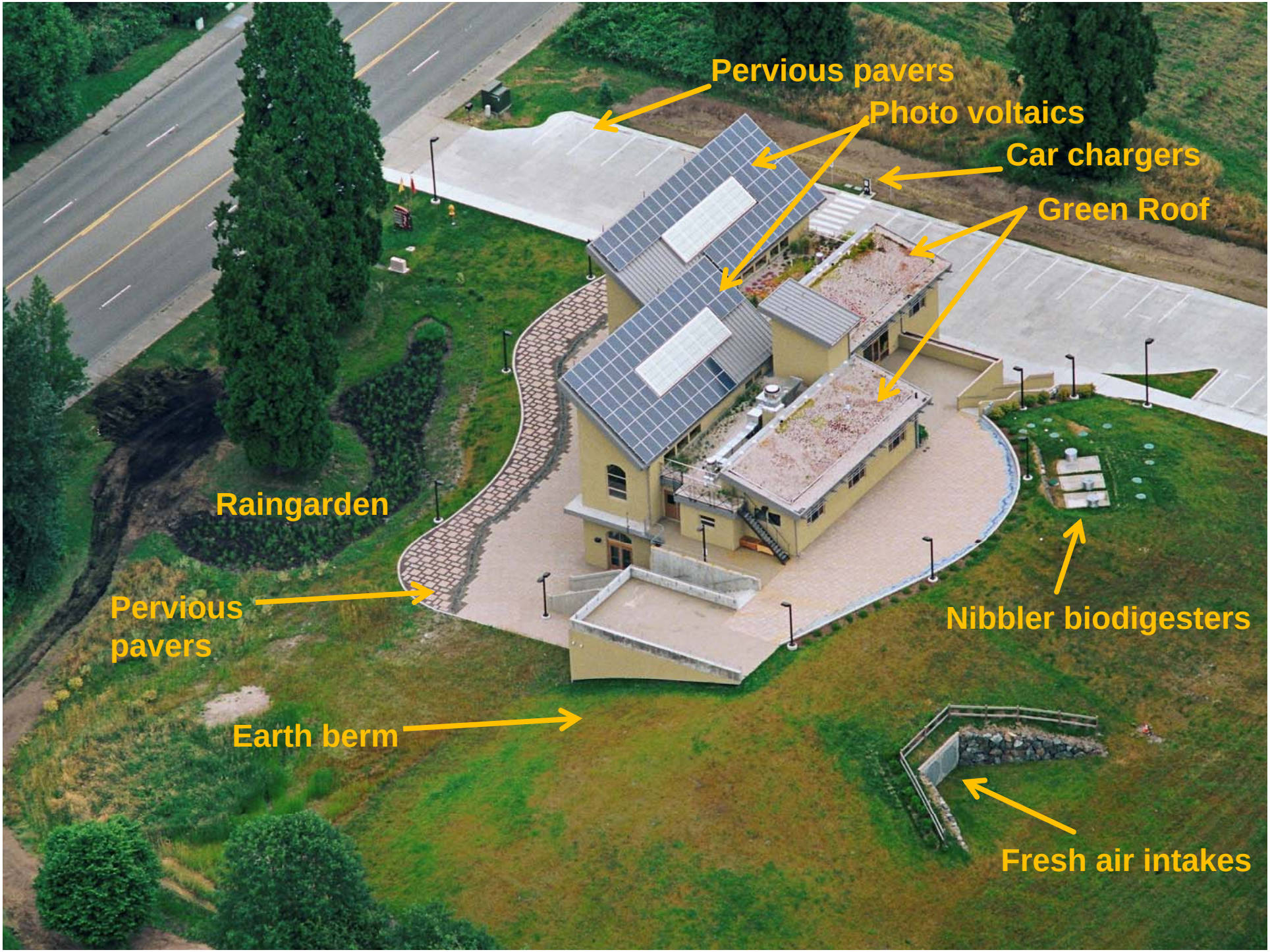
SOLTERRA SYSTEMS

SUNERGY SYSTEMS


Pervious pavers
Photo voltaics
Car chargers
Green Roof
Raingarden
Pervious pavers
Nibbler biodigesters
Earth berm
Fresh air intakes

The Program

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What is a green building?

- A green building maximizes the efficient use of energy, water, and materials, while minimizing impacts on health and the environment throughout its life cycle.

  Working with the constraints of its unique site, program, and local regulatory framework.

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Why a green building?

- Regulatory requirements
  - Energy code
  - 2030 challenge
  - Energy use reporting
- Lending requirements
- Public agency or corporate mandate
- Carbon footprint
- Risk management
- Net operating income
- Market incentives and competitive advantage

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All leading to many shades of green

Recognizing a green building

- Become familiar with sustainable building and site measures
- And how they are integrated
- Typically evaluated by category, including:
  - Sites
  - Materials
  - Energy
  - Water
  - Indoor Environment

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Site Issues

- Erosion control during construction
- Proximity to infrastructure
- Storm water management
- Landscaping and open space
- Parking amenities
- Exterior lighting
- Heat island effects

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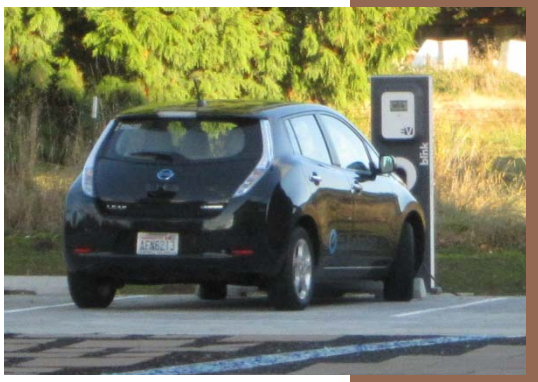
Sustainable Site Strategies

