Building for Sustainability

An integrated approach to the built environment, sustainable design balances the social, economic and environmental aspects of our lives and enhances the well-being of our communities.

Report: Six Scenarios for The David and Lucile Packard Foundation Los Altos Project

October 2002

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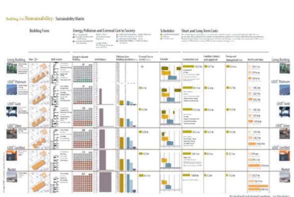
Sketch of downtown Los Altos, California

Introduction

As an initial step in the David and Lucile Packard Foundation's Los Altos Project, a Goalsetting Charrette was held in late February 2001. The design team was charged by the Foundation's Facilities Steering Committee to develop a decision-making method or tool that would clearly explain the aesthetic, economic, schedule and environmental impacts implied by the sustainability goals for their proposed office building. In their *Facilities Master Plan 2000*, the Foundation had already decided to use the U.S. Green Building Council's LEED™ rating system as the measuring device for its sustainability goals. In collaboration with the Committee, the design team responded in the form of a report and summary matrix. The *Sustainability Report and Matrix* hold the Market building scenario and the Living Building scenario at opposite ends of a spectrum with the four LEED™ levels spread between them.

A conceptual building model for each scenario was designed and described by the team in the form of building footprints, wall sections and outline specifications. Construction costs were estimated based on these assumptions, as were impacts to research, design and construction schedules. This base information, as well as other design assumptions, is documented in the *Sustainability Report*. From the data in the *Report*, it was possible to estimate amounts of energy required to run the facility under each scenario, as well as consider how much energy could be generated on-site by the systems and technologies incorporated at each level. Based on information from Jonathon Levy's Harvard dissertation in May 1999, "Environmental Health Effects of Energy Use: A Damage Function Approach", projections were made for the external costs to society for each scenario, taking into account pollution generated by each building. This in turn implies external costs to society that are not usually "charged" to a project, such as health care and environmental cleanup. Finally, long-term costs were forecast using 30-year, 60-year and 100-year cost models. These numbers were calculated as net present values and consider a range of factors such as building durability, value of money over time, equipment and/or building replacement, increasing energy costs, etc.



Sustainability Matrix

The *Sustainability Report* illustrates and outlines the base assumptions and calculations generated for each scenario and each set of data. The *Sustainability Matrix* summarizes the results of these explorations. Two versions of the cost numbers were created, each based on a 90,000 square foot office building for 300 employees with a three-level below-grade parking garage in the downtown area of Los Altos, California. For the Packard Foundation's internal use, a first set of estimated costs was documented for the actual building requirements listed above. A second set of generic cost numbers was based on this first set, but with the Market building construction costs set at $10 million and all other numbers factored proportionally, including construction costs, FF+E, and design and management fees. This second set of numbers allows outside readers to understand the cost trends more easily as well as compare with other projects of varying scale.

The Foundation has made these "generic" numbers available for public review. In an effort to help readers unfamiliar with the work, the following summary of the two documents is provided in an attempt to help frame the work.

Executive Summary

Sustainability Report

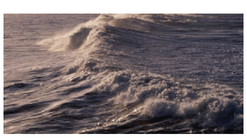
The *Sustainability Report* documents all assumptions and calculations made for each scenario mentioned above. It is the information contained in this report that is summarized in the *Sustainability Matrix*. Key components of the *Sustainability Report* include:

- Definition of Terms - For the purposes of this report, a consensus on terminology is provided.
- Sustainability Scenarios - A one-page summary of key data for each of the six building scenarios is provided.
- Comparison Summaries - A side-by-side analysis is provided to illustrate key assumptions made by the design team. These include side-by-side Site Plans, Cost Impacts, Schedule Impacts, Wall Sections, Building Components and Energy Model Performance Criteria, Building and Site Attributes based on the LEED™ Rating System (points assigned to each level), Energy Model Backup information and External Costs to Society.
- Appendix - The appendix contains information for each building scenario representing the various levels of sustainability. These include: (1) Site Plan, (2) Project Narrative (a conceptual outline specification), (3) Wall Section with list of key building components, and (4) Detail Cost Summary.
- Technology - Four technologies that may be considered for the various levels of sustainability are summarized in the final pages of the report. They include: Raised Access Flooring, Photovoltaics, Ecological Wastewater Treatment Systems and Fuel Cells.

Sustainability Matrix

As stated earlier, the matrix format was chosen by the design team as a way to summarize and compare the information detailed in the *Sustainability Report* in as clear a format as possible. While the *Sustainability Matrix* allows a quick comparison between sustainability levels for various parameters, it also begins to reveal the interrelationship between the parameters themselves.

The Y-axis of the Matrix lists six levels of sustainability in the leftmost column: Market , LEED™ Certified, LEED™ Silver, LEED™ Gold, LEED™ Platinum and Living Building. A few characteristics of each level are listed in this leftmost column, including such things as the expected lifespan of the building, the form-generating ideas and key strategies that would most likely characterize that level, including systems such as raised access flooring or ecological wastewater treatment systems.



The X-axis lays out the primary criteria determined by the Committee and design team to have value in their decision-making process. These parameters can be broken out into four main categories.

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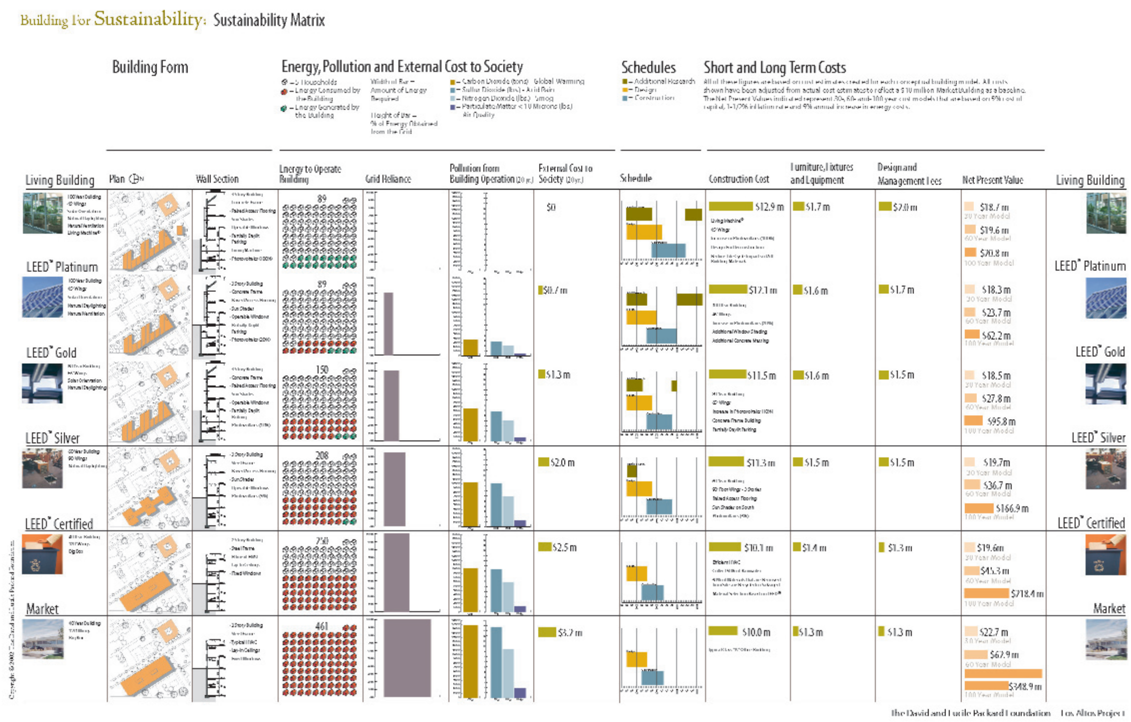
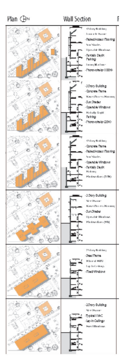
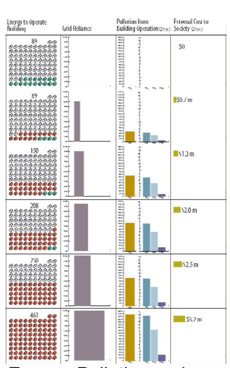




Building Form

Building Form

The first two columns of the *Sustainability Matrix* represent variations in building Plan and typical Wall Section as one moves from Market, represented by a "big box", to Living Building, which accounts for solar orientation and incorporates narrow building wings that accommodate natural daylight and natural ventilation for as many occupants as possible. Also listed in the Wall Section column are modifications to construction systems from one level to the next. *All plans shown in the* Sustainability Report *and* Sustainability Matrix *are oriented with North to the right.*



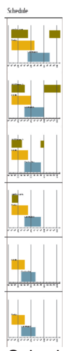
Energy, Pollution and External Costs

Energy, Pollution and External Costs

Based on the systems and building design outlined, and other basic assumptions catalogued in the *Sustainability Report*, the design team generated expected energy consumption for each level. The Energy to Operate Building quantities are illustrated using a standard unit of measure, equivalent to one typical household. Also incorporated into the graphics for the Energy column is an indication (in green) of renewable energy sources. So, by comparison, the design of the Living Building requires 89 households worth of energy to run, but the systems include generation of all of the energy by renewable sources. Grid Reliance is proportional to the information in the Energy column and demonstrates the Living Building as requiring no net annual reliance on outside energy sources. The width of this bar reflects the amount of energy required for each building scenario. The height of the bar reflects the percentage of energy obtained from the grid as compared to the total amount of energy required. The Pollution from Building Operation column further explores the expected pollution generated by

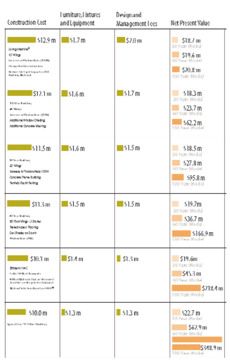
Executive Summary

this grid reliance. Finally, a conservative estimate is made for External Costs to Society, in particular, health costs and cleanup costs associated with standard energy generation. As previously mentioned, these estimates are based primarily on Jonathan Levy's "Environmental Health Effects of Energy Use: A Damage Function Approach" (May 1999).


