Resource Guide for Sustainable Development

in an urban environment

a Case Study
in South Lake Union
Seattle, Washington

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VULCAN
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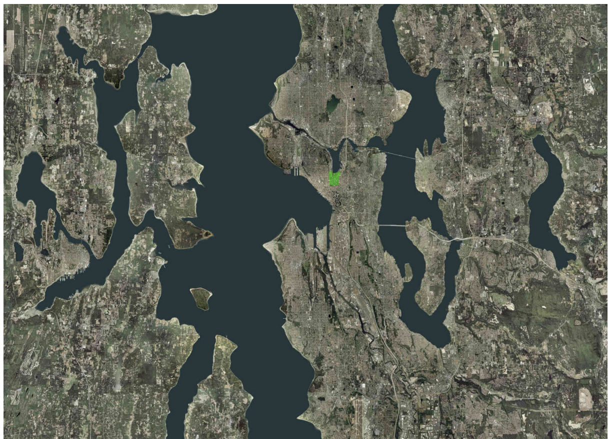

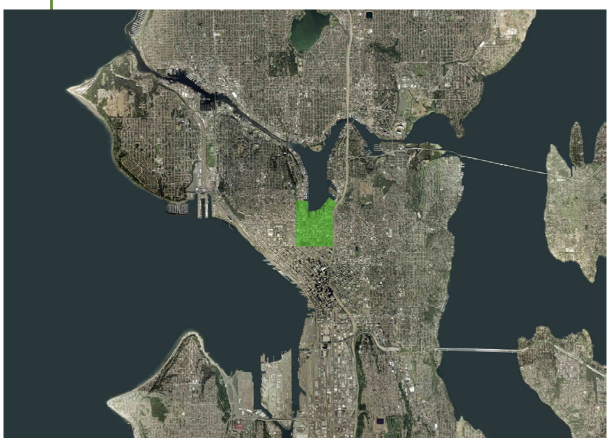

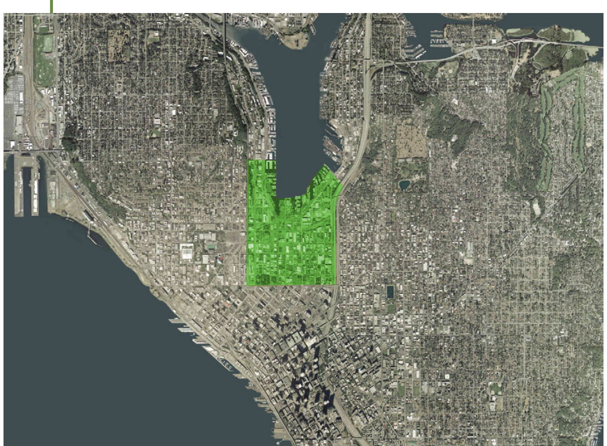

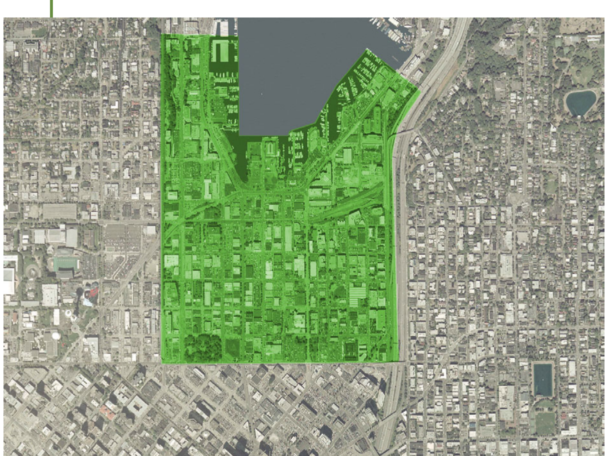

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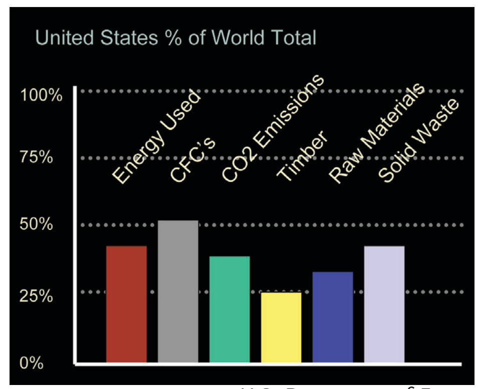
executive summary

Buildings consume a large portion of all resources within the United States. The United States consumes a large portion of the world's resources. Changing resource consumption in development practices can positively impact the world.

The Urban Environmental Institute and their consultant team of Mithun, Arup Engineers, 2020 Engineering, ValueMiner and Built-e received sponsorship from Vulcan, Inc. to develop a sustainability resource guide using South Lake Union as a case study area. Vulcan challenged the Urban Environmental Institute team to develop recommendations that would be 'repeatable' within the larger development community.

The following resource guide proposes goals, design principles and tools for designing and building sustainably in a mixed use development market. Many of the high performance buildings that have been completed in the last 10 years have been owner-occupied or for institutional owners. Within that community, the 'triple bottom line' concept of economic, environmental and social payback can be tuned to each owner or institution's unique environmental and social values. This study examines possibilities for the developer marketplace, and prioritizes a series of strategies that can be accomplished within a range of conventional payback time periods.



U.S. Department of Energy

Make wise choices within the budget

All buildings have budgets. At its best, the process of designing high performance and healthy buildings involves the integration and optimization of many aspects of building design: creative programming, appropriate siting, orientation for solar and wind access, quality envelope design, intelligent systems selection, careful clustering of uses, attention to detailing and selection of materials. Much of this can be accomplished with no additional cost if performance goals are established at the beginning of the process, and wise choices are made. It's how you make your choices that counts.

But, to push buildings to a higher level of energy performance and sustainability goals will require modifications to the standard development pro-forma. The added cost of these building and site modifications will be included in the pro forma because they meet some of the following economic criteria:

1. Payback as investment – Acceptance of payback goals longer than 5 years.
2. Additional income stream – Tenant–perceived amenities and response to new market demand for 'green' buildings.
3. Changing market value – Additional value created for 'green' design, as recognized by the appraisal, secondary lending markets, or purchasers. *More than the sum of the parts.*
4. Outside incentives – government, institution, or utility.
5. Internal incentives – Longer ownership or environmental values, two additional legs of the triple bottom line.
6. Marketing budget allocation – Transfer of funds to improve or create a unique brand identity for individual properties.
7. Aggregated savings from multiple buildings – Reductions in cost to individual buildings may pay for collected systems for multiple buildings, such as central energy systems.

Strive for Future Proof buildings
What is the value of providing flexibility to be able to respond to the future? Consider the value of "Future Proofing." Create buildings that will respond to the rapid changes in our society, including potentially unstable energy and water costs.

www.arttoday.com

Use Whole Building Design
Factor the synergistic relationships between building systems and building envelopes, rather than only looking at individual elements. Be lean and green! Juggle items within the construction budget to create sustainable design, before increasing the overall budget.

Create a Multi-Block Energy and Water Master Plan
Design collections of buildings to cluster uses based on synergistic energy, water, space, or transportation sharing opportunities. Optimizing energy performance for the multi-block level may depend on block scale use adjacencies.

Follow the Principles Because Recommendations and Tools Will Change
The principles which follow this summary are intended to be "time–proof." Use these as the map to guide your design choices. The resource guide gives specific recommendations for strategies that should be pursued. Strategies and tools will change over time, and should therefore be re-evaluated biannually.

Use a Common Sustainability Indicator
We believe that the U.S. Green Building Council (USGBC) LEED™ Rating System will become the green standard for buildings in the United States. As the system is untested in the speculative market, we would recommend running a LEED™ pilot project with possible assistance from utilities, and then re-evaluating the levels biannually as new versions are issued and developer teams gain experience with LEED™ and higher performance buildings.

Create a Green Building Brand
The development of a unique, strong brand identity for buildings that is focused around sustainability, can create value and lead the market. Elements such as natural daylight within the building, fresh air control for individuals through operable windows, and durable environmentally sensitive materials have the higher qualitative values which can develop a brand
.

Where Are We Going?
This study is a snapshot of sustainable design in 2002, and has the limitations inherent in evaluating the most current technology and cost information. As the designer and developer teams progress through their projects, they will generate feedback that will aid in assessing and revising goals for ongoing development. To keep this process timely, the collection of information and feedback from individual development projects should be distributed. This information should be shared with the greater development and construction community to further propel green strategies into the mainstream.

goals

October 2002

Seattle and Vulcan

Seattle is humming with sustainable activity! The City Council has declared several sustainability initiatives in recent years and set up new offices to promote sustainability programs. As part of these initiatives, all new city buildings over 5,000 sf of occupied space will now employ green design strategies and technologies that meet the U.S. LEED™ Silver Standard. As part of a comprehensive program, there is also serious interest in eventually bringing private sector development up to similar standards.

Vulcan is a Seattle based company that was started by Microsoft co-founder Paul Allen. Vulcan holds about 50 acres of urban properties in South Lake Union, an older industrial district just north of Seattle's downtown core, that is now zoned for mixed-use development. Vulcan wishes to use its portfolio to help promote cost-effective and repeatable environmentally sensitive urban development. This will be taken up by the speculative development sector because it can be shown to be good business.

The Urban Environmental Institute (UEI)

The Urban Environmental Institute is a non-profit organization based in Seattle with a focus on advanced environmental science research and demonstration. The UEI mission is:

To develop and operate a model sustainable community providing innovative solutions to environmental challenges through collaborative, cutting edge scientific research and education.

The UEI is a true multi-disciplinary group made up of professionals from the backgrounds of: environmental science and research, business management, urban planning and design, education, social services, law, and public administration. The purpose of the UEI is to reduce and ultimately reverse the global pollution trend by modeling solutions to global environmental problems, promoting advanced environmental science research, and creating a culture for sustainability by education. South Lake Union is a focal point for the UEI and the future location of its Environmental Campus, a multi-function research, education and technology incubator project.

The South Lake Union Project

When Vulcan became interested in studying the feasibility of advanced environmental design solutions for its commercial and residential market developments in South Lake Union, they approached the UEI. The UEI negotiated a contract with Mithun, a Seattle architecture, landscape and planning firm with substantial environmental design expertise, to prepare a study under the guidance of the UEI. Mithun, in turn, assembled some of the best available technical consultants to advise on many sections of the work.

This report represents the results of combining three key elements:

- the vision demonstrated by Vulcan in advancing market-driven urban development toward a more sustainable future
- the commitment and skill of the founders and board of the Urban Environmental Institute in guiding the work on this project from its mission and policy positions
- the tremendous experience and professional expertise assembled by the consultant team and their dedication to producing great work

The South Lake Union Goals

The purpose of this study is to identify design and technology solutions appropriate to South Lake Union that will reduce the short and long-term environmental impact of urban development and construction. These solutions must be proven repeatable, and make market sense. That is, the South Lake Union development cannot be a high risk experiment. The project must not be so unique it can't be repeated, and it must not incur extra costs that are not justified.

The premise of the work is that there are principles and strategies to guide sustainable building decision making. *Principles* are agreed approaches, such as saving potable water where possible, or reducing heating and air conditioning demand beyond energy code requirements. *Strategies* are methods of meeting the intent of the principle, such as recycling water or high performance energy design. The work is organized around categories of environmental effect, i.e. effects on *site and landscape*, effects on *water use and waste*, effects on *energy use and the atmosphere,* etc.

In addition to the above criteria, solutions for South Lake Union must promote urban livability and quality residential and workplace environments, while preserving and enhancing the historical fabric and economic future of the city. This goal extends the considerations of the work to broader issues such as transportation and the regional economy. Each principle and strategy must also be considered for its effects on a range of environmental, social and economic factors that exist at the local, regional and global level; for example the materials purchased can affect forestry practices, sustainable economies and habitat protection, some of which may occur far away in the producing region.

Conclusion

The Urban Environmental Institute is grateful to Vulcan for its exemplary vision in supporting this work. It also thanks the consultant team for their dedication to high-quality work. At the Institute, it is our belief that this project will contribute substantially to a fresh vision of urban development that will aid in reducing and ultimately reversing the global pollution trend. We believe it will promote advanced environmental design and environmental science and technology for the future.

David Rousseau, Co-Chair
Technical Standards Committee
The Urban Environmental Institute
Seattle, WA

principles

Listed below are design and planning principles to achieve sustainability goals.

Be Environmentally Smart

- Make wise choices, transferring costs from fluff to items that improve sustainable performance.
- **Whole Building Design** factors the synergistic relationships between building systems and building envelopes, rather than looking at individual elements. Use integrated multi-purpose design so that more than one purpose is being served by components of systems, and sustainable design is integrated into the building.
- Be lean and green! Juggle items within the construction budget to create sustainable design, before increasing the overall budget.
- Accept that sustainable strategies may challenge traditional aesthetic norms but have the opportunity to create an exciting new aesthetic.
- Limit risk through Future Proofing. Create buildings that will respond to rapid change in our society, including potentially unstable energy and water costs.
- Locate buildings and mix uses in a pattern that will enhance the symbiotic sharing of water, energy, flexible space and transportation modes.
- Reduce demand first. Prioritize expenditures to reduce demand for energy, water and materials.
- Make sustainable methods visible as an educational tool and brand opportunity.
- Develop a maintenance strategy to keep all systems at optimal performance.
- Re-evaluate strategies, sustainability indicators and tools on a regular basis.

Landscape and Site

- Maximize the quantity and quality of landscape. Consider all surfaces as opportunities, including roofs. Create an entire new look and feel for the public and private realm.
- Use plants that don't require irrigation. Select plants that thrive on available rain water.
- Use landscape for many functions: to treat storm water, to create animal habitat, to reduce heat islands, and to cool the local microclimate in summer.
- Use native Northwest plants as a first tier choice to help create habitat and restore native ecosystems.
- Encourage alternative transportation.

Water

- Eliminate use of potable water for toilet flushing, and other uses where potable water is not required.

- Strive to reduce the quantity and improve the quality of all water that comes through the site.

- Don't use potable water to irrigate plants.

- Strive to make exterior surfaces over soil pervious to allow water to percolate into the subsoil for detention, groundwater recharge and water filtration.

- Reduce wastewater load to wastewater treatment plants.

Energy and Atmosphere

- Site, orient and configure buildings to optimize daylighting and exterior views.

- Site, orient and configure buildings to use natural ventilation first, minimizing the use of energy consuming cooling.

- Site buildings and design facades and roofs to respond to the sun. Create distinct north, south, east and west facades based on solar impacts, passive solar gain, and control. Consider shading devices where appropriate.

- Locate buildings to mitigate noise pollution and/or adjacent air pollution.

- Maximize the use of affordable renewable energy sources to minimize dependence on utility power. Work towards carbon neutral design.

- Use the highest quality, highest performance envelope you can afford. Design for longevity.

- Re-examine current human thermal comfort assumptions based on type of activity and seasonal use, such as in transitional spaces like lobbies and corridors.

Materials and Resources

- Eliminate the concept of waste.

- Use less.

- Utilize local materials whenever possible.

- Design for longevity, durability, and flexibility of use.

- Create healthy buildings with low toxicity. Eliminate finish coatings where possible. Use low emitting materials.

- Evaluate materials to minimize embodied energy and maximize recycled content.
- Think “Cradle to Cradle,” being mindful of recycling opportunities and materials selection.
- Encourage responsible forest management by maximizing the use of sustainably certified wood.
- Request Life Cycle Assessment data from suppliers.

recommendations

The following recommendations are grouped by their relative cost and enviromental impact. These recommendations are specific to the Pacific Northwest. Economics and climates of other regions will require different recommendations (i.e. photovoltaics in California and Arizona).

DO THESE:
No additional cost, savings, or less than 5 year payback

PROCESS

When programming spaces, combine uses with similar energy profiles and orient for desired solar exposure. Increase comfort swings in transition spaces. Create adjacencies to eliminate utility duplication.

All buildings have budgets. Make wise choices within the budget. At its best, the process of designing high performance and healthy buildings involves the integration and optimization of many aspects of building design: creative programming, appropriate siting, orienting for solar and wind access, quality envelope design, careful clustering of uses, attention to detailing and selection of materials. Much of this can be accomplished with no additional cost if performance goals are established at the beginning of the process, and appropriate choices are made.

Strive for **Future Proof Buildings**. Create buildings that will respond to rapid changes in our society, including potentially unstable energy and water costs.

Use **Whole Building Design.** Factor the synergistic relationships between building systems and building envelopes, rather than only looking at individual elements.

Develop portfolio-wide building standards if they will eventually be managed by one entity. Standardize items such as hardware, plumbing, electrical devices, etc. Have mechanical and other relevant systems tied to a common language portfolio. Make key maintenance points accessible. Develop a maintenance strategy to ensure that systems remain at optimal performance.

Establish sustainability goals before starting schematic design. Circulate them to the design and contractor team when issuing the program document.

Provide "Welcome Package and Sustainable Operator's Manual" to explain green systems, material care, cleaning products, etc. to all tenants and building operators. This will empower them to contribute to a better environment.

Develop a "Green Housekeeping" Janitorial Program for all tenant spaces and buildings, utilizing environmentally sensitive materials and methods.

Use LEED™ as a guide, considering the future market value of the LEED™ label.

Run a LEED™ pilot project with possible assistance from utilities.

Join and participate in the USGBC and offer a developer's feedback on LEED™.

Create a leading green building brand. The creation of a unique, strong brand identity that is focused around sustainable buildings, can create value and lead the market. Things such as extensive natural daylight within the building, fresh air control for individuals through operable windows, and durable environmentally sensitive materials, have the higher qualitative values that can help create a brand.

Design real estate marketing materials to highlight sustainable features as part of the brand identity.

Perform research and development. Require a cost study of sustainable options as part of the schematic design process and initial project cost model. Use a cost estimator or contractor knowledgeable about sustainable design elements. Include cost reductions for integrated design strategies. For example, daylighting reduces daytime lighting requirements and daytime cooling loads, which can reduce sizing of HVAC equipment. Establish cost of meeting LEED™ Certified and LEED™ Silver certifications along with associated payback periods.

SITE

Make all landscaping multi-functional. Use landscaping to enhance and create animal habitat (primarily birds) as well as treating stormwater runoff.

Use xeriscaping with native plantings as first tier choice for landscaped areas. Identify any potential irrigation needs and tap existing greywater sources.

Celebrate site and sustainable features, such as rain collection, water runoff, trellises, etc.

Use high cutoff exterior light fixtures to reduce light pollution.

Eliminate pesticides for pest control and ongoing landscape maintenance.

Provide covered, lockable bicycle storage at 20% beyond code requirement and changing rooms with showers in non-residential buildings.

WATER

Use water conserving plumbing fixtures that exceed current code standards by 20%.

Use meter water, electricity and gas for all tenancies. Create awareness of energy use through a graphic display system providing real-time readouts in the building lobby.

ENERGY

Price commissioning on all projects and deduct for reduction in HVAC subcontractor's warranty. Work with developers and their mechanical and electrical consultants to come up with an alternative to basic commissioning. Review and negotiate with USGBC.

Site and orient buildings to maximize solar gain and control of heating, cooling and lighting. Ideally, buildings should be on an east-west axis. Each façade should respond to its respective solar and wind orientation. *The north, east, south and west façades should not be identical in design.*

Explore alternative building footprints. Investigate narrow building widths between 50 and 60 ft around atria for optimum natural ventilation and daylighting. Confirm fit with proposed building use, floor plate and acoustical context. Adjacent traffic or other noises will affect the degree of natural ventilation utilized.

Use simple lighting controls to maximize daylight harvesting and keep lights on only when needed. Use the most light-efficient and affordable lamps and luminaires available (2001, T5 fluorescent).

Provide highest possible ceiling for daylighting, natural ventilation, and thermal stratification. Daylighting in buildings with deeper footprints requires higher ceilings. Eliminate added ceilings when possible.

Use distributed heat pumps connected to district condenser water loop (if proper use adjacencies exist) in offices.

Provide wiring pathways, room and structural capacity for future placement of photovoltaics on rooftops or parking areas.

Provide wiring pathways, room and structural capacity for future fuel cells on rooftops or other locations at each building.

Provide information on Energy Star appliances to tenants and recommend that all appliances and office equipment be rated.

As a use strategy emerges for a full block or contiguous four-block areas, perform detailed engineering analysis of centralized energy and waste water strategies.

Meet with utilities at the beginning of the project and review current incentives. Optimize design to maximize incentive programs.

Pursue an additional 10% energy performance over the July 2001 Seattle code revisions. This should result in a less than 5 year payback above the newly created base case. This will need to be tested on actual projects with payback analyses in the schematic design phase.

MATERIALS

Use materials with high recycled content wherever possible. Meet current minimum of 25% high recycled content LEED™ goal.

Use a minimum of 20% fly ash content in all concrete. Strive for 50% as appropriate.

Use low emitting materials. Meet all current LEED™ requirements for adhesives, paints, carpets and composite wood.

Recycle a minimum of 95% of construction waste.

Use local and regional materials. Achieve at least one related LEED™ credit, with 20% of materials within each building manufactured within a 500 mile radius.

Provide space and access within each building for storage and collection of recyclable materials per LEED™ requirements.

Design envelopes and choose materials for durability. Careful design will weather without repeatedly adding finishes and replacing sealants. Consider overhangs, recessing critical joints or exposed areas. Mechanically overlap joints.

Use TPO (Thermoplastic Polyolefins) lightcolored roofing on all *flat* roofs.

DO THESE:
No conventional payback, but strong environmental, qualitative or marketing benefits

SITE

Use trellises and low level planted façade shading to encourage bird habitat.

On exterior surfaces over soil, use pervious concrete, porous concrete pavers, reinforced grass paving, crushed gravel and paving blocks wherever possible.

Use intensive vegetated roofs for at least 80% of roof surfaces.

Create a habitat plan to identify planting strategies and techniques that encourage a healthy ecosystem.

WATER

Provide separate water supply piping to all toilets for future and/or implemented water re-use.

Use composting toilets at unique low rise public spaces in mixed use buildings.

MATERIALS AND RESOURCES

Purchase Forest Stewardship Council (FSC) certified wood starting at 50% minimum, and increase by 5% each year to reach 100% in ten years. Combine with bulk purchasing strategy for optimum benefit.

All interior trim and finish wood to be certified by the FSC.

If finishing tenant improvements for a lease tenant, offer the option of leasing carpet. For common areas that will be carpeted, run the carpet lease option through a management and accounting benefit analysis.

Install CO2 monitors in educational and assembly spaces.

SHOULD DO THESE:
5–30 year payback, future proofing, but dependent upon pro-forma assumptions

PROCESS

Register for LEED™ Silver certification at minimum.

ENERGY

Use solar hot water heaters for heating domestic hot water. Review per building type.

Increase energy performance by 20% over the 2001 Seattle Energy Code. Use cutting edge technologies.

Develop 100% of residential space that is naturally ventilated. Enhance with cross ventilation where possible.

Create 50% of commercial floor area within 25 feet of operable windows.

Choose high quality exterior envelope for durability and reduced maintenance.

Office: Consider ventilated dual facades.

Office: Consider natural ventilation strategies using flues, atria and high-mass construction. Provide mixed mode HVAC systems if cooling is utilized, to maximize natural ventilation. Optimize *economizer* capacity of conventional ducted system to create a high capacity outdoor air system for better indoor air quality and energy savings.

Use total daylighting design using sophisticated controls, exterior light shelves etc., for office and lab buildings.

Use building integrated photovoltaics (BIPV) at high quality glass canopies or screening elements, i.e. entry canopy, sun controlled skylights and atria.

Examine leasing alternates that amortize the cost of higher efficiency HVAC systems that supply greater quantities of fresh air.

WATER

Investigate localized waste water treatment and implement if a detailed feasibility study checks out. Negotiate and review current incentives with city agencies to define capital incentives for decentralized biological wastewater treatment.

Use plumbing fixtures with the highest level of conservation, those that exceed the Energy Policy Act of 1992 by 30%.

CONSIDER DOING THESE:
no conventional payback, but strong environmental, qualitative or marketing benefits

Collect rainwater for flushing toilets and irrigation. (Do this only if green roof, composting toilets or living machine is not done). Review possible incentives with the City of Seattle.

Minimize use of PVCs in all building materials. Eliminate PVCs where an affordable environmentally friendly substitute is available. Develop phase-out plan for PVCs. Research alternates and supplies.

Provide air supply in raised floor distribution system for office and lab buildings.

Provide “Flexcars” for tenant use on a portfolio basis.

POSSIBLY DO THESE:
only if incentives can be negotiated with government agencies or utilities

Create a ‘Big Tree’ neighborhood. Work with the city to plant a double row of trees at all streetscapes. Plant extensively in sidewalk areas to achieve a 15% increase in planted area within the right of way.

Plant trees that will grow over 40' in height to create a continuous canopy on each side of the street.

Use pervious surfaces at the exterior over soil on the City of Seattle Right of Way (R.O.W.). Use pervious concrete, porous concrete pavers, reinforced grass paving, crushed gravel and paving blocks wherever possible.

Negotiate with the city for possible lane narrowing or planting projections at parallel parking streets.

Use photovoltaic panels over all parking areas, and partial coverage of roof areas.

Wind power or geothermal energy production: Explore with Seattle City Light in Eastern Washington or Central Oregon for a neighborhood utility district utilizing green power or other renewable strategy.

Commit to acheiving 30% consumption below the 2001 Seattle Energy Code in exchange for additional Floor Area Ratio (F.A.R.) and added height to allow for narrower buildings utilizing natural ventilation and daylighting.

Work with the City of Seattle to review additional incentive programs to help defray the costs of intensive green vegetated roofs. Vegetated roofs benefit the city in stormwater reduction, carbon offset, and reduction in the heat island effect, lowering demand for energy consuming cooling systems.

economics

of sustainable design

Green Can Be Gold

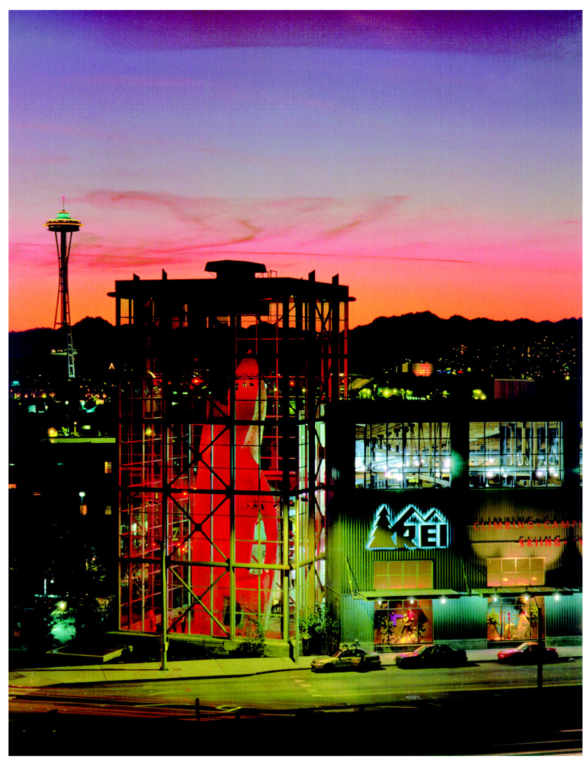
The market is changing. Market demand will be the true driver of sustainable development. In 1999, the USGBC LEED™ registered square footage of buildings in the United States was identified as "not applicable." In 2000, approximately 8,400,000 square feet were registered, and by September 2002 over 71,000,000 square feet of space had been registered to certify within the program. Understanding this, developers who provide buildings meeting credible sustainable criteria can have an edge over their competition today and meet the market demand of tomorrow. Green can be gold. Building value can be increased through incorporation of targeted sustainable strategies.

Making Wise Choices and Sustainable Cost Transfer

All projects have a fixed budget for which costs must be controlled to meet the budget criteria. Along the path to a completed building, the project team must make a series of choices to determine the makeup of the final constructed project. For example, the team could choose to have a marble floor or could allocate those costs to a more energy efficient lighting system, while still remaining within the original budget parameters.

Recreational Equipment, Inc. (REI) is a good example of a company whose capital projects need to meet the bottom line ("no dividend impact"), while also leading the industry in incorporating sustainable strategies. Opening in 1996, REI's Seattle Flagship store broke new ground in green architecture. The Flagship was recognized by the AIA with a Regional Honor Award and named one of the AIA Top Ten Green Buildings in the United States in 1999. The store also exceeded the 5th year annual sales target the first year. REI's Denver Flagship was 1.5% under the building construction budget, was named one of the AIATop Ten Green Buildings in the United States in 2001, received a National Trust for Historic Preservation Honor Award, and exceeded the first year sales goals. These successes are a result of making wise choices and transferring costs on a holistic basis.

Sustainable Cost Transfer within a fixed budget is a concept that eliminates certain elements and transfers those costs to other elements that have a higher environmental benefit. A common strategy in cost transfer is to move mechanical systems budgets to building envelope budgets. For example, air conditioning can often be eliminated through good design, and the budget line items transferred to operable windows for natural ventilation.



REI Flagship Store, Seattle
Robert Pisano / Mithun

Understanding Choices and Additional Costs Beyond Base Building Budget

Every project includes many choices and requires the team to make rapid decisions. We grouped some typical sustainable choices into three categories of relative economic viability:

1. Economically viable
2. Flexibility provides economic viability
3. No direct economic viability

Category 1 – Economically Viable: Strategies that are economically viable because the increased income, decreased expenses and/or lower risk are sufficient to offset the incremental cost of adopting the strategy.

Example: installation of high efficiency lighting and controls		
Economic factor	Impact	Rationale
Construction Costs	--	Increased construction costs for lighting, dimmable ballasts and controls. Incentives from City Light will help offset increased costs.
Rent	+	Lower operating costs may influence rent levels
Operating Cost	+	Reduced operating costs
Capital Cost	--	NA
Net Impact	+	Adds value to building through decreased operating costs.

Category 2 – Flexibility Provides Economic Viability: Strategies where providing the flexibility to implement solutions at a later date is economically viable because the increased income, decreased expenses and/or lower risk are not sufficient to offset the incremental cost of adopting the strategy for a short term investor. However, inflation, technology development and/or a longer investment horizon for a subsequent buyer are expected to make the strategies economically viable in the long term.

Example: option to install wastewater treatment		
Economic factor	Impact	Rationale
Construction Costs	---	Cost of pipe & machine installation
Rent	NA	No impact forecast
Operating Cost	+	Water savings, expect to increase over time with inflation
Capital Cost	+	Reduced cost of capital as a result of reducing future costs for water
Net Impact	-/+	Not viable now / will be later

Category 3 – No Direct Economic Viability – Strategies that are not economically viable because the increased income, decreased expenses and/or lower risk are not sufficient to offset the incremental cost of adopting the strategy. Costs for these elements must be justified through trade out with other building elements, environmental values incentives, or allocation from marketing budgets for improving brand identity.

Example: vegetative roofs		
Economic factor	Impact	Rationale
Construction Costs	--	Increased cost for construction
Rent	NA	No impact forecast
Operating Cost	+	Storm water savings
Capital Cost	NA	No impact forecast
Net Impact	-	Not viable

Guidelines Must Be Repeatable

The challenge of this resource guide is to create guidelines that can be applied repeatedly within the global development community. The guidelines for sustainability we outline can be followed without requiring reduced financial return expectations, additional funding outside the norm, and/or special incentives beyond what is now offered by institutions or government.

More specifically, the guidelines for sustainable development must provide developers and investors with returns for a given level of risk that are comparable to those they would receive from more traditional non-sustainable development projects.

It is important to note that we recognize funds may be available for research and development from institutions interested in advancing sustainability within the construction industry. However, we have chosen to treat these funds as potential incentives and have not included them in the baseline analyses.

Background

All property development projects have goals for profitability and expected financial return. Success in meeting these goals is dependent on many things, including the choices the project team makes as they work to complete the building. This section of the resource guide describes a framework for making those choices in a way that enhances sustainability and project financial performance.

The economics associated with property development are reasonably straight-forward. To be successful, the income received from renting space within and/or selling a property needs to exceed the cost of designing, developing, financing, building and operating the property. These factors are summarized in Equation 1.

Equation 1 The Baseline

Financial Return Equation:

Rental Income + Sales Price > Design Cost +
Building Cost +
Development Cost +
Financing Cost +
Operating Cost

The level of profitability for the project is determined by how much the sum of the Rental Income and the Sales Price exceeds the total of the five cost elements. As discussed later, the value of the project is determined by the timing of the different cash flows and the risk associated with the cash flows. The profitability required to adequately compensate investors for the level of risk they assume when financing development varies by the type of project.

Equation 2 Externality Cost

Financial Return Equation:

Rental Income + Sales Price > Building Cost + Design Cost + Development Cost + Financing Cost + Operating Cost + Environmental Cost + Infrastructure Cost

Taking a broader perspective, Equation 1 (the Financial Return Equation) would be modified as shown below in Equation 2 to capture the cost of environmental impacts and public infrastructure impacts collectively referred to as "externalities" – that are not normally charged directly to a development project.

Given our guidelines, we will use Equation 1 as the basis for the economic analysis framework except for specific instances where there are existing programs that compensate developers for reducing environmental and/or infrastructure costs. In these cases we will use Equation 3.

Equation 3 External Incentive

Financial Return Equation:

Rental Income + Sales Price + Infrastructure Cost Program Compensation > Building Cost + Design Cost + Development Cost + Financing Cost + Operating Cost + Environmental Cost + Infrastructure Cost

One of the challenges in establishing a framework for analyzing the economics of sustainability is that many sustainable building practices have an impact on each element of the financial return equation as shown in Table 1 following.

Table 1

Economic Impacts of Sustainable Construction		
Element	**Expected Impact**	**Rationale**
Property Rental Income	Increase	Less turnover, some will pay more for green space
Sales Price	Increase	Higher income, less risk
Building Cost	Increase	Invest to reduce impacts
Design Cost	Increase	Green design not standard
Development Cost	Increase	Green development not standard
Financing Cost	Decrease	Reduced environmental risk
Operating Cost	Decrease	Payoff from investments and reduced risk
Environmental Cost	Decrease	Payoff from investments
Public Infrastructure Cost	Decrease	Payoff from investments

Examination of Table 1 highlights the dilemma for those interested in promoting sustainable development. Up-front costs (design, development and building costs) often high while the measurable benefits are in the distant future. The dilemma is exacerbated by the fact that developers can't always capture the benefit of reducing environmental costs and public infrastructure costs. Even if the latter problem of internalizing "externalities" could be overcome (we believe it can) the absence of a large number of well-documented cases where sustainable designs have generated increased rents and sale prices while reducing operating costs, could make it difficult to finance these types of projects.

Breaking out of this "Catch-22" requires a framework for financial analysis that clearly identifies how sustainable development will affect project risk and returns.

Framework for Economic Analysis

We have already identified the need for the financial analysis framework to account for the fact that sustainable development will have an impact on all seven (or nine) elements of the Financial Return Equation. Completing the framework requires us to consider four more factors:

1. The perspective that should be used for evaluating each strategy;
2. The impact of ownership structure on investment incentives;
3. The way flexibility produces economic sustainability; and
4. The impact of soft benefits on project economics.

After these four factors are reviewed, we will present some numeric examples to illustrate the application of the framework.

Perspective

The sections that follow the resource guide outline specific strategies for improving sustainability in commercial properties. These strategies fall into three categories (listed from lowest level to highest):

1. Strategies that can be implemented one building/block at a time;
2. Strategies that can be implemented within a cluster of buildings/blocks; and
3. Strategies that can be implemented at the neighborhood level

Table 2 shows the category for each of the sustainability strategies.

Completing the analysis of each strategy from the appropriate perspective is a critical first step. The analyses should start at the highest level and move down. The results of each analysis (inclusion or exclusion of the strategy) at each level need to be passed down to the level(s) below.

If they are available, incentive programs from government agencies should also be examined at each level they apply, and the results passed down to the level(s) below.

We can look at the South Lake Union neighborhood to see how this should be applied. Sustainability strategies that are identified as neighborhood level strategies in Table 2 should ideally first be evaluated by neighborhood stakeholders and the recommendations of the analysis passed on to the developers before the design of building clusters or individual buildings begins. For example, the decision that sharing parking stalls across the neighborhood is economically viable has a direct impact on the number of parking stalls that need to be included in each building cluster and each building within the project.

Ownership Impact

The economic analyses are further complicated by the fact that the benefits of some of the strategies that are recommended in the resource guide will apply to the occupants of the buildings and not necessarily the owners. For example, an increase in employee productivity or retention, from the inclusion of extensive daylighting, or the lower costs to a tenant during reconfiguration of a space during the lease term due to a raised floor mechanical distribution system, may not be directly recouped by the owner. Absent a change in standard lease terms and/or an ability to increase rents, many investments that provide clear economic benefits to the building occupants will not be economically viable for the owner.

If we only consider developer perspective, then the sustainability strategies that are favored are those related to alternate sources for utilities.

Table 2

Sustainability Strategy	Implementation Level
Sites & Landscape	
1. Build near public transportation	Building/Block
2. Building services support alternative transportation	Building/Block
3. Alternative parking programs	Building/Block
4.Peak load/parking stall analysis	Block/Neighborhood
5. Vegetated roofs	Building
6. Increase tree cover	Block/Neighborhood
7. Light colored roofs	Building
8. Reduce light pollution	Building/Block/Neighborhood
9. Optimize site orientation	Building/Block
10.Enable animal habitat expansion	Block/Neighborhood
11. Make sustainable sites visible	Building/Block
Water Efficiency	
1. Water efficient landscaping	Building/Block
2. Treated effluent for flushing toilets	Cluster
3. Reuse of greywater for irrigation	Building/Block
4. Permeable surfaces on sidewalks and streets	Block/Neighborhood
5. Stormwater treatment and detention	Block/Neighborhood
6. Rainwater collection for toilets	Building/Block
7. Water conservation	Building/Block
Energy & Atmosphere	
1. Distributed heat pumps	Building/Block
2. Chilled water	Building/Block/Cluster
3. Cogeneration	Neighborhood
4. Photovoltaics	Building/Block
5. Fuel cells	Building/Block/Cluster
6. Microturbines	Building/Block/ Cluster/Neighborhood
7. Energy efficiency	Building/Block
8. Daylighting & natural ventilation	Building/Block
Materials & Resources	
1. Reuse and rehabilitate buildings	Building/Block
2. Purchase green certified products	Building
3. Construction waste management	Building/Block
4. Material reuse pilot project	Neighborhood
5. Store and collect recycled materials	Building/Block
6. Use recycled building materials	Building/Block
7. Use local/regional materials	Building/Block
8. Use rapidly renewable materials	Building/Block
Indoor Environmental Quality	
1. CO_2 Monitoring	Building/Block
2. Ventilation effectiveness	Building/Block
3. Indoor pollutant control	Building/Block
4. Construction management	Building/Block
5. Low emitting materials	Building/Block
Flexibility	Building/Cluster/Neighborhood

Flexibility and Economic Sustainability

A commercial building typically lasts 40 years in the United States. One of the best ways to minimize the environmental impact of a commercial building is to ensure that it is fully and productively utilized over that time period (or even longer). This is not as easy as it sounds. Over a 40 year period: the efficiency of most building systems will improve dramatically, prices for utilities will probably increase markedly, the facility's occupants will experience many different business cycles, and the needs of these occupants will evolve as technology and business practices advance.

One of the keys to a long life for a commercial property is the flexibility to adapt to these changing conditions.

Fortunately, we now have tools that allow us to evaluate the flexibility that is designed in to a building. For the purposes of our discussion, we will define flexibility as the ability to respond to changing economic conditions. This type of flexibility has two financial impacts. First, giving the building the ability to adapt to changing conditions reduces the risk associated with investing in the building. The same flexibility also increases the building's expected life, income and value. In short, adding flexibility can create economic sustainability.

For a number of reasons, economic sustainability supports and reinforces environmental sustainability. First, avoiding the need to replace the building prematurely has a direct and obvious impact on reducing the overall impact on the environment. Second, the flexibility features that add the most value are generally the ones that will have the greatest impact on reducing environmental impacts. Understanding why this is so will take a little more discussion concerning the value of flexibility.

The value of flexibility is directly related to the amount of uncertainty surrounding the factor(s) that require(s) adaptation. For example, if the price of butter was increasing and it routinely fluctuated by 50% or more every month, then the flexibility to switch to margarine would be very valuable to a business that used a large amount of butter. Alternatively, if the price of butter was stable or declining, then the flexibility to switch to margarine would probably not be worth much.

For the development projects we are discussing, a large part of the uncertainty surrounds prices for commodities like electricity and water that are increasingly scarce and have a number of related environmental impacts. As a result, the value of the flexibility to use alternative sources for these commodities is relatively high. The alternatives identified for these commodities rely on renewable sources and/or conservation. Carrying the logic one step further we can conclude that the value of adding the flexibility to switch to sustainable sources is relatively high (see Equation 4 for a summary of this logic chain).

Equation 4 ***Flexibility***

Energy Price Uncertainty → Value from Flexibility → Sustainable Energy Solutions

Providing the flexibility to switch to sustainable solutions when it adds value represents a middle ground between "sustainability at any cost" and "5 year payback or else". We can now modify the Financial Return Equation as shown in Equation 5.

Equation 5 Flexibility Value
Financial Return Equation:

Rental Income + Sales Price + Program Compensation >	Building Cost +
Value of Flexibility	Design Cost +
	Development Cost +
	Financing Cost +
	Operating Cost +
	Index Cost +
	Environmental Cost +
	Infrastructure Cost

Examples of adding the flexibility to switch to a sustainable solution could include providing the infrastructure required to enable a rapid photovoltaic retrofit, providing for effluent wastewater treatment retrofits, providing for fuel cell technology retrofits and providing for the later installation of on-site co-generation.

Soft-Benefit Impact on Value

The framework for analysis outlined above already has the ability to capture many of the soft benefits that sustainable strategies are expected to generate. Using the prior example within the framework of Equation 1 the project team:

- Could choose to have a marble floor,
- Could choose to spend the same money installing more energy efficient lighting, or it
- Could choose to install both a marble floor and more energy efficient lighting because the benefit of having both is expected to increase rental income enough to offset the increased cost.

Using the framework of Equation 5, some of the environmental benefits that sustainable strategies generate can also be captured.

It is worth noting here there is no reason to restrict these benefits to cost reductions. Projecting increases in revenue is clearly justified in many cases. For example, developers in the Seattle area routinely charge more for properties located on the borders of greenbelt. Along similar lines, there are "soft" benefits beyond flexibility. These are associated with new energy solutions discussed in the previous section that should be included in the economic analysis.

The growing "digital economy" is at least partially responsible for the increasing demand for "green" workspace. The same digital economy is having two related impacts on the energy industry that are not as widely publicized. First, digital technology is radically improving the efficiency capable from power conversion devices of all types (for example, LEDs for lighting). Second, the digital economy is also creating a demand for high quality, highly reliable power to keep the computers and electronic equipment that power the digital economy running smoothly. In a recent study the Electric Power Research Institute (EPRI) noted:

> "U.S. business activity is becoming more reliant on digital circuitry and more sensitive to incredibly minute variations in power supply — variations that would have gone unnoticed in years past."

By designing a sustainable power grid to supply "the high quality, high 9s power" (99.999% available) that many high technology industries require, developers can justify and should charge a premium for "high quality, reliable, green" power.

Beyond explicitly capturing soft benefits in one of the twelve elements of the Financial Return Equation (Equation 5) at the individual strategy level, there are soft benefits that need to be analyzed at both a building and cluster level. The two most important benefits that need to be analyzed at these levels are risk reduction and brand value.

Brand Identity Positive Impact of Value

The "dot bomb" phenomenon and its close linkage with the now bankrupt companies that spent millions of dollars advertising their unprofitable web sites has generated a great deal of cynicism regarding the concept of branding, particularly for new endeavors. While some of this cynicism is misplaced, there is an element of truth in it as well. Building a strong brand is not a simple task. Having said that, we will explore the potential for a branding effort to add value to sustainable development projects.

Within the framework that we have defined, brand value appears as value over and above the value associated with the addition of each individual component as described in the previous section. In other words if brand value were present, the overall value impact of a bundle of features (or strategies) would be greater than the sum of the individual strategy impacts.

Strong brands require at least three things:

1) A promise to provide a benefits package that people value;
2) Awareness that the owner of the brand can provide this value package; and
3) The consistent delivery of the promised value package.

The combination of aesthetic benefits, environmental benefits, health benefits and the benefits associated with reliable, high quality power that can be part of the "value package" provided by sustainable development, has the potential to support the creation of a brand. With well-defined programs at the project level to promote awareness of the brand value package and ensure the consistent delivery of the value package to consumers, brand value could be added to the Financial Return Equation as shown in Equation 6.

Equation 6 Brand Value

Financial Return Equation:

Rental Income + Sales Price + Value of Flexibility + Program Compensation + Brand Value > Building Cost + Design Cost + Development Cost + Financing Cost + Operating Cost + Environmental Cost + Infrastructure Cost

At the same time, without well-defined programs to promote brand awareness and ensure consistent delivery of the package to consumers, brand value should be regarded as a potential upside and re-evaluated when a branding program is developed.

Concept brochure for marketing green office spaces *Mithun*

Risk Reduction Positive Impact on Value

All real estate projects face a number of risks. The seven risks most commonly associated with real estate projects are shown in Table 3.

Table 3

Real Estate Project Risks	*Description*
1. Economic Risk	Income is derived from rent, economic conditions affect the ability to rent space, this risk is also a function of the amount of leverage used
2. Liquidity Risk	The ability to sell a property and the price that can be obtained for a property are subject to varying market conditions
3. Inflation Risk	Unexpected inflation can reduce the operating income for the property
4. Interest Rate Risk	Changes in interest rates can affect the value of a property even if the mortgage rate is fixed
5. Operation Risk	Effective operation of the property is required to maximize income
6. Legislative Risk	Regulations may affect the economic value of a property development
7. Environmental Risk	Real estate is often affected by changes in the environment or new awareness of hazards that exist in the environment

While each building and cluster needs to be analyzed individually, adherence to the guidelines outlined in the resource guide will reduce project exposure to inflation risk, business risk and environmental risk as shown in Table 4.

Table 4

Guideline	Impact
Add flexibility to respond to changing use for space	Reduce Business Risk
Use sustainable resources and/or add the flexibility to respond to changes in technology and relative price levels	Reduce Inflation Risk
Follow LEED standards	Reduce Environmental Risk
Adopt low impact construction practices	Reduce Environmental Risk

The reduced risk for projects adopting the guidelines should eventually reduce the rate of return required by investors providing capital for these projects. As seen later in the examples, depending on the cost associated with adopting these strategies, this reduction in the cost of capital can improve operating income and project value.

Examples

The application of the framework for valuing real estate projects will be illustrated by providing four examples of how the framework would be applied to valuing changes to a real estate project.

The four examples are:

1. The analysis of low emission materials at the building level;
2. The analysis of energy saving fixtures at the building level;
3. The analysis of waste water treatment at the cluster level; and
4. The analysis of vegetative roofs at the building level.

These examples may be viewed in detail in Appendix A: economics

Analysis Overview

The examples are intended to be realistic but they were not prepared with sufficient detail to support a project decision.

There are two primary methods for valuing a real estate project. The simplest method states that a property's indicated value equals its net operating income (NOI) divided by the investor's required overall capitalization rate. Mathematically, the larger the denominator is, the smaller the left-hand side of the equation (i.e., value) will be. Therefore, investors with higher required rates of return will offer less for a property than those with lower rates.

The other valuation method is the income capitalization approach. Under this valuation technique, the indicated value of the subject property equals the present value of the anticipated future income stream. Of course, an underlying premise of the income approach is that the property either generates income or has the potential to do so.

In the simplest of all scenarios, the income approach states that a property's indicated value equals its net operating income (NOI) divided by the investor's required overall capitalization rate. Mathematically, the larger the denominator is, the smaller the value will be. Therefore, investors with higher required rates of return will offer less for a property than those with lower rate of return requirements. Analyzing the present value of projected cash flows is the basis of a more sophisticated approach to real estate project valuation. This methodology discounts anticipated cash flows to a present value, given an appropriate discount or capitalization rate. In other words, the income capitalization approach implies that the indicated value of the subject property equals the discounted value of the anticipated cash flows, whereby the land, improvements permanently attached to the land, and all rights associated with the land are capitalized into the income stream. On a before-tax basis, the indicated value equals the sum of the present value of the before-tax cash flows (BTCF) and the before-tax equity reversion (BTER).

Equation 7 Sustainable Value

$$\textbf{Value} = BTCF_1/(1+i)^1 + BTCF_2/(1+i)^2 + \ldots + (BTCF_N + BTER_N)/1+i)^N$$

Using the terminology of Equations 1, 2, 3 and 5, the annual BTCF equals rental income minus operating cost and annualized debt service payments (financing cost), while the BTER equals the future sales price of the property minus selling expenses and the unpaid mortgage balance owed to the lender. Equation 7 shows the form of the equation for an income capitalization valuation.

In Equation 7, $BTCF_j$ (j=1, 2, ..., N) equals the before-tax cash flow in year "j"; "i" equals the discount rate; "N" equals the holding period; and, $BTER_N$ equals the before-tax equity reversion in year "N."


Roofscapes, Inc.

Some of the methods outlined in the economics section (as well as software and systems for implementing these methods) are covered by one or more ValueMiner patents.

Summary: Green can be Gold

We have seen that the the economic viability of the sustainable strategies recommended in the resource guide fall in to three categories:

1. Strategies that are economically viable.
2. Strategies where the flexibility to implement at a later date are economically viable and worth investing in. This is particularly true for strategies where technology development, inflation or a different ownership time frame are expected to change the economic prospects of a strategy.
3. Strategies that are not economically viable. Costs for these elements must be justified through trade-out with other building elements, incentives or allocation from marketing budgets.

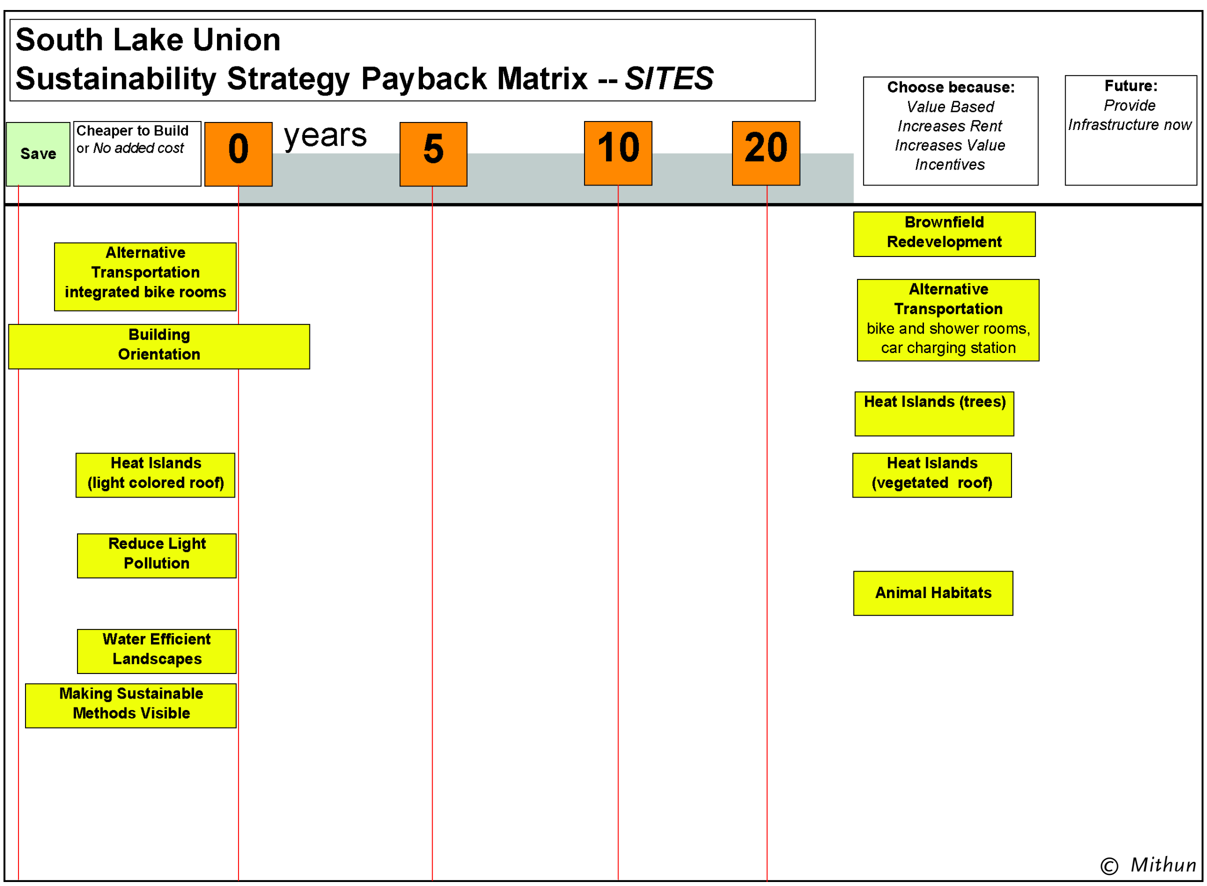
As described above, the economic analysis of a sustainable development project requires consideration of the impact of sustainable strategies on the 12 elements of the financial return equation from the proper perspective (in our case: the building, block or cluster level). The *ownership* of the benefits from the sustainability strategy also needs to be considered.