- Proximity to infrastructure reduces automobile use and emissions
  - Walking distance to transit & community services
  - Bike storage and showers
  - Preferred parking for low emitting cars
  - Electric charging stations
  - Adequate but minimum parking



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Sustainable Site Strategies

- Storm water management means dealing with rainwater onsite
  - Detention ponds to settle solids
  - Limited impervious roof & parking surfaces
  - Infiltration via bioswales or rain gardens
  - Infiltration via green roof or pervious pavers
  - Rainwater collection for irrigation or flushing

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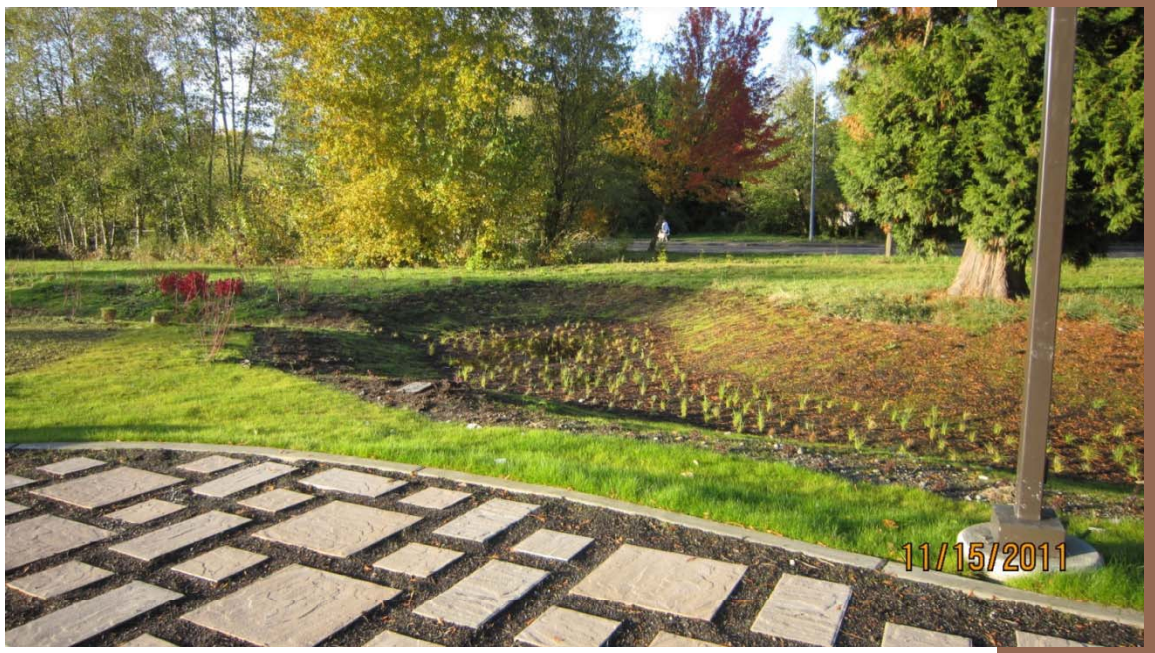
Stormwater Management at 21 Acres

- The main “green” stormwater features on the site include:
  - Conveyance Swale
  - Bioswale
  - Raingarden
  - Filter Strip
  - Porous Pavers



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Stormwater Management at 21 Acres

- Conveyance Swale

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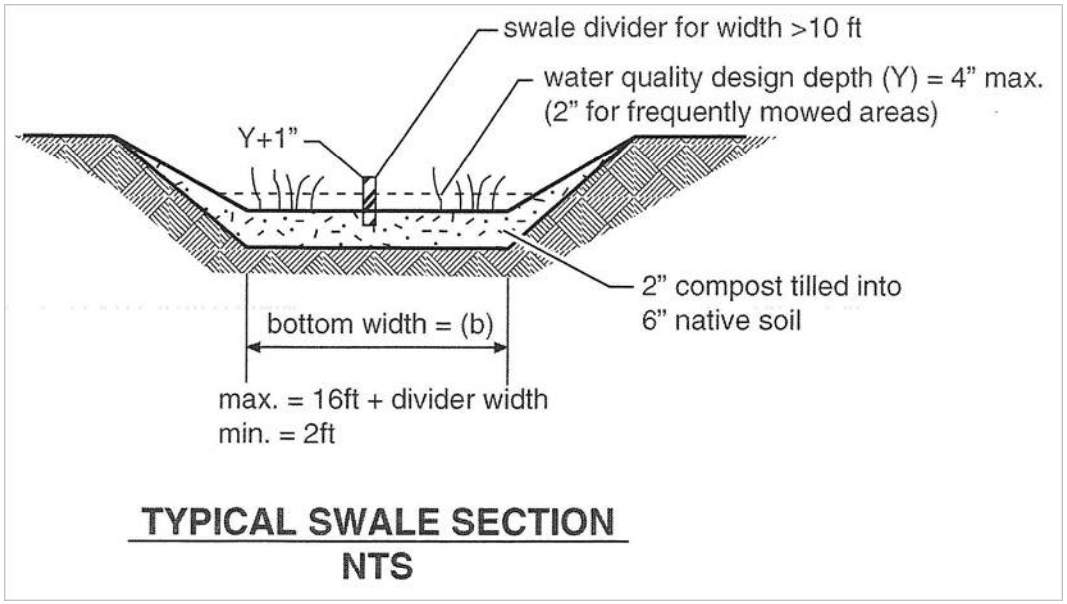
Stormwater Management at 21 Acres

