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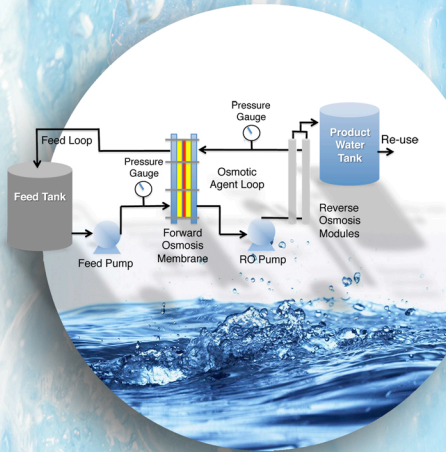
Living Blue

Demonstrating synergy between terrestrial and space applications, Sustainability Base is beta-testing a NASA-developed grey water recycling system. Once-used soapy water from sinks and showers will be reclaimed in a three-stage process and used secondarily to flush toilets (in our low flow fixtures, which use only 0.8 gal., less than 0.5 L, per flush.) The technology uses both forward and reverse osmosis and relies on specially engineered osmotic membranes. This feature lowers potable water consumption ~60%, and is made possible by the thoughtful incorporation of a double-piping system in Sustainability Base's design and construction, allowing isolation of both the grey water and reclaimed product. Another instance of "native-to-place" design makes use of our unique location adjacent to a superfund clean-up site. Remediated and tested

groundwater from a treatment facility supervised by the Environmental Protection Agency is used for irrigation. You can see the lavender fixtures and utility boxes around the building.

Drought tolerant native plants minimize watering requirements and landscaped bio- swales (undulating basins and hillocks) maximize absorption of rainwater by vegetation, and minimize freshwater run-off while providing natural filtering through soil and vegetation. One of the larger hillocks conceals a 6000 gal. on-site storage tank for reclaimed water.

The combination of these features reduces this facility's potable water demand by 85-90% of a comparably sized office building.



sustainability base



Recycled and recyclable materials are used whenever possible, supporting the facility's commitment to sustainability.



Living Green

Sustainability Base's interior design focuses on the productivity and comfort of the residents and includes architectural features and furnishings in keeping with the building's goals of resource and energy saving. Recycled and recyclable materials are used whenever possible, supporting the facility's commitment to sustainability. For example, the elegant and durable 1" (2.54 cm) thick tongue-and-groove oak floor in the central atrium was recovered from the demolition of the 14-Foot Wind Tunnel. Waste generated by the residents' activities is recycled, and refuse collected in 'landfill' and 'recyclable' streams.

Up to half the energy consumed by a high-performance building is attributable to plug load, the electricity used by everything that is plugged in. In Sustainability Base, we share networked copiers and printers, encourage the transition to digital documents, and minimize personal devices wherever possible. We are also a test bed for research on minimizing plug loads through programmable controllers, energy-smart purchasing, and aligned resident choices.

There are few private offices: Work areas are predominantly open and collaborative, with both scheduled and on-demand 'huddle' rooms and conference facilities of varying sizes, in addition to quiet study and library areas. Teleconferencing and/or videoconferencing services facilitate interactions with telecommuting employees and other remote collaborators. Individual workspaces provide

ergonomic seating and fully height-adjustable worktables—because people come in different sizes, and may like to break up periods of sitting by standing. Sectional dividers are uniformly 42 inches (107 cm) to allow daylight to penetrate from windows on both sides of the building. The large windows give the residents uninterrupted views. Residents on the ground floor have extra-high ceilings while those on the second floor enjoy skylights; both design choices maximize sunlight.

Whether inside or outside, Sustainability Base's "native-to-place" design lets residents enjoy both natural lighting and fresh air. In our comfortable California climate, working outside, with power outlets and wireless communication, is often an attractive choice. Rooftop air handlers bring in cool nighttime air and subfloor spaces throughout Sustainability Base store and re-supply this fresh air for ventilation and humidity control during daytime hours. Indoor air quality is also positively affected by the choice of non-toxic furnishings and cleaning products. Windows in the bottom row on each floor can be manually opened, while those in the upper row are automatically operated by the building's comfort control systems. Vines trained to climb the exterior elements create shade and visually join the facility with its surrounding landscape. Landscaping choices and expansive views contribute to a sense of biophilia, the connection between humans and their natural environment.



