an approach to systems

CLARK NEXSEN

architecture + engineering

an approach to systems
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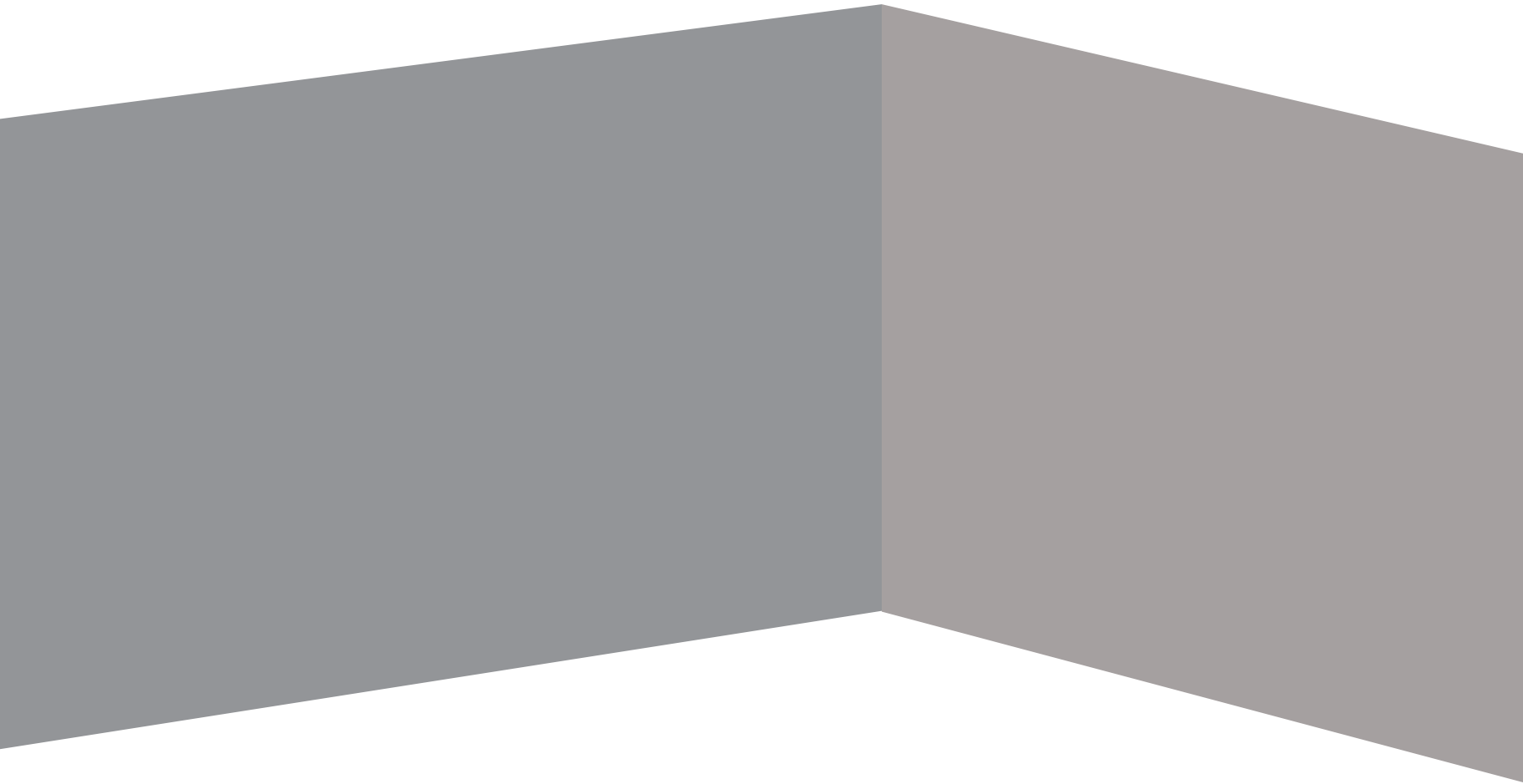
summer intern research project 2009

As a part of the Clark Nexsen summer internship in Norfolk, we researched new and conventional LEED related systems for the design of the Defense Distribution Center. In this book, we documented some of our discoveries as well as elements of the system selection process for the DDC project.

Each section of the book follows a consistent format. First, we anatomized certain sustainable systems through graphic explanations and general pros and cons. Second, we chose and documented relevant case studies that reflect compelling examples of specific systems. Finally, we applied these systems to the DDC, explaining why these systems were or were not used.

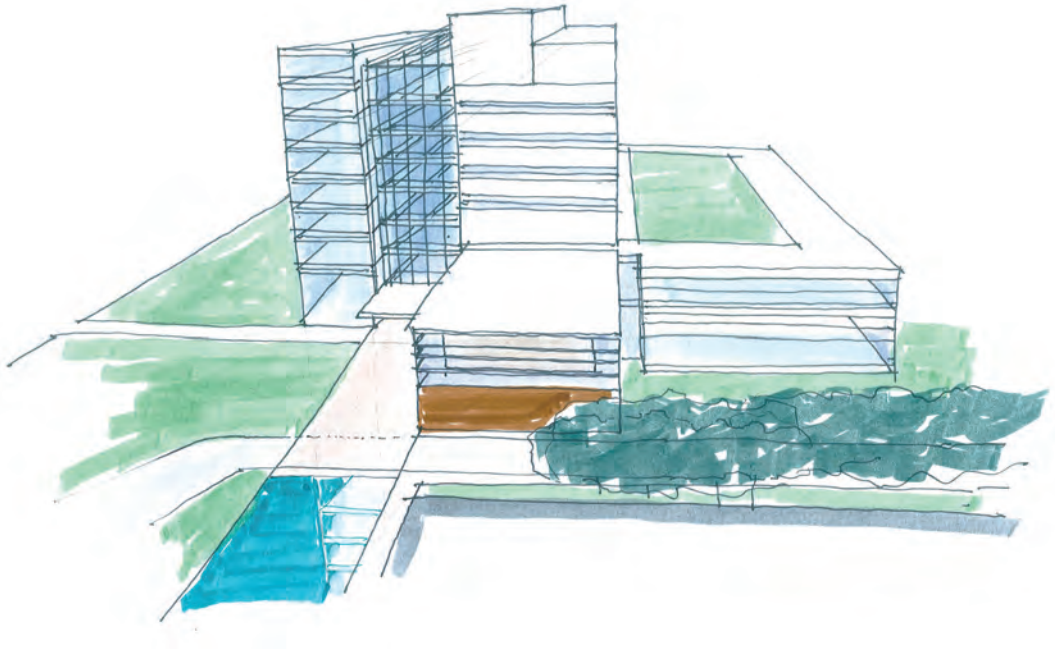


contents

defense distribution center

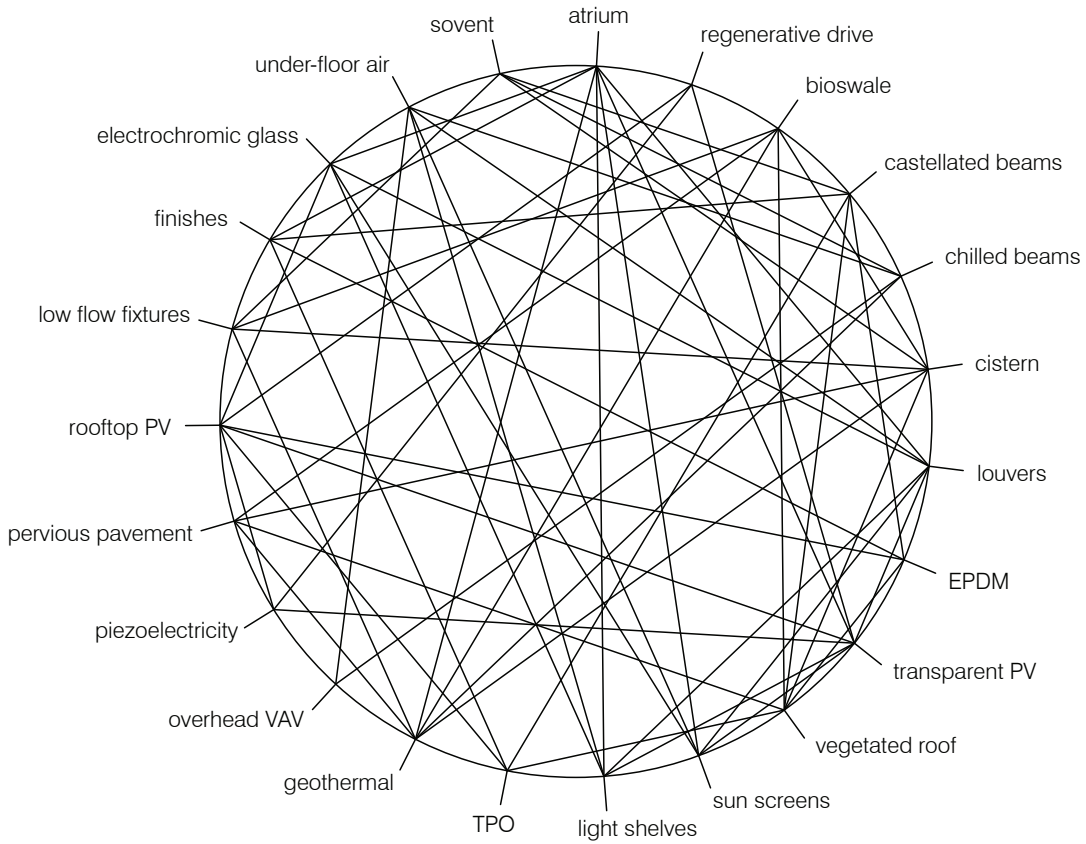
- Client: Department of Defense
- Program Type: Office Building
- Location: New Cumberland, PA
- Size: 9 Stories; 265,000 ft^2
- Budget: $102,800,000
- LEED v2.2 Gold

This facility will serve as the Defense Distribution Center's world-wide headquarters. The program includes an auditorium, a data center, and numerous office spaces. The upper floors of the building are primarily composed of four parts: a building core, two large open office spaces, and an atrium spanning all nine stories. The building will incorporate a number of sustainable, integrated systems to achieve LEED Gold certification.



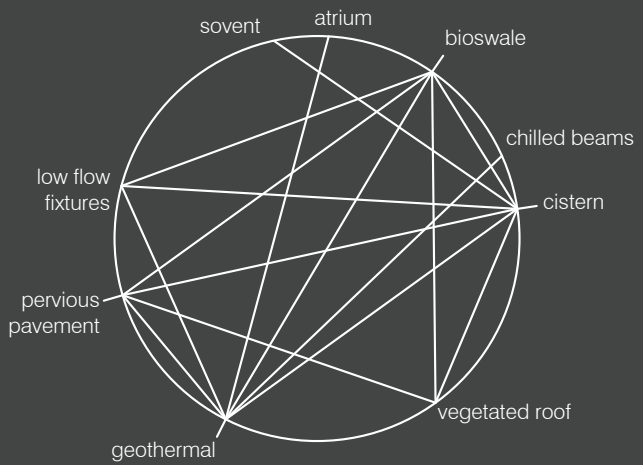
integrated design

Sustainable systems cannot be designed autonomously; they must be considered as an integrated whole. In this wheel diagram, one system may be connected to another inside and outside of its category. While an under floor air system may complement a chilled beam system by facilitating air flow, it concomitantly works with electrochromic glass to increase individual thermal comfort and control. The former relationship is intuitively categorical while the latter expresses one that is less concrete, one in which two systems operating under entirely different principles find common ground under a singular purpose. Every section title page includes a variation of this wheel to illustrate this interconnectivity.


sovent
atrium
regenerative drive
under-floor air
bioswale
electrochromic glass
castellated beams
finishes
chilled beams
low flow fixtures
cistern
rooftop PV
louvers
pervious pavement
EPDM
piezoelectricity
transparent PV
overhead VAV
vegetated roof
geothermal
sun screens
TPO
light shelves

i. SITE

Engagement of the site is the first and perhaps most crucial consideration in green building design. Buildings affect ecosystems in a variety of ways; they should fluidly incorporate themselves with their surroundings. Buildings should preserve and respond to the natural conditions of the area as much as possible, limiting their impact on local ecosystems.



rain water collection cisterns
Chesapeake Bay Foundation,
Annapolis , MD

geothermal energy

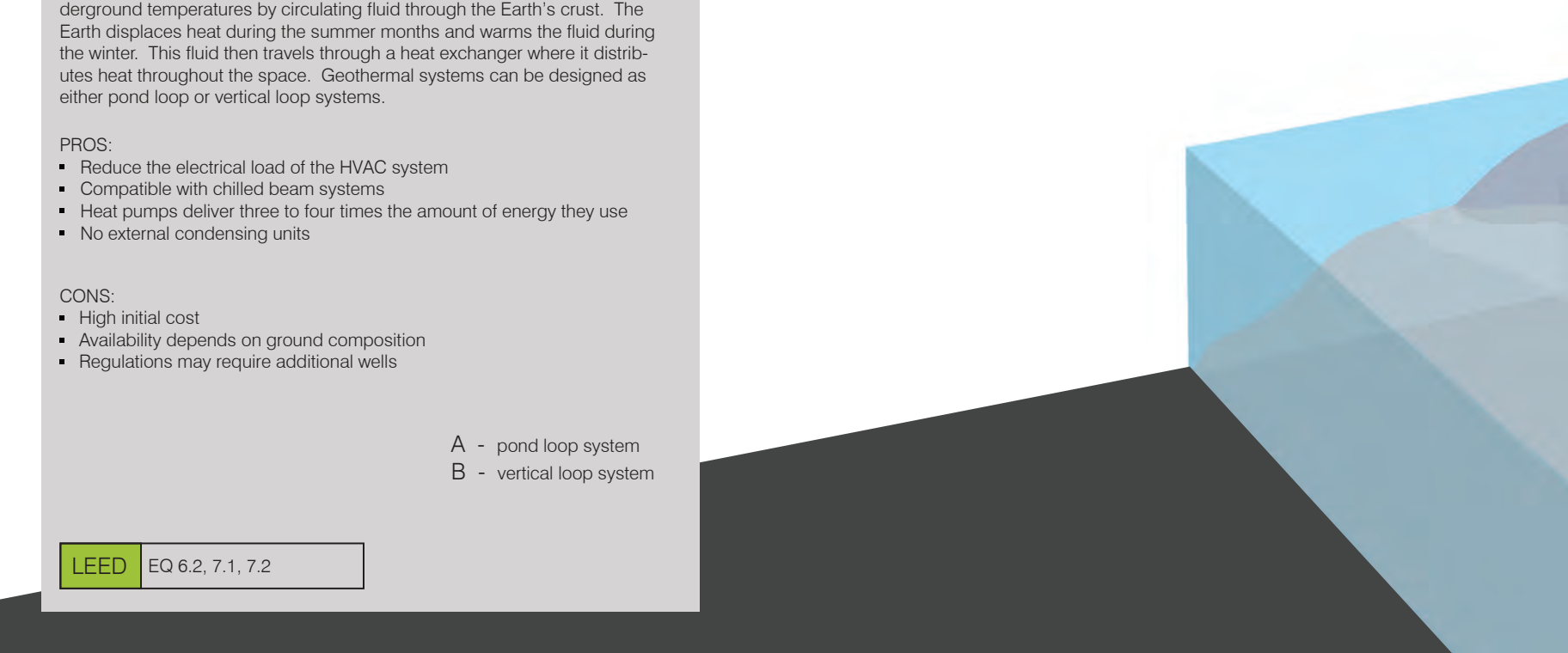
Throughout the year, geothermal systems take advantage of constant underground temperatures by circulating fluid through the Earth's crust. The Earth displaces heat during the summer months and warms the fluid during the winter. This fluid then travels through a heat exchanger where it distributes heat throughout the space. Geothermal systems can be designed as either pond loop or vertical loop systems.

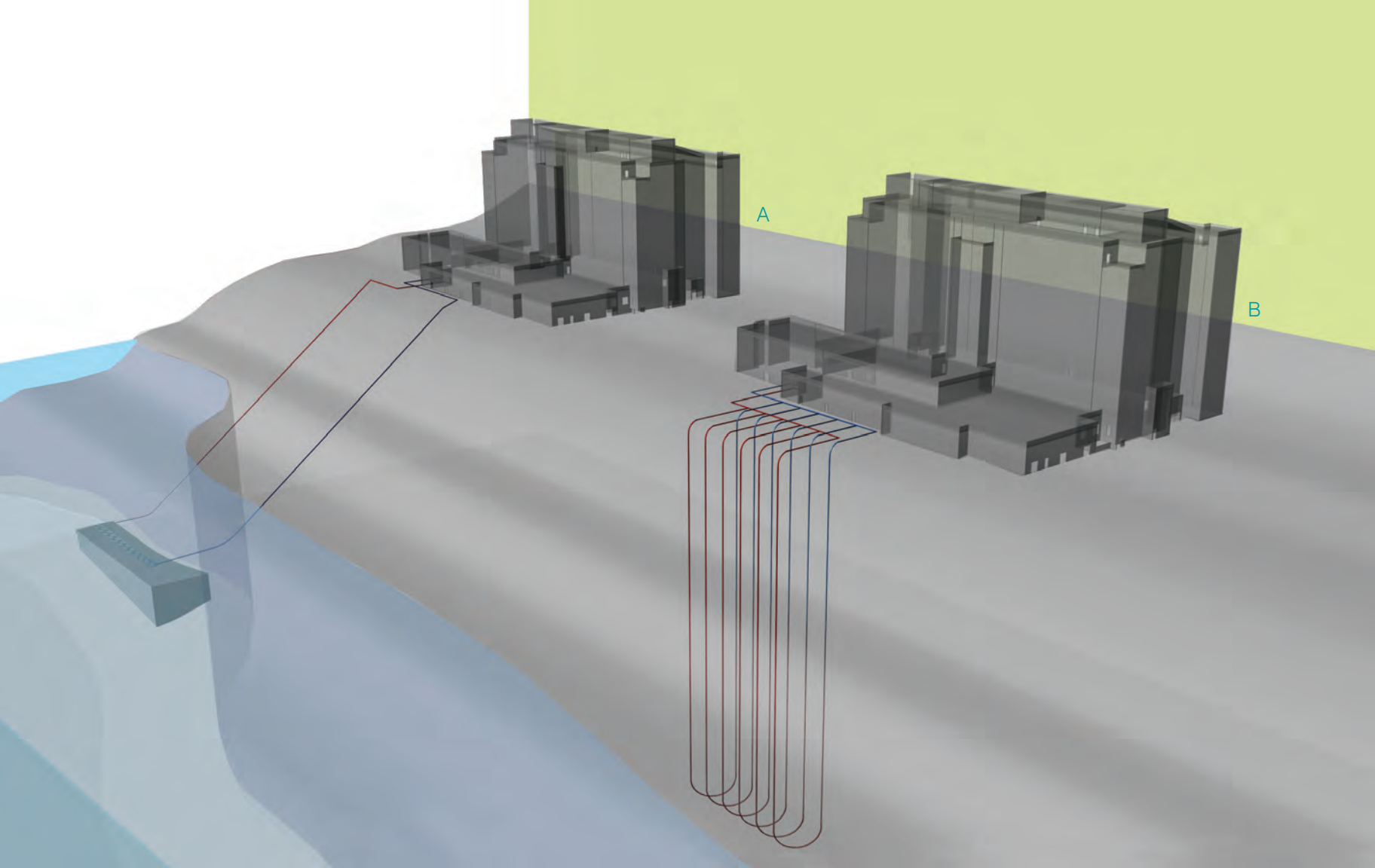
PROS:
- Reduce the electrical load of the HVAC system
- Compatible with chilled beam systems
- Heat pumps deliver three to four times the amount of energy they use
- No external condensing units

CONS:
- High initial cost
- Availability depends on ground composition
- Regulations may require additional wells

A - pond loop system
B - vertical loop system

LEED	EQ 6.2, 7.1, 7.2




A
B

bioswale

Bioswales are landscape elements designed to manage and clean water on-site. An example of low impact development (LID), bioswales remove silt and pollution from surface runoff water. They consist of a gently sloped (less than a 6% grade) swaled drainage course filled with vegetation, compost and/or rip-rap. The water's flow path, along with the wide and shallow ditch, is designed to maximize the time water spends in the swale, which aids the trapping of pollutants and silt.