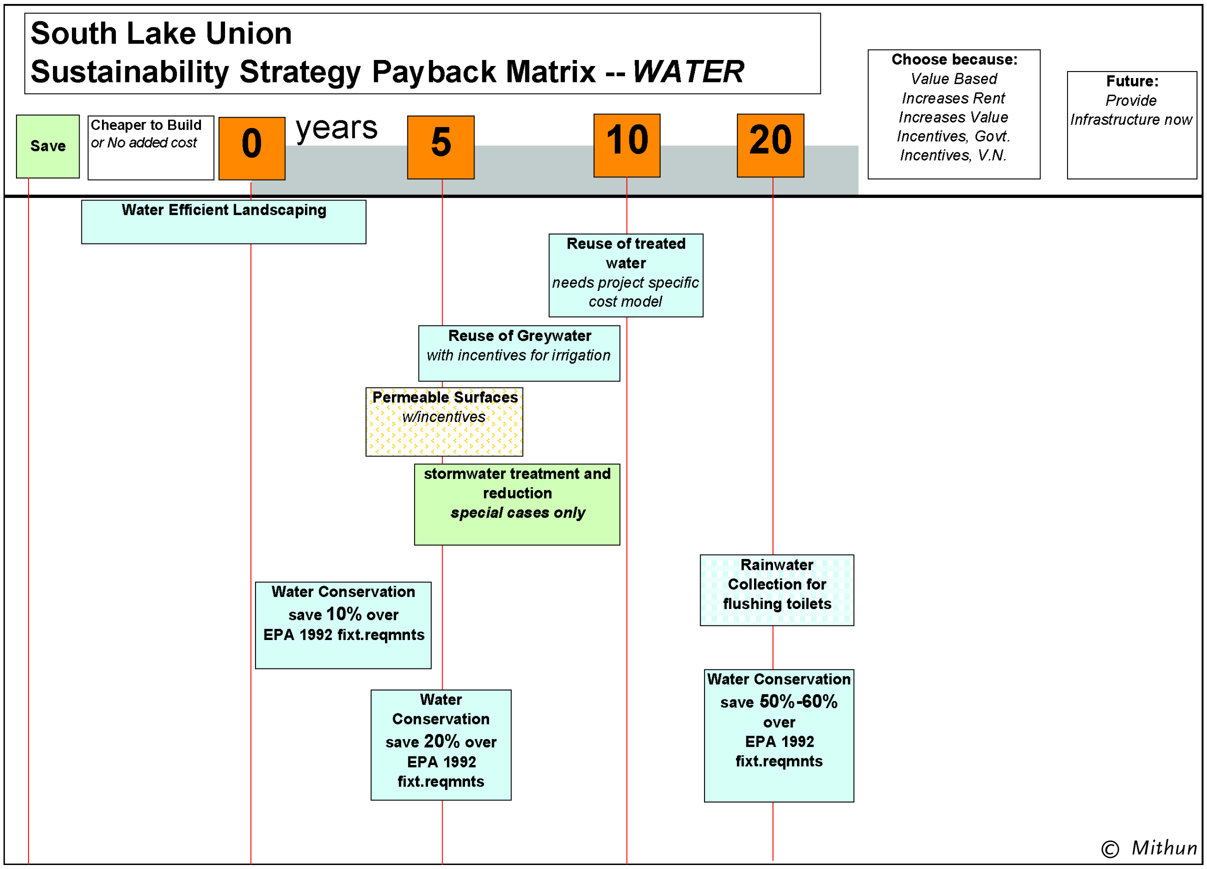
Moving beyond the individual strategy level we have seen that a branding strategy at the multi-building level has the potential to positively impact value if it is more clearly defined. We have also seen that increased flexibility and adherence to the environmental sustainability guidelines of the resource guide are expected to enhance economic sustainability, reduce risk and perhaps reduce the cost of capital for development.

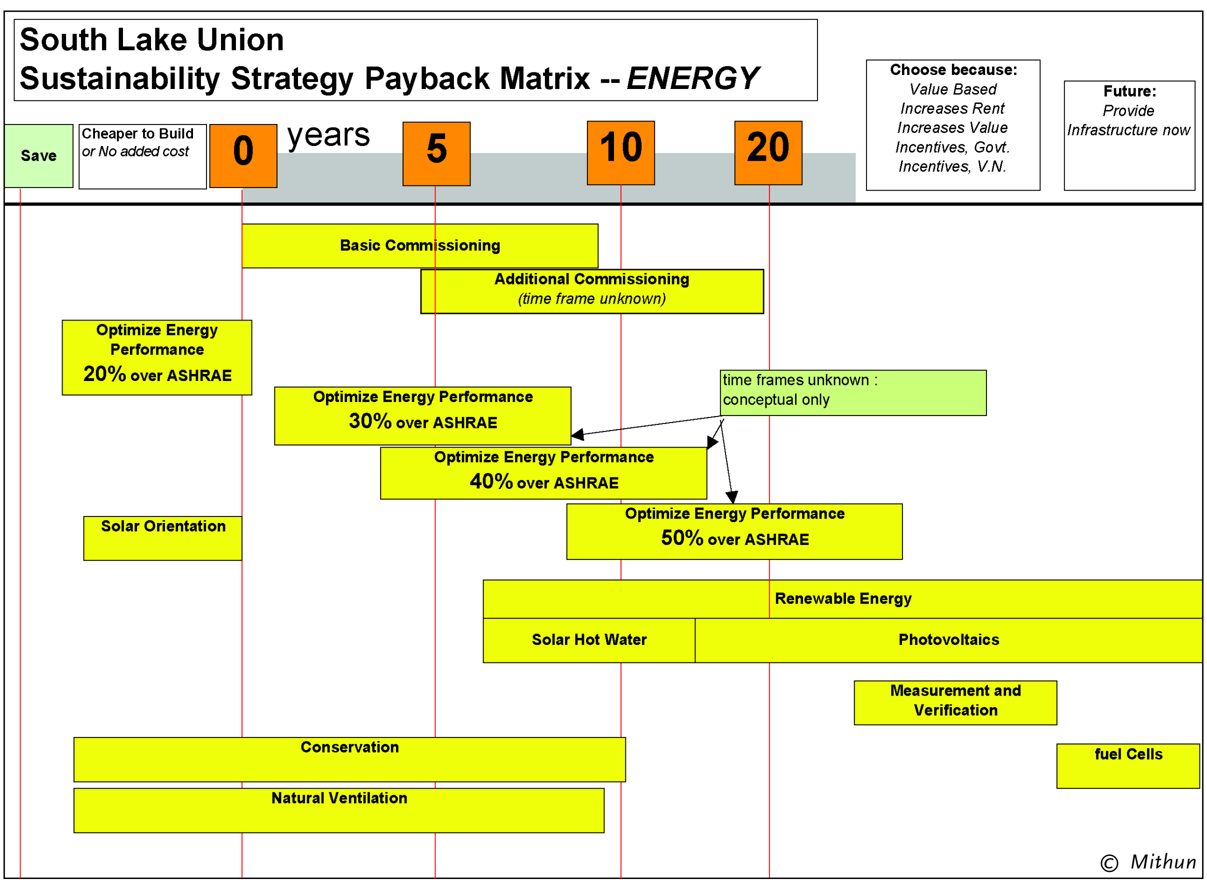
payback summaries

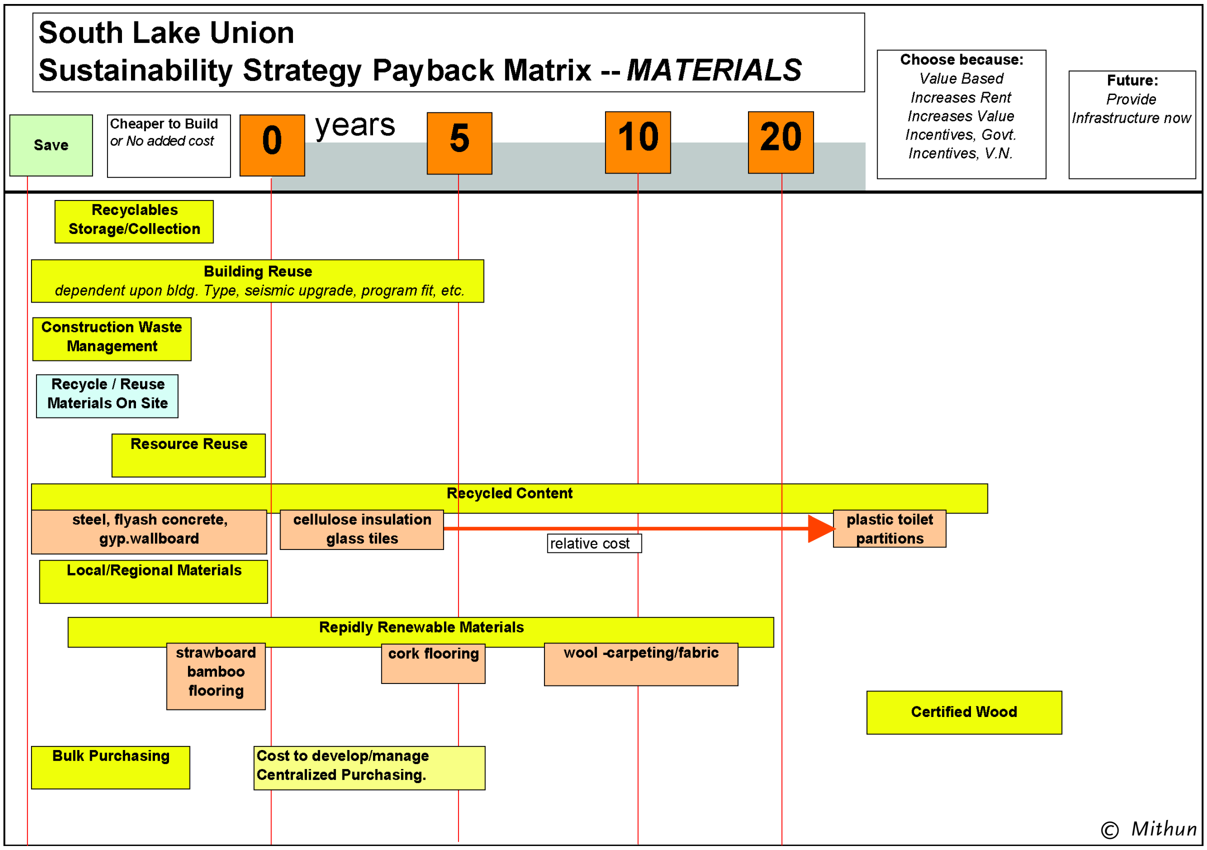
sustainability strategies

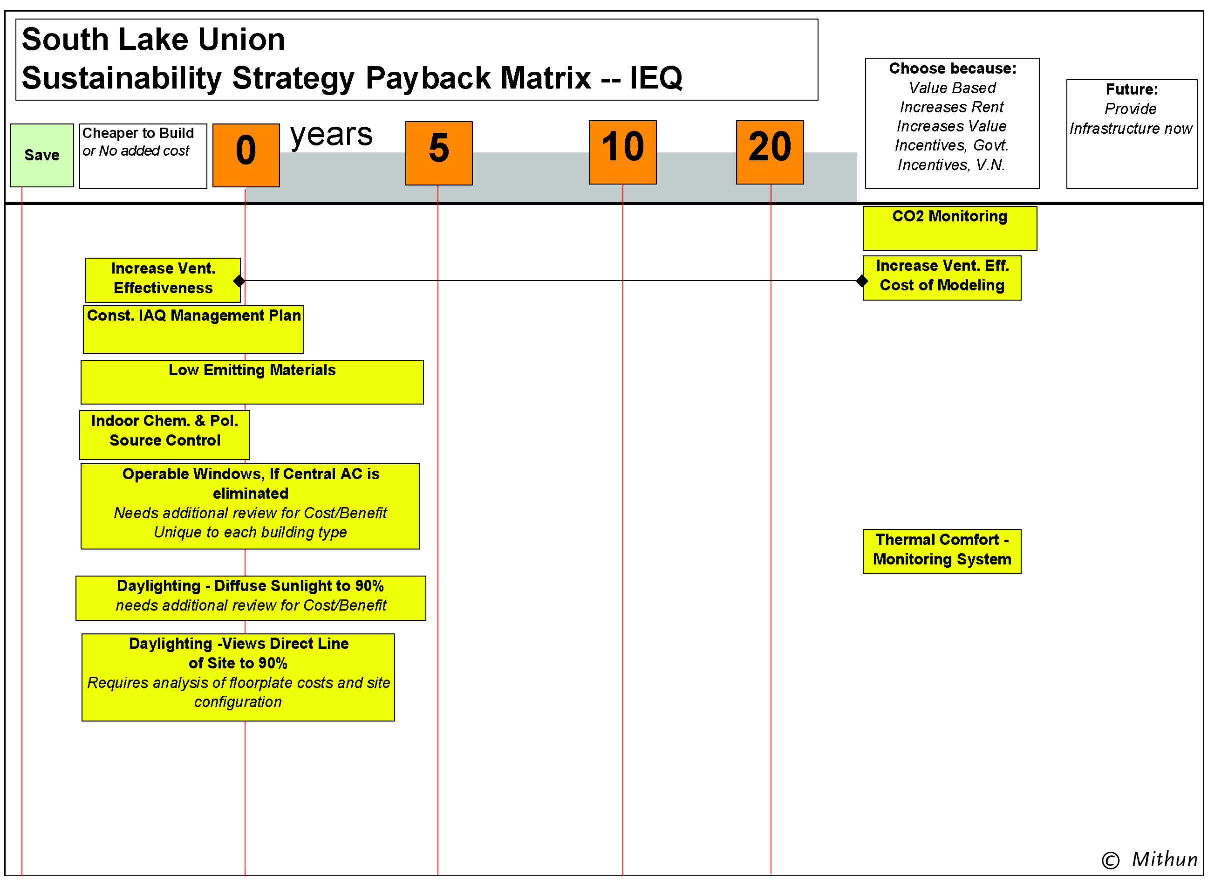
Payback Summary charts are a conceptual tool for mapping each sustainability strategy, and their respective payback periods. These strategies are roughly modeled for multi-story commercial buildings in Seattle in 2001. These need to be analysed for each project, as size, occupancy, and orientation can affect these numbers substantially. The strategies, listed from top to bottom, correspond with the strategies listed in the sections that follow. Across the top of the chart is a range of values and payback periods. Starting on the left is 'save' strategies that will reduce costs. Next is 'cheaper to build or no added costs' vs. standard market construction for a class A office building. Next are the years, indicated current ballpark numbers for payback. On the right is a category for items that are value based, these desirable because of environmental or social benefits that cannot be justified financially or increase rent or value. This also includes strategies that would be economical because of government. incentives or internal owner incentives. An owner can select the strategies that fit within their budget and value goals. Changes in water rates, power prices and material costs will impact these charts substantially in the coming years.




South Lake Union
Sustainability Strategy Payback Matrix -- WATER
Choose because:
Value Based
Increases Rent
Increases Value
Incentives, Govt.
Incentives, V.N.
Future:
Provide
Infrastructure now
Save
Cheaper to Build
or No added cost
0
years
5
10
20
Water Efficient Landscaping
Reuse of treated water
needs project specific cost model
Reuse of Greywater
with incentives for irrigation
Permeable Surfaces
w/incentives
stormwater treatment and reduction
special cases only
Rainwater Collection for flushing toilets
Water Conservation save 10% over EPA 1992 fixt.reqmnts
Water Conservation save 20% over EPA 1992 fixt.reqmnts
Water Conservation save 50%-60% over EPA 1992 fixt.reqmnts
© Mithun


South Lake Union
Sustainability Strategy Payback Matrix -- ENERGY
Choose because:
Value Based
Increases Rent
Increases Value
Incentives, Govt.
Incentives, V.N.
Future:
Provide
Infrastructure now
Save
Cheaper to Build
or No added cost
0
years
5
10
20
Basic Commissioning
Additional Commissioning
(time frame unknown)
Optimize Energy Performance
20% over ASHRAE
time frames unknown :
conceptual only
Optimize Energy Performance
30% over ASHRAE
Optimize Energy Performance
40% over ASHRAE
Solar Orientation
Optimize Energy Performance
50% over ASHRAE
Renewable Energy
Solar Hot Water
Photovoltaics
Measurement and Verification
Conservation
fuel Cells
Natural Ventilation
© Mithun


South Lake Union
Sustainability Strategy Payback Matrix -- MATERIALS
Choose because:
Value Based
Increases Rent
Increases Value
Incentives, Govt.
Incentives, V.N.
Future:
Provide
Infrastructure now
Save
Cheaper to Build
or No added cost
0
years
5
10
20
Recyclables
Storage/Collection
Building Reuse
dependent upon bldg. Type, seismic upgrade, program fit, etc.
Construction Waste
Management
Recycle / Reuse
Materials On Site
Resource Reuse
Recycled Content
steel, flyash concrete,
gyp.wallboard
cellulose insulation
glass tiles
relative cost
plastic toilet
partitions
Local/Regional Materials
Repidly Renewable Materials
strawboard
bamboo
flooring
cork flooring
wool -carpeting/fabric
Certified Wood
Bulk Purchasing
Cost to develop/manage
Centralized Purchasing.
© Mithun


South Lake Union
Sustainability Strategy Payback Matrix -- IEQ
Choose because:
Value Based
Increases Rent
Increases Value
Incentives, Govt.
Incentives, V.N.
Future:
Provide
Infrastructure now
Save
Cheaper to Build
or No added cost
0
years
5
10
20
CO2 Monitoring
Increase Vent.
Effectiveness
Increase Vent. Eff.
Cost of Modeling
Const. IAQ Management Plan
Low Emitting Materials
Indoor Chem. & Pol.
Source Control
Operable Windows, If Central AC is
eliminated
Needs additional review for Cost/Benefit
Unique to each building type
Thermal Comfort -
Monitoring System
Daylighting - Diffuse Sunlight to 90%
needs additional review for Cost/Benefit
Daylighting -Views Direct Line
of Site to 90%
Requires analysis of floorplate costs and site
configuration
© Mithun

future proofing

GOAL

Limit long term risk and increase value by creating structures that are healthy economical to operate, respond to a growing demand for green buildings, have qualitative value, and can adapt to change.

STRATEGY: LIMIT RISK

What is the value of providing flexibility to be able to respond to future change? Consider the value of **Future Proofing**. Create buildings that are better able to respond to the rapid change in our society, including potentially unstable energy and water costs.

Change is constant. Within the three month time period of this resource guide a new energy code amendment by the City of Seattle was created, discussed, and implemented, requiring a 20% improvement in commercial structures' energy performance. What energy changes are in the future? What will be the cost of energy? Limiting risk of the unknown through creating energy efficient structures, and providing the potential for future technology implementation within a building's design, can help "future proof" the portfolio.

What will be the cost of water in the future? Is water a finite resource? How can a company limit the future risk of high water costs? Implementing strategies today that limit the exposure providing infrastructure to incorporate or adapt to future technologies is a future proofing strategy.

Creating healthy buildings with good indoor air quality limits risk.

In cases where the technology has not arrived or costs are too high to implement today (i.e. photovoltaics, fuel cells, rainwater re-use, data upgrades, etc.), reasonable assumptions should be made about future technologies and shortages. Infrastructure should be provided for their future implementation.

COSTS: INCREASE VALUE

Future Proofing a building could have economic benefit in impacting lending rates due to lower future risk, provide competitive lease rates and respond to a higher demand from the growing awareness of green buildings. Other benefits may include lower insurance rates for healthy buildings, lower vacancy rates, and adaptability to change.

MARKETING AMENITY

A marketing amenity could be capitalized through a brand identity that indicates lower risk of high energy or water costs being passed on to tenants.

rating systems

GOAL
Establish a benchmark to measure the success of sustainable strategies.

An essential part of any sustainable design program is evaluation. There are several green building rating systems available to choose from. Within the last four years, there has been a proliferation of rating systems. The systems that were researched and evaluated for this paper include LEED™, BREEAM, GBTool, Air Force Green Building Guidelines, the NYC High Performance Buildings Guidelines, and the Minnesota Sustainable Design Guide.

Additionally, rating systems have been developed which relate to cities or urban development collectively, such as the City of Austin's Smart Growth Matrix. The City of Seattle's comprehensive land use plans encourage a diversity of uses in the South Lake Union neighborhood, which can help minimize impacts and support those plans.

What is the reason behind the proliferation of the green building rating systems? The reasons are as numerous as the rating systems. Below are some of the more commonly cited reasons:

- To establish a high performance building benchmarking tool. Prior to the emergence of these rating systems, many projects were labeled as "green" without conclusive evidence as to why or how. In using a green building rating system, it becomes easier to compare projects. The underlying assumptions for the relative weighting of points is contentious, but at the end of the day, it still gives the industry a common benchmark.
- To educate building designers, builders, owners and occupants about the benefits of sustainable buildings.
- To accelerate use and stimulate demand for sustainable buildings.
- To establish green labeling for marketing to the public.
- To distinguish buildings designed and constructed with reduced environmental impact.
- To encourage best environmental practices in building design and construction.
- To establish criteria and standards that go beyond those required by law and building codes.

All of these rating systems focus on five basic areas:

- Site
- Water
- Energy
- Materials
- Indoor Environmental Quality

Many of the systems establish prescriptive requirements with associated points or credits. Some go further than others in attempts to quantify the various elements of the rating system. At least one system has established penalty points for unsustainable practices. None of the rating systems are comprehensive and each has its strong and weak points.

Of the systems evaluated, LEED™, BREEAM, and GBTool are the most comprehensive and are the recommended models for use in establishing sustainable guidelines. The organizations responsible for these three systems have begun discussing the possibility of coordinating efforts to foster improvement and consistency amongst their respective guidelines.

> *"There is a growing realization that a major jump in performance levels, at least in market economies, will depend on changes in market demand, and that such change cannot occur until building investors and tenants have access to a relatively simple method that allows them to identify buildings that perform to a higher standard." - GBTool*

RATING SYSTEM CRITERIA - RATING THE RATING SYSTEMS

Good rating systems should have the same basic elements. The evaluation of these rating systems is based on the following criteria:

- ***Credibility:*** Rating system criteria must be objective and consistent with current, universally accepted scientific knowledge and data. Rating system requirements and criteria must be completely consistent and be synergistic in nature.
- ***Performance-Based:*** Criteria should offer prescriptive recommendations, but be performance-based.
- ***Verification:*** Credits must be easily verifiable by independent, third party assessors. In order to be verified, credits must be measurable.
- ***Ease of Use:*** Credit data must be easy to collect. Documentation requirements must be simple and straightforward.
- ***Regular Updates and Improvements:*** Rating systems need to be regularly and systematically updated and improved. Rating systems should adapt to changing laws and regulations, changes in the market, new sustainable materials and systems, etc. As systems are updated, criteria should be as consistent as possible from version to version.

LEED™ RECOMMENDED†

The recommendation of this guide is that LEED™ be adopted as the framework used to evaluate all future development and all development uses, including residential projects. It is further recommended that LEED™ be adapted to suit the particular requirements of developments in the South Lake Union neighborhood. Modifications to LEED™ should be developed based on the information contained in the body of this guide, and initial *testing of the waters* by projects in the pipeline.

† The use of the US Green Building Council and the LEED™ rating system is by permission of the US Green Building Council. This does not indicate an endorsement of products or services appearing in this document by the US Green Building Council or the LEED™ rating system.

GENERAL

Leadership in **E**nergy and **E**nvironmental **D**esign, LEED™, is a green building rating system written and maintained by the non-profit US Green Building Council (USGBC). The rating system was originally developed for commercial buildings over six stories in height. The council is currently developing additional criteria that will incorporate the areas of commercial interiors, commercial core and shell, residential projects less than six stories, operation and maintenance, and community design.

LEED™ is quickly becoming the national green building rating system of choice among design professionals, owners and governmental agencies. The USGBC has had conversations with the authors of GBTool and BREEAM in an effort to improve it. One of the primary authors of BREEAM, Nigel Howard, was hired in 2001 to work on LEED™ Version 3.0.

LEED™ is a self-assessing rating system. The project team performs the documentation. There is no third party assessment requirement for certification; however, the council has ultimate authority to approve projects for certification to ensure that the rating system requirements have been met. LEED™ contains prescriptive requirements as a guideline to achieving the credit intents, but where inconsistencies occur, the credit intents are the overriding criteria. Each LEED™ credit has been designed to be verifiable.

The USGBC allows adaptation of LEED™ within prescribed limits. Organizations or governmental bodies are free to adapt the rating system by incorporating specific requirements and still obtain council-sanctioned LEED™ certification. LEED™ estimates that in the near future, there will be 10 adaptations of LEED™ in use.

> "LEED™ Commercial Building is most closely targeted to owner-occupant (including government/ institutional) markets, along with enlightened spec developers. Multi-building/PUD developers also have shown intense interest in LEED™ and may be a natural market for a product merging the greening of community-level systems with individual buildings. Subtenants are the next market to be addressed. The exact nature of the market in the residential sector is still being worked out, given the strong role of the builder in determining market offerings. Spec commercial developers are a potentially rich field, but a great deal of thought has to be given to structuring financing and marketing packages for them that make sense given the timing of their cash flow, risks, etc. For example, spec developers often count on leasing a project even before the ground is broken, using the leases as collateral for loans. In these instances, a LEED™ rating after construction provides little assistance in leasing up the building." — *Quote from the USGBC*

STATUS

As of June 2002, there are currently 22 buildings with LEED™ certifications in the US. Of these, eight have been certified under the newest version, LEED™ 2.0. At the time of this writing, just over 400 buildings are registered with the council. Registration is the first step in acquiring certification. The USGBC projects that by the year 2005, 5000 buildings will be registered and 1000 certified.

CERTIFICATION PROCESS – COSTS AND PREREQUISITES

Buildings certified with the US Green Building Council LEED™ program are certified after construction is complete and documentation is evaluated and accepted by the council. The USGBC is considering implementation of a process for certification prior to construction for core and shell projects. This will enable developers to market their projects as LEED™ certified early in the development process. The project registration fee is currently $1,250 for members and $1,500 for non-members. Documentation can be time consuming. The documentation process can range from $10,000–$50,000, depending on the extent and size of the project, and could be significantly higher depending on the project complexity and team experience.

Building commissioning of **fundamental systems** is a prerequisite to being certified. Independent building commissioning costs can be as much 0.5%–1.5% of the overall construction cost for sophisticated building systems. The prerequisite does not require independent commissioned involvement, but does require that someone not intimately involved with the design process develop a commissioning plan during design development. This can be done by an employee of one of the design team consultant firms without jeopardizing the requirement. This may even be substantially less costly than contracting an independent commissioning authority.

For buildings with few systems, or unsophisticated systems, commissioning prerequisite requirements are minor. It is recommended that systems such as occupancy sensors, lighting controls, operable windows, solar shades, water saving and collection devices, photovoltaic systems and alternative waste treatment systems be commissioned following the prerequisite requirements.

If points are tallied for improving energy efficiency beyond the ASHRAE standard referenced, computer modeling is required to show the difference between a base case building modeling based on the actual project, and anticipated results due to energy efficient design. The cost for this modeling can add costs to the project.

WHAT IS THE ADDED COST TO THE CONSTRUCTION BUDGET FOR DOING A LEED™ RATED BUILDING?

Many parties are looking for the answer to this question. Right now it is difficult to compile definitive information correlated to the different levels of certification. Because of the interlocking nature of sustainable strategies, the costs frequently overlap into many trades and disciplines. Some LEED™ points are easy to segregate and price, i.e. commissioning, whereas others such as Optimize Energy Performance involve multiple strategies including envelope, orientation, lighting, lighting controls, etc. As LEED™ certified projects are completed, additional information will become available.

Mithun contacted all projects that had been certified by the USGBC as of June 1, 2001, and received a range of responses that are tabulated in the following chart.

Phone survey of LEED™ certified projects. April/May 2001

QUESTION: What was added to the construction cost to obtain LEED Certification?

Category	Project Name	Project Owner	Location	Rating	Project Team	Response	Added Cost
LEED 1.0 Certified Projects (Pilot version)	Bachelor Enlisted Quarters, Great Lakes Naval Training Center	U.S. Dept. of the Navy	Great Lakes, Illinois	**Certified**	Wight & Co., Architect and James McHigh Construction Co.	Because this project was so large and sustainable elements were incorporated at the outset, **the added cost was minimal**. Time to develop sustainable elements were absorbed into normal project costs and fees; again, due to the time when sustainability was defined and the economies possible to be realized in a project of this size." -	**Minimal**
	Brengel Technology Center	Johnson Controls, Inc.	Milwaukee, Wisconsin	**Certified**	The Zimmerman Design Group	The attitude that the design team for the Brengel Center took in the early development was to demonstrate that we could achieve a high level of efficiency without adding to the budget. The 130,000-square-foot Brengel Center was built for a cost of just under $17 million, which puts it in line with the market average **construction cost of $125 per square foot.** We knew we could do it because it's been done before. In fact, the building Kurt Zimmerman designed with HOK for S.C. Johnson & Son was built for $34.8 million, 10 to 15% below the U.S. average for traditional office and laboratory space. And West Bend Mutual Insurance Co. constructed its 150,000-square-foot headquarters for $90 per square foot — 28% below the U.S. average. Both of those projects include many green and high-tech features, including the under floor air systems and ERWs used at the new tech center.	**None**
	Donald Bren School of Environmental Science & Management	Univ. of California, Santa Barbara	Santa Barbara, CA	**Platinum**	Zimmer Gunsul Fransca Partnership	Greening recommendations resulted in many innovative technologies and ecologically sensitive materials for the new 84,672-square-foot building, which **will be completed in 2002**	Unknown
	Energy Resource Centre	Southern CA Gas Company	Downey, CA	**Certified**	Wolff/Lang/Christopher Architects, Inc.	Project costs computed by architectural team reported that this recycled building project was much less than a typically constructed similar type building, and reflects expenses unique to a recycled building project, such a dismantling, sorting and hauling, and for special environmentally sensitive materials and processes. When these figures are costed over the building life cycle, cost benefits are greater still.	None
	Greater Pittsburgh Community Food Bank	GPCFB	Duquesne, PA	**Silver**	Gardner and Pope Architects	No Response	NA
	Kandalama Hotel	Aitken Spence Hotels, Ltd.	Damulla, Sri Lanka	**Bronze**	Green Technologies, Inc.	Project: out of country. Different cost structure.	NA
	KSBA Architects Office	Larenceville	Pittsburgh, PA	**Certified**	KSBA Architects	No additional cost. Location was in-fill site. $70-80/s.f.	None
	Nidus Center for Scientific Enterprise	Monsanto Company	Creve Coeur, MO	**Silver**	HOK	"A document I have shows a 3.4% increase in cost for the Nidus Center. (This was a 45,000 SF, $10 million project). Some of the items that increased the cost due to LEEDS incorporation also are items that we designated as being over the required spec quality (and thus cost even more) or requirements by the client despite LEEDS incorporation. This means that some cost items were included for several reasons and we used our judgment as to whether to attribute the cost to LEEDS itself." - Project Architect	**3-4%**
	Oquirrh Park Speeding Skating Oval	Salt Lake City Organizing Committee of the Olympic Winter Games 2002	Salt Lake City, UT	**Certified**	Gillies Stransky Brems Smith (Architect)	Greening recommendations resulted in many innovative technologies and ecologically sensitive materials for the new 84,672-square-foot building, which will be completed in 2002. Total construction cost was $28 mil. About $100,000 was specially added for obtaining the LEED certification. For example: $5,000 for additional trees, $25,000 for water management plan, $10,000 air monitoring system, $14,000 filtration, $24,000 oil grit separation, etc. Fees for architect was higher than originally anticipated.	**3/10 % negligible increase**
	Pennsylvania Dept. Of Environmental Protection South Central Regional Headquarters	New Morgan Municipal Authority	Harrisburg, PA	**Bronze**	Kulp Boecker Architects	More than construction cost, he thinks these items are the additional cost: 1) Commissioning - 1/2 - 1% of construction cost, and if the project is more than 10,000s.f., 2) Energy $8-15,000, Daylight $2-7,000 and 3) LEED Documentation $12-15,000.	**1/2 to 1-1/2%**
	Sundeck Restaurant	Aspen Skiing Co.	Aspen, CO	**Bronze**	Aspen Skiing Co.	out of season.	Unknown
LEED 2.0 Certified Projects	PNC Firstside Center	PNC Financial Services Group	Pittsburgh, PA	**Silver**	L.D.Astorino Companies	$100MIL project. During the construction, they decided to go to the LEED certification. For Certified level, didn't need to add any cost, but needed to add $200-300,000 to go to Silver level. He believes if things were done properly (lighting, mech/elec, etc.) could save some money (instead of adding cost). Construction cost was $160/s.f. - the project/design required high security systems.	**Certified:** No add **Silver:** .2-.3%
	McCaw Performance Hall	City of Seattle	Seattle, WA	**Silver**	LMN Architects	The estimated incremental construction cost for the project to reach Silver is $900,000, or less than 1%.	**under 1%**
	Municipal Courts	City of Seattle	Seattle, WA	**Silver**	NBBJ	4% was added to the budget for the project to cover design and construction costs.	**4%**
Other Study	City of Seattle, FAQ site.			**Silver**	Various	In some cases, additional costs vary by project size. Some projects with budgets of over $10 million have required **an additional 4%** to meet LEED Silver, compared to projects under $10 million which required **an additional 6%.**	**4% over $10 million 6% under $10 million**
	Study of 3 City of Portland, OR, buildings built since '94			**None**		If they had been designed to meet Silver LEED, first costs would have increased from zero to 2.2% and that future savings would have more than offset the initial investment.	**0-2.2%**

context

HISTORICAL NOTES

Lake Union is believed to have formed roughly 12,000 years ago, following movement during the Vashon glaciation, which carved the basin of Lake Union and the many depressions, ridges, and troughs in the area. Prior to the mid 19th century, South Lake Union was inhabited by the Duwamish people. According to T.T. Waterman, Lake Union was known as Xa'ten, or "little lake,[1]" (EIS, 15–4). The area at the southern end of Lake Union, where a trail from Seattle Harbor terminated, was known as Ctca'qwcid, or "Where a trail descends to the water." This became the location of some of the first industry in the South Lake Union area including the Denny sawmill.

South Lake Union – c. 1880s
Paul Dorpat

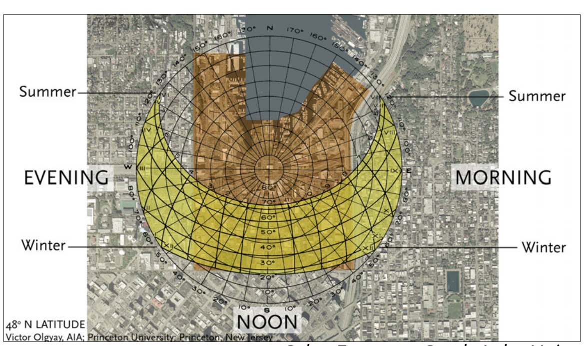
Early industry in the South Lake Union area included coal shipping, timber and shingle milling. As a result of that early industry, the water of Lake Union and many portions of land surrounding it had been heavily polluted. The regrading of much of the surrounding area by sluicing into the lake has shrunk its size from approximately 900 acres to its current size of 600 acres. In addition to showing a larger lake, some early maps show a stream flowing toward Lake Union around what is now Boren Avenue.

South Lake Union – c. late 1920s
Paul Dorpat

NATURAL RESOURCES

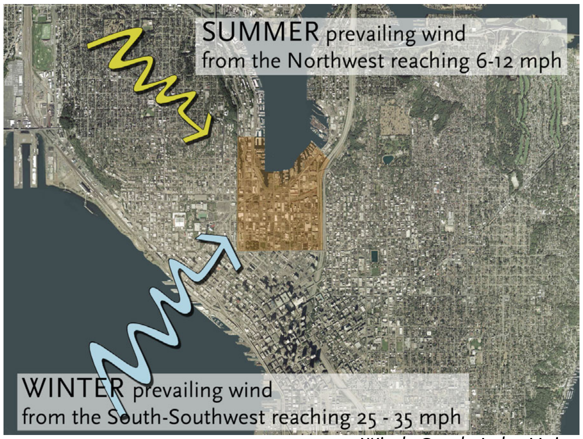
Sun: In Seattle, the average annual daily radiation ranges from 3.5 kWh/m^2 to 3.8 kWh/m^2. Relative to some other areas of the world where solar energy is being explored and utilized, this number is above average. In Northern Germany, for example, where solar energy is being used as a viable alternative energy source, the average annual daily radiation only ranges from 2.5kWh/m^2 to 2.75 kWh/m^2. Areas like Phoenix, Arizona, on the other hand, receive an average of 5.7 kWh/m^2.

Wind: According to the sailors at the Center for Wooden Boats, prevailing winds in the immediate area come from the south-southwest in the winter months and can reach 20–30 knots (23–35 mph). Winds are generally lighter in the summer, coming from the Northwest at 5–10 knots (6–12 mph).



Solar Exposure, South Lake Union
Mithun

Water: The potable water supply for the South Lake Union Planning Area comes from the greater Seattle interconnected water system, which is supplied by both the Cedar River Watershed (Chester Morse Lake) and the South Fork Tolt Watershed (Tolt Reservoir). Roughly one million gallons of potable water flow into the South Lake Union Planning Area from this system. The existing sewer system then carries used water out of the Planning Area, eventually taking it to the West Point Treatment Facility in Magnolia, which

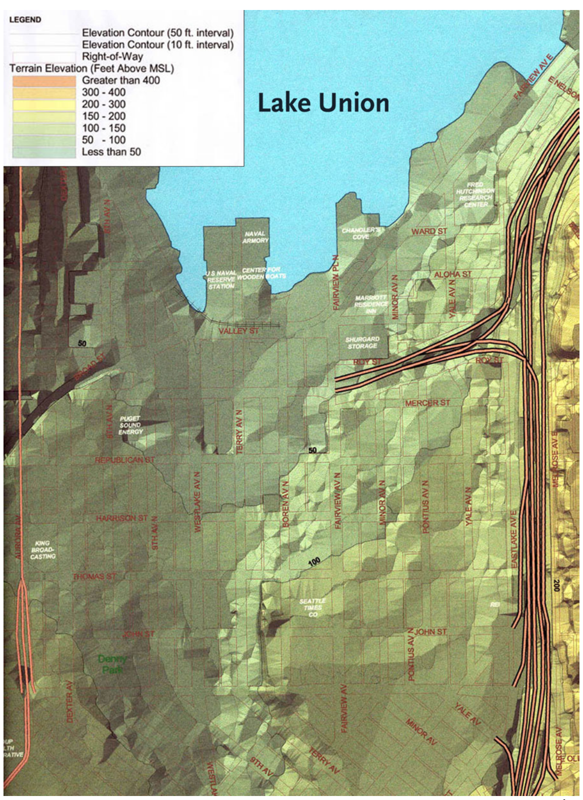


Wind, South Lake Union
Mithun

provides a secondary level of treatment.

Groundwater in South Lake Union generally flows with the current topography (the result of massive regrading efforts). In the eastern portion of the planning area, water flows from east to west (from Capitol Hill) towards the depressed area of the site, around Westlake Avenue. Water flows from the western portion of the planning area towards this same trough, where it then flows north toward Lake Union. Due to the high number of utility trenches and waste fill in the area, water flow is influenced at times by local conditions and may not drain with the topography of the land[2]. The high amount of impervious surface in the South Lake Union area prevents the natural drainage of water into the ground. Therefore, most groundwater in the area comes from the Capitol Hill and Queen Anne neighborhoods.

Groundwater in the area is contaminated by a high number of underground storage tanks, many of which leak into the soil. As of 1995, there were 290 known tanks, and 50 sites with a leaking tank[3]. The Unocal site at 600 Westlake Avenue North released 80,000 gallons of leaded gasoline in 1980 (40,000 gallons have been recovered.) Current storm water runoff is contaminated, both by automobile and industrial pollutants. Clearly, an effort to address these groundwater and contamination issues is needed.



Topography
DCLU, City of Seattle

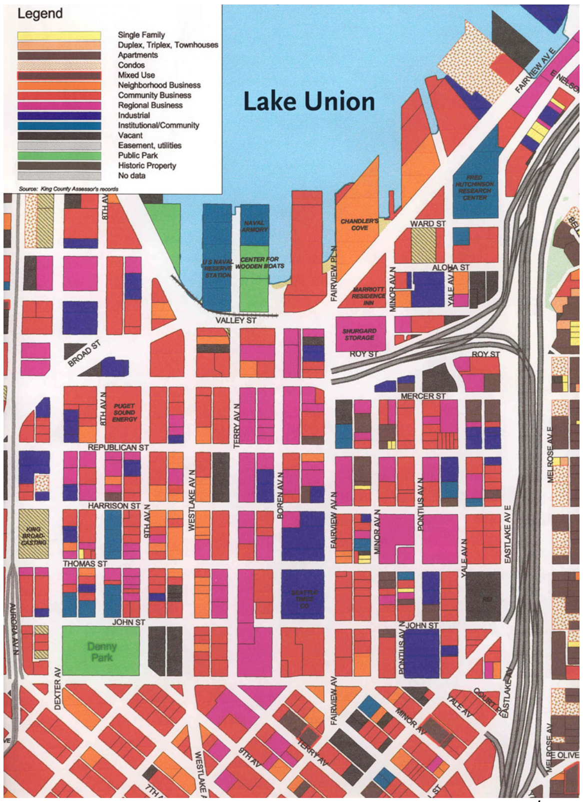
LAND USE

The neighborhood of South Lake Union was identified by the City of Seattle's 1994 Comprehensive Urban Plan as a Hub Urban Village. The South Union Planning Area (SLUPA), for the purposes of this study, is defined by Denny Avenue to the south, Lake Union to the north, Interstate 5 to the east, and Aurora Avenue on the west. SLUPA is approximately 370 acres in total area, with roughly 125 acres (34%) currently dedicated to the public right of way.

Zoning in the South Lake Union neighborhood varies, including commercial, residential, and mixed-use areas. Building height limits in South Lake Union generally decrease from south to north, with the area along the lake having the shortest height limit in the area.

According to the South Lake Union Neighborhood Plan of 1998, land use in the area consists mainly of office and retail services which combined, total approximately 41% of the land. Only 3% of the developed area of South Lake Union is used for housing, while warehouse and industrial buildings total 35% and parking occupies 16%[4].

Much of the land along the waterfront in the South Lake Union neighborhood is the result of regrading and filling. In the early 20th Century, city engineers sluiced the western portion of Denny Hill (to the Southwest of South Lake Union) into Elliott Bay, and regraded the area to fill the trough around Westlake and Valley Streets. The area now slated to become South Lake Union Park sits on wood waste fill from early timber mills.



Land Use
DCLU, City of Seattle

INFRASTRUCTURE

Sewer and Stormwater: The majority of the South Lake Union Planning Area is "paved as streets or parking lots or supports buildings, and as such, does not allow rainfall to infiltrate into the ground[5]." The result of this large amount of impervious surface is a high amount of water runoff, which finds its way to storm drains and ditches. Because many of the storm sewers discharge into Lake Union, the vast majority of runoff water, and all the material that is picked up along the way, ends up in the lake.

Most storm water in South Lake Union runs into small storm sewers, which are coupled with sanitary sewers. This combines most storm water with sewage from the planning area into a 72-inch diameter Metro trunk sewer, running below Republican west from Terry. The remaining storm water drains into Lake Union. All storm and sewer water in the trunk line eventually runs to the West Point treatment plant.

In the event of a large storm and high rainfall runoff, sewer water overflows from the system through combined sewer overflows (CSOs). In South Lake Union, five CSOs carry sewer overflow into Lake Union, draining raw, untreated sewage into the Lake. Two storm sewer overflows also exist in South Lake Union, carrying only storm water to the Lake[6]. A new CSO line intended to mitigate sewer overflow into the lake is under construction.

Electrical Power: Seattle City Light (SCL) has a medium voltage distribution system that runs along most of the streets within the portfolio neighborhood. According to SCL the proposed neighborhood density will require an upgrade to this distribution system including a new substation for the area to supplement the existing system capacity. If a co-gen plant were built, it would tie into the same distribution grid. Negotiations with City Light will be required to determine how to coordinate new construction work with the utility infrastructure.

FOOTNOTES:

1 From the Environmental Impact Statement prepared for the Seattle Commons proposal, 1995, p. 15–4.
2 From the Environmental Impact Statement prepared for the Seattle Commons proposal, 1995, p. 3–7.
3 From the Environmental Impact Statemend prepared for the Seattle Commons proposal, 1995, p. 7–5.
4 From the South Lake Union Neighborhood Plan, 1998, p. 9.
5 From the Environmental Impact Statement prepared for the Seattle Commons proposal, 1995, p. 3–3.
6 From the Environmental Impact Statement prepared for the Seattle Commons proposal, 1995, p. 3–4.

sustainability strategies

The following section reviews over 35 strategies and evaluations for implementing sustainable design and construction. The section is loosely organized around the LEED™ framework and is organized under the following headers:

- **Sustainable Sites & Landscape** – landscaping, urban design, transportation, etc.
- **Water Efficiency** – water reduction and re-use, irrigation, efficient fixtures, etc.
- **Energy & Atmosphere** – portfolio level, building level
- **Materials & Resources** – low emitting materials, recycled materials, etc.
- **Indoor Environmental Quality** – air quality, daylighting

Each section has an introduction with an overview and recommendations.

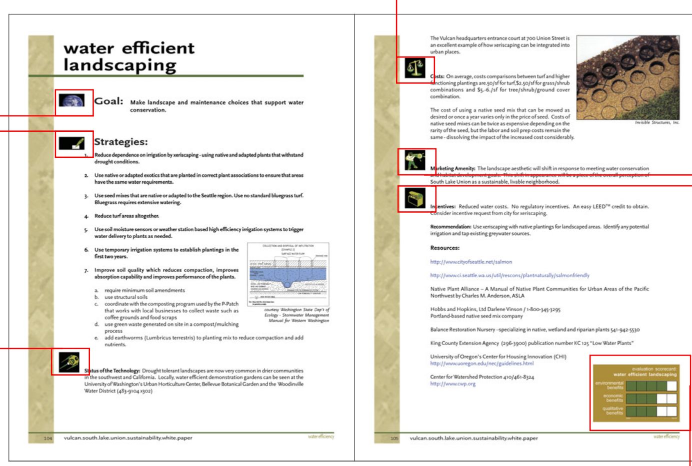
TYPICAL STRATEGIES PAGE

COST: What are the relative costs? What is the increase or savings over baseline construction?

GOALS: What are the broad environmental goals being addressed?

MARKETING: Does this strategy create value in the eyes of the consumer? Does it increase value,or enable leasing more quickly in a tight market?

STRATEGIES: What are the specific design, process, or construction strategies that can be implemented?



INCENTIVES: Are there any City, State, or Federal incentives? Should this be a point for future negotiation? Should incentives be proposed to government agencies?

TECHNOLOGY: Is this a tried and true strategy? Are there risks? Cutting edge or bleeding edge?

SCORECARD: A Triple Bottom Line evaluation, with relative benefits for environmental, cost, and qualitative criteria. A very broad brush look at relative benefits.

SCORECARD INCLUDES:
Environmental Benefits: relative contribution toward meeting environmental goals
Economic Benefits: the greater the benefit, the less impact on pro-forma.
Qualitative Benefits: effect on human health, aesthetics, productivity, sense of well being.

sustainable sites & landscape

introduction

OVERVIEW

Recognizing the power of natural processes as functioning systems is key to creating a sustainable site and landscape environment. A re-evaluation of traditional methods of establishing and maintaining the urban landscape will support these natural functions.

There are many low cost and no cost solutions to developing a sustainable approach to site and landscape issues, such as choice of plant material, permeable paving, collection and re-use of rainwater, and recognizing and utilizing solar heat gain and cool air zones.

NEIGHBORHOOD SCALE

Redevelopment and Densifying

South Lake Union is a growth management area in an "urban core village." Redevelopment and densification in this location maximizes investment in public infrastructure, protects greenfields, cleans up brownfield sites and preserves habitats and natural resources.

Optimize Passive Solar and Natural Ventilation

Energy savings gained from appropriate building orientation is another influential site factor of sustainability. Because the existing block orientation does not support the ideal building orientation this may be harder to achieve. Narrower building widths of 60 to 80 feet support the orientation issues of controlling solar heat gain, natural ventilation and daylighting; but it may be difficult to maximize the FAR under that design goal.

Addressing the building orientation impacts would be a worthwhile issue to evaluate and negotiate with the City because of the broad energy cost impacts, the ability to provide truly high performing buildings and the sustainability message that it communicates.

Reduce Heat Islands and Improve Microclimate

Reducing urban heat islands has been a goal of international interest and its importance has recently been reinforced with greater acceptance of the validity of global warming. Potential solutions have synergy with many of the other sustainable goals, making this issue one of the most multi-functional investments. Using the natural functions of vegetation as a tool for cycling carbon dioxide into oxygen, sequestering carbon, filtering water, reducing storm runoff and peak loads all make landscape not only a valued aesthetic amenity but a high performing element in the overall sustainable strategy.

The Big Tree Neighborhood Over Time

Big trees in the South Lake Union neighborhood could provide a dramatic and distictive identity and a marketable brand for the neighborhood. This branding will assist in the competition for tenants who are evaluating the downtown against the more pastoral Eastside. As part of an overall marketing strategy it will draw the educated companies that are looking to link their services and products with a sustainable approach. In order to grow big trees, the city must cooperate and assist by creating a strategy for relocating utilities.

The introduction of new trees that will grow **big** (and therefore be higher performing), vegetated roofs, vegetated walls and pervious paving systems can create a critical mass that can contribute to a reduction in neighborhood temperatures and an improvement in microclimate. A cooler summer microclimate can lower cooling loads and improve the effectiveness of natural ventilation. Some studies indicate differences in temperatures of up to 3.5°F–7.5°F based on neighborhoods with contrasts in tree cover. The impact on the overall urban heat island is unclear without running specific modeling programs.

Big trees are high performance elements that provide many environmental benefits: they sequester carbon, produce oxygen, reduce temperatures, filter water, reduce soil erosion, slow stormwater flows, provide habitat and create pleasant urban environments. The dramatic character of a heavily treed neighborhood will be visible not only by residents, workers and visitors to the neighborhood, but is uniquely visible from the surrounding hillside neighborhoods, parts of Interstate-5, Kenmore Air Service and the Space Needle.

www.arttoday.com

Improve Habitat

Habitat connections and species diversification are a natural outgrowth of an increase in vegetation in the neighborhood. Songbirds would likely be the first to venture back to a friendlier environment. Enhancing this effort would be a comprehensive approach linking the private open spaces to create critical mass and encouraging the introduction of food, water and shelter into those spaces. With connections to some of the larger parks in the downtown area including Denny Park, the future South Lake Union Park and the lakefront, developers can make some real progress as pioneers in the arena of urban habitat redevelopment.

Seek Permeable Surfaces in Public Right of Way

Since sustainability is an interdependent process, it is clear that site and landscape issues are integral to many of the water issues, particularly in the area of permeable surfaces and water efficient (drought tolerant) landscapes.

Making Sustainable Methods Visible

Making sustainability methods visible in South Lake Union responds to both an educational mission and a marketing opportunity. With substantial trees, plentiful vegetation, songbirds, rainwater features, water runnels in the paving, a variety of porous paving materials, and interpretive signs, the South Lake Union neighborhood will have its own character in the context of Seattle's many eclectic neighborhoods.

LEED™ 2.0

Many of the sustainable site issues are easily achievable points within the LEED™ 2.0 rating system. Site and landscape issues are an area that LEED™ is interested in strengthening in the future. For example, regional differences in climate conditions and recognition of the ecological functions of the landscape have not been clearly addressed and have large impacts. Also under consideration is the certification of multi-building development and the use of the current building level system as a second-tier assessment.

alternative transportation

Goal: **Reduce air pollution and fossil fuel consumption by reducing the use of private automobiles.**

Strategies:

There are several strategies for reducing the impacts of automobiles.

King County Metro

1. Locate near public transportation.

Most properties in South Lake Union have immediate or walkable access (¼ mile) to existing bikeways and bus routes. Light rail, monorail and trolley systems that would serve this neighborhood are currently under consideration.

2. Encourage services in the building that support alternative transportation.

www.arttoday.com

a. Provide bike lockers. Provide easy to navigate and secure bike pathways and bike storage areas for bike commuters. These are often provided in parking garages with immediate access to elevators.
b. Provide showers and changing areas for cyclists that go beyond code requirements.
c. Encourage telecommuting and teleconferencing options in the building design and project programming.
d. Solicit electric vehicle users and provide electric car recharging stations. Electric vehicles (EVs) require a receptacle specifically designed for this purpose, generally 240 volts. EVs with conventional lead-acid batteries require recharging after 50 miles.

3. Consider alternative parking programs.

a. Buddy parking is the coordination of parking between colleagues with routine schedules. This approach can be used in build-to-suit situations which can affect zoning requirements by allowing a reduction in the number of spaces through double parking.
b. Share parking between uses that have requirements at different times of the day. Use this complementary relationship to obtain parking reduction requirements.

4. Evaluate assumptions about peak load and parking stall size.

Alternatives for "peak load events" can be evaluated to reduce the overall parking total, such as shared parking with adjacent users, valet parking or parking in flexible use areas – loading docks/ sport courts. Parking stall sizes and aisle widths can be evaluated to provide the minimum deemed appropriate.

5. **Create a livable pedestrian environment.**

A livable pedestrian environment is a safe, comfortable, and visually enjoyable system of outdoor spaces that can include public and private sidewalks, streets, alleys, parking lots and parks. A livable pedestrian environment is an important part of a city's efficient transportation system. It also fosters social sustainability by increasing opportunities for social interaction and physical fitness. Reductions in crime are an added benefit to providing a livable pedestrian environment.

6. **Implement a "Flexcar" vehicle sharing program, exploring partnerships with City.**

Photo by Mithun

"Flexcar is car-sharing in the Seattle, Portland, and Washington DC metropolitan areas. Shaped after a successful European model, Flexcar provides an alternative to car ownership. Flexcar features a network of vehicles parked in leased parking spaces in neighborhoods where members live and work. Individuals and businesses can reserve these vehicles for use and pay only for the time the car is used. As a member, you reserve a car when you need it and return it to the original location. At the end of the month users receive a statement of usage and a credit or debit card is charged."

From www.flexcar.com

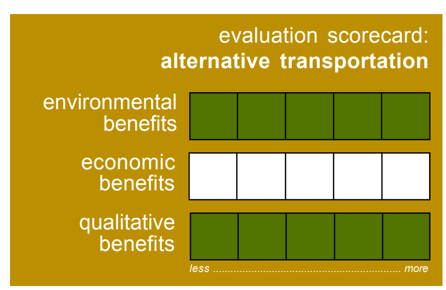
Status of Technology: The City of Seattle is estimated to have about 60–100 EVs, so the market demand for EV charging stations is minor. Two-seater EVs are on the verge of becoming legally recognized for highway use by the State of Washington. They are offered by Toyota and Ford's THINK group. They are more price competitive ($12–14K) than the typical EV price of $30–40K. The University of Washington uses some on their campus.

The City of Seattle's vehicle fleet is researching a bio-diesel program. The current fleet includes 100 Compressed Natural Gas (CNG), 20 hybrid electrics and one electric vehicle.

The big three American automakers, Ford, Chevy, and GM, as well asToyota and Honda, offer their EV product in markets that have a regulatory system supporting EVs, such as Southern California, Arizona and some New England states at the time of printing.

REI's store in the Cascade neighborhood of Seattle has demonstrated its commitment to bicycling by providing bike parking beyond the code requirement, employee bike storage, shower facilities, and bike testing areas.

The National Wildlife Federation Headquarters in Reston, Virginia uses preferred parking stalls for carpooling and buddy parking between employees that have routine schedules. These programs, combined with choosing to locate near public transportation, permit them to reduce the parking ratio to the zoning code minimum: 1.75 stalls/1,000 gsf (from 4/1,000 gsf which is the market minimum). They also have bikes available for employees to check out at lunch time to reduce vehicular trips.