- Bioswale



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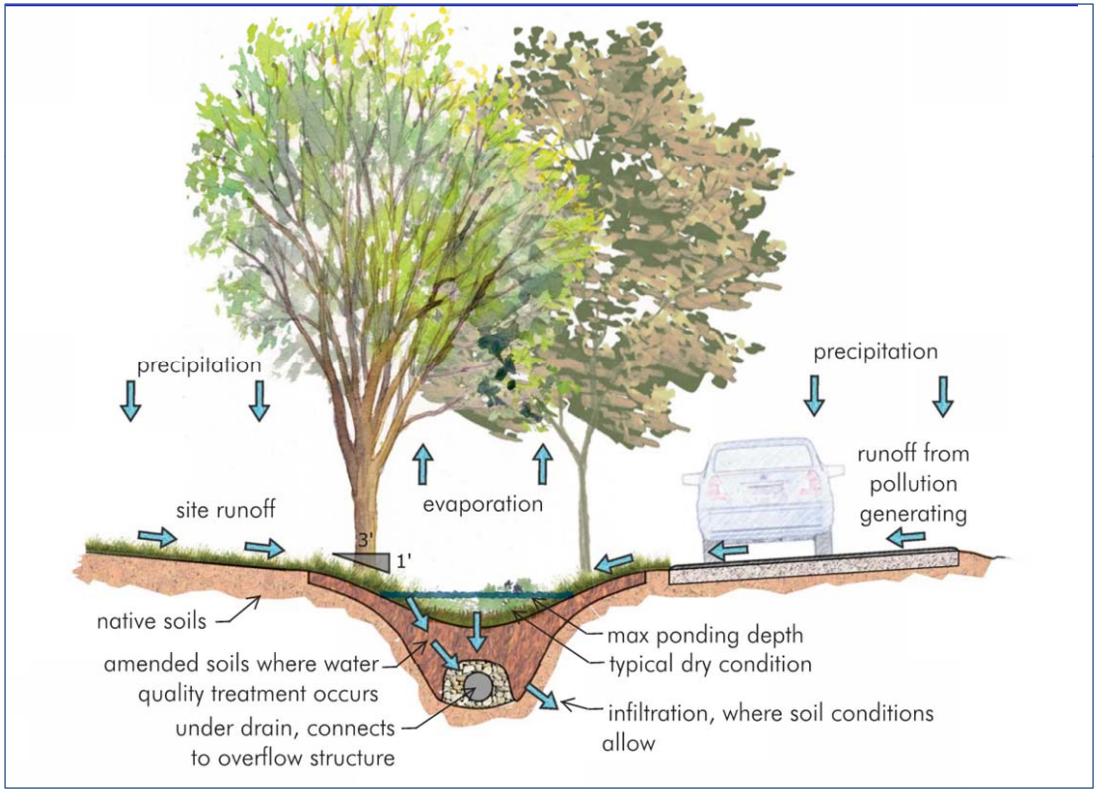
Stormwater Management at 21 Acres

- Raingardens



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Stormwater Management at 21 Acres

- Filter Strip

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Stormwater Management at 21 Acres

- Porous pavers at drive aisles and plaza

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Stormwater Management at 21 Acres

- Pros and cons
  - More civil site design permitting fees & inspections
  - No sewer interceptor or annual sewer fees
  - Elevations are crucial for directing water
  - Better flood control and drainage through retention of natural hydrology and less hardscape
  - Aesthetics - plants instead of culverts and piping

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Stormwater Management at 21 Acres

Conventional rain gutters, piping & detention to direct water off of hard surfaces to the sewer

Typical cost – $164,104

Asphalt Paving:

$22/sy x 1,600 sy = $35,200

Concrete Courtyards:

$8/sf x 5,488 sf = $43,904

Detention System: $85,000

Monthly sewer fees

21 Acres filters and carries rainwater to the adjacent wetland which provides natural biofiltration before it re-enters the groundwater.

Cost – $182,282

Pervious driveway:

$5.21/sf x 13,962 sf = $72,750 (machine)

Pervious courtyards:

$13.97/sf x 5,488 sf = $76,650 (by hand)

Swales: $32,882

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Sustainable Site Strategies

- Landscape and open space encourage habitat and recreation
  - Native and drought tolerant vegetation
  - Maximum habitat
  - Opportunity for activity outdoors
  - Maximum views to outdoors

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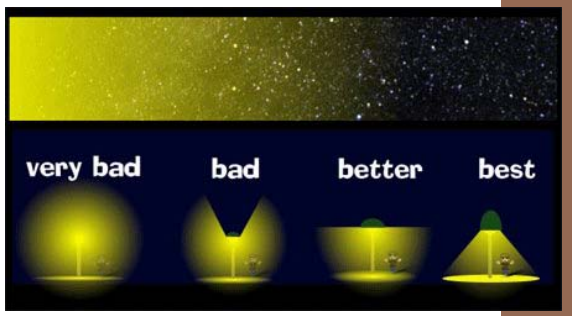
Sustainable Site Strategies

- Exterior lighting should provide safety without polluting the night sky
  - Automatic shutoff
  - Downshield fixtures
  - Direct only where needed
  - Avoid light trespass onto other sites



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Sustainable Site Strategies

- Heat Island Effect refers to dark surfaces that absorb heat and elevate temperatures
  - Minimize dark **roof** surfaces
  - Minimize dark **parking** surfaces
  - Minimize dark **pedestrian** surfaces