Schedules

Schedules

The Schedule column focuses on three major efforts: Additional Research, Design and Construction. Variations from one scenario to the next represent two primary strategies: (1) a more sustainable design strategy involves more design team members in early meetings to ensure an integrated design approach and (2) this additional research in the more sustainable approaches is more critical early in the process and continues after owner occupancy. It is not just limited to general, or typical, research in the Design phases.


Short and Long Term Costs

Short and Long Term Costs

The next four columns contain short and long term cost information for each scenario. The first three columns in this series encompass Construction Costs, costs for Furniture, Fixtures and Equipment (FF+E), and Design and Management Fees. All of these figures are based on cost estimates created for each conceptual building model. The outline specifications for each are included in the *Sustainability Report*, along with detailed cost backup information. All costs shown in this particular report have been adjusted from actual cost estimates to reflect a $10 million Market building as the baseline. Significant components that contribute to cost increases from one level to the next are listed beneath each cost.

For all levels, three cost models were created for 30-year, 60-year and 100-year scenarios. The Net Present Values are estimates, in today's dollars, of all the expenses (annual as well as capital) associated with a building over a set period of time. Energy costs were estimated to increase 5% annually with a 5% cost of capital assumed for all models. One factor in these calculations is the expected lifespan of each building, which ranges from 40-year for Market and LEED™ Certified to 100-year for the LEED™ Platinum and Living Building levels.

All calculations are based on information and costs available to the design team in the summer of 2002.

It is worth repeating that the *Sustainability Matrix* does not stand alone, but is a summary of the findings described in the *Sustainability Report*, which documents the initial assumptions and calculations, and better demonstrates the process undertaken by the design team.

Definition of Terms

Within the design and construction industry, many of the terms below have varying definitions, depending in part on the context in which they are used. The design team understands this and has chosen the definitions indicated in an effort to provide clarity for this report.

ASHRAE

An acronym for American Society of Heating Refrigeration and Air-conditioning Engineers. When ASHRAE is cited in this report, it is in reference to ASHRAE Standard 90.1 1999, which specifies performance characteristics for buildings to meet minimal energy compliance. With regard to ventilation, mention of ASHRAE refers to Standard 62-1999, Ventilation for Acceptable Indoor Air Quality. The LEED™ rating system also refers to other ASHRAE standards as a baseline against which to compare the energy performance, acceptable ventilation, effective air changes and thermal comfort. While the state of California chooses to measure its buildings against Title 24 standards, reference to ASHRAE standards are used in this report in an effort to remain more global in approach and understanding.

Commissioning

Commissioning is traditionally a one-time metering and balancing of equipment to determine whether or not it is performing as designed. Usually, if commissioning is administered, it is done after installation and before final occupancy. Typically, only HVAC is tested. If additional commissioning is done, as suggested by LEED™, equipment will be measured and balanced at periodic points within the first year of occupancy. Usually lighting, HVAC, air quality and water use are tested. To perform "super commissioning" and monitoring (or continual commissioning), all the building systems (lighting, heating and cooling equipment, water consuming equipment, irrigation and fixtures, and indoor air quality sensors) are tied together with sensors and monitors and continuously metered throughout the life of the building. As the computer keeps track of actual performance it can also tell the building operators when to adjust equipment.

Construction Costs

The actual cost of construction of the facility, including material, labor, overhead and profit of the general contractor and their subcontractors. For the purpose of this report, costs not included in this figure include land acquisition costs, legal fees, and other related soft costs.

Cost of Capital (interest rate, time value of money)

The cost of capital is a factor that recognizes that interest compounds on money when it is kept. The rate is the effective interest rate that a bank or other financial institution pays annually for the privilege of keeping the funds. Also called the time value of money, this principle states that funds placed in a secure investment will increase in value in a way that depends on the elapsed time and interest rate. The cost of capital assumed in this model is 5%. This is a standard rate for a fairly conservative, stable, bond fund type of investment.

Design and Management Fees

Fees for professional services rendered by the architectural design team and their consultants, as well as the construction management team.

Ecological Wastewater Treatment System

A wastewater treatment system that relies on microorganisms and plants, in the presence of sunlight, to purify water instead of harsh chemicals and massive energy inputs. See the Appendix of this report for a more detailed summary of this technology.

Energy Model

A computer model typically created by a mechanical engineer and based on a design from the architect that will predict how much energy the building will use on an annual basis. The energy model takes into account the local climate; it also takes into account the type of construction including walls, windows and roof, the amount of insulation in the building, quantity of equipment, lighting and people in the building, as well as several other energy-relevant factors. By modifying any of these factors, the design team can see how building design modifications affect projected energy efficiency.

External Costs to Society

This is a rough and very conservative number taken from an average of several governmental, industrial and environmental studies that quantify the cost of pollution born by the general public through a complex mixture of health-related impacts, pollution remediation impacts and losses to the economy based on resource depletion and quality of life degradation. Each scenario is analyzed to determine the amount of pollution generated and the external costs to society of the pollutants over a 20-year period. The intent of including this number is to remind ourselves that pollution imposes a real cost on our society that is not generally included in the cost of that which generates it.

Furniture, Fixtures and Equipment (FF+E)
This includes items purchased by the owner, typically under a separate contract from the base building construction contract.

Green Building
Any building that has significantly lower negative environmental impacts than traditional buildings.

IAQ
An acronym for Indoor Air Quality, one aspect of Indoor Environmental Quality that addresses air contaminants throughout a building.

IEQ
Indoor Environmental Quality refers to a variety of factors that affect the well being and productivity of building occupants, including indoor air quality, thermal comfort, acoustics and access to daylight.

Inflation Rate
The inflation rate is the change in the cost of living or price index that varies (generally increases) with time. In an economic comparison, it is important to bring all of the costs to a constant point in time so that the comparison is at a real, fixed point and is a fair comparison. In other words, the inflation rate takes into account the market pressures that make the cost of living or the cost of doing business increase, while the cost of capital takes into account the financial pressures associated with planning expenditures over a period of time. The inflation rate for a standard "basket of goods" over the past 100 years has been approximately 2%. For the analysis shown here, the rates are 1.5% for most construction-related items because these costs have traditionally inflated slower than the average. The energy costs have been inflated more quickly (5%) based on a conservative extrapolation of the latest trends in the energy market.

LEED™
An acronym for Leadership in Energy and Environmental Design, LEED™ is a rating system for measuring the sustainability of building projects recently developed by the U. S. Green Building Council, (Current version: 2.0, March 2000) It is also used as a design tool for designing "green buildings". For this study, a conceptual design for each of the four LEED™ ratings (Certified, Silver, Gold and Platinum) was based on distributing the points evenly between five major categories (Site, Water, Energy, Materials, and Indoor Environmental Quality) and on awarding points in each category beginning with the easiest to achieve and ending with the more difficult. A copy of LEED™ can be downloaded from www.usgbc.org, the website of the U. S. Green Building Council.

Life-Cycle Assessment
A life-cycle assessment takes all of the revenues and expenditures associated with a building over a set period of time and brings them all back to their net present value or total cost in today's dollars. It is not assumed that the building owner has all of the money today sitting in a bank account generating interest at the assumed cost of capital. It does assume that the money exists somewhere in the world and will generate interest accordingly.

Living Building
A Living Building is defined as having zero net annual impact on the environment from an operational standpoint. While a truly sustainable building would also mitigate burdens created during construction and operation, as well as by the embodied energy in the materials, this study considers only net zero annual impact from building operation.

Maintenance Costs
The costs associated with keeping a building in operation including all time and materials and, for example, the cost to replace lights, fix equipment and provide general upkeep.

Market Building
For the purposes of this report, a Market Building is defined as a San Francisco Bay Area Class A office building. For a more detailed description, refer to the Market Scenario Summary and the Market Project

Definition of Terms

Narrative provided. As of March 2001, a stricter version of Title 24 (California's Energy Code) was adopted in the state of California, which is used as the baseline for the Market Building in this study.

Net Present Value (NPV)
The value in today's dollars of all the income and expenses (annual as well as capital) associated with a building over a set period of time. The Net Present Value uses the cost of capital so that expenditures and revenues incurred at different points in time can be compared equally in today's dollars.

Operating Costs
The cost of providing water, electricity and natural gas to the building as well as repairs and maintenance. This report uses costs based on 2002 published PG+E and California Water Service rates for medium-sized commercial buildings.

Photovoltaics (PV)
Solid-state technology, typically made from silicon and originally developed by NASA, that converts sunlight (photo-) directly into electricity (-voltaic) with no moving parts and no pollution created. The most compelling applications of PV in the building industry are those that integrate the PV cells directly into a building component, such as glazing or roofing.

R-Value
A unit of thermal resistance used for comparing insulating values of different materials; the higher the R-value, the greater its insulating properties. The R-value for any total wall section is the sum total of the R-values of all the materials taking into account the loss for thermal bridging at various locations in the wall assembly.

Site Plan
The Packard Foundation property in downtown Los Altos, California is used as the basis of design for each scenario.

Sustainable Design
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Report: Six Scenarios for The David and Lucile Packard Foundation Los Altos Project

Sustainability Scenarios

1 Market
2 LEED™ Certified
3 LEED™ Silver
4 LEED™ Gold
5 LEED™ Platinum
6 Living Building

Scenario Summary 1: Market

Scenario Description

Office: 2 floors at 45,000 sf — 90,000 sf
Garage: 3 floors at 45,000 sf — 135,000 sf
Building Life Expectancy: 40 years

The Market building is defined in this report as a typical San Francisco Bay Area Class A office building. The building occupies most of the site with minimal traditional landscaping. All water is supplied and returned to municipal storm and sanitary systems. Construction includes: steel frame; concrete floors over metal deck; precast exterior; large percentage of traditional, non-operable, exterior glazing; minimum R-values for exterior walls and roof system to meet code; flat roof; 10'-0" lay-in ceilings; gypsum board interior walls; small amounts of interior glass; and ceiling-based mechanical and electrical lighting system that meets minimum ASHRAE requirements. Minimal commissioning is used. Traditional building materials are selected without knowledge of their impact on the environment or human health. Estimated LEED™ Points: Less than 26 points. Refer also to Pages 25-26.