Mithun

Costs: No cost increases for many parking programs.

Electric car recharging stations are $2,000–3,000 each. In Portland they are provided in the street R.O.W.

Cost savings by reducing parking requirements range from $3,000–$5,000 for surface spaces, $12,000–$18,000 per structured space above grade and $15,000–$25,000 per structured space below grade (2001 estimates).

Marketing Amenity: Green power could be made available for tenants' green vehicle fleet. There is a potential to establish a "Bicycle Neighborhood" with safe and secure storage for tenants' bicycles.

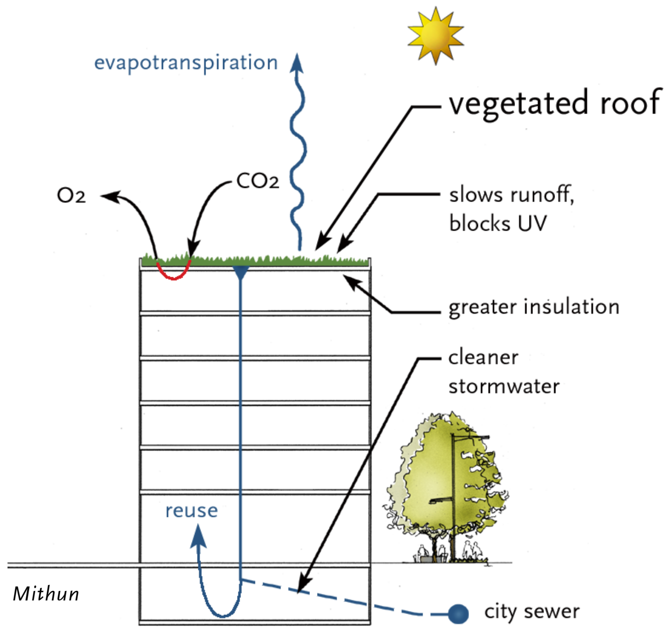
Incentive: Work with Seattle City Light to see if the city can provide electric recharging stations. Explore partnerships and incentives from King County Trip Reduction Program and City Flexcar Program.

Recommendation: Provide covered bicycle storage at 20% beyond code requirement and changing rooms at non-residential buildings.

heat islands

Goal: To reduce temperatures caused by solar gain on roof surfaces.

Strategies:



Vegetated roofs are one of the strategies to reduce heat gain on rooftops.

1. **Green or vegetated roofs have several benefits.**

There are two types of vegetated roofs – intensive and extensive.

Extensive roof gardens are commonly developed in the U.S., providing people with access to a garden environment and featuring deep root plantings.

Intensive vegetated roofs or eco-roofs are developed with a thin layer of soil over a heavy waterproofing membrane (approx. 15 lbs/sq. foot). The roof is then planted with alpine-type plants, low horizontally spreading succulents and grasses that can tolerate the extremes of temperature and dryness in the harsher roof environment.

Benefits of intensive roof systems include storm water retention (15–35% wet season and 65–100% warm season), improved water quality through filtering, improved air quality through evapo-transpiration and carbon storage, energy conservation by insulating, reduced noise and glare, slow roof degradation (35 years vs. 20 years), habitat for insects and birds, and visual relief. These roof systems needs comparable maintenance to standard roof systems.

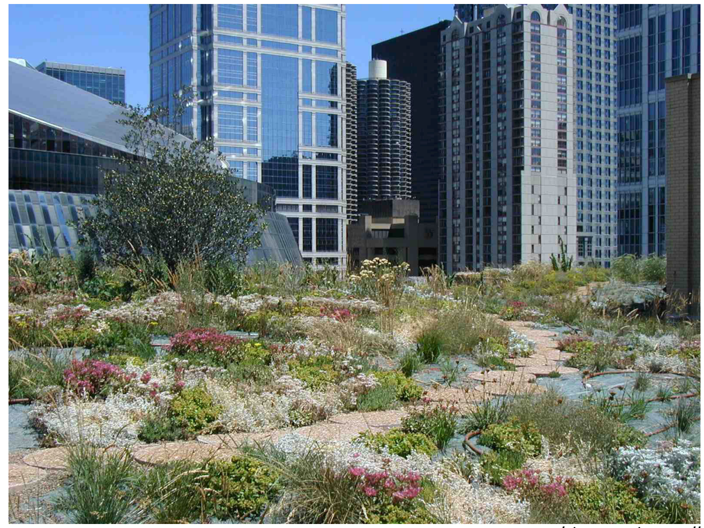
Status of Technology: Systems used extensively in Germany have been developed for the U.S. market. Ford Motor Co. is currently installing a 450,000 square foot green roof on their new Dearborn, Michigan assembly plant. Chicago's City Hall eco-roof project is 20,000 square feet and is part of a $1.5 million municipal demonstration project on limiting urban heat islands. The Gap, Inc. corporate offices in San Bruno, California and a variety of

Washington Convention Center
Photo by Mithun

buildings in Portland all feature green roofs.

Locally, Seattle's new Civic Center and a parking garage being constructed at University Village will have vegetated roofs.

Costs: The current U.S. costs (2001) are in the range of $15–20 square foot including plantings. As the industry develops and the installation techniques become familiar, it has been projected that the price will drop to the $8–$15 square foot range.

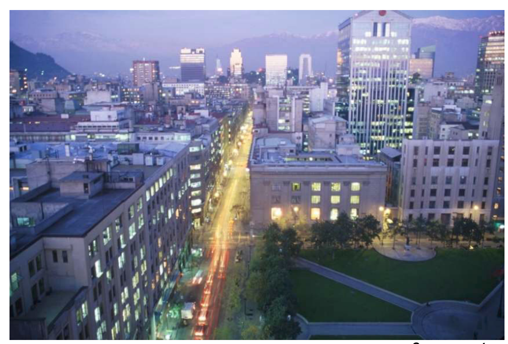


Chicago City Hall
Roofscapes, Inc.

In Germany, where green roofs are required on most new commercial construction to respond to stormwater runoff, the costs of vegetating flat roofs are comparable to traditional roofing systems. Pitched roofs remain more expensive.

Marketing Amenity: The green roof is a dominant visual representation of the market branding approach. The amenity value increases if there is visual and/or physical access to the roof (but not on the vegetation). Because of the surrounding topography, green roofs in South Lake Union will be a highly visible element from surrounding buildings in Denny Triangle, Capitol Hill, Queen Anne, the Space Needle, parts of I-5 and the Kenmore Air Service routes, serving as a type of 'green billboard' for the project.

Incentives: Stormwater management design options in the City are identified in the *Flow Control Technical Requirements Manual* and include impervious surface reduction credit for the use of porous pavement, eco-roof, roof garden or landscape planters. Roof gardens and landscape planter areas are considered equivalent to providing a pervious surface and receive a 1:1 credit. The porous pavement and the eco-roof credit varies according to the site conditions and design. See the manual for details. www.cityofseattle.net/dclu/codes/Dr/DR2000-26.pdf

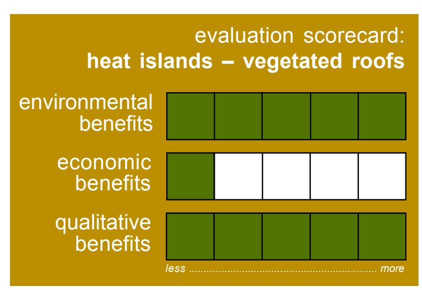


Rooftop garden
www.arttoday.com

Additional financial incentives for a range of water conservation technologies can be found through the Seattle Public Utilities Water Smart Technology Program. http:www.ci.seattle.wa.us

There is potential funding for green roofs that can be obtained through EPA's Clean Water Act, Section 319 grant program.

Talk to Seattle City Light to see if the city's carbon offset funds could create incentives for green roofs.

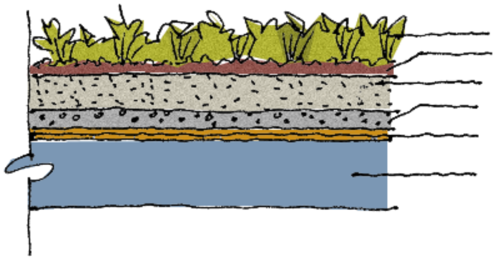


Mithun

Recommendations: Work with the city of Seattle to review additional incentive programs to help defray the costs of intensive green vegetated roofs. Vegetated roofs benefit the city in stormwater reduction, carbon offset, and reduction in the heat island effect, lowering demand for energy consuming cooling systems.

Explore opportunities to increase incentives for extensive green roofs in order to take full advantage of the definite but less quantifiable, environmental benefits.

Synergies: Water quality, water re-use, reducing stormwater flows, habitat connections and expansion.



TYPICAL ECO-ROOF SECTION
credit: City of Seattle 'Flow Control Technical Requirements Manual' Appendix B: Impervious Surface Reduction credit

Resources:

"Environmental Design and Construction"
Green Roofs: Stormwater Management From the Top Down by Katrin Scholz-Barth, January/February 2001

City of Portland Bureau of Environmental Services
1211 SW 5th, Room 800, Portland, OR 97204
503-823-7267
toml@bes.ci.portland.or.us
www.ecobuilding.org

www.roofmeadow.com Charlie Miller 215-247-8784

Roof Gardens: History, Design and Construction
Theodore Osmundson, FASLA 1999

"Going Green to Reduce Energy Costs" The Washington Post, November 11, 2000

Chicago City Hall
Roofscapes, Inc.

heat islands

big trees and green streets

Goal: **Reduce microclimate temperatures and contribute to the reduction of the urban heat island by using trees.**

Strategies:

Trees planted in an urban area are ten times more effective than those planted in rural areas because they not only sequester carbon, they also reduce carbon emissions and energy use by keeping cities cooler in the summer.

1. Create South Lake Union as the "big tree neighborhood."

Choose large canopy deciduous trees as the dominant feature in private open spaces. Large canopy trees are the hardest working, highest performing vegetation in providing environmental benefits such as sequestering carbon, producing oxygen, reducing temperatures, filtering water, reducing soil erosion, slowing stormwater flows, providing habitat and creating pleasant urban environments.

2. Create an environment that supports healthy, fully mature development of tree canopy.

Provide the optimum growing environment to protect the investment in trees as a highly functioning element and reduce damage to surrounding side walks. This would include the use of structural soils, a crushed gravel enhanced with a binder that is used under the entire sidewalk area to provide root systems with more oxygen, water and space. Significant tree growth and health benefits have been documented, resulting in higher performing trees and less damage to surrounding sidewalks.

Investment in the initial cost of larger caliper size and a productive growing environment through structural soils, soil amendments and pervious surfaces will result in enhanced performance.

Work with the neighborhood to become an urban forestry laboratory with a range of partners. Some partner candidates may be American Forests (www.americanforest.org), the University of Washington Center for Horticulture, and structural soil additive manufacturers.

3. Develop a tree planting program for permanent, interim and retrofitted surface parking lots and/or other land holdings.

Shaded parking lots and on-street parking improve air quality by reducing actual temperatures and reducing the carbon emissions that come from fuel tank evaporation. Evaporation from a stationary fuel tank can be 16% of its daily carbon

Trellis, REI Flagship Store, Seattle
Mithun

emission.

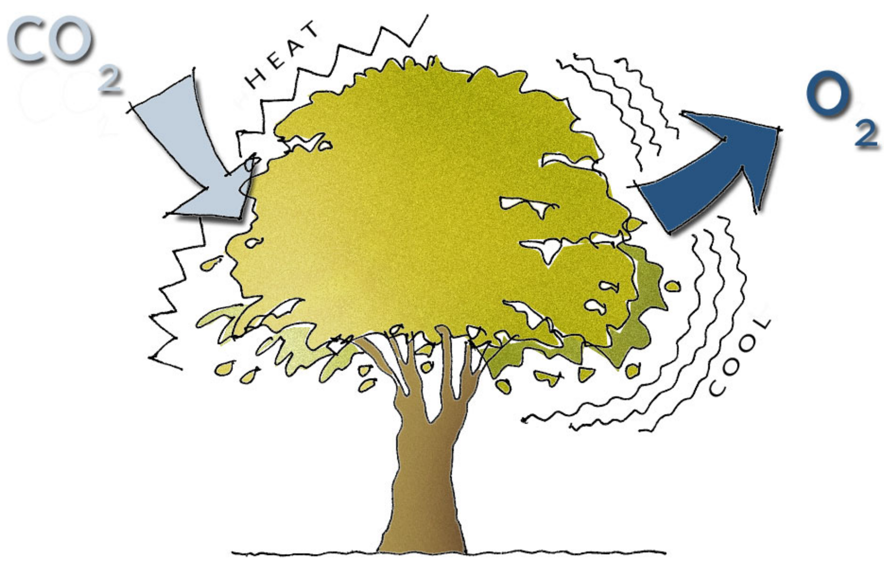
Although surface parking lots are not anticipated in the future development of South Lake Union, long term land holdings could be developed as tree nursery areas adding trees to the South Lake Union neighborhood and providing larger, less expensive specimen trees for future projects as needed. As projects are developed and redeveloped, coordination with the salvage nursery established by the Cascade Neighborhood Council and the P-Patch could benefit all parties by re-locating, re-using and restoring existing plant material.

4. **Consider spearheading a research and development effort to calculate the economic and environmental benefits provided by existing and proposed trees in the South Lake Union neighborhood, as a an urban ecology model for the nation.**

The results of this modeling can be used to demonstrate value and establish City incentives both locally and nationally as part of the overall sustainable strategy for both the City and the neighborhood. The non-profit American Forests offers a software model called CITYGreen. Used in the City of Seattle to calculate stormwater runoff reductions, this software can be utilized to determine a wide range of benefits. Another successful model that evaluates the economic and environmental benefits of trees has been created in Los Angeles by TREES (Trans-Agency Resources for Environmental and Economic Sustainability. (www.treepeople.org)

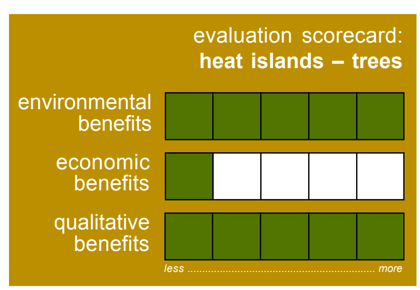
Trees and landscape contribute to a reduction in microclimate temperature in summer months. For buildings without air conditioning, they create a more pleasant environment, and for buildings with air conditioning they reduce cooling loads and costs.

Each tree sequesters between 8 and 115 pounds of carbon each year.



CARBON SEQUESTERING
and
EVAPOTRANSPIRATION

Even a minimum tree canopy has a big effect. For example, a 10% tree canopy can reduce the microclimate temperatures by 1.8°F.



Status of Technology:

Structural Soils: Structural soil is an alternative to backfilling tree pits with amended soil that provides for healthier tree growth. Structural soils are a combination of locally available gravel, (¾"–1½" with no fines), a growing medium of clay loam and hydrogel to fix the stone and soil together. This combination provides the load bearing required for urban conditions without creating compaction, allowing roots the space and oxygen to continue to grow. An additional advantage is that sidewalk heaving from root growth is reduced.

Although the costs of structural soils are three to four times the cost of amended soils, the less quantifiable environmental and marketing benefits of trees can offset the added cost. If structural soils are cost prohibitive, alternatives such as root paths and continuous trenching can be used. Continuous trenching involves the removal of the subgrade along the entire length of the tree planting area, as an alternative to tree pits increasing the amended soils and the root growth space. The cost of this can be offset by the dual need for laying drainage pipe.

One of the key factors in successful street plantings is structural soils. Structural soils provide both support for adjoining hardscape while providing room for roots to grow and soil to drain.The primary structural soil additive manufacturer from Massachusetts has just completed a multi-year, independent study of the effects of structural soil use on plant growth. The study demonstrates marked improvements in speed of growth, maturity, health and reduced damage to surrounding sidewalks.

CITYGreen software: CITYGreen is a GIS (geographic information systems) software application for land-use planning and policy-making. The software conducts complex statistical analyses of ecosystem services and creates easy-to-understand maps and reports. CITYGreen calculates dollar benefits based on specific site conditions and provides updates to users incorporating the most recent scientific research. CITYGreen analyzes stormwater runoff, air quality, summer energy savings, carbon storage and avoidance, and tree growth.

Seattle Department of Transportation's Landscape Architecture office has utilized CityGreen for calculating stormwater benefits.

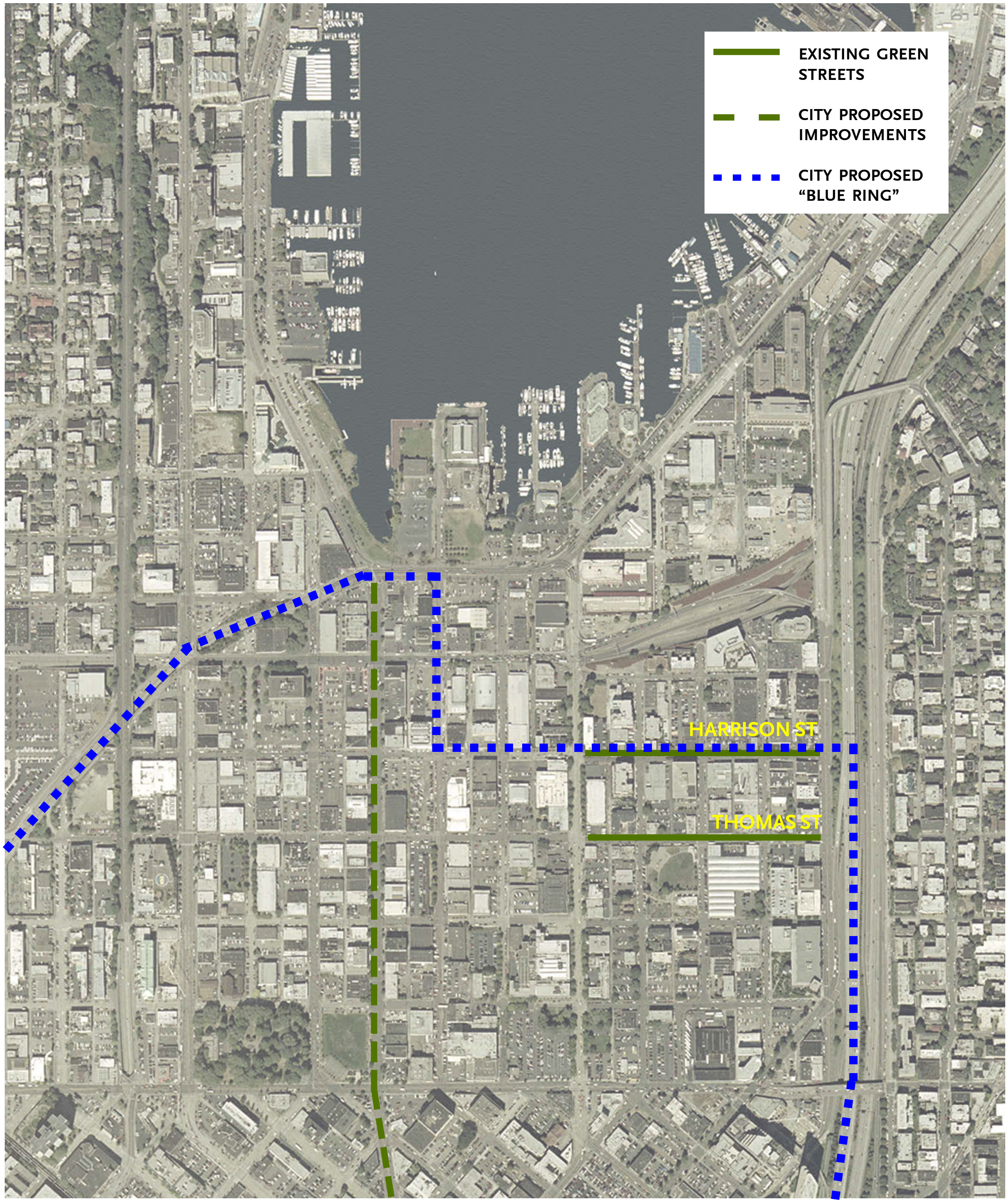
Costs: University of Washington is working on making structural soils more affordable by using local suppliers. Current (2001) pricing is $50.–65./cy compared to $18./cy for standard backfill material.

According to arborist standards, the most viable size for an urban, large canopy tree installation is a 3–3 ½" caliper tree (caliper is the diameter of the tree trunk measured 6" from the base). Smaller sizes succumb to damage and tip over more easily, larger sizes often have their root mass limited during transplanting and have difficulty overcoming the damage. Installation cost for a typical, large canopy deciduous tree, 3–3 ½" caliper is $1,350, and a 4–4 1/2" caliper tree is $2,000 (2001).

Marketing Amenity: Big trees strongly influence people's opinions about the comfort and welcoming

Urban neighborhoods with contrasting tree cover can vary in air temperature from 3.6°F–7.2°F.

Downtown Seattle has about 5% tree cover. Downtown Los Angeles has about 10% tree cover.



Existing and Proposed Sustainable Streets

43% of the trees in Seattle are plums, cherries and other small deciduous trees which cannot perform as effectively as big trees.

Each single degree in temperature reduction from improved plantings, results in a 2–4% energy savings from reduced air conditioning use.

qualities of a place. Dr. Kathy Wolf at the University of Washington conducted visual preference surveys in 8 business districts across the U.S. She found that people are willing to pay more for parking and services in a well-landscaped environment. The amenity and comfort ratings were about 80% higher for a tree-lined sidewalk compared to a non-shaded street. In addition, the highest occupancy ratings for attractive office space occurred when landscape amenities were provided.

Incentives: No current incentives for tree planting exist. Future opportunities may exist to use the neighborhood as a receiving site for Seattle City Light and others working to achieve the city's carbon neutral policy, as well as reducing Seattle City Light's energy load through lowering microclimate temperatures in summer months.

Recommendations: *(If incentives can be negotiated with government agencies or utilities)*

Create the Big Tree Neighborhood. Work with the city to plant extensively to achieve a 15% increase in pervious area within the Right of Way.

Negotiate with the city to reduce lane widths and consider expanding planting projections on streets with parallel parking.

In Seattle, a mature and higher performing tree canopy competes with the desire for water and territorial views, electric bus lines, and fiber optic lines. This makes it more important to take advantage of opportunities to plant large canopy deciduous trees where there is a choice. Large canopy deciduous trees have substantially more leaf and root area so they can provide greater heat reduction, air pollution removal and infiltration of stormwater than the smaller trees that are typical of Seattle streets.

Coniferous trees are effective in a different way. Although challenging to integrate into an urban environment, conifer trees capture 30% of rainfall before it hits the ground.

Seattle has an aging tree canopy because many trees planted at the turn of the century are being lost. Tree planting efforts have occurred in waves: in the 20s during the Depression with the Civilian Conservation Corps, in the 70s during the voter-funded Forward Thrust program, and in the 90s a public/private effort sought to plant 20,000 trees by Earth Day 2000.

The environmental value of tree canopy in a city has been well documented in economic terms. Most cities across the nation have lost 1/3 of their tree cover over the last 25 years. Seattle's loss of tree cover in that time period has resulted in an additional 11.5 million cubic feet of stormwater runoff at a cost of $23 million to contain and manage it. In addition, the lost tree canopy would have removed 159,000 pounds of air pollutants from the atmosphere each year.

Synergistic effects: A strong tree canopy improves air and water quality, reduces summer temperatures and improves habitat connections.

Resources:

www.americanforests.org
CITYGreen software and tree performance information

www.mtsgreenway.org
Visual preference survey information by University of Washington

www.treepeople.org
Quantifying the economic and environmental impacts of trees

"Effects of Tree Cover on Parking Lot Microclimate and Vehicle Emissions"
Journal of Arboriculture, May 1999.

"Giving Street Trees a Better Chance" by Dean W. Koontz and Jim Howard, Daily Journal of Commerce, April 19, 2001.

Western Center for Urban Forest Research and Education
University of California
c/o Department of Environmental Horticulture
Davis, CA 95616

City of Seattle Forest Coalition / Strategic Plan for Seattle's Urban Forest

City of Seattle, Office of Sustainability and the Environment

Second Nature – Adapting LA's Landscape for Sustainable Living
By Tree People with commentary by Paul Hawken

Seattle Urban Nature Project
5218 University Way NE Seattle, WA 98105
206-522-0334
www.seattleurbannature.org

Portland streetscape
www.arttoday.com

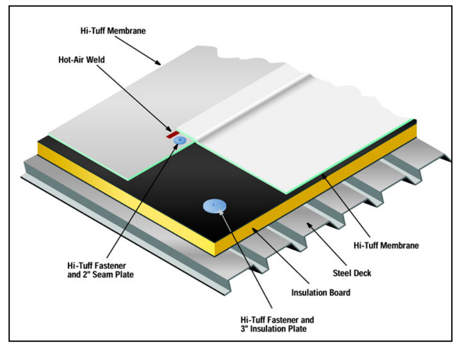
heat islands

Goal: **To reduce temperature increases caused by solar gain on roof surfaces.**

Strategies:

1. **Light colored roofs are the first and most basic option (high albedo-definition or reflectance).**

There are a range of roofs that come in a lighter color. One option is TPO (Thermoplastic Polyolefin), a single membrane roof that is fully recyclable. TPO has a longer history of use in Europe and is relatively new to the United States.



Stevens Roofing Systems, Holyoke, MA

Status of Technology: A Cool Roof Rating Council is currently being formed. A solar reflectance index can be used to evaluate roofing systems. See www.eetd.lbl.gov. A more detailed index is scheduled to be available in 2003.

Costs: There is minimal or no cost impact to using light colored roofing compared to other better quality roofing products; and other than TPO, the technology is well tested in the U.S.

Marketing Amenity: The light colored roof would probably be considered an amenity only to the more educated 'green' consumer. However, for triple net rent tenants, potential reduced cooling costs can be marketed.

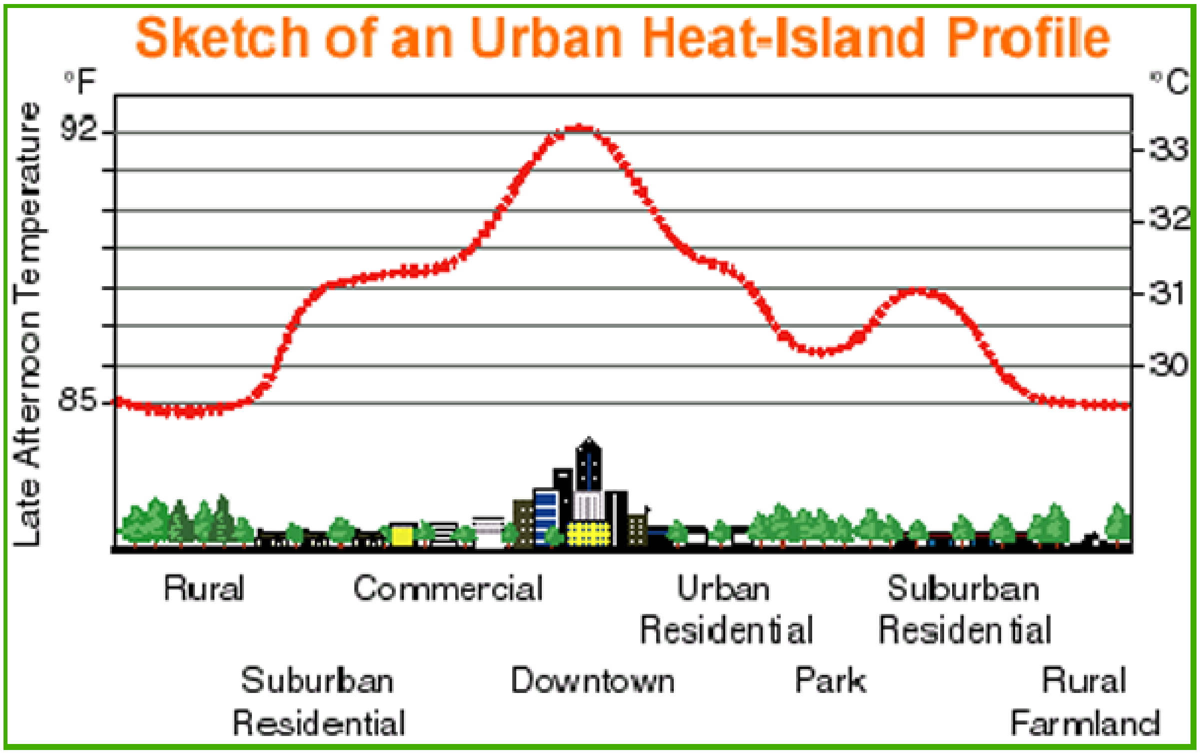
Incentives: No city incentive exists for light colored roofs, but they can lower cooling loads, reducing energy consumption. Investigate potential of incentive from City Light and Seattle Solid Waste for TPO roofs.

Recommendation: Use TPO (Thermoplastic Polyolefin) light colored roofing on all flat roofs that are not vegetated.

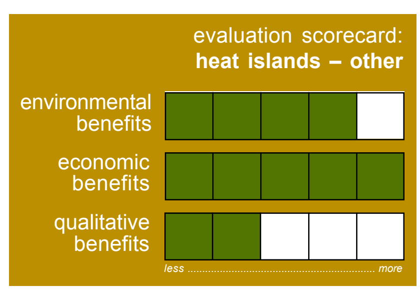
Synergistic Effects: TPO roofs can be recycled at the end of their useable life – built up roofs can not.

Resources:

www.eetd.lbl.gov/heatisland



Heat Island Group
http://eande.lbl.gov/HeatIsland/LEARN/



reduction of light pollution

Goal:

Reduce ambient light and glare in the night sky, reduce energy consumption, protect the nocturnal habitat of animals, plants and ecological processes. Reduce the impact on residents and facilitate astronomy for both professionals and amateurs.

Strategies:

1. Use only cut-off, semi, or full cutoff exterior light fixtures.

Cut-offs control the angle of light distribution from the fixture, casting the light down instead of out. To qualify, a cut-off fixture must not cast lumens beyond an 80° angle. Various fixtures are rated for this angle in the cut-off, semi-cut-off and full cut-off categories. Although urban environment ambient light limits are not as restrictive as some rural environments where the night sky preservation is an issue, lighting design choices still have an impact on overall ambient light. Cutoff fixtures improve the opportunities for urban astronomy.

New York City
www.arttoday.com

Aesthetically, the fixture/hardware design choices are more limited in cut-off fixtures. Lenses need to be large to reflect the light down, so cutoff fixtures are bulky. In an urban project with high visibility and immediate and frequent visual contact, this is an important consideration.

2. Use motion sensors in appropriate exterior locations.

Exterior use of motion sensors is somewhat limited because the conditions are difficult to control. Wind, low temperatures or ultra-sonic sounds can set off sensors unintentionally.

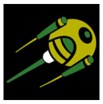
The re-strike ability of HID (metal halide) and HPS (high pressure sodium) is two to five minutes which limits their applicability in a motion sensor system. Fluorescent and incandescent lamps are suitable because they can restrike immediately.

3. Use lowest lumens possible within safety expectations.

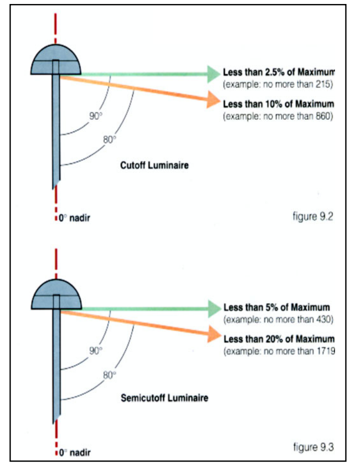
The Illumination Engineering Society of North America sets the typical standards for safe lumen levels for various site uses. Their members are primarily manufacturers and, as such, their level may be considered high because they are subject to liability issues.

4. Consider the use of high pressure sodium (HPS) instead of metal halide (HID), where appropriate.

There are more lumens per watt in HPS than HID. However, the rendering quality, (the level of detail that you can perceive), is very different as well; HPS has a yellow-orange cast to the light and lower rendering quality, and HID is white with a bluish tint.



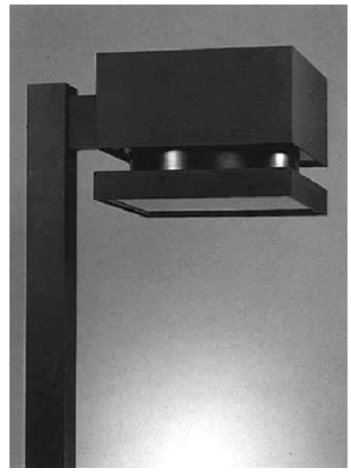
Status of Technology: The State of Maine has passed a law that all state-funded new and replacement outdoor lighting must be fully-shielded fixtures so that no light is emitted above the horizontal. The Central Maine Power Company, which had to buy full-cutoff lights for all state funded applications, has elected to install only full-cutoff lights in cities and towns (because it is cheaper to do so). Many other states have similar legislation currently being considered (Arizona, Connecticut, and New Mexico have passed bills; Texas, New Hampshire, and others have pending bills.)



KIM Lighting

Marketing Amenity: Limited. Potentially increased perception of a higher quality lighting, potential lower available fixutre aesthetic and increased safety concerns.

Incentives: Reduced electrical energy costs from sensor-based system.



KIM Lighting

Recommendation: Use high cutoff exterior light fixtures to reduce light pollution.

Synergistic Effects: By using photovoltaic powered exterior fixtures/cutoff fixtures energy consumption would be reduced.

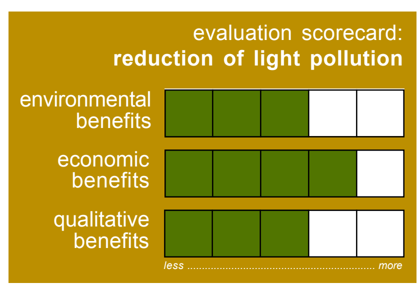
Resources:

www.IESNA.org
Illumination Engineering Society of North America
ecommended practices: “Lighting for Exterior Environments” publication #RP-33-99

www.kimlighting.com
lumen level definitions of cut off, semi-cut off, full cut off

Wes McKean
Cross Electrical
253-759-0118

Eric Strandburg
The Lighting Design Lab
400 East Pine Street, Suite 100
Seattle, WA 98122
1-800-354-3864



habitat connections & expansion

Goal: **Create additional wildlife habitat in the urban environment.**

Strategies:

The most likely species to be attracted by increasing habitat connections in an urban environment are songbirds and insects, including hummingbirds and butterflies. Currently the bird population in downtown consists of non-natives such as rock doves, starlings, house sparrows and gulls. The types of birds that may venture into an improved urban habitat would be black-capped chickadees, bush tits and house finches. With taller trees, kinglets may come and with sheltered areas, white crowned sparrows and dark-eyed juncos may be attracted. With the establishment of this kind of diversity, little sharpshint hawks are offered a food source. These hawks often hang out at bird feeders in more suburban areas to prey on song birds.

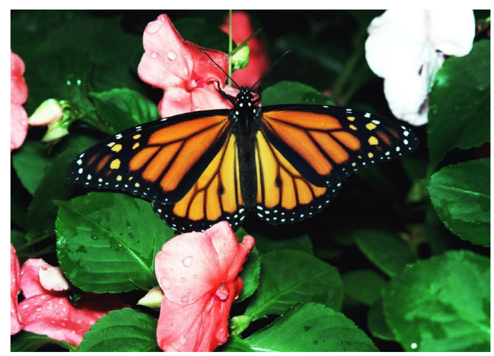
www.arttoday.com

Amphibians and reptiles need bigger natural areas adjacent to water sources than may be feasible in an urban environment. A system of collecting and using rainwater would have synergy with the goal of attracting a greater variety of species.

1. **Create an environment that supports healthy, fully mature development of tree canopy.**

See section regarding reducing the urban heat island with trees.

2. **Provide ready access to food, water and shelter.**



www.arttoday.com

   a. Use seed, berry and nectar producing shrubs attractive to birds, butterflies and other insects.
   b. Provide layers of planting to develop shelter not only for birds but for insects and spiders. With falcons downtown, shelter is important to attracting a greater range of bird species. Vertical vegetation that doubles as solar, seasonal shading devices can also provide vertical habitat and shelter.
   c. Consider areas where leaves can naturally compost, reducing weeds, creating insect habitat, increasing nutrient recycling and soil quality, and decreasing water runoff.
   d. Consider naturally replenished water features.

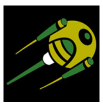
www.arttoday.com

e. Accept aphids, snakes and other "pests" as part of an interdependent system.
f. Introduce earthworms to the planting mix to reduce compaction, add nutrients and supply food.

3. Use no pesticides.

Native plants have their own arsenal to protect themselves. Pesticides kill food sources for birds and other animals and work their way back to the groundwater, impacting salmon habitat. Integrated pest management programs use a combination of native and pest resistant plant choices, natural predators and inorganic products to maintain landscapes.

The Federal Reserve Bank in Boston was able to eliminate non-organic fertilizers from their operating budget by implementing an IPM (integrated pest management) program.



Status of Technology: Existing habitat mapping for the city has been done by Seattle Urban Nature Project. This private, non-profit organization has mapped habitats based on dominant vegetation types defined in all public areas of the city. The maps include invasive species. The intent is to make this information available to anyone that may find it useful in their decision-making process. They are beginning to map species as well.

Bird migration patterns were researched for application to South Lake Union but because birds have tremendous mobility, they are typically mapped at much larger scales than what is useful to this study.

www.arttoday.com

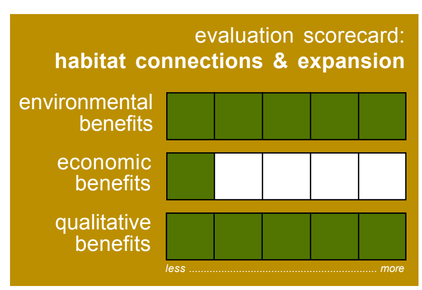
Costs: The National Wildlife Federation Headquarters uses a vertical habitat wall on their new headquarters in Reston, Virginia. The energy cost modeling indicated that this deciduous vine-covered superstructure with prefabricated metal trellis ($7.–10./sf) on the south façade of the building would provide more effective solar control and was less expensive than an architectural solution with louvers. It also provides a large quantity of habitat for nesting birds, squirrels and insects.

No additional costs are associated with choosing plant materials that support habitat.

Additional costs occur in expanding the quantity of tree canopy and vegetation beyond typical urban planting.

Marketing Amenity: High. The introduction of many trees and a landscape aesthetic that will begin to create habitat is consistent with the overall sustainable appearance that can be linked with the branding approach. Songbirds and a greater range of wildlife will add a richness and variety that adds perceived value to the community.

Incentives: No specific regulatory support. The National Wildlife Federation has a Backyard Habitat Program certifying spaces that meet the requirements of offering food, water and shelter. Grants are available through urban wildlife programs.

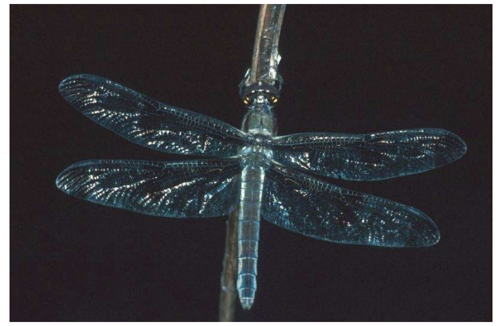


Recommendations:

Eliminate pesticides for pest control and ongoing landscape maintenance and create an integrated pest management program.

Use trellises and low level planted facade shading to encourage bird habitat and shade facades.

Synergies: Vegetated roofs, vertical vegetation, water quality, water conservation, water re-use, air quality, and reduced heat islands.



www.arttoday.com

Resources:

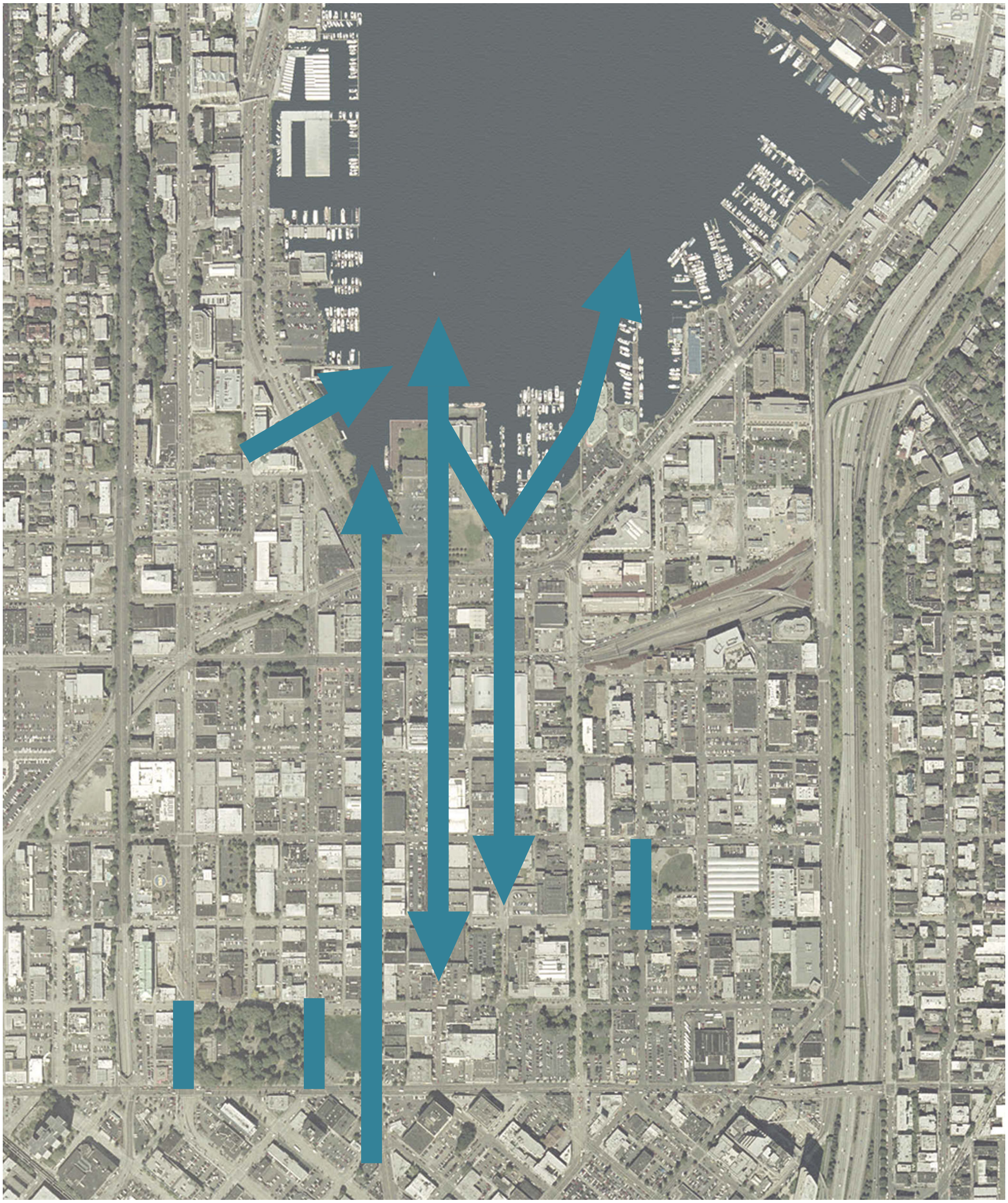
"Noah's Garden – Restoring the ecology of our own backyards," Sara Stein, 1997

"The National Wildlife Federation's Guide to Gardening for Wildlife," Craig Tufts and Peter Loewer, 1995

Helen Ross
Seattle Audubon Society
206-523-0722 x13

Pacific Northwest Ecosystem Research Consortium
http://www.orst.edu/dept/pnw-erc

Bonneville Dam fish ladder
www.arttoday.com



Primary Potential Habitat Corridors and Patches in South Lake Union

making sustainable sites visible

Goal: **Incorporate the education process into the development of the neighborhood by making sustainability methods visible.**

Strategies:

Rainwater harvesting

1. **Show how rainwater is collected and re-used.**

Rainwater collection features can be integrated in to the façade of the building or collected in rain barrels at the end of downspouts as is done in the Cascade neighborhood. It can also be collected at the ground level through the elimination of curbs in selected areas which lets the water to run into planting strips, allowing natural irrigation to occur.

2. **Use Living Machines™ as amenity features in open spaces.**

Living Machines™, biological wastewater treatment systems that look like greenhouses, serving large projects or a four-block areas. are interesting places to walk through or look into.

3. **Consider photovoltaic potential in plaza spaces.**

Plazas that are south facing could feature PV panels integrated into the design that power a clock, fountain, lighting, or other site amenities.

Cascade neighborhood

4. **Develop an interpretive sign system that identifies watershed edges and/or sustainable features.**

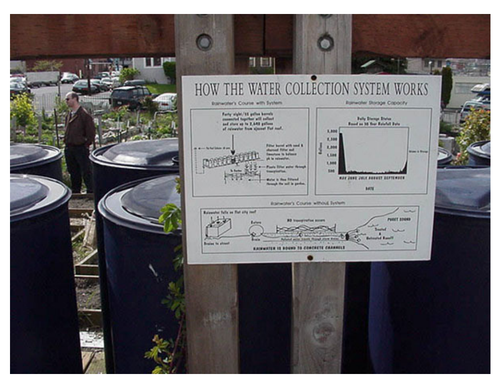
5. **Work with the city to develop an arts approach that features ecological artists.**

6. **Develop a policy that encourages on-site responses to resource balance.**

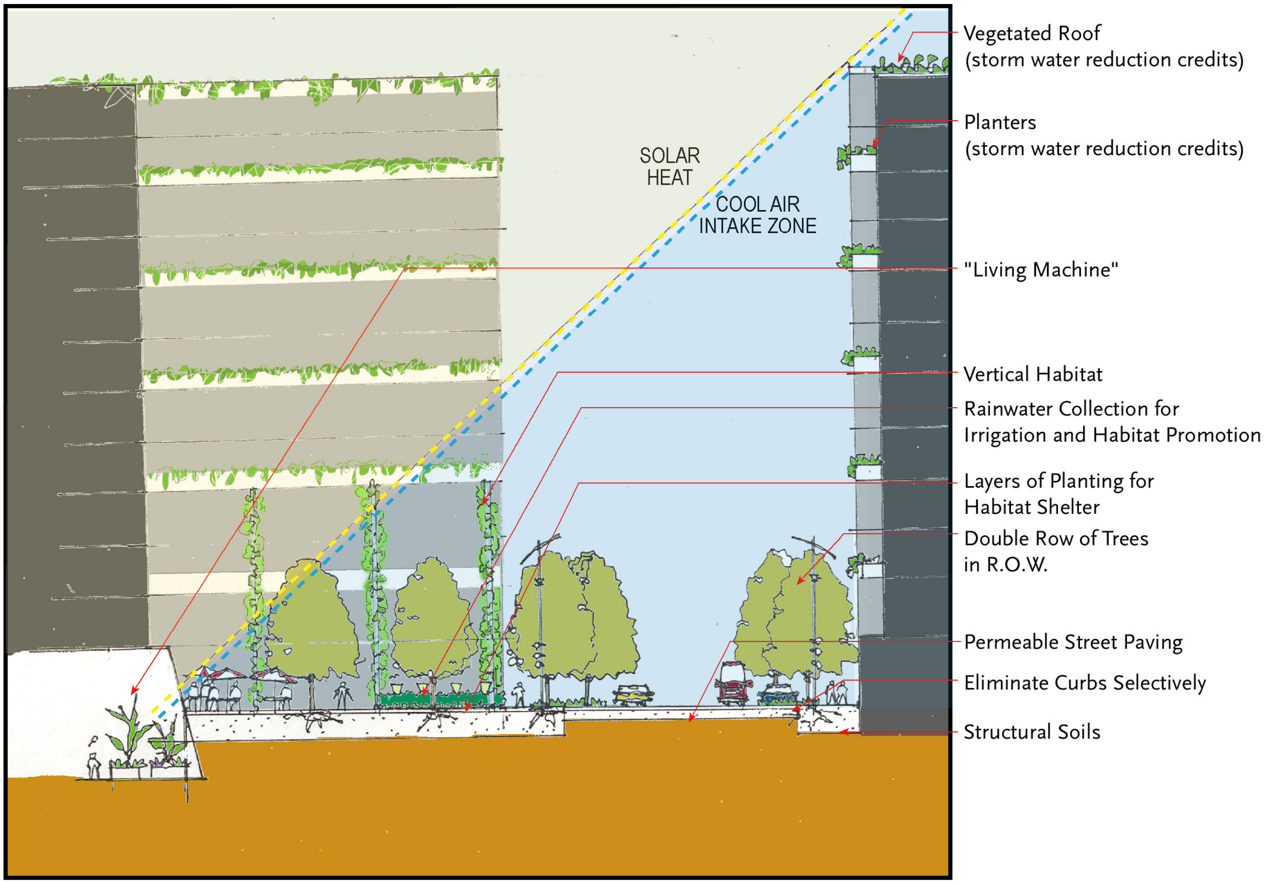
For example, photovoltaics on site may be preferable to windfarm generation off site. Be a receiving site for various credits rather than looking for receiving sites.

7. **Team with Seattle Public Schools, and other local foundations to develop a sustainability education program.**

8. **Participate in ongoing media relations and public relations programs to highlight successful examples.**



Cascade P-Patch, rainwater harvesting
Mithun



Section at proposed street
Mithun

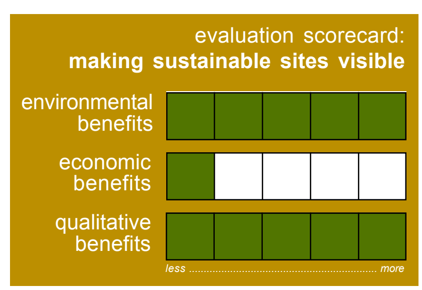
Status of Technology: Growing Vine Street has been a tremendous pilot project for the type of work that could be done in South Lake Union. This project will collect rainwater in cisterns, introduce pervious paving and eliminate curbs.

Costs: The cost to implement these ideas are minimal and/or have no pay-back. The value is in the contributions to marketing the neighborhood as a whole.

Marketing Amenity: South Lake Union becomes an international example of resource balance, and an opportunity for a strong brand identity.

Incentives: None at this time. Consider possibilities of grants from foundations of jurisdictions in creating educational interpretive programs and the creation of visible systems as an educational amenity.

Recommendation: Celebrate site and sustainable features such as rain collection, water runoff, trellises, etc.



Resources:

Sustainable Strategies
Proposed Cascade Neighborhood Council Design Guidelines October 1997
http://www.scn.org/neighbors/cascade

Biomimicry: Innovation Inspired by Nature
Janine M. Benyus, May 1998

www.sustainable.doe.gov

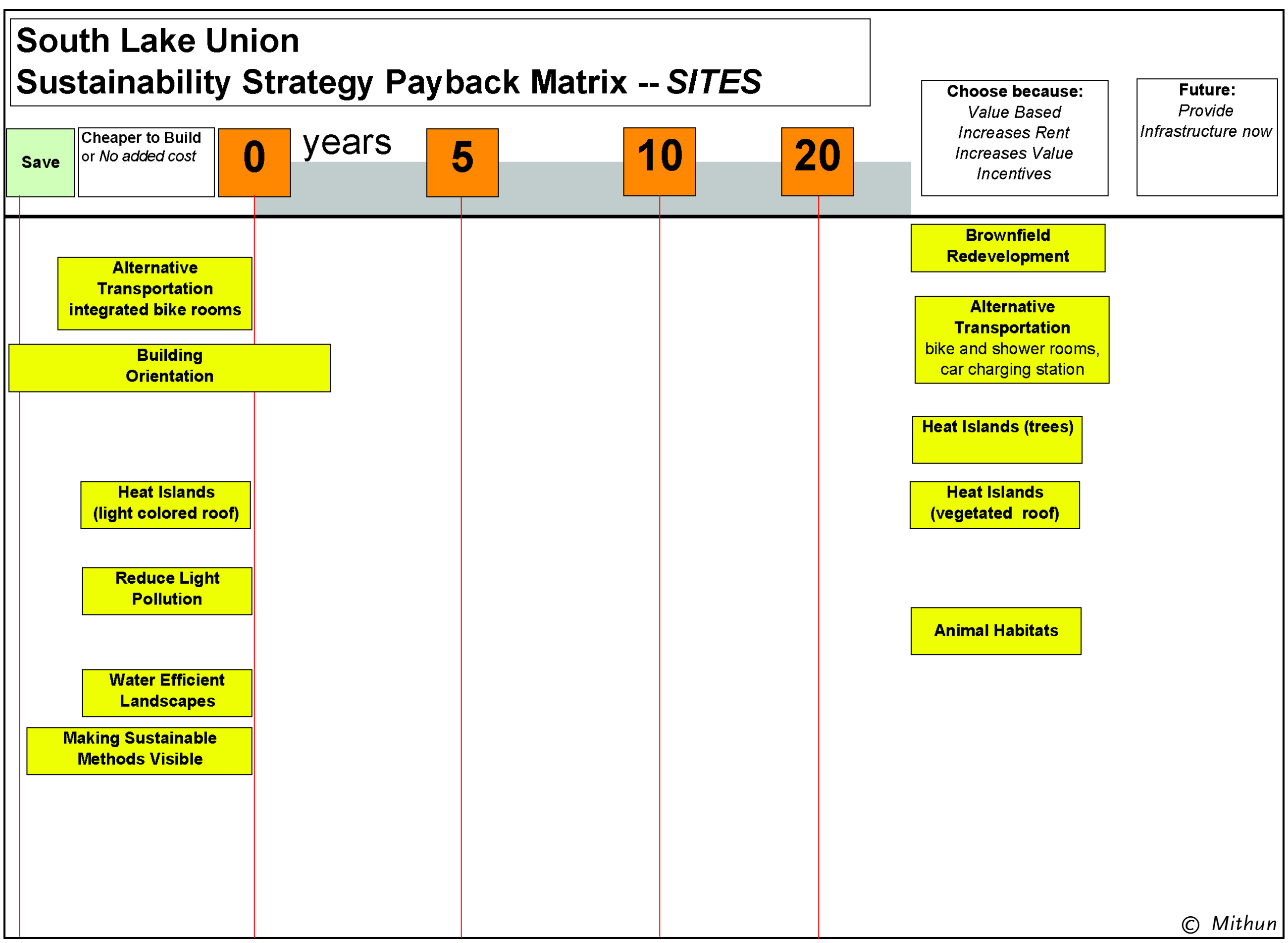
http://www.epa.gov

www.artsednet@getty.edu

sustainable sites & landscape

payback summary

Payback Summary charts are a conceptual tool for mapping each sustainability strategy, and their respective payback periods. These strategies are roughly modeled for multi-story commercial buildings in Seattle in 2001. These need to be analysed for each project, as size, occupancy, and orientation can affect the numbers substantially. The strategies listed from top to bottom correspond with the strategies listed in the sections that follow. Across the top of the chart is a range of values and payback periods. Starting on the left is 'save' strategies that will reduce costs. Next is 'cheaper to build or no added costs' vs. standard market construction for a class A office building. Next are the years, indicated current ballpark numbers for payback. On the right is a category for items that are value based, desirable because of environmental or social benefits that cannot be justified financially or increase rent or value. This also includes strategies that would be economical because of government incentives or internal owner incentives. An owner can select the strategies that fit within their budget and value goals.



water efficiency

introduction

OVERVIEW

This section contains seven strategies for increasing water efficiency and improving water quality. The issue of water is crucial, especially with the 2001 drought and corresponding low water levels in the Western Cascade region. It has been predicted that our region may have significant water shortages by 2020.