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Green Roofs at 21 Acres

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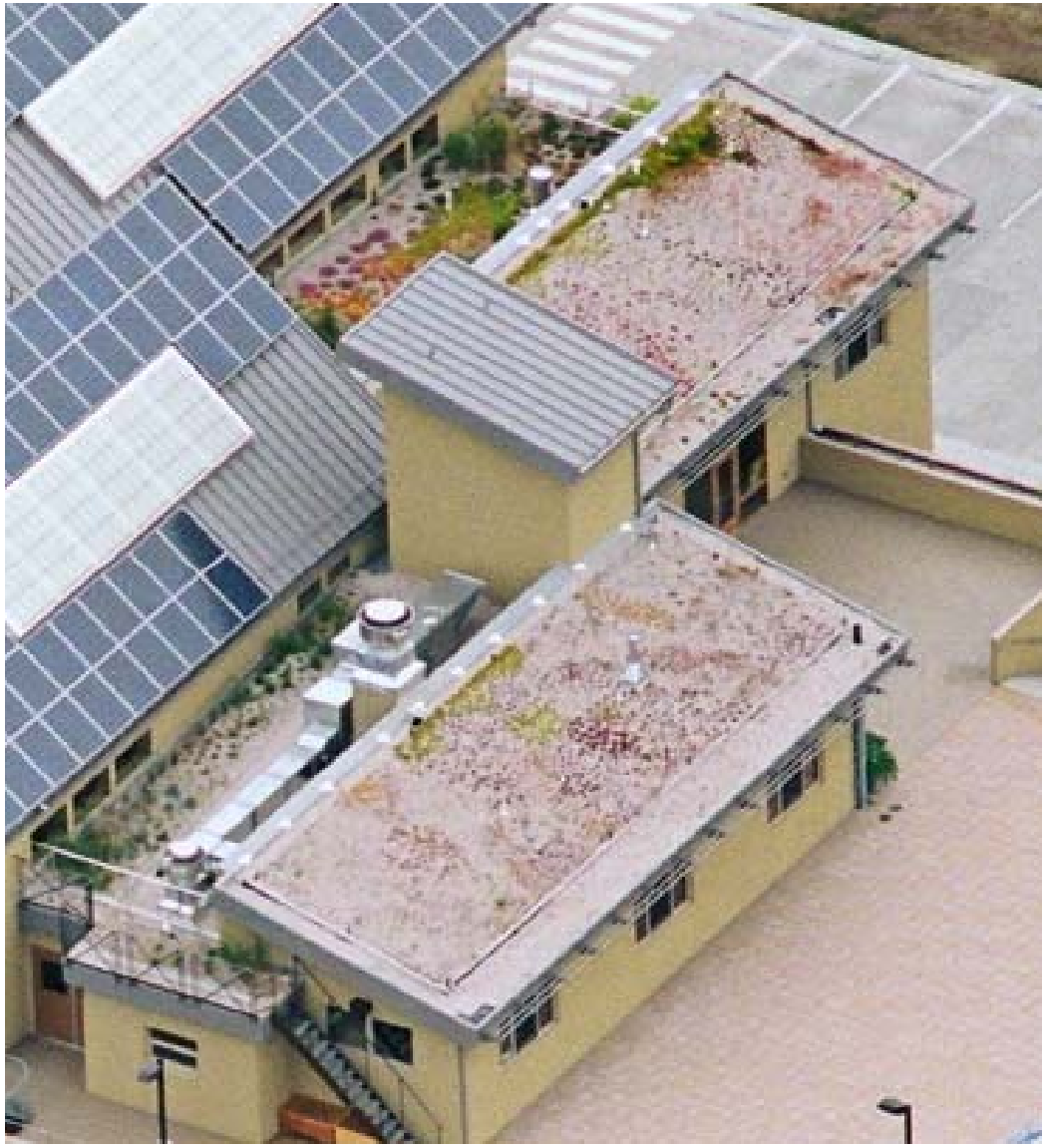
Green Roofs at 21 Acres



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Green Roofs at 21 Acres

- A green roof is a vegetated roof cover, with growing media and plants taking the place of bare membrane, gravel, shingles or tiles.

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Green Roofs at 21 Acres

- All living roofs include a single to multi-ply waterproofing layer, drainage, growing media and the plants, covering the entire roof surface.

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Green Roofs at 21 Acres

- The soil and plantings serve as a filtration system for rainwater falling on the roof. After slowing down the flow of water and capturing some for irrigation, the rest of the water is guided down to rain gardens on the site.

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Green Roofs at 21 Acres

- Pros and cons
  - Greater installation cost
  - Longer lifespan
  - Stormwater management
  - Heat island benefit
  - Aesthetics and habitat
  - Plants can die and require weeding
  - Leaks are under soil

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Green Roofs at 21 Acres

A conventional roof system would use TPO membrane or shingles

Typical cost – $35,000

Roofing: $8-$12/sf

3,550sf x 10/sf = $35,500

(insulation/densdeck/TPO)

20 year life span

The green roof system at 21 Acres uses

Cost – $111,776

Roofing:

3,550sf x 9.86/sf = $35,000

(insulation/densdeck/TPO)

Green Roof:

3,550sf x $21.63/sf = $76,776

50+ year life span

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Material Resource Issues

- Construction waste
- Building and site materials
  - The most significant impact of building materials in typical new construction are the structural and envelope components, i.e., the materials that go into foundation, walls, roof, ceiling and floor substrates.