External Costs to Society

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	838	160	16,760	2,067,765
SO_2	14,310	.68	41,553	13.6	454,436
NO_2	22,815	.47	66,250	9.4	500,779
PM_{10}	35,775	.09	103,883	1.8	150,366
				Total	**$ 3,173,346**

Cost Summary

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 10 m	$ 11.7 m	$ 14.7 m	$ 15.4 m	1a
FF+E, Permits, Fees, Etc.	$ 1.3 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.3 m	$ 1.4 m	1.8 m	$ 1.9 m	
Operating Costs		$ 9.2 m	$ 46 m	$ 333.1 m	1b
Mech + TI Replacement Costs		$ 420,000	$ 420,000	$ 530,000	1c
Total – Net Present Values		**$22.7 m**	**$62.9 m**	**$348.9 m**	1d

1a - Assumes typical Market building's designed life span to be forty (40) years. Building replacement costs figured into 60- and 100-year costs, based on NPV of capital costs and percentage of building life remaining.

1b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

1c - Includes expected mechanical and electrical equipment and TI replacement costs.

1d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Schedule Impacts

Quarter - Year	Q3-2001	Q4-2001	Q1-2002	Q2-2002	Q3-2002	Q4-2002	Q1-2003	Q2-2003	Q3-2003	Q4-2003	Q1-2004	Q2-2004	Q3-2004	Q4-2004	Q1-2005	Notes
Add'l Research																
Design																12 mos
Construction																13 mos

1 - Design schedule based on Schematic Design - 3 months; Design Development - 3 months; Construction Documents - 6 months. The design team has worked on condensed and expanded versions of either the design or construction schedule or both, but this represents a manageable timeframe.

2 - Additional Research represents studies and collaboration required by an integrated design team to strategize and fine-tune a high performance building and system design, as well as post-occupancy studies at higher levels of sustainability.

Scenario Summary 2: LEED™ Certified

Scenario Description

Office: 2 floors at 45,000 sf 90,000 sf
Garage: 3 floors at 45,000 sf 135,000 sf
Building Life Expectancy: 40 years

The LEED™ Certified Building is similar to a Market Building with improved mechanical systems, envelope and a more conscious use of materials. The building occupies most of the site. All water is supplied and returned to municipal storm and sanitary systems. Native, xeriscape landscaping requires little irrigation. The mechanical and electrical lighting systems improve minimum ASHRAE energy requirements by 30 percent. Ventilation effectiveness and thermal comfort are improved. Additional commissioning is used. Building materials are more likely to be, salvaged, recycled content, rapidly renewable, low emitting or certified. Daylighting and views are accessible from common spaces. Estimated LEED™ points: 26 points. Refer also to Pages 25-26.

External Costs to Society

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	659	160	13,180	1,626,082
SO_2	14,310	.54	41,553	10.8	360,876
NO_2	22,815	.37	66,250	7.4	394,230
PM_{10}	35,775	.07	103,883	1.4	116,951
				Total	**$ 2,498,140**

Cost Summary

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 10.1 m	$ 11.9 m	$ 14.9 m	$ 15.7 m	2a
FF+E, Permits, Fees, Etc.	$ 1.4 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.3 m	$ 1.5 m	$ 1.8 m	$ 1.9 m	
Operating Costs		$ 5.7 m	$ 28.1 m	$ 200.2 m	2b
Mech + TI Replacement Costs		$ 460,000	$ 460,000	$ 580,000	2c
Total – Net Present Values		**$19.6 m**	**$45.3 m**	**$218.4 m**	2d

2a - Assumes LEED™ Certified building's designed life span to be forty (40) years. Building replacement costs figured into 60- and 100-year costs, based on NPV of capital costs and percentage of building life remaining.

2b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

2c - Includes expected mechanical and electrical equipment and TI replacement costs.

2d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Schedule Impacts

Quarter - Year	Q3-2001	Q4-2001	Q1-2002	Q2-2002	Q3-2002	Q4-2002	Q1-2003	Q2-2003	Q3-2003	Q4-2003	Q1-2004	Q2-2004	Q3-2004	Q4-2004	Q1-2005	Notes
Add'l Research																
Design	■	■	■	■												12 mos
Construction				■	■	■	■									13 mos

1 - Design schedule based on Schematic Design - 3 months; Design Development - 3 months; Construction Documents - 6 months.

2 - Additional Research represents studies and collaboration required by an integrated design team to strategize and fine-tune a high performance building and system design, as well as post-occupancy studies at higher levels of sustainability.

Scenario Summary 3: LEED™ Silver

Scenario Description

Office:	3 floors at 30,000 sf	90,000 sf
Garage:	3 floors at 45,000 sf	135,000 sf
Building Life Expectancy:		60 years

The LEED™ Silver Building is similar to a LEED™ Certified Building with improved mechanical systems, envelope and a more conscious use of materials. The building footprint allows more access to exterior courtyard green space and light into the building. All water is supplied and returned to municipal storm and sanitary systems. Native, xeriscape landscaping requires little irrigation. The mechanical and electrical lighting systems improve minimum ASHRAE energy requirements by 40 percent. Five percent of the building's electricity will be supplied by photovoltaics. Raised access flooring and some operable windows allow greater user control over thermal comfort. Additional commissioning is used. Building materials contain higher percentages of recycled content. Daylighting and views are accessible from common spaces. Horizontal exterior shading devices on the south, east and west protect glazing from thermal heat gain. Estimated LEED™ points: 37 points. Refer also to Pages 25-26.

External Costs to Society

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	514	160	10,280	1,268,295
SO_2	14,310	.42	41,553	8.4	280,681
NO_2	22,815	.29	66,250	5.8	308,991
PM_{10}	35,775	.06	103,883	1.2	100,244
				Total	**$ 1,958,211**

Note: Includes a 5% renewable energy deduction.

Cost Summary

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 11.3 m	$ 13.2 m	$ 13.2 m	$ 14.9 m	3a
FF+E, Permits, Fees, Etc.	$ 1.5m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.5 m	$ 1.6 m	$ 1.6 m	$ 1.8 m	
Operating Costs		$ 4.4 m	$ 21.2 m	$ 149.4 m	3b
Mech + TI Replacement Costs		$ 480,000	$ 720,000	$ 790,000	3c
Total – Net Present Values		**$ 19.7 m**	**$ 36.7 m**	**$ 166.9 m**	3d

3a - Assumes LEED™ Silver building's designed life span to be sixty (60) years. Building replacement costs figured into 100-year costs based on NPV of capital costs and percentage of building life remaining.

3b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

3c - Includes expected mechanical and electrical equipment and TI replacement costs.

3d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Schedule Impacts

Quarter - Year	Q3-2001	Q4-2001	Q1-2002	Q2-2002	Q3-2002	Q4-2002	Q1-2003	Q2-2003	Q3-2003	Q4-2003	Q1-2004	Q2-2004	Q3-2004	Q4-2004	Q1-2005	Notes
Add'l Research	■	■														6 mos
Design	■	■	■	■	■											15 mos
Construction					■	■	■	■	■							15 mos

1 - Design schedule based on Schematic Design - 4 months; Design Development - 5 months; Construction Documents - 6 months.

2 - Additional Research represents studies and collaboration required by an integrated design team to strategize and fine-tune a high performance building and system design, as well as post-occupancy studies at higher levels of sustainability.

Scenario Summary 4: LEEDTM Gold

Scenario Description

Office: 3 floors at 30,000 sf — 90,000 sf
Garage: 3 floors at 45,000 sf — 135,000 sf
Building Life Expectancy: 80 years

The LEEDTM Gold Building is similar to a LEEDTM Silver Building with improved mechanical systems, envelope and a more conscious use of materials. The building orientation works better with the solar orientation. 30 percent of the building's water is supplied by rainwater and returned to municipal sanitary systems. Native, xeriscape landscaping requires little irrigation. The mechanical and electrical lighting systems improve minimum ASHRAE energy requirements by 50 percent. 10 percent of the building's electricity will be supplied by photovoltaics. Partial natural ventilation is used. Raised access flooring and operable windows allow greater user control over thermal comfort. Additional commissioning is used. Building materials contain more salvaged materials. Daylighting is used for ambient general lighting. Horizontal exterior shading devices on the south, east, and west protect glazing from thermal heat gain. Estimated LEEDTM points: 46 points. Refer also to Pages 25-26.

External Costs to Society

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	353	160	7,060	871,028
SO_2	14,310	.29	41,553	5.8	193,804
NO_2	22,815	.2	66,250	4.0	213,098
PM_{10}	35,775	.04	103,883	.8	66,829
				Total	**$ 1,344,758**

Note: Includes a 10% renewable energy deduction.

Cost Summary

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 11.5 m	$ 13.7 m	$ 13.7 m	$ 14.6 m	4a
FF+E, Permits, Fees, Etc.	$ 1.6 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.5 m	$ 1.7 m	$ 1.7 m	$ 1.8 m	
Operating Costs		$ 2.5 m	$ 11.4m	$ 78.4 m	4b
Mech + TI Replacement Costs		$ 570,000	$ 980,000	$ 1 m	4c
Total – Net Present Values		**$ 18.5 m**	**$ 27.8 m**	**$ 98.5 m**	4d

4a - Assumes LEEDTM Gold building designed life span to be eighty (80) years. Building replacement costs figured into 100-year costs based on NPV of capital costs and percentage of building life remaining.

4b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

4c - Includes expected mechanical and electrical equipment and TI replacement costs.

4d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital account for long-term costs expressed in today's dollars.

Schedule Impacts

Quarter - Year	Q3-2001	Q4-2001	Q1-2002	Q2-2002	Q3-2002	Q4-2002	Q1-2003	Q2-2003	Q3-2003	Q4-2003	Q1-2004	Q2-2004	Q3-2004	Q4-2004	Q1-2005	Notes
Add'l Research	■	■	■							■						9 mos +
Design	■	■	■	■	■											15 mos
Construction					■	■	■	■	■							15 mos

1 - Design schedule based on Schematic Design - 4 months; Design Development - 5 months; Construction Documents - 6 months.

2 - Additional Research represents studies and collaboration required by an integrated design team to strategize and fine-tune a high performance building and system design, as well as post-occupancy studies at higher levels of sustainability.