A common application is around parking lots: the paving collects automotive pollution, which is then flushed by the rain. Bioswales manage and treat this flush of water before it reaches the municipal water system.

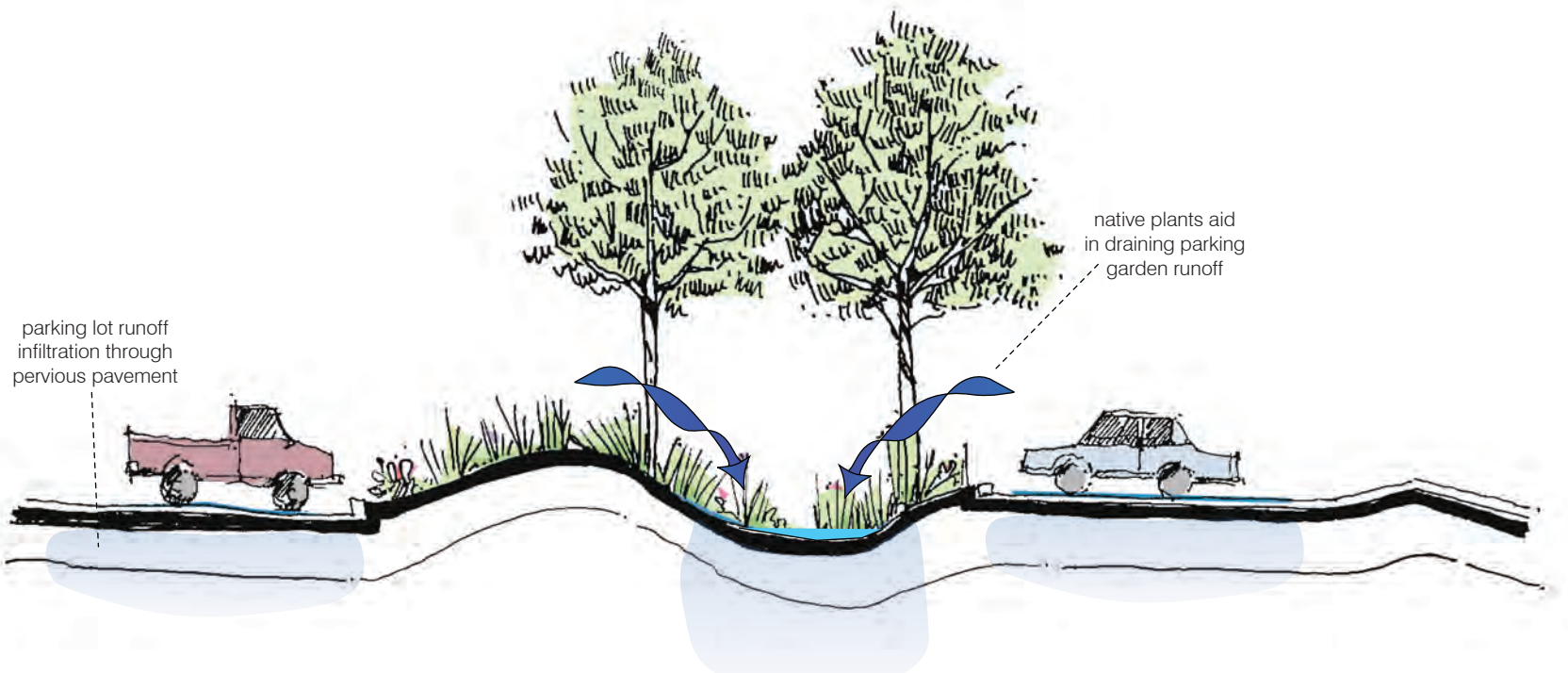
PROS:

- Increased infiltration, decreased storm water runoff quantity and the probability of flooding
- Improved water quality
- Improved aesthetics of the project site
- Lower lifetime costs
- Maintenance requires little more than normal landscaping

CONS:

- Drainage areas require frequent monitoring to be kept clear to function properly
- Vegetation health is critical- native plants should be selected and maintained accordingly

LEED	WE 1.1, 1.2 SS 6.1, 6.2


native plants aid
in draining parking
garden runoff
parking lot runoff
infiltration through
pervious pavement

12th Avenue Green Street.

Kevin Robert Perry. Portland, OR.

The 12th Avenue Green Street project utilizes a pedestrian zone to manage street runoff. The storm water planters are integrated into the urban condition of the street, creating an elegant and functional landscape.

native plants

Vegetative cover is a key component to a sustainable site. Without vegetation, a site loses its natural capacity for storm water management, filtration and groundwater recharge. Removing vegetation also increases the likelihood of erosion, which contributes to increased sedimentation.

Utilizing native plants as the vegetative cover creates beautiful landscapes with the potential to protect, restore and enhance ecosystem services. Native plants have adopted to the geography, hydrology, and climate of their particular region. Native plants occur in communities, evolving with other plants.

It is more important to use native plants that are nursery grown, legally harvested, or salvaged for reuse from on or off site. Salvaging native plants and creating 'no disturbance zones' around mature trees is another way to enhance natural ecosystems and reduce purchasing cost.

PROS:

- Improved habitat and increased biodiversity
- Reduce pesticide use and maintenance cost
- Needs little or no irrigation once established
- Enhance soil health
- Improve water quality and reduce storm water damage
- Strong visual interest throughout the year

CONS:

- Not as much variety
- Takes more planning to salvage appropriate plants on-site

LEED	SS 5.1

kalmia latifolia

acer rubrum
acer saccharum
betula nigra
liriodendron tulipifera




carpinus caroliniana
carya ovata
amelanchier canadens
chamaecyparis thyoid




cercis canadensis
fagus grandifolia
juniperus virginiana



cornus racemosa
rosa palustris
aesculus parviflora
hydrangea quercifol

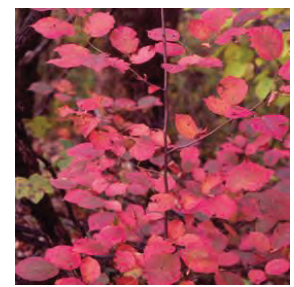



aronia melanocarpa
rosa virginiana
cornus serica
ilex glabra




fothergilla gardenii
itea virginica
corylus americana





shrubs




aster divaricatus
carex pennsylvanica
lobelia siphilitica
rudbeckia fulgida



eupatorium maculatum
cephalanthus occidentalis
andropogon scoparius




juncus canadensis
aster laevis
elymus hystrix
monarda fistulosa

grasses and perennials

rainwater cisterns

Rainwater cisterns are used as a catchment system for gray water systems. The cisterns are coupled with a system that catches the rain water off the roof of a building and then funneled to the tanks. The gray water can be used for irrigation, toilets, or washing clothes, but requires specific treatment to remove contaminants.

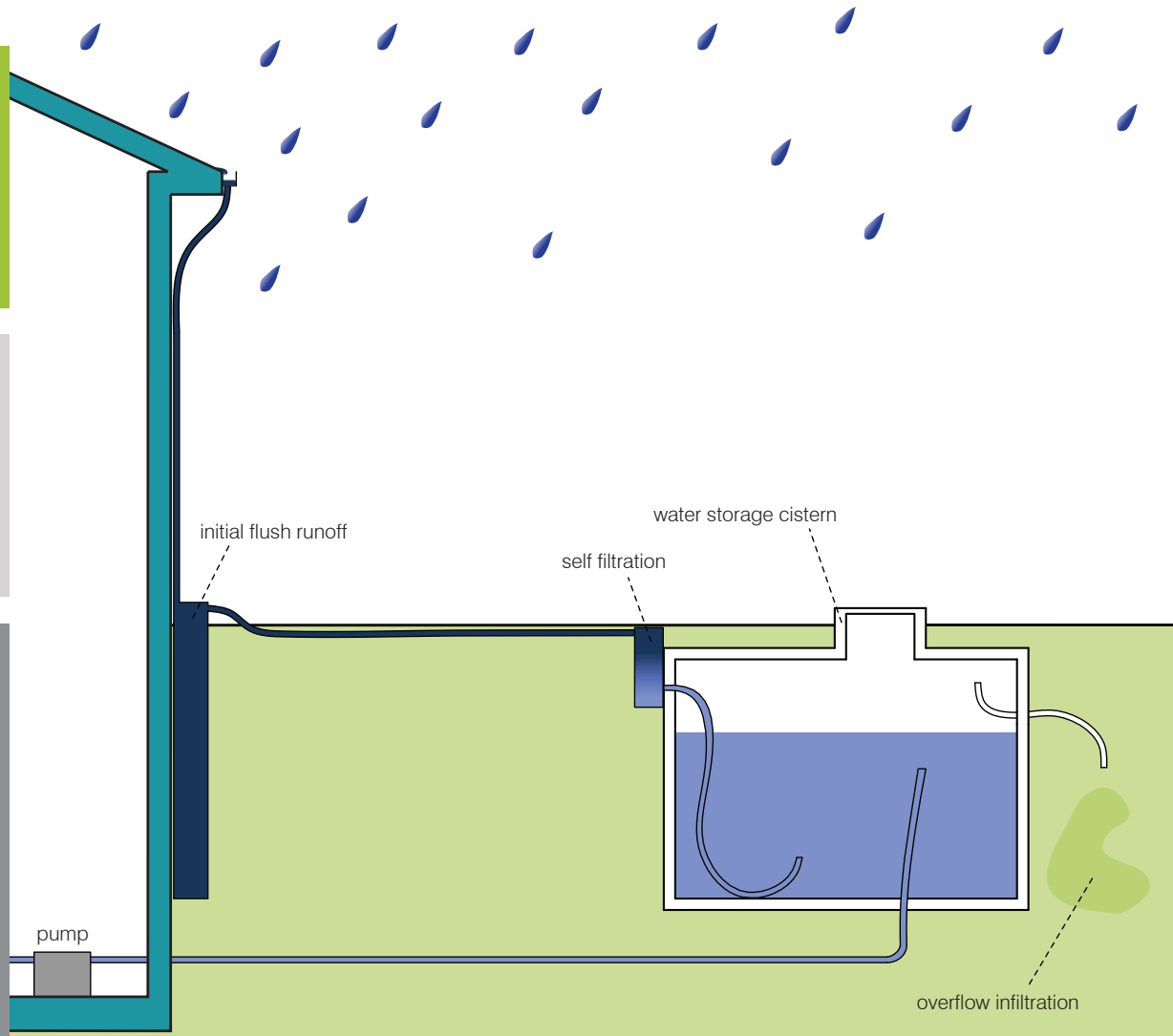
PROS:

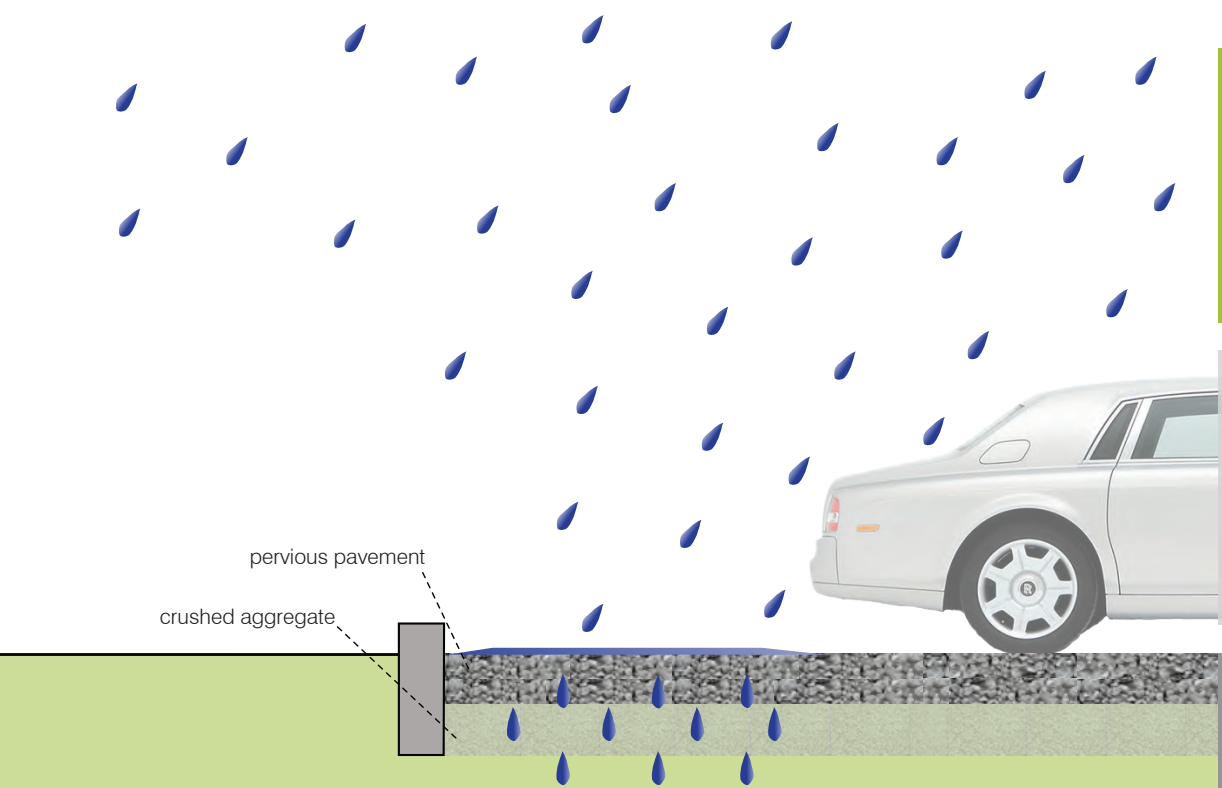
- Reduces the amount of city water needed
- Reduces the amount of runoff created by impermeable surfaces
- Avoids wasting potable water for irrigation
- Integrate system with fire protection

CONS:

- Need to be kept cool and out of direct sunlight
- Filtration systems are expensive

LEED WE 1.1, 1.2





pervious pavement

Pervious pavement allows storm water to seep into the ground and reduce runoff. Fine particulates are left out of the mixture to allow for water permeability. This paving technique encourages more efficient land use by eliminating the need for retention ponds, swales, and other storm water management devices..

PROS:

- Reduce storm water runoff
- Microorganisms located on the larger surface area of the pavement biodegrade oil from cars
- Recharge groundwater supply

CONS:

- Reduced strength
- Drainage issues in areas with high concentration of clay soil
- Working time of pervious concrete is reduced

LEED	SS 6.1, 6.2, 7.1 WE 1.1 MR 4.1, 4.2, 5.1, 5.2

ddc application

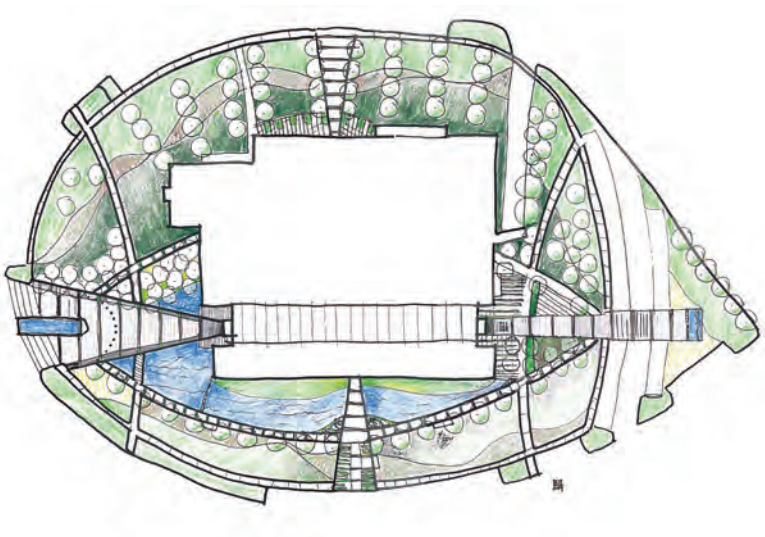
SITE

geothermal

The design team chose not to use geothermal cooling or heating because of the site's contaminated soil and ground water. Furthermore, karst formations below the soil could compromise the building's structural stability.

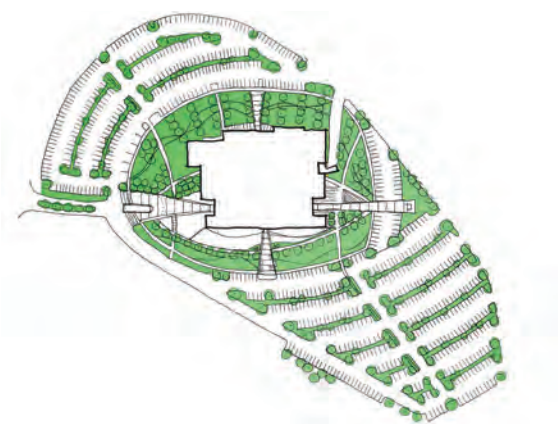
cisterns

Rainwater cisterns will collect water as it permeates the green roof. They will be part of a strategy to recycle runoff for toilets and mechanical functions.



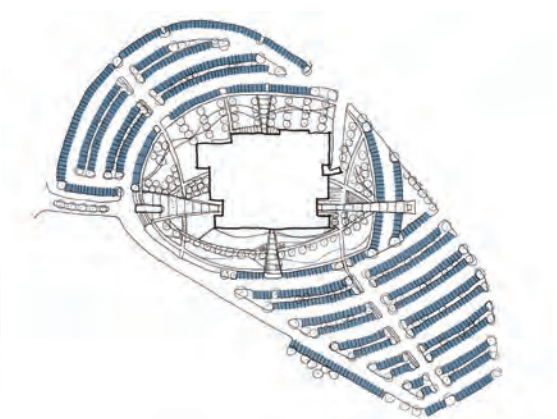
native plants

Native plants will be used extensively across the entire site of the DDC to minimize water runoff and eliminate the need for on-site irrigation.



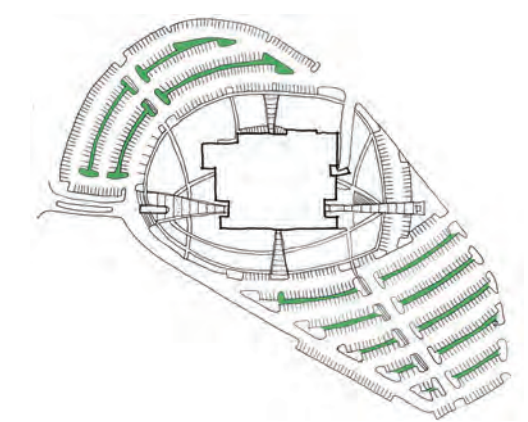
pervious pavement

Due to maintenance concerns and cost, pervious pavements will only be used within the parking stalls surrounding the DDC. Main thoroughfares will be graded to allow runoff to flow into these pervious areas.



bioswale

To reduce the need for retention ponds, bioswales will be integrated into the parking islands surrounding the DDC. They will control runoff from the islands and excess water not capable of infiltrating the pervious pavement.



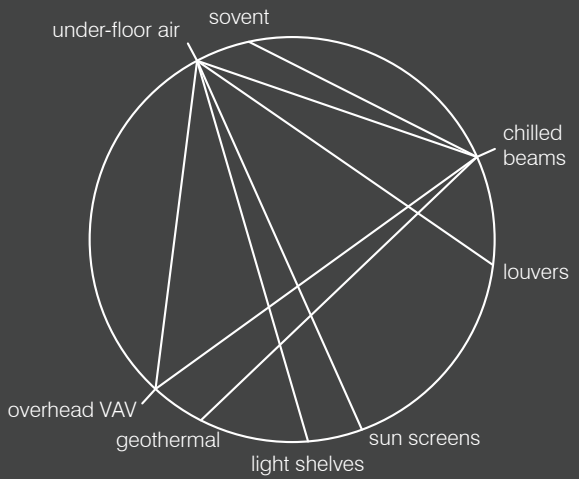
Queens Botanical Garden.

BKSK Architects. Queens, NY.