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Material Resource Strategies

- Construction waste should be diverted from the landfill and minimized during construction whenever possible
  - Construction waste management plan
  - Source separated or commingled recyclables

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Material Resource Strategies

- Sustainable building and site materials
  - Salvage/reuse
  - Regional materials
  - Recycled content materials
  - Rapidly renewables
  - Sustainably harvested wood

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Material Resource Strategies

- Reuse of existing materials minimizes waste of embodied energy, that which was already expended in the extracting, making and transporting
  - Brick, concrete, steel, asphalt all represent large amounts of embodied energy

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Material Resource Strategies

- Regional materials reduce transport emissions and contribute to the local economy
  - Sourced within 500 miles of the site
  - Concrete, asphalt, lumber, infill, rebar, plantings can be local
  - Manufacturing can be differentiated from also harvested or extracted locally

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Geotechnical Site Services

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- Subsurface exploration and testing
- Foundation analysis and design
- In-situ testing and performance monitoring
- Dynamic analysis and evaluation
- Soil stabilization and ground improvement
- Groundwater control
- Subgrade design

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Site and Foundation Strategies

- Repurposing of material asphalt for site fill
- Low impact development utilizing site infiltration
- Innovative design with Geo Piers

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Site and Foundation Strategies

- Repurposing of material asphalt for site fill
  - Divert asphalt from the waste stream by using as fill material
  - Required added level of inspection for verification of compaction

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Site and Foundation Strategies

- Use of Geo Piers for building foundation
  - Locally sourced material
  - Naturally occurring material
  - Quick and flexible to install
  - Increased soil bearing capacity to aid in design of structure

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Material Resource Strategies

- Recycled content products reduce the use of virgin materials
  - Pre-consumer recycled content uses scrap from the manufacturing process
  - Post-consumer recycled content uses products discarded after consumer use

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Potential Wall Strategy

- Rastra Panel System
  - Recycled material: Mixture of recycled polystyrene beads, Portland cement, admixtures, water.
  - Product support: Representative not responsive to requests for assistance. Marketing literature indicates use for single family residences; product history with commercial projects not clear.

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Walls at 21 Acres

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Walls at 21 Acres

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Image courtesy of Lowe's / Apex block

Walls at 21 Acres

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Walls at 21 Acres

- Apex Block Interlocking System
  - Recycled material: Similar to Rastra system; mixture of recycled expanded polystyrene (EPS) aggregate, portland cement, proprietary admixture and water.
  - Structural properties: Material is molded with 6-inch diameter vertical and horizontal cores spaced at 16” on center. Reinforcing quantities are prescriptive; shear capacity has upper limit (cannot increase with more reinforcing).

Image courtesy of Lowe’s / Apex block

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Walls at 21 Acres

- Apex Block Interlocking System
  - Product support: Same rep as ARRX; indicated products could be integrated
  - ARXX only used where Apex structural properties are insufficient
  - Insulation: Lacking thermal bridging there is no heat loss via framing members so higher effective R-value; thermal mass walls ensure that what heat loss does occur happens more slowly

Image courtesy of Lowe's / Apex block

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Walls at 21 Acres

- ARXX High Performance Wall System
  - Recycled material: Hollow core forms of expanded polystyrene (EPS) face shells [40% to 50% recycled material] connected with polypropylene webs [recycled from post-industrial plastic].

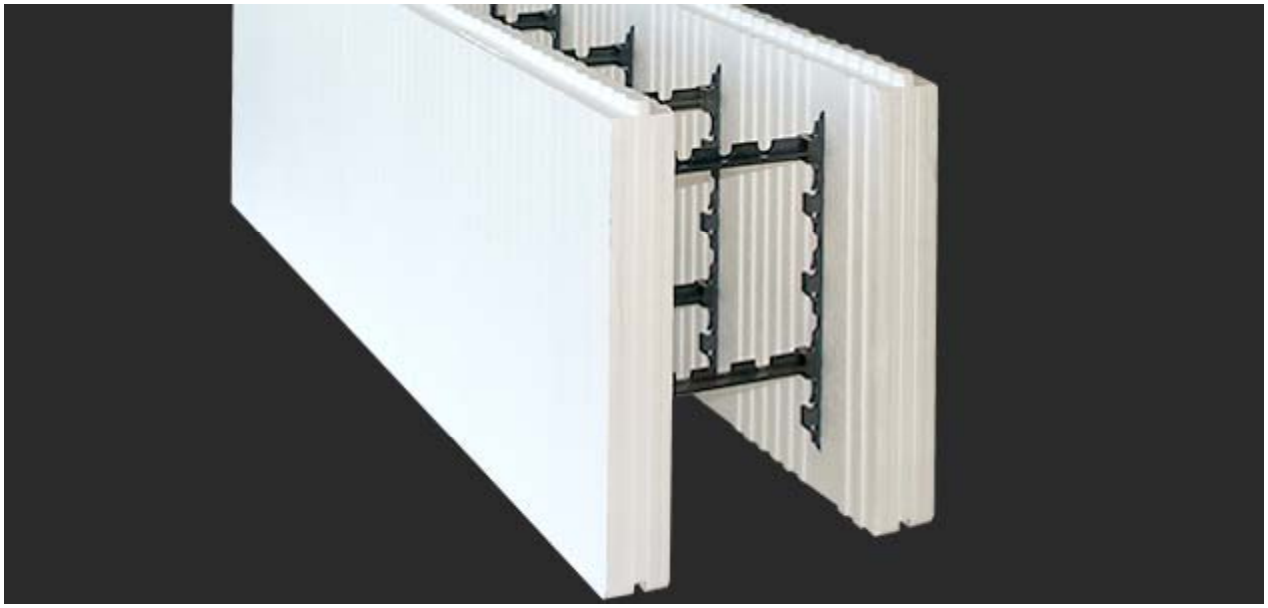

Image courtesy of ARXX ICF

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Walls at 21 Acres

- ARXX High Performance Wall System
  - Structural properties: Solid thickness concrete walls are formed between the face shells; shear capacity significantly higher than Apex. Horizontal reinforcing spacing needs to match layout of polypropylene webs (16 ¾" on center)
  - Insulation: Contributes to energy efficiency via thermal mass and reduced air leakage.
  - Product support: Same rep as Apex; products could be integrated.