Scenario Summary 5: LEED™ Platinum

Scenario Description

Office: 3 floors at 30,000 sf 90,000 sf
Garage: 3 floors at 45,000 sf 135,000 sf
Building Life Expectancy: 100 years

The LEED™ Platinum Building is similar to a LEED™ Gold Building with improved mechanical systems, envelope and a more conscious use of materials. The building orientation and width are optimum for the solar orientation. Rainwater is fully utilized. Greywater is recirculated for non-potable uses within the building. Native, xeriscape landscaping requires little irrigation. The mechanical and electrical lighting systems improve minimum ASHRAE energy requirements by 60 percent. Twenty percent of the building's electricity will be supplied by photovoltaics. Natural ventilation is utilized. Raised access flooring and operable windows allow greater user control over thermal comfort. Additional commissioning is used along with some monitoring. Building materials are regional. Daylighting is used for task lighting. Horizontal exterior shading devices on the south; and screens on the east and west protect glazing from thermal heat gain. Estimated LEED™ points: 58 points. Refer also to Pages 25-26.

External Costs to Society

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	186	160	3,720	458,955
SO_2	14,310	.14	41,553	2.8	93,560
NO_2	22,815	.10	66,250	2.0	106,549
PM_{10}	35,775	.02	103,883	.4	33,415
				Total	**$ 692,479**

Note: Includes a 20% renewable energy deduction.

Cost Summary

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 12.1 m	$ 14.3 m	$ 14.3 m	$ 14.3 m	5a
FF+E, Permits, Fees, Etc.	$ 1.6 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.7 m	$ 1.9m	$ 1.9 m	$ 1.9 m	
Operating Costs		$ 1.5 m	$ 6.6 m	$ 44.9 m	5b
Mech + TI Replacement		$ 600,000	$ 900,000	$ 1.1 m	5c
Total – Net Present Values		**$ 18.3 m**	**$ 23.7 m**	**$ 62.2 m**	5d

5a - Assumes LEED™ Platinum building's designed life span to be one hundred (100) years.

5b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

5c - Includes expected mechanical and electrical equipment and TI replacement costs.

5d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Schedule Impacts

Quarter - Year	Q3-2001	Q4-2001	Q1-2002	Q2-2002	Q3-2002	Q4-2002	Q1-2003	Q2-2003	Q3-2003	Q4-2003	Q1-2004	Q2-2004	Q3-2004	Q4-2004	Q1-2005	Notes
Add'l Research	■	■	■	■							■	■	■	■	■	12 mos +
Design	■	■	■	■	■	■										18 mos
Construction					■	■	■	■	■	■						18 mos

1 - Design schedule based on Schematic Design - 4 months; Design Development - 6 months; Construction Documents - 8 months.

2 - Additional Research represents studies and collaboration required by an integrated design team to strategize and fine-tune a high performance building and system design, as well as post-occupancy studies at higher levels of sustainability.

Scenario Summary 6: Living Building

Scenario Description

Office: 3 floors at 30,000 sf 90,000 sf
Garage: 3 floors at 45,000 sf 135,000 sf
Building Life Expectancy: 100 years

The Living Building is similar to the LEED™ Platinum building, but its design is further refined to operate with zero net annual pollution generated. The building materials are selected base on their life-cycle impact on social, environmental, and economic systems. Rainwater is fully utilized. An ecological wastewater treatment system treats wastewater for non-potable reuse within the building (shown as separate structure on site plan). Native, xeriscape landscaping requires little irrigation. The mechanical and electrical lighting systems improve minimum ASHRAE energy requirements by 60 percent or more. Photovoltaics and clean renewable energy will supply all of the building's electricity and will be used for on-site power generation. User control and comfort are optimized. Super commissioning and monitoring are implemented. Daylighting is optimized. Horizontal exterior shading devices on the south with vertical fins on the north, and screens on the east and west protect glazing from thermal heat gain. Estimated LEED™ points: More than 58 points. Refer also to Pages 25-26.

External Costs to Society

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	0	160	0	0
SO_2	14,310	0	41,553	0	0
NO_2	22,815	0	66,250	0	0
PM_{10}	35,775	0	103,883	0	0
				Total	**0**

Note: Because clean renewable energy is used to supply 100% of the energy for the building, the net annual externalized costs to society due to pollution during operation becomes zero for the Living Building.

Cost Summary

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 12.9 m	$ 15.2 m	$ 15.2 m	$ 15.2 m	6a
FF+E, Permits, Fees, Etc.	$ 1.7 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.9 m	$ 2.2 m	$ 2.2 m	$ 2.2 m	
Operating Costs		$ 510,000	$ 990,000 m	$ 1.9 m	6b
Mech + TI Replacement Costs		$ 780,000	$ 1.2 m	$ 1.5 m	6c
Total – Net Present Values		**$ 18.7 m**	**$ 19.6 m**	**$ 20.8 m**	6d

6a - Assumes Living Building's designed life span to be one hundred (100) years.

6b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

6c - Includes expected mechanical and electrical equipment and TI replacement costs.

6d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Schedule Impacts

Quarter - Year	Q3-2001	Q4-2001	Q1-2002	Q2-2002	Q3-2002	Q4-2002	Q1-2003	Q2-2003	Q3-2003	Q4-2003	Q1-2004	Q2-2004	Q3-2004	Q4-2004	Q1-2005	Notes
Add'l Research	■	■	■	■	■							■	■	■	■	15 mos +
Design	■	■	■	■	■	■	■									21 mos
Construction						■	■	■	■	■	■	■				20 mos

1 - Design schedule based on Schematic Design - 5 months; Design Development - 6 months; Construction Documents - 9 months.

2 - Additional Research represents studies and collaboration required by an integrated design team to strategize and fine-tune a high performance building and system design, as well as post-occupancy studies at higher levels of sustainability.

Building for Sustainability An integrated approach to the built environment, sustainable design balances the social, economic and environmental aspects of our lives and enhances the well-being of our communities.

Report: Six Scenarios for The David and Lucile Packard Foundation Los Altos Project

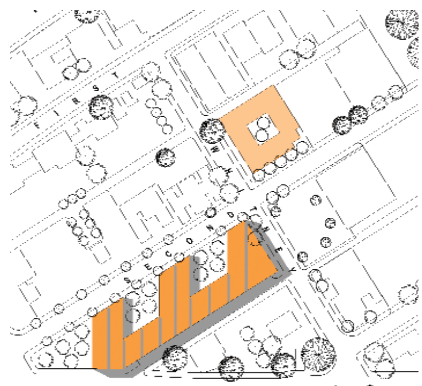
Comparison Summaries

Comparison Summary: Site Plans

Market N

LEED™ Certified N

LEED™ Silver N



LEED™ Gold N

LEED™ Platinum N

Living Building N

Comparison Summary: Cost Impacts

Conceptual Cost Estimate Notes and Assumptions

Cost estimates are included for each scenario, Market through Living Building, using the criteria, outline specifications and site diagrams described in the appendix of this report. The purpose of the cost estimates is to demonstrate the relative cost differences between the various LEED™ ratings following the theoretical change in criteria between the scenarios. The methodology included the development of an estimate for a typical San Francisco Bay Area Class A office building, which is termed Market building in this report. Then, quantities and unit prices were modified for each successive scenario based on the changing criteria developed, thus forming relationships between the various criteria for the LEED™ ratings and the overall cost of the project.

The reader should be aware of the following series of qualifications and assumptions. First, the cost of the parking, the cost of the site development and, to a small degree, the configuration of the building are all site dependent. Thus, the overall cost of the project, and the cost to achieve a given LEED™ rating are site dependent, and as such would have to be revisited should there be a change in site. Second, the design work generated for the purpose of these estimates was conceptual in nature and in no way reflected a developed design solution. Both the cost and LEED™ rating would need to be continually reevaluated throughout design and construction document phases. It is possible, and in fact likely, that how this project achieves any given LEED™ rating will change, and as such the costs are theoretical. It is the experience of the design team that with some "value engineering" and "constructability" discussions, the cost for a given rating would be the same or less than is currently shown in these models. This can not be determined finally until the design is developed further.

As stated, the starting point for the Market building is the assumption of providing a "Class A" office building. This assumption includes a building life expectancy of forty years. It is noted and accepted that developers of office buildings have different models and starting points for cost. The intent of this study is not to create data for all these models, but instead to take one model and develop data that uses cost as one variable in the decision-making process for sustainable design goals. Within the range of type of owner and building to be developed, the changes in cost relative to a more sustainable building should follow the curve (percentage increase) defined by the data that follows. However, if an owner or developer started with a model that is substantially different from the model used in this report, then the curve would also change substantially. The market-rate cost for this model is $200/sf for the initial construction cost. If one started at $185-190/sf up to $210-215/sf, the overall percentage change in cost to achieve LEED™ Platinum or beyond will not change. However, if the starting point is substantially changed to say, $150/sf or $250/sf, then the curve (i.e., percentage change) will shift substantially as well.

Two versions of the cost numbers were created, each based on a 90,000 square foot office building for 300 employees with a three-level below-grade parking garage in the downtown area of Los Altos, California. For the Packard Foundation's internal use, a first set of estimated costs was documented for the actual building requirements listed above. A second set of generic cost numbers was based on this first set, but with the Market building construction costs set at $10 million and all other numbers factored proportionally, including construction costs, FF+E, and design and management fees. This second set of numbers allows outside readers to understand the cost trends more easily as well as compare with other projects of varying scale. The Foundation has made these "generic" numbers available for public review.

Comparison Summary: Cost Impacts

Market

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 10 m	$ 11.7 m	$ 14.7 m	$ 15.4 m	1a
FF+E, Permits, Fees, Etc.	$ 1.3 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.3 m	$ 1.4 m	1.8 m	$ 1.9 m	
Operating Costs		$ 9.2 m	$ 46 m	$ 333.1 m	1b
Mech + TI Replacement Costs		$ 420,000	$ 420,000	$ 530,000	1c
Total – Net Present Values		**$22.7 m**	**$62.9 m**	**$348.9 m**	1d

1a - Assumes typical Market building's designed life span to be forty (40) years. Building replacement costs figured into 60- and 100-year costs, based on NPV of capital costs and percentage of building life remaining.

1b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

1c - Includes expected mechanical and electrical equipment and TI replacement costs.