Queen's Botanical Garden mimics the hydrology of its site through its comprehensive water management strategy. The system collects, stores, and recycles gray water and rainwater through a poetic integration of architectonic forms.

ii. VENTILATION

Selecting the most appropriate method by which to condition and move air is a fundamental factor in ensuring high occupant comfort levels and optimal energy efficiency. Alternative and complimentary approaches to ventilation can significantly reduce energy consumption and facilitate a more ergonomic air flow throughout the building.



fans servicing an atrium
300 New Jersey Avenue
Washington DC

overhead vav

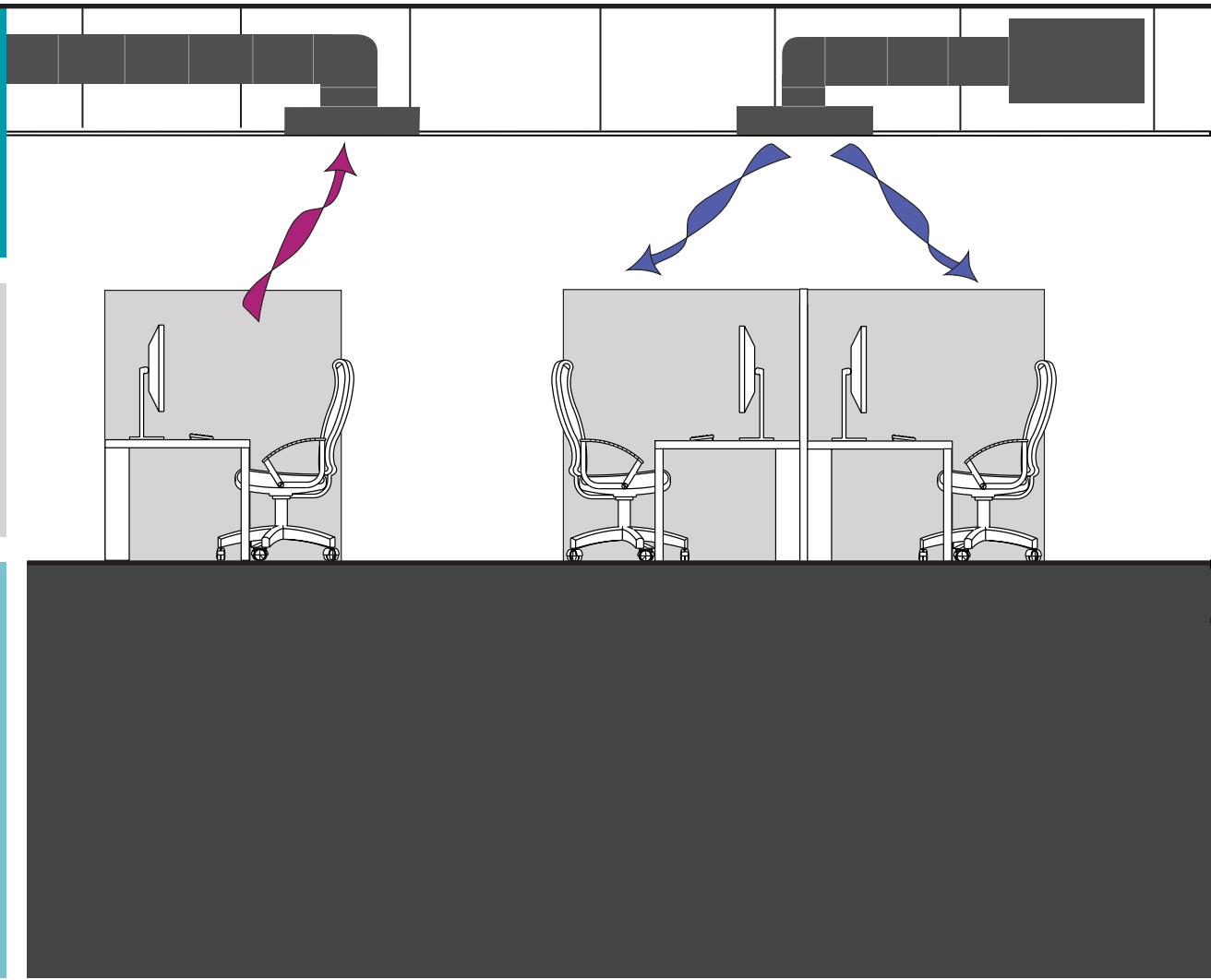
Conditioned air from the air handling unit enters the space through an array of diffusers positioned evenly throughout the ceiling. The conditioned air mixes with the room air to maintain the desired temperature.

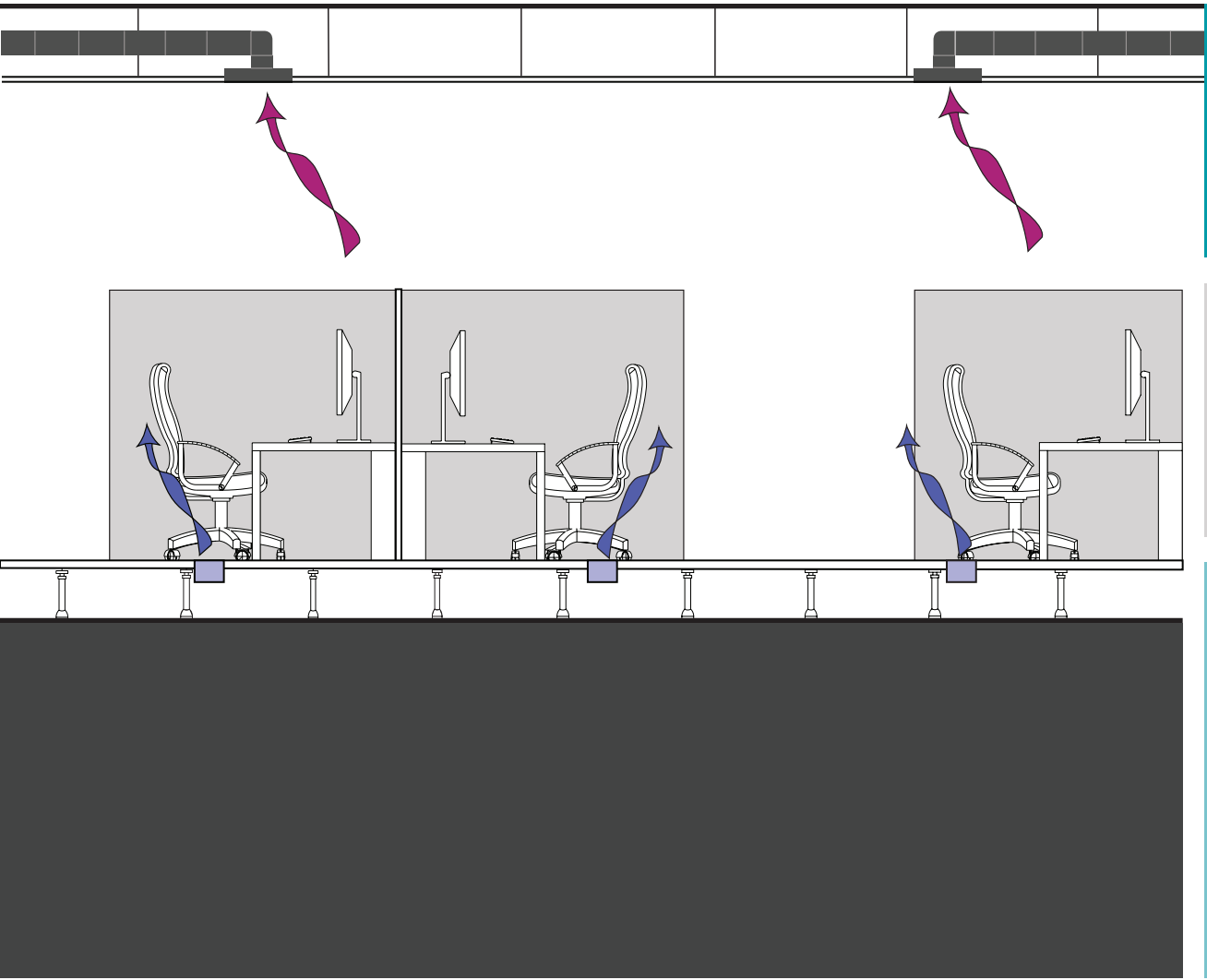
PROS:

- Provides uniform temperature within space
- Proven and well understood system
- Low installation cost

CONS:

- Poor ventilation efficiency
- Difficult maintenance
- Minimal controllability
- Complexity may increase cost





underfloor air

Conditioned air from the air handling unit is channeled into the under-floor plenum where it flows freely to a large number of supply outlets. The natural stratification of air efficiently removes heat loads and contaminants from the space via a return duct in the ceiling. Individuals within the space can manually adjust the volume of air entering their immediate area.

PROS:

- Improved thermal comfort through personal controllability
- Improved indoor air quality through continuous stratification of air
- Reduced energy use through controlled thermal stratification

CONS:

- Higher initial cost
- Maintenance problems; spillage and dirt can clog plenum
- Limited occupant knowledge of system and its operation

LEED	EA 1 EQ 6.2

chilled beams

Chilled water pipes located in the ceiling cool rising hot air and return it to occupant level. Active chilled beams are coupled with a fresh air intake system to provide the building with fresh, dry air. Sensors keep the temperature of the water in the beams above the dew point in the room, preventing condensation.

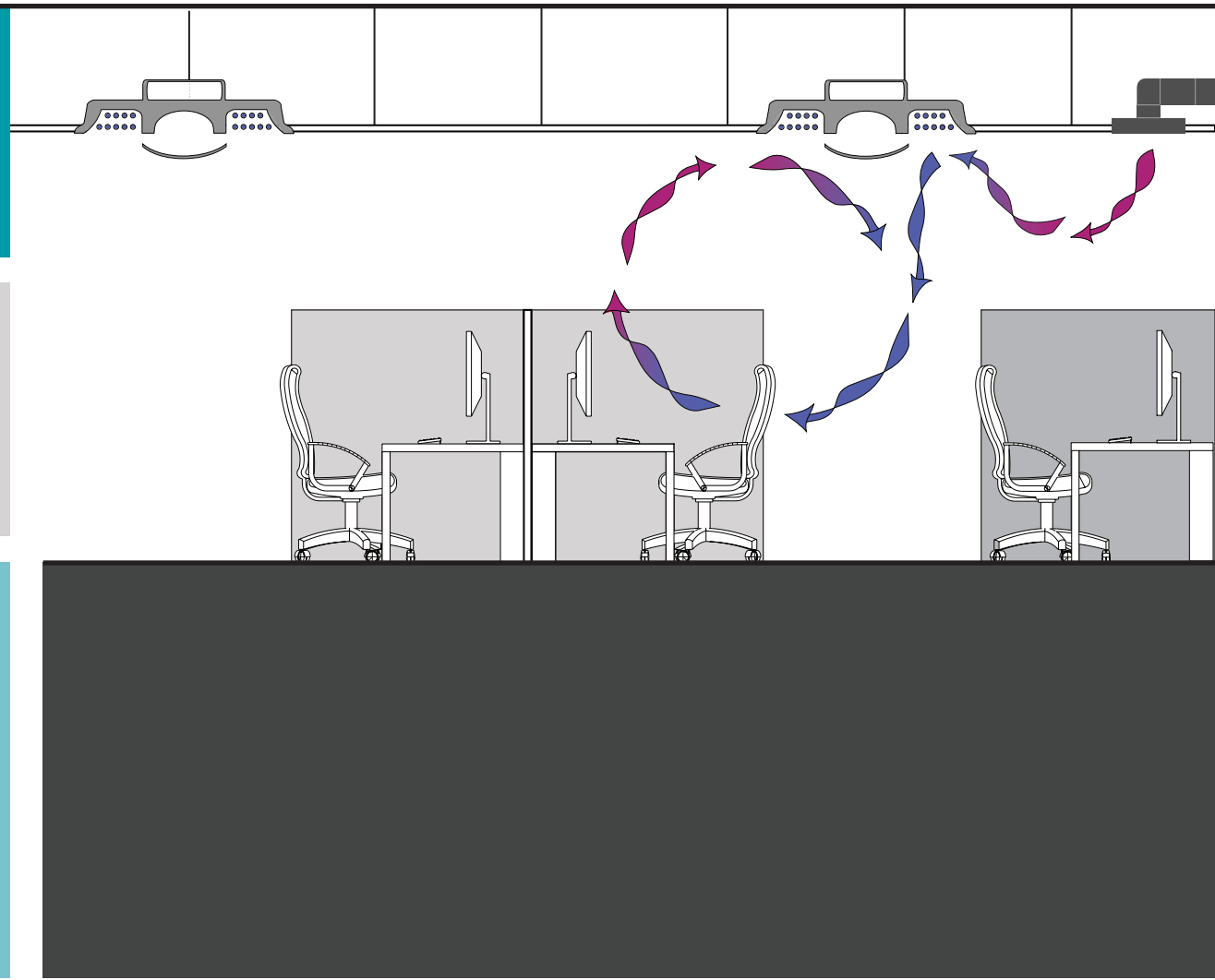
PROS:

- Fire suppression, communication, lighting, and electrical can be bundled within the beam
- Can use geothermal cooling or a high efficiency chiller because beams are effective even when water is as temperate as 60° F.
- Low maintenance, no moving parts, high life expectancy
- Compactness reduces required floor to ceiling height

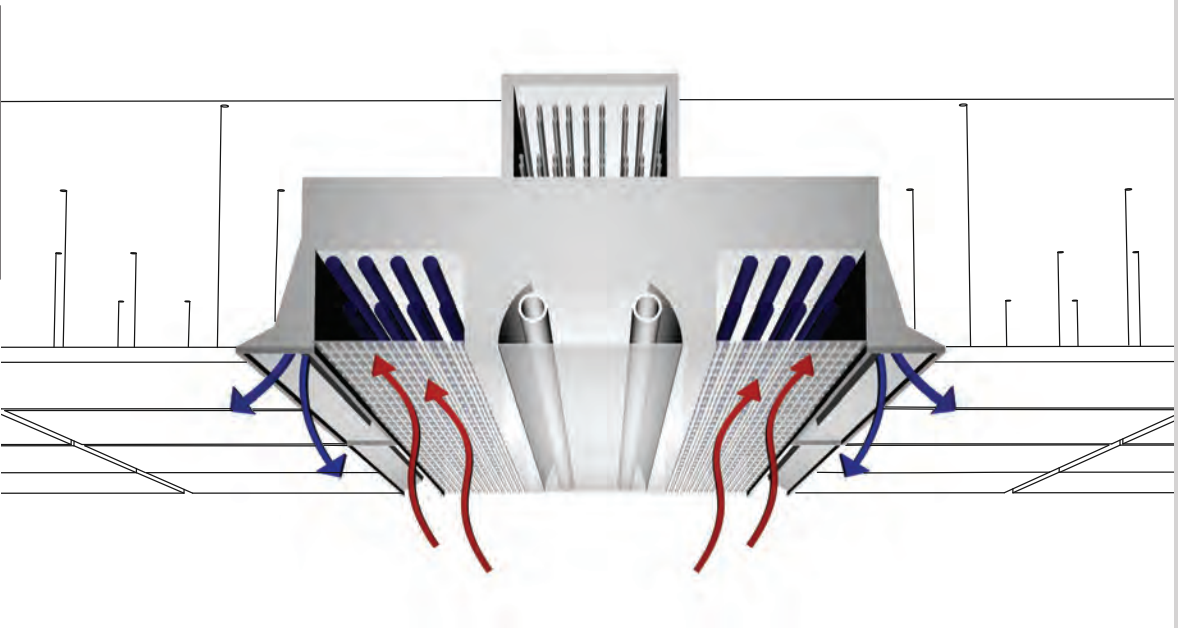
CONS:

- Must be used in conjunction a fresh air intake system to control humidity
- Many contractors still unfamiliar with system

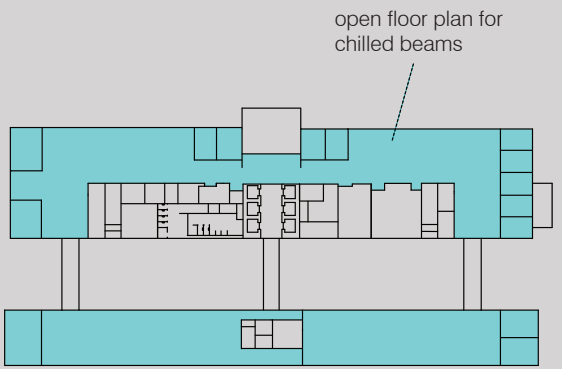
LEED	EA 1,4 EQ 7.1

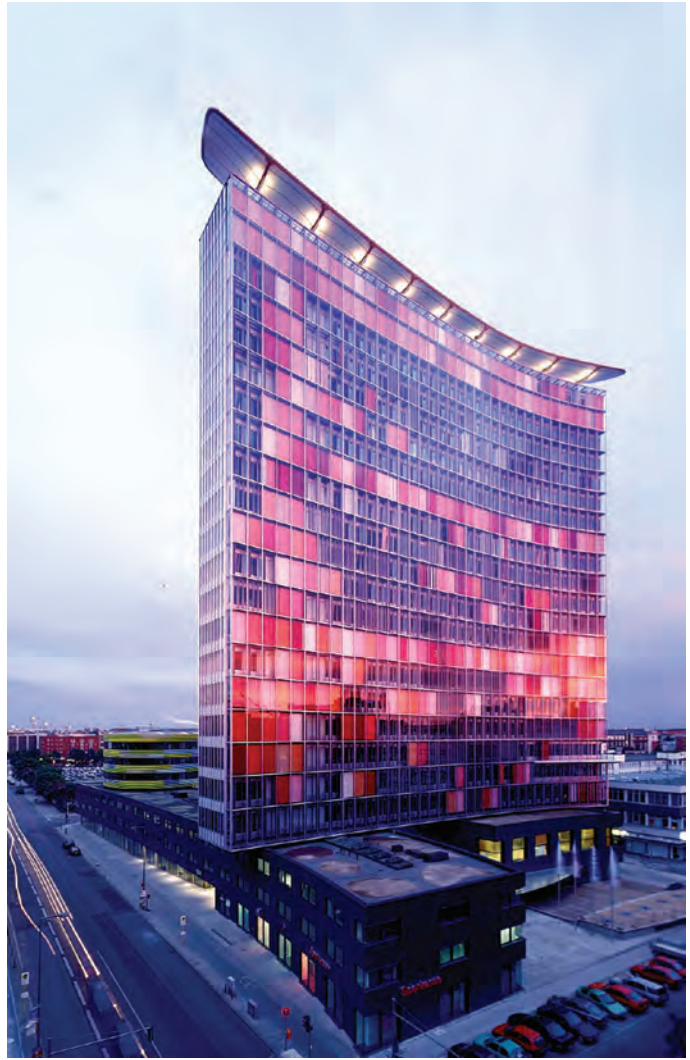


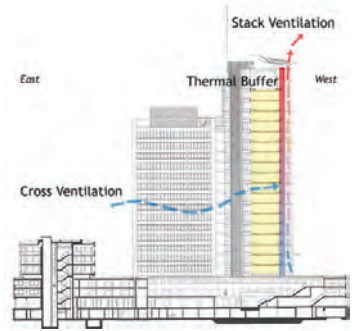
ddc application
VENTILATION



The DDC will use active chilled beams because much of the floor plan consists of open work spaces that promote unobstructed air flow. This system presents an optimum scenario for this fixed in place, highly cost effective ventilation system. Chilled beam systems will not be used in the conference rooms, auditoriums, and smaller enclosed spaces.







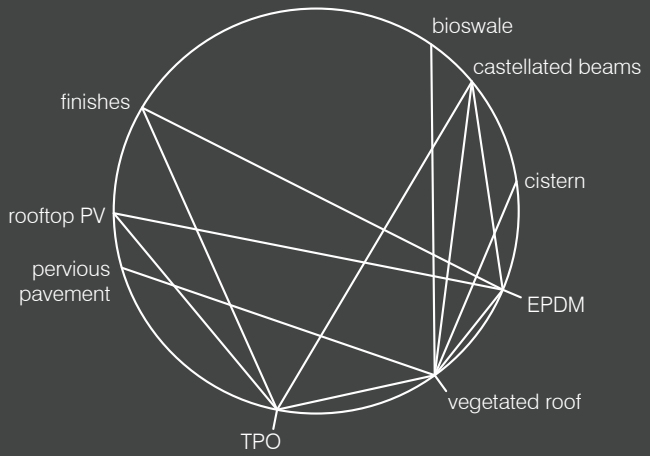
GSW Building.