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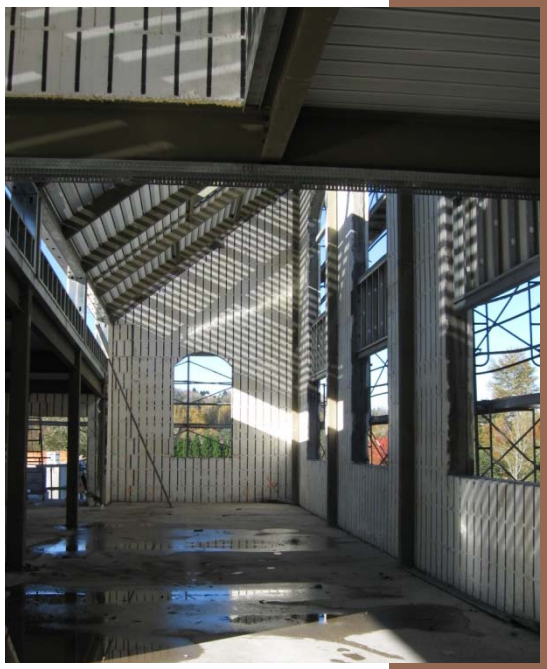
Image courtesy of ARXX ICF

Acoustics at 21 Acres

- Spatial acoustics - strive for an ideal relationship between absorption and reflection. Sound absorption characteristics of walls, floors and ceilings play an important role.
- Sound transmission between spaces is determined by wall construction: Low Sound Transmission Class (STC 25) walls allow normal speech to be heard. High STC walls (STC 50) allow very loud sounds to be only faintly heard.
- ARRX walls have a STC of 50.



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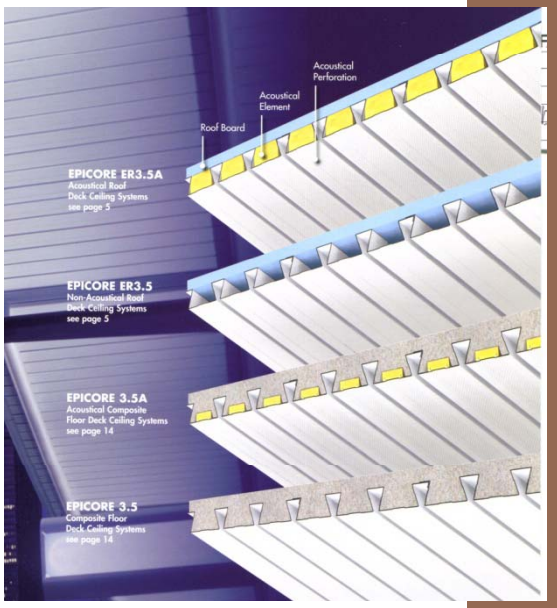
Ceiling/Floor Substrates at 21 Acres

- Roof Decking
  - Epicore ER3.5A: An acoustical option with finished appearance used at areas which needed higher sound absorption.
  - Epicore ER3.5 used in spaces with no specific acoustical requirements, overhangs and exterior balconies



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Ceiling/Floor Substrates at 21 Acres

- Floor Decking
  - Epicore 3.5A: An acoustical floor deck with concrete topping
  - Epicore 3.5: Non-acoustical floor deck with concrete topping
  - Verco: Non-acoustical floor deck with concrete topping at non-public areas.

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Walls and decking at 21 Acres

- Pros and cons
  - Coordinating multiple proprietary systems
  - Insulation had to be protected from moisture. Deck welding inspection required prior to placing insulation.
  - Good acoustic benefits
  - Good energy efficiency benefits
  - Good recycled content
  - Labor intensive due to two story structure and large window openings

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Walls and decking at 21 Acres

A conventional envelope structure might use steel frame or concrete

Typical cost:

Structural steel with metal stud infill:

$28/sf x 11,000sf = $308,000

Shotcrete Walls:

$31/sf x 11,000 sf = $341,000

Typical deck: $4/sf

At 21 Acres expanded polystyrene blocks : ICF Systems - Apex and ARXX

Cost – $357,860

ICF walls:

$32.53/sf x 11,000

(Does not include Structural Steel system needed due to height of wall. Was essentially an infill system)

Epic deck: $9.14/sf

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Material Resource Strategies

- Rapidly renewable materials re-grow within 10 years of harvest
  - Products like cork flooring, bamboo flooring or casework, linoleum, cellulose insulation
  - Wood does not qualify
  - Most rubber products are synthetic rather than natural

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Material Resource Strategies

- Wood products from sustainably managed forests ensure harvest does not outpace growth
  - Several programs exist, Forest Stewardship Council (FSC) is most rigorous
  - Must be purchased from a certified provider and have an unbroken chain of custody

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Energy Issues

- Energy system efficiency
- Lighting system efficiency
- Commercial kitchen equipment
- Greenhouse gases
- Measurement & verification
- Renewables

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Energy Reduction Strategies

- Energy system efficiency represents the interaction of building system, envelope & users
  - Demand reduction via orientation and thermal mass
  - Commissioning
  - Energy modeling
  - Highly efficient HVAC or boiler
  - Zoning and controls
  - Alternative heating systems; ground source heat pump and radiant heat.

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Radiant Heating at 21 Acres

- Radiant heat systems warm people and objects in the room rather than heating the air (convection). This system uses warm water running through plastic tubing embedded in the concrete to warm the floor.

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Radiant Heat at 21 Acres

- A radiant system allows higher comfort at lower air temperatures. Using water to transfer heat energy is highly efficient, but you still need water that is warmer than air.
- Ground source heat pumps use significantly less energy than electric resistance heat.

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Radiant Heat at 21 Acres

- Pros and cons
  - Better comfort without drafts
  - Energy Efficient
  - Reduced ambient noise levels (few constantly running air handling units)
  - Improved air quality
  - Radiant systems have slow response times
  - Limits flexibility for future changes (can't easily make new floor penetrations)

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Radiant Heat at 21 Acres

A conventional packaged rooftop unit heat pump system

Typical cost:

$118,000– $140,000.