The recommendations and strategies seek to provide a baseline of understanding at a broad-brush or macro level of the opportunities that exist to carry out more sustainable management of water resources at the cluster and individual building scales. These examples are provided as a way to understand what solutions can, from an economic point of view, be implemented immediately without question (i.e. 10% water conservation), those which are promising, but require further study (i.e. aggressive re-use of treated "waste" water effluent for toilet flushing), and those which do not appear to be applicable given the specifics of planned development in South Lake Union (i.e. composting toilets).

Water Efficient Landscaping
Seven strategies are recommended for xeriscaping and eliminating irrigation. This is a minimal cost item and fits well into the overall landscape strategy. Highly recommended.

Treated Effluent for Flushing Toilets
If developers have projects whose timing and proximity are on roughly the four-block scale, a distributed wastewater system using a Living Machine™ can be utilized to process wastewater. Based on the current cost of 8/10 of a cent per gallon to purchase and dispose of potable water, a very broad economic study suggests that this system could pay for itself in under 15 years and have ongoing savings. Based on the current shortages there may be volatility in water and treatment prices that could reduce the payback time. If there is an option to plan four blocks simultaneously this should be explored.

Reuse of Greywater for Irrigation
The prime use for greywater re-use, as allowed by code, is for irrigation. This would only make sense if there is extensive non-native landscaping, or if there is a sports field or similar landscaping use adjacent to one of the buildings. By utilizing native plantings as a first tier choice, the need for irrigation should be minimized.

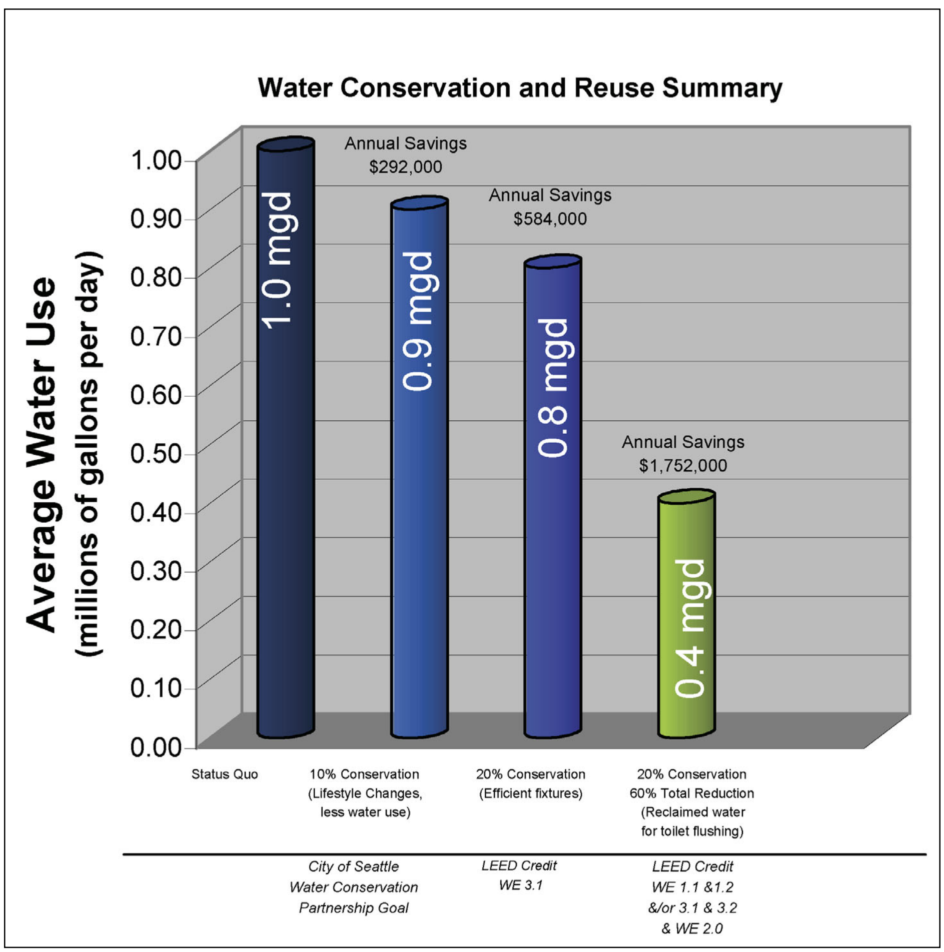
Permeable Surfaces on Sidewalks and Streets
This is recommended wherever possible for all surfaces over soil at interior courtyards, interior drives, and if an agreement can be reached with the city, for all surfaces in the right of way.

Stormwater Treatment and Detention
On a unique building-by-building level this could be combined into a landscape feature designed into one of the courtyards or landscaped areas. It should be investigated for those special situations. With incentives it could have a 5–10 year payback.

Rainwater Collection for Flushing toilets
Rainwater collection requires extensive storage which costs approximately $1–$2 per gallon plus the cost of providing the basement space. This has a fairly long payback but could be appropriate on a smaller basis with discovered opportunities in special buildings, or with incentives.

Water Conservation
It is simple to monitor conservation through the use of water conserving fixtures, appliances and building audits. It is recommended to proceed with the 10%–20% reduction depending upon the building type. This strategy is interconnected with several of the strategies above, and would need to be considered with the overall water re-use concepts.

Recognizing all water as a potential water source reveals that the challenge for the future is not a water supply problem, but a water management problem. We propose using a new paradigm of water management that views all water as valuable, and a resource that should be used to its highest potential.



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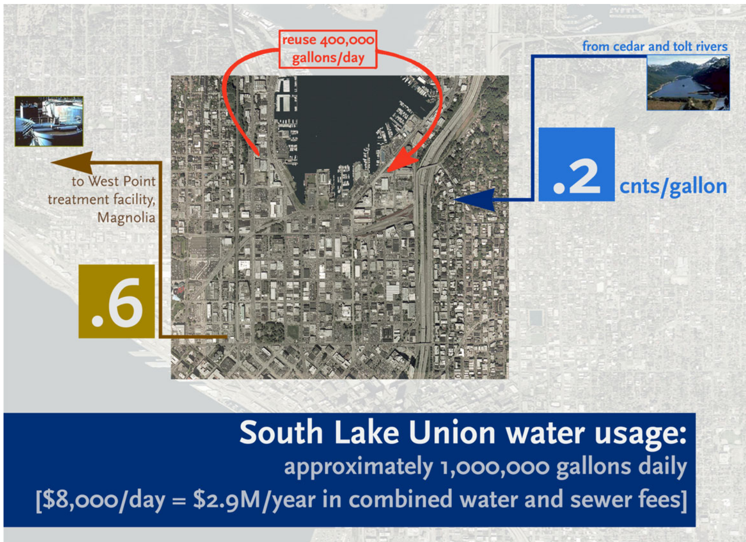

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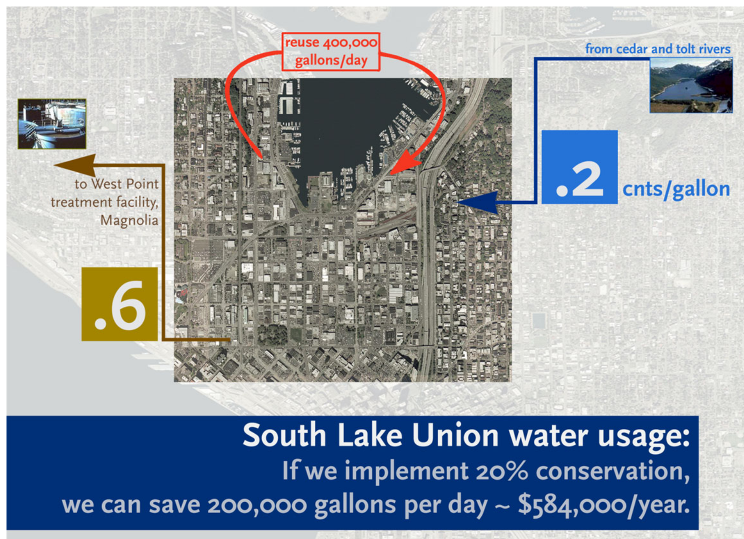

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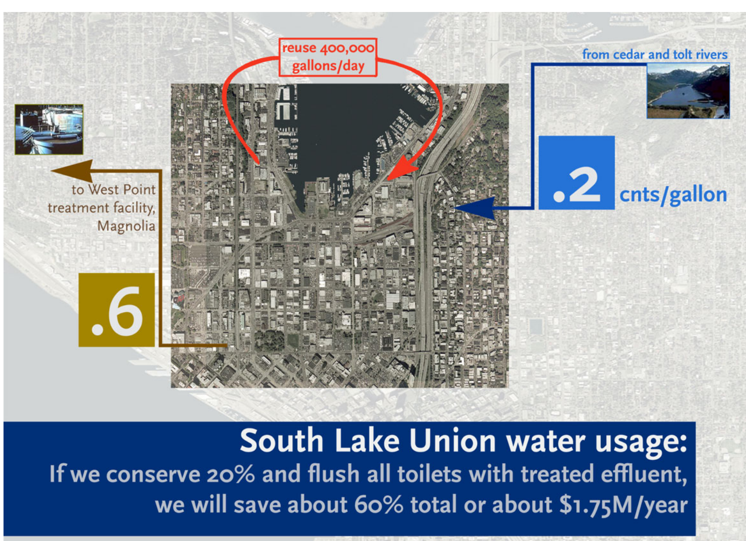

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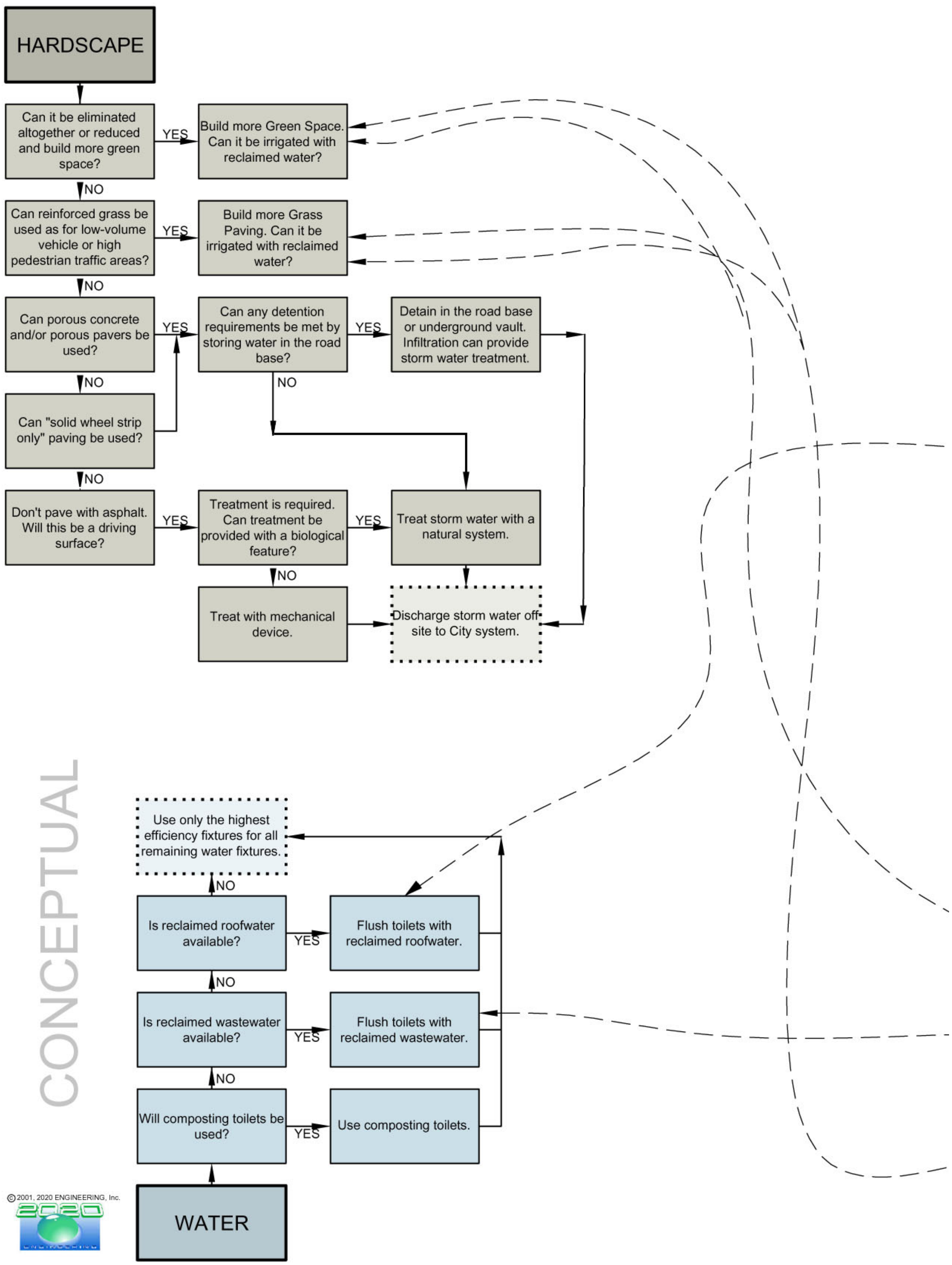
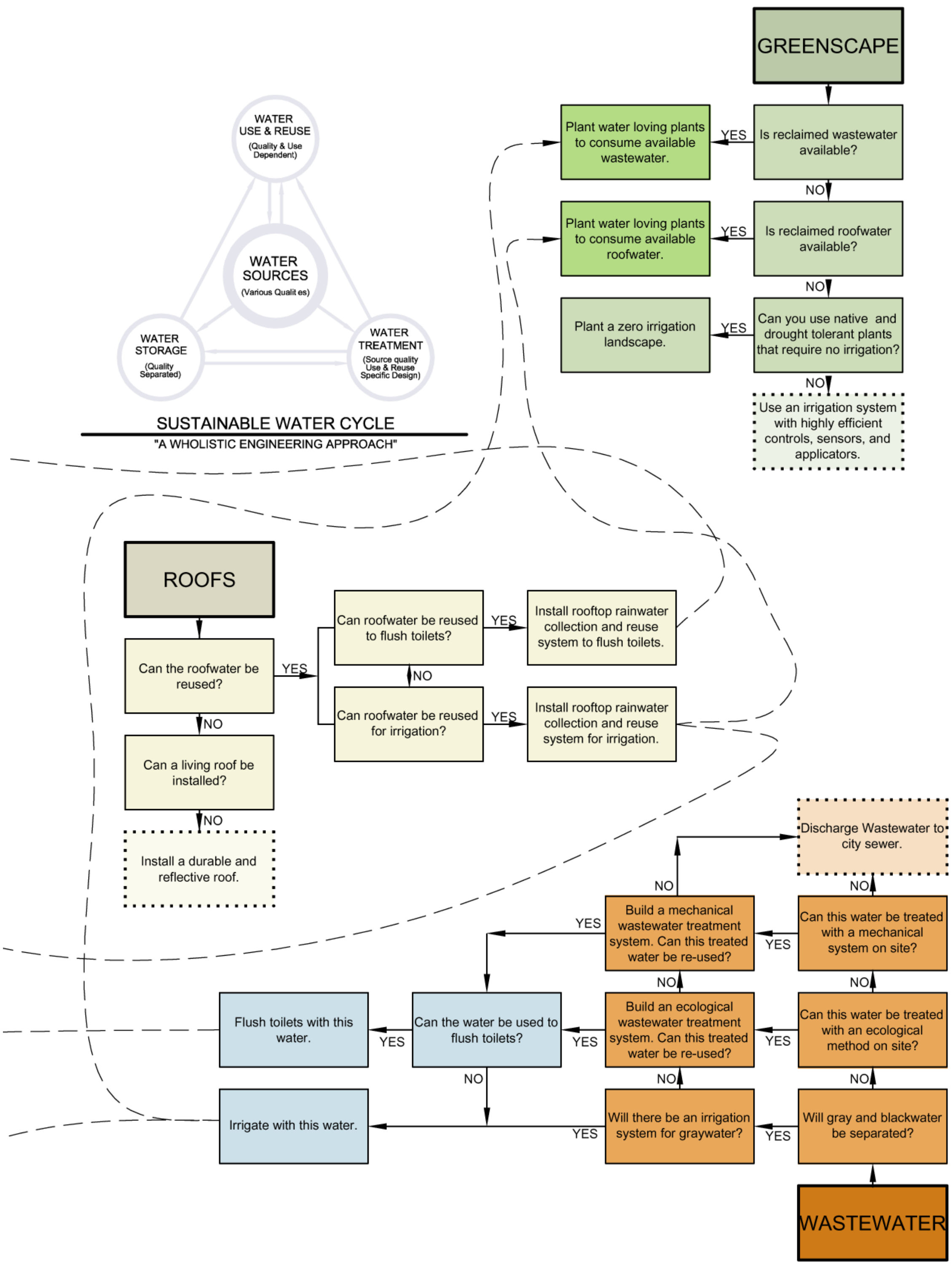
water efficiency

decision tree





GREENSCAPE
Is reclaimed wastewater available?
YES
Plant water loving plants to consume available wastewater.
NO
Is reclaimed roofwater available?
YES
Plant water loving plants to consume available roofwater.
NO
Can you use native and drought tolerant plants that require no irrigation?
YES
Plant a zero irrigation landscape.
NO
Use an irrigation system with highly efficient controls, sensors, and applicators.
WATER USE & REUSE
(Quality & Use Dependent)
WATER SOURCES
(Various Qualities)
WATER STORAGE
(Quality Separated)
WATER TREATMENT
(Source quality Use & Reuse Specific Design)
SUSTAINABLE WATER CYCLE
"A WHOLISTIC ENGINEERING APPROACH"
ROOFS
Can the roofwater be reused?
YES
Can roofwater be reused to flush toilets?
YES
Install rooftop rainwater collection and reuse system to flush toilets.
NO
Can roofwater be reused for irrigation?
YES
Install rooftop rainwater collection and reuse system for irrigation.
NO
Can a living roof be installed?
NO
Install a durable and reflective roof.
WASTEWATER
Will gray and blackwater be separated?
YES
Will there be an irrigation system for graywater?
YES
Irrigate with this water.
NO
Can this water be treated with an ecological method on site?
YES
Build an ecological wastewater treatment system. Can this treated water be re-used?
YES
Can the water be used to flush toilets?
YES
Flush toilets with this water.
NO
NO
Can this water be treated with a mechanical system on site?
YES
Build a mechanical wastewater treatment system. Can this treated water be re-used?
YES
NO
NO
Discharge Wastewater to city sewer.

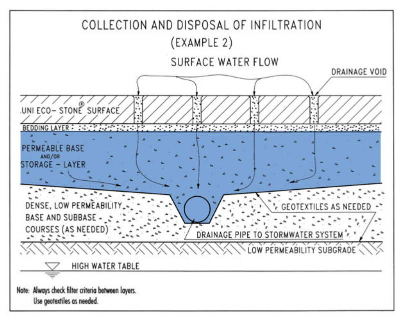
water efficient landscaping

Goal: Make landscape and maintenance choices that support water conservation.

Strategies:

1. **Reduce dependence on irrigation by xeriscaping – using native and adapted plants that withstand drought conditions.**
2. **Use native or adapted exotics that are planted in correct plant associations to ensure that areas have the same water requirements.**
3. **Use seed mixes that are native or adapted to the Seattle region. Do not use standard bluegrass turf as it requires extensive watering.**
4. **Reduce turf areas.**
5. **Use soil moisture sensors or weather station based high efficiency irrigation systems to trigger water delivery to plants as needed.**
6. **Use temporary irrigation systems to establish plantings in the first two years.**
7. **Improve soil quality which reduces compaction, improves absorption capability and improves performance of the plants.**

   a. Require minimum soil amendments.
   b. Use structural soils.
   c. Coordinate with the composting program used by the P-Patch that works with local businesses to collect waste such as coffee grounds and food scraps.
   d. Use green waste generated on site in a compost/mulching process.
   e. Add earthworms (Lumbricus terrestris) to planting mix to reduce compaction and add nutrients.



Courtesy Washington State Dep't of Ecology – Stormwater Management Manual for Western Washington

Status of the Technology: Drought tolerant landscapes are now very common in drier communities in the southwest and California. Locally, water efficient demonstration gardens can be seen at the University of Washington's Urban Horticulture Center, Bellevue Botanical Garden and the Woodinville Water District (425-483-9104 x302).

The Vulcan headquarters entrance court at 700 Union Street is an excellent example of how xeriscaping can be integrated into urban places.

Costs: On average, cost comparisons between turf and higher functioning plantings are.$.50/sf for turf, $2.50/sf for grass/shrub combinations and $5–6/sf for tree/shrub/ground cover combination.

The cost of using a native seed mix that can be mowed as desired varies only in the price of seed. Costs of native seed mixes can be twice as expensive depending on the rarity of the seed, but the labor and soil prep costs remain the same, dissolving the impact of the increased cost considerably.

Invisible Structures, Inc.

Marketing Amenity: The landscape aesthetic will shift in response to meeting water conservation and habitat development goals. This shift in appearance will be a piece of the overall perception of South Lake Union as a sustainable, livable neighborhood.

Incentives: Reduced water costs. No regulatory incentives. An easy LEED™ credit to obtain. Consider incentive request from city for xeriscaping.

Recommendation: Use xeriscaping with native plantings for landscaped areas. Identify any potential irrigation and tap existing greywater sources.

Resources:

http://www.cityofseattle.net/salmon

http://www.ci.seattle.wa.us

Native Plant Alliance – A Manual of Native Plant Communities for Urban Areas of the Pacific Northwest by Charles M. Anderson, ASLA

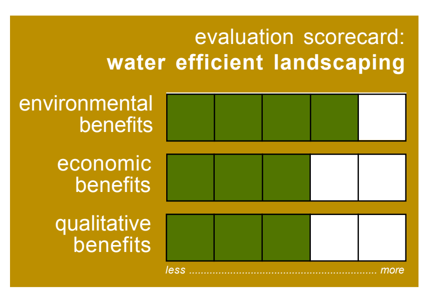
Hobbs and Hopkins, Ltd Darlene Vinson
Portland-based native seed mix company
1-800-345-3295

Balance Restoration Nursery
specializing in native, wetland and riparian plants
541-942-5530

King County Extension Agency (206-296-3900)
publication number KC 125 "Low Water Plants"
206-296-3900

University of Oregon's Center for Housing Innovation (CHI)
http://www.uoregon.edu

Center for Watershed Protection
http://www.cwp.org
410-461-8324



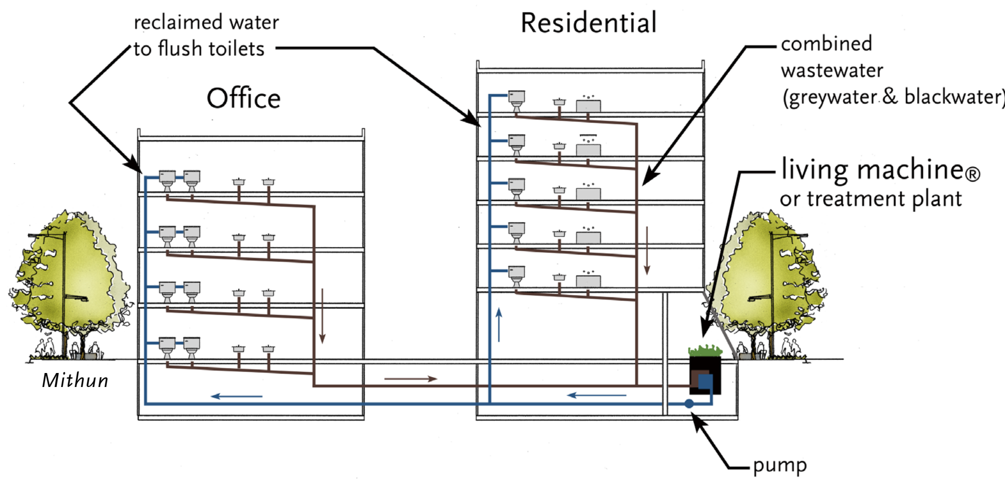
reuse of treated wastewater

effluent for flushing toilets

Goal:

To reduce potable water usage and decrease wastewater production and resulting pollution.

Strategies:



1. Collect and Re-use Wastewater

To re-use wastewater one must first collect it. Second, the water collected will need to be treated according to its current quality and anticipated use. Third, the water needs to be distributed for re-use.

The State of Washington has published standards on the re-use of treated "waste" water. Uses vary from toilet flushing and irrigation, to use in street sweepers and industrial processes or boilers. The standard can be found at: http://www.doh.wa.gov/ehp/dw/Publications/standard.pdf. They are called "Water Reclamation and Reuse Standards," September 1997, Washington State Departments of Health and Ecology, Publication #97-23 (Health).

The collection infrastructure for a development's wastewater re-use system within a building would be largely the same as a traditional one. However, the untreated wastewater would need to be pumped or otherwise conveyed to the treatment system via new pipes.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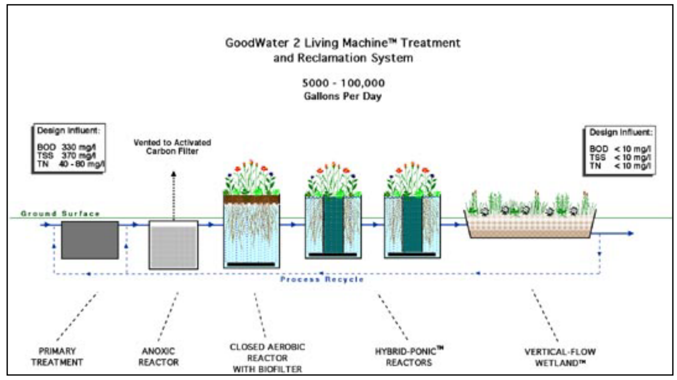
The choice about the most appropriate type of treatment and re-use system for a project will depend on several factors. If a developer wished to install a treatment and re-use system that would be out of public view and provide the required level of treatment and re-use at a minimal cost, then a fairly traditional treatment chain could be designed. This treatment chain could be comprised of a traditional mechanical/ chemical system (such as any number of aerobic secondary treatment technologies and systems) followed by a filtration and disinfection system. Some examples of on-site systems that could be designed and used as part of a wastewater treatment and water reuse system include the Orenco-AdvanTex textile filters, Zenon ZeeWeed membrane system, and Hydroxyl's Moving Bed Biofilm Reactor (MBBR) process. This type of treatment chain is currently being used as part of the new Building 18A at Battery Park City in Lower Manhattan, New York City (http://www.batteryparkcity.org).



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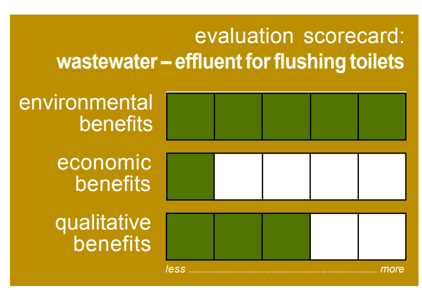
However, if the treatment and re-use system is to be a design feature and exposed to public view, an ecological treatment technology such as a Living Machine™ could be used. Depending on the scale and other factors the Living Machine™ may be more expensive than a traditional treatment system, however this cost can be mitigated by the marketing appeal of such systems. Living Machines™ accelerate nature's own water purification process. Unlike chemically based systems, Living Machines™ incorporate helpful bacteria, plants, snails and fish that thrive by breaking down and digesting organic pollutants. Wastewater treatment takes place in a greenhouse through a series of differently managed environments and a diversity of organisms that eat the waste in the water. The water would then be ready for re-use. More information on Living Machines™ can be found at http://www.livingmachines.com.

To convey the treated wastewater effluent back to toilets for flushing, a conveyance system would need to be built between the treatment system and the toilets. This would mean a dual set of plumbing in the buildings. These reclaimed water lines would need to be purple in color and labeled as such per the Uniform Plumbing Code. A piping system such as this was recently built as part of 555 City Center (a 20-story office building in downtown Oakland, CA). This building will use reclaimed water from the East Bay Municipal District's treatment plant to flush toilets (http://www.shorenstein.com).

Multi-topic Education Opportunity: Conservation of water and elimination of *waste* water at this scale not only reduces water consumption and pollution but also saves large amounts of energy The reduced need for large conveyance pipes and underground tunnels will save land and resources. The use of the ecological methods of a Living Machine™ eliminate the need for many water and wastewater treatment chemicals such as chlorine.

Status of Technology and Regulatory Status: This type of re-use is not the norm, however each of the components that make up a collection, treatment, and re-use system are fairly well understood; however, utilizing and combining them in this way to achieve aggressive water conservation and pollution prevention is new. In other words, the water collection and distribution is comprised primarily of standard equipment. The treatment technology could be comprised of traditional or ecological methods, as discussed above.

There is regulatory precedence in Washington State for flushing toilets with wastewater treated by a Living Machine™ at IslandWood (www.islandwood.org) on Bainbridge Island, WA. Additionally, the new Oberlin College's Adam Joseph Lewis Center for Environmental



Studies in Ohio (http://www.oberlin.edu/envs/ajlc/) features a Living Machine™.

Building Impact: Each building would be required to install a separate reclaimed water system consisting of additional pipes to toilets. Each building would have added costs for separate plumbing lines to toilets.

Costs: The costs of a wastewater reuse system will vary depending in large part on the ability to effectively collect and distribute the water. These costs will vary so greatly that determination of realistic costs for this type of strategy is beyond the scope of this study. Intuitively, however, a particular economy apparently exists at the four-block scale. That is to say, when development activities are occurring at this scale, the ability to influence the development of the street and sidewalk in the public right-of-way greatly increases the feasibility of installing new water collection and distribution infrastructure. An additional benefit of this scale is relative to the ability to co-mingle other utilities (such as new electric power and communications infrastructure) in a common trench further enhancing the feasibility of both strategies.

The specific costs for the treatment with a Living Machine™ are better understood at a broad level on the four-block scale The costs are summarized in the following chart.

Conceptual Pro-Forma Wastewater Re-Use			
Assumptions			
4 blocks of office		1,300,000	sf
Lease Rate for LM	$	15.00	per year sf
Re-Use		82,000	gallons per day
LM O&M		82,000	per year
Piping in Street	$	100.00	per foot
Dual Plumbing	$	1.50	per sf
Saved Cost on H2o	$	0.008	per gallon
Marketing Advantage	$	0.10	per sf year
No inflation and no increase in utility fees			
Costs:			
Collection and Distribution			
Infrastructure in the Street		$	480.000
Dual plumbing in the building		$	1,950,000
Living Machine™		$	1,300,000
15 yrs of O&M		$	1,230,000
Space for LM 15 yrs		$	1,800,000
Contingencies (10%)		$	676,000
Total cost:		**$**	**7,436,000**
Benefits:			
Reduced Utility Bills for 15 yrs		$	3,591,600
Incentive (50% of incremental)		$	1,922,200
Marketing Advantage		$	2,000,000
Total benefit		**$**	**7,513,800**
Conclusion: Expect ~ 15 year Payback			

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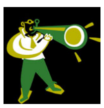


Marketing Amenity: The implementation of a multi-block wastewater treatment and re-use system, especially with a "Living Machine™" would have vast marketing implications. This type of aggressive strategy would attract attention and serve as a selling and public relations point. Additionally, the timing of such an endeavor with the drought, the Endangered Species Act listing of the salmon, and population increases in Seattle would only serve to amplify this concept's already strong appeal.

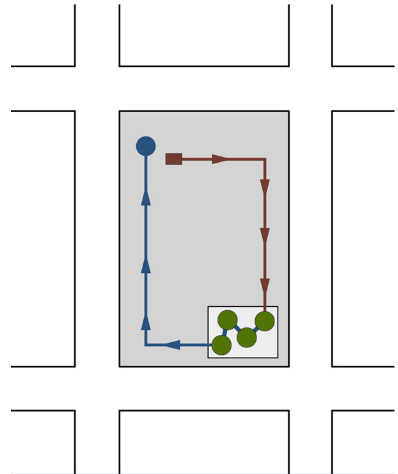
Incentive: Subsidies and incentives of up to 50% of the construction costs may be available from Seattle Public Utilities on a system such as this. These incentives are shown in the pro-forma worksheet. Details on these incentives are available on the Water Smart Technology Program website found at http://www.ci.seattle.wa.us/util/RESCONS/wst/default.htm.

Recommendations: Provide separate water supply piping to all toilets for future and/or implemented water re-use.

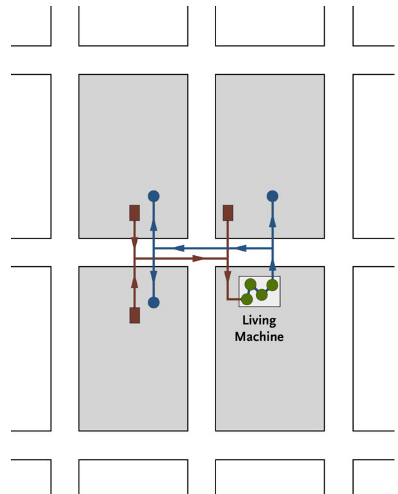
Multi-Block level: Investigate localized wastewater treatment and implement if detailed engineering study checks out. Provide independent water supply to all toilets. Negotiate and review current capital incentives with Seattle Public Utility for Living Machine™ treatment.

Mutual Exclusivity/Conflict with Another Strategy: This strategy does not appear to be mutually exclusive with any other strategy, as long as the re-uses of the water are kept sufficiently broad. For example, the use of composting toilets would prevent the use of toilet flushing.

Multiplier Effect, Synergies, and Economies of Agglomeration: The implementation of a multi-block power generation and distribution plan would be synergistic with a multi-block or series of multi-block wastewater treatment and re-use systems because common utility trenching could be employed.



Decentralized Wastewater Treatment Plant
BLOCK SCALE



Decentralized Wastewater Treatment Plant
MULTI-BLOCK SCALE

Decentralized Wastewater Treatment Plant
NEIGHBORHOOD SCALE

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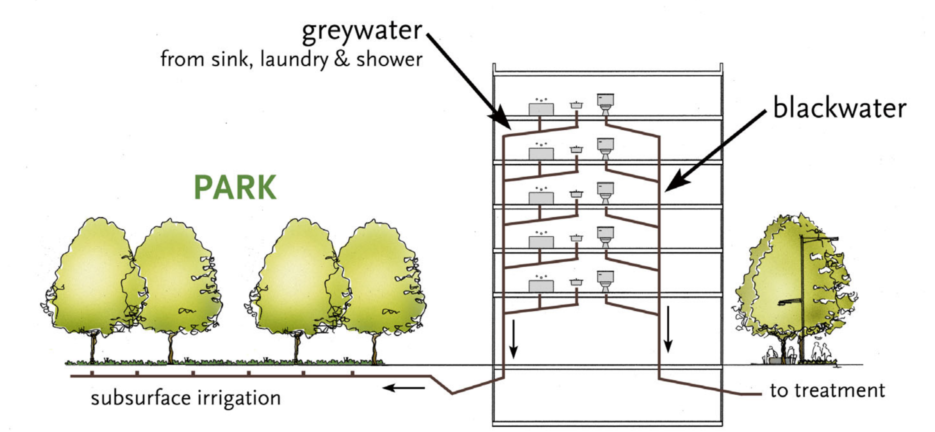
reuse of greywater

Goal: **To reduce potable water usage and decrease wastewater production and resulting pollution.**

Strategies:



Mithun

1. **Reuse Greywater.**

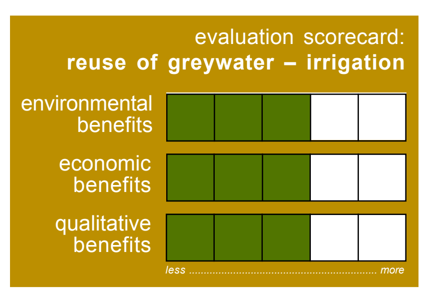
Re-use of greywater (all wastewater except for toilets including sinks, showers, laundry facilities, etc.) for irrigation. This requires that it first be collected separately from the toilet flows (blackwater). Second, it needs to be stored and potentially treated (filtered) prior to use. And third it needs to be pressurized and distributed. The irrigation is via subsurface drip irrigation.

Status of Technology and Regulatory Status: The State of Washington has a published guideline on the use of greywater for irrigation: "Water Conserving On-Site Wastewater Treatment Systems – Recommended Standards and Guidance for Performance, Application, Design, and Operation & Maintenance, Effective Date: May 15, 2000", http://www.doh.wa.gov. The system can be run all year round and is subject to approval by the Seattle/King County Health Department. The technology is simple and readily available from companies such as Geoflow (www.geoflow.com).

Costs: The costs will vary greatly depending on the proximity of the greywater source to its eventual use. The benefit would be a savings of $0.008 for every gallon re-used for irrigation in lieu of a traditional irrigation system using potable city water, and $0.006 for every gallon used for irrigation in an area where landscape irrigation would not have ordinarily been used. The costs to install the system could be similar to those of a traditional subsurface drip irrigation system plus a collection and pressurization system.

Based on the anticipated development pattern with limited extent of landscaping, this re-use option does not appear to have a sufficient opportunity or payback to justify large scale implementation at this time. However, in unique building-by-building design situations, this option should be investigated for feasibility and may achieve a 5–10 year payback with incentives.

Incentives: Review if the development pattern creates sufficient greywater load adjacent to a city green space, such as Cascade, South Lake Union, or Denny Park to receive an incentive from the city to provide greywater for irrigation of city property.



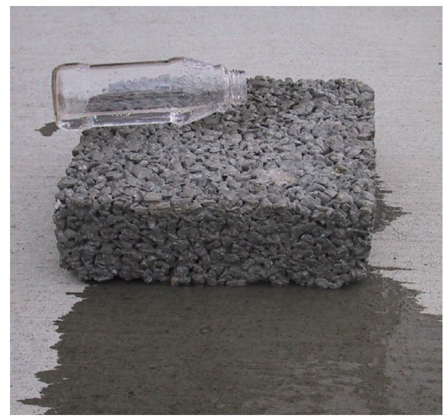
permeable surfaces

Goal: To reduce stormwater run-off quantities, increase groundwater recharge and filter water.

Strategies:

1. **Use Permeable Surfaces.**

There are a variety of options for pervious surfaces that can be used: porous concrete, porous paving stones, reinforced turf, crushed gravel with soil stabilizer and paving block with planted joints.



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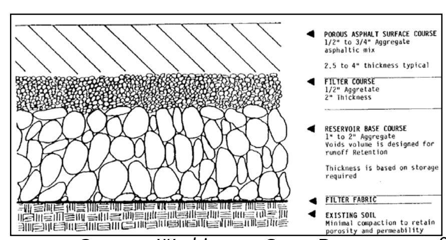
Porous Concrete: Porous concrete paving has been in use for years in Florida and other places and the technology is relatively well understood. Currently the concept is being researched and promoted actively by the American Concrete Institute (http://www.aci-int.net) and locally by the Washington Aggregates and Concrete Association (http://www.washingtonconcrete.org). Concrete for the street or sidewalk would be mixed without the typical fine aggregate leaving only the larger aggregate that creates 15 - 20% voids that allows the stormwater to infiltrate. The section has to be designed to promote treatment of potentially contaminated stormwater before it is introduced into the ground. This treatment occurs by filtration in the base materials. Therefore, this pavement reduces stormwater run-off quantity and increases stormwater quality. This pavement section can be used for virtually any high or low volume vehicular traffic area at virtually any speed.

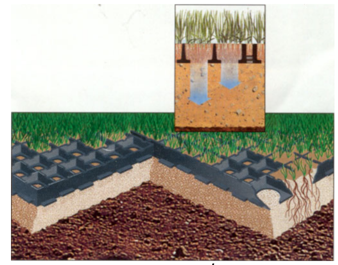
Interlocking Concrete Pavers: The porous interlocking concrete pavers are well understood and promoted and distributed locally by several companies such as Mutual Materials with their UNI Eco-Stone product (http://www.mutualmaterials.com/environ/eco.html). They have several projects locally that are available for viewing. These pavers are placed on a base and are shaped in such away as to provide a drainage void. This void is designed to facilitate the infiltration and treatment of stormwater similar to the porous concrete. This pavement should be used for moderate to low vehicular traffic areas.

Porous asphalt: Porous asphalt is another pervious surface that qualifies for an impervious surface reduction credit. (see below for incentives) This paving option is used frequently in park settings but is increasingly considered for urban applications to allow infiltration.



Courtesy Washington State Department of Ecology – Stormwater Management Manual for Western Washington

Reinforced Grass: Reinforced grass paving consists of a somewhat traditional base with the top course consisting of a plastic cellular confinement and reinforcement layer that supports and contains a sandy soil-growing medium for grass. The surface, therefore, looks like a typical lawn area with an occasional view of the edges of the plastic confinement material. The result is a surface that is completely pervious, provides significant amounts of stormwater treatment, and can achieve the desired aesthetic look and feel while being able to support light to low vehicular traffic loads. The material is available from several local sources including Grassy Pavers (http://www.rkmfg.com) and Geoblock (http://www.sspco.org/geoblock.html). Both of these products are in use locally and are available for viewing.



Presto Products Company

Crushed gravel with soil stabilizer: Crushed gravel is frequently used in urban parks such as Central Park in New York and locally at the Urban Horticulture Center and Parsons Garden. It will also be used in the Thea Foss Waterfront Esplanade in Tacoma. It has application to sidewalks and planting strips. With the addition of soil stabilizer, a natural binder, only the top ¼" of crushed stone is mobile. Some of the pervious nature of the material may be lost with the addition of a binder, but the manufacturer claims it remains porous.

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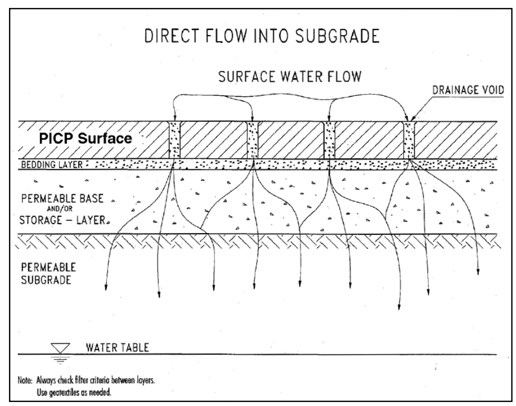
Paving block with planted joints: A variety of porous or non-porous paving blocks can be installed on a stone dust or sand bed with 4" wide planting joints. This treatment would be appropriate for planting strips and areas with low pedestrian traffic. Low growing, drought tolerant and *crush-proof* sedums are an ideal ground cover for the joints.

Status of Technology and Regulatory Status: This use of this technology is fairly well understood but it is not widely used. There are published design guidelines for these surfaces in the August 2001 version of the Washington State Department of Ecology Stormwater Management Manual for Western Washington (http://www.ecy.wa.gov/programs/wq/stormwater/manual.html).

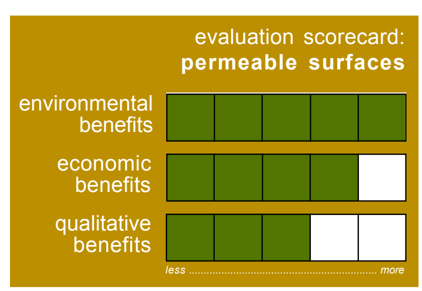


Courtesy Washington State Department of Ecology – Stormwater Management Manual for Western Washington

Costs: The costs for the porous concrete are very nearly that of traditional concrete paving. If one considers the fact that one still has to build a base, and the labor to place and finish the concrete is the same as traditional solid concrete slabs, the only additional cost is about $15 more per yard for the material (about $80/yd vs. about $65/yd in the greater Puget Sound Area) according to the Washington Aggregates and Concrete Association. Given the amount of labor involved in placing the concrete (either solid or permeable), this additional cost of 23% on the material cost will be minor compared to the benefit. The benefits will be in the form of directly reduced stormwater fees of several hundred dollars per year per acre and could potentially be greater depending on incentives available from Seattle Public Utilities and others.

As for the UNI EcoStone porous interlocking pavers, Mutual Materials states the pavement can be placed for $6–$8/sf on average. If the area is large enough to install the pavers mechnically the cost becomes competitive with concrete, about $3/sf.

The Grassy Pavers and Geoblock material is available for $2–3/sf for the material plus the cost of the base, installation, and planting and maintaining, which totals $7.00–7.50/sf depending on quantity of area



installed. The benefits will be in the form of directly reduced stormwater fees of several hundred dollars per year per acre and could potentially be greater depending on what incentives are available from Seattle Public Utilities and others. The real benefit is the ability to design a dual use space. One could design a grass paved area that serves for delivery trucks at night and then as an outdoor café area during the day, or a fire truck access lane that is part of a park like setting, etc.

Crushed stone installed 4" deep on a compacted soil sub-base with binder costs about $.30/sf using local material.

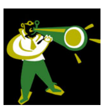
Paving blocks with 4" wide planted joints is a comparable cost to installing concrete block paving units.

In summary, if the market will tolerate the aesthetic look of porous concrete, this material can be placed in lieu of standard solid concrete for roads and sidewalks at a payback well below five years based on nearly cost neutral placement of the material with significant possibility for incentive and a reduced stormwater fee.

In the case of the segmented pavers, the installation cost may be two or more times greater to install the pavers than a traditional solid concrete slab. However, in many cases the look of the pavers are superior to a concrete slab and as such the pavers can be considered an amenity.

In the case of the reinforced grass pavers, the installation cost may be 2 or more times greater to install the pavers than a traditional solid concrete slab; however, in many cases, the ability to have the green space function and the drivability function could allow for dual use of the space – adding value to the project. A payback well below five years could be achieved.

Crushed gravel and paving blocks with planted joints involve limited additional investment because their installation cost is comparable to standard paving.



Marketing Amenity: Pearmeable surfaces can contribute to the special look of a neighborhood with unique walking and driving surfaces, and reinforce the branding of that neighborhood.

Incentive: Seattle Public Utilities offers an impervious surface reduction credit under the November 2000 Flow Control Manual's stormwater code which varies based on native soil percolation rates. Additional credit reductions under this manual include a one to one credit for roof gardens that include 8" of soil and 1" of surface storage area; a one to one credit for landscape planters which include 18" of loamy sand and 2" of surface storage area; and design specific credit for eco-roofs. See the "Flow Control Technical Requirements Manual" for more detail. www.ci.seattle.wa.us/dclu/codes/dr/DR2000-26.pdf

Recommendation: Use pervious concrete, porous concrete pavers, reinforced grass paving, crushed gravel and paving blocks, at exterior hardscape areas.

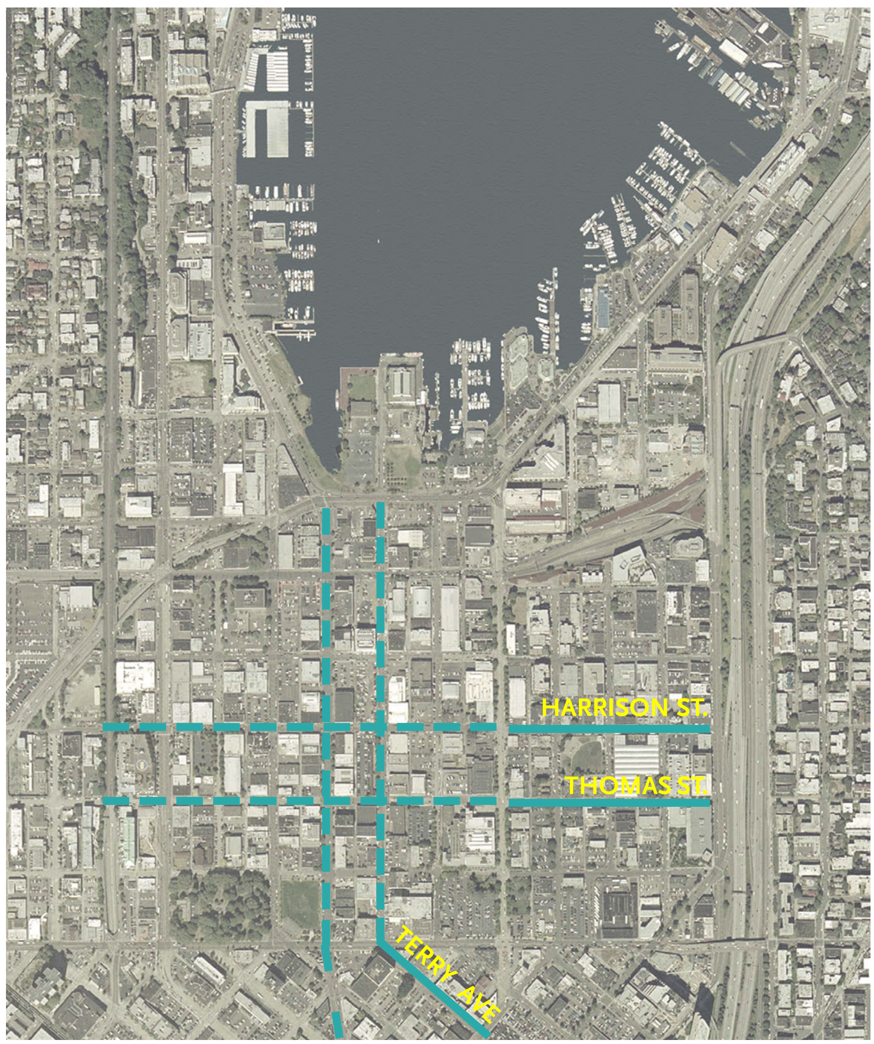
Basement Flooding: There has been a regulatory issue raised relative to the risk of basement flooding due to introducing water into the ground adjacent to buildings with basements by using porous paving. This is a simple issue to address in design with the use of a plastic liner and under drain system. This type of under drain system is common with the use of porous pavements on impermeable clayey soils. This issue does not represent a significant technical obstacle to implementation. The environmental benefits even without direct infiltration to both the stormwater quality/quantity and mitigation against the CSO problems in this neighborhood should be sufficient to warrant assistance through incentives and cooperation from Seattle Public Utility.

Additional 5.1 acres of potential permeable surface in public R.O.W./Streets, with the following recommendations:

Terry Avenue (76' R.O.W.) 100% permeable

Harrison Street (66' R.O.W.) make one parking lane permeable

Thomas Street (66' R.O.W.) make one parking lane permeable



Potential Permeable Surfaces in South Lake Union

stormwater

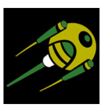
treatment & detention

Goal: To increase stormwater quality.

Strategies:

1. **Install green space that serves a dual purpose of providing an aesthetic amenity and treatment for stormwater run-off.**

This would increase the water quality of Lake Union, contribute to the goals of the Endangered Species Act, and assist in meeting requirements of the new guidelines from the Department of Energy. This would be a creative use of landscaping to make visible and celebrate the stormwater treatment abilities of natural systems.

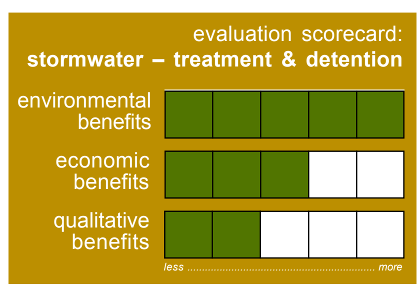


Status of Technology and Regulatory Status: SPU has developed a demonstration program in an urban single-family residential neighborhood that utilizes 15' wide bio-retention areas and overflow systems that could have some application in selective portions of the South Lake Union neighborhood. The urban stormwater flows in the South Lake Union neighborhood will be much higher due to a generally greater percentage of impervious surface; so this approach would be part of the education mission.

Costs: If the stormwater treatment were also serving as the landscaping (at about $5.50/sf for a combination of shrubs and ground cover), the costs may be lower than attempting to provide treatment through an expensive underground filter system, which may be required.

Based on the anticipated development pattern with limited extent of landscaping, this option does not appear to have a sufficient opportunity or payback to justify large scale implementation at this time. However, in unique building-by-building design situations, this option should be investigated for feasibility and may achieve a 5–10 year payback with incentives.

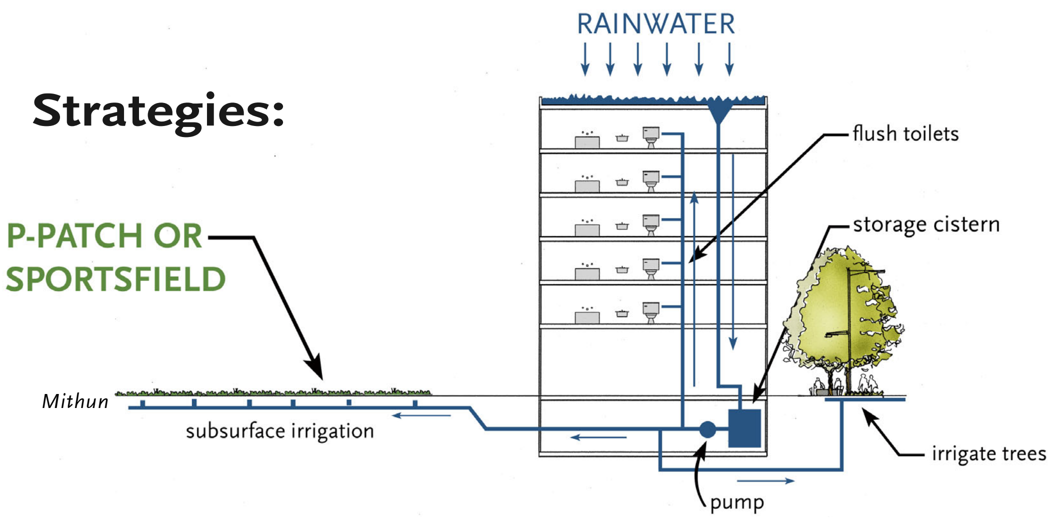
Recommendation: Make all landscaping multi-functional. Use landscaping to enhance and create animal habitat (primarily birds) as well as treating stormwater runoff.



rainwater collection

Goal: To reduce run-off generated by the building and to reduce potable water usage.