Sauerbruch Hutton Architects. Berlin, Germany.

The GSW Building achieves optimal natural daylighting and ventilation through its thin floor plate. Its animated western facade features colorful, adjustable louvers that can appropriately respond to the varying conditions of the site. This double facade also enhances the building's natural ventilation strategy through use of the stack effect and the Venturi effect.

iii. ROOFING SYSTEMS

In sustainable architecture, roofing systems require considerable attention because of their effect on other building systems. Appropriate roof systems can extend the life of a roof, utilize recycled materials, reduce solar heat gain, reverse the urban heat island effect, and control rainwater runoff. These benefits can have a positive impact on the design of mechanical systems, plumbing, and storm water control.



glass atrium roof
Smithsonian Institution
Foster + Partners

layered roofing systems

built-up

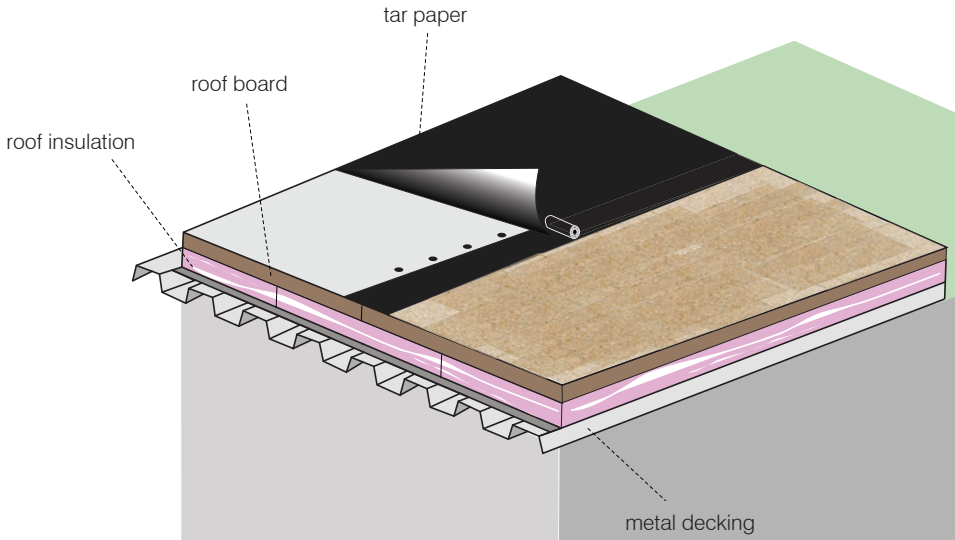
Built-up roofs are multiple ply waterproof systems comprised of layers of bitumens alternating with plies of reinforcing felt. Redundant layers provide resistance to weathering and water damage.

thermoplastic olefin

Thermoplastic Olefin is a single ply “cool roofing system” that reduces the amount of solar gain by reflecting the sun’s rays back into the atmosphere.

ethylene propylene diene monomer

Ethylene Propylene Diene Monomer is a single ply roof system developed as both a liquid format and a sheet material that reflects solar rays back into the atmosphere.



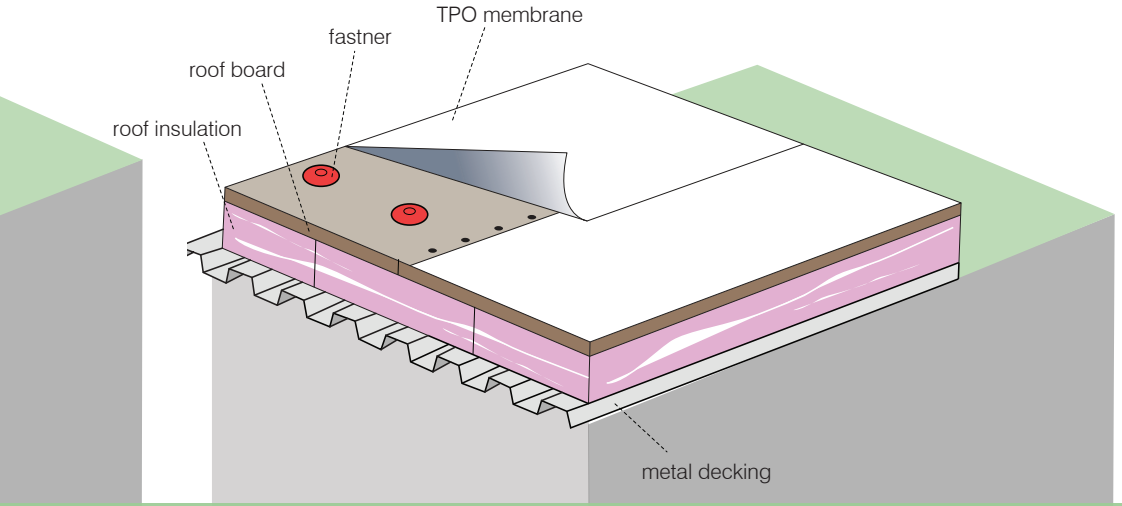
BUILT-UP ROOFING

PROS:

- Low initial cost
- Good weather resistance
- Thirty year lifespan if properly maintained
- Abuse tolerant

CONS:

- Messy to install
- Not intended for high rain or snow loads
- Poor fire resistance
- Leaks difficult to locate
- Require a new top layer every ten years



TPO ROOFING

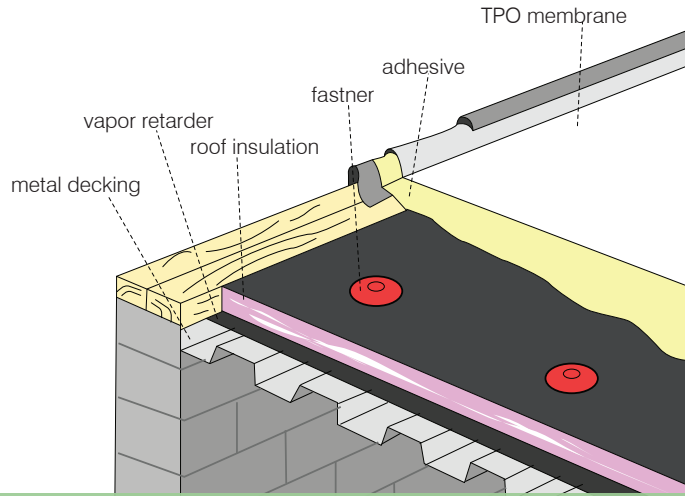
PROS:

- Reduce heat island effect
- Highly tear resistant
- Low initial cost
- Requires less labor for instillation
- Reduce cooling load for building

CONS:

- A newer product with little long term performance data
- No evidence white membranes are beneficial in cold states

LEED	SS 7.2 MR 4.1, 4.2, 5.1, 5.2



EPDM ROOFING

PROS:

- Performs well in areas of high wind and hail loads
- Lighter than standard built-up roof
- Improve contractor efficiency with fewer seams

CONS:

- Lifespan of roof depends on craft of seams
- Not intended for high rain or snow loads

LEED	SS 7.2 MR 4.1, 4.2, 5.1, 5.2

vegetated roofing

Vegetated roofs utilize roof-top space to cultivate live plants, provide storm water control, thermal moderation, and roof protection for the building tenants. They reduce the urban heat island effect, while creating an aesthetically pleasing space for the surrounding built environment. The two types of vegetated roofing systems are extensive and intensive. Extensive vegetated roofs are shallower in depth (3"-6" of soil), and only support small, grassy growth, intensive vegetated roofs utilize more soil (6"-36") to support larger plant life, up to full-sized trees.

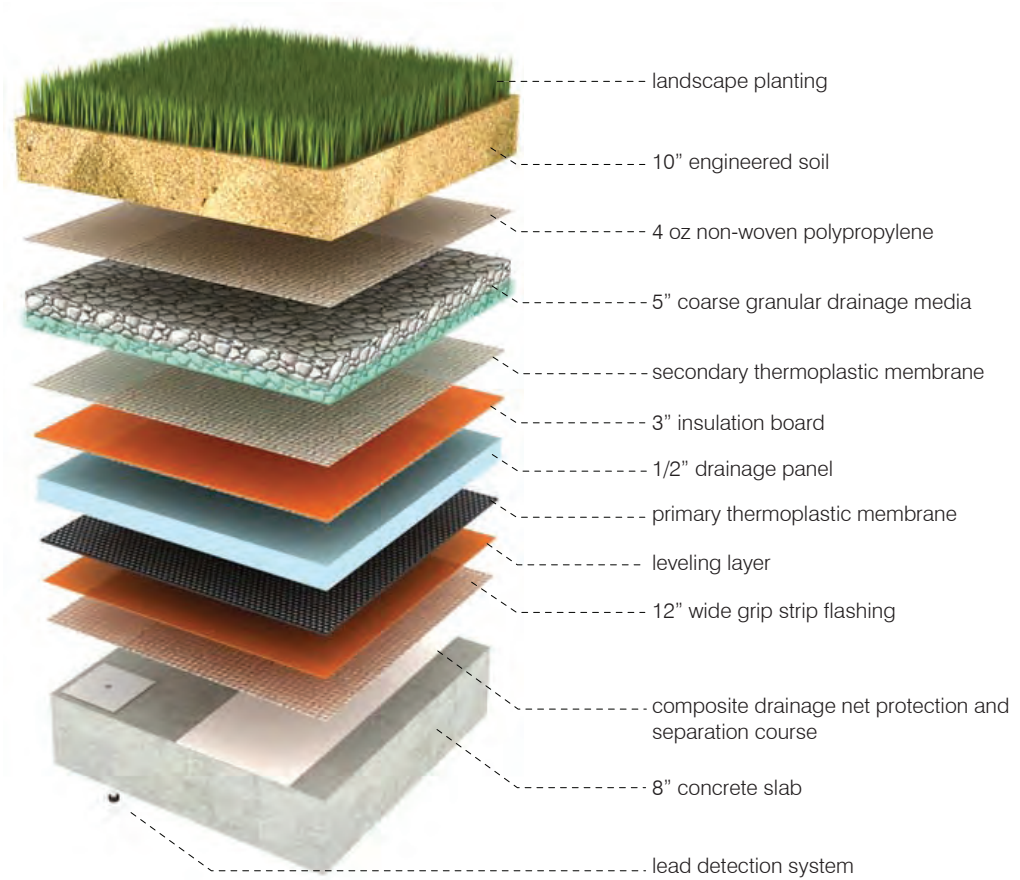
PROS:

- Stabilized roof temperatures
- Increase lifetime expectancy of roof to 40+ years
- Delayed and greatly reduced storm water runoff
- Addition of aesthetically pleasing environment to an otherwise ignored space

CONS:

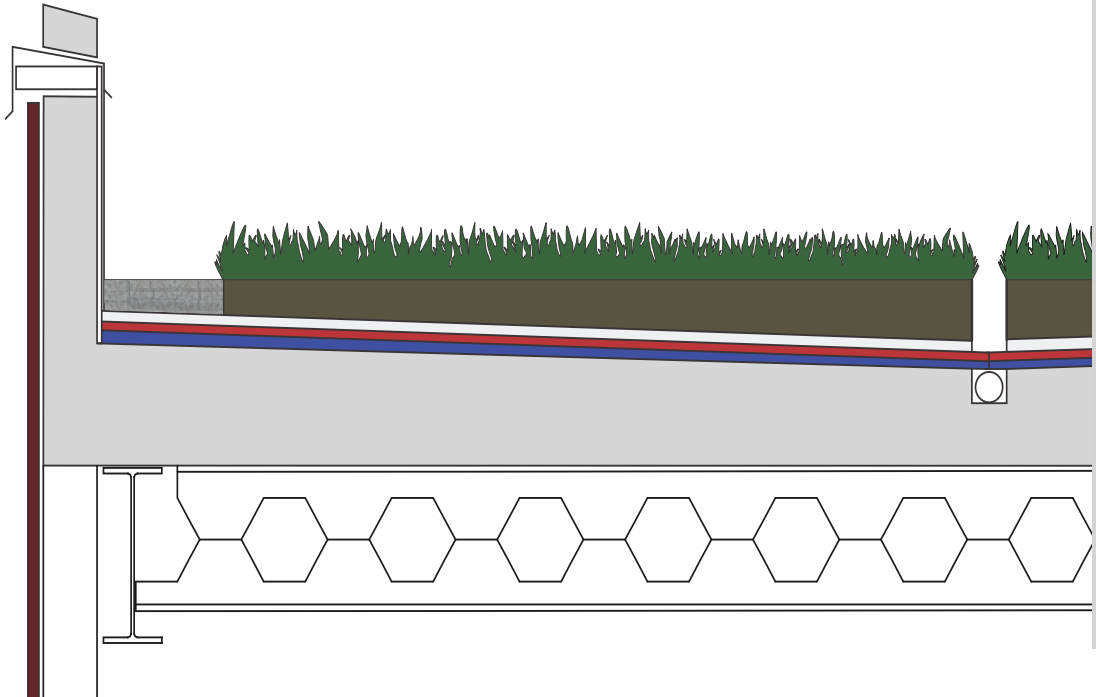
- Design and installation often require working with a third party consultant
- R-value ≈ 1 per inch, requiring conventional levels of insulation to be included in roof design
- Increased structural load may increase cost
  - -Extensive 12-30 psf
  - -Intensive 10-100+ psf

LEED	SS 5.1, 6.1, 7.2 WE 1.1, 1.2 EA 1 MR 4.1, 4.2, 5.1, 5.2

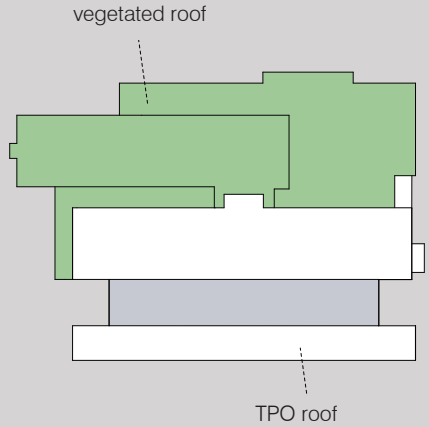


ddc application

ROOFING



Two different roofing systems will be employed. On the higher portion of roof, Dow's Cimarca roofing will be applied. Gray and white in color, it has an 85% installed solar reflectance, reducing heat gain and cooling loads in the building. The Dow GardenTop roofing will be installed on the lower portion of the roof and have a similar effect. The extensive vegetative roof uses material in 6" of soil to shade the area from both solar heat and UV damage. This extends the life of the Dow Tiempo or Dow Viento waterproofing membrane beneath the soil. The system also provides storm water control and an aesthetically pleasing space.



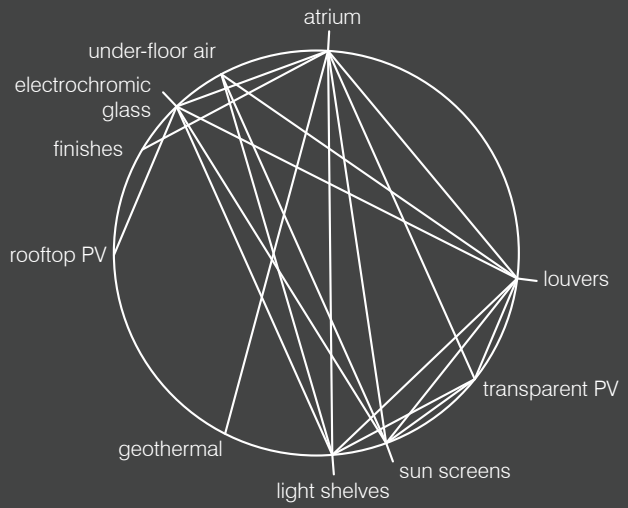
Howard Hughes Medical Institute.

Rafael Viñoly Architects. Ashburn, VA.

The Howard Hughes Medical Institute seamlessly integrates itself with the surrounding landscape through three descending planted terraces. The building's horizontal forms follow the gentle slope of the site, creating considerable vegitated roof space.

iv. LIGHT

Natural light is a crucial and obvious consideration for sustainable building design. High quality natural light generally affords healthier, happier and more productive occupants. Appropriate natural light can also reduce lighting and energy costs. Designers can use natural light in seemingly infinite variety of sustainable strategies, but these strategies should attempt to be contextually responsive, purposeful, and compelling.



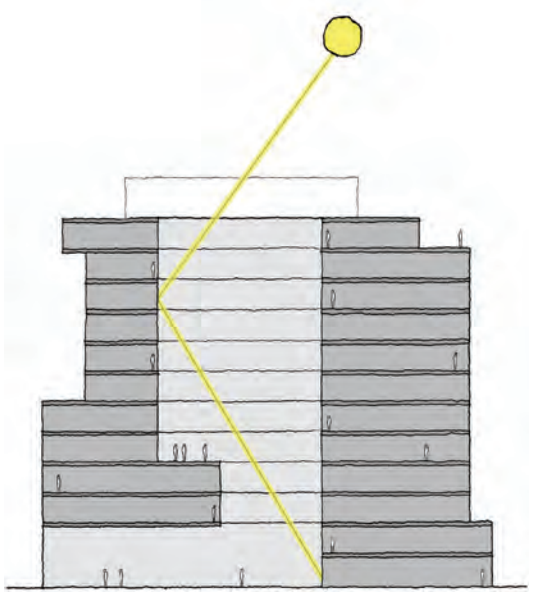
Sun shading canopy
200 New Jersey Avenue
Washington D.C.

general strategies

lighting

Although there are a many of daylighting strategies that can be used for sustainable building practice, light shelves and louvers are some of the most common. They can be very effective in addressing glare problems, minimizing solar gain and distrubuting natural light. Louvers and light shelves come in a wide variety of prefabricated options as well. Metal sun screens are also effective building strategies for addressing similar natural light issues and can be a spatially flexible aesthetic tool. Atria are another effective means of distributing natural light. They can facilitate the lighting of spaces deep in the interior of buildings and also act as a social center through spatial connection.

LEED	EQ 6.1, 6.2, 7.1, 7.2 8.1, 8.2

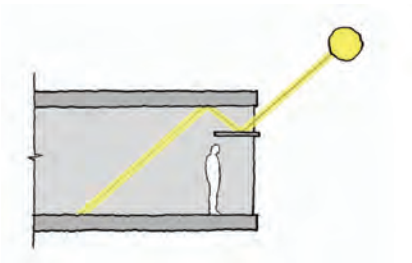


Atrium

PROS:
- interior natural light
- social unifier

CONS:
- less square footage
- ventilation and heating challenges

Atria can serve as a fantastic spatial design strategy. They can volumetrically unify the interior spaces of a building and promote social interaction. They can also serves as mediums for light, -natural ventilation and thermal strategies.

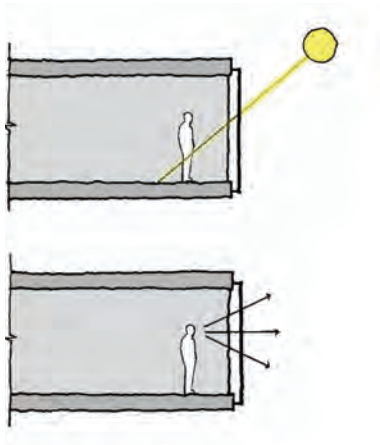


Light Shelves

PROS:
- uniform natural light
- easy prefabrication

CONS:
- requires cleaning
- potential solar gain

Light shelves can effectively distribute natural light into an interior space. They should be above eye level and low enough to distribute light. Tinted glazing can reduce their benefit, and regular cleaning is an absolute necessity for effectiveness

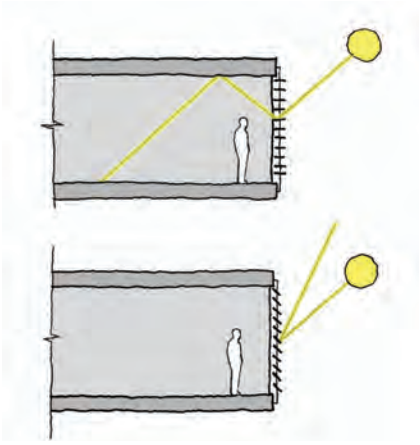


Sun Screen

PROS:
- reducing heat gain, glare and energy costs
- mantains exterior view
- flexible aesthetic tool

CONS:
- cost and maintenance

Metal screens can modulate solar loads, but appear transparent from the interior. Perforated metal, for instance, will block a controlled amount of light proportional to the density of perforations, while permitting views to the exterior.