$11 - $13/sf

At 21 Acres, ground source heat pumps with radiant floor heat

Cost: $186,000

$17.36/sf x 10,715 sf

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Energy Reduction Strategies

- Lighting system efficiency maximizes available light and supplements only when and where needed
  - Demand reduction via daylighting and task lighting
  - Highly efficient lighting fixtures
  - Daylight controls and occupancy sensors

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Energy Reduction Strategies

- Greenhouse gases are often a byproduct of building energy system use
  - Demand reduction means using less energy
  - No CFCs or halons
  - Environmentally friendly refrigerants
  - Green power

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Energy Reduction Strategies

- Measurement & verification refers to getting feedback on actual energy performance
  - Net lease terms requiring payment of utilities
  - Submeters to track specific use
  - Occupant surveys
  - M&V plan to calibrate energy model and use it to assess post occupancy utility data

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Energy Reduction Strategies

- Renewable energy can offset fossil fuel use
  - Solar thermal to preheat water
  - Photovoltaic panels (PVs) which can be net metered and provide building power
  - Geothermal wells and ground source heat pumps for building heating/cooling
  - Wind turbines

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Solar Panels at 21 Acres

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Solar Panels at 21 Acres

- The PV array capacity of 25.4 kW which will generate approximately 38,100 kilowatt hours annually, or about 9% of the facility's electric needs

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Solar Panels at 21 Acres

- Power generated by the solar panels that is not used by the Center is delivered back to the electrical grid through net-metering for an equivalent credit applied to the facility's account.

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Solar Panels at 21 Acres

- Pros and cons
  - Upfront installation costs
  - Subject to leaks as part of roofing
  - Offsets power needed from the grid
  - Need storage for non-sunny times
  - Necessary changes in occupant usage and behavior
  - Tax credits and rebates

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Solar Panels at 21 Acres

At 21 Acres, PV system

Cost – $93,455

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Water Efficiency Issues

- Landscape irrigation
- Indoor water fixture efficiency
- Commercial kitchen equipment
- Greywater systems
- Wastewater systems

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Water Reduction Strategies

- Landscape irrigation uses lots of potable water
  - Native and drought tolerant plantings
  - High efficiency irrigation
  - Use non-potable water

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Water Reduction Strategies

- Low water use fixtures
  - Low flow kitchen faucets and showerheads
  - Low flow lavatory faucets with sensors
  - Low flush toilets and urinals
  - Waterless urinals
  - Composting toilets

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Water Reduction Strategies

- Commercial kitchen equipment uses lots of water
  - Low flow dishwashers
  - Low water use ice machines
  - Pedal operated sinks
  - Combination ovens

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Water Reduction Strategies

- Dealing with greywater means collecting and treating water used for washing hands, dishes, clothes and showers onsite
  - Septic or bio-filtration system
  - Bio digester system
  - Living machine

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Bio-Filtration at 21 Acres

- First, the Nibblers break down organic matter from commercial kitchen waste using bacteria.

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Bio-Filtration at 21 Acres

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Bio-Filtration at 21 Acres

- Then release to the Glendon bio-filter system in which layers of sand and gravel are placed in watertight boxes built into the soil with a sand fill placed over the top.

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Bio-Filtration at 21 Acres

- Effluent pumped into the bottom of the filter wicks itself up through the sand. Filtering progresses as it rises through the layers and what spills over the rim of the box and into the surrounding soil is clear water.
- Any remaining effluent remains under the cover sand.

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Bio-filtration at 21 Acres

- Pros and cons
  - No sewer fees
  - Onsite system to maintain
  - High groundwater issues
  - Perceptions of hazard or odor

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Bio-filtration at 21 Acres

Conventional garbage disposals and piping to sewer or septic

Typical cost:

Garbage disposals and piping:
$15,000

Sewer connection:
$10,000

Below ground septic with gravel and trenches:
$25,000

At 21 Acres, Glendon bio-filtration system with Nibbler bio-digesters

Cost – $169,000

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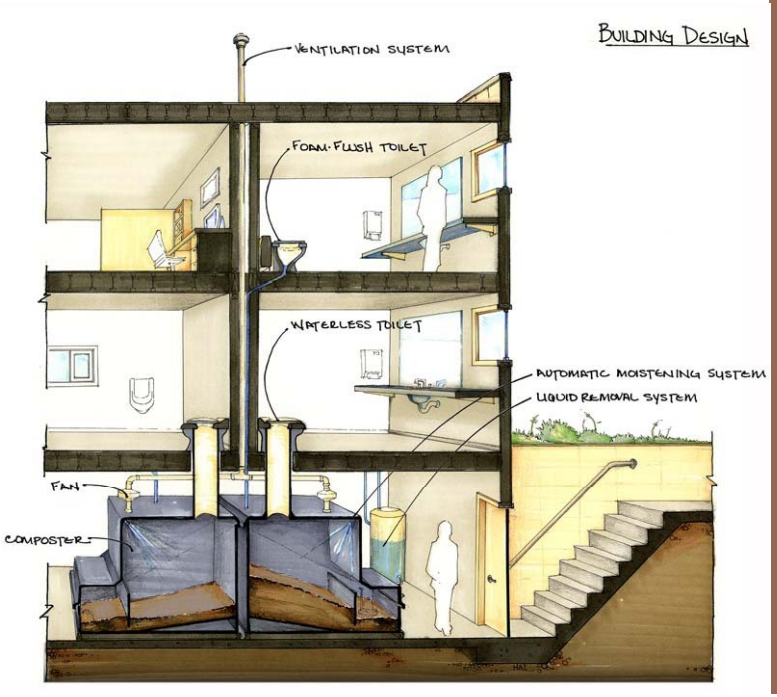
Wastewater Reduction Strategies

- Dealing with wastewater means addressing water used for flushing toilets and urinals
  - Collecting rainwater for toilet flushing
  - Waterless urinals
  - Composting toilets



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Composting toilets at 21 Acres

- Foam rather than water helps effluents settle to the bottom of the composter in the room below.