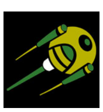
Strategies:



1. **Reuse Rainwater**

The primary system consists of the collection of rainwater from a clean roof surface, storage in cisterns, filtration, pressurization, and plumbing back to toilets.

The system could also be developed for landscape needing special watering, such as P-Patches.



Status of Technology: This technology is simple and available. King County Department of Natural Resources utilizes this technology in their new building, King Street Center (http://dnr.metrokc.gov/market/map/kingst.htm).

Costs: This strategy is best applied on a single building basis. Additionally, since a large portion of the cost of this scenario is in providing the storage required (at about $1–2/gallon plus the cost of the space), a hybrid system could be employed where a portion of the toilet flushing needs are met by the rainwater when it is available, and augmented with city provided water when rain supply is low.

The example of the potential payback on such a system is shown using a single block is used as the scale. The example assumes collecting all of the roof water from a whole block and using it to flush the toilets in an 85,000 sf office space. Our example uses a very conservative construction cost for dual plumbing of $1.50/sf. A recent office building in California constructed dual plumbing for less than $.20/sf. Based on the assumptions shown, we expect a 15-year payback on such a system.

Marketing Amenity: The usage of collected rainwater for flushing toilets and the associated educational/interpretive signage could be a popular amenity, as a discussion point or as a memorable facet of that building.

Incentives: Subsidies and incentives of up to 50% of the construction costs may be available from Seattle Public Utilities. Details on these incentives are available on the Water Smart Technology Program website found at: http://www.ci.seattle.wa.us/util/RESCONS/wst/default.htm.

Recommendations: Provide separate cold water supply piping for toilets. Evaluate rainwater re-use and city incentives on a building by building basis if green roof, composting toilets, or Living Machine™ is not done.

Multi-topic Education Opportunity: Educational linkages could be made between air pollution reduction and water quality. For example: "Please bike to work. We are trying to keep our roof clean to re-use the water."

Mutual Exclusivity/Conflict with Another Strategy: The use of rainwater collection for toilet flushing would only be done if composting toilets were not used. This strategy would also be mutually exclusive with a living roof. Use of native landscaping with xeriscape removes the need to store rainwater to use for landscape irrigation.

Conceptual Pro-Forma
Flushing Toilets with Rainwater

Assumptions			
Collection Roof Area		86,400	sf
Office Space Supplied		85,000	sf
Toilet Demand		0.05	gpd/sf
Toilet Demand		13	gal/sf/year
Rainfall		35	in./year
Dual Plumbing	$	1.50	per sf
Saved Cost on H2O	$	0.002	per gallon
Saved Drainage Cost	$	630.00	per year
Water Storage Cost	$	1.00	per gallon
Storage Needs		61,000	gallons
Pressurization & filter	$	5.00	per gallon
Lost lease revenue for basement	$	5.00	per sf/year
Space Needed for tanks & equip.		1,500.00	sf
Operation & Maint.	$	5,000.00	per year
Marketing Advantage	$	0.10	per sf year
No inflation and no increase in utility fees			
Costs:			
Storage	$	61,000.00	
Dual Plumbing in the bldg	$	127,500.00	
Pressurization & filtration	$	21,250.00	
O&M for 15 yrs	$	75,000.00	
Basement Space usage cost	$	112,500.00	
Contingencies (10%)	$	39,725.00	
Total Cost	**$**	**436,975.00**	
Benefits:			
Reduced Water bills for 15 yrs	$	33,150.00	
Reduced Stormwater fees	$	9,450.00	
Incentive (~50% of incremental)	$	275,000.00	
Marketing Advantage	$	127,500.00	
Total Benefit	**$**	**445,100.00**	

Conclusion: Expect 15 year Payback

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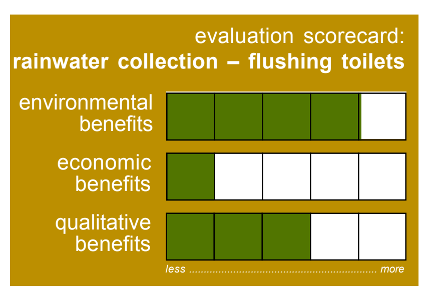
Multiplier Effect, Synergies, and Economies of Agglomeration: The performance of rainwater collection for a toilet flushing system would be greatly enhanced by employing a rigorous water conservation strategy (i.e. lowest flow toilets available).

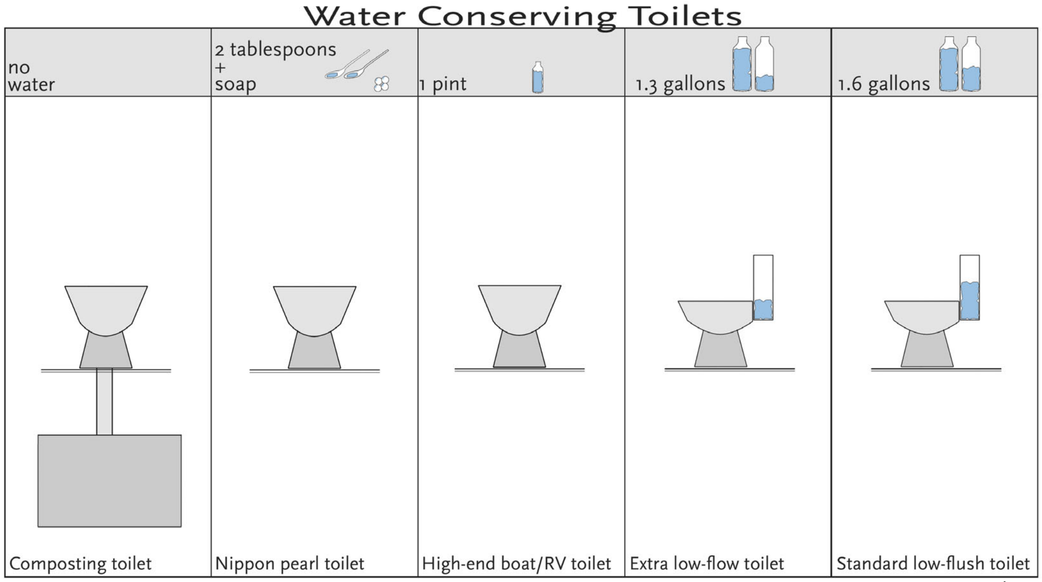


water conservation

Goal: To reduce potable water usage and the production of sewage.

Strategies:

Water Conserving Toilets



Mithun

1. Implement Water Conserving Fixtures or eliminate a landscape irrigation system.

On new construction, this consists of designing the lowest flow devices (fixtures, appliances, and systems including composting toilets, resource audits, and high efficiency landscape irrigation) possible into a building. Meet LEED™ 2.0 criteria of exceeding Energy Policy Act of 1992 fixture performance requirements by 20%. On existing buildings this may consist of performing a water audit and then making operational or physical changes to optimize resource usage. It is often stated that in existing buildings which have not had a resource usage audit, that there is 10%–20% savings to be made in *low-hanging fruit* such as single pass water based heat exchangers, old irrigation systems, leaks, high flow fixtures, etc. The most aggressive strategy for water conservation might be the use of composting toilets, which would reduce the use of water and the production of sewage by about 50%.

Status of Technology: The basic water conserving fixtures and systems are required in most new buildings. The conservation measures are often the common sense implementation of better control systems and lower flow fixtures. Current low flow fixture requirements are 1.6 gallons per flush on toilets, 1.0 gallon per flush on urinals, and 2.5 gallons per minute on sinks and showers. There is a new generation of ultra lowflow fixtures on the market today. These fixtures are fairly traditional in their appearance and function but, use significantly less water.

The high efficiency landscape irrigation systems are very well understood. These high efficiency systems utilize rain, weather sensors, and sophisticated timers and controls to deliver just the right amount of water at just the right time to just the right place. Xeriscaping is an increasingly common technique of landscaping with drought tolerant and native plants that require less water. It is also based on the principle of grouping plants with the same water requirements together to ensure that minimum amounts of water will satisfy them. (See site section on water efficient landscapes.)

Waterless Urinals: zero gallons per flush (100% reduction) – These urinals, available in plastic or ceramic, have been tested and installed at many projects around the region and have performed well. The most common and proven urinals are manufactured by Waterless Company and Falcon Waterfree Technologies.

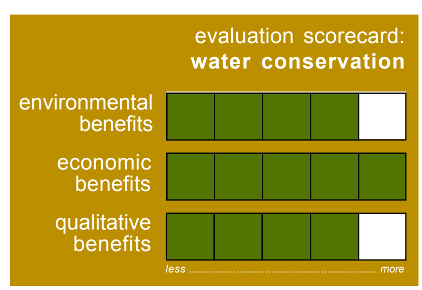
Flush Urinals: Ultra Low Flow Systems: 0.7 gallons per use (30% reduction) – These urinals use "fuzzy logic" sensors to monitor use and flush between uses, which results in a manufacturer claim of 30% less water use over conventional flush urinals. Manufactured by Toto. Urinals are standard porcelain with chrome finished flush assemblies.

Flow Reduction Aerators:

- Lavatory Sinks: 0.5-1.0 gallons per minute (60%–80% reduction). Low-flow bathroom sink fixtures are now available at these lower flow rates that have been tested to have acceptable flow patterns at these lower flows.
- Kitchen Sinks: 1.5 - 2.0 gallons per minute (20%–40% reduction). Low-flow kitchen sink fixtures and aerators are now available at these lower flow rates that have been tested to have acceptable flow patterns at these lower flows.

Toilets: 1.0–1.3 gallons per flush (20%–38% reduction)

- Pressure Assist: The new generation of pressure assist toilet components in the 1.0 gallon per flush range are currently being tested and promoted by (Sloan Valve Company http://www.sloanvalve.com) and (W/C Technology Corporation http://www.pf2wctc.com/). These two manufacturers have pressure assist modules to fit several types of china bowls.
- Gravity Flush: Also available are dual-flush toilets that use as little as half the water normally used by single flush toilets. These are manufactured by Coroma (www.edgewaterenviro.com).
- Waterless Toilets: Some may consider the use of composting toilets "new." Due to advances in composting toilet technology, particularly in the larger scale units, composting toilets are now approved by the State Health Department and feasible for wide scale usage. Additionally, there are several composting toilet fixture options available from the simple chute type common at highway rest areas to 1-pint flush models common in the RV and boat market to 1-tablespoon flush models from Japan. The ultra-low flow models combine the 1-tablespoon of water with soap to create a sudsy lubricant to facilitate waste transport. These 1-cup and 1-tablespoon toilets offer a ceramic bowl and a toilet-use experience more similar to the "look and feel" of traditional toilet fixtures. These ultra-low flow toilets are standard on boats and RVs Some manufacturers include: Sea Land at (http://



www.sealandsanitation.com/ VacuFlush%20Intro.htm) or Nippon Pearl Toilets (http:// www.jademountain.com/waterProducts/nepon.html).

Showers: 1.5–2.0 gallons per minute (20%–40% reduction). There are several lower flow shower heads from Energy Technology Laboratories (http://www.energytechlabs.com) that make a nice shower pattern at these lower flow rates and are warrantied[1] not to clog for the life of the fixture. Other manufacturers such as Niagara Conservation and Brasscraft also manufacture ultra low-flow showerheads.

Resource Audit and Analysis: This is routinely used by institutions such as school districts to control utility costs. The audits of existing buildings most often are performed at a net profit to the owner and can be done on a performance contract basis.

Costs: Water conservation is a net gain by providing savings greater than the cost of implementation. The profits from an aggressive conservation program are often used to fund less profitable green strategies.

Marketing Amenity: There is an obvious opportunity to lead by example with this type of "low-hanging fruit" conservation strategy. The use of composting toilets could be a draw if the compost was to be re-used and made publicly available such as the "Zoo Doo" that is produced by the Woodland Park Zoo. This creative example illustrates how a "waste" can become a "resource."

Incentives: Subsidies and incentives of up to 50% of the construction costs may be available from Seattle Public Utilities. Details on these incentives are available on the Water Smart Technology Program website found at: http://www.ci.seattle.wa.us/util/RESCONS/wst/default.htm.

The cost analysis relative to calculating a payback on these systems is relatively easy to predict on the moderately aggressive strategies, and harder to predict on the more aggressive strategies. This is due to the greater influence of market factors at the upper ends of water conservation. For example, a high-end office space in SLU probably will not tolerate the use of composting toilets, and this marketing component can significantly increase the payback times and potentially reduce the ROI. For purposes of discussion, it would be appropriate to summarize the paybacks as follows:

Strategy	Approximate Payback
Resource Conservation Audits on Existing Buildings to achieve 10-20% water conservation	1-5 years
Implementation of 10% conservation over Energy Policy Act of 1992 fixture performance requirements on new construction	1-5 years
Implementation of 20% conservation over Energy Policy Act of 1992 fixture performance requirements on new construction	3-7 years
Implementation of aggressive 50 - 60% conservation over Energy Policy Act of 1992 fixture performance requirements on new construction with the use of composting toilets or wastewater re-use	15 years

Recommendations:

Use water conserving fixtures, exceeding current code standards by 20%, up to 30% depending on payback or goals.

Meter water, electricity, and gas for all tenancies. Create awareness of resource use. For example, create a graphics system that provides real-time readouts at each building lobby.

Use composting toilets at unique low rise public spaces of mixed use buildings.

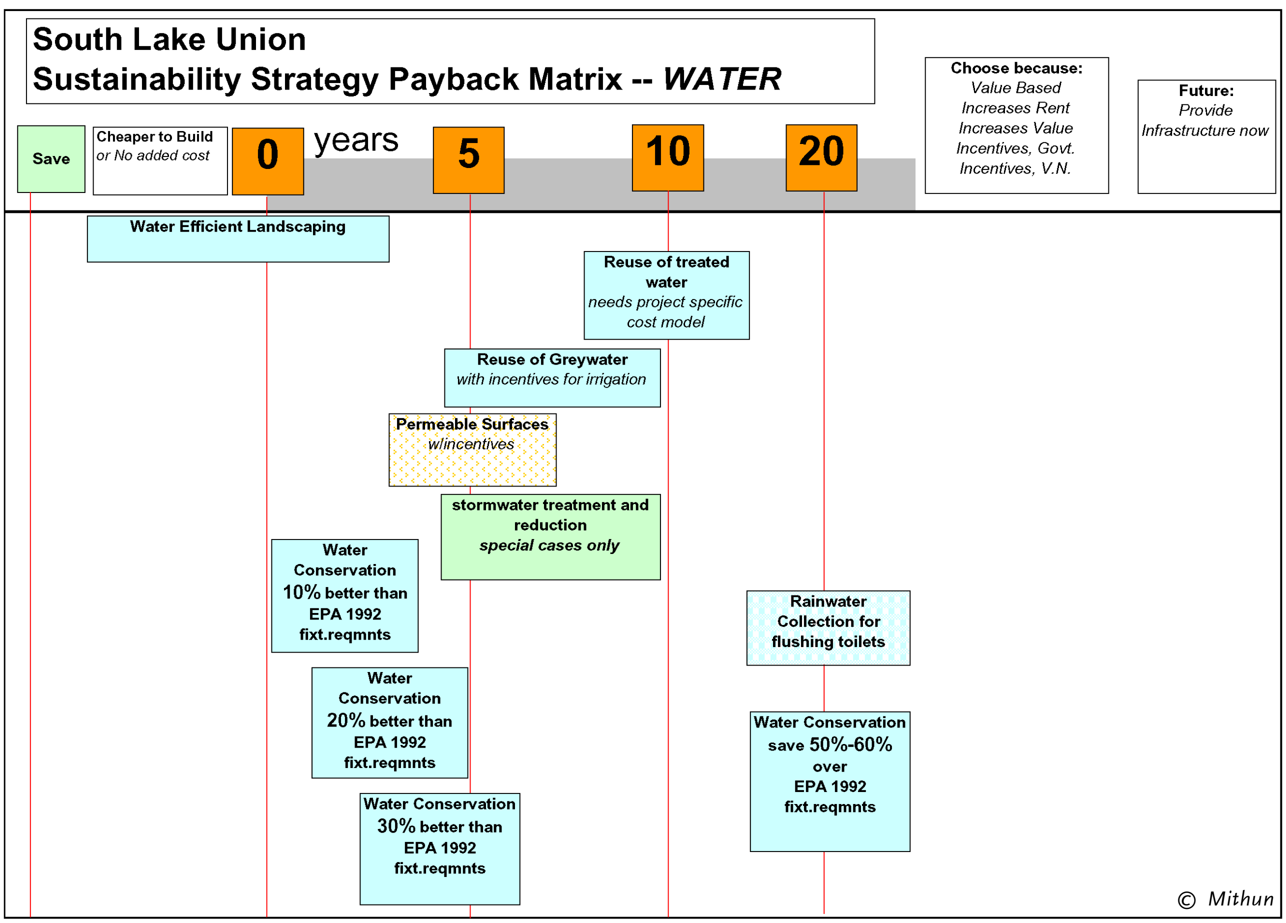
Mutual exclusivity/conflict with another strategy: An area where conservation of water would not be beneficial is if the goal of a system is to "get rid of water" as in the case of an irrigation system that is trying to use up treated wastewater effluent on site. Additionally, the use of composting toilets would be mutually exclusive with the concept of using either rainwater or treated wastewater effluent for toilet flushing.

Multiplier Effect, Synergies, and Economies of Agglomeration: The performance of many systems such as rainwater collection for toilet flushing, on-site wastewater treatment, greywater irrigation, etc. would be greatly enhanced by employing a rigorous water conservation strategy (i.e. lowest flow toilets available).

water efficiency

payback summary

Payback Summary charts are a conceptual tool for mapping each sustainability strategy and their respective payback periods. These strategies are roughly modeled for multi-story commercial buildings in Seattle in 2001. These need to be analysed for each project as size, occupancy, and orientation can affect the numbers substantially. The strategies listed from top to bottom correspond with the strategies listed in the sections that follow. Across the top of the chart is a range of values and payback periods. Starting on the left is 'save' strategies that will reduce costs. Next is 'cheaper to build or no added costs' vs. standard market construction for a class A office building. Next are the years, indicated current ballpark numbers for payback. On the right is a category for items that are value based, desirable because of environmental or social benefits that cannot be justified financially or increase rent or value. This also includes strategies that would be economical because of government incentives or internal owner incentives. An owner can select the strategies that fit within their budget and value goals. Water rates are changing in Seattle, as this paper is being written and we anticipate a change in payback.



energy & atmosphere

introduction

OVERVIEW

Commercial buildings are responsible for 32% of electrical energy use in the United States. When combined with residential and government buildings, the figure exceeds 60% . The bulk of this energy usage results from lighting and HVAC loads. Case studies have demonstrated that with low to moderate levels of additional cost, savings in total building energy consumption ranging from 30–60% can result; and that with no increase in cost, savings of 10–20% can be realized. The methods for achieving this level of success depend heavily on:

1. Reducing internal loads and selecting passive energy strategies before active energy strategies.
2. Selecting integrated strategies that are scrutinized for both benefit and cost to the overall development.

Awareness of both is integral to sound decision-making.

Reduce Load First (Passive Before Active)
The first goal is to make the building and community perform as best as is possible at a *passive* level, without any supplementary mechanical or electrical input. Strategies for massing, siting, natural ventilation, thermal storage, adding vegetation, and others lend themselves well to this purpose.

After all passive strategies have been pursued, the design team applies more *active* systems. Utilized in this stage of design would be high efficiency HVAC systems, a central chilled water system, and various combined heat and power alternatives. Initial costs, life costs, and environmental costs are highly dependent on the amount of such active control that is required.

A winning situation for all parties will result from the implementation of both passive and active strategies. Developers may benefit from decreased construction costs, increased leasing rates, and better tenant retention. The municipality and community benefit from reductions to infrastructure load and environmental damage. The tenants benefit from greater space quality, lower operational costs, and increased productivity.

Integrated Design (Whole Building Design)
Throughout both active and passive decision making, strategies must be balanced wherein needs and costs are considered in the context of the entire building or community. Many of the strategies presented here and in other sections may be either mutually exclusive, mutually supportive, or independent of one another.

Consider for example that daylighting, lighting controls, natural ventilation, and views may all suggest a building of narrow cross-section. Conversely, the use of a co-generation system to provide heat to a building displaces the opportunity to use solar hot water panels to supply the same load. In one case, the strategies support each other; in the second they exclude each other. The key is to match those strategies most appropriate to the building or community needs while balancing the positive and negative consequences ingrained in each.

NEIGHBORHOOD-WIDE ENERGY SOLUTIONS

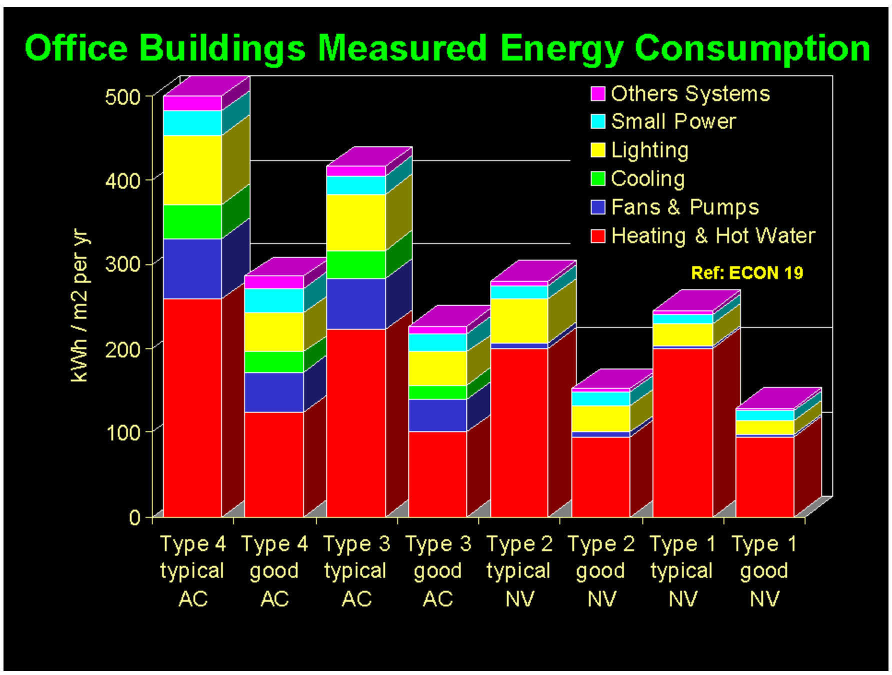
The South Lake Union development area is facing a stressed utility grid, generation shortages, and escalating electrical and gas rates. With the anticipated growth of the area, all of these issues will continue to worsen unless large scale solutions are uncovered. Among the solutions explored are new electrical generating strategies in the form of photovoltaics, microturbines, and fuel cells. In addition, large-scale *utility district* systems are examined, including a centralized chilled water system, a distributed heating system, and the opportunity for co-generation processes.

BUILDING ENERGY SOLUTIONS

The large variety of building uses anticipated for the neighborhood result in a multitude of technologically and financially diverse strategies for reducing energy usage and greenhouse gas emissions at the building level. A general overview of the predominant and most widely applied strategies is presented in this section on Energy Efficiency. The majority are interrelated and have extensive effects on other building systems. As a result, it is imperative that they all be considered holistically. The presentation proceeds from the more passive strategies of siting, massing, and envelope design, to the more active strategies of lighting control, thermal storage, and HVAC systems. As discussed earlier, it is most beneficial for the buildings to perform with the least amount of additional mechanical and electrical systems. Reduce the load first, then pick the right system. Commissioning, although presented last, must follow through the entire design process, and is a key element to achieve *performance as designed*.

CARBON NEUTRALITY

This section summarizes some of the impacts of carbon neutrality on and by development in the neighborhood.



Graph showing eneergy use of typical office buildings using air conditioning (AC) and natural ventilation (NV).

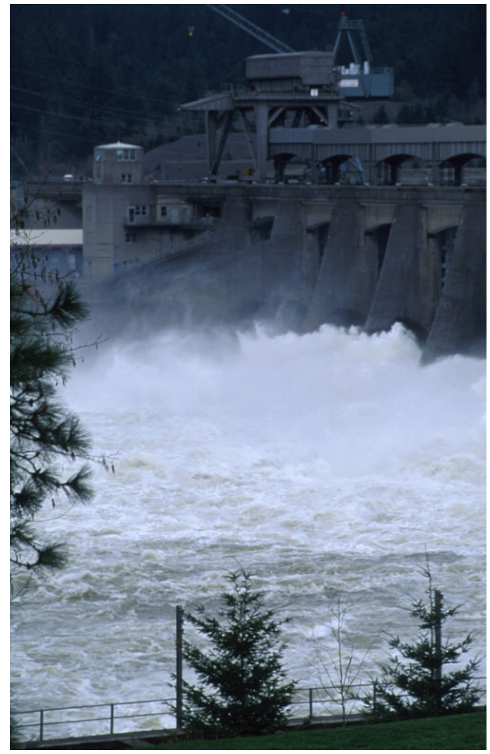
Arup

DECISION CHARTS

Because of the early stage of development planning and to best present the multitude of systems and inter-related criteria, two decision charts were developed: one for the multi-block level and one for the building level. These charts are general in scope and seek to identify the key factors that need to be considered before embarking on the next level of analysis.

(Chart 1. Multi-block Level Decisions)

Central energy systems make the most sense when the development occurs in a fairly compact manner. If development blocks are separated by more than two or three blocks that are not being developed, then the cost of distribution starts to dominate. The chart for Multi-block Systems refers to two development patterns. The "clustered" development assumes that the office and other high load buildings such as laboratories are grouped closely together. The second type, a "patchwork" development of well mixed sites, assumes that office and residential blocks are evenly distributed and are located on adjacent blocks. There is also a criteria of zero carbon development that refers to the City of Seattle's aim of achieving zero net CO_2 increase with new developments.



Bonneville Dam
www.arttoday.com

(Chart 2. Building Level Decisions)

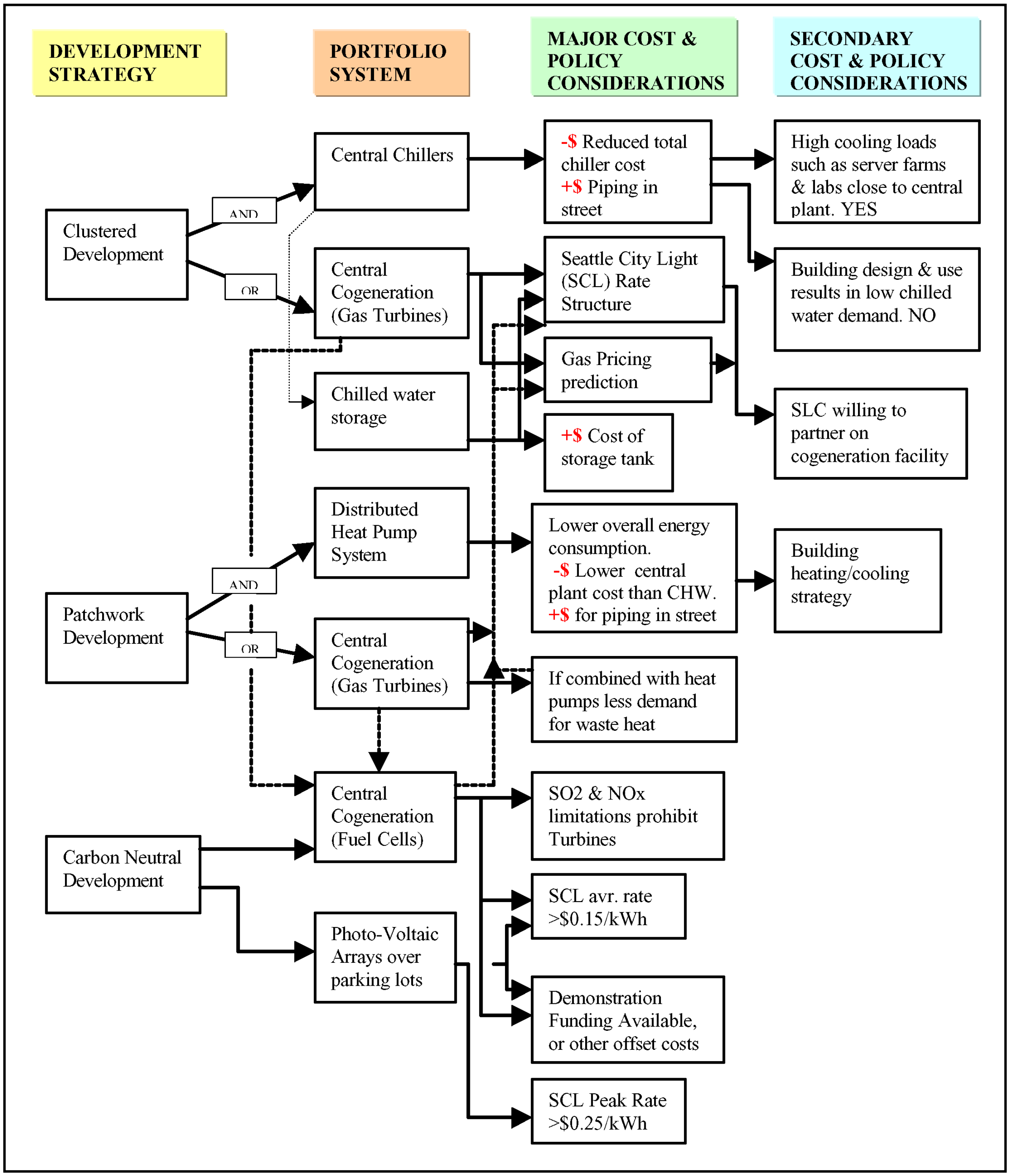
The Building Level Decision Chart looks at strategies tied to investment policies. The grouping is not definitive. For instance, by good integrated design, it may be possible to achieve savings above the 20% limit for little or no additional cost. The current assessment of payback range is based on existing buildings and studies of buildings in similar climates. In the charts, the payback assessment is based solely on saved operating costs. Savings due to increased productivity, increased rental value and other less tangible benefits may be worth more than the saved utility costs.

If development continued at the same rate as 2000 in South Lake Union and seven million square feet of development space was created over the next ten years, intelligent design practices would result in savings of 14,500 tons of CO_2 emissions; a savings equivalent to the planting of 600,000 trees.

The proposed strategies for electrical energy savings, described in this study, would save 24 million kWh per year, enough to power nearly 3,000 Seattle area homes or spill an additional 38,000 cubic feet of water over the Bonneville Dam.

energy & atmosphere

multi-block scale decision tree



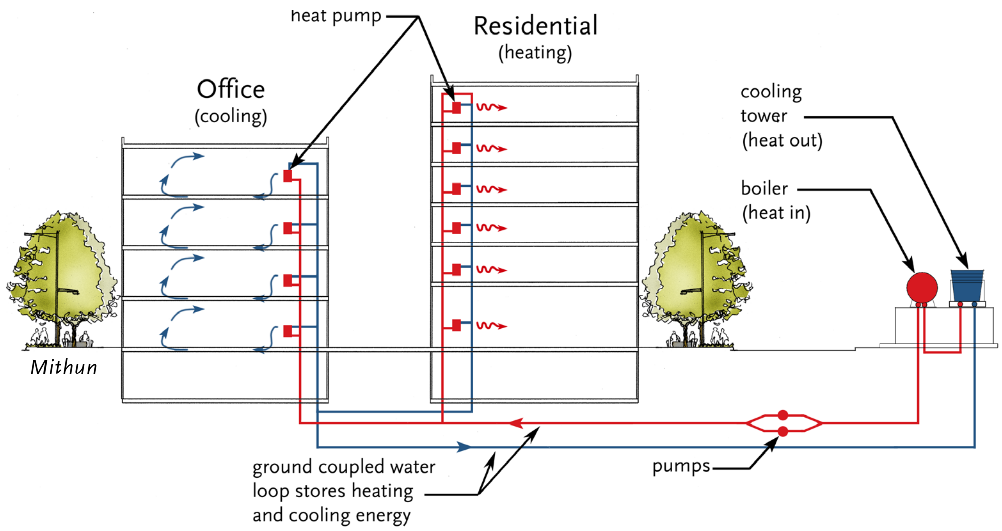
Arup

distributed heat pumps

Goal:

To take advantage of the diverse load requirements of the development while reducing energy costs.

Strategies:



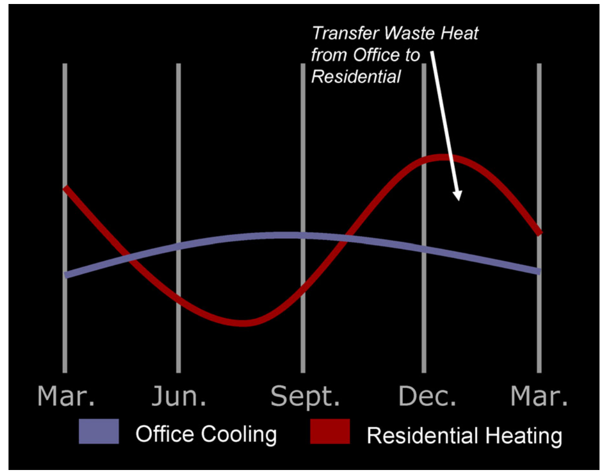
1. **The transfer of heat from areas of heat production to areas of heat demand.**

There is potential for the integration of office, laboratory, biotech, retail, and residential spaces into a community of *symbiotic* sites that would take advantage of the daily variation in occupancy, and the contrary schedules for heating and cooling, to reduce energy costs throughout the mixed-use development. A condenser water loop is proposed to cycle water between the areas that produce an excess of heat and those areas that have a demand for heat.

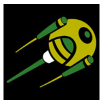
Since the pipes are laid into the ground, the ground becomes a coupled storage mechanism for the system. During the peak heat production hours of the daytime when all of the offices and laboratories will be dumping excess heat into the system, the soil will help to store that energy for later release to residential or early morning demands. Over the course of its cycle, the system would move between 75°F and 95°F with the ground acting to stabilize temperature swings.

A small central plant that adds and removes heat from the system would be required to allow control of the loop water temperatures.

The greatest efficiency of this strategy would be realized when heat-producing sites are located adjacent to heat-demand sites. To this end, a *patchwork* development layout with residential units interspersed among the office buildings and laboratories is most appropriate. However, current zoning limits these proximities. If a variance could not be achieved, the system strategy may still be viable, but would have to be reconsidered in relation to the zoning constraints.

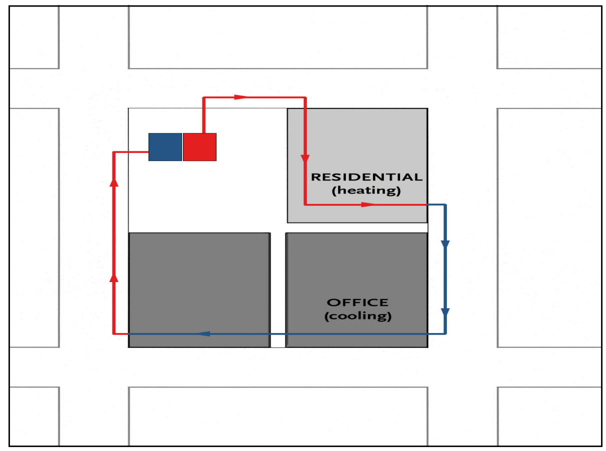


Mithun

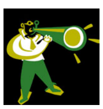


Status of Technology: The technology is well proven and no more complex than that found in everyday building construction. Although similar ideas have been seen in large university settings, there is little precedent for large scale municipal application.

Costs: Costs are heavily dependent on the size and capacity of the distribution network, the cost of permitting and street work, and the phasing of the build out. Further analysis is justified when the development scheme reaches a more detailed phase in its growth.



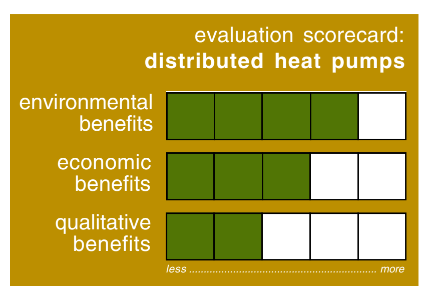
Potential heatpump scenario on typical SLU block
Mithun



Marketing Amenity: Tenants would receive the benefits of reduced energy costs.

Incentives: None at this time, however the energy savings to the local utility and the innovative nature of this energy saving strategy may lead to interest from the local utilities and the US Department of Energy.

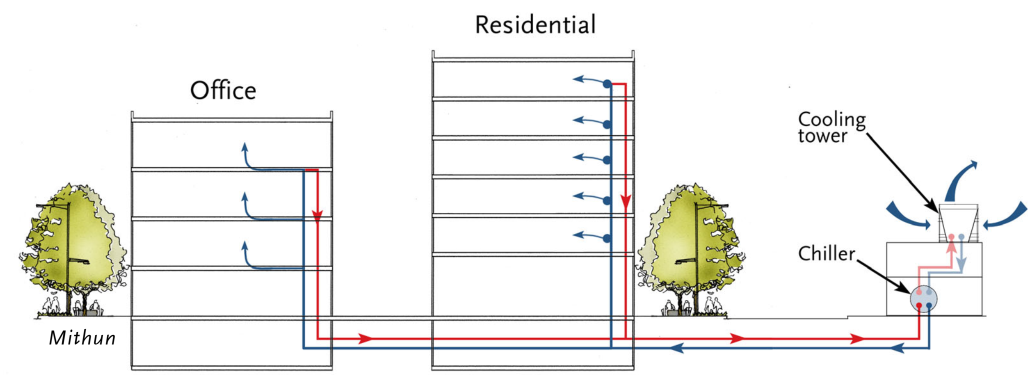
Recommendation: If a patchwork pattern of mixed-use emerges, undertake further engineering analysis.



chilled water

Goal: **The provision of an energy efficient chilled water source.**

Strategies:



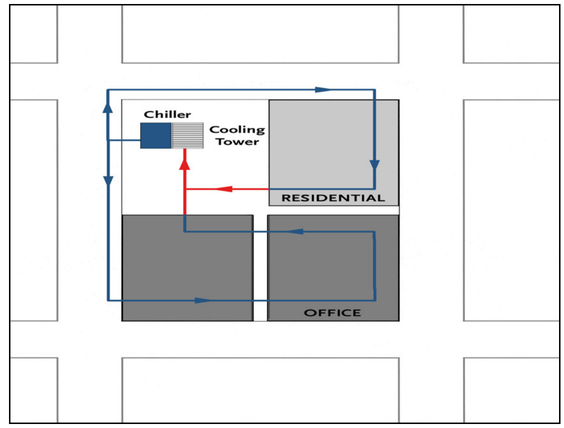
1. Centralized System

This is a typical system for a university campus wherein roughly 80% of building-by-building chilled water capacity would be installed at a centralized location i.e. a central plant. If buildings are closely located to the central plant, a reduction in energy costs will meet or exceed any additional piping costs.

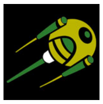
As with any centralized system, maintenance cost is concentrated in one location and as a result, is reduced in comparison with a building by building installation. In addition, the larger, higher efficiency chillers would be designed to save energy by functioning in a staged operation with a few chillers running at or near full load rather than many machines running at partial load. Since not all loads occur simultaneously, the district's diversity would allow installation of a lower total capacity than would be possible with individual building chillers. Redundancy could also be optimized as each building would no longer have to maintain redundant capacity. Cooling towers can be located at one place avoiding the need to deal with tower locations on individual buildings and associated plume issues. Generally, if more than two million square feet of office and retail is connected, then an additional strategy using chilled water storage may be an appropriate addition to improved performance. Review this strategy for smaller projects. Most of the electric load associated with producing chilled water would then shift to off-peak hours where decreased rate structures (if available from the utility) offer further financial benefit.

There is an increased cost incurred by the need to place chilled water pipes in the street, although this cost is expected to be offset by the increase in efficiency. Exit strategies for individual buildings that are tied into the chilled water loop must also be considered.

A chilled water loop is most appropriate for a development of dense loads wherein infrastructure costs are lessened and efficiencies are maximized. As a rule for implementation, connected concentrations of adjacent development should be no more than two blocks apart. If a space with a high cooling demand was planned (e.g. a collocation server farm), its high demand would lend itself to an adjacent location.



Potential chilled water system on a typical SLU block
Mithun



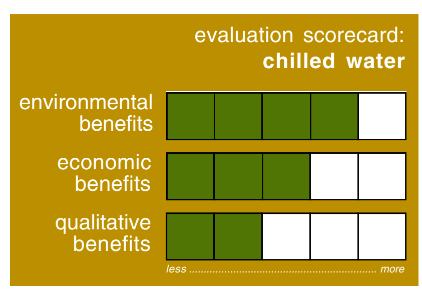
Status of Technology: Similar systems are in place at numerous college campuses throughout the country. As a municipal case study, St. Paul, Minnesota has been operating a chilled water district system since 1992 and now serves over eight million square feet of building space.

Costs: A cost neutral system is expected. Although centrally located chillers will have an additional piping cost for distribution to loads, that cost will be offset when higher efficiencies are factored in. The cost of a storage tank would be \$1–\$2 million depending on size, but would shift electrical demand to reduced rate hours, if available.

Marketing Amenity: Cooling towers would be centralized at one location. The result is a more picturesque development landscape, enhanced by the absence of heat rejection equipment on each individual rooftop. This will also allow for redundant centralized chiller systems for greater reliability.

Incentives: None.

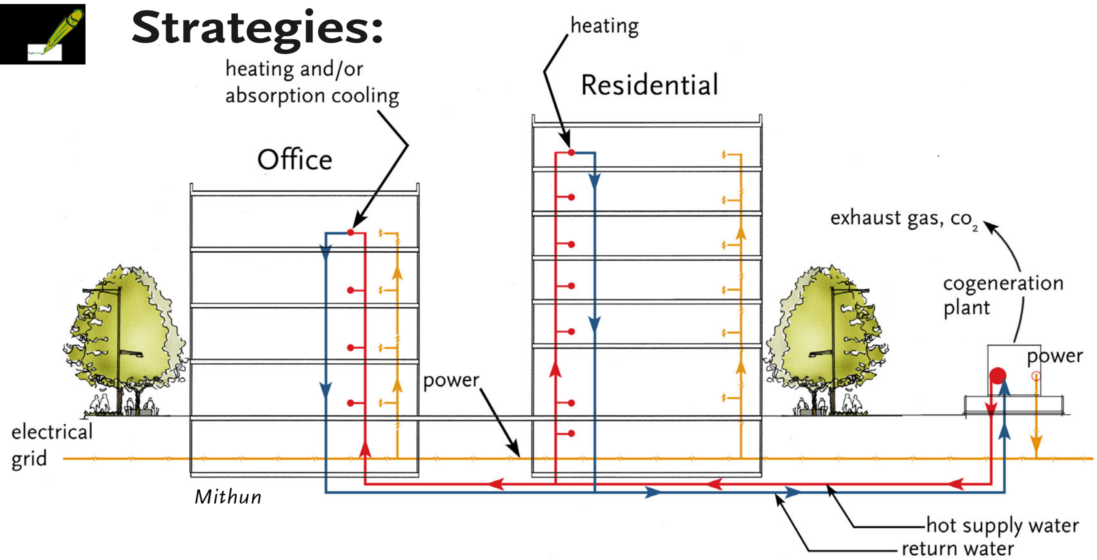
Recommendation: See multi-block decision chart.



co-generation of electricity & heat

Goal: **To enhance the South Lake Union district energy supply quality while simultaneously minimizing the cost of that supply.**

Strategies:



Buildings consume both electricity and heat. In the generation of the former, the latter is an invariable side effect. It follows then that energy efficiency as a whole is optimized when the *waste* heat is reclaimed for building use rather than exhausted to the environment. Through the utilization of heat exchangers and heat transfer technology, the cost of heat generation can be greatly reduced. Application is especially appropriate for use with fuel cells and microturbines. See the discussion on these strategies for further information.

1. Centralized Co-Generation

This strategy consists of a single centralized cogeneration plant, including one or more units (probably gas turbines) connected in parallel with the Seattle City Light grid. The location of the connection is not critical, as the electrical power will flow to the loads regardless of location. For the purposes of heat recovery, the plant should be close to the concentration of buildings which can use the heat. If a suitable heat demand is not available, a secondary option is to utilize the waste heat in an absorption process to produce chilled water for cooling.

If first cost is of primary concern, the owner can negotiate with Seattle City Light to use their medium voltage distribution system, and the cogen plant will act as a supplementary source of power into this system. If reliability of power to certain selected loads is critical, a separate distribution system can be installed directly from the cogen plant to these loads; but the cost of the distribution system can be quite high.

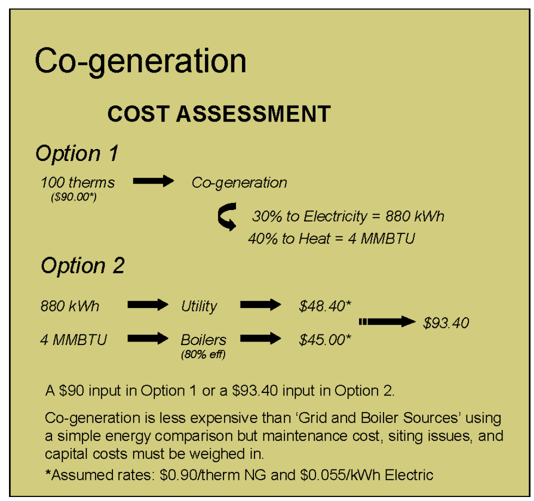
Another option is to use City Light's distribution system, but to isolate this system from the main grid in case of a power outage and feed it only from the cogen plant. Nonessential loads could then be dropped using a remote control system so as not to overload the cogen plant. A policy for dealing with nonvested property owners on the same branch of the distribution grid will need to be determined.

The scheduling and operation of the cogen plant can be used not only to reduce dependency on the electrical grid, but also to improve the load factor of the entire property. This means that the ratio of the maximum to minimum loads is relatively close to one, which can be achieved by running the cogen plant at times of peak load and turning it off at times of minimal usage. A better load factor will give the owner more leverage in negotiating for better utility rates. It is possible that the utility rates can be improved over the standard rates if the proper negotiating strategy is used. However, this strategy of partnering with the utility and obtaining lower unit energy costs does not necessarily lead to energy savings.

A centralized co-generation scheme would be most appropriate when placed in close proximity to those sites that have a demand for heat, i.e. laboratories, offices, multi-family housing complexes, mixed use projects, etc.

Status of Technology: The technology is well developed and thoroughly implemented. Air quality and permitting issues need to be reviewed.

Costs: To put the strategy into context, co-generation of heat from an electrical generating source i.e. large gas turbine, microturbine, fuel cell, etc., depends in part on the cost of the input form of energy. Most often, that source will be natural gas. As a result, and to simplify the decision making process, natural gas is a variable on which the lifetime cost of co-generation can be considered. If it is not viable from a natural gas input perspective, then it cannot be viable when the additional costs of infrastructure and maintenance are factored in.



Assume a natural gas cost of $0.90/therm and electricity cost of $0.055/kWh (reasonable values for present utility prices in the Seattle metropolitan area). Now buy 100 therms of natural gas for $90. Supply the generating units with this input. Assume an output efficiency of 30% to electricity and 40% to heat. The remaining 30% is lost in the process. The resulting output of the generating units is approximately 880kWh of electricity and 4MMBTU of energy for the cost of $90 input. If instead, the electricity had been purchased directly from the utility at $0.055/kWh and the heat had been produced by a natural gas ($0.90/therm) fired boiler at 80% efficiency, the cost would only have been $93.40. There is a simple savings of only 3.6% with co-generation excluding capital expenditure and operations.

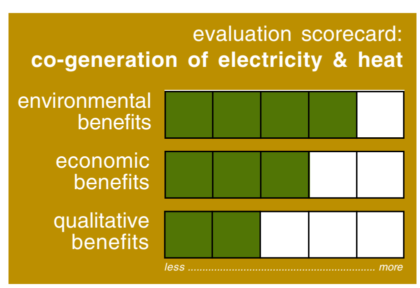
If however, the electricity could be sold back to the grid at a premium of $0.110/kWh without a corresponding increase in gas rates, the savings with co-gen would increase to 36.5%. The justification for this would come from the city's current peak purchase of electricity from wholesale suppliers, as in Spring 2000, at five times this cost, or roughly $0.50/kWh.

Although a full life cycle analysis is recommended, this simple example should give basis for further exploration in the decision making process. It demonstrates some of the variables and considerations that will most likely determine the viability of co-generation and its application to the SLU development area. The creation of a South Lake Union Utility District in partnership with Seattle City Light could be an implementation strategy.

Marketing Amenity: Developments would have a minimized need for heat generating equipment . Cogeneration would result in a greater efficiency in space use as on-site mechanical rooms can decrease significantly in size and possibly be eliminated, thus recapturing valuable floor space. If the system supplemented the local utility grid and provided back-up power and heat during electrical outages, a significant added value could be demonstrated to potential residents and business owners.

Incentives: Would require negotiations with Seattle City Light.

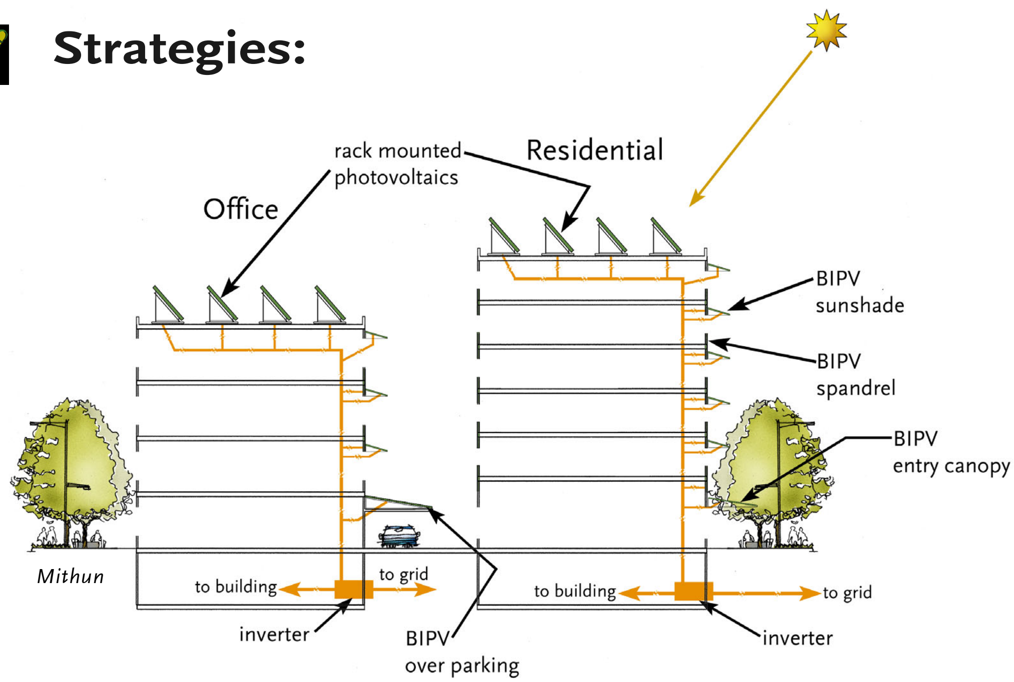
Recommendation: Refer to multi-block decision chart.



photovoltaic cells

Goal: **To enhance electrical supply security through the distributed use of photovoltaic technology.**

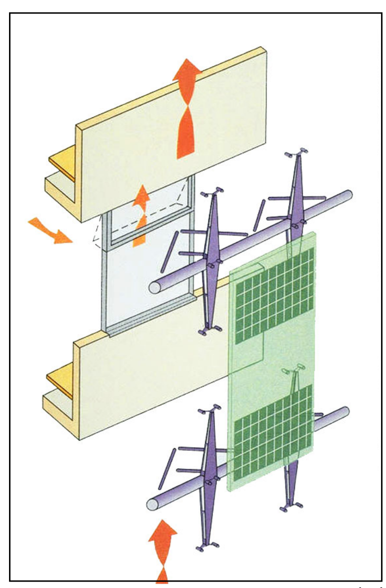
Strategies:



Mithun

During the past decades, photovoltaic (PV) technology has seen enhancements in efficiency, reliability, aesthetic appeal, and product diversity while simultaneously dropping in price. Although still a premium product, new strategies in building integrated PVs (BIPV) coupled with escalating utility rates and rebate programs have allowed an increasing number of developments to take advantage of the clean, modular power that PVs provide.

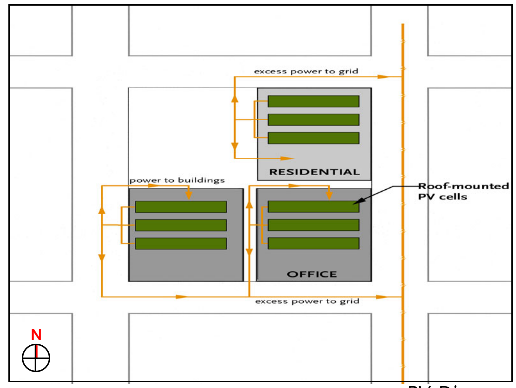
A typical PV cell consists of a glass shell, an antireflective interior coating, a front conductive material, a rear conductive material, and semi-conductor layers in-between. Radiant sunlight striking the semi-conductor layers causes electrons to break free. The electric field that exists between the two dissimilar contact materials directs the free electrons along an electrical circuit where the power can then be used.



BIPV spandrel
Arup

1. Distributed Generation

The modularity and easily distributed nature of PVs would allow the development to install the modules as building progressed rather than having to build a central facility with an oversized production capacity. Furthermore, the peak output of the modules would come during the peak electrical demand hours of midday and from a utilities perspective, would be displacing wholesale purchases that in Spring 2000 were reaching $0.50/kWh. The modules are also carbon neutral, have no moving parts, no emissions, and minimal maintenance requirements. They can be mounted as integral components of the building cladding on nearly any exposed surface: vertical, horizontal, or inclined. They can be separated to act as shading devices for walkways, windows, or parking areas. They can be mounted in a plane or as a three-dimensional assemblage or as a 'skin'. They can be translucent or made to blend in with the building envelope so as to be unidentifiable by an untrained eye. The architectural malleability of the technology is a strong incentive for its use.