1d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

LEED™ Certified

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 10.1 m	$ 11.9 m	$ 14.9 m	$ 15.7 m	2a
FF+E, Permits, Fees, Etc.	$ 1.4 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.3 m	$ 1.5 m	$ 1.8 m	$ 1.9 m	
Operating Costs		$ 5.7 m	$ 28.1 m	$ 200.2 m	2b
Mech + TI Replacement Costs		$ 460,000	$ 460,000	$ 580,000	2c
Total – Net Present Values		**$19.6 m**	**$45.3 m**	**$218.4 m**	2d

2a - Assumes LEED™ Certified building's designed life span to be forty (40) years. Building replacement costs figured into 60- and 100-year costs, based on NPV of capital costs and percentage of building life remaining.

2b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

2c - Includes expected mechanical and electrical equipment and TI replacement costs.

2d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

LEED™ Silver

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 11.3 m	$ 13.2 m	$ 13.2 m	$ 14.9 m	3a
FF+E, Permits, Fees, Etc.	$ 1.5m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.5 m	$ 1.6 m	$ 1.6 m	$ 1.8 m	
Operating Costs		$ 4.4 m	$ 21.2 m	$ 149.4 m	3b
Mech + TI Replacement Costs		$ 480,000	$ 720,000	$ 790,000	3c
Total – Net Present Values		**$ 19.7 m**	**$ 36.7 m**	**$ 166.9 m**	3d

3a - Assumes LEED™ Silver building's designed life span to be sixty (60) years. Building replacement costs figured into 100-year costs based on NPV of capital costs and percentage of building life remaining.

3b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

3c - Includes expected mechanical and electrical equipment and TI replacement costs.

3d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Comparison Summary: Cost Impacts

LEED™ Gold

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 11.5 m	$ 13.7 m	$ 13.7 m	$ 14.6 m	4a
FF+E, Permits, Fees, Etc.	$ 1.6 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.5 m	$ 1.7 m	$ 1.7 m	$ 1.8 m	
Operating Costs		$ 2.5 m	$ 11.4m	$ 78.4 m	4b
Mech + TI Replacement Costs		$ 570,000	$ 980,000	$ 1 m	4c
Total – Net Present Values		**$ 18.5 m**	**$ 27.8 m**	**$ 98.5 m**	**4d**

4a - Assumes LEED™ Gold building designed life span to be eighty (80) years. Building replacement costs figured into 100-year costs based on NPV of capital costs and percentage of building life remaining.

4b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

4c - Includes expected mechanical and electrical equipment and TI replacement costs.

4d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital account for long-term costs expressed in today's dollars.

LEED™ Platinum

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 12.1 m	$ 14.3 m	$ 14.3 m	$ 14.3 m	5a
FF+E, Permits, Fees, Etc.	$ 1.6 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.7 m	$ 1.9m	$ 1.9 m	$ 1.9 m	
Operating Costs		$ 1.5 m	$ 6.6 m	$ 44.9 m	5b
Mech + TI Replacement Costs		$ 600,000	$ 900,000	$ 1.1 m	5c
Total – Net Present Values		**$ 18.3 m**	**$ 23.7 m**	**$ 62.2 m**	5d

5a - Assumes LEED™ Platinum building's designed life span to be one hundred (100) years.

5b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

5c - Includes expected mechanical and electrical equipment and TI replacement costs.

5d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Living Building

	First Year	30 yrs (NPV)	60 yrs (NPV)	100 yrs (NPV)	Notes
Hard Costs					
Initial Construction Costs	$ 12.9 m	$ 15.2 m	$ 15.2 m	$ 15.2 m	6a
FF+E, Permits, Fees, Etc.	$ 1.7 m	Inc. above	Inc. above	Inc. above	
Soft Costs					
Design + Mgmt Fees	$ 1.9 m	$ 2.2 m	$ 2.2 m	$ 2.2 m	
Operating Costs		$ 510,000	$ 990,000 m	$ 1.9 m	6b
Mech + TI Replacement Costs		$ 780,000	$ 1.2 m	$ 1.5 m	6c
Total – Net Present Values		**$ 18.7 m**	**$ 19.6 m**	**$ 20.8 m**	6d

6a - Assumes Living Building's designed life span to be one hundred (100) years.

6b - Includes electricity, water and natural gas costs, based on January 2002 published PG+E and California Water Service rates for medium-sized commercial buildings with a 5% annual increase based on 1.5% inflation per year.

6c - Includes expected mechanical and electrical equipment and TI replacement costs.

6d - In addition to this number, external costs to society should also be considered.

General - NPV (net present value) numbers are based on 5% cost of capital and account for long-term costs expressed in today's dollars.

Comparison Summary: Cost Impacts

Cost of Construction

The following pages outline initial costs of construction that were derived for six conceptual models created by the design team in their sustainability research. The costs reflect varying levels of sustainability, beginning with a Market building (defined as a typical Class A office building in the Bay Area) and ending with a Living Building (defined as a building whose operation has zero net annual negative impact on the environment). The cost breakdowns are called out by building systems and include a brief description of the factors that influence these costs. Net present values indicated in the Scenario Summaries represent 30-, 60- and 100-year cost models and are based on 5% cost of capital. The original cost estimates that were calculated were based on a 90,000 square foot new office building in downtown Los Altos, California with 135,000 square feet of underground parking structure beneath the office building.

Cost Summary

Building Systems		Market	LEED™ Certified	LEED™ Silver	LEED™ Gold	LEED™ Platinum	Living Building
1.0	Site Preparation	$49,041	$88,375	$88,375	$88,375	$144,568	$144,568
2.0	Substructure	$128,349	$128,349	$147,505	$147,505	$147,505	$147,505
3.0	Superstructure	$710,069	$710,069	$839,312	$919,514	$919,514	$919,514
4.0	Exterior Closure	$574,415	$570,226	$911,213	$927,815	$1,212,736	$1,235,597
5.0	Roofing and Waterproofing	$115,578	$115,578	$166,981	$287,029	$338,113	$646,980
6.0	Interior Construction	$890,958	$884,904	$924,290	$897,037	$901,379	$887,586
7.0	Conveying Systems	$60,381	$60,381	$90,010	$90,010	$90,010	$90,010
8.0	Mechanical Systems	$667,226	$687,059	$653,710	$636,687	$660,916	$755,639
9.0	Electrical Systems	$504,928	$517,763	$496,001	$479,756	$463,486	$463,486
10.0	Finish Work	$127,710	$127,710	$178,794	$178,794	$178,794	$178,794
Subtotals		**$3,828,655**	**$3,890,415**	**$4,496,192**	**$4,652,523**	**$5,057,022**	**$5,469,679**
General Conditions 9.0%		$344,579	$350,137	$404,657	$418,727	$455,132	$492,271
Contractor's Fee 4.5%		$187,797	$190,825	$220,538	$228,206	$248,047	$268,288
Design Contingency 10%		$436,103	$443,138	$512,139	$529,946	$576,020	$623,024
Subtotal Building Construction Cost		**$4,797,132**	**$4,874,516**	**$5,633,527**	**$5,829,401**	**$6,336,221**	**$6,853,262**
Subtotal Parking Garage Cost		$4,062,226	$4,062,226	$4,291,335	$4,305,417	$4,283,015	$4,305,417
Construction Contingency		$664,452	$670,256	$744,365	$760,111	$796,443	$836,901
Escalation to Construction Start		$476,190	$480,350	$640,154	$653,696	$684,941	$899,668
Total Hard Costs		**$ 10,000,000**	**$ 10,087,347**	**$ 11,309,380**	**$ 11,548,625**	**$ 12,100,619**	**$12,895,248**

All of these figures are based on cost estimates created for each conceptual building model. All costs shown have been adjusted from actual cost estimates to reflect a $10 million Market Building as a baseline. For further explanation, refer to Page 13.

Comparison Summary: Cost Impacts

Cost Deltas from One Level to the Next

LEED™ Certified		Delta from Market	
1.0	Site Preparation	$39,335	Deconstruct existing building
4.0	Exterior Closure	(-$4,198)	More insulation ; Small window upgrade
6.0	Interior Construction	(-$6,053)	Floor, wall and ceiling finishes upgrade for recycled or certified content
8.0	Mechanical Systems	$19,833	Save on basic mechanical; Add for 50% storm water collection
9.0	Electrical Systems	$12,835	Save on basic power supply; Add for more efficient lighting
	Total	**$61,752**	

LEED™ Silver		Delta from LEED™ Certified	
2.0	Substructure	$19,156	Raised access flooring for one floor
3.0	Superstructure	$129,242	Three-floor construction; Raised access flooring for two floors
4.0	Exterior Closure	$340,986	Higher floor-to-skin ratio 73%; Partial sunshades
5.0	Roofing and Waterproofing	$51,403	3,000 square feet of photovoltaics
6.0	Interior Construction	$39,385	Higher percentage of recycled, certified or eco-friendly materials
7.0	Conveying Systems	$29,628	One more level of elevator and stairs
8.0	Mechanical Systems	(-$33,348)	Smaller mechanical needs
9.0	Electrical Systems	(-$21,761)	Smaller electrical needs
10.0	Finish Sitework	$51,084	Larger planting area; Smaller footprint; Native materials
	Total	**$605,775**	

LEED™ Gold		Delta from LEED™ Silver	
3.0	Superstructure	$80,202	Add for going to concrete frame
4.0	Exterior Closure	$16,602	Higher floor-to-skin ratio 12%; Better glazing and insulation
5.0	Roofing and Waterproofing	$120,047	Standing seam metal roof; 3,000 additional square feet of photovoltaics
6.0	Interior Construction	(-$27,253)	Exposed concrete ceilings
8.0	Mechanical Systems	(-$17,023)	Smaller mechanical needs
9.0	Electrical Systems	(-$16,244)	Smaller electrical needs
	Total	**$156,331**	

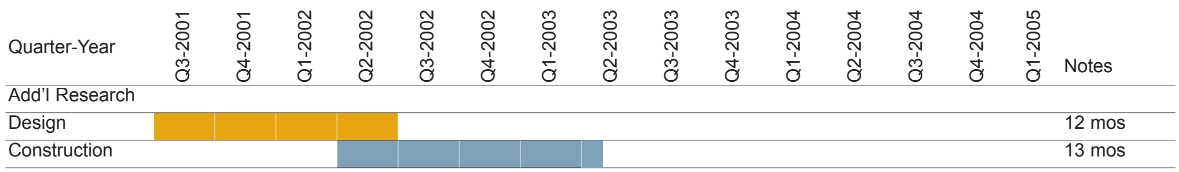
LEED™ Platinum		Delta from LEED™ Gold	
1.0	Site Preparation	$56,192	25% more of existing structures are salvaged
4.0	Exterior Closure	$284,921	Advanced windows; Sunshades on east and west sides
5.0	Roofing and Waterproofing	$51,084	2,000 additional square feet of photovoltaics
6.0	Interior Construction	$4,342	Less walls; More interior glazing
8.0	Mechanical Systems	$24,229	Indoor air quality monitoring; Greywater and stormwater filtering for reuse
9.0	Electrical Systems	(-$16,270)	Smaller electrical needs
	Total	**$404,498**	

Living Building		Delta from LEED™ Platinum	
4.0	Exterior Closure	$22,860	Larger sunshades; Glass fully shaded
5.0	Roofing and Waterproofing	$308,857	32,000 additional square feet of photovoltaics
6.0	Interior Construction	(-$13,793)	Less walls; More open office
8.0	Mechanical Systems	$94,723	Ecological wastewater treatment system
	Total	**$412,657**	

The numbers above are subtotal costs and do not include general conditions, contractor's fees, design contingency, parking garage cost, construction contingency and escalation to construction start costs.