Louvers

PROS:
- reducing heat gain, glare and energy costs
- can respond to a variety of conditions

CONS:
- cost and maintenance

Louvers have a myriad of shapes, sizes and materials. Louver's orientation, spacing and form affect their effectiveness and should respond to climatic and contextual concerns. Operable louvers can most effectively respond daily variety and seasonal conditions.

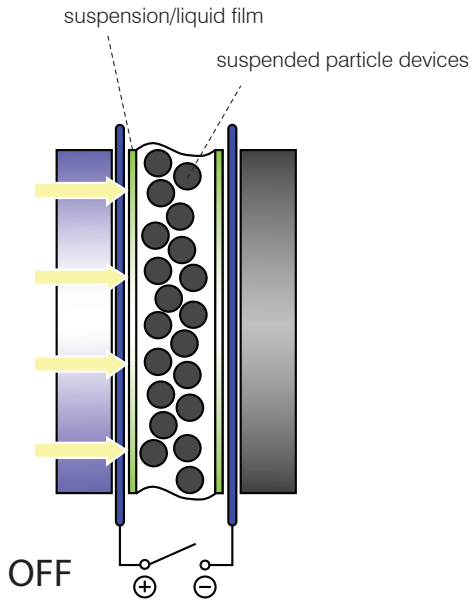
electrochromic glass

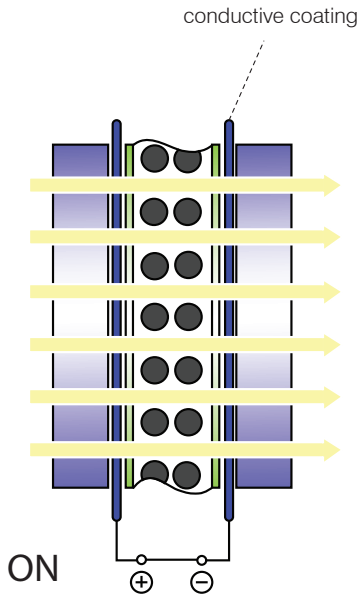
These “smart” windows have the ability to alter their transmittance of visible and infrared light. These systems can be controlled via photovoltaic sensors, electronic thermostats, or a manual switch. The windows can be programmed to respond to certain environmental conditions based on weather, solar incidence, seasonal variability, and occupancy demands.

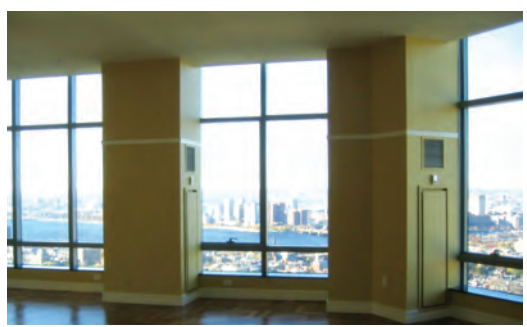
PROS:
- Can block 5-80% of light
- Window transparency can respond to both exterior conditions and occupant preferences

CONS:
- High cost of emerging technology
- Unknown long-term dependability and life expectancy
- Limited maximum dimensions

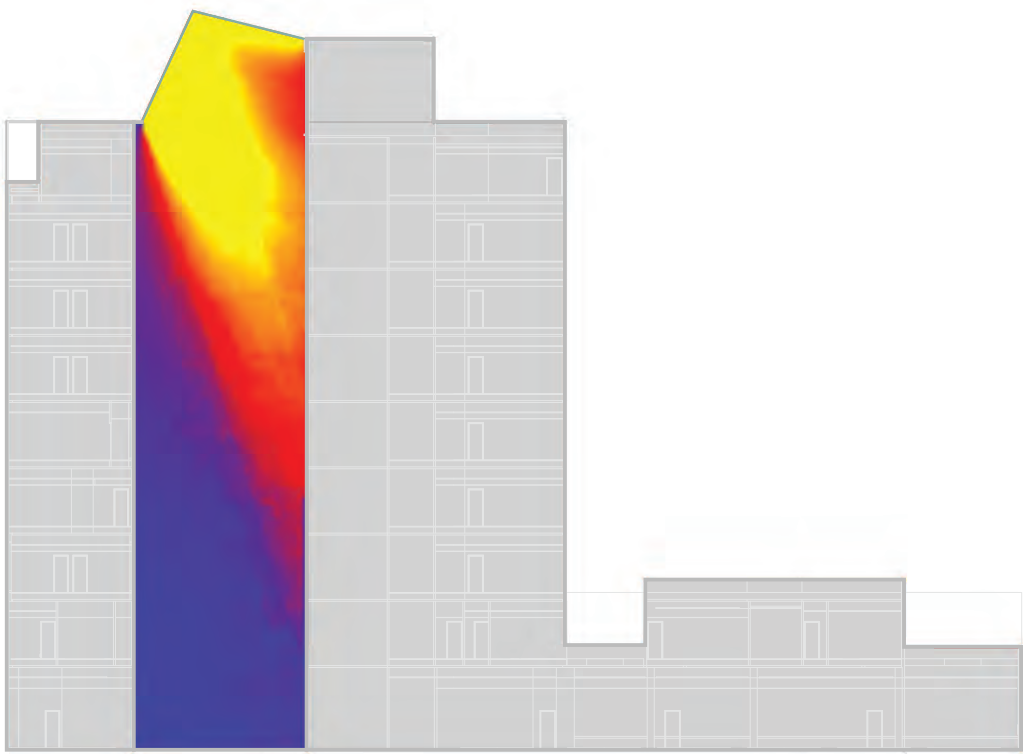
LEED	EQ 6.1, 6.2, 7.1, 7.2 ID 1.1







ddc application
LIGHT

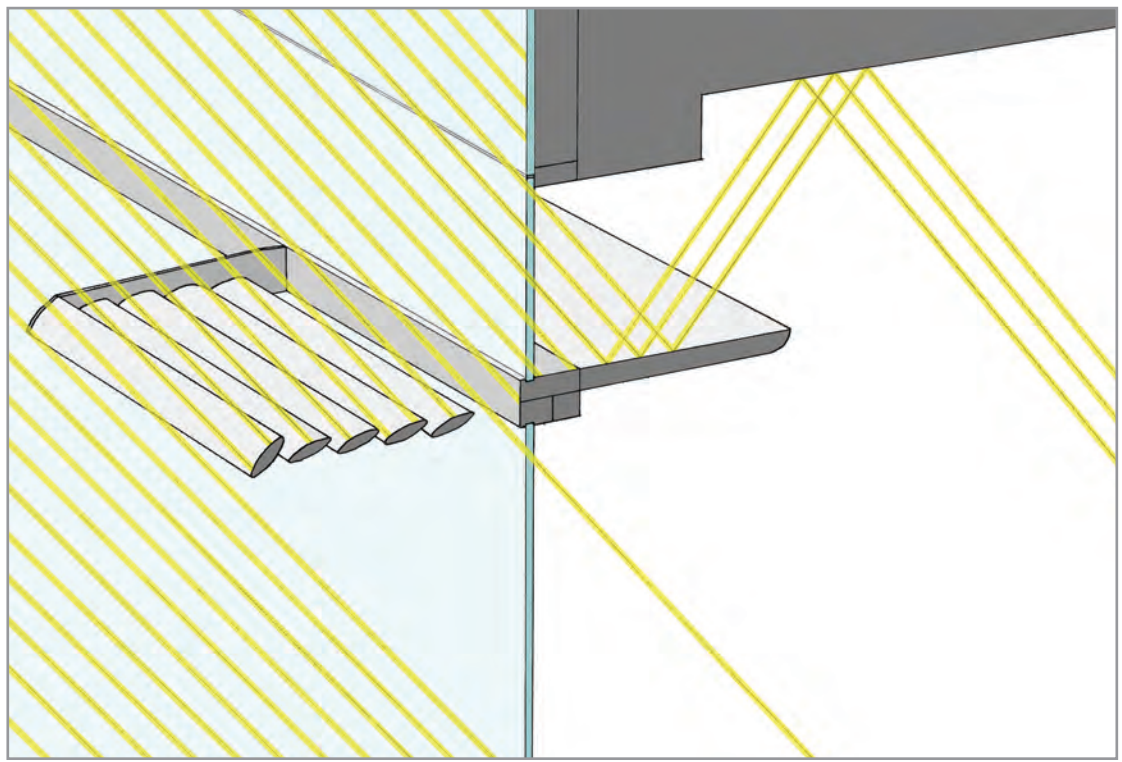


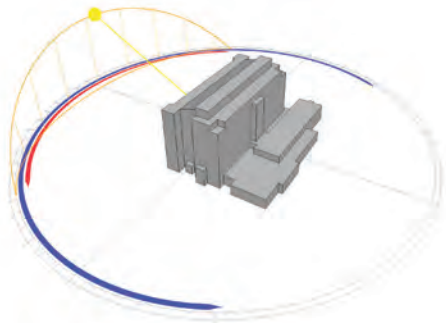
The DDC's central atrium will provide natural light for the interior spaces of the building. Its unusually shaped skylight maximizes vertical fenestration to meet ASHRAE requirements. This diagram sectionally illustrates light penetration by BTU per year

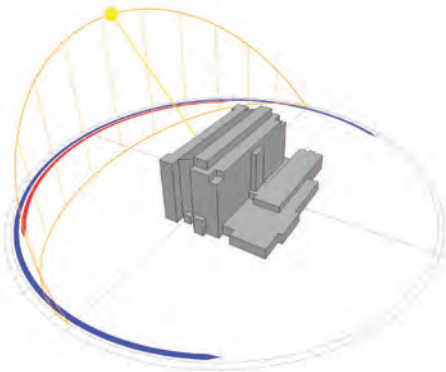
1,500,000
1,390,000
1,280,000
1,117,000
1,106,000
950,000
840,000
730,000
620,000
510,000
480,000

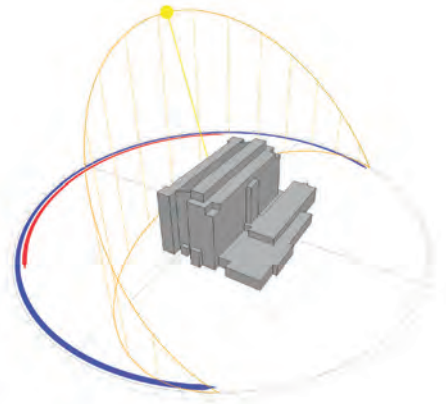
ddc application
LIGHT

The DDC incorporates light shelves and louvers into its southern facade. The custom-designed louvers will block direct sunlight during the summer without obstructing the low winter sun. Light shelves will distribute light deeper into the interior spaces while minimizing glare on people and horizontal surfaces. Ecotect, a building and environmental analysis program, was used for these solar studies.

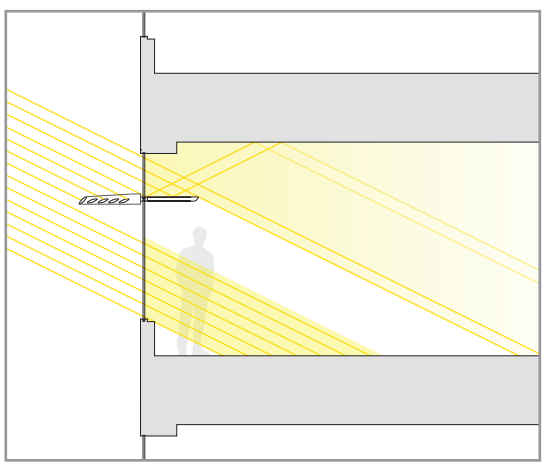




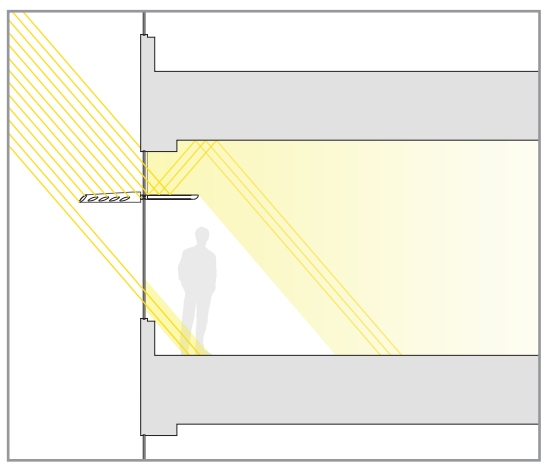




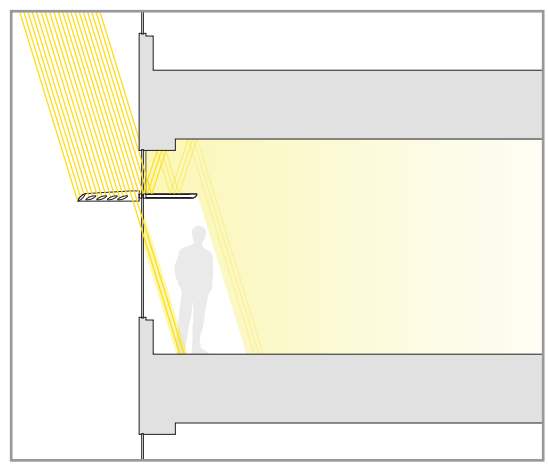
winter.

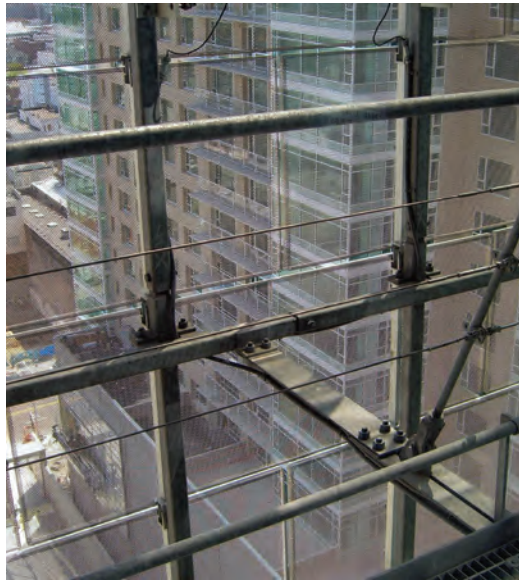


spring.



summer.





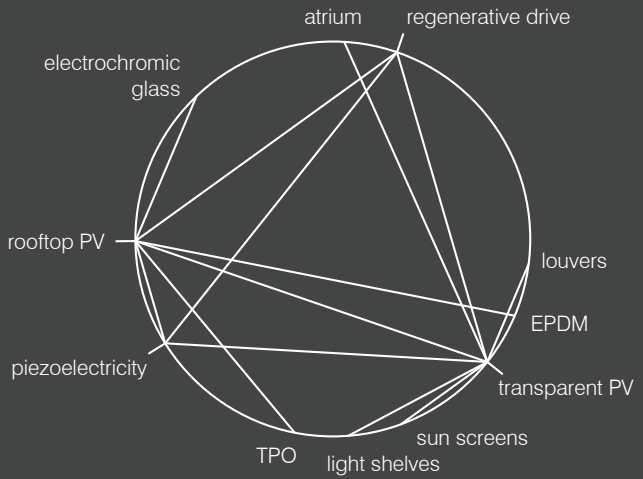
Federal Building.

Morphosis. San Francisco, CA.

The Federal Building by Morphosis employs a crumpled, perforated-metal mesh to shade the southern facade. This screen unfolds from the building to engage the public space on the site. Vertical louvers shade the northern facade, and a narrow floor plate facilitates natural ventilation.

V. ENERGY

Researchers and designers are constantly discovering and reinventing architectural applications for sustainable energy. Many emerging strategies harvest energy from a building's immediate environment; others may take advantage of its interior activity. All assist in maintaining a wholistic approach to sustainable design.



Building integrated photovoltaic panels
Chesapeake Bay Foundation
Annapolis, MD

building integrated photovoltaics

ROOFTOP PHOTOVOLTAICS:

Thin film rooftop mounted solar cells are more commonly employed than any other building integrated photovoltaic system. Standard roof-top panels are about two and a half feet wide and five feet long. On average, they each generate around 125 watts at about fifteen percent efficiency. Energy output is highly dependent on geographic location; higher latitudes generally have fewer usable hours of daylight than equatorial locations.

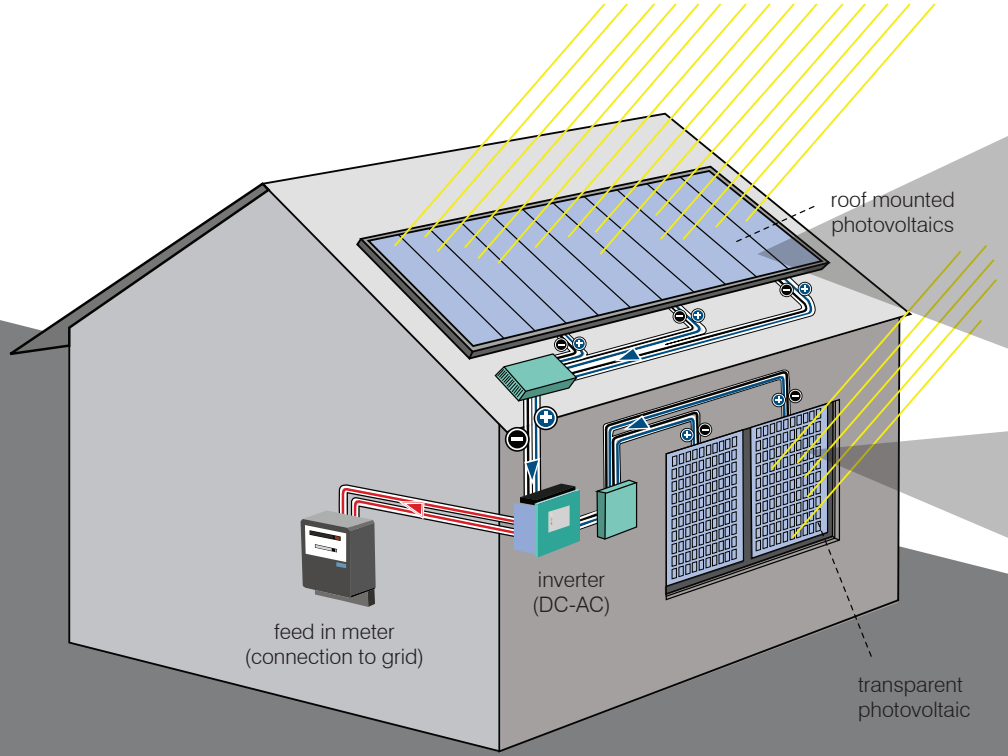
PROS:

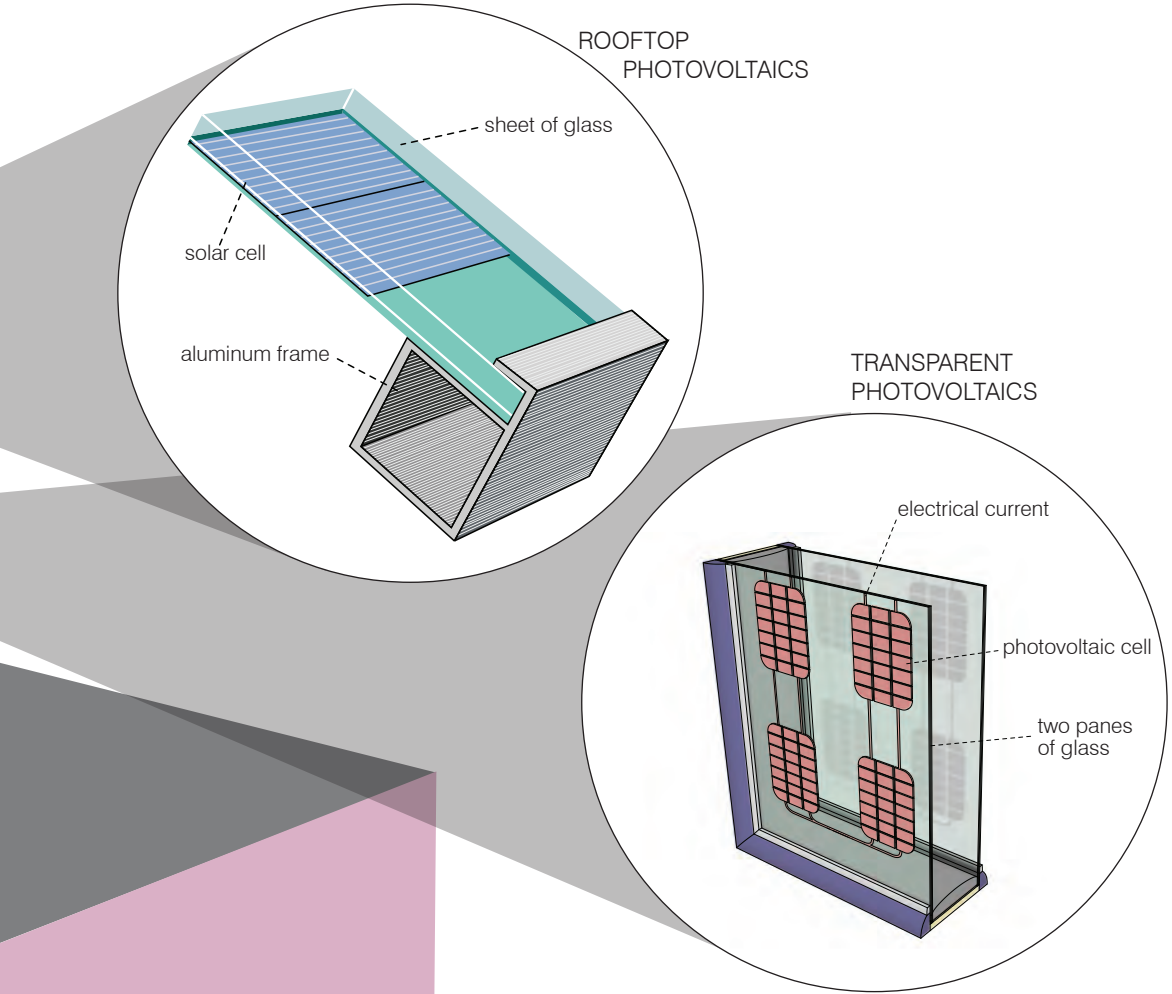
- Photovoltaic panels have become more efficient and affordable
- Harvesting energy otherwise unused from site
- Sell energy back to city grid

CONS:

- Battery banks are cost intensive and have short life expectancies
- Fifteen percent efficiency at most

LEED	EA 2, 6





TRANSPARENT PHOTOVOLTAICS:

Semi-transparent photovoltaic cells are comprised of thin-film, translucent crystalline wafers made from semi-conductor grade silicon. Electric wires extend from the sides of each glass unit and connect to adjacent wafers. Cell opacity ranges from ten to ninety percent and can thus be applied to exterior glass panels without completely obstructing views to the outside. The denser the pv array, the more opaque the window unit will be.