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Composting toilets at 21 Acres

- The Clivus composter mixes toilet waste (nitrogen) with added wood shavings or mulch, and a constant flow of oxygen, to convert toilet wastes into compost.

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Composting toilets at 21 Acres

- Pros and cons
  - Need SF for the composting room
  - Perceived issues of users
  - Composting becomes available for use
  - No sewer fees
  - No clogs or flooding potential
  - Manual mixing in composting bins

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Composting toilets at 21 Acres

Flush toilets and piping to sewer

Typical cost:

Fixtures and piping:

4 x $5,000 = $20,000

Sewer connection:

$10,000

Ongoing sewer fees

At 21 Acres, composting toilet system

Cost – $45,916

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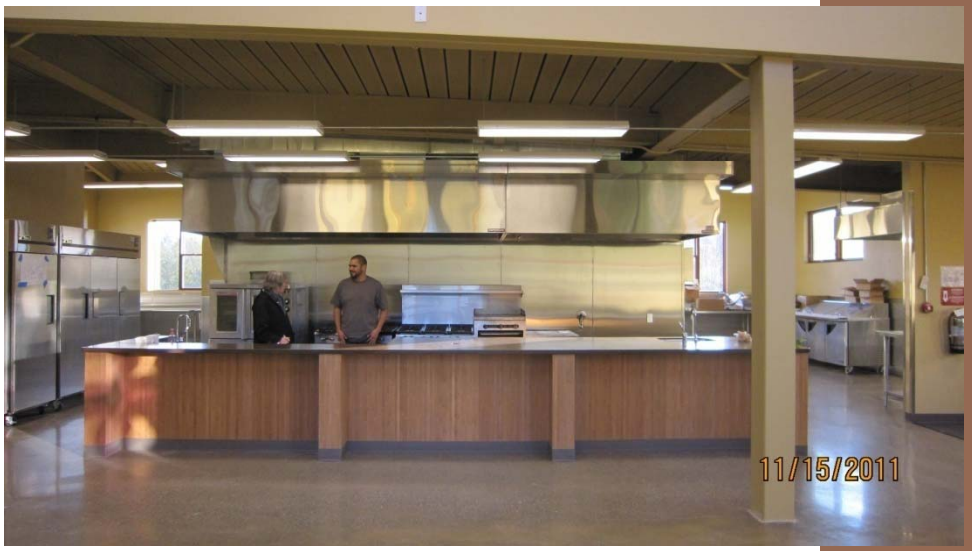
Indoor Environmental Issues

- Ventilation
- Indoor air quality
- Occupant comfort
- Daylighting
- Views



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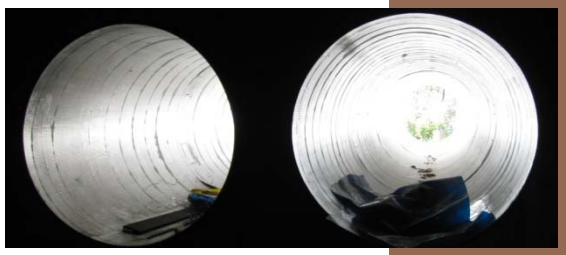
Indoor Environmental Strategies

- Ventilation should bring sufficient fresh air into the breathing zone
  - CO2 sensors
  - Demand control ventilation
  - Increased ventilation in breathing zone
  - Natural ventilation



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Indoor Environmental Strategies

- Indoor air quality means keeping contaminants out during construction and occupancy
  - No smoking
  - Construction IAQ practices
  - Entryway systems
  - Low emitting materials
  - Separate ventilation & plumbing of chemicals
  - Added filtration in HVAC systems
  - Flushout pre-occupancy
  - Green cleaning and integrated pest management

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Indoor Environmental Strategies

- Occupants are most comfortable when they have control over their environment
  - Occupant lighting controls
  - Occupant thermal comfort controls
  - Occupant comfort surveys
  - Operable windows

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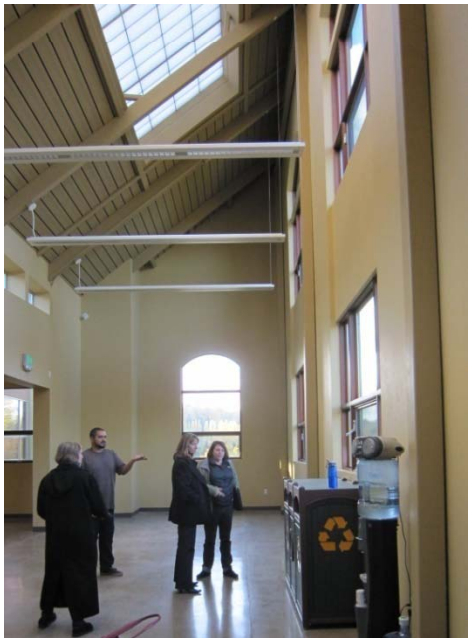
Indoor Environmental Strategies

- Access to daylight improves productivity and well being
  - Orientation and percentage of building glazing
  - Improved thermal windows
  - Dimmable fixtures with daylight controls
  - Skylights, light wells & solar tubes
  - Automatic shades



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Indoor Environmental Strategies

- Access to views connects us with nature, improving health and well being
  - Orientation and percentage of building glazing
  - Improved thermal windows
  - What you are looking at

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Lessons Learned

- Lessons learned
  - Permitting was more difficult
  - Challenging coordination among trades and systems
  - New habits are needed by occupants
  - More communication with users needed
  - More training needed for facility managers

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