PV Diagram
Mithun

Unlike other distributed sources of electricity that are capable of constant production, photovoltaics have a variance in output based on daily and seasonal solar radiation. As a result, as stand alone generators they make poor back-up power, and depending on the system design may be automatically disconnected in the event of a grid power failure. If uninterruptible power is a design intent, the PVs must be accompanied by a storage system, usually in the form of batteries, or a supplemental source of power (e.g. a diesel generator, microturbine, or fuel cell).

As a result of the premium capital cost but attractive market amenities and incentives, it is expected that one or a combination of the options below will be most appealing:

1. The development team invests in the technology at its price premium with the expectation that the market advantages that it presents will pay back the cost.

2. The development team uses research and development monies to negotiate a subsidy with local agencies (e.g. partial cost of install, increased net metering rate, etc.).

3. The development team applies the technology only to those areas with high material costs, which can then discount the cost of the PV assembly, a foundation of "building integrated" PV technology. This option would result in limited generating capacity.

4. The development team installs PV-ready structural capacity at all non-vegetated rooftops, along with electrical capacity and conduit runs.

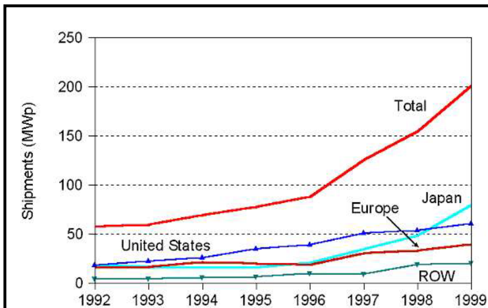


CHART 1

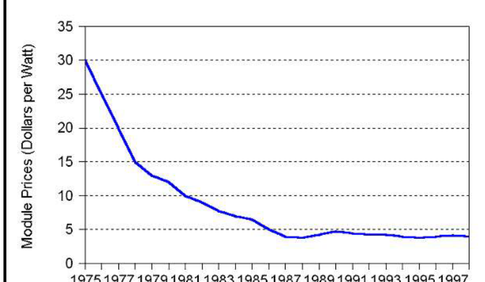
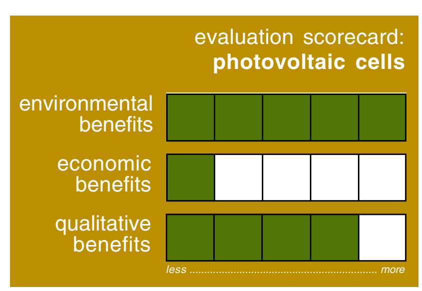


CHART 2

Paul Maycock, PV News

Multi-block installation of thin film photovoltaics could result in significant energy generation. If photovoltaics were installed on 20 acres of roof tops, they would generate 5,800 MWh/year of electricity (about 11% of the development's total annual), and eliminate 3,500 tons of CO_2/year. If the more expensive polycrystalline panels were used, twice as much power would be produced.



Status of Technology: Photovoltaic technology is not new. First invented in 1839, it has existed in various forms since the early 1900s, but the efficiency of current production was so small that the predominance of uses focused on the measurement of light rather than the generation of electricity. It was not until the advent of transistor technology in the late 1940s that power production became a viable consideration. The current industry is roughly 30 years old, has established a strong manufacturer base and experienced distribution network, and is selling a diverse product line. Growth is expected to continue at 8–15% per year.

Costs: A first cost of $5,600–$10,000 per kW (2001) installed is typical. Over a thirty-year life, the cost per kWh can range from $0.15–$0.30. Considering the low cost of utility electricity in Seattle, any economic justification is heavily dependent on the offset of material costs that occurs with BIPV or the additional cooling benefits if the PVs are used for shading.

As an example, if a reasonable assumption of 10W/sq ft production is made, then a $5,600/kW system would cost $56/sq ft. If the PV modules were being used in place of laminated spandrel glass of comparable installed cost, then there would be no premium to the installation of the PVs and the system payback would be instantaneous. If instead, the replaced material is $25/sq ft, the system would need to pay back an installed cost of $3,100/kW. At current utility rates of $0.055/kWh and assuming a Seattle climate that can produce 1000 kWh/kW of panel per year, the system would bring in $55 dollars in annual savings. Since interest on savings and utility escalation rates are a wash, the system would save roughly one half to two thirds of the installed cost over a 30 year period. It would not pay back.

Photovoltaics

Renewable

COST ASSESSMENT

$5600/kW → *$56/sq ft - $25/sq ft =$31/sq ft*
(Material Offset)
$3100/kW

First Year Savings of = $55

Over 30 Years (interest and escalation are a wash)

Capital Recovery is → *$1650/kW**

Integrating PV's into the structure or using PV's in a sun-shading role, will provide offset material costs and decreased solar loading respectively.

*Assumed Values: $0.055/kWh Electric, De-rated for Peak Output by 33%, Climate Factor of 0.5

Marketing Amenity: PVs are readily recognized as a renewable technology and would be an ideal demonstration of the development's commitment to sustainability. Their use as a shading device can also enhance the local environmental conditions and provide enhanced levels of comfort and property valuation.

Incentives: There is evidence that utilities and government agencies at the local and national levels possess an increased willingness to subsidize the installation of this technology. The large development scope of SLU could spur additional incentive action if the development team was willing to take the lead on negotiations. Manufacturers and distributors in the PV market face greater internal market competition than do those in the fuel cell and microturbine markets and thus are likely to employ more aggressive pricing strategies to capture market share.

Seattle City Light is paying high costs for power beyond its current in house generation capacity. The cost of PVs compared to the cost of this new power purchased outside the existing system is attractive. Additionally, PVs would help Seattle City Light to realize its goal of carbon neutrality. A cooperative relationship should be pursued that benefits both SLU developers and the utility.

Washington State Legislation, H.B. 1859: exempts photovoltaic systems from sales and use taxes. The exemption applies to those systems that have a generating capacity of at least 200 watts. This tax exemption took effect July 1, 2001.

Energy Policy Act of 1992 (EPACT) (P.L.102–486): Established a permanent 10 percent business energy tax credit for investments in solar and geothermal equipment.

Internal Revenue Code: Contains a Modified Accelerated Cost Recovery System (MACRS) by which businesses can recover investments in solar, wind, and geothermal property through depreciation deductions. For property placed in service after 1986, the current MACRS class life for applicable renewable energy technologies is 5 years.

Photovoltaics over parking area
APC Schott

Bonneville Environmental Foundation: There is a new 2002 program that enables property owners to install a grid-connected PV system under 10 KW and to sell their 'green tags' to BEF for $0.10/KWh for three years. https://www.greentagsusa.org

Recommendations:
Use photovoltaic panels over all parking areas, and partial coverage of roof areas, if incentives exist.

Use building integrated photovoltaics at high quality glass canopies or screening elements, such as entry canopies, sun controlled skylights, and atria.

Provide pathways, room, and structural capacity for future photovoltaics on rooftops or other locations at each building.

Review any additional incentives available from Seattle City Light.

Mutual Exclusivity: If vegetated roofs are incorporated on the neighborhood level, then this would exclude PV roofs. However, infrastructure could be installed for the future, to mitigate the risk of excessive energy costs. PV for non-rooftop applications could proceed.

Typically, a good estimate for photovoltaic cell angle is to simply tilt them at an angle equal to the region's latitude. For Seattle, with a latitude of 47.45°, a good angle for photovoltaic cells might be be around 47°. However, PV cells would work fairly well in the area, facing due south, at an angle ranging anywhere from 30–60°, according to the Washington Chapter of the American Solar Energy Society.

Resources:

The Center for Renewable Energy and Sustainable Technology
http://www.crest.org/solar/index.html

National Center for Photovoltaics
http://www.nrel.gov/ncpv/

Sandia National Laboratories Photovoltaics Program
http://www.sandia.gov/pv/main.html

US DOE Photovoltaics Program
http://www.eren.doe.gov/pv/

Solarbuzz
http://www.solarbuzz.com/

CREDITS:

CHART 1: 1993 through 1999 revised data from: Paul Maycock, PV News, Vol. 19, No. 3 (Warrenton, VA: PV Energy Systems, Inc., March 2000). 1992 data from: P. Maycock, PV News, Vol. 18, No. 2 (Warrenton, VA: PV Energy Systems, Inc., February 1999).

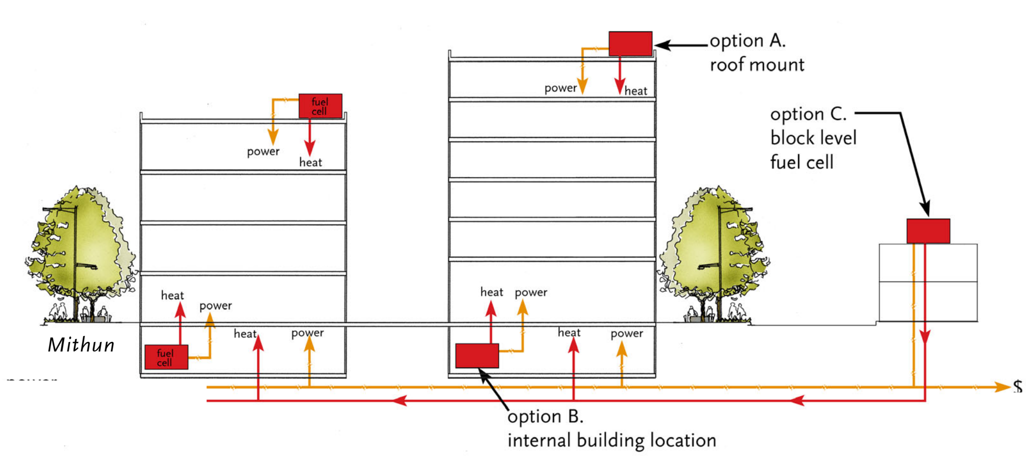
CHART2: P. Maycock, The World Photovoltaic Market 1975–1998 (Warrenton, VA: PV Energy Systems, Inc., August 1999), p. A-3.

Building Integrated PV
Arup

fuel cells

Goal: **To provide electricity and heat supply security to developments in the SLU district using the emerging technology of fuel cells.**

Strategies:



Fuel cell power plants consist of a fuel reformer, a fuel cell, and a DC to AC inverter. The reformer converts a hydrocarbon fuel, such as propane or natural gas, into hydrogen. The hydrogen is supplied to the fuel cell, which allows the hydrogen and atmospheric oxygen to combine producing water, heat, and direct electrical current. The inverter converts the output DC into usable AC, which flows directly to the end user, to the grid, or to a temporary storage facility. Fuel cell power plants currently run on natural gas, hydrogen, anaerobic digester gas (wastewater treatment output), and landfill gas. The SLU development would most likely make use of natural gas fired units and as a result, would not be totally pollution free, and would require regulatory approval for air quality. The units would exhaust CO_2 but not NOx or SO_2. In the future, when utility hydrogen is available there will be no pollution at the point of use. Fuel cells produce electricity at approximately 40% efficiency. An additional 30–40% energy efficiency can be realized by taking advantage of the unit's cogeneration of heat. Through reclamation, the heat can be used to generate hot water for space heating and domestic applications.

Fuel cell power plants are a modular source of energy and can therefore act as distributed or collected sources of power. Generation facilities of 11 megawatts have been produced from multiple 200kW units.

1. Centralized Generation

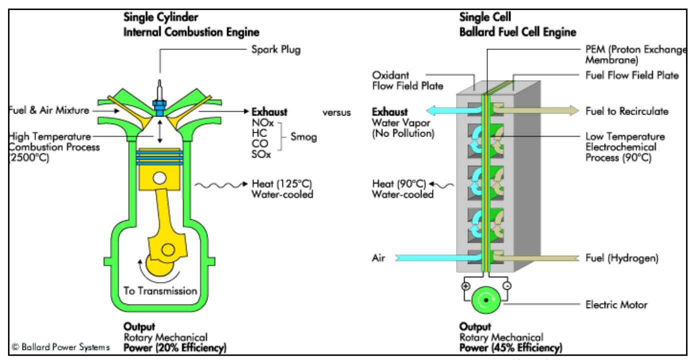
The benefits of a centralized scheme are greater maintenance efficiencies, reduced infrastructure cost, and localization of associated architectural elements, i.e. flue vents, intake louvers, etc.

Security of the electricity supply and minimized infrastructure cost for heat transmission suggest the locating of the generation facility in close proximity to the loads, namely office buildings, computer server farms, laboratories, or biotech facilities. An agglomerated development scheme that optimized this layout would enhance the strategy's effectiveness.

Ballard Power Systems

Status of Technology: Fuel cell technology was theorized in the mid 19th century, but it took another century before an appropriate use was discovered in the form of space exploration. Since then, researchers have been actively seeking out new technologies to bring fuel cells into widespread use as power generators. Currently fuel cell power plant demonstration systems are widely distributed and marginal commercialization has occurred, but the emergence of diverse technology offerings and competitive manufacturers is still several years off. King County is currently installing a fuel cell at one of its waste treatment plants.

Costs: Capital costs of $3,500–$4,500/kW installed are typical. Over the system's 20 year life the cost of the electricity would range from $0.15–$0.30/kWh ($0.10–$0.20 if 100% of the waste heat can be used). If fuel cells were not purchased to provide building power, many sites would require back-up power to be purchased. This contingency generator would be displaced if the fuel cell were purchased. As a result, the cost of the fuel cell can be credited by the cost of the combustion generator ($200–$500/kW).

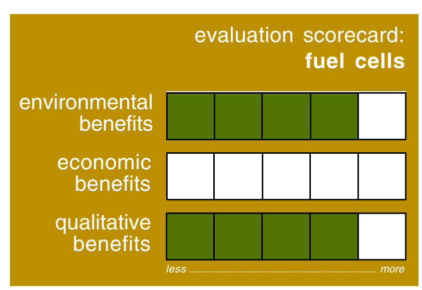


Ballard Power Systems

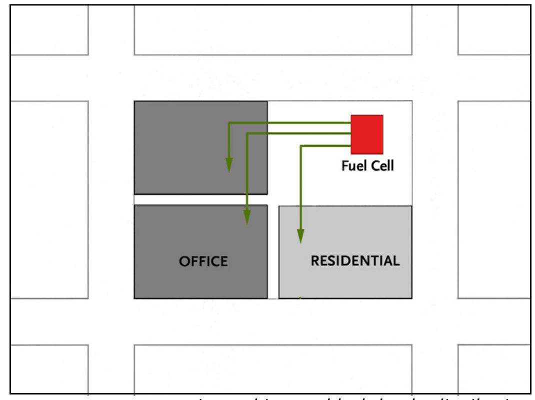
Incentives: *Washington State Legislation, H.B. 1859* exempts fuel cell systems from sales and use taxes. The exemption applies to those systems that have a generating capacity of at least 200 watts. This tax exemption took effect July 1, 2001.

2. Distributed Generation

Fuel cells can function as stand-alone generating systems and can be placed within a distributed power network with each system serving its own building or development block and supplying any excess production to the grid. Localized cogeneration systems can be built to reclaim waste heat.



For multi-block or building development, distributed generation would allow for the modular increase in power generation to follow closely with the phase of the development build out. Provided the relatively high cost of transporting the heat energy, it is most beneficial for the generation sources to be located close to the point of heating demand. Therefore in a development layout where buildings of high heat demand are interspersed throughout the development rather than centralized in one locale, the applicability of distributed rather than centralized generation would take precedent. Distributed generation would also allow for the modular increase in power generation to follow closely with the phase of the development build out – more closely than would occur with a centralized scheme.



Microturbine – "block level" distribution
Mithun

Costs: Although there would be an expected decrease in distribution costs with distributed generation (since the electricity and heat are closer to their point of use), there would also be increased space, equipment, and operational costs. Unit costs would be comparable to those discussed in the centralized generation strategy.

Marketing Amenity: Fuel cells represent a cutting edge technology that is significantly cleaner than the bulk of utility generated supplies. They are an effective means of demonstrating the developer's commitment to sustainability and can hence serve as a marketing tool. The security of on-site generation is an additional benefit and may be of significantly greater importance to many potential tenants than the source of that security. In either case, the development value is enhanced.

Incentives: *Washington State Legislation, H.B. 1859* exempts fuel cell systems from sales and use taxes. The exemption applies to those systems that have a generating capacity of at least 200 watts. This tax exemption took effect July 1, 2001.

Recommendation: Provide wiring pathways, room, and structural capacity for future placement of fuel cells at rooftops and parking areas. Review with Seattle City Light on additional incentives to help Seattle City Light offset high cost of non-hydro power.

Ballard Power Systems

microturbines

Goal: To provide electricity and heat supply security to the SLU district, in mixed use blocks or adjacent blocks, through application of microturbine technology

Strategies:

Capstone Turbine Corporation

A microturbine is a relatively small power generator that can simplistically be described as a small aircraft engine coupled with a generator. They take up roughly 50–100 sq ft of floor area and are 7 –9 feet in height. Commercially available systems output 25 –100kW at an efficiency of 25–30% and run off of a variety of hydrocarbon based fuels. In the process of generating electricity, the turbine creates heat at approximately 40% efficiency. This heat can be reclaimed for space heating, absorption cooling, and domestic uses, and lead to combined heat and power (CHP) systems that achieve energy efficiency levels greater than 80%. As a result of the stand-alone ability of the design, microturbines can be used in a distributed role at the building or block level, or in a centralized facility that would supply power and heat to the SLU district. The engines create a significant amount of noise and would likely require sound attenuation if installed in sensitive locations.

A benefit to microturbine technology is the flexibility of the power output. Microturbines can be shut down during periods of low energy demand. The result is a flatter electrical demand curve that benefits utilities and leads to decreased rate structures for owners.

A microturbine system operates in parallel to the utility grid and typically does not provide emergency back-up power. However, when under continuous or scheduled operation, the units would provide protection from low quality grid feeds and accompanying voltage spikes, thereby improving the reliability and quality of the power supply while simultaneously reducing peak demand charges.

1. Centralized Generation

Centralized generation is the agglomeration of generators in one facility or location for the purposes of decreased facility construction, and maintenance costs. It would require the dedication of space, facility, and infrastructure in advance of development need. The units themselves could be installed as build-out progressed or all at once. A negotiated premium related to the excess power spilled into the grid could justify an early installation strategy. However, the current available size range of microturbines would require a large number of units and it would be difficult at this time to justify as an alternate to large turbine generators.

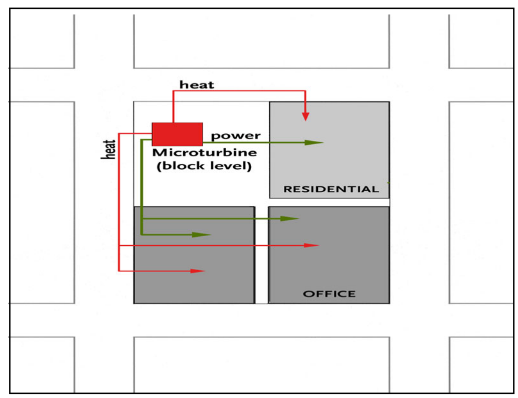
A centralized generation facility should be placed as close to the load source as is reasonably possible. This is especially true for co-generation systems where the distribution costs can be the deciding factor in the system's economic feasibility. As a result, this strategy would be most appropriate for a development where heavy energy loads (i.e. office, laboratory, and biotech sites) were located in close proximity to one another.

Capstone Turbine Corporation

Status of Technology: Centralized generation is a proven technology. Due to their small size and power flexibility, microturbines are poised to capture a significant share of the distributed generation market. Microturbines are sold in a commercial market with generating capacity per unit of 25–100kW available. Seattle City Light has a microturbine installed within the city.

Costs: Capital costs of $2,000–$2,200/kW installed are typical. Over the system's lifetime, the cost of the electricity ranges from $0.10–$0.12/kWh. As a potential strategy to cost reduction, the offset costs of back-up generators should be considered. However, due to time delays in startup of equipment, this system may not be permitted to support life safety system. If microturbine generation were not installed, many sites would still require contingent power to be purchased. The result could be a reduced cost premium of $1,400–$1,800/kW installed.

2. Distributed Generation



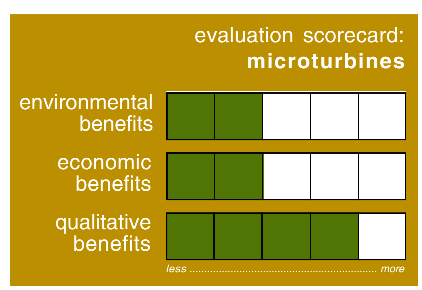
Centralized block distribution
Mithun

Distributed generation is the apportionment of generating units throughout a multi-block or building area to serve individual buildings or small groups of buildings. This is a better application for microturbine technology than central generation.

The viability of the technology is dependent on the development's ability to make full use of the waste heat produced as a by-product of the electricity generation process as well as on concerns over power quality supplied from the grid. In the mixed-use development of South Lake Union where the future power supply is strained, it is likely that there are both significant levels of heating demand as well as power quality concerns. Provided the relatively high cost of transporting the heat energy, it is most beneficial for the generation sources to be located close to the point of heating demand. Therefore in a development layout where buildings of high heat demand are interspersed throughout the development rather than centralized in one locale, the applicability of distributed rather than centralized generation would take precedent. Distributed generation also allows for the modular increase in power generation to follow closely with the phase of the development build out; more closely than would occur with a centralized scheme.

Status of Technology: Distributed technology is a proven technology. For information on the status of microturbine technology, consult the cogeneration section.

Costs: Although there would be an expected decrease in distribution costs with distributed generation since the electricity and heat are closer to their point of use, there would also be increased space, equipment, and operational costs. Unit costs would be comparable to those



discussed under the centralized generation strategy.

Marketing Amenity: Microturbine technology is in the vanguard of distributed power generation and hence demonstrates the development's intent to support cleaner more efficient sources of energy. The inherent improvement to supply security may be seen as the greatest benefit to potential tenants.

Incentive: None at this time. Review with Seattle City Light for possible power generation partnership or incentives.

Recommendation: Refer to multi-block decision tree.

wind energy

Goal: **To provide electricity to the individual buildings, or a neighborhood utility district through wind generated power.**

Strategies:

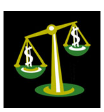
www.arttoday.com

Wind generation in South Lake Union utilizing conventional technology is not recommended. A location in eastern Washington could be a preferred alternative for a wind generating facility.

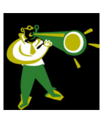
Modern wind turbines are divided into two major categories: horizontal axis turbines and vertical axis turbines.

Horizontal axis turbines (HAWT) are the most common turbine configuration used today. They consist of a tall tower, topped with a fan-like rotor that faces into or away from the wind, the generator, the controller, and other components. Most horizontal axis turbines built today are two- or three-bladed.

A 15MW facility will be on line in eastern Washington in 2001. There currently is a proposal for a 300MW facility in Walla Walla, projected to be on line in 2003.



Costs: An economic study is necessary to determine feasibility; however, private industry is responding to a market demand for green power.

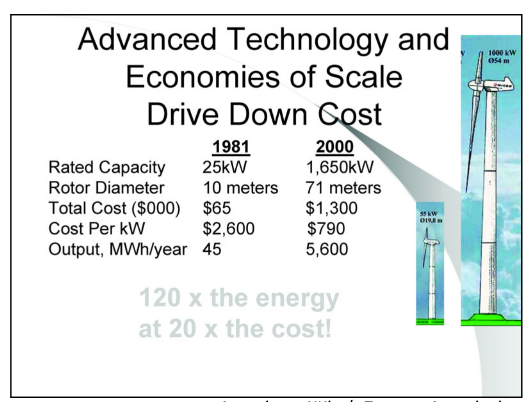


Marketing Amenity: Communicate that the power used is *green* from a wind farm with no net carbon impact.

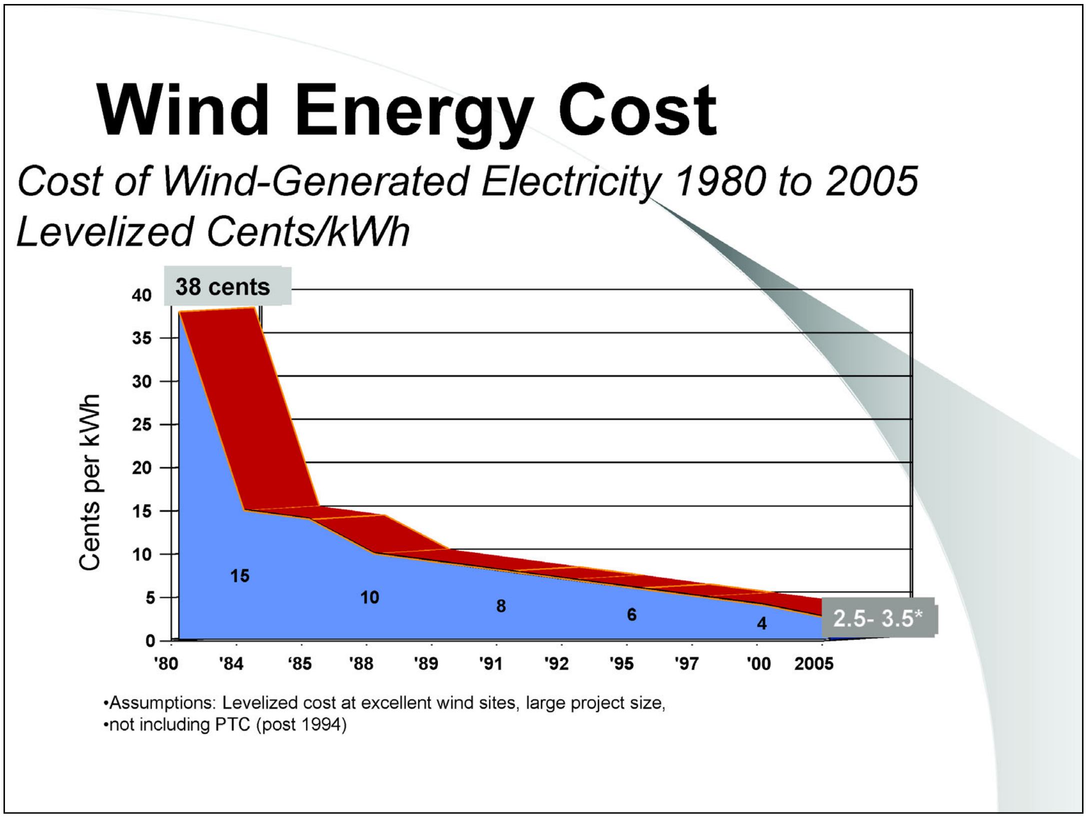
Incentives: There is currently a federal tax credit for wind energy that can reduce the owner's federal tax burden from $0.015–0.017 cents/kW. This has been extended by congress to December 31, 2003.[1]

Recommendation: Not recommended within South Lake Union area, but examine off-site possibilities if there is a goal of source power with carbon neutral power generation. Do a detailed financial analysis with tax credits.

Also review geothermal, tidal force, and other renewable energy options.



American Wind Energy Association



American Wind Energy Association

Resources:

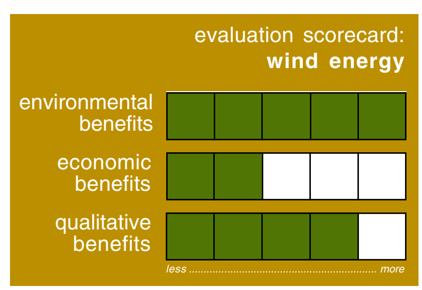
American Wind Energy Association
www.awea.org

Energy Efficiency & Renewable Energy Network
www.eren.doe.gov

FOOTNOTES:

1 Phone conversation with Robert D. Kahn, Energy Consultant, Robert D. Kahn & Company.

www.arttoday.com



carbon neutrality

Goal: **To reduce and compensate for carbon dioxide emissions.**

Strategies:

Is it possible to comply with Seattle's goal of no net carbon dioxide increase for new development? There are three strategies for achieving this:

www.arttoday.com

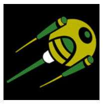
- Reduce the use of energy to the minimum.
- Derive all electric power and heating from non-fossil fuel sources.
- Compensate for CO_2 emissions associated with energy production.

Experience shows that with an integrated design approach, energy savings of 20% over the national energy standards can be achieved with little or no increase in first cost of construction. Energy savings could be doubled to 40%, but this would most likely require increased first cost of the order of 10–20% above a standard building.

Seattle City Light already derives a fair proportion of its power from hydroelectricity, which does not produce CO_2. Other sources that do not create CO_2 are wind, geothermal, tidal force, and solar. Wind power is not an attractive option for an urban site. Solar power from PV panels could meet some power load. If photovoltaics (thin film panels) were installed on 20 acres of rooftops it would generate 5,800 MWh/year of electricity (about 11% of total annual power), and eliminate the production of 3,500 tons of CO_2/year. If the more expensive polycrystalline panels were used, twice as much power would be produced, and twice as much carbon would be eliminated. A tidal force generator is being considered at Tacoma Narrows.

If the 20% energy improvement were adopted and PVs provided 11% of the power, then the remaining annual power consumption would be approximately 50,000MWh. Considering the current source mix for power generation, 60 million pounds of CO_2 are produced. The absorption of this quantity of CO_2 would require 1.25 million trees covering roughly 3.5 sq. miles. Seattle itself covers 86 sq. miles.

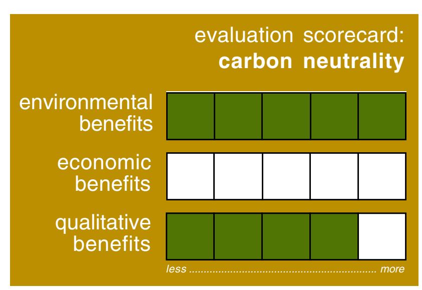
One proposed long-term solution at the city level is to run fuel cells on hydrogen. If fuel cells are implemented now, they will be part of a larger power unit which includes a fuel reformer to convert a hydrogen rich fuel like natural gas into hydrogen. The units could be converted at a later date to direct hydrogen input if a hydrogen utility network was built. Although research into the necessary technologies is intense, such a network is still estimated to be 10–30 years off, if it is to be implemented at all. It is important to note that hydrogen is just a carrier of energy and is not a source. Its creation most often results in carbon dioxide formation and would only lend itself to localized carbon neutrality.



Status of Technology: To date, carbon neutrality on a citywide level has not been implemented. However, many of the technologies that would reduce emissions and or compensate for those emissions are not only proven but also remarkably simple. They range from turning off lights and planting trees to the installation of photovoltaic generators.

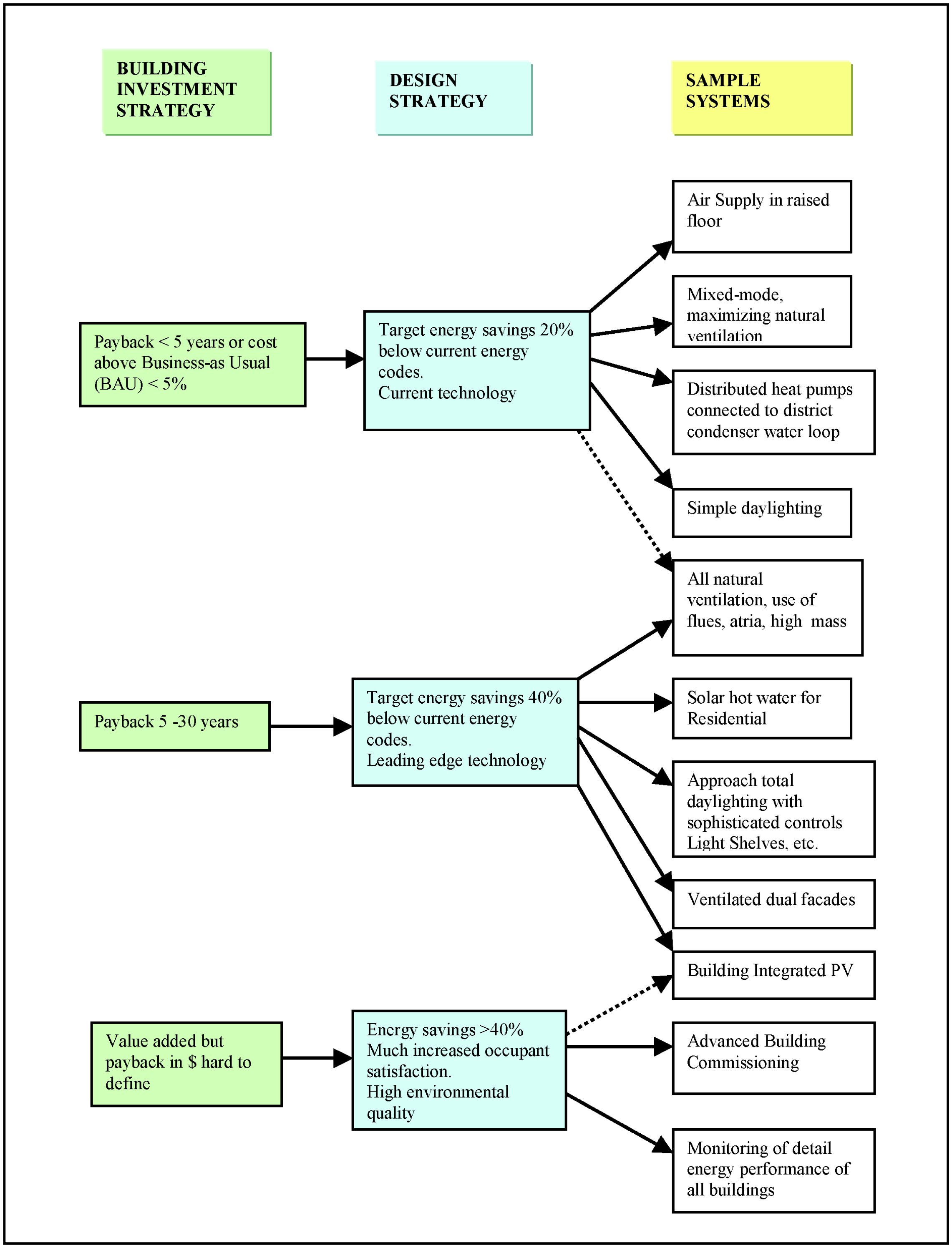
Costs: Given a lack of precedent and the variable paths to success, the cost of carbon neutrality has not been examined. However, as the city develops a new policy for carbon neutral power incentives, a partnership with Seattle City Light might be explored. Specific programs could include a tree planting program in the city.

Marketing Amenity: The term 'carbon neutrality' is one of the most sought after conditions of sustainable development, but as it cannot be seen, heard or felt, it is for the most part a marketing amenity to an educated consumer. The greater marketing amenities are those things that accompany carbon neutrality – namely cleaner air, cleaner water, and greener streets – all of which have been shown to enhance property value.



energy & atmosphere

block / building scale decision tree



Arup

energy efficiency

Goal: To reduce fossil fuel consumption by increasing the energy efficiency of buildings.

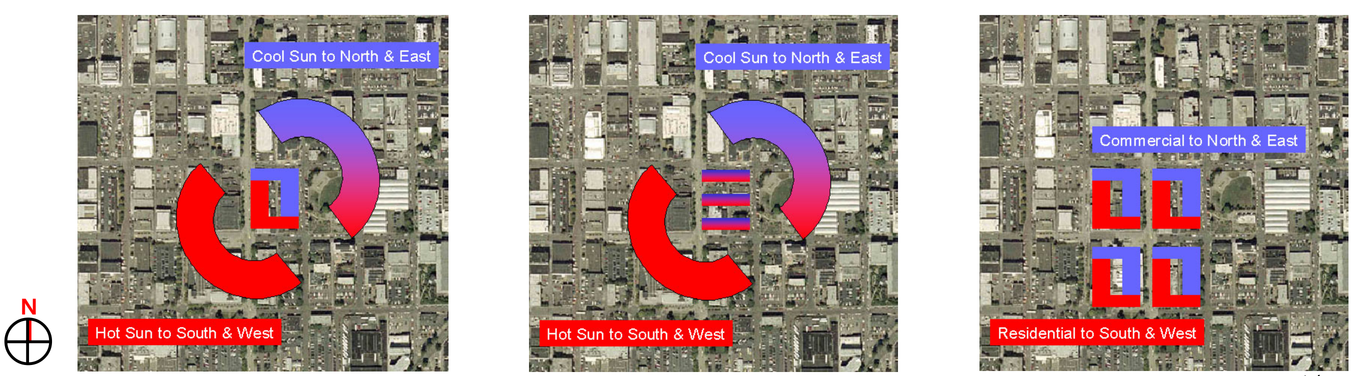
Strategies:

1. Start with Passive Strategies

The development of an energy efficient building requires the sequential design of building orientation and massing, the building envelope, and finally the building systems. The building should be optimized for a passive mode without any supplemental aid from mechanical or electrical systems. Once the orientation, massing and envelope have been optmized, then active systems can be designed to meet those loads that cannot be met by the passive design strategies. The result has the combined effect of limiting both capital and operating costs while producing a highly responsive and comfortable environment. The building functions as a moderator between the desired indoor and existing outdoor environments, letting as much interaction occur naturally as possible, while maintaining the ability to balance conditions actively if necessary. The moderate climate of Seattle is ideal for many such passive strategies.

2. Siting as an Energy Advantage

Proper siting is the foundation for sustainable building and can have a cumulative effect on cost savings as further technologies are explored. The shape and placement of a building prior to any engineering design, product purchases, or conservation efforts can have one of the greatest effects on the building's energy use efficiency. This is in isolation of those effects on community, local architecture, and the site environment (i.e. watershed, solar access, and heat island effects). By aligning the building along an east-west axis (i.e. long facades facing north and south, short facades facing east and west), solar loading is easier to control, resulting in lower cooling requirements. By situating the building to take advantage of solar access and by minimizing the depth of the building footprint, cross ventilation and daylighting can be leveraged to reduce costs and enhance occupant comfort.

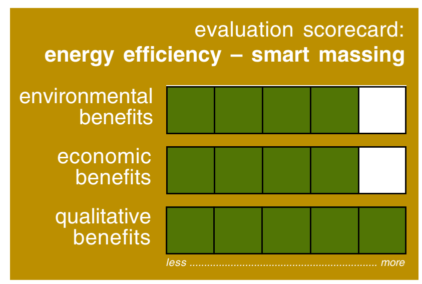


Mithun

SHS.com office bulding with shallow footprint
www.dougscott.com / Mithun

3. Smart Massing

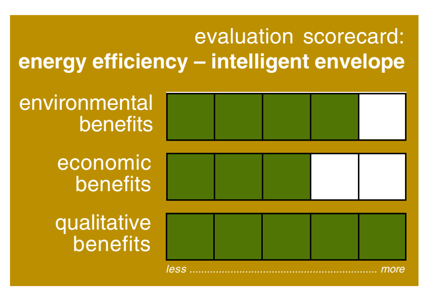
Maximizing daylighting and natural ventilation places restrictions on the building shape. By minimizing the depth of the building footprint, cross ventilation and full daylight penetration can enhance occupant connectivity to the environment and decrease HVAC operational and capital costs. A maximum building width of 60 feet is desirable as single sided natural ventilation is effective over a 20–25 ft deep perimeter zone. Atria, courtyards, light-wells and ventilation shafts can allow increased overall floor plates. As a rule of thumb, the maximum distance from the perimeter to an atrium should be 50 feet. For effective daylighting and long term flexibility (i.e. changes in use patterns in the future), buildings should be designed with the highest ceiling possible, with higher ceilings being preferred for larger floor plates.



4. An Intelligent Envelope

Through the use of operable windows, shading devices, sun shelves, motorized blinds, high performance glazing, premium insulation, and thermal mass, the envelope acts to mitigate building heat gain in the summer and heat loss in the winter while simultaneously allowing daylight and views for building occupants.

In addition to the use of operable windows and natural ventilation strategies for which the SLU environment is uniquely suited, the façade must address direct solar energy transfer. As it effects cooling energy costs as well as local thermal comfort in the building perimeter zones, an intelligent façade will control solar gain during times of peak cooling, typically mid to late afternoon hours, 12–5pm, June to September, and late afternoon hours, 2–4pm, September and October. Setting maximum allowable solar gain and total building envelope gain performance requirements early in the design process can insure that an appropriate level of solar control is designed into the building



envelope. For a true north-south building orientation in Seattle, the maximum daily allowable solar and envelope gain could be stipulated at:

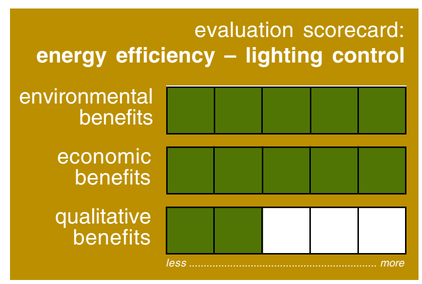
	Allowable Solar Gain *(BTUH/sq ft)*	Envelope Gain *(BTUH/sq ft)*
North Face	150–200	180–230
South Face	250–300	300–350
East Face	350–400	400–450
West Face	400–450	450–500

Note: any divergence from the orientation would decrease the gain on some surfaces and increase it on others. The lower the value adopted, the better the building's energy performance.

However, design to minimize solar gain during peak cooling hours must be balanced against the numerous additional performance parameters an intelligent façade must include in design: maximizing daylight penetration and views, the impact on local thermal comfort and occupant satisfaction, structural adequacy, waterproofing, constructability, procurement, and cost. In addition, as the façade is often the most recognized architectural element of the building, the aesthetic is an *integral* component of a balanced design. If the façade highlights the characteristics of the sustainable design as a component of that aesthetic, the building itself becomes recognized as a sustainable project which can be leveraged as a marketing tool.

In short, thoughtful design of the façade is integral to the intelligent design of the building as a whole. The integration of elements of the façade design and consideration of the resulting implications on the overall building design is paramount.

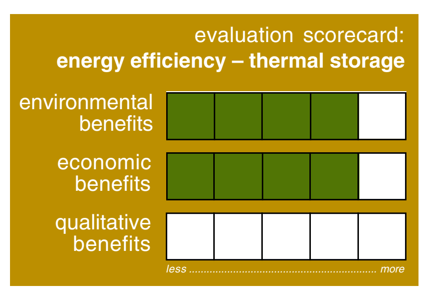
5. Lighting Control



Artificial lighting elements can be responsible for 20–30% of whole building energy consumption. Through daylight sensors and motion detector technology, it can be assured that lights are only on when needed. By taking advantage of daylight access, times of use can be greatly reduced.

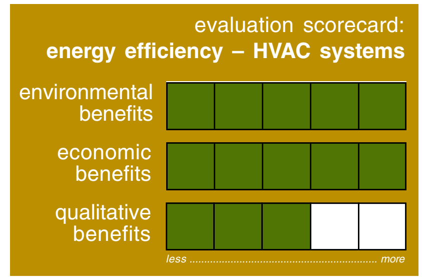
6. Thermal Storage

A passive system for energy storage can also be implemented for energy savings. Thermally massive floors and Trombe walls can be incorporated to curb temperature swings and create a more balanced internal environment. They can be used as a component in an active system for the preheating or precooling of supply air. The building is able to meet a greater proportion of the load passively, and as a result, the cost of cooling for both first cost and operational cost, is reduced. Once passive systems have been considered, more active thermal storage systems may arise for consideration. Active thermal storage such as ice production and chilled water storage can leverage the price differential of peak and off-peak electrical rate structures to significantly reduce peak hour cooling costs and cooling system capacity. In both cases, the medium for the storage of cooling energy, ice and chilled water respectively, is produced during off hours when rates are low. When loads are high in the mid-day, the stored 'coolth' (the opposite of heat) is called upon to meet the load. Whether passive, active, or a combination of the two, the applicability of each thermal storage strategy is highly dependent on the building being considered. Fortunately, the precedence for application to modern construction is well documented and the technology proven.



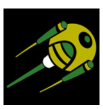
7. HVAC Systems

The HVAC system consumes roughly twice the energy that the lighting system does, topping out at up to 60% of the building's entire energy profile. As a result of the high proportion of energy use, it is seen as one of the greatest opportunities for money savings. The responsible governing bodies and associated public and private institutions and corporations have been driving toward improved performance over the past decades. Currently a multitude of technologies exist for optimized system design ranging from the variable responsiveness of air and water systems to the use of high efficiency equipment and recaptured waste heat technologies. The technology chosen depends largely on building type and usage profile. Discussion of each is beyond the scope of this paper, but it is worth noting that diligent effort toward reducing the HVAC system size by integrated system design offers deep financial incentive to both the developer and tenant.



8. Commissioning

In order to assure that the building performs to the standards laid forth in the construction documents, commissioning is necessary. Throughout the construction process, from design inception to building turnover to trained operators, and routinely onward on an annual or biannual schedule, the building and systems integration, use, and equipment should undergo review. The benefits include increased efficiencies of 5–10%, the early warning and repair of potential problems, as well as decreased operational problems and tenant complaints, thereby resulting in higher productivity. The process has shown so many positive results that nearly all certification programs require some level of commissioning be undertaken. Due to the highly integrated nature of sustainable building systems, the benefits of commissioning such structures is of comparatively greater importance.



Status of Technology: There are literally hundreds of modern documented case studies of buildings that take advantage of all or a portion of the strategies presented in this section, many of which are, in practical terms, thousands of years old. Over the past twenty years, there has been a resurgence of age-old ideas and their commensurate melding with the modern age. Additionally, among modern technologies, there has also been continued improvement, including variable frequency drives, variable volume systems, absorption chillers, and heat exchangers as well as dimmers, light sensors, and occupancy sensors. The result of the integration of new and old technology is a new and evocative style that seeks to suit the aesthetic, environmental, economic, and comfort priorities that have become the standard. Intelligent, sustainable, and green design is the new vanguard.

Costs: Many of the energy efficiency ideas discussed herein require little or no first cost increase. When first cost does increase, it often occurs in additional design fee, construction time, and material cost. Note, however, that net energy savings over the building life is always positive. Although great for owner developers, non-owner developers must be convinced by a reasonable increase to the property valuation. Just as finishes and architectural additions add value but often come at a premium, energy efficiency can undergo a similar consideration. The key is education and marketing.

As a rule of thumb, case studies have shown that increases to the entire construction budget due to the implementation of energy saving sustainable technologies can be summarized as:

Increase to Cost*	New Building (Energy-use Below Code)	Existing Building (Energy-use Below 2000 Code)
0–3%	20%	10%
3–7%	35%	25%
7–15%	50%	40%

*Note that numbers are crude and assume that systems are integrated from the start of design.

Incentives: There are two incentives offered by Seattle City Light that may be applicable. In addition, there is a Washington State sales tax exemption and two federal tax based incentives. In a show of its support, Seattle City Light has set up an incentive that will provide $5,000 –$10,000 to help fund a commissioning plan.

Through the Energy Smart Design Program, "Seattle City Light pays cash incentives to customers to help defray the costs to companies for design services, energy efficient lighting and mechanical equipment. The incentive amount is directly related to the reduction in electricity consumption achieved at the customer's facility after the customer installs energy efficient electrical equipment or otherwise modifies the facility." (http://www.ci.seattle.wa.us/light/conserve/business/cv5_esd.htm)

Seattle City Light will help fund a commissioning plan, which would commence at the design stage of new construction and conclude with a final commissioning report. They offer $5,000–$10,000 depending on the size of the construction budget and can pay 70% of the amount for which the project qualifies upon submittal of the completed commissioning plan and 30% upon receipt of the final report. (http://www.ci.seattle.wa.us/light/conserve/business/bdgcoma/cv5_bca.htm#Incentives)

Washington State Legislation, H.B. 1859, exempts solar, wind, landfill gas, and fuel cell systems from sales and use taxes. The exemption applies to those systems that have a generating capacity of at least 200 watts. This tax exemption took effect July 1, 2001. (http://www.leg.wa.gov/pub/billinfo/2001-02/House/1850-1874/1859_sl_05102001.txt)

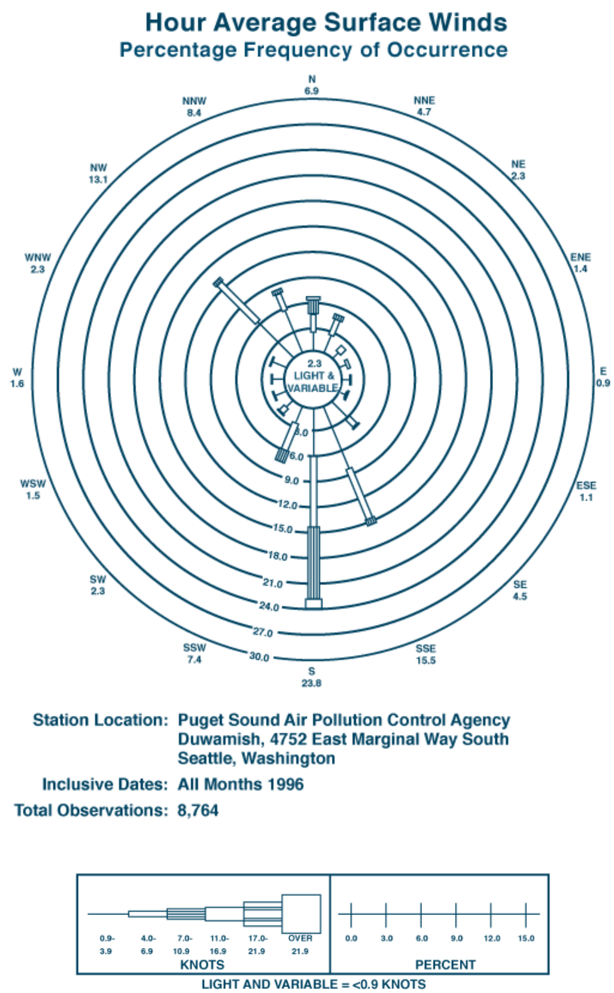
Energy Policy Act of 1992 (EPACT) (P.L.102–486): Established a permanent 10% business energy tax credit for investments in solar and geothermal equipment. (http://www.eren.doe.gov/consumerinfo)

Internal Revenue Code contains a Modified Accelerated Cost Recovery System (MACRS) by which businesses can recover investments in solar, wind, and geothermal property through depreciation deductions. For property placed in service after 1986, the current MACRS class life for applicable renewable energy technologies is 5 years. (http://www.eren.doe.gov/consumerinfo)

A wind rose is a quantitative graphical summary of the wind direction and speed for a given time. The following wind rose graphs show the number of hours-expressed as a percentage-that the wind blew from a particular direction and speed.

The wind rose spokes or arms represent 16 points of the compass and are labeled by wind direction. The percentage of time the wind blew from a given direction is expressed by percentage for that direction on the perimeter of each rose.

The length of each segment of a spoke represents the percentage of time the wind speed was within a specific speed interval for a particular direction. If summed for all wind directions, the result would provide the percentage of all hours the wind speed was measured within a specific interval. The percentage of time when the winds were light and variable is shown in the center of the rose.



Wind data from Seattle 1996
Puget Sound Clean Air Agency

indoor environmental quality

Goal: **To add aesthetic, productivity, health, and economic value by providing enhanced indoor environmental quality.**

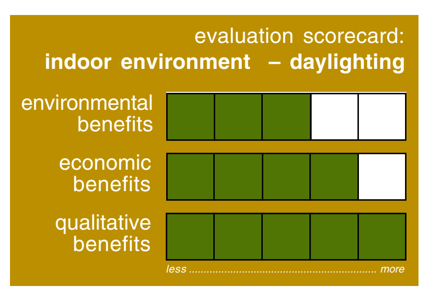
Strategies:

A high indoor environmental quality (IEQ) is a key element of sustainable development. Through an enhanced connectivity with their urban environment, those who work and live in high IEQ buildings can take advantage of daylight, air quality, view, and appropriate acoustics. The key to successfully building this environment is the balancing of an appropriate amount of each element of IEQ design, some of which are mutually supportive and others mutually exclusive, while keeping in context the resulting economic, environmental, and qualitative costs incurred by each. With high IEQ comes longer building life, higher property values, urban revitalization, improved environmental impact, and a elevated standard in which people can live, work, and play.

Dining Hall at REI Corporate Campus
Lara Swimmer / Mithun

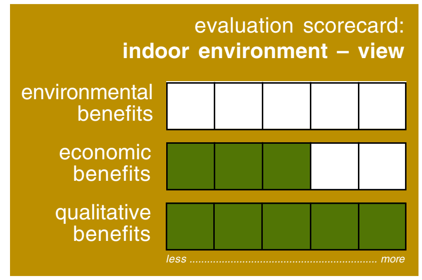
1. Daylighting

It is well known that access to natural light is a priority among building occupants and that in many instances daylighting, as more than just an aesthetic element, delivers superior value by improving color rendition and enhancing visual acuity. What is less well known are those additional benefits that can justify daylighting from an economic perspective. For instance, post occupancy studies indicate the potential for a 50–80% decrease in lighting energy costs which can constitute 20–30% of the total building energy usage. In addition, it is a decrease that occurs during periods of peak demand when electricity prices are at their highest. Every reduced kilowatt-hour of use also decreases the need for the production of that kilowatt-hour and hence there is benefit to the environment. As a result of lower heat output from the electrical lighting system, the HVAC system is faced with a reduced cooling load and as a result can be downsized. Lower first costs and operating costs often result. Arguably, the greatest impact is evidence of up to a 15% increase in productivity from satisfied building occupants. In whole, the aesthetic and the economic complement one another and produce an attractive strategy for IEQ. The success of daylighting designs depends largely on the building's floor to ceiling height and cross-sectional depth. The shallower the depth and the greater the height, the greater the influx of light. A general rule is for floor plates to extend no deeper than 50–60 ft, floor to ceiling heights to be no less than 9–10 ft, and interior partitions to be transparent. This



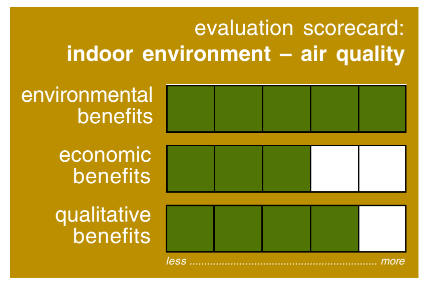
results in the majority of occupied areas being located within 20–25 ft of a natural light source. Clerestories, atria, light wells, and sun shelves can be integrated to meet this goal.

2. View



Just as they do with daylighting, tenants place a high value on views to the outside. There is a high demand for corner offices and desk space adjacent to windows not to mention the value placed on high-rise developments with panoramic views of picturesque skylines. But views don't have to be majestic to be effective. The bulk of architectural growth in today's market involves taking advantage of the high quality of glazing and façade technologies coupled with decreased floor plate depth to supplant such long held notions. The envelope is being pushed to greater and greater window-to-wall ratios while shading devices, high performance glass, and multiple 'skins' help to control heat transfer and solar heat gain. Although the building cost can be a premium, the dollar value increase to the leased spaces is a motivation to many developers. Strategies for access to view closely parallel those of daylighting and natural ventilation.