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Sustainability Base's orientation takes maximal advantage of the sun, wind, weather patterns, climate, and geography.



Living Light

Sustainability Base uses a “native-to-place” approach. Its orientation takes maximal advantage of the local sun, wind, and weather patterns, climate, and geography. The design optimizes natural lighting penetration using a narrow footprint with no interior columns to cast shadows. The maximum height of 42 inches (107 cm) for interior furnishings parallel to the windows, and the extensive use of glass enclosures for offices and other internal workspaces enhance the impact of natural lighting. The ground floor has high ceilings and the second floor has triple-glazed polycarbonate prismatic skylights supplemented with light-emitting diode (LED) bars. Overhead are both high-efficiency fluorescents and LEDs. The Lutron® interior lighting system enhances the building's energy efficiency by

adjusting maximum lighting levels to optimally augment prevailing daytime seasonal sunlight. Occupancy sensors turn the lights off when not needed in the enclosed spaces. The automated shades using SolarTrac® by MechoSystems, Inc. allow the sunlight in while preventing glare and limiting additional heat load.

Not only do the windows bring sunlight in, they give the residents wonderful views. Rapidly growing vines on the building's exoskeleton blend this architectural element with the designed landscape to create integral and visually arresting elements. Residents can also use external workspaces, with wireless coverage and power outlets, so they can be productive outside, if they choose, in our comfortable California climate.



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Sustainability Base's design leverages its local assets to minimize water and energy demands.



Working Assets

Sustainability Base's design leverages its local assets to minimize water and energy demands. Under a grassy oval in the nearby NASA Research Park, 106 interconnected well bores averaging 140 ft (42.7m) deep were dug between February 2009 and July 2010. Water now circulates in a closed-loop system of 6 in. bores with 1" pipes over 15,000 ft (~ 5km) long. These condition the water to a temperature of 58°F (14.5°C), taking advantage of the ground's constant thermal inertia. Thermally conditioned water can be boosted up (warmed) or down (chilled) by heat exchangers. The combined system (geothermal wells, water pumps, and heat exchangers) is up to 70% more energy efficient than traditional methods that heat, cool, and blow air using natural gas and electricity.

Chilled water circulates in ceiling panels and warmed water in wall-mounted radiators. The cooling ceiling panels were particularly complicated to install. The building's two-wing half-moon design, fire suppression sprinkler system, and interior design required 434 panels of 25 different

sizes. The open lobby also receives radiant heating and cooling through foundation piping beneath a 1 in. (2.54 cm) tongue-and-groove oak floor recovered and recycled from the demolished 14-Foot Wind Tunnel. Combining passive and active heating and cooling systems maximizes our positive energy profile.

On the North side an interior horizontal light shelf gives an additional bounce to available daylight for inside lighting. On the East, West, and South exteriors you may notice both horizontal and vertical aluminum grills. These baffle sunlight glare and reduce thermal load in the summer. Additional insulation is contributed by double-paned, argon-filled windows with Solarban™ 70XL glaze and high performance siding. Rooftop air handlers transfer cool outside air during the night to underfloor spaces (plenums) for ventilation throughout the day. Automated upper windows provide additional ventilation and humidity control. The lower windows on each floor can be opened by occupants for fresh air and a cool breeze.



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Sustainability Base is a powerhouse, using its location and climate optimally and harnessing its resources and demands ambitiously.



Energy Dieting

Sustainability Base has been designed to take advantage of the climate in Santa Clara Valley, on the edge of San Francisco Bay. The primary heating and cooling systems take advantage of the prevailing deep ground temperature of 58°F (14.4°C). These “native-to-place” solutions combine with on-site electricity generation for the comfort and productivity of the building’s residents.

Earth’s first installation of the second generation Energy Server (ES-5700), or BloomBox®, from Bloom Energy can more than provide for the facility’s electricity demand. This solid oxide fuel cell produces about 200kW of electrical power by chemical reaction with steam and air, rather than combustion, reducing CO² green house gas emissions by 40%. The fuel cell’s efficiency is estimated at 55%, roughly twice that of a conventional gas-fired power plant. With its small size and low profile, this dynamo is surprisingly unnoticeable—close by there is only a low hum. This pilot installation is constantly monitored by NASA Ames and Bloom Energy to analyze and optimize operations.