PROS:

- Can generate thousands of kW per year
- Can be used for interior shading
- Utilize existing building features without compromising visibility or aesthetic

CONS:

- High installation costs
- Minimal annual energy return
- Only two to six percent efficiency

LEED	EA 2, 6 ID 1.1

piezoelectricity

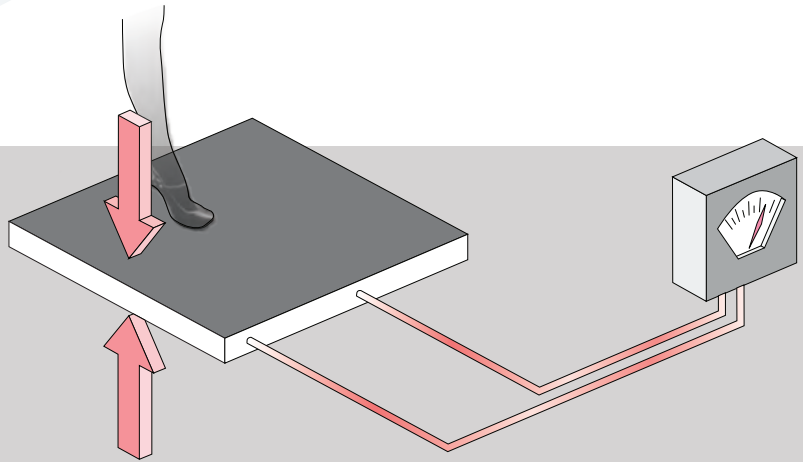
Piezoelectricity generates electrical energy through mechanical pressure, or compressive forces produced by movement. It can be applied in walkways, parking lots, dance floors, or even the structure of a building.

PROS:

- In-house renewable energy

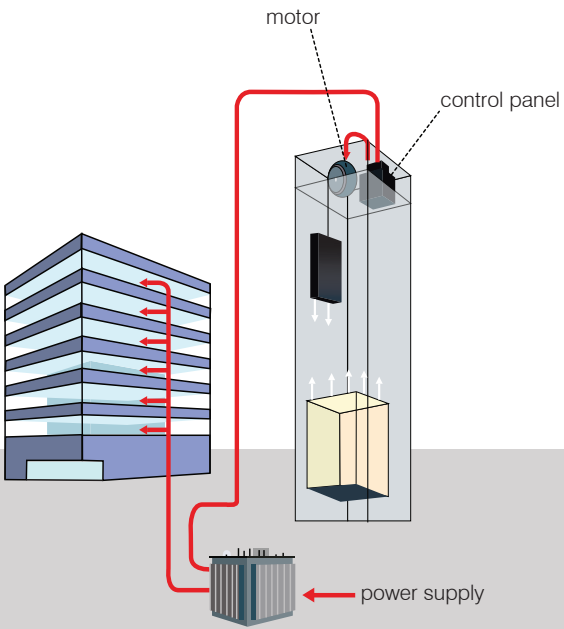
CONS:

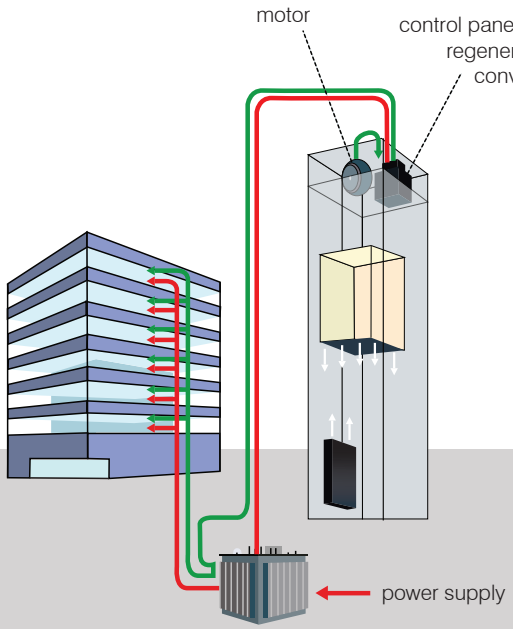
- High installation costs
- Nominal amount of power produced
- Unfamiliar technology



LEED	EA 2, 6 ID 1.1

regenerative elevator





Regenerative elevators gathers electricity while braking during downward movement. This energy is then returned to the building's power grid. Coupled with such features as automatic shut-off and LED cabin lighting, regenerative elevators can afford a 75 percent reduction in energy usage.

PROS:

- No machine room
- Low maintenance with no oil or gears
- 95 percent recycled material
- Saves 10,000 Wh/year
- Automatic shut-off saves energy
- 'Brown-out' tolerant

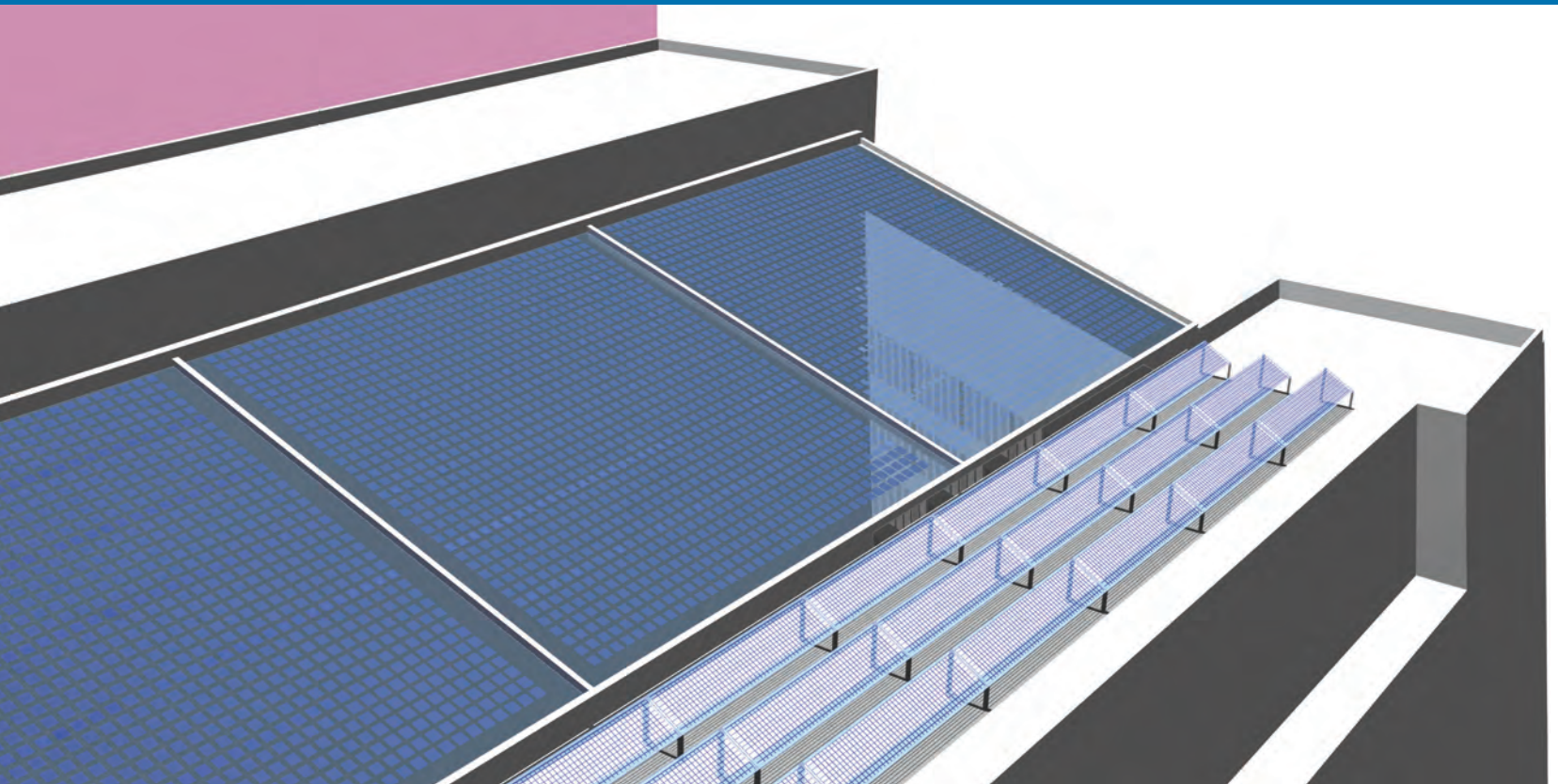
CONS:

- May have lower cabin capacity
- May travel slower

LEED	EA 1, 2, 6 MR 4.2 ID 1.1

ddc application

ENERGY

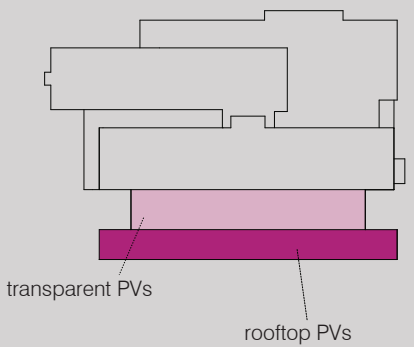


piezoelectricity

Piezoelectric systems are in preliminary stages of development. Moreover, there will probably not be enough foot traffic in the DDC to justify the initial investment of installing this system.

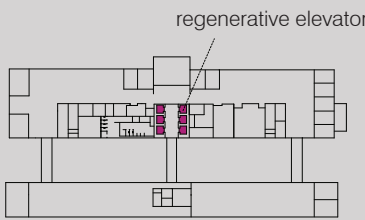
photovoltaics

Both roof-mounted and semi-transparent photovoltaics are being considered. The atrium glazing provides an opportunity for a semi-transparent system, and the roof of the south tower could easily host a thin film solar array.



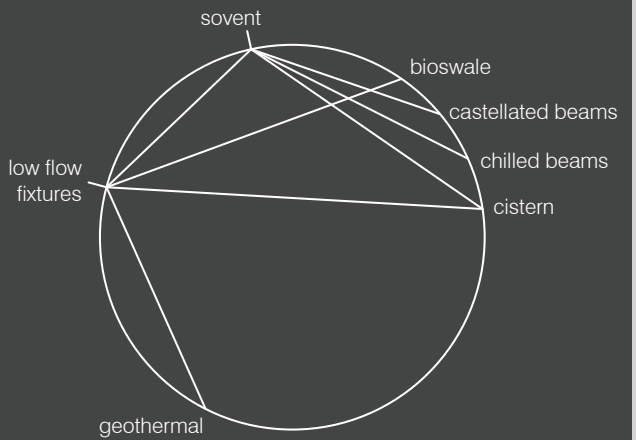
regenerative elevator

Regenerative drives will be used for all of the passenger elevators and could potentially save 60,000 watts of electricity annually.



vi. PLUMBING

A drippy faucet can waste 7,000 gallons of water a year, a leaky toilet 73,000. Plumbing systems must be designed with such potential for waste in mind. The methods by which water enters and waste leaves must also be optimized to reduce installation costs, material usage, and requisite square footage for water and waste management systems.



Exposed plumbing system
Pompidou Center
Paris, France

sovent

The sovent is a single-stack system that incorporates drainage, waste and ventilation into one pipe. There are two primary components: the aerator and the deaerator. An aerator is located at each floor to keep waste from reaching terminal velocity and causing back pressure. The deaerator is located at the base of the stack to separate the water from air and transition the waste outside the building.

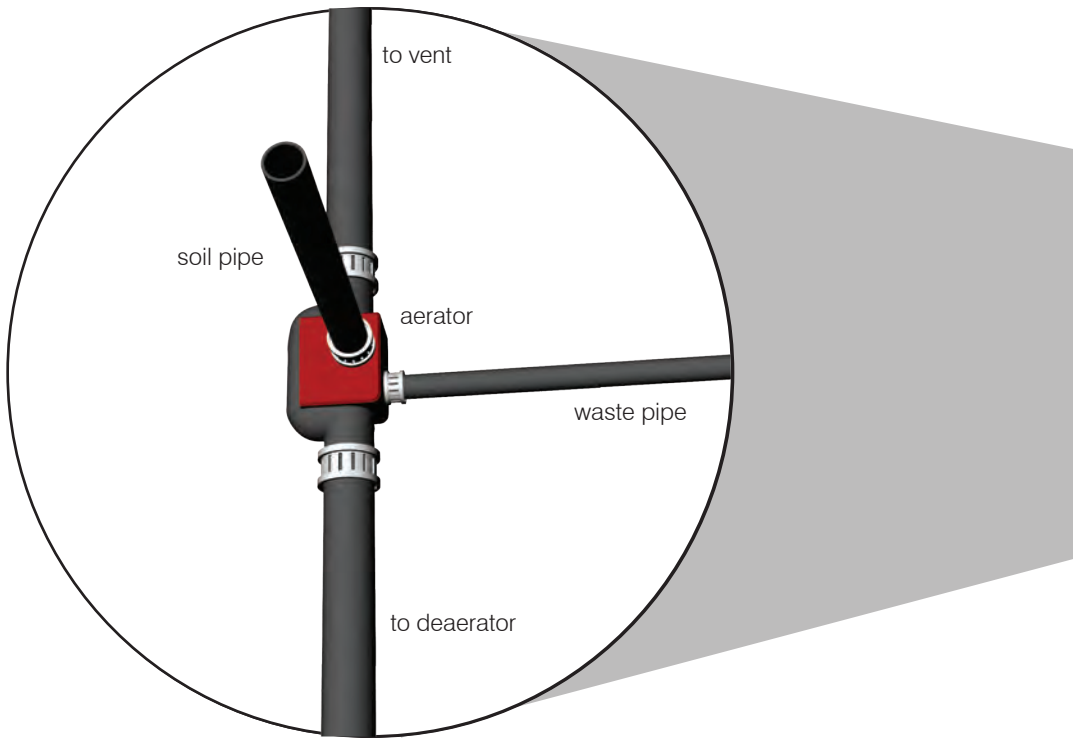
PROS:

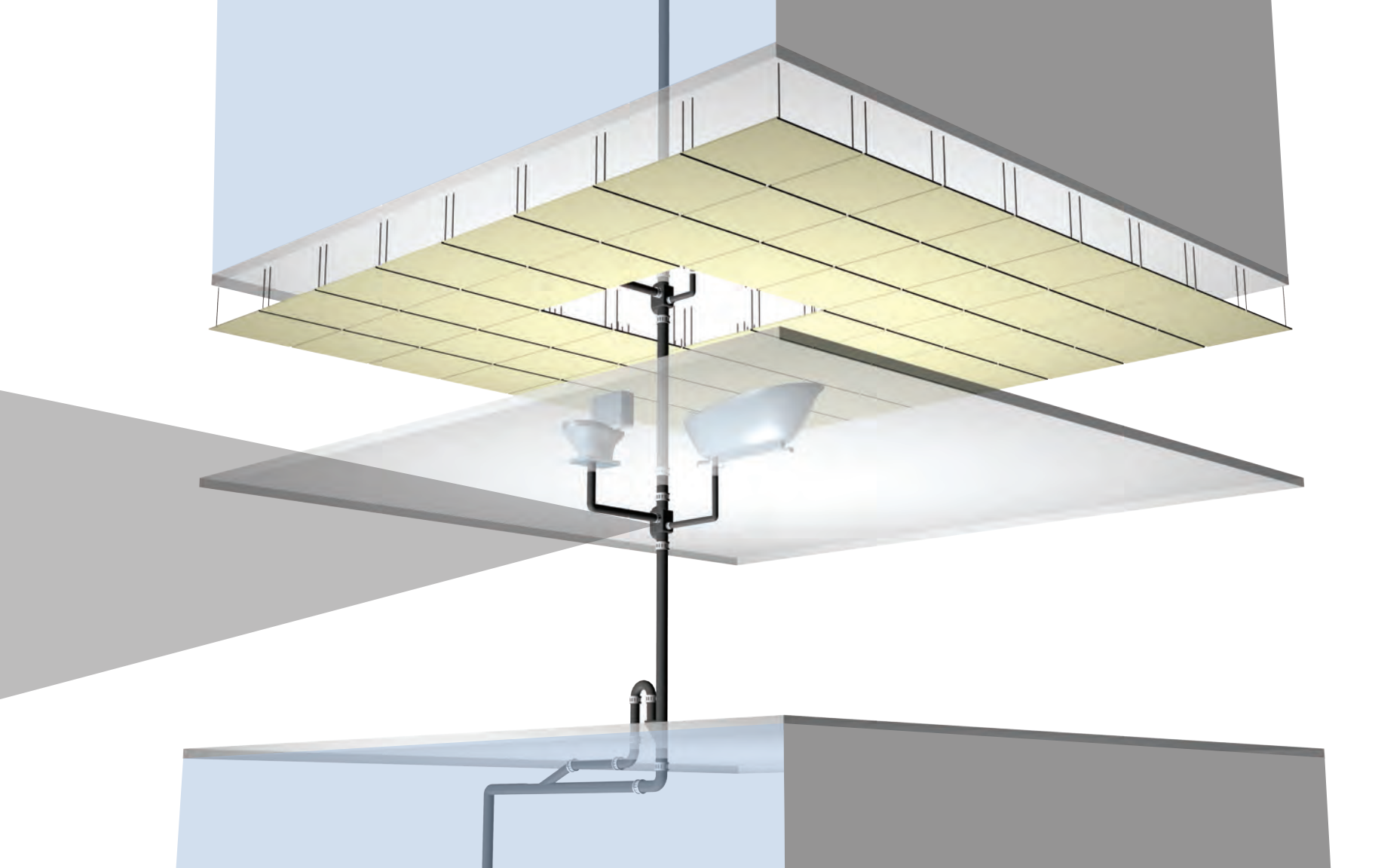
- Reduce plumbing system to one pipe
- Aerator doesn't contain any moving parts or require maintenance
- Saving materials and space by only having a one pipe system

CONS:

- Only a few manufacturers of the sovent system
- Individual approval of system is required
- Vertical distance between aerators must not exceed twenty feet

LEED	WE 2 ID 1.1





low-flow fixtures

The EPA has developed a rating system, Water Sense, that sets requirements to reduce the amount of water used by fixtures. Toilets, shower heads and faucets have been redesigned to cut usageby fifty to seventy-five percent.