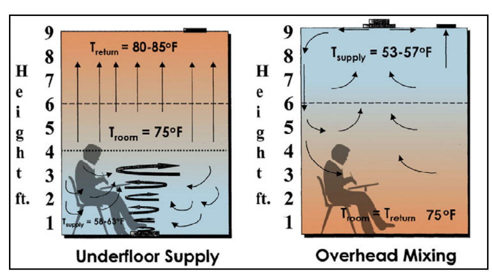
3. Air Quality



A great deal of research by national and international, and by federal and non-governmental organizations has expanded the information base on this topic over recent years. *Sick-building Syndrome*, when employees complain of above normal numbers of illnesses and allergic reactions as a result of poor air quality, has garnered widespread media attention. The result of this and more complex human reactions has increased owner liability and expense in combination with decreased employee productivity. It is the challenge of designers today to restrict air-born pollutants in the form of Volatile Organic Compounds (VOCs), biological contaminants such as spores, molds, and pollens, and particulates like dust and soot from entering occupied spaces. As a guideline, air quality is maintained by a combination of dilution, filtration, and source reduction. Point source areas of potential pollution should have dedicated exhaust systems, some measure of filtration should be installed (as appropriate to the building and site), and ASHRAE standards for minimum outside air must be followed. It is worth noting that in the context of whole building integration, higher air quality may or may not result in higher operational and capital costs. For example, enhanced filtration and supplied air may increase HVAC system size and complexity, but operable windows, which have both positive and negative IAQ characteristics, could drive HVAC operational and capital costs down. To some extent, indoor air quality strategies will, counter the benefits of other indoor environmental quality strategies, specifically natural ventilation which is typified by difficulty of filtration. Conversely, an underfloor supply can enhance indoor air quality, as pollutants are more likely to be displaced than diluted as is typical in an overhead mixing system. The design balance must be considered and overall performance optimized.

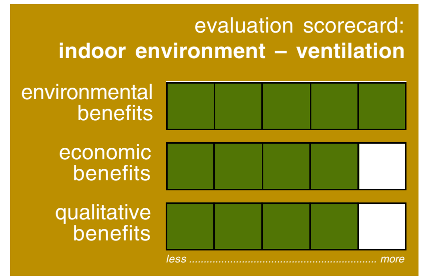
4. Natural Ventilation

Through the use of air pressure differentials resulting from prevailing wind conditions and variations in heat content, buildings can be made to self ventilate without supplemental mechanical systems, thereby enhancing the occupant connection to the environment while simultaneously decreasing energy demand by the HVAC system. In concert with a nighttime flush system, comfort can be better maintained and energy use further reduced as the thermal mass of the building is leveraged to decrease daytime temperatures. As strategies for daylighting,



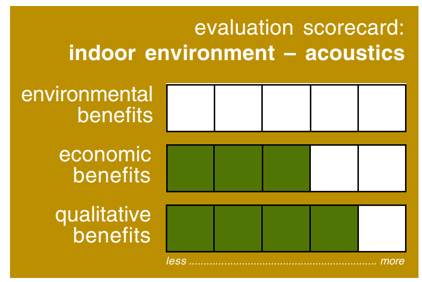
Ove Arup & Partners

views, and natural ventilation share a common criterion of maximized access to windows, all three are often found in a holistic design approach. The challenge with a design that includes operable windows is the balance of air quality levels, which can fluctuate more widely and impact control, and fire safety issues, since pressurization and exhaust attempts can be stymied by openings in the building envelope. As with daylighting and views, natural ventilation performs best over narrow building floor plates. Fifty feet is a general rule for maximal depth, but can be extended through the application of atria and air chimney technology. Placement of 50% of commercial floor area within 25ft of an operable window or naturally ventilated air source is a good general guideline.



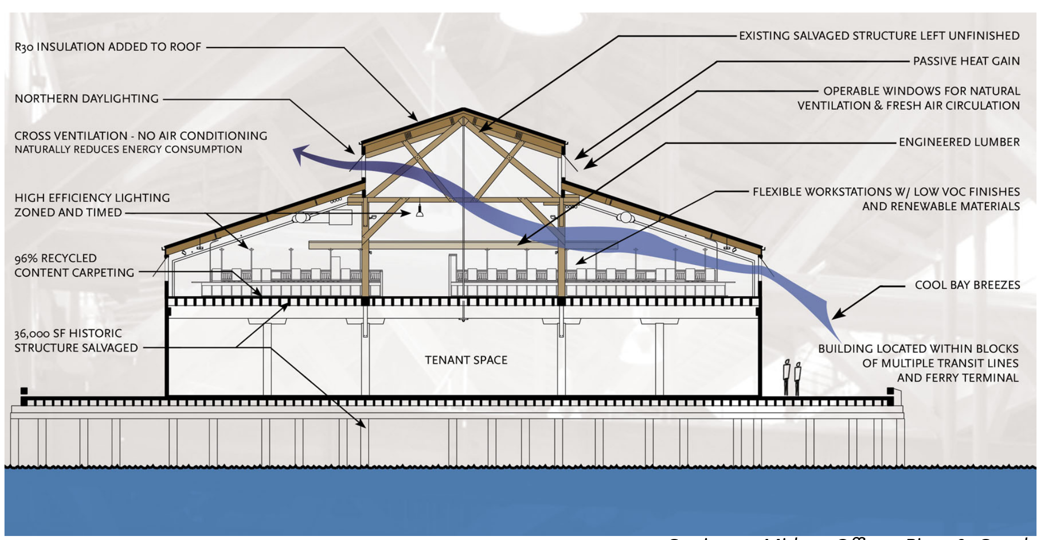
The temperate Seattle climate is appropriate for the incorporation of a 'mixed mode' concept of operable windows and underfloor air supply; a mode that combines thermal mass, nighttime flushing, enhanced temperature and humidity control with operable windows.

5. Acoustics



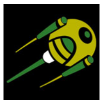
The internal acoustic environment is also important for occupant satisfaction and productivity. Achieving the correct acoustic environment requires an integrated design approach. Operable windows, light weight construction, and hard surfaces typically do not combine well with a good acoustic environment. However, by considering overall performance it is possible to design buildings that can achieve high energy performance and have good acoustic design. Buffering mechanical equipment noise by locating low occupant use areas like hallways, bathrooms and closets between office space and the mechanical room can significantly reduce the associated noise migration. To cut down on the transmission of noise consider heavy weight building materials, sound baffles such as full height partitions (with glass upper sections for light transmission), and sound absorbent materials such as carpet, acoustic tiling, and sound-attenuating ductwork.

With the exception of exterior site factors, the quality of the indoor environment is what drives the value of built space more than nearly any other issue. Tenants who choose to occupy the building desire a space that best balances the sometimes contrary forces of maximized benefits and minimized operational and rental costs. Among the many benefits of the strategies proposed in this section, increased comfort conditions in the form of air, view, and light result in increases to productivity as



Section at Mithun Offices, Pier 56, Seattle
Mithun

high as 15%. Combined with strategies for energy efficiency, reduced usage costs like 'churn', and decreased personnel costs associated with employee retention, tenants will realize an increased value. From the building owner's perspective, this will result in higher occupancy rates, lower tenant turnover during periods of economic downturn, and higher average dollar per square foot leasing rates.



Status of Technology: The majority of the ideas presented here are not new. What is new is the level of early design collaboration, market demand, and industry precedent. Case studies that showcase successful implementation of these technologies abound and are evidence of the maturity of sustainable design.

Costs: A higher performance design tends to increase cost exponentially. As investment increases, the return on the investment diminishes correspondingly (i.e. a law of diminishing returns). As a result, increased performance must be closely watched so that the investment delivers an acceptable benefit versus its cost (i.e. value). However, many of the indoor environmental quality improvements can be gained through little or no additional cost simply through more knowledgeable design practices. Additionally, there is a turning point wherein increased performance can lead to elimination of entire capital expenditures. For example, entire cooling systems can be eliminated through effective passive design. In such a case, there can actually be a decrease in first cost.

Incentives: Greater property valuations, higher productivity, and increased tenant retention are the most direct incentives to enhanced indoor environmental quality. High quality indoor air can maximize good health, potentially reducing insurance costs due to reduced risk. In addition, all of the incentive programs highlighted in the discussion of incentives for the 'Building – Energy Efficiency' section act as passive incentives for IEQ. In many instances, higher efficiencies and IEQ issues are mutually supportive. Consider the decreased cost and enhanced comfort as a result of daylighting, or the increase in energy efficiency and indoor air quality that comes with underfloor ventilation. In the holistic process of sustainable design, the greatest incentives arise out of an integration of systems.

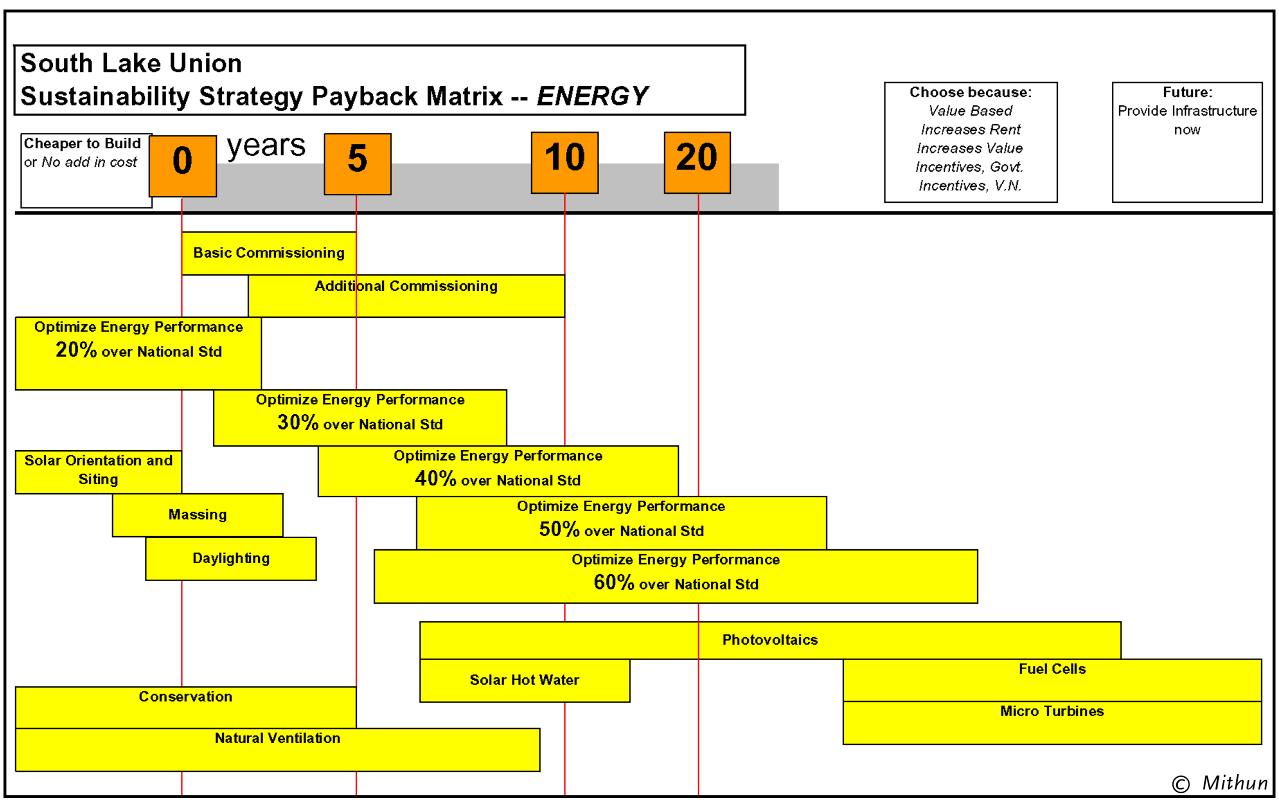
Recommendations:

- Design 100% of residential to incorporate natural ventilation.
- Design 50% of commercial floor area within 25 ft of operable windows.
- For office and lab buildings use total daylighting design, utilizing sophisticated controls, exterior light shelves, etc.
- Provide highest possible ceiling for daylighting, natural ventilation, and thermal stratification. Daylighting in buildings with deeper footprints requires higher ceilings. Eliminate hung ceilings if possible. Maintain acoustic dampening.
- First consider all natural ventilation in offices using flues, atria, and high mass construction, Provide mixed-mode HVAC systems if cooling is utilized, maximizing natural ventilation. An excellent mixed mode model is the Phillip Merrill Center in Maryland, utilizing a very simple signal system, to facilitate system control by the building occupants.

energy & atmosphere

payback summary

Payback Summary charts are a conceptual tool for mapping each sustainability strategy and their respective payback periods. These strategies are roughly modeled for multi-story commercial buildings in Seattle in 2001. These need to be analysed for each project, as size, occupancy, and orientation can affect the numbers substantially. The strategies listed from top to bottom correspond with the strategies listed in the sections that follow. Across the top of the chart is a range of values and payback periods. Starting on the left is 'save' strategies that will reduce costs. Next is 'cheaper to build or no added costs' vs. standard market construction for a class A office building. Next are the years, indicated current ballpark numbers for payback. On the right is a category for items that are value based, these desirable because of environmental or social benefits that cannot be justified financially or increase rent or value. This also includes strategies that would be economical because of government incentives or internal owner incentives. An owner can select the strategies that fit within their budget and value goals.



materials & resources

introduction

OVERVIEW

The construction industry consumes 40% of the total flow of materials, some three billion tons of raw materials[1] into the global economy. The flow of resources cause environmental impacts during each stage, from extraction to manufacturing, transportation to use, maintenance, and disposal. While the construction industry is fragmented, it is the nation's largest manufacturing industry.

The industry is resource intensive, and in a time when natural resources are becoming increasingly scarce, it is facing an interesting challenge. For the industry to begin its journey towards sustainable materials use, a number of strategies must be considered.

Use Less
Minimizing material use is the first step. This can be achieved by designing buildings that survive the test of time, and can be adapted for future uses. Selecting durable materials and careful detailing protect buildings from moisture infiltration and increase longevity. Efficient space planning, modular design, standard dimensions, advanced engineering, and utilizing resource efficient materials can all contribute to overall resource conservation.

Purchase Environmentally Preferable Products
Environmentally preferable procurement drives change in the marketplace by leveraging the purchasing power of large organizations to increase demand for products that *have a lesser or reduced effect on human health and the environment.* Developers can expand selection criteria for products and materials to include:

- Traditional functional, economic, aesthetic criteria
- Life cycle benefits
- Environmental benefit
- Human health benefit

Request Life Cycle Assessment (LCA) from Manufacturers
LCA is used to measure the environmental and health impacts of a product from extraction of virgin materials through the end of the products useful life. Few manufacturers have evaluated the life-cycle impacts of the products they make. Independent third party LCA is the first choice. However, manufacturers are currently in the best position to provide the information from both a financial and product responsibility standpoint if no third party certification is available.

Eliminate the Concept of Waste
Waste is generated in all phases of a building's life from construction to occupancy, rehabilitation to demolition. Strategies that eliminate waste are cost effective. Rehabilitating buildings, reusing building materials, and recycling construction and demolition waste contribute to reducing disposal costs.

South Lake Union is a neighborhood whose community has a strong connection to its past. The community has expressed a strong desire to maintain a historical connection. Developers can provide that link by rehabilitating buildings that hold historic or cultural significance. In addition to providing value to the community, rehabilitating buildings can sometimes reduce developments costs and keep useful resources in service.

Support and Strengthen our Local Economy

Developers in South Lake Union can support the local economy in the same way that Boeing and Microsoft have strengthened the economy by bringing jobs into the area and purchasing goods and services from local companies. The Pacific Northwest Region is host to a significant number of manufacturing facilities that provide products and services to the building industry. Locally manufactured products and services can be more economical because of reduced transportation costs. Local manufacturers may provide better quality service leading to stronger relationships.

Encourage Responsible Forest Management

Protecting the earth's remaining forests is a goal of international interest for a number of reasons. Forest ecosystems stabilize global climate patterns by absorbing CO_2 and cleaning the air. They hold an abundance of biodiversity, provide habitat for fish and wildlife, purify and hold water, and offer recreation and inspiration. While most individuals in the green building industry agree that this is a desirable strategy, gaining access to certified forest products at competitive costs and without impacting schedule has proven challenging.

Many of the criteria for materials and resources are cost effective and feasible to attain. Identifying products that meet the criteria may be the most challenging aspect for project teams. Developers in South Lake Union can facilitate greater success by assisting teams with product research and developing a *preferred products* list. The list can be expanded with each new project.

Requiring teams to use unfamiliar products has resulted in increased costs and schedule impacts. By bringing contractors on board early and building partnerships with firms with a shared commitment and vision, developers can lessen the aversion to risk leading to greater success.

1 David Malin Roodman and Nicholas Lenssen, *A Building Revolution: How Ecology and Health Concerns Are Transforming Construction*, Worldwatch Paper 124 (1995), pg. 22.

building reuse

Goal:

Rehabilitate buildings with cultural or historical significance to provide continuity and a connection to the past, while reducing the environmental impact from demolition and construction.

Strategies:

1. **Reuse existing buildings where possible.**

Many of the properties in South Lake Union are either parking lots or one-story concrete block buildings and, not of historical or cultural interest. A few buildings provide a connection to the neighborhoods past. The South Lake Union Neighborhood Plan expressed a vision to honor the past while moving into the future characterized in part by:

- retention of a significant element of the area's commercial activities, including opportunities for business growth,
- ecologically sound development, and
- a sensitivity to the area's history and historical elements.

2. **Analyzing the economic feasibility of rehabilitating existing building structure for existing or new uses.**

Rehabilitating buildings is common practice. By the end of the 1980s, commercial rehabilitation expenditures had gone from 75% of new construction to 150% of new construction. Some $200 billion was spent on renovation and rehabilitation in 1989. With historic preservation accounting for $40 billion a year of goods and services.[1] Stewart Brand, author of *How Buildings Learn: What Happens After They're Built*, surmised, "Age plus adaptivity is what makes a building come to be loved."

Building specific factors that must be considered include structural integrity, energy efficiency, code compliance, fire and safety compliance, adaptability, moisture infiltration, and hazardous materials.

Establish whether an increase in FAR to improve financial performance can be achieved.

Smith Tower
Chris Roberts / Mithun

3. **Investigate the feasibility of moving residential structures to new locations instead of demolishing the homes.**

Moving an existing structure might be cost effective. A new site must be identified and road conditions (including overhead wires) assessed before the fee can be established. Consider partnering with the Seattle Housing Authority or Habitat for Humanity to identify appropriate locations.

4. **Review the cultural and historic significance of existing buildings.**

In 1994, NBBJ, Caroline Tobin and Hart Crowser prepared Historical and Cultural Resources as part of The Draft Environmental Impact Statement for the Seattle Commons / South Lake Union Plan for the City of Seattle Planning Department and Committee for the Seattle Commons.

Metropolitan Laundry

Status of Technology: Building rehabilitation is common practice.

Cost / Benefit Analysis (Tangible Benefits and Intangible Benefits): In 1993, the National Audubon Society moved into its new headquarters, a rehabilitation of a 100 year old, eight story building. During the rehabilitation, the existing building shell and floors were maintained. According to the book *Green Development: Integrating Ecology and Real Estate* by the Rocky Mountain Institute:

Building size:	98,000 sf
Renovation costs:	$14 million
Estimated savings:	$8 million, 27% average
Materials conserved:	300 tons steel, 9,000 tons masonry, 560 tons concrete

Telus Corporation, one of Canada's leading telecommunications companies, has a strong environmental commitment and was able to communicate its values while demonstrating leadership through the development of its new office building. Telus met their internal business needs and designed an *ecologically sound* office building by rehabilitating an existing office building built in the 1947. The interior was gutted and renovated, and the exterior received a high-performance skin contributing to energy performance that is 39% better than city requirements. The innovative design and adaptive reuse provided Telus with significant public recognition, and the project received several industry awards. According to Peter Busby, Busby + Associates:

Building size:	127,000 sf
Renovation Costs:	$14 million, $110/sf
Savings:	Approx. $4.6 million, 33%

Marketing Amenity: Historic structures add to the quality of the neighborhood by adding texture, detail, historic interest, and a connection to Seattle's past.

Incentives: No incentives exist for building rehabilitation, other than those constructed at least 50 years ago, and those that have been identified as qualifying for the National Historic Register. U.S. tax credits are available at 10% and 20% of qualifying rehabilitation costs.

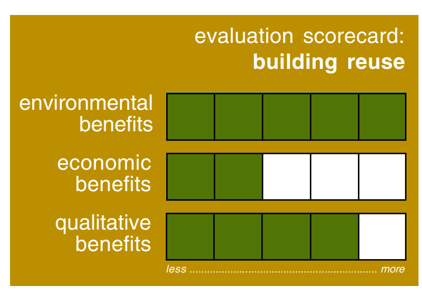
Recommendation: It is recommended that buildings registered or that meet the Landmark and National Register Criteria be identified. In addition, identify buildings that hold historic and cultural significance. Conduct a feasibility study for rehabilitating the identified buildings for historic or adaptive reuse. Investigate tax credit potential. Consider intangible benefits to the developer and the community within the analysis framework.

Repeatability – HIGH: Bill Browning, Green Development: Integrating Ecology and Real Estate, said, "Renovating an existing building can be an excellent way to demonstrate ecologically responsible and community sensitive development to clients as well as the larger community." Building rehabilitation for adaptive use is common practice.

FOOTNOTES:

1 Stewart Brand, How Buildings Learn: What happens after they're built, (Penguin Books, 1994), pg. 5.

2 Audubon House, National Audubon Society and Croxton Collaborative (John Wiley & Sons, 1994), pg. 134.



construction waste management

Goal:

Recycle construction and demolition waste (C&D) to decrease demand for raw materials extraction, conserve energy, and reduce pollution and landfill waste.

Strategies:

1. **Include C&D waste management goals and requirements in project specifications and construction contracts.**

Construction Waste Recycling
Sellen Construction

Develop a report template for use on projects and track:

- Specific materials recycled, processor, and end-use
- Amount recycled in weight (tons)
- Percentage of waste stream for each material
- Total cost per ton to dispose of each material
- Trash figures: weight, percent, total cost
- Recycling rate
- Overall savings
- Pounds of waste generated per square foot, and cost for disposal per square foot.

2. **Recycle materials on site to reduce transportation costs and environmental impacts.**

Transportation can be the most significant cost of recycling construction materials. It can be more economical to process wood waste and aggregates on-site (concrete, asphalt, and brick) and re-use on the project. Chipped wood can be used as mulch, or for temporary roadbeds and crushed aggregates can be used as fill material and pervious paving surface.

3. **Identify and catalogue materials for recovery and reuse.**

See Resource Reuse section.

4. **Reduce waste by requiring and specifying reduced packaging or alternative packaging methods.**

Packaging waste constitutes 15% of C&D waste stream. In the U.S., 20% of lumber is used to make pallets, which are not typically recovered and reused.[2]

5. **Include a provision for extended manufacturer responsibility in bulk-buying contracts requiring the manufacturer to recover waste created during installation whenever economically feasible.**

For example, the percentage of waste from installation of ceiling tile is approximately 10%. For every 100,000 square feet of ceiling tile, 10,000 square feet of waste is generated. Ceiling tiles weigh approximately 0.6 pounds/ sf, generating 6,000 pounds of waste for each 100,000 sf of installation. At a rate of $139/ton for disposal, potential savings can be as much as $415.00.

Leasing carpet can create a "cradle to cradle" cycle , tying the manufacturer to a sustainable strategy.

6. **Consider the creation of a permanent construction office or an office in rented space for multiple projects to reduce use of temporary jobsite trailers.**

Jobsite trailers have a very short life, are not energy efficient, and typically incorporate unfriendly materials such as PVC flooring. A permanent construction office or an office in rented space can serve multiple functions, and provide a central project management location that may reduce construction costs by stimulating integration and improving communication between projects.

7. **Recycle and reuse of materials on-site may provide both economic and environmental benefits to developers in South Lake Union.**

Concrete and asphalt processing requires mobilization of equipment, and becomes cost effective when more than 2,500 cubic yards (in place) will be excavated at one time. A recommendation has been made to reduce stormwater run-off by installing permeable surfaces on sidewalks and streets. Consider converting all existing parking lots to permeable surfaces, and processing and stockpiling crushed aggregates for future use as structural fill, backfill, or ballast material.

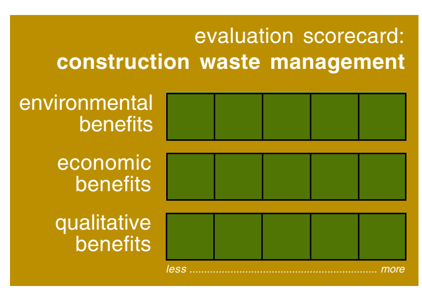
Status of Technology: C&D waste management and resource recovery have been successfully practiced in the Seattle marketplace for over five years. For example, Sellen Construction Company recycled 83% of the waste stream during construction of AT&T at Redmond Town Center, saving $79,940.

AT&T at Redmond Town Center

Material	Tons	% By Weight	Disposal Fees	$ / Ton
Wood Waste	211.5	23.5 %	$24,703.97	$116.83
Drywall	118.4	13.2 %	$7,641.69	$64.56
Cardboard / Paper	34.8	3.9 %	$0.00	$0.00
Concrete / Asphalt	308.0	34.3 %	$4,980.38	$16.17
Metals	74.9	8.3 %	$(3,051.66)	$(40.74)
TOTAL	747.5	83.2 %	$34,274.38	$45.85
Construction Waste	*151.3*	*16.8 %*	*$23,111.44*	*$152.79*
SUMMARY	83% recycling rate, $79,940 savings gained			

RAFN Construction recycled 98% of construction waste at IslandWood in 2001–2002.

Cost / Benefit Analysis (Tangible Benefits and Intangible Benefits): The Associated General



Contractors report that on average 2.5 pounds of waste is generated per square foot of construction. The table below lists the estimated waste stream generated by construction (LEED™ Technical Manual) on a 100,000 sf commercial building, and figures provided by Sellen Construction of average disposal costs of materials.

Material	% By Weight	Tons	$ / Ton	Total $ for Disposal
Misc. Waste	22.9%	229	$139	$31,831
Acoustical Ceiling Tile	1.5%	15	$0	$0
Cardboard / Paper	2.7%	27	$23	$621
Concrete / Asphalt / Brick	23.3%	233	$15	$3,495
Drywall	13.4%	134	$89	$11,926
Metals	8.8%	88	$(30)	$(2,640)
Wood	27.4%	274	$106	$29,044
Total	100.0%	1,000		$74,277
Landfilling all Materials		1,000	$139	$139,000
Potential Savings				$64,723

Marketing Amenity: Adds to the overall goals of a green development.

Incentives: There are no financial incentives available for recycling construction waste. However, King County Department of Natural Resources and the Business and Industry Resource Venture publicly recognize projects that meet minimum levels of construction waste recycling through Construction Works.

The economic savings provide a strong business case. The Cascadia Region Green Building Council recommended that the City of Seattle facilitate construction waste recycling on urban projects by reducing the cost for street use permits and providing dedicated space for recycling. On urban projects space is limited, and recycling containers often lose out to the competing demands for space.

Recommendation: Require projects to attain a 95% C&D recycling rate.

FOOTNOTES:

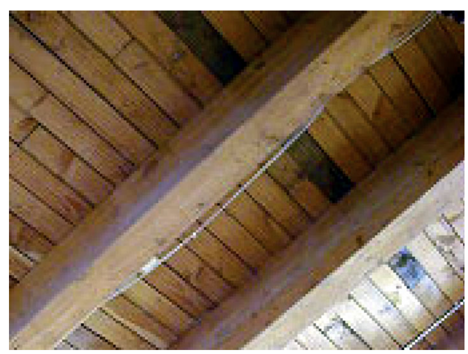
1 U.S. Environmental Protection Agency, Characterization of Building-Related Construction and Demolition Debris in the United States, (EPA530-R-98-010), 1998, p. 2–11.
2 Janet Abramovitz, Taking a Stand: Cultivating a New Relationship with the World's Forests, Worldwatch Paper 140, 1998, pg. 8.

RW Rhine Demolition

resource reuse

Goal: Extend the life cycle of targeted building materials.

Strategies:



Timbers in South Lake Union buildings

1. **Select one project to demonstrate this strategy. For the demonstration project, set an aggressive goal for resource reuse at 50% or above.**

Utilizing recovered materials can also reduce acquisition costs, and support Seattle's rapidly growing salvaged building materials industry. Salvage companies include:

Building Materials: The ReStore, Second Use Building Materials, Earthwise, RW Rhine, Seattle Building Salvage
Timber: Duluth Timber Company, JR Plume, Resource Woodworks
Carpet: Value Floor and Pacific Modular
Internet Exchange: Reusable Building Materials Exchange, www.metrokc.gov/rbme

2. **Target a project that will benefit from communicating this strategy to potential tenants and the community.**

3. **Identify and catalogue the building materials from SLU properties such as brick and old growth timbers, that can be salvaged and refurbished for reuse.**

Develop a worksheet or database and document:

- item
- description
- dimensions
- quantity
- cost to clean and refurbish
- avoided supply costs
- avoided disposal costs
- savings

4. **Partner with demolition contractor(s) to identify and source building materials including timber, brick, roofing insulation, doors and relites, plywood, etc.**

5. **Challenge the design team to create an innovative and attractive building using available salvaged and refurbished building materials.**

There are costs associated with storage, cleaning and refurbishing building materials.

Consider hiring a firm like the ReStore to catalogue and clean materials until needed to reduce overall costs. Consider locating storage in the neighborhood, especially if a vacant building exists that will provide for safe and protected storage.

CIty of Vancouver Materials Testing Laboratory
Busby + Associates

Status of Technology: The Seattle marketplace is home of a number of salvaged building materials stores, and demolition contractors that are willing to recover building materials for reuse. Designing to optimize use of recovered materials requires more planning and careful detailing which can increase design fees.

Cost / Benefit Analysis (Tangible Benefits and Intangible Benefits): Utilizing recovered building materials can reduce materials acquisition even when costs for cleaning and refurbishment are considered.

The CK Choi Institute of Asian Research building was constructed with a significant amount of recovered materials. http://www.usgbc.org/Chapters/Cascadia/choi.pdf

Projected goal:	Use 50% recovered material
Building size:	30,000 sf
Total Dev. Costs:	$5.9 million, $197/sf

Materials used: Heavy timbers for 60% of the structure, brick cobblestones for 100% of the exterior façade, railings, bathroom fixtures, and doors and door frames.

The City of Vancouver Engineering Services planned to construct a new building for a materials testing laboratory. The original budget was established to construct an inexpensive, light metal frame facility. The architect convinced the owner to demonstrate the economic advantage of using recovered, cleaned and refurbished building materials, and to increase the project budget to design a high-performance building. Simple construction details facilitated the use of recovered materials. In a conventional building, materials and labor each are about 50% of the construction costs. In the Materials Testing Laboratory, the building costs shifted dramatically with 20% of the costs for materials and 80% of the costs for labor. The environmentally responsible building constructed from *garbage* received the 2000 Consulting Engineers of BC Structural Award of Merit. According to Busby + Associates:

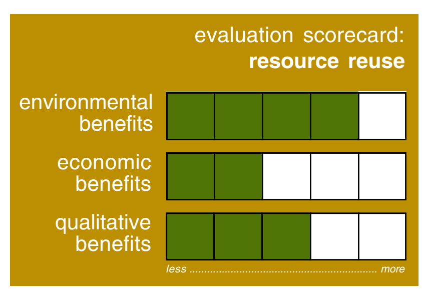
Project Goal:	Use 90% recovered materials
Building Size:	4,284 sf
Building Costs:	$550,000

Recovered materials used: Structurally upgraded timber trusses, re-milled heavy timber structural members, T+G decking re-milled for studs and mullions, recycled glass, lab equipment, mechanical equipment, light fixtures, furniture.

Incentives: No incentives exist for resource reuse, although innovative green buildings receive public recognition in local journals, as well as trade journals. A project constructed from a significant amount of salvaged building materials will likely receive public recognition, providing a developer with an opportunity to communicate its values and demonstrate leadership, thus strengthening its brand.

Recommendation: Select a targeted project to demonstrate the economic and environmental benefits of resource reuse. Set a 50% or greater goal for the project. If using LEED™, submit for an innovation credit in addition to the two credits awarded for using salvaged / refurbished building materials for 10% of total building materials.

Repeatability – MODERATE to LOW: There are a number of case studies available that demonstrate the feasibility of using a significant amount of salvaged and refurbished building materials. However, achieving this goal is difficult on most conventional projects.



storage & collection of recyclables

Goal: Facilitate recycling in occupied buildings.

Strategies:

1. **Require space and access dedicated to the storage and collection of recycling that meets city requirements. The City of Seattle Ordinance 119836 calls for:**

Structure Type	Structure Size	Minimum Area	Container Type
Multifamily	1–15 units	75 sf	Rear Loading
	16–25 units	100 sf	Rear Loading
	26–50 units	150 sf	Front Loading
	51–100 units	200 sf	Front Loading
	More than 100 units	200 sf plus 2 sf per add'l	Front Loading
Commercial	0–5,000 sf	82 sf	Rear Loading
	5,001–15,000 sf	125 sf	Rear Loading
	15,501–50,000 sf	175 sf	Front Loading
	50,001–100,000 sf	225 sf	Front Loading
	100,001–200,000 sf	275 sf	Front Loading
	200,001 plus sf	500 sf	Front Loading

2. **Develop a comprehensive waste management plan.**

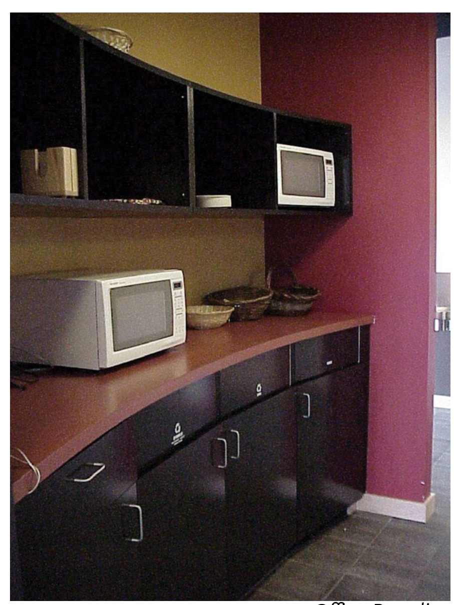
Address all waste streams including: hazardous waste, special waste, electronics, landscaping waste, construction and renovation waste, office waste, and organic waste.

3. **Provide recycling stations in common areas of commercial buildings and in the kitchen of residential units to facilitate occupant recycling.**

4. **Require garbage and recycling service providers to submit a monthly garbage and recycling report that illustrates the recycling rate and associated savings.**

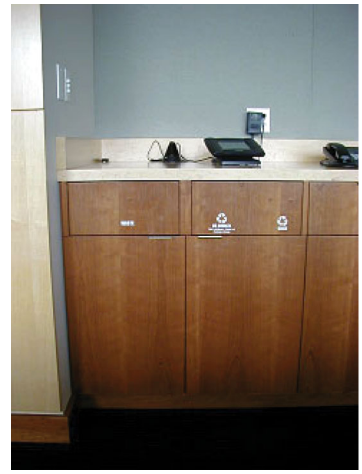
5. **Establish building-type goals for recycling and identify potential savings to tenants. Provide tenant education to increase awareness and encourage recycling.**

6. **In high-rise and large structures analyze the cost effectiveness of installing equipment such as compactors and waste and recycling chutes.**



Office Recycling
Sellen Construction

Status of Technology: In 2000, the City of Seattle improved the recycling program offered to residents and local businesses to increase the recycling rate and reduce its long-term costs for managing solid waste.



Materials that can be recycled through the city's services are cardboard, glass, metals, mixed paper, plastics, and organic wastes. Buildings are required to separate glass and yard waste into separate containers. Cardboard, glass, metals, mixed paper, and plastics are combined in one container. For high-rise buildings or specialty businesses it can be more cost effective to separate high-grade paper and cardboard to receive additional savings. Independent services exist for recycling batteries, computer diskettes, electronic equipment, hazardous waste materials, polystyrene packaging, and other materials.

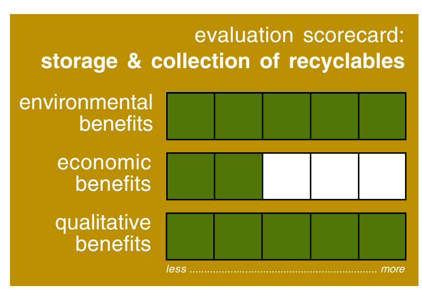
Residential Recycling Stations
Sellen Construction

Cost / Benefit Analysis (Tangible Benefits and Intangible Benefits): Recycling reduces disposal fees. Emerald City Disposal estimates that waste from commercial buildings is comprised of 75% recyclables and 25% garbage, and a 100,000 sf building requires a four cubic yard container for recyclables, 32-gallon glass container, and a 1 cubic yard container for garbage scheduled for weekly service.

Savings Gained by Recycling 75% of Commercial Building Waste

Material	Container Size	Monthly Fee	Annual Cost
Recycling + garbage collection			
Garbage	1 cy	$87.60	$1,051.20
Recycling	4 cy	$144.73	$1,736.76
Glass	60 gal	$12.75	$153.00
		$245.08	$2,940.96
Garbage only			
Combined	6 cy	$ 288.10	$3,457.20
Annual Savings			$516.24

To increase residential recycling, the City of Seattle offers recycling services to residential buildings free of charge. The City estimates that one residential unit with two people generate 32 gallons of garbage per week and 16 gallons of recyclables. A 28-unit residential building will require a four



cubic yard container for garbage scheduled for weekly pick-up, and a four cubic yard container for combined recyclables and 32-gallon glass bins for bi-weekly pick-up.

Savings Gained by Recycling at 70-Unit Residential Building

Material	Container Size	Monthly Disposal Fee	Annual Cost
Garbage	10 cy	$448.50	$5,382.00
Recycling	10 cy	-	-
Glass	60 gal	-	-
		$448.50	$5,382.00
Combined - 2x / wk	8 cy	$728.80	$8,745.60
Annual Savings			$3,363.60

Marketing Amenity: Interpretive signage can make recycling areas a positive green attribute to the project.

Incentives: While there are no public sector incentives, the cost savings for recycling provides a strong business case. The City of Seattle and the Business and Industry Resource Venture (www.resourceventure.org) provide assistance to residential and commercial buildings interested in establishing a recycling program, and provides public recognition to successful programs.

Recommendation - YES: Facilitate recycling in buildings to provide interior recycling stations and exterior storage and collection areas. Projects shall meet the LEED™ prerequisite for storage and collection of recyclables.

Partner with Seattle Public Utilities for public place recycling containers.

recycled content

Goal:

Reduce raw material extraction by using recycled building products.

Strategies:

1. **Identify commonly used recycled content materials, and develop guidelines for incorporation into specifications.**

Incorporate the recycled content stardards for building related materials listed in EPA's Comprehensive Procurement Guideline as the benchmark (http://www.epa.gov/cpg/). To illustrate, listed below are four of the ten insulation products with recommmended recycled content listed in the CPG:

Cellulose, Loose Fill	75% post-consumer paper
Fiberglass	20–25% glass cullet
Rock Wool	75% slag
Polyisocyanurate Rigid Foam	9% recovered

The structure and building skin each constitute approximately 25% of building costs for a total of 50%. Focus on structure and skin materials. Require project teams to use identified products unless they can demonstrate the benefit of using an alternative.

Many commonly used building materials are manufactured with recycled materials and are considered conventional building materials. For example, acoustical ceiling tiles are manufactured with recycled newsprint and mineral wool (recycled slag from the steel industry), structural steel and reinforcing steel are made from almost 100% recycled steel, drywall can contain from 12–39% recycled materials, and carpet manufacturers turn recycled carpet into backing for new carpet. According to the Steel Recycling Institute, each year steel recycling conserves the equivalent amount of energy need to power 18 million households for one year. And for every ton of steel that is recycled, we eliminate the need for 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone.

2. **Specify documentation of recycled content materials by contractor through the submittal process.**

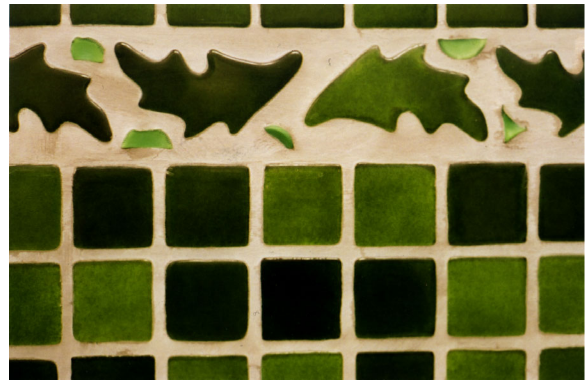
Recycled Content Material at Puget Sound Environmental Learning Center
Art Grice / Mithun

3. **Identify a variety of recycled content finish products to incorporate into buildings.**

Highlight the finish products to educate tenants and the community about the benefits of products made with recycled materials.

4. **Be cautious about the use of certain imported raw materials, such as marble.**

Be certain there is a clear understanding of the environmental impact to countries outside the U.S. Additionally, consider the energy consumed in transferring materials over long distances.



Recycled glass tiles, IslandWood
Mithun

Target specific materials that will be used in new development. For example, brick and pre-cast concrete are commonly used material for building façades with low percentages of 10 - 5% recycled materials. There is strong potential to increase the recycled content of these products. Developing a new mix design requires willingness from a manufacturer and may require financial support for the research, product development, and testing.

In addition, local markets for recycling can be strengthened by requiring use of targeted building materials that incorporate construction and demolition waste. In the Puget Sound Region, Georgia Pacific and James Hardie recover drywall from construction and demolition projects. The drywall is processed and used as feedstock for new drywall. Armstrong World Industries began recovering acoustical ceiling tile more than five years ago. Sellen Construction Company, Microsoft Corporation and Armstrong tested the feasibility of recovering acoustical ceiling tiles from a 1,000,000 square foot renovation project. The pilot was so successful that Armstrong subsequently launched a formal program in all nine manufacturing regions. Today Armstrong accepts the material at no cost to projects, and backhauls the material to the nearest plant where it can be directly incorporated into the manufacturing process.

Status of Technology: Many recycled content building materials exist in the marketplace. The Northwest Federal Credit Union incorporated a number of recycled-content materials in their office building near Northgate, including:

- soil amended with recycled compost
- concrete containing fly-ash
- rebar with recycled steel
- fiberglass insulation containing recycled glass, and fabric for office partitions made from recycled PET bottles[1].

Facilitate use by providing a listing to project teams. While not comprehensive, the list below includes building materials that can be found with recycled content:

Compost / mulch / soil
Metal siding / roofing
Biocomposite panels
Site Accessories and furniture
Roofing tiles
Cement composite countertop
Pavers
Ceiling suspension systems

Medium density fiberboard
Recycling containers
Roofing shingles
Panel board
Playground equipment
Acoustical ceiling tiles
Plastic Lumber
Crushed aggregates

- Structural insulated panels
- Asphalt
- Flooring – carpet
- Thermal / acoustical insulation
- Insulating concrete forms
- Flooring – ceramic tiles
- Rigid foam insulation
- Structural steel
- Carpet cushion
- Cotton insulation
- Framing steel
- Bathroom partitions
- Mineral wool insulation
- Sound deadening underlayment
- Gypsum wallboard
- Concrete
- Flooring – rubber
- Fiberglass insulation
- Concrete masonry units
- Flooring – marble tiles
- Cellulose insulation
- Reinforcing steel
- Fabric wrapped paneling
- Polystyrene insulation
- Miscellaneous and architectural metal
- Fabric / textiles

Cost / Benefit Analysis: Many recycled content building materials are considered conventional building materials and are priced competitively. There are finish materials that are more expensive than their conventional counterparts. For example, ceramic tiles and countertop materials made with recycled materials compare in price to a moderate to high quality product. Highlighting a few recycled-content finish products in educational and marketing materials may strengthen the brand.

Mithun's IslandWood on Bainbridge Island utilized 50% fly ash content concrete with a concrete cost savings of 5%.

Armstrong Cirrus Products
60% recycled content

Incentives: There are no financial incentives available for utilizing recycled content materials.

Recommendations:

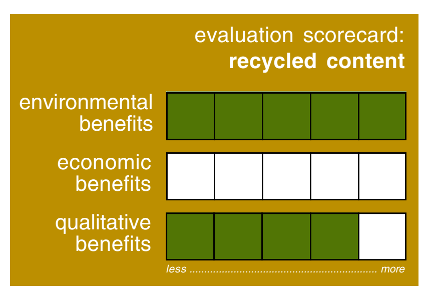
Require specification of recycled content building materials in projects and facilitate use by providing guidelines and resources. Meet current minimun LEED™ goal.

Use a minimun of 20% fly-ash content in all concrete; strive for 50% as appropriate.

Repeatability – HIGH: A wide variety of recycled content building materials are available at a competitive price.

FOOTNOTES:

1 Paladino and Company, 2001.



local/regional materials

Goal:

Purchase regionally manufactured products to support and strengthen our local economy, and to reduce transportation costs and the associated environmental impacts.

Strategies:

1. **Identify regionally manufactured materials, and develop guidelines for incorporation into specifications.**

The structure and building skin each constitute approximately 25% of building costs, for a total of 50%. Focus on structure and skin materials.

2. **Require project teams to achieve a specified goal for use of regionally manufactured products, unless a benefit for not achieving the goal can be demonstrated.**

3. **Specify documentation of regionally manufactured materials by project contractor and through the submittal process.**

Maintain a database or listing of regionally manufactured products and materials.

Highlight these materials and the benefits of supporting the local economy in educational and marketing materials to increase demand.

Request that regional manufacturers provide information on initiatives that demonstrate environmental and social responsibility.

Klaus Toepfer, Executive Director for the United Nations Environment Programme reports, "It is becoming more and more evident that consumers are increasingly interested in the 'world that lies behind' the product they buy. Apart from price and quality, they want to know how and where and by whom the product has been produced. This increasing awareness about environmental and social issues is a sign of hope. Governments and industry must build on that."

Building materials manufacturing centers within 500 miles

The Center for a New American Dream, whose mission is to help "individuals and institutions change the way they consume to protect the environment and enhance quality of life for all," recommends that purchasing locally produced goods offers the additional benefit of transparency. It is much easier to determine a local company's environmental and social responsibility.

Support Washington State's photovoltaic technologies (PV) industry. Washington hosts the largest number of component manufacturers for PVs of any state. Partner with Washington State Energy Extension to identify PV components manufactured in Washington that would be appropriate to incorporate into projects. (http://www.energy.wsu.edu/renewables)

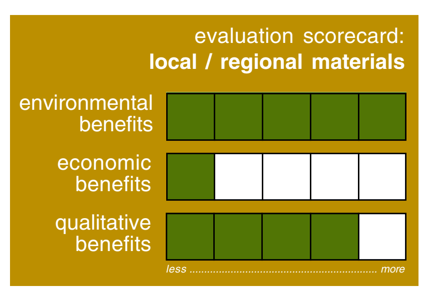
Status of Technology: Many regionally manufactured building materials exist in the marketplace. The Sellen Construction corporate headquarters building incorporated a significant amount of local and regionally manufactured materials at no additional cost to the project. In fact, many of the products were the most competitively priced. The following local and regional products were used: concrete and reinforcing steel, lumber for concrete forms, brick and pre-cast concrete panels, framing steel and drywall, acoustical ceiling tile, travertine, casework, glass architectural countertop, window systems, metal roofing, architectural steel items, and site accessories.

Sellen HQ Office Exterior

Facilitate use by providing a listing of local and regional products to project teams. While not extensive, below is a listing of local and regional materials.

Sellen HQ Lobby

Compost / mulch / soil
Cellulose insulation
Framing steel
Site accessories and furniture
Mineral wool insulation
Medium density fiberboard
Pavers
Roofing shingles
Straw board
Asphalt
Flooring – bamboo
Flooring – rubber
Flooring – stone
Forest products
Concrete masonry units
Cement composite countertop
Brick
Plastic lumber
Polystyrene insulation
Ceramic tiles
Pre-Cast concrete panels
Gypsum wallboard
Paint
Façade stone panels
PV components
Reinforcing steel
Recycling containers
Miscellaneous and architectural metal
Playground equipment
Metal siding / roofing
Plywood / panel products
Crushed aggregates
Acoustical ceiling tiles
Certified forest products
Concrete



Cost / Benefit Analysis (Tangible Benefits and Intangible Benefits): Most local and regional materials are considered conventional building materials and are priced competitively. In many instances, regionally manufactured materials are more economical due to lower shipping fees. Projects with these typically experience no cost impacts. Communicating support of local communities may strengthen the brand.

Incentives: There are no financial incentives available for utilizing recycled content materials.

Recommendation: Require that projects use regionally manufactured materials, and that 20% of materials within each building be manufactured within a 500 mile radius per LEED™ requirements.

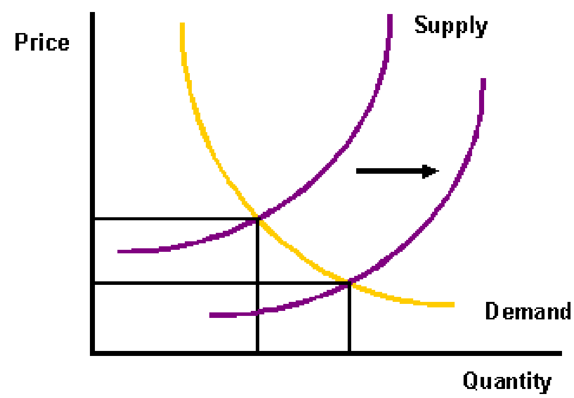
IslandWood
Art Grice / Mithun

rapidly renewable materials

Goal:

Increase demand for rapidly growing plant materials that replenish themselves faster than conventionally used materials to reduce depletion of finite raw and long-cycle renewable materials.

Strategies:



As demand increases, supply increases and prices lower.
Mithun

1. **Identify rapidly renewable materials and develop guidelines for incorporating into specifications. Availability is limited and most products are interior finish products.**

Manufacturers of rapidly renewable materials are small compared to the size of their competitors. Materials to include are:

- Bamboo
- Bio-based panels / straw board
- Casein paints
- Compressed straw acoustic panels
- Cork
- Cotton insulation
- Linoleum flooring / countertop
- Natural fiber textiles
- Natural fiber wall coverings
- Plant-based coatings
- Plant-fiber flooring
- Wool carpeting

2. **Communicate a preference to project teams for using rapidly renewable products within a specified cost premium and when performance criteria are met.**

3. **Specify documentation of rapidly renewable materials by project contractor and through the submittal process.**

Develop a database or listing of rapidly renewable materials

Straw board can be used as the substrate for casework, and bamboo and cork are excellent alternatives for wood flooring. In addition, wool carpeting in residential units can provide multiple benefits from durability to protecting human health.

Timbergrass Bamboo Flooring
Art Grice

Status of Technology: Many products manufactured from rapidly renewable materials were commonly used in buildings before WWII. For example, cork, linoleum, and wool flooring products were common, as were textiles made from natural fibers such as cotton, and coatings made from plant based waxes and oils. Environmental and human health concerns are stimulating a renaissance for the use of many of these products.

Bamboo matures in three years, regenerates without replanting, and requires minimal fertilizers or pesticides. Bamboo flooring is harder than oak, durable, and dimensionally stable.

Cork products are made from bark of the cork oak tree, Quercus suber. Harvesting schedules are set to ensure that trees have nine years to regenerate. Producers strip the thick bark in long, wide slabs. They stamp out wine corks, then grind the scraps and press them back together to make bulletin boards and flooring. Cork is durable, warm to the touch, insulates, and is easy to install.

Cost / Benefit Analysis (Tangible Benefits and Intangible Benefits): Rapidly renewable materials are priced competitively when compared to competing moderate to high quality products. Rapidly renewable, have extremely long life cycles, as well as low maintenance costs, providing a long-term economic benefit. These products become very competitive when considering durability, longevity, replacement costs, and maintenance costs.

In 1999, Sellen Construction began using a new generation of concrete form release agents made from canola oil. Historically, petroleum-based form release agents have been used that are classified as a hazardous material and pose heath risks to workers. At the Sellen headquarters building, the project team found that the benefits outweighed the slight increase in cost. The coverage was 30% greater and required less product overall, it was environmentally safe and biodegradable, eliminated potential clean-up costs and hazardous waste disposal fees, produced a smooth finish, and kept concrete forms cleaner. The crew preferred the product because it was easy to wash out of their clothes and was odor-free. The headquarters team also investigated using straw board as the substrate for casework. Straw board is made of 100% agricultural wheat straw waste and non-formaldehyde binders. Straw board's density is similar to a medium density fiberboard. Sellen typically used particleboard as a substrate for casework. The cost per square foot for particleboard was $0.33. The cost per square foot of straw board was $0.34. The price premium was negligible, as the unit price below indicates.

	Particle Board	Straw board
Cost per sf	.33	.34
Cost per 4'x8' sheet	10.56	10.88
37 sheets per unit	$390.72	$402.56

Applying EnviroForm
Sellen Construction

Sellen also used the following rapidly renewable materials in its headquarters building:

- Linoleum flooring in core service areas for each floor
- Isobord (a straw board product) as the substrate for all of the casework, and
- EcoColors for the kitchen cabinets (a product made from straw board finished with non-toxic dyes and a low-VOC UV acrylic finish)

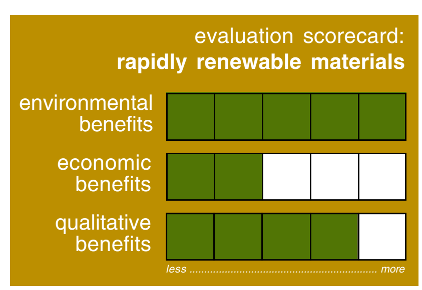
Plant-based wood finishes offer tangible and intangible benefits: increased durability, longer life-cycle, lower maintenance costs, and better performance, and reduced risk associated with health impacts, lower environmental impacts, and enhanced corporate image. As an example, Built-e provides a cost analysis over a seven-year period for using OS Hardwax Oil, a plant-based wood finish, as compared to polyurethane. Typical costs were pulled from actual bids. OS Hardwax Oil provided 52% savings over the seven-year period for a total of $6,198 for 1,000 sf of floor area.