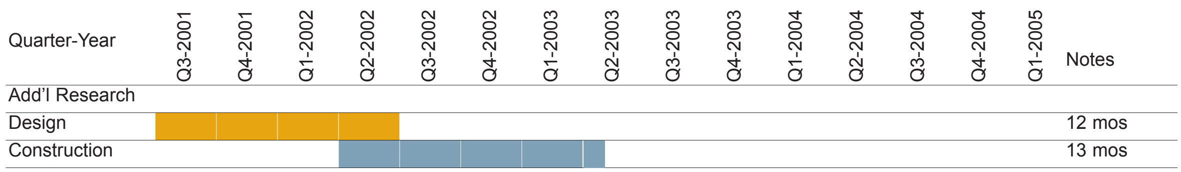
Comparison Summary: Schedule Impacts

Market



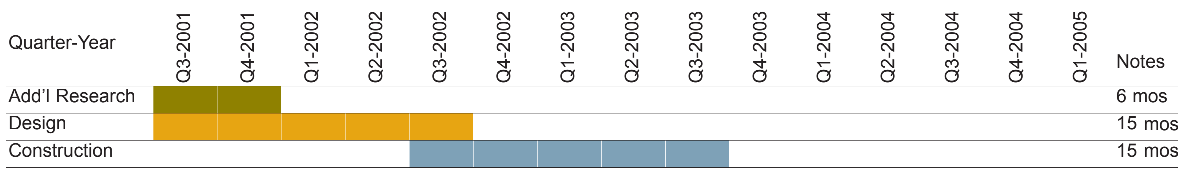
Design schedule based on Schematic Design - 3 months; Design Development -3 months; Construction Documents - 6 months.

LEED™ Certified



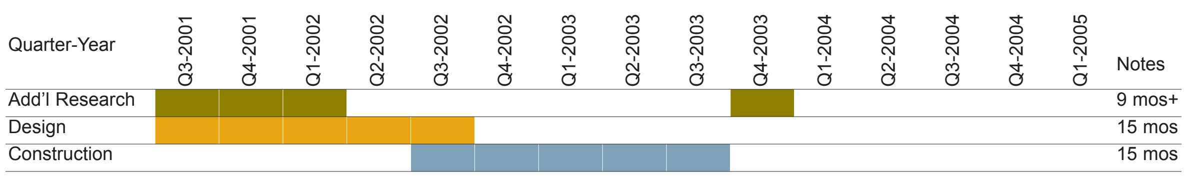
Design schedule based on Schematic Design - 3 months; Design Development - 3 months; Construction Documents - 6 months.

LEED™ Silver



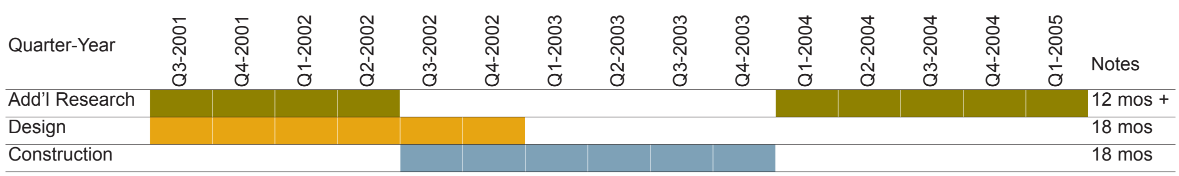
Design schedule based on Schematic Design - 4 months; Design Development - 5 months; Construction Documents - 6 months.

LEED™ Gold



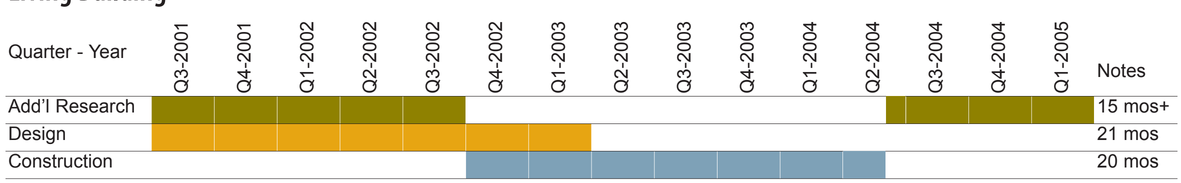
Design schedule based on Schematic Design - 4 months; Design Development - 5 months; Construction Documents - 6 months.

LEED™ Platinum



Design schedule based on Schematic Design - 4 months; Design Development - 6 months; Construction Documents - 8 months.

Living Building

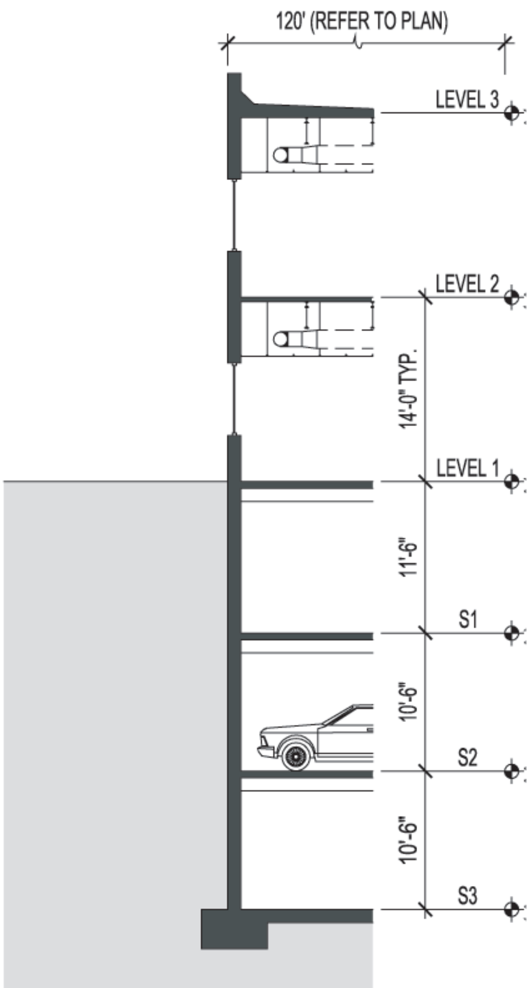


Design schedule based on Schematic Design - 5 months; Design Development - 6 months; Construction Documents - 9 months.

Note: Additional Research represents studies and collaboration required by an integrated design team to strategize and fine-tune a high performance building and system design, as well as post-occupancy studies at higher levels of sustainability.