Sustainability Base also harnesses the sun, with 432 SunPower® E-19 photovoltaic panels distributed across the building’s roof. These arrays have 19% efficiency in converting incident photons to harvested electrons, among the highest conversion efficiencies commercially available. At peak output, the arrays will produce 87kW. This may be at or above Sustainability Base’s peak demand. Over the course of a year, PV-generation can account for approximately 30% of the building’s electricity needs. Both the solar and fuel cell power generation are measured and their contribution of excess energy to the electricity grid is a net benefit to NASA Ames.

Also located up on the white polyvinylchloride (PVC) ‘cool roof’ is another solar collection assembly, this time solar thermal. The Sun heats water for sinks and showers, further reducing the building’s need for electricity or natural gas. Sustainability Base is a powerhouse, using its location and climate optimally and harnessing its resources and demands ambitiously.



sustainability base

Conscientious design and unique NASA resources make this 2-story, half-moon building singularly high performing.



NASA Inside and Out

Sustainability Base is a 50,000 ft² (4645 m²) mixed-use facility designed to accommodate 220 staff. Most of the workspaces are open and collaborative. There are few private offices but many accessible 'huddle' rooms for team discussions and areas for quiet individual work. The materials selected, throughout, are non-toxic and, where possible, derived from recycled materials and acquired thoughtfully in anticipation of further recycling/re-use at the conclusion of their functional life cycle, a cradle-to-cradle™ concept.

The planning and design phase consumed approximately one year followed by 18 months of construction. When Sustainability Base was designed the standard for new federal construction was LEED Silver (Leadership in Energy and Environmental Design, a building certification program developed by the US Green Building Council). In November 2011, the General Services Administration (GSA) upped the ante and required new federal buildings to achieve LEED Gold certification. This facility was designed to go beyond this and achieved the highest standard: LEED Platinum.

Conscientious design and unique NASA resources make this 2-story/2-wing half-moon building singularly high performing. Resource savings are optimized through passive and active systems, energy generation and water reclamation. Structural elements are externalized to maximize interior spaces and minimize thermal load. The exo-skeleton is also a reflection of Ames' long history with wind tunnels. Floor-to-ceiling windows, solar shades, skylights and ultra-high efficiency artificial lighting provide illumination with minimal energy demand, controlling

heat and glare. On-site geothermal wells maintain a constant water temperature resource to condition the building's ambient temperature. An open office plan flows into outdoor workspaces offering a range of environments with pleasing light, views, and natural ventilation.

The Intelligent Building Interface System (IBIS) will show real-time energy data on a building dashboard display located in the lobby. The data shown on the dashboard are received from the building's systems and subsystems. An Integrated Intelligent Building Control (IIBC) adaptive software tool is in development at Sustainability Base. Techniques developed for NASA's mission-related planetary exploration and aeronautics requirements are being used to address challenges of the built environment. Real-time input from distributed sensors (light, temperature, ventilation, humidity), current and anticipated weather conditions, residents' calendar schedules, and reported comfort levels will inform energy management. Prognostic (predictive) algorithms using physics-based models will support fault-detection and just-in-time performance intervention. Fault-checking diagnostics can identify operational instabilities and equipment degradation/failure. Maintenance schedules responsive to real system conditions will economically optimize operations. Data mining algorithms assess the performance of building systems. Indications of off-nominal performance are reported, enabling timely correction. These revolutionary technologies will enable gains in efficiency and overall cost-savings, not only for this facility but also, through development partnerships, for many others.



Sustainability Base has been honored with many recognitions and awards:

- 2012 - LEED Platinum Certification (U.S. Green Building Council)
- 2011 - "Leadership in Innovation Award" (Center on Environmental Innovation and Leadership)
- 2011 - White House "Lean Green and Mean" GreenGov Award
- 2011 - Engineering News Record California "Best Green Building Award"
- 2010 - "Real Property Innovation Award" (Government Services Agency)
- 2010 - San Jose Business Journal's 2010 "Green Project of the Year" Structures Award



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