	Hardwax Oil	Polyurethane
Day 1:		
1,000 square feet of cherry flooring, costing $5,890, is delivered. OS Hardwax Oil costs slightly more but needs only two coats. Polyurethane is cheaper but needs three coats. Cost to install, sand & finish is the same.	$5,250	$5,250
Year 2:		
Scratch in floor needs repair. Hardwax Oil gets professional touch-up. (Homeowner could do.) Polyurethane can't be repaired, so scratch stays.	$55	$0
Year 7:		
Traffic area looks badly worn. OS Hardwax Oil gets another touch-up, involving 300 sf. Floor with polyurethane must be sanded to bare wood and refinished, involving 1,000 sf.		
Labor to sand and apply required finish	$300	$3,500
Finish required	$49	$112
Handwork in toe kick areas	$0	$440
Move & reinstall baseboards	$0	$500
Move household contents	$0	$1,000
Move & reset refrigerator	$0	$125
Mask to control dust	$0	$375
Clean up	$0	$550
Total after seven years	**$5,654**	**$11,852**

Incentives: There are no financial incentives available for utilizing rapidly renewable materials. Using life cycle cost analysis on products can be used as a tool to demonstrate the economic viability of these materials. In addition, most rapidly renewable materials are made from natural products and do not impact air quality when compared to synthetic alternatives.

Recommendation: Require projects to incorporate rapidly renewable materials and provide a specified cost premium when performance criteria are met, but do not require attainment of the LEED™ 2.0 credit.

Repeatability – MODERATE: There is a range of rapidly renewable building materials available at competitive pricing is not competitive with lower quality products such as vinyl flooring and inexpensive synthetic carpeting.



certified wood

Goal: **Encourage environmentally responsible forest management.**

Strategies:

Protecting the earth's remaining forests is one of the most important challenges we face today. Conventional forest practices cause soil erosion, sedimentation in streams, destroy habitat, pollute water resources, contribute to global climate instability, cause desertification, and primarily responsible for the loss of approximately 27,000 species each year.[1]

1. **Use a minimum of 50% of wood-based materials certified in accordance with the Forest Stewardship Council (FSC) guidelines for wood components including framing and finish materials, as a requirement of LEED™ 2.0.**

Lakeview Forest
The Collins Company

Negotiate a relationship with FSC Chain-of-Custody broker based on long-term requirements. Require the broker to present a cost comparison of certified versus non-certified forest products. Accept a cost premium within a specified range. Require the broker to maintain current listing of FSC certified species, lumber, and wood products availability.

2. **Require that projects specify FSC certified wood products and list broker as contact for supply.**

The Certified Forest Products Council has developed sample architectural specifications (www.certifiedwood.org).

3. **Specify documentation of certified wood products by project contractor through the submittal process.**

4. **Encourage wood-use efficiency in design, engineering and construction.**

IslandWood lumber
Mithun

The Natural Resource Defense Council has published "Efficient Wood Use in Residential Construction, A Practical Guild to Saving Wood, Money, and Forests." While targeted at the residential marketplace, many of the strategies can be applied to larger projects.

The Natural Resource Defense Council reports that half of the earth's forests are gone and only one-fifth remain pristine and undisturbed. The global building industry consumes 25% of timber harvested, Americans use 27% of the timber produced even though we represent only 5% of the world's population. Roughly 20% of the wood delivered to construction sites ends up as waste.

5. **Highlight use of FSC certified forest products to educate tenants and the community about the benefits of forest preservation and environmentally and socially responsible forest management.**

Environmental groups and foundations are teaming up to conserve the remaining forestlands and promote environmentally sound forest management practices. Many are supporting or partnering with the Forest Stewardship Council (FSC), promoting market-based solutions. FSC develops environmentally and socially responsible forest management practices.

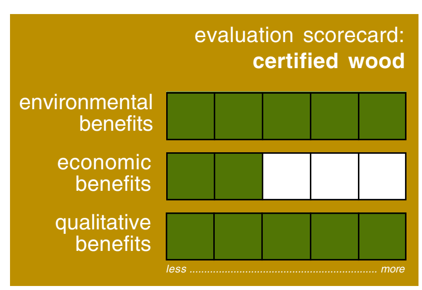
Partners of the Forest Stewardship Council that promote market-based solutions to environmentally and socially responsible forest management include an impressive roster. these include the Ford Foundation and Rockefeller Brothers Fund, as well as 23 environmental groups ranging from Greenpeace to the World Wildlife Fund, and three forestry groups including the Forest Stewards Guild.

The Ford Foundation granted $5 million to the Forest Stewardship Council (FSC), who will use the grant "to expand its worldwide forest certification program over the next five years." The Doris Duke Charitable Foundation supports forest conservation and forest management practices that focus on an ecosystem approach and protect biodiversity, habitat, recreation, and forestry. The foundation recently granted $5 million to create "economic incentives that increase the supply and demand for certified wood products and improved forest management."

Status of Technology: Certified forest products are available but require up-front planning to meet schedule and budget requirements. At a time when demand is rapidly increasing, the supply market is not yet stable. In the U.S. only 8.2 million acres are certified with 55.3 million acres certified globally. In addition, certified forest products have been considered a *niche* product and priced accordingly. Conversely, a few lumber companies understand the shift that is occurring in the marketplace and are positioning their companies to gain control of the available supply. Rafn Construction sourced lumber for the IslandWood from Hayward Lumber in Hayward, California. Hayward Lumber boasts having the largest inventory of certified framing lumber in the State of California, but may well hold the largest inventory of any supplier in the U.S.

Cost / Benefit Analysis (Tangible Benefits and Intangible Benefits): Certified wood products can add from 10%–30% to the material cost. In addition, the schedule can be impacted without adequate lead time. Cost and schedule impacts can be controlled, but require the development of a strong partnership with a FSC certified Chain-of-Custody broker that understands the market and has relationships with the players.

Middlebury College in Vermont sourced 125,000 board feet of FSC certified wood in its 220,000 sf Bicentennial Hall. The certified wood was used for interior millwork. Randy Landgren, director of academic facility planning for the college reported that, "The use of certified wood was the most dramatic environmental objective we accomplished with the project." The species selected were native to Vermont and included: hard and soft maple, beech, yellow birch, red oak, black cherry, poplar, basswood, and ash. The team also selected *character wood*, which features naturally occurring markings such as knots. Landgren estimated that certified wood came at a 3% cost premium over non-certified wood. The wood



was sourced by Natural Forest Products, a broker with a mission to facilitate the use of certified wood products in buildings.

There are significant intangible benefits for making a commitment to purchase FSC certified wood. The primary benefit is that this strategy clearly demonstrates the developer's commitment to forest preservation.

Incentives: There are no financial incentives available for utilizing certified wood products.

Recommendation: Examine the use of FSC certified forest products to encourage responsible forest management for a minimun of 50% of forest products used on projects.

Require that all interior trim and finish wood be certified by Forest Stewardship Council (FSC).

Repeatability – MODERATE: Certified forest products are available, but projects are experiencing significant challenges in sourcing the material to meet project budget and schedule requirements.

ENDNOTES:

1 Paul Hawken, The Ecology of Commerce, (New York: HarperCollins, 1993), pg. 29.
2 Brown, Lester, Flavin, Christopher and French, Hillary, State of the World 2000, The Worldwatch Institute (New York: WW Norton & Company, 2000), Pg. 24.

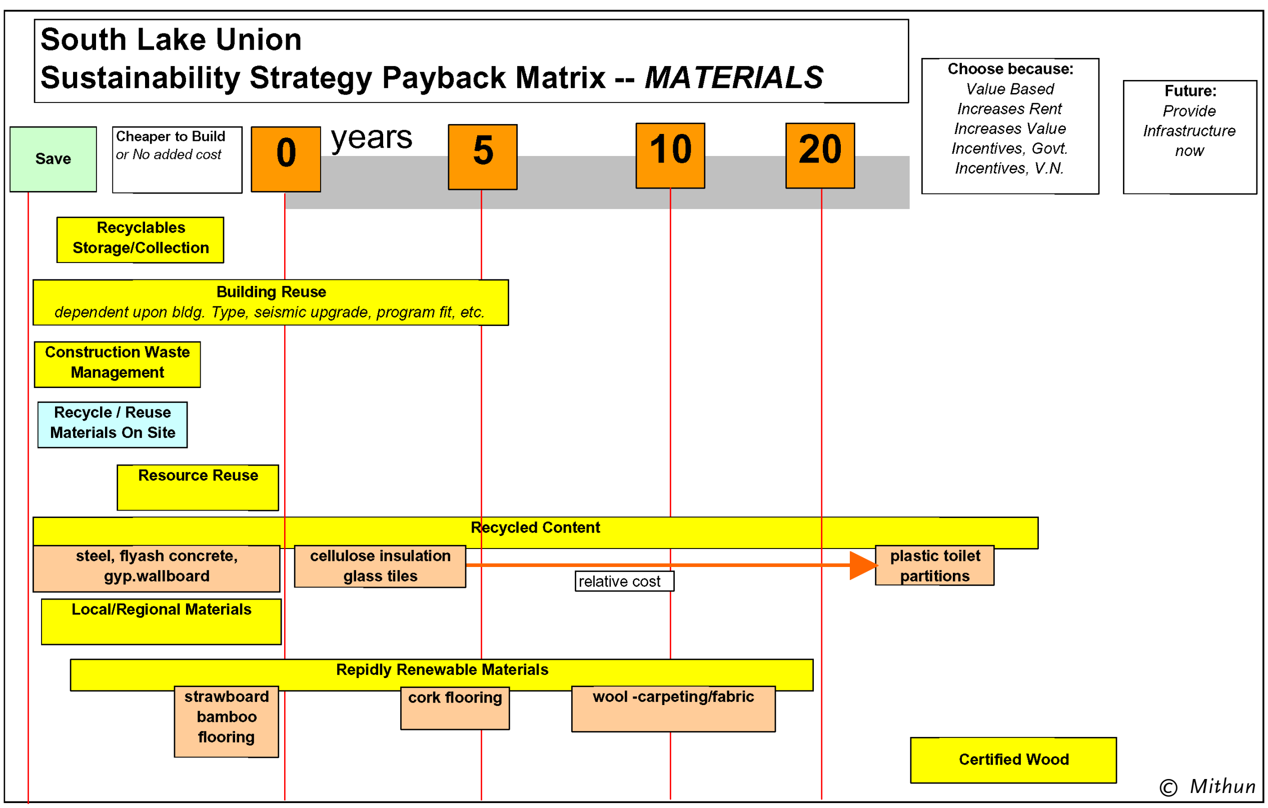
IslandWood used over 50% FSC wood

IslandWood
Art Grice / Mithun

materials & resources

payback summary

Payback Summary charts are a conceptual tool for mapping each sustainability strategy, and their respective payback periods. These strategies are roughly modeled for multi-story commercial buildings in Seattle in 2001. These need to be analysed for each project, as size, occupancy, and orientation can affect the numbers substantially. The strategies listed from top to bottom correspond with the strategies listed in the sections that follow. Across the top of the chart is a range of values and payback periods. Starting on the left is 'save' strategies that will reduce costs. Next is 'cheaper to build or no added costs' vs. standard market construction for a class A office building. Next are the years, indicated current ballpark numbers for payback. On the right is a category for items that are value based, desirable because of environmental or social benefits that cannot be justified financially or increase rent or value. This also includes strategies that would be economical because of government incentives or internal owner incentives. An owner can select the strategies that fit within their budget and value goals. The cost matrix for mateirls is showing relative costs, rather than payback for 'recycled content' and 'rapidly renewable materials.'



indoor environmental quality

introduction

OVERVIEW

Indoor environmental quality is one sustainability issue that most people have experienced or read about in their local newspaper. Asthma, sick building syndrome and mold issues are commonplace and involve millions of dollars in lawsuits and lost productivity. It is possible for the design and owner's team to dramatically affect the indoor environment through selection of materials, ventilation strategies and daylighting and view guidelines. IEQ extends into all phases of the process and continues into the operation and maintenance of the occupied building. Some of these issues are quite specific or dealt with under the Energy section, so they have not been developed into full sustainability strategies sections. We have included low-emitting materials as a full section.

Indoor Environmental Quality Strategies include:

CO2 monitoring: Tie ventilation to CO2 levels in the building. Review on a case by case basis, but especially recommended for schools or other areas with children.

***Ventilation effectiveness*:** Make sure that ventilation flow patterns reach all areas of a room. This involves computer modeling of ventilation and air distribution patterns. This is good design practice, but may be above standard fees to document properly.

Indoor chemical and pollutant source control: Congregate and ventilate potentially off-gassing areas such as copy rooms, chemical storage, etc.

Construction Indoor Air Quality management plan: Assure that contractors follow procedures for keeping ducts clean from construction debris. It is recommended to follow existing LEED™ guidelines.

Low-emitting materials: reduce the levels of toxic substances in building materials. (Refer to following section). This is an area where a constantly updated ratings system can help the owner and design practitioner stay abreast of changes in industrial hygiene and toxicology. It is recommended to follow LEED™ guidelines.

Daylight and views: This is discussed in the Energy section as a building strategy. Provide daylight and views to any space that is occupied for most of the day.

Indoor Environmental Quality is an important part of the sustainability package and can be marketed for the health benefits, productivity and quality of interior space. The new Mithun architectural offices on Pier 56 are a good example of daylight, natural ventilation, and low emitting materials creating a desirable and very rentable space within tight tenant improvement budgets. IEQ should be an essential part of project develpment in South Lake Union.

Mithun Office at Pier 56
Robert Pisano / Mithun

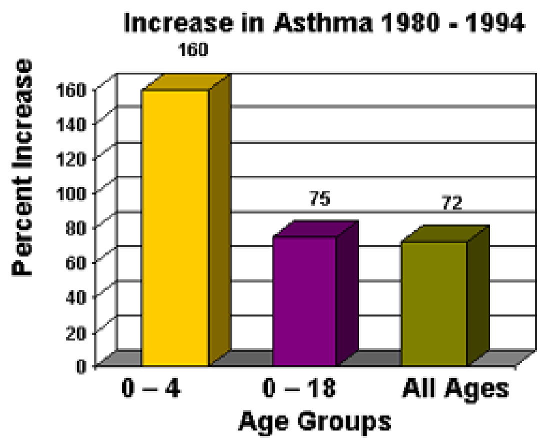
low-emitting materials

Goal:

Provide healthy places for the South Lake Union community to "live, work, play, and learn."

Strategies:

The World Health Organization reported that 30% of buildings have poor indoor air quality – known as sick building syndrome. According to the U.S. Environmental Protection Agency, poor indoor air quality costs Americans $1.5 billion in medical costs and tens of billions in absenteeism and lost productivity. Poor indoor air quality is recognized as the single greatest trigger of multiple chemical sensitivity, a biochemically induced handicap recognized in the Americans with Disability Act. In addition, environmental factors such as poor indoor air quality play a key role in the increase in asthma. The Pew Environmental Health Commission reports that asthma is the fastest growing chronic disease in America, and is the primary cause of missed school days in grades K–12.



Data from *Attack Asthma: Why America Needs a Public Health Defense System to battle Environmental Threats,* *Pew Environmental Health Commission*

1. **Develop Indoor Air Quality (IAQ) guidelines and require projects to adhere to the guidelines.**

Address all stages of the building's life cycle from design development to construction to operations and management to renovation.

IAQ is influenced by the choice of building materials, ventilation rates, construction practices, and cleaning procedures. The main sources of indoor air pollution are volatile organic compounds (VOC), formaldehyde, biological and microbial contaminants, tiny particles suspended in the air, combustion gases, and radon. LEED™ Version 3 expands criteria to improve air quality by addressing moisture control and microbial growth.

Consider the following recommendations:
Require architects to specify products that meet VOC emission standards, and clearly state VOC limits in all sections where adhesives, sealants, coatings, carpets, and composite wood products are addressed.

Require manufacturer submittals on recommended application rates and drying times. Prohibit the use of fabric protectants or spot cleaners, and require that dry materials are aired-out prior to delivery.

Require contractor submittals of emissions reports, verification of specified material use in accordance with manufacturers' instructions, minimization of construction dust and fumes, and sequencing application of wet materials before installation of dry materials. Protect building against moisture infiltration and microbial growth, and flush-out building prior to occupancy.

Asthma is the fastest growing chronic disease in America Environmental factors such as poor indoor air quality play a key role.

- *1.8 million emergency room visits, in 1999*
- *10 million missed school days*

Require mechanical contractor to protect ventilation system and components, provide filtration or replacement filter, and commission building to ensure optimum efficiency.

Develop an IAQ plan for building operations and maintenance. Require building manager to understand IAQ goals, maintain HVAC equipment according to O&M manual, and address issues of moisture infiltration and microbial growth. Implement a non-toxic cleaning program, prohibit the use of sprays and chemicals in building, apply integrated pest management principles to avoid chemical use, and apply design and construction guidelines during future renovations.

2. **Require specification of low-emitting materials.**

Work with project teams to research and identify low-emitting materials that meet durability, performance and environmental criteria. Develop a list of products over time and provide to subsequent projects as a resource.

3. **Develop a proactive moisture control program to minimize opportunities for microbial growth in buildings.**

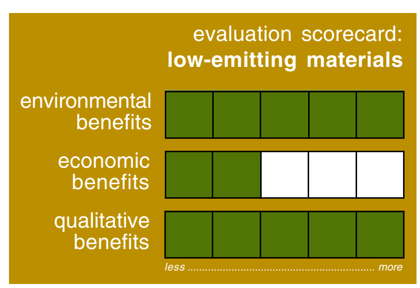
Molds and mildews are the most common sources of indoor air quality problems and can be prevented by controlling moisture and relative humidity, especially in the ventilation system.

4. **Develop a green housekeeping program to clean for health and appearance.**

Green housekeeping reduces particulate and biological contaminants, and relies on non-toxic cleaners. Negotiate a contract with a janitorial service provider to develop the program and provide services to buildings. Provide residential units with a green housekeeping kit.

Cost: According to Sellen Construction the overall cost for paints, coatings, adhesives and sealants constitute a small percentage of the total construction costs (less than 1%). An increase of 10% in materials cost for these products would add less than $5,000 to the overall construction costs of $10,000,000. The advantage that healthy buildings provide for enhancing tenant recruitment and retention and strengthening the brand can provide a significant return on investment for the expenditure. Lower health risks may result in lower insurance rates and reduced vacancies.

Status of Technology/Cost Benefits: Designing for good indoor air quality (IAQ) makes good business sense because it reduces the costs associated with absenteeism and lost productivity. Additionally, planning for IAQ reduces potential liability. Based on recent settlements of IAQ case law, the potential of legal exposure due to poor IAQ is significant.[1]



Designing for good indoor air quality takes a considerable commitment from design teams and building owners. Increased up-front planning is required to research impacts to indoor air quality and identify products that meet recommended standards. In addition, low-emitting and low-toxic products can cost more than conventional counterparts. When considering the overall construction costs, the incremental cost increase for targeted *healthy* products is a very small percentage of the overall budget. In addition, the return in investment may be substantial when considering tenant recruitment and retention, and enhanced brand.

MATERIAL TOXICITY

While we know what contributes to poor indoor air quality, many products and materials have not been tested for their affects on human health. In fact, the Center for Disease Control reports that of the nearly 65,000 synthetic chemicals in use today, few have been tested for their affects on human health or the environment.

As an example, LEED™ references standards for volatile organic compounds (VOCs) because VOCs evaporate readily at typical room temperatures and become airborne pollutants. Government rules about VOCs grew out of the clean air movement in Southern California, and address only those ingredients that evaporate at room temperature and react with nitrous oxides in the atmosphere to form smog. Existing VOC standards for paints, coatings and adhesives were not created to set a standard to protect human health, but to reduce smog formation.

Because many VOCs are highly toxic, companies have championed the new paint formulas as ones that help promote better health. Some paint manufacturers took out VOCs and substituted ammonia, acetone and other ingredients that aren't regulated because they play no role in forming smog. Yet some of these substitutes are highly toxic. Others have not been adequately studied from a health perspective.

LEED™ standards for low-emitting materials: The product categories singled out by LEED™ (paints, coatings, adhesives, sealants, composite wood products, and carpet systems) are recognized as significantly contributing to indoor air quality problems.

Paints, Coatings and Adhesives: The Green Seal standard for paints sets requirements for product performance, environmental performance based on VOC concentrations, chemical component limitations, toxicity in packaging, and labeling. In addition to VOC concentration limits in grams / liter (interior coatings: non-flat = 150 / flat = 50; Exterior coatings: Non-flat = 200 / Flat = 100), the chemicals prohibited are:

Aromatic Compounds: no more than 1.0% by weight
Halomethanes: methylene chloride
Chlorinated ethanes: 1,1,1-trichloroethane
Aromatic solvents: benzene, toluene (methylbenzene), ethylbenzene
Chlorinated ethylenes: vinyl chloride
Polynuclear aromatics: naphthalene
Chlorobenzenes: 1,2-dichlorobenzene
Phthalate esters: di (2-ethylhexyl) phthalate, butyl benzyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate
Miscellaneous semi-volatile organics: isophorone
Metals and their compounds: antimony, cadmium, hexavalent chromium, lead, and mercury
Preservatives (antifouling agents): formaldehyde
Ketones: methyl ethyl ketone, methyl isobutyl ketone
Miscellaneous volatile organics: acrolein, acrylonitrile

The first step towards providing healthy places is to incorporate the listed standards for paints, coatings, adhesives and sealants in architectural specifications as a baseline, and require that manufacturers submit documentation certifying that their products meet requirements.

While there is no single resource that lists all of the products that meet the standards, manufacturers have responded to the regulations and requirements by developing products that do. It is recommended that developers begin to generate a master list of products successfully used on projects and require project teams to summarize any performance and cost considerations.

The World Resource Institute designed their new office building to provide a healthy environment for the employees. Walls, ceilings and metal surfaces were coated with products supplied by ICI Paints North America because those paints are *Zero VOC*. Milk paint made by the Old Fashioned Milk Paint Company was used in the lunchroom, and is manufactured with no toxic ingredients. Zero VOC clear wood finishes were used made from linseed oil and beeswax, manufactured by Tried and True.

Carpet: The Carpet and Rug Institute (CRI) provides information about the Green Label Indoor Air Quality Test Program on its website www.carpet-rug.com. CRI lists the products and materials that meet the test standards for VOC emissions and toxicity. There are 32 carpet manufacturers listed with products that meet the standards, 54 carpet adhesives, and 26 carpet cushion products. Paladino and Company estimates as much as a $1.60/sf cost premium for CRI Green Label carpets.[2] A project that requires 100,000 sf of carpet might experience an increase of as much as $160,000.

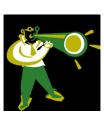
Composite Wood and Agrifiber Products: Formaldehyde is classified as a probable human carcinogen by the EPA, and when airborne acts as an irritant to the respiratory system. Formaldehyde-based resins are commonly used in paints and coatings, plywood, paneling, fiberboard, and particleboard. Alternatives to urea-formaldehyde include phenol-formaldehyde or isocyanate (MDI) resins:

Anthony Forest Products	Glulam Beams, I-Joists
Sierra Pine	Medite II, Medex, Medex FR
Primeboard / Isobord / Natural Fibre Boards	Straw board products
Panel Source International	Agri-board
Winter Panel	Structural Insulated Panel
Advanced Wood Resources	Composite Plywood
Rodman Industries	Particle Board
Trus Joist MacMillian	Glulam products / Laminated Strand Lumber
Louisiana Pacific	OSB
Ingenuity Wood	Stress Panel System

While many of these products are *conventional* products sold at competitive pricing, some come at a premium price. For example, in 2001, comparing the cost for Medite II against conventional medium density fiberboard:

	Medite II	*MDF*
4'x 8' Sheet	$ 23.46	$ 17.70
Unit Cost (35 Sheets)	$ 821.10	$ 619.50

The cost differential for 1,120 square feet of product is $ 201.60.



Marketing Amenity: Marketing healthy places can increase the economic value of building projects, and strengthen the brand.

Recommendation: Require projects to design for human health and productivity by careful selection of products. Projects can attain this LEED™ criteria by selecting low-emitting materials and employing a source control strategy for good indoor air quality.

Repeatability – HIGH: There are numerous examples of businesses and buildings that have taken the time to research products and materials, and selected products that were the healthiest choice for the building and its occupants.

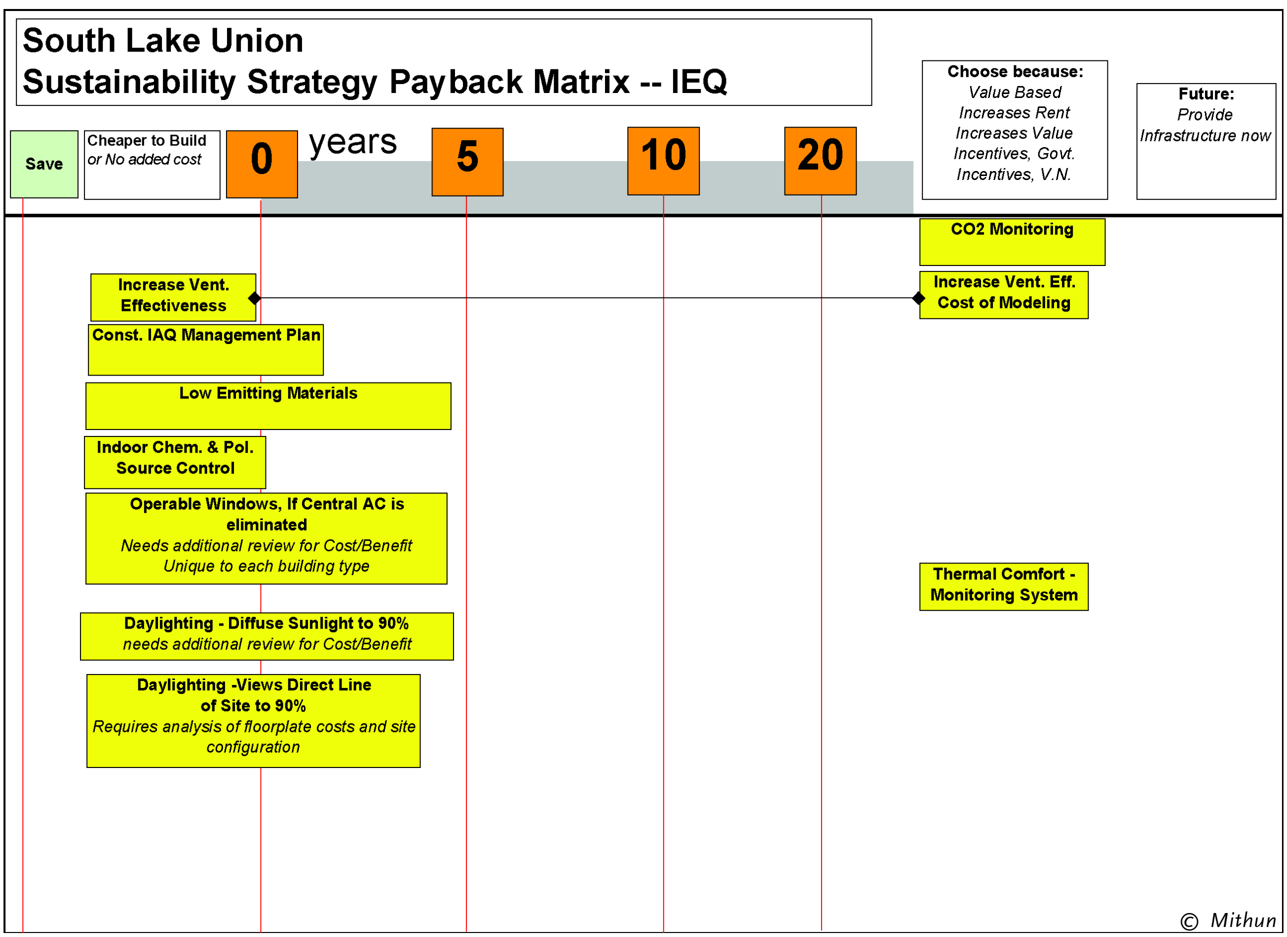
FOOTNOTES:

1 Ross Spiegel and Dru Meadows, *Green Building Materials: A Guide to Product Selection and Specification*, (John Wiley & Sons, Inc.1999), pg. 10–12.
2 Tom Paladino, Cost Benefit Analysis of a LEED™ Model Building, Mainstreaming Green: National AIA Conference, 1999.

indoor environmental quality

payback summary

Payback Summary charts are a conceptual tool for mapping each sustainability strategy, and their respective payback periods. These strategies are roughly modeled for multi-story commercial buildings in Seattle in 2001. These need to be analysed for each project, as size, occupancy, and orientation can affect the numbers substantially. The strategies listed from top to bottom correspond with the strategies listed in the sections that follow. Across the top of the chart is a range of values and payback periods. Starting on the left is 'save' strategies that will reduce costs. Next is 'cheaper to build or no added costs' vs. standard market construction for a class A office building. Next are the years, indicated current ballpark numbers for payback. On the right is a category for items that are value based, desirable because of environmental or social benefits that cannot be justified financially or increase rent or value. This also includes strategies that would be economical because of government incentives or internal owner incentives. An owner can select the strategies that fit within their budget and value goals. IEQ has items where the 'payback' is difficult to quantify, especially daylighting and low emitting mateials.



future R & D options

Listed below are additional areas for study to optimize sustainability options.

1. **Prepare a detailed incentives summary and negotiation** for a group of buildings. Detailed analysis and discussion with city agencies to facilitate new and innovative incentive strategies, esp. wastewater, storm water, power utility district (Cogen, PV, fuel cells etc.), right of way plantings and recycling. Carbon neutral power generation, and carbon offsetting plantings could help support the City of Seattle's current power strategy. Some of these incentives would be:

    - Review incentives/strategies for localized generation, CoGen, PV
    - Initiate discussions on future rate structures and rate/cost sharing for central cogeneration.
    - Provide electric car charging stations or dedicated hybrid vehicle parking.
    - Incorporate green roofs to mitigate stormwater. Improve efficiency of envelope, light fixtures, equipment to concerve energy.
    - Meet with city to review height limit incentives for narrowing floor plates to enable space natural ventilation and daylight, resulting in lower energy consumption.

2. **Cost Study:** Require a cost study on each project for sustainable design options. Review first cost, operating cost, and value modifications. As part of the schematic design process and initial project cost model, use a cost estimator or contractor knowledgeable about sustainable design elements. Include cost reductions for integrated design strategies, i.e. daylighting reduces daytime lighting requirements, which reduces daytime cooling loads, which can reduce sizing of HVAC equipment. Determine cost of meeting LEED™ Silver and LEED™ Certified levels.

3. **Portfolio Master Energy and Infrastructure plan:** As proposed development land use patterns are being designed, research options and develop an integration of sustainability practices and urban design. Design for collections of buildings to cluster uses based on energy, water, space or transportation sharing opportunities.

    Re-visit the centralized heating/cooling options and power co- generation. Optimizing energy performance for the multi-block level may depend on block scale use adjacencies and concentrations of heating or cooling loads.

4. **Urban Ecology:** Research and document potential for power sharing between adjacent users, i.e. glass furnace next to a user that needs to heat. Take inventory and analyze the collective benefits available from transferring energy between recycling water, combining waste streams for treatment, shared parking and transportation.

5. **Detailed block analysis of optimum orientation and floor plate size:** Perform energy modeling for optimizing a proposed building for solar gain, cooling, daylighting, views, and

air distribution. Check against marketable plans for comparable office and residential configurations.

6. **Habitat plan**: Develop a habitat plan for South Lake Union. Review existing habitat inventory and identify the potential corridors, critical mass and specific needs that would encourage species diversification. Provide a menu of elements that would support this plan, and the anticipated growth in species population.

7. **Environmental Benefits of Trees:** Analyze environmental benefits of trees and plantings using CITY Green software. Model and evaluate carbon offset impact, stormwater runoff benefits, air quality and habitat development potential within the neighborhood. Produce a report showing quantitative impacts of alternative planting scenarios.

8. **Urban Design Plan/Sustainability Plan Integration:** Mesh specific use plans and urban design criteria with sustainable methods. Some coordination needs to occur to reach sustainability goals.

9. **Design Terry Avenue Streetscape as a Model Sustainable Street:** work with city agencies to review incentives for permeable surfaces, structural soil, etc.

10. **Toxic Materials:** Review current scientific literature and develop a list of available building material alternates for PVC, formaldehyde and other toxic materials. Alternates should be reviewed for cost, relative toxicity and availability in Seattle.

11. **Automated Building System and Multi-block Integration:** Develop protocols or select vendor for multi-block energy management.

12. **Travel to Case Study Projects:** Developers could identify key projects from around the country and the world that have implemented some of the strategies outlined in this report, and interview the owners, design teams, and see the systems in place.

13. **Develop the Subcontractor and Supplier Base:** Assign a point person or consultant to develop subcontractor and supply relationships, especially for more specialized items such as vegetated roofs, certified wood, renewable materials, etc. Produce a list of sources and prices that can be achieved through long term supplier relationships that respond to a market driven development schedule.

appendix a: economics

SAMPLE BUILDING ECONOMIC ANALYSES

A sample office building example (see below) will be used as the basis for each analysis (hereinafter, referred to as the baseline analysis). A cluster consists of four sample buildings while a neighborhood consists of forty sample buildings.

The perspective for all analyses is that of a developer that is constructing a building for sale to a long term buyer five years after completion. The analyses would of course be very different for an owner occupied building. General inflation is assumed to be 2% for all analyses. Separate rates for inflation are used for electricity and water as detailed below.

Sample Office Building

Retail	15,000	Building cost	$45,000,000
Office	310,000	Design & Development Cost	$15,000,000
area total	325,000	Total	$60,000,000
		Developer Equity	($9,000,000)
square feet/floor	43,200	Mortgage	$51,000,000
		Property Value	$65,000,000

Rents:	Year 1	Year 2	Year 3	Year 4	Year 5
Office	$10,524,500	$10,629,745	$10,736,042	$10,843,403	$10,951,837
Retail	$300,000	$300,000	$300,000	$300,000	$300,000
Total	$10,824,500	$10,929,745	$11,036,042	$11,143,403	$11,251,837
Operating Cost	($3,940,000)	($3,985,000)	($4,040,000)	($4,100,000)	($4,165,000)
Net Operating Income	$6,884,500	$6,944,745	$6,996,042	$7,043,403	$7,086,837
Cap Rate	10.6%				
Debt Service (Financing)	($4,845,000)	($4,845,000)	($4,845,000)	($4,845,000)	($4,845,000)
Depreciation	$1,666,667	$1,666,667	$1,666,667	$1,666,667	$1,666,667
Before Tax Cash Flow	$3,706,167	$3,766,412	$3,817,709	$3,865,070	$3,908,504
				Sale:	$70,000,000
				Selling Expense:	($2,100,000)
				Mortgage:	($51,000,000)
				Before Tax Equity Reversion	$16,900,000
Discounted Cash Flow	$3,351,221	$3,079,527	$2,822,521	$2,583,864	$12,578,572
Discount Factor	1.11	1.22	1.35	1.50	1.65
Total Value	$24,415,705	(sum of discounted cash flows)			
Less Equity Investment	($9,000,000)				
Net Value	$15,415,705				

Low Emission Materials

The addition of low-emission materials to the buildings within the project provides many benefits. The cost increase is offset by slightly higher rent, reduced cost of capital from the reduced environmental risk and the lower cost of insurance enabled by the reduced emissions.

Example 1 - "low emission materials"

Incremental building cost	$200,000	(paints, adhesives, carpet, wood & agrifiber)
Incremental design cost	$0	
Government incentives	$0	
Operating Changes:		
increased office rent	0.75%	(more productive environment)
decreased mortgage interest	-0.10%	(reduced environmental risk)
reduced insurance	($25,000)	(reduced environmental risk)
operation & maintenance	$0	
total change	($25,000)	

Office Building Space

Retail	15,000	Building cost	$45,200,000
Office	310,000	Government incentives	$0
area total	325,000	Design & Development Cost	$15,000,000
		Total	$60,200,000
		Developer Equity	($9,200,000)
square feet/floor	43,200	Mortgage	$51,000,000
		Property Value	$65,981,290

Rents:	Year 1	Year 2	Year 3	Year 4	Year 5
Office	$10,603,434	$10,709,468	$10,816,563	$10,924,728	$11,033,976
Retail	$300,000	$300,000	$300,000	$300,000	$300,000
Total	$10,903,434	$11,009,468	$11,116,563	$11,224,728	$11,333,976
Operating Cost	($3,915,000)	($3,960,000)	($4,015,000)	($4,075,000)	($4,140,000)
Net Operating Income	$6,988,434	$7,049,468	$7,101,563	$7,149,728	$7,193,976
Cap Rate	10.6%				
Debt Service (Financing)	($4,794,000)	($4,794,000)	($4,794,000)	($4,794,000)	($4,794,000)
Depreciation	$1,666,667	$1,666,667	$1,666,667	$1,666,667	$1,666,667
Before Tax Cash Flow	$3,861,100	$3,922,135	$3,974,229	$4,022,395	$4,066,642
				Sale:	$70,000,000
				Selling Expense:	($2,100,000)
				Mortgage:	($51,000,000)
				Before Tax Equity Reversion	$16,900,000
Discounted Cash Flow	$3,491,316	$3,206,850	$2,938,240	$2,689,039	$12,674,166
Discount Factor	1.11	1.22	1.35	1.50	1.65

Original Net Value	$15,415,705	
New Value	$24,999,612	(sum of discounted cash flows)
Less Equity Investment	($9,200,000)	
New Net Value	$15,799,612	
Change in Value	$383,907	

Energy Efficient Lighting

The analysis of energy savings from the addition of energy efficient lighting highlights the problem caused by the ownership split. The investment isn't justified from the owners perspective; however, it is justified from the overall perspective. The numbers would improve with incentives from local utilities for better lamping and controls.

Example 2 - "energy efficient lighting"		
Incremental building cost	$180,000	(T8 lamps, electronic ballasts)
Incremental design cost	$0	
Government incentives	$0	
Operating Changes:		
reduced electricity common area	($7,000)	
operation & maintenance	$0	
total change	($7,000)	

Office Building Space			
Retail	15,000	Building cost	$45,180,000
Office	310,000	Government incentives	$0
area total	325,000	Design & Development Cost	$15,000,000
		Total	$60,180,000
		Developer Equity	($9,180,000)
square feet/floor	43,200	Mortgage	$51,000,000
		Property Value	$65,066,090

Rents:	Year 1	Year 2	Year 3	Year 4	Year 5
Office	$10,524,500	$10,629,745	$10,736,042	$10,843,403	$10,951,837
Retail	$300,000	$300,000	$300,000	$300,000	$300,000
Total	$10,824,500	$10,929,745	$11,036,042	$11,143,403	$11,251,837
Operating Cost	($3,933,000)	($3,978,000)	($4,033,000)	($4,093,000)	($4,158,000)
Net Operating Income	$6,891,500	$6,951,745	$7,003,042	$7,050,403	$7,093,837
Cap Rate	10.6%				
Debt Service (Financing)	($4,845,000)	($4,845,000)	($4,845,000)	($4,845,000)	($4,845,000)
Depreciation	$1,666,667	$1,666,667	$1,666,667	$1,666,667	$1,666,667
Before Tax Cash Flow	$3,713,167	$3,773,412	$3,824,709	$3,872,070	$3,915,504
				Sale:	$70,000,000
				Selling Expense:	($2,100,000)
				Mortgage:	($51,000,000)
				Before Tax Equity Reversion	$16,900,000
Discounted Cash Flow	$3,357,550	$3,085,250	$2,827,696	$2,588,544	$12,582,804
Discount Factor	1.11	1.22	1.35	1.50	1.65
Original Net Value	$15,415,705				
New Value	$24,441,844	(sum of discounted cash flows)			
Less Equity Investment	($9,180,000)				
New Net Value	$15,261,844				
Change in Value	($153,861)				
Other Operating Changes:					
Inflation Rate	5%	for electricity			
Tenant Energy Savings	$61,328	$64,394	$67,614	$70,995	$74,545
Discount Factor	1.11	1.22	1.35	1.50	1.65
Discounted Cash Flow	$55,455	$52,651	$49,989	$47,461	$45,062
Value of Tenant Savings	$250,617				
Total Value Change	$96,756				

Wastewater Treatment

On-site treatment of wastewater would reduce wastewater production as well as provide a high level of treatment. The treatment of wastewater requires the collection of the wastewater and the distribution of the treated water. The total cost of providing for the collection, treatment and distribution of wastewater for a four building cluster is estimated at $3.83 Million as detailed in the example following. Government incentives for reducing water usage pay for half of this increased cost. The cost increase is further offset by the reduced need for water that is enabled by the re-use of the treated water.

The results of the analysis show that if the cost of water increases by an average of more than 1.5% per year, then maintaining the flexibility to add a treatment facility at a later date by including only the dual piping and infrastructure is justified on an economic basis. At the 5% rate of inflation shown, adding the flexibility to provide on-site wastewater treatment adds over $2,400,000 of value to the cluster. Part of the increase in value is derived from the lower cost of capital. An alternate analysis would be to review less expensive mechanical/chemical systems, but they would have reduced biological action.

It is worth noting that some of the methods outlined in the economics section (as well as software and systems for implementing these methods) are covered by one or more ValueMiner patents. It is also worth mentioning that the justification shown above was based purely on cost reductions. Because the treatment of wastewater occurs largely in tanks filled with attractive plants, the addition of a wastewater treatment facility could very easily be turned into an amenity which would increase rents and the value of adding flexibility to the cluster even more than the amount shown.

Example 3b - option to treat wastewater at cluster level

Incremental building cost	$870,000	(dual piping, infrastructure)
Incremental design cost	$100,000	
Government incentives	($435,000)	
Operating Changes (after full installation)		
reduced utilities	($239,440)	
operation & maintenance	$85,000	(primarily electricity)
net change	($154,440)	

Office Cluster Space

Retail	60,000	Building cost	$180,870,000
Office	1,240,000	Government incentives	($435,000)
area total	1,300,000	Design & Development Cost	$60,100,000
		Total	$240,535,000
		Developer Equity	($36,535,000)
square feet/floor	43,200	Mortgage	$204,000,000
		Property Value	$260,000,000

Rents:	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Office	$42,098,000	$42,518,980	$42,944,170	$43,373,611	$43,807,348
Retail	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000
Total	$43,298,000	$43,718,980	$44,144,170	$44,573,611	$45,007,348
Operating Cost	($15,760,000)	($15,940,000)	($16,160,000)	($16,400,000)	($16,660,000)
Net Operating Income	$27,538,000	$27,778,980	$27,984,170	$28,173,611	$28,347,348
Cap Rate	10.6%				
Debt Service (Financing)	($19,278,000)	($19,278,000)	($19,278,000)	($19,278,000)	($19,278,000)
Depreciation	$6,666,667	$6,666,667	$6,666,667	$6,666,667	$6,666,667
Before Tax Cash Flow	$14,926,667	$15,167,647	$15,372,836	$15,562,278	$15,736,014
				Sale:	$280,000,000
				Selling Expense:	($8,400,000)
				Mortgage:	($204,000,000)
				Before Tax Equity Reversion	$67,600,000
Discounted Cash Flow	$13,497,115	$12,401,505	$11,365,494	$10,403,646	$50,375,947
Discount Factor	1.11	1.22	1.35	1.50	1.65

Original Net Value	$61,662,820	
New Value	$98,043,707	(sum of discounted cash flows)
Less Equity Investment	($36,535,000)	
New Net Value	$61,508,707	
Change in Value	($154,113)	
Value of Flexibility	$2,494,601	(see calculation below)
Net Change in Value	$2,340,489	

Value of the flexibility to add living machine to long term owner

Inflation rate	10.00%	for water savings
	5.00%	for living machine operaing expenses
Annual utility savings	$385,621	original savings with 5 years of inflation
Annual operating expense increase	($108,484)	original savings with 5 years of inflation
Annual operating income change	$277,137	
Perpetuity value of increased income	$4,956,357	(1/(cap rate - growth rate))
Investment	($829,583)	original investment with 5 years of inflation
Value Difference (+/(-))	$4,126,774	
5 year discount factor	1.65	
Value of Flexibility	$2,494,601	

Note: to facilitate explanation of concept a real option calculation was not used

Vegetative roof example

Vegetative roofs use a thin layer of soil over a heavy water proofing membrane. The roof is planted with alpine type plants and grasses that can tolerate the extremes in temperature and moisture in the roof environment. Adding the heavier, stronger, vegetative roof costs between $8 and $10 per square foot more than traditional construction. Benefits of these roofs include increased storm water retention, improved water quality and improved air quality. Their green appearance may make their addition an important amenity on their own or they may be an important part of an overall project branding strategy.

The conventional economic analysis shows that vegetative roofs don't pay for themselves. Justifying their addition on an economic basis would require an increase in expected revenues or a decrease in expected costs by $.40/sq.ft./year to break even on a purely economic basis. The increase in expected revenue could bve the result of:

a. building green roofs into a branding campaign
b. an incentive from the city for carbon offset value
c. increased city incentives for stormwater reduction

On taller buildings, the incremental cost will be less due to the reduced sq. footage of rooftop relative to the entire project.

Example 4 - vegetative roof	
Incremental cost - $8/sq. ft.	$345,600
Smaller retention tank	($60,000)
Net investment	$285,600
Annual Benefits:	
reduced storm water charges	($1,000)

Office Building Space			
Retail	15,000	Building cost	$45,285,600
Office	310,000	Design & Development Cost	$15,000,000
area total	325,000	Total	$60,285,600
		Developer Equity	($9,285,600)
square feet/floor	43,200	Mortgage	$51,000,000
		Property Value	$65,009,441

Rents:	Year 1	Year 2	Year 3	Year 4	Year 5
Office	$10,524,500	$10,629,745	$10,736,042	$10,843,403	$10,951,837
Retail	$300,000	$300,000	$300,000	$300,000	$300,000
Total	$10,824,500	$10,929,745	$11,036,042	$11,143,403	$11,251,837
Operating Cost	($3,939,000)	($3,984,000)	($4,039,000)	($4,099,000)	($4,164,000)
Net Operating Income	$6,885,500	$6,945,745	$6,997,042	$7,044,403	$7,087,837
Cap Rate	10.6%				
Debt Service (Financing)	($4,845,000)	($4,845,000)	($4,845,000)	($4,845,000)	($4,845,000)
Depreciation	$1,666,667	$1,666,667	$1,666,667	$1,666,667	$1,666,667
Before Tax Cash Flow	$3,707,167	$3,767,412	$3,818,709	$3,866,070	$3,909,504
				Sale:	$70,000,000
				Selling Expense:	($2,100,000)
				Mortgage:	($51,000,000)
				Before Tax Equity Reversion	$16,900,000
Discounted Cash Flow	$3,352,125	$3,080,344	$2,823,260	$2,584,533	$12,579,177
Discount Factor	1.11	1.22	1.35	1.50	1.65
Original Net Value	$15,415,705				
New Value	$24,419,439	(sum of discounted cash flows)			
Less Equity Investment	($9,285,600)				
New Net Value	$15,133,839				
Change in Value	($281,866)				

Summary

The examples shown demonstrate that the economic viability of the sustainable strategies recommended in the White Paper fall into three categories:

1. strategies that are economically viable for developers;
2. strategies where the flexibility to implement at a later date is economically viable (worth investing in) – this is particularly true for strategies where technology development, inflation or a different ownership time frame are expected to change the economic prospects of a strategy; and
3. strategies that are not economically viable for developers.

As described above, the economic analysis of a sustainable development project requires consideration of the impact of sustainable strategies on the 12 elements of the financial return equation from the proper perspective (in our case: the building, block, cluster or project level). The "ownership" of the benefits from the sustainability strategy also need to be considered.

sustainable design resources

internet

CITY OF SEATTLE SITES

City of Seattle, Sustainable Building Program
http://www.cityofseattle.net/sustainablebuilding/

Seattle's DCLU website
http://www.cityofseattle.net/dclu/sustainability/

Seattle Public Utilities
http://www.cityofseattle.net/util/RESCONS/susbuild/default.htm

Seattle City Light
http://www.cityofseattle.net/light/conserve/sustainability/

REGIONAL SITES

King County Construction Recycling Directory
http://dnr.metrokc.gov/swd/bizprog/sus_build/CDLguide.pdf

Cascadia Chapter of the US Green Building Council
http://www.usgbc.org/Chapters/Cascadia/

Built Green: Joint venture of Master Builders, King and Snohomish County and Fannie Mae
http://www.builtgreen.net/

Better Bricks, a sustainability resource for commercial buildings funded by Northwest Utilities
http://www.betterbricks.com/default.aspx

Northwest Eco Building Guild
http://www.ecobuilding.org/

Western Sun, Northwest cooperative purchasing Renewable Energy equipment and links to PV information
http://www.westernsun.org

CITY OF PORTLAND

Portland office of sustainable development
http://www.sustainableportland.org/
Interactive site - G-Rated
http://www.green-rated.org/g_rated/grated.html

GENERAL

The web site from the publisher of Environmental Building News. *highly recommended.*
http://www.buildinggreen.com/

Green Building News
http://www.oikos.com/

National Canadian site with multiple links
http://www.advancedbuildings.org/index.htm

COMMERCIAL SITES FOR GREEN PRODUCTS

The Environmental Home Center, located in Seattle
http://www.environmentalhomecenter.com/

The Real Goods Catalogue, located in Ukiah California
http://www.realgoods.com/

SUSTAINABLE SITES:

British Astronomical Association – Campaign for Dark Skies
http://www.dark-skies.freeserve.co.uk

University of Oregon's Center for Housing Innovation (CHI)
http://www.uoregon.edu

Sustainable Strategies
Proposed Cascade Neighborhood Council
Design Guidelines October 1997
http://www.scn.org/neighbors/cascade

Western Center for Urban Forest Research and Education
University of California
c/o Department of Environmental Horticulture
Davis, CA 95616

Biomimicry: Innovation Inspired by Nature
Janine M. Benyus, May 1998

http://www.sustainable.doe.gov/

http://www.ecobuilding.org

http://www.epa.gov

http://www.americanforests.org/

"Effects of Tree Cover on Parking Lot Microclimate and Vehicle Emissions"
Journal of Arboriculture, May 1999

http://www.mtsgreenway.org/

Center for Watershed Protection
410-461-8324
http://www.cwp.org

City of Portland
Bureau of Environmental Services
1211 SW 5th, Room 800
Portland, OR 97204
503-823-7267
toml@bes.ci.portland.or.us

Pacific Northwest Ecosystem Research Consortium
http://www.orst.edu/dept/pnw-erc

Heat Island Group
http://eande.lbl.gov/HeatIsland/

http://www.advancedbuildings.org/index.htm

Roof Gardens: History, Design and Construction
Theodore Osmundson, FASLA 1999

MATERIALS

Recycled-Content Product Database – Integrated Waste Management Board
http://www.ciwmb.ca.gov/RCP/

GREEN BUILDING PRODUCTS:

GreenSeal
http://www.greenseal.org/

GreenSpec – the Environmental Building News Product Directory
http://www.greenspec.com/

Jade Mountain
http://www.jademountain.com/

Oregon Residential Energy Tax Credit Program
http://www.energy.state.or.us/res/tax/taxcdt.htm

RATING SYSTEMS

Leadership in Environmental and Energy Design (LEED™)
http://www.usgbc.org

Minnesota Sustainable Design Guidelines
www.sustainabledesignguide.umn.edu/MSDG/pdf.html

GB Tool
http://greenbuilding.ca/gbc2k/gbc-start.htm

Building Research Establishment Environmental Assessment Method — BREEAM Canada
www.breeamcanada.ca

TOP TEN SUSTAINABLE DESIGN INTERNET RESOURCES

from Mendler, Sandra F, and Odell, William, The HOK Guidebook to Sustainable Design

Center of Excellence for Sustainable Development
http://www.sustainable.doe.gov

Energy Efficiency and Renewable Energy Network (EREN) – Department of Energy
http://www.eren.doe.gov/

United States Green Building Council
http://www.usgbc.org

Center for Renewable Energy and Sustainable Technology
http://solstice.crest.org/index.shtml

Environmental Protection Agency (EPA)
http://www.epa.gov/

Lawrence Berkeley National Laboratory
http://eande.lbl.gov

Environmental Building News
http://edn@www.buildinggreen.org/

Public Technology, Inc. (PTI)
http://pti.nw.dc.us/

American Planning Association Smart Growth
http://www.planning.org/plnginfo/growsmar/gsindex.html

about the urban environmental institute

Ed Geiger, President

The UEI's purpose is to promote environmental health through catalyzing integrated scientific research, education and outreach, services, and products. Its mission is:

Fueling Solutions to Global Environmental Challenges

The initial goals are to:

- Develop and operate a model sustainable community
- Create a venue to support collaborative, cutting-edge environmental science
- Attract economic investment to stimulate environmental solutions
- Showcase solutions to environmental challenges
- Integrate sustainable practices in everyday living

Seattle has an international reputation for being *green*. The UEI seeks to leverage this reputation and build a Seattle base for environmental sciences, technologies, education, services, and products. Seattle can become a magnet for advanced environmental work similar to what Boeing, Microsoft and the Fred Hutchinson Institute have done for Seattle's technology industries and bio-medical research.

The UEI proposes building a Seattle Sustainability Resource Center in South Lake Union. This information and education center will be the seed for an alliance of related businesses, nonprofits, and governmental agencies that will fill an entire city block: the Environmental Campus. Organizations that want to be on the cutting edge of environmental science and technology will be drawn to locate in the UEI in order to draw on the enormous breadth and depth of environmental knowledge present. Entrepreneurs that develop a new environmental technology will see the UEI as the best vehicle to help launch its idea by showcasing it within the UEI complex.

The atmosphere will be designed to encourage formal and informal interaction between companies, non-profits, governmental organizations, and the public. To help launch the Environmental Campus, the UEI is proposing an international conference of the world's top environmental science researchers. This will take place in 2003 or 2004 and will emphasize a wide range of environmental science research and technology developments. Environmental challenges will be explored by interdisciplinary groups at the conference, resulting in a list of the most important directions for future research and development.

A critical feature necessary to help create change in our society is education. The UEI will integrate education of K–12 students, undergraduate and graduate students, the public, businesses, and governmental agencies through interactive programs and demonstration.

Finally, within this city complex, the UEI will model sustainable behavior and demonstrate how to make such a community financially gratifying, intellectually stimulating and socially enriching. There are many supporters and participants in the UEI. The founding Board Members are listed below.

UEI Board Members:

Don Anderson (Treasurer)
Clothier & Head, PS (CPAs), Partner
Roger Anderson
Battelle Seattle Research Center, Manager – Environmental Policy
Dan Ballbach
CEO at large
Dierdre Devlin
Getty Images, Consulting Director of Marketing
Ed Geiger (President)
Frontier Geosciences, President; SLUFAN, President; Cascade Neighborhood Council, Vice-President
Rick Pleus (Secretary)
InterTox, President & CEO
David Rousseau
Archemy Consulting, Ltd., Principal

www.UrbanEnvironmentalInstitute.org