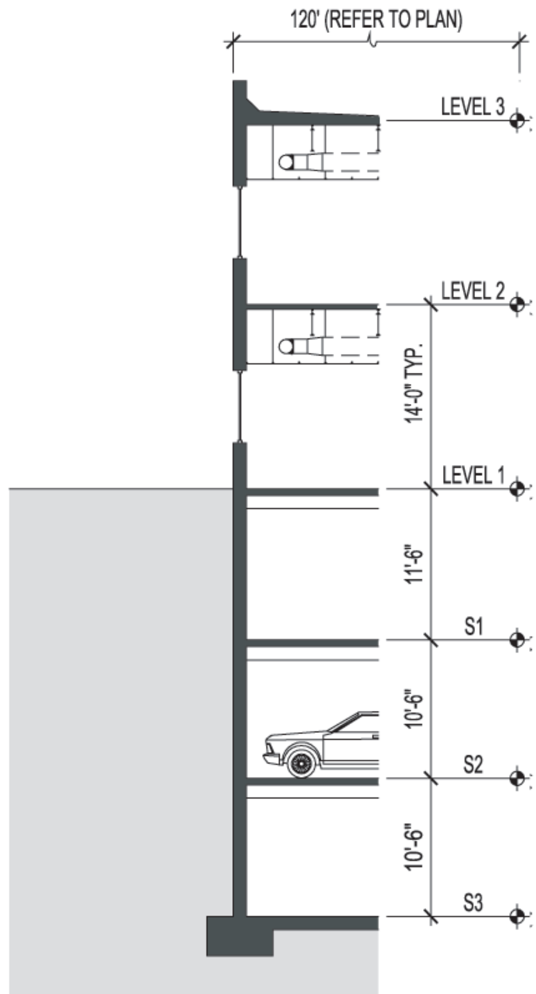
Summary Sheet: Wall Sections

Market



Two-story building
Steel frame
Typical HVAC
Lay-in ceilings
Fixed windows

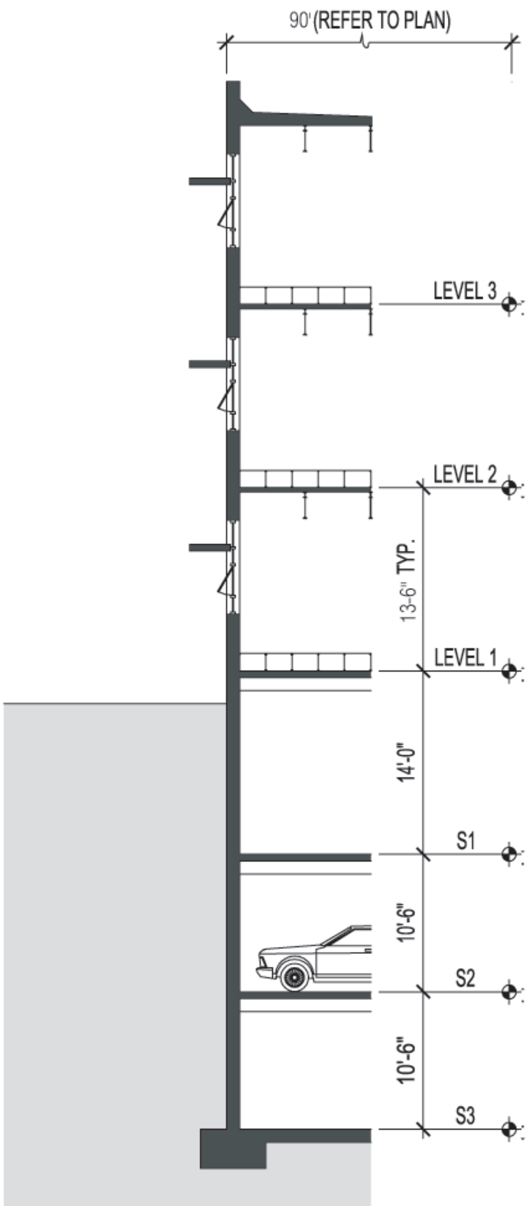
LEED™ Certified



Two-story building
Steel frame
Efficient HVAC
Lay-in ceilings
Fixed windows

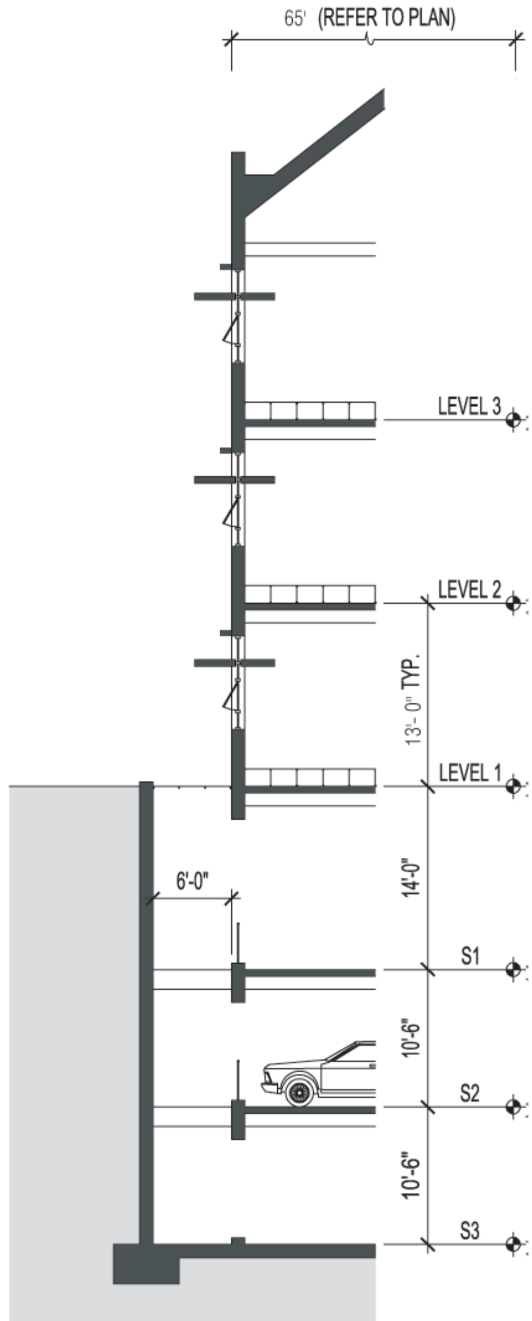
Comparison Summary: Wall Sections

LEED™ Silver



Three-story building
Steel frame
Raised access flooring
Sunshades
Operable windows
Photovoltaics (5%)

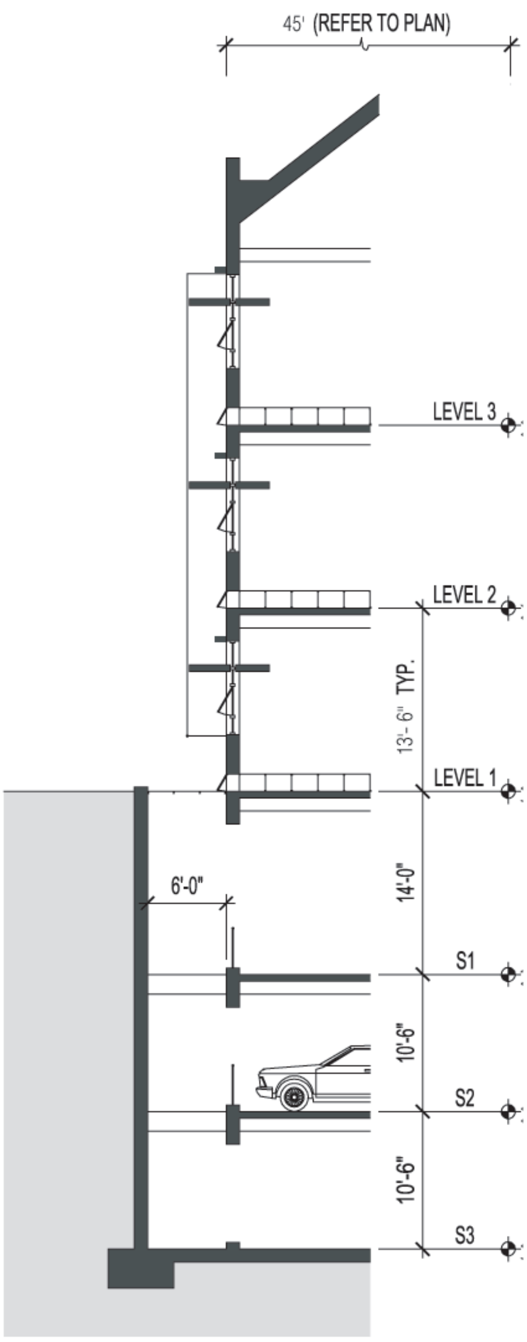
LEED™ Gold



Three-story building
Concrete frame
Raised access flooring
Sunshades / light shelves
Operable windows
Partial daylight into parking
Photovoltaics (10%)

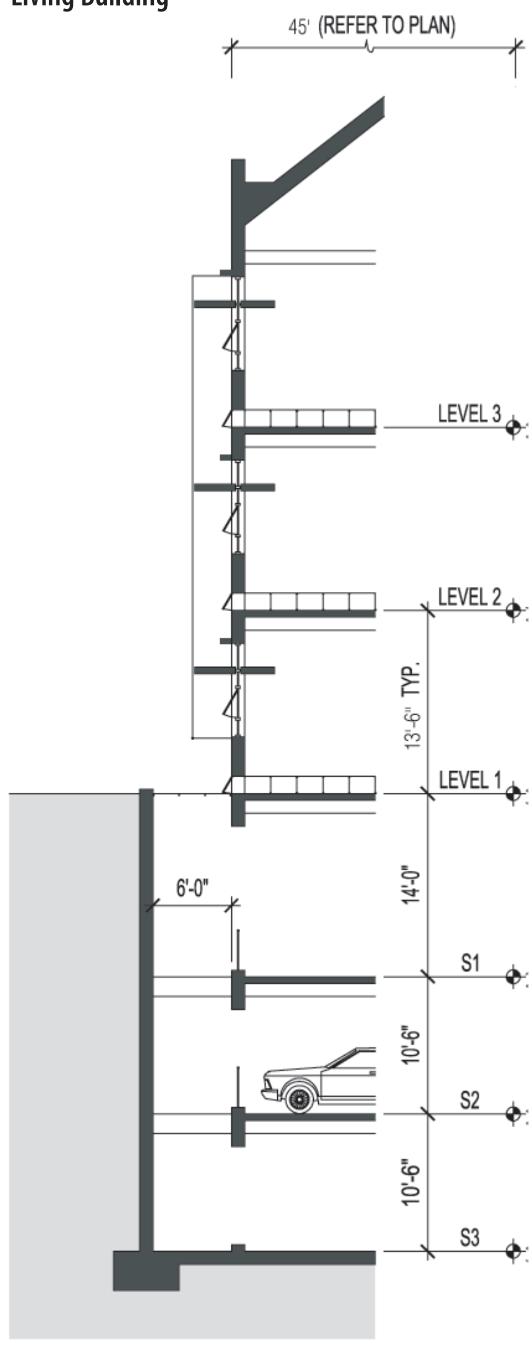
Comparison Summary: Wall Sections

LEED™ Platinum



Three-story building
Concrete frame
Raised access flooring
Sunshades / light shelves
Operable windows
Partial daylight into parking
Photovoltaics (20%)

Living Building



Three-story building
Concrete frame
Raised access flooring
Sunshades / light shelves
Operable windows
Partial daylight into parking
Photovoltaics (100%)
Ecological wastewater treatment system