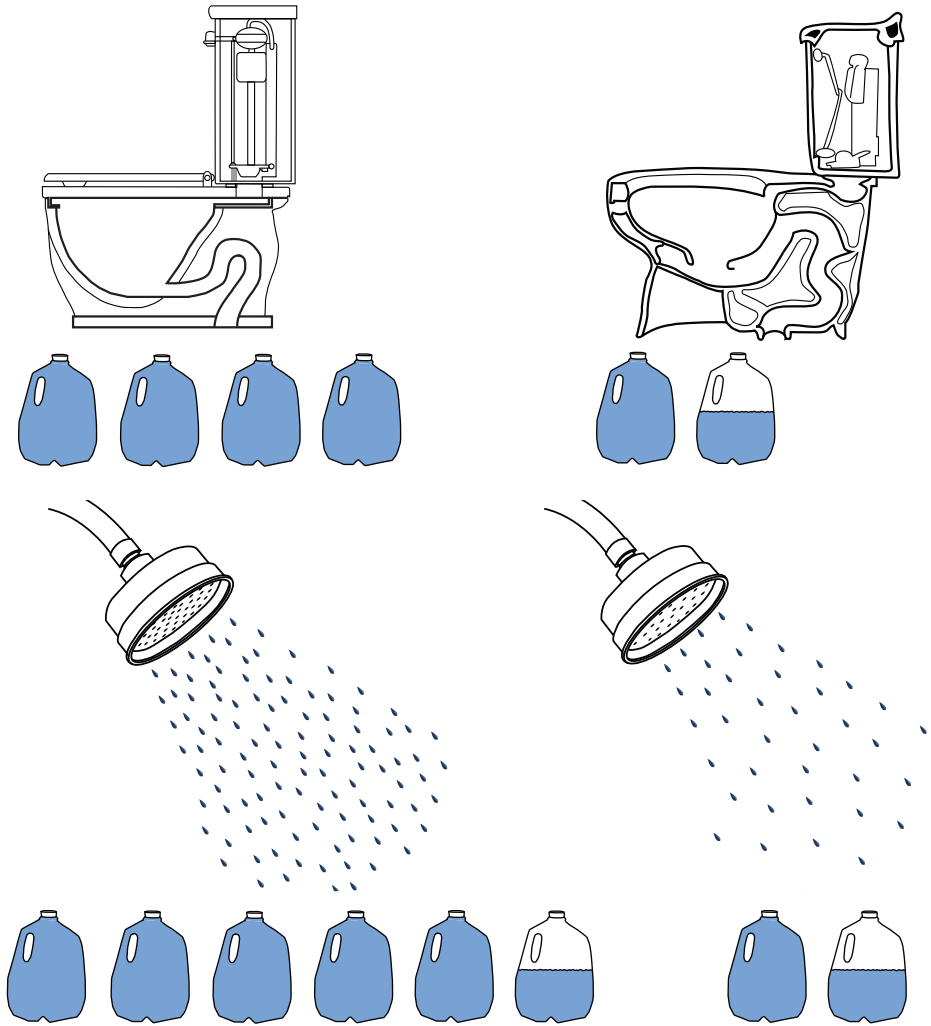
PROS:

- Reduce toilet consumption from 3.2-5 gpf to 1.6 gpf
- Shower consumption reduced from 5.5 to 1.5 gpm
- Faucet consumption reduced from 5 to 1.5 gpm

CONS:

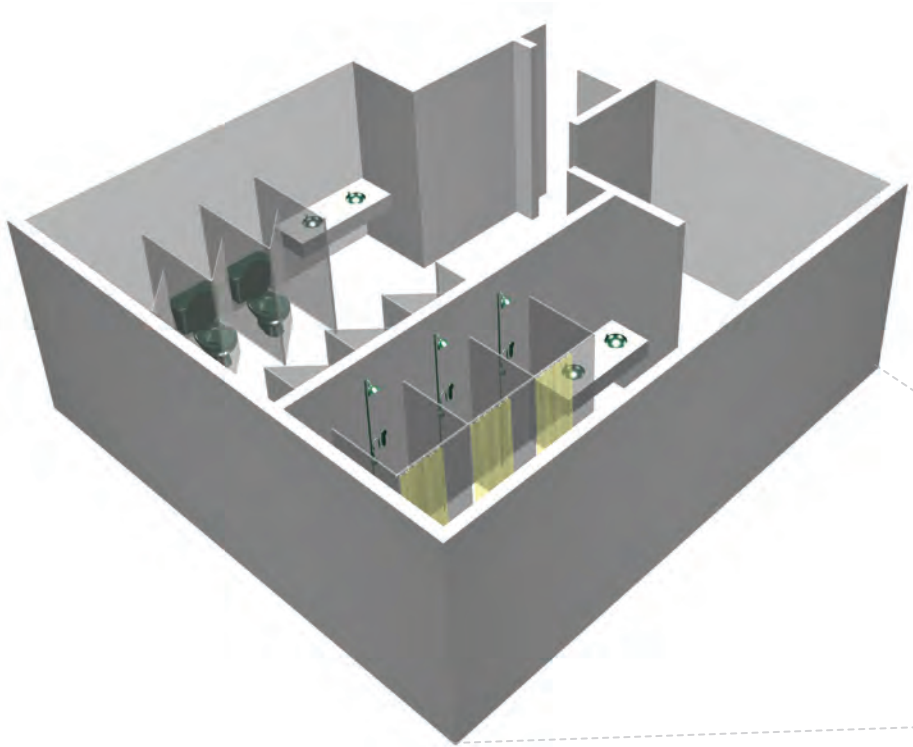
- Water velocity may be reduced in shower
- Toilets could be noisy
- Toilets could clog

LEED	WE 3.1, 3.2

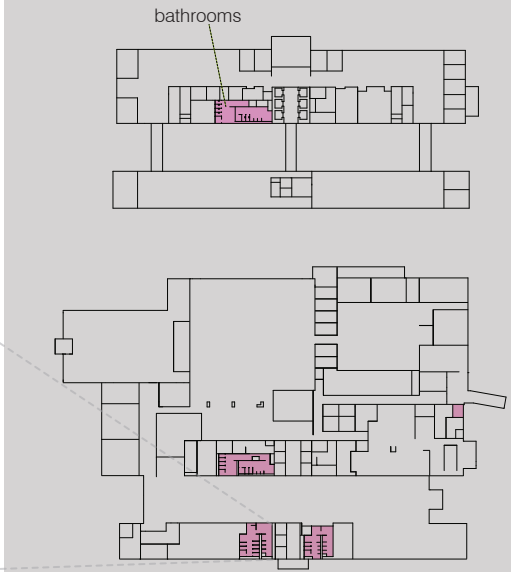


ddc application

PLUMBING

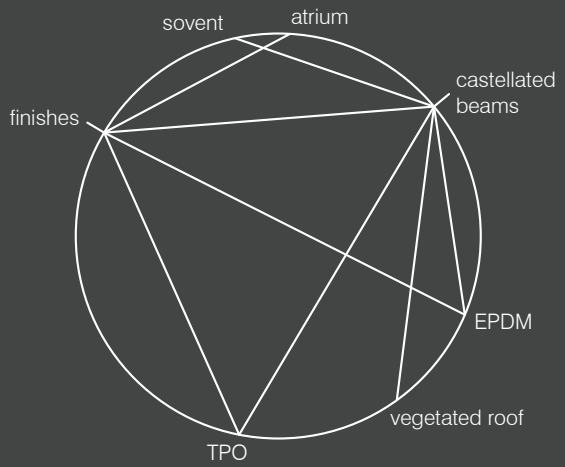


Low flow toilets, urinals, and sink faucets will be used throughout the building's twenty-one bathrooms. Low flow showers will be installed on the ground floor of the south tower to encourage jogging or biking as an alternative to driving.



vii. MATERIALS

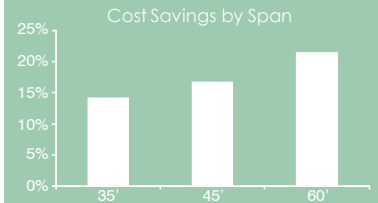
Material selection should value both the aesthetic appeal and environmental impact of the component. The material's color, texture, thickness, durability, and heaviness can drastically alter the spatial condition of the design. Designers should have an environmental consciousness that looks beyond the sustainable qualities of the material itself to consider the effects of material extraction, processing, transportation to site, installation, and renewability.

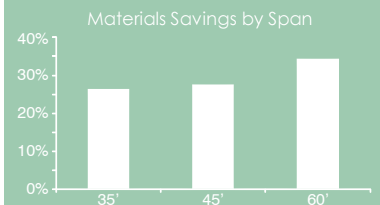


cumaru interior paneling
Virginia Beach Convention Center
Virginia Beach, VA

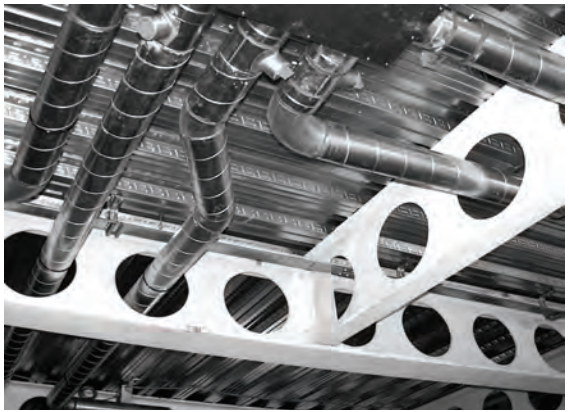
castellated beams

Castellated beams are most economical with long spans, such as those found in auditoriums, gymnasiums, and parking lots. The beam's greater strength and depth allow the members to span greater distances without being interrupted by vertical supports. Welding can be pricey, and the greater level of exposure may deem additional fireproofing. Depth and shape are dictated by a custom cutting pattern; beams can easily be tapered, cambered, and cranked.





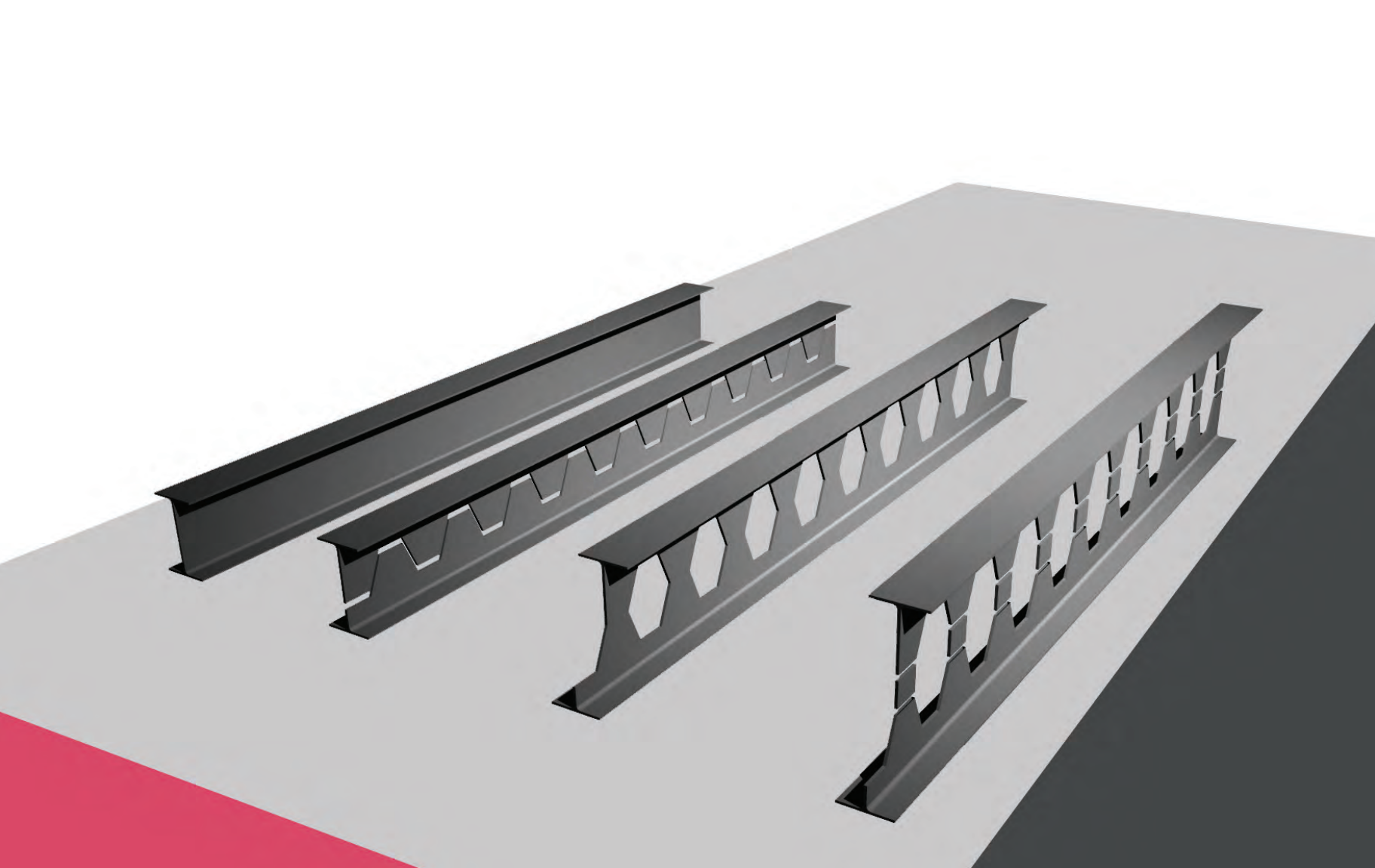
LEED | ID 1.2



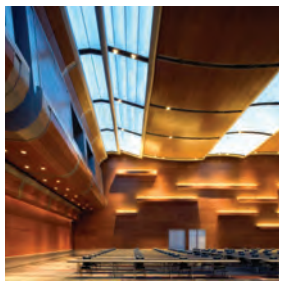
01 I-beams can be plasma cut, offset, and welded back together to form structural members that are stronger, lighter, and more flexible.

02 Perforations not only lighten the beam but allow for ventilation and electrical components to pass through the structure unhindered. Perforations that correspond to vertical supports can be rewelded for added strength.

03 Extension plates can be used between the two cut halves to further increase the depth of the beam.



finishes



cumaru

This renewable, reddish brown South American timber can be used as a highly durable decking, interior finish, or exterior paneling. It is also known as Tonka, Almendrillo, and Brazilian Teak.

PROS:
- Resistant to rot, decay, and insect attack.
- One of the hardest deckings commercially available
- Has a minimum life expectancy of 25 years
- Virtually maintenance free after installation

CONS:
- Natural oils make gluing difficult
- Difficult to saw and bore due to hardness

LEED	MR 6, 7

kraft derivatives

Kraft pulping describes a process in which wood is converted into pulp to create a strong material consisting of pure cellulose fibers. The resulting cellulose paper can be thermoset under high temperatures to produce durable exterior wood paneling. A moving air chamber is required between the wood paneling and the load-bearing structure beneath to prevent sweating.

PROS:
- Any type of wood can be used, even highly resinous types and non-wood species such as bamboo; any local supply of timber can be utilized nondiscriminately
- Paneled facade enhances the building's acoustic, solar, and moisture protection

CONS:
- If adequate ventilation is not provided, the wood will condense and wrinkle
- The kraft process is water intensive and can produce malodorous by-products

LEED	EA 1 EQ 4.4 MR 5.1, 5.2, 6.0 ID 1.1, 1.2

agrifiber

Agrifiber is a term used to describe a composite wood manufactured from renewable and recyclable fibrous materials, such as straw or hemp. Agrifiber wood panels are designed with a calculated life-cycle analysis; every factor from raw construction materials to methods of reuse and recycling is considered to create this sustainable wood paneling.

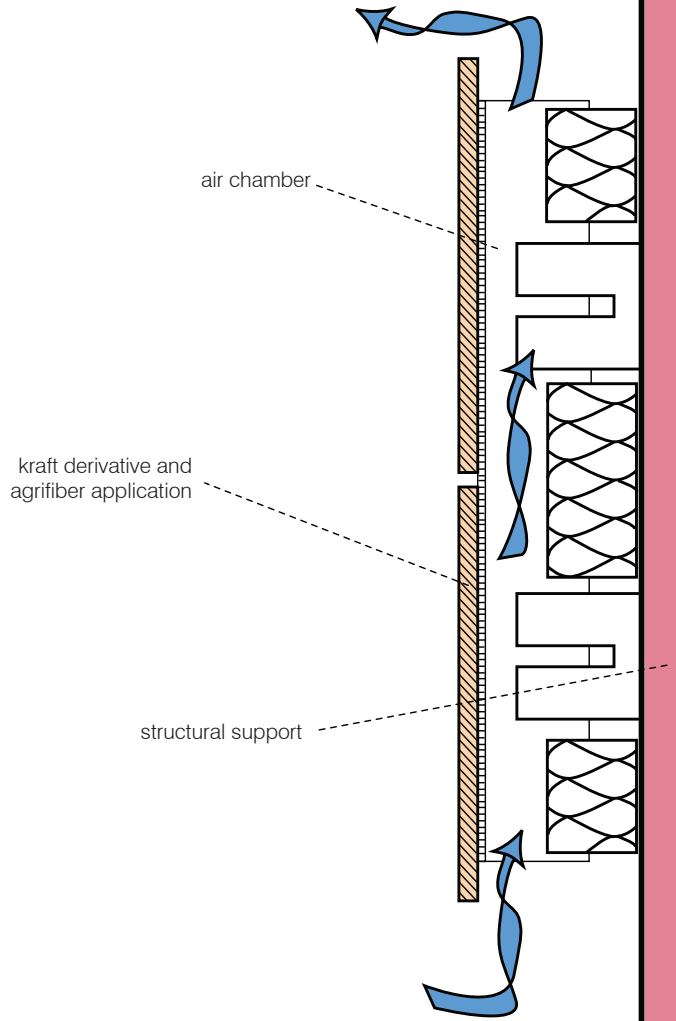
PROS:

- Expanded insulation can lower energy costs
- Paneling can be affixed to existing walls, allowing redesign without demolition
- Low maintenance and extremely weather resistant
- Excellent rain screen

CONS:

- If adequate ventilation is not provided, the wood will condense and wrinkle

LEED	EA 1 EQ 4.4 MR 5.1, 5.2, 6.0 ID 1.1, 1.2



ddc application

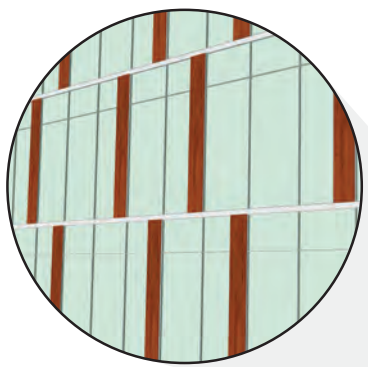
MATERIALS

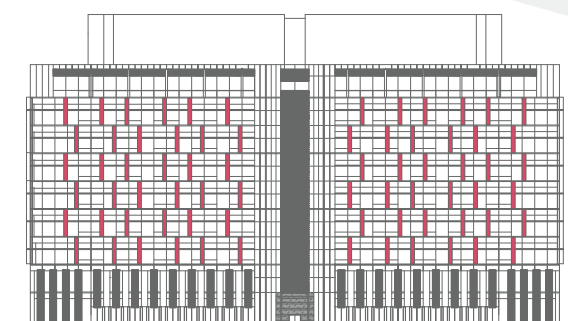
kraft derivatives

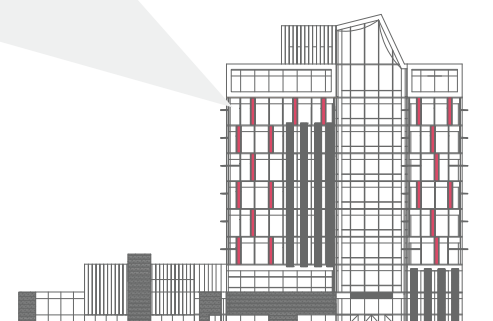
An exterior wood paneling derived from kraft paper will break the monotony of the curtain wall.

cumaru

It has yet to be determined whether or not cumaru will be used for interior finishes.

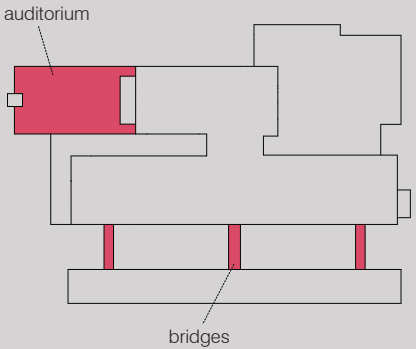


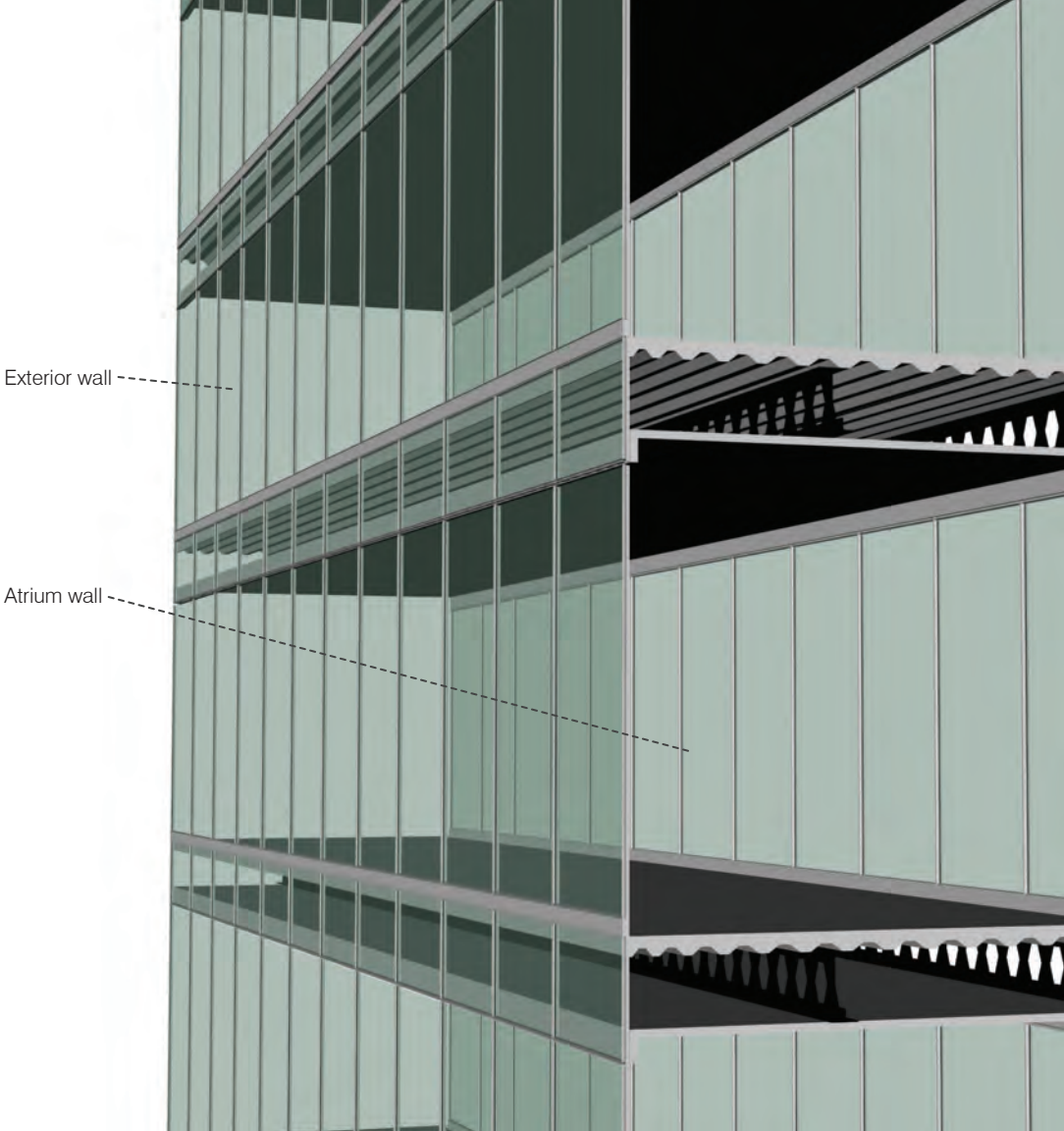




castellated beams

Due to high cost, castellated beams will only be used in areas requiring long spans and additional strength. Castellated beams will be used in the auditorium to not only span the large space but also support additional weight of the vegetated roof. They will also be used to support the bridges spanning the atrium.



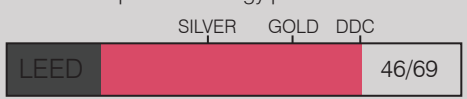


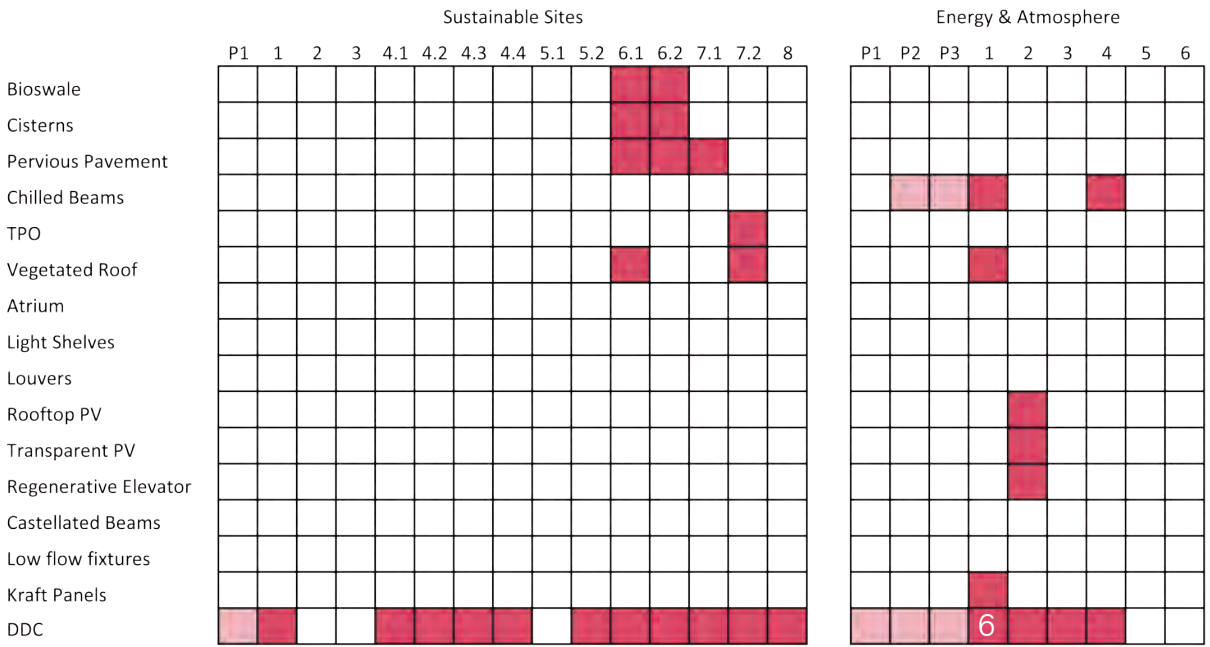
defense distribution center
LEED analysis

This chart compares the systems chosen for the DDC to LEED credits by category. A colored box indicates that the corresponding system can contribute towards the respective LEED credit.

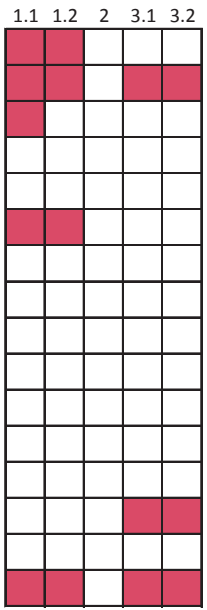
The DDC is expected to qualify for some credits that do not overlap any system, such as appropriate site selection (SS 1), enhanced commissioning (EA 3), proper management of construction waste (MR 2.1, 2.2), and maintaining LEED certified principal participants on the project team throughout design and construction (ID 2). The compilation of this book and the research that made it possible contributed to one innovation and design point (ID 1.2).

Two credits, optimized energy performance (EA 1) and on-site renewable energy (EA 2) can earn more than one point. The DDC is expected to generate at least 2.5% of its own power via building integrated photovoltaics and regenerative elevator drives and perform at 25% higher energy efficiency than ASHRAE Standard 90.1, earning one credit for on-site renewable energy and six for optimized energy performance.

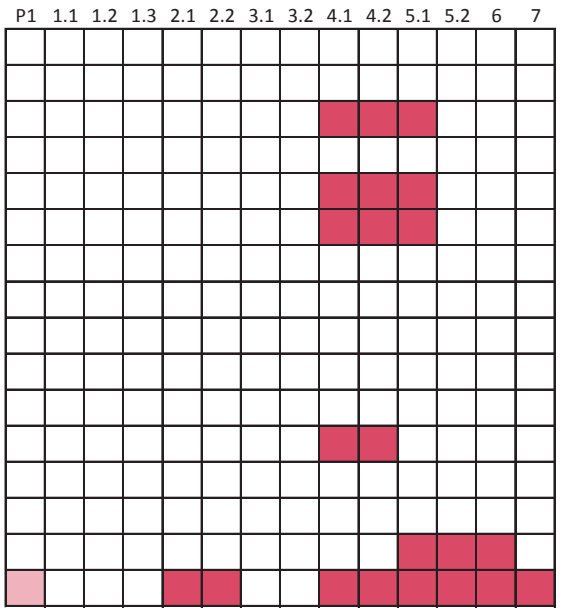




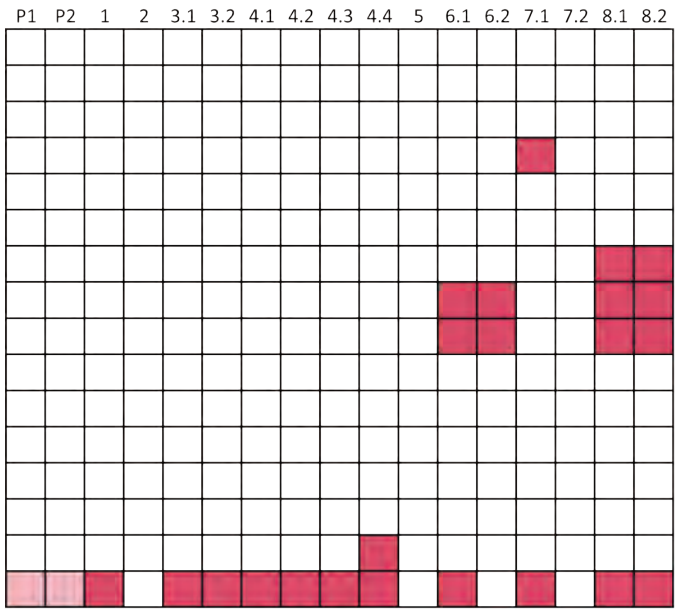
Water Efficiency



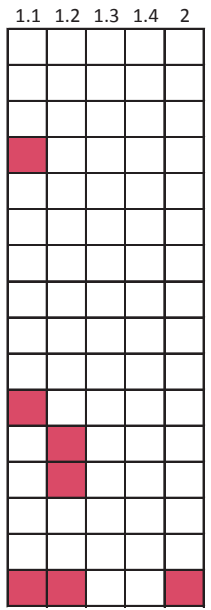
Materials & Resources



Indoor Environmental Quality



Innovation & Design



glossary of terms [a - g]

aerator — used in the sovent plumbing system to add air to the waste/vent pipe to reduce the speed of falling waste and not allow it to reach terminal velocity.

agrifiber — the term given to a number of products made from organic material or other agricultural materials which utilize a plant's insulation value, low cost, lack of harmful compounds, or sustainable, regional production process.

atrium — a large open space within a building meant to allow light to penetrate deep into the building's interior, as well as provide a sense of connection with rest of the building and the outdoors.

bioswale — a storm water runoff management tool that traps water in a vegetated space, allowing the water to pool and infiltrate rather than be washed along impervious surfaces into water bodies.

built-up roof (BUR) — a continuous roof covering made of laminations or plies of saturated or coated roofing felts, alternated with layers of asphalt and surfaced with a layer of gravel or a cap sheet.

ballast crushed aggregate that is placed upon flat or low sloped roofs to provide a protective final layer.

castellated beams a rolled metal beam the web of which is first divided by a lengthwise zigzag cut, then welded together so as to join the peaks of both halves, thus increasing its depth and strength.

chilled beams architectural feature that provides heating and cooling for a space by natural convection, driven by a system of water pipes in the ceiling of the space. By changing the temperature of water running through the pipes, warm or cool air circulates through the space, providing efficient thermal comfort to occupants.

cistern a reservoir or tank used to store water, especially for catching and holding rainwater for later use.

cumaru made from an exotic South American hardwood by the same name, this wood's hardness increases the deck's strength and can extend the lifespan to 20+ years.

deaerator used in the sovent plumbing system at the base of the stack to stop build-up as the vertical pipe meets the horizontal drain.

electrochromic glass technology that controls the transparency of a window by applying a small voltage to align or scramble electrons between the windows exterior layers, blocking or allowing solar light and radiation to pass through.

EPDM roof ethylene propylene diene monomer is a single ply membrane consisting of synthetic rubber; usually about 45 to 60 mils in thickness. Application can be ballasted, fully adhered or mechanically attached.

exterior polymer these compact strong finishes can be used to as covering for structural elements to provide protection weathering and an aesthetic appearance.

geothermal heating and cooling produced by pumping water into the Earth's crust and then conveying the heated water back to the surface so the energy can be extracted through a heat exchanger.

glossary of terms [l - z]

light shelf	an architectural tool used to reflect high-angle incoming daylight deep into a space otherwise inaccessible to natural light.
louvers	angled sun shades that allow sunlight to penetrate at certain desired times and seasons, while blocking it at others.
low flow fixtures	plumbing fixtures that significantly reduce the amount of water released per use. These fixtures use just enough water to be effective, saving excess, potable water that usually goes down the drain.
overhead variable air volume	air-conditioning delivering system that utilized a dual-layer, low static volume air delivery system in the ceiling above occupants. The system utilizes “time” modulation to control the amount of air that conditions a space.
pervious pavement	paving mixed without small particles, leaving small connected voids in the installed products. These voids help maintain slower, constant runoff levels, as well as recharge groundwater and retain pollutants that would otherwise wash into water bodies.

piezoelectric flooring a system comprised of crystals whose chemical property causes them to produce voltage when a mechanical pressure is applied.

regenerative drive regenerative elevators regain power through braking, convert it to electricity, and return it to the building's power grid.

roof-top photovoltaic a system of thin film solar cells that convert sunlight into electrical energy. Their performance depend on orientation, angle, and geographic location.

sovent a plumbing system that combines the vent and waste stacks into one pipe. Through the use of aerators on every floor and a deaerator on the ground floor the system never allows waste to reach terminal velocity which eliminates back pressure.

sun screen a shading device that modulates direct solar incidence into spaces.

TPO roof thermoplastic olefin is a single ply membrane formulation composed of reinforced polyester fabric and manufactured using an ultraviolet-resistant compound.

transparent photovoltaic comprised of thin-film, semi-transparent (10-90% opacity), crystalline wafers are made from semi-conductor grade silicon and applied to glass. Electric wires extend from the sides of each glass unit and connect to adjacent units, forming the entire system.

under-floor air cooling system that supplies conditioned air to a space from diffusers beneath an access floor, with return air being draw from above.

vegetative roof a system on roof-top space that cultivates live plants, provides storm water control, and thermal moderation, while reducing the urban heat island effect and creating an aesthetically pleasing result.

vegetative roof- intensive with a soil depth from 6" to beyond 36", intensive vegetative roof systems cultivate larger, heavier plants, sometimes even full grown trees. Also called "Rooftop Gardens," these require considerably more maintenance and structural support than extensive roofs.

vegetative roof- extensive with less than 6" of soil, extensive systems adds less dead load to a roof while providing UV protection and storm water control. A cheaper and more widespread system than intensive roofs.

references

- *Advantages of Hybrid Geothermal Systems*

  google search: "advantages of using the hybrid geothermal option"

  <http://intraweb.stockton.edu/eyos/energy_studies/content/docs/proceedings/SINGH.PDF>

- *A Cost Comparison of Ground Source Heat Pump Systems*

  google search: "PME commercial geothermal heat pump systems"

  <http://geoheat.oit.edu/pdf/tp38.pdf>

- *Assessment of Hybrid Geothermal Heat Pump Systems*

  google search: "federal energy management program geothermal pdf"

  <http://www1.eere.energy.gov/femp/pdfs/hyhgp_tir.pdf>

- *Bioswales/Vegetated Swales*

  google search: "University of Florida bioswales"

  <http://buildgreen.ufl.edu/Fact_sheet_Bioswales_Vegetated_Swales.pdf>

- *The Basics of Cisterns*

  google search: "the basics of cistern systems"

  <http://www.ose.state.nm.us/water-info/conservation/pdf-manuals/Roof-Reliant-Landscaping/RRL-Chapter-2.pdf>

- *Sustainable Stormwater Storage*

  google search: “sustainable stormwater storage system”

  <http://ceae.colorado.edu/mc-edc/pdf/final_project_4-11-08.pdf>

- *Rainwater Harvesting*

  google search: “conservation technology rainwater”

  <http://www.conservationtechnology.com/rainwater.html>

- *Sustainable Design - Chilled Beams*

  google search: “affiliated engineers chilled beams”

  <http://www.aeieng.com/services/sustainable/chilledbeam.htm>

- *Active Chilled Beams*

  google search: “trox active chilled beams”

  <http://www.trox.us/usa/products/air_water_systems/ceiling_induction_diffusers/index.html>

- *The Big Chill*

  google search: “eco-structure constitution center”

  <http://www.eco-structure.com/hvac/the-big-chill.aspx>

- *Waterproofing: EPDM Roofing*

  google search: “conservation technology waterproofing”

  <http://www.conservationtechnology.com/waterproofing_epdm.html>

- *Vegetated Roof: PA Stormwater Best Management Practices*

  google search: “Pennsylvania stormwater management vegetated roof”

  <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-68000/6.5.1%20BMP%20Vegetated%20Roof.pdf>

- *Light shelves*

  google search: “install light shelves”

  <http://www.energybooks.com/pdf/10001005.pdf>

- *Elements of Daylighting*

  see 2008 summer intern research

  <http://www.clarknexsen.com/intern/2008/2008.html>

- *Electrochromic Windows*

  google search: “electrochromic glass universita degli studi di lecce”

  <http://www.antonio.licciulli.unile.it/tesine2003/ELECTROCHROMIC%20GLASS.pdf>

references

- *Applications of Piezoelectricity* — google search: "piezoelectric harvesting San Jose State University"
  <http://platinum.ts.odu.edu/Apps/FAAUDCA.nsf/Second%20Place%20Environmental.pdf?OpenFileResource>
- *EPA Watersense* — google search: "EPA watersense"
  <http://www.epa.gov/watersense/>
- *Castellated Beams* — google search: "grünbauer castellated"
  <http://www.grunbauer.nl/eng/wat.htm>
- *Macsteel Trading Cellular Beams* — google search: "macsteel cellular"
  <http://www.macsteel.co.za/cellbeam/cellbeam.htm>

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