Comparison Summary: Building Components and Energy Model Performance Criteria

Design Criteria/Characteristics		Market	LEED™ Certified	LEED™ Silver	LEED™ Gold	LEED™ Platinum	Living Building
Estimated LEED™ score	Points (V. 2.0)	Less than 26	26	37	47	58	More than 58
Site area	Total area (sf)	56,000	56,000	56,000	56,000	56,000	56,000
Building form	Width (ft)	120	120	90	65	45	45
	Area (sf)	90,000	90,000	90,000	90,000	90,000	90,000
	Stories	Office: 2 floors Garage: 3 levels	Office: 2 floors Garage: 3 levels	Office: 3 floors Garage: 3 levels	Office: 3 floors Garage: 3 leve ls	Office: 3 floors Garage: 3 levels	Office: 3 floors Garage: 3 levels
	Orientation	-	-	-	Solar-based	Solar-based	Solar-based
Occupancy	People	300	300	300	300	300	300
	Percent closed office	60%	50%	40%	30%	20%	10%
Amount of glazing (percent of building skin area)	North	60%	50%	40%	40%	40%	40%
	South	60%	50%	40%	40%	40%	40%
	East	60%	50%	30%	25%	20%	20%
	West	60%	50%	30%	25%	20%	20%
Glazing characteristics (U-factor / solar heat gain coefficient / visible light transmittance)	North	.42 / .60 / .71	.32 / .46 / .70	.29 / .43 / .70	.29 / .43 / .70	.29 / .43 / .70	.29 / .43 / .70
	South	.42 / .60 / .71	.32 / .46 / .70	.29 / .43 / .70	.29 / .43 / .70	.29 / .43 / .70	.29 / .43 / .70
	East	.42 / .60 / .71	.32 / .46 / .70	.31 / .40 / .47	.31 / .40 / .47	.31 / .40 / .47	.31 / .40 / .47
	West	.42 / .60 / .71	.32 / .46 / .70	.31 / .40 / .47	.31 / .40 / .47	.31 / .40 / .47	.31 / .40 / .47
Glazing and daylight strategies	Daylight and views	Limited access to daylight and views	Daylight and views at common areas	Daylight and views at common areas	Ambient daylight for general lighting	Daylight for visual tasks	Daylight for visual tasks
	Insulation, operability	Double-glazed, fixed	Double-glazed, fixed	Double-glazed, operable	Double-glazed, operable	Double-glazed, operable w/ controls	Double -glazed, operable w/ controls
	Light shelves	No	No	No	Yes	Yes	Yes
Amount of shading (percent of total window area)	North	0%	0%	0%	0%	0%	100%
	South	0%	0%	50%	100%	100%	100%
	East	0%	0%	0%	50%	100% (20% by landscaping)	100% (20% by landscaping)
	West	0%	0%	0%	50%	100% (50% by landscaping)	100% (50% by landscaping)
	Exterior shade	No	No	South	South	South	South
	Vertical screen	No	No	No	East and west	East and west	East and west
	Vertical fin	No	No	No	No	No	North
Temperature range (degrees Fahrenheit)	Cooling/RH	74°	74°	74°	76°	78°	78°
	Heating/RH	70°	68°	68°	68°	68°	68°

Comparison Summary: Building Components and Energy Model Performance Criteria

Design Criteria/Characteristics		Market	LEED™ Certified	LEED™ Silver	LEED™ Gold	LEED™ Platinum	Living Building
Thermal properties (overall system R-value)	Wall R-value	R-8	R-13	R-20	R-25	R-33	R-33
	Roof R-value	R-20	R-30	R-30	R-33	R-40	R-40
	Floor R-value	R-19	R-19	R-19	R-23	R-27	R-27
	Mass	No	No	No	Yes	Yes / high mass	Yes / high mass
Energy efficiency goal (beyond baseline – ASHRAE 90.1, 1999)	% of ASHRAE baseline	ASHRAE	70% ASHRAE	60% ASHRAE	50% ASHRAE	40% ASHRAE	< 40% ASHRAE
Technologies introduced	Ecological waste-water treatment system	No	No	No	No	No	Yes
Renewable energy	Photovoltaics (kW)	No	No	30	60	80	200
	% of net annual	0%	0%	5%	10%	20%	100%
Supply air system		VAV	VAV	Under floor	Under floor	Under floor and natural ventilation	Under floor and natural ventilation
Outside air	CFM/person	20	20	20	20	20	20
	SF/person	150	150	150	150	150	150
Unit supply air	CFM/sf	1.5	1.5	1.4	1.3	.75	.75
Total air supply volume	CFM	135,000	90,000	126,000	117,000	90,000	67,500
Outside air	CFM – 150sf/person at 20 CFM each	12,000	12,000	12,000	12,000	12,000	12,000
Design loads	Lighting (W/ft^2)	1.25	1.2	1.2	0.8	0.5	0.5
	Plugs (W/ft^2)	4.0	2.0	1.5	0.8	0.5	0.5
Electric feed size	kW	1200	800	600	600	400	400
Generator size	kW	200	200	200	100	100	0
Cooling capacity	Ft^2/ton	240	350	450	600	1,000	1,000
Chiller capacity	Tons	375	250	200	150	90	90
Heating (boiler) load	BTU/h	950	850	950	950	875	875
Domestic hot water load	BTU/h	165	75	Included in heating	Included in heating	Included in heating	Included in heating
Rainwater catchment tank	Gallons	0	12,500	25,000	25,000	25,000	25,000
Treated water storage tank	Gallons	0	0	0	0	0	20,000
Design fees (Design / Research / LEED™ Certification)	% of construction costs	12%	12%	12%	12%	12%	12%
	% of construction costs	-	-	1%	1%	2%	3%
	Estimated at $1,000 per point	-	$26,000 - 32,000	$33,000 - 38,000	$39,000 - 51,000	$52,000 - 64,000	$58,000 - 64,000

Comparison Summary: Building Components and Energy Model Performance Criteria

Design Criteria/Characteristics		Market	LEED™ Certified	LEED™ Silver	LEED™ Gold	LEED™ Platinum	Living Building
Materials used (percent of total material cost)	Min. 20% post-consumer recycled content materials	0%	25%	50%	50%	50%	Reduce material impact based on life-cycle assessment
	Salvaged or reused materials	0%	5%	5%	10%	10%	Reduce material impact based on life-cycle assessment
	Regionally manufactured materials	0%	20%	20%	20%	20%	Reduce material impact based on life-cycle assessment
	Regionally extracted raw materials	0%	0%	0%	10%	10%	Reduce material impact based on life-cycle assessment
	Low emitting materials	Carpet	Carpet, adhesives, sealants, composite wood	Carpet, adhesives, sealants, composite wood	Carpet, adhesives, paint, sealants, composite wood	Carpet, adhesives, paint, sealants, composite wood	Understand and control sources of IAQ hazard
	Certified wood	0% of wood used	50% of wood used	50% of wood used	50% of wood used	50% of wood used	Reduce material impact based on life-cycle assessment
	Rapidly renewable materials	0%	5%	5%	5%	5%	Reduce material impact based on life-cycle assessment
Recycled construction waste	% of total waste by weight	0%	50%	50%	50%	75%	Maximum possible
Plumbing	Greywater use (rainwater and building greywater)	0%	0%	50% (site irrigation)	100% (site irrigation)	100% (building)	100% (building)
	Black water use	0%	0%	0%	0%	0%	100% (building)
	Ecological wastewater treatment system	No	No	No	No	No	Yes
Electrical	Lighting at garage (lamps)	175-watt metal halide	175-watt metal halide	T-5	T-5	T-5	T-5
	Lighting at garage stairs (lamps)	T-8	T-8	T-5	T-5	T-5	T-5
	Interior building lighting (lamps)	T-8	T-8	T-5	T-5	T-5	T-5
Structural	Structural system	Steel	Steel	Steel	Concrete	Concrete	Concrete
	Floor-to-floor height	14’-0”	14’-0”	13’-6”	13’-0”	13’-6”	13’-6”
	Office ceiling height	10’-0”	10’-0”	Exposed	Exposed	Exposed	Exposed
	Height of raised access flooring	NA	NA	16”	16”	16”	16”

Note:
1 - These performance criteria are based on a building site located in downtown Los Altos, California with a specific owner in mind. Criteria will vary for buildings in different climates and with different owners.
2 - The Market building is designed to meet the revised version of Title 24, California's Energy Code, adopted in March 2001.

Summary Comparison: Building and Site Attributes Based on LEED™ Rating System

MARKET	LEED™ CERTIFIED	LEED™ SILVER All of LEED™ CERTIFIED Rating plus:	LEED™ GOLD All of LEED™ SILVER Rating plus:	LEED™ PLATINUM All of LEED™ GOLD Rating plus:	LIVING All of LEED™ PLATINUM plus:
SITE					
Total SITE Points Possible = 14 Estimated LEED™ V. 2.0 Points:	7 out of 14	8 out of 14	10 out of 14	13 out of 14	13+ out of 14
Develop most of the site with building footprint and paving	Develop brownfield or non-greenfield sites	Locate near public transportation systems (buses or rail)	Reduce impervious surfaces	Manage most storm water on site	Maximize opportunities to use clean, efficient transportation
Develop the site without knowledge of the impacts on site resources	Reduce urban heat islands with shade or underground parking		Manage 25% of storm water on site	Increase the zoning requirements for open space	Capture and filter the maximum possible amount of storm water on-site
Transfer storm water to the municipal sewer system	Minimize site disturbance and restore natural habitat		Provide alternative fueling stations		Eliminate or remediate any soil or water pollution
Consider development of greenfield or suburban sites	Minimize light pollution				Protect all site resources (soil, water, habitat and bio-diversity)
Use conventional paving methods without knowledge of heat absorbing properties	Protect soil during construction				
Incorporate traditional landscaping	Use native landscaping				
	Provide bike storage and showers				
	Increase urban density				
WATER					
Total WATER Points Possible = 5 Estimated LEED™ V. 2.0 Points:	2 out of 5	3 out of 5	4 out of 5	5 out of 5	5+ out of 5
Rely on municipal water supply for landscape irrigation	Use efficient irrigation system & rainwater for 50% of irrigation needs	Use rainwater for 100% of irrigation needs	Use alternative fixtures and plumbing systems	Recirculate or treat wastewater	Maximize opportunities to use rainwater for building supply water
Rely on municipal water supply for building use	Use water efficient landscaping		Use rainwater and efficient fixtures to reduce the water supplied by 30%		Reuse all water in the building
Comply with minimal code requirements for fixture efficiency	Use efficient fixtures to reduce water supplied by 20%				Treat all water on site
Convey wastewater to municipal waste water treatment plant	Convey wastewater to a municipal wastewater treatment center				Filter and return clean pure water to natural aquifers
ENERGY					
Total ENERGY Points Possible = 17 Estimated LEED™ V. 2.0 Points:	5 out of 17	9 out of 17	12 out of 17	15 out of 17	15+ out of 17
Use minimal commissioning	Use additional commissioning	Reduce the energy cost budget by 40%	Reduce the energy cost budget by 50%	Reduce the energy cost budget by 60%	Use super-commissioning and continuous monitoring
Use minimal monitoring	Reduce the energy cost budget by 30% based on ASHRAE 90.1-1999	Supply 5% of the building power from an on-site renewable energy source	Supply 10% of the building power from an on-site renewable energy source	Supply 20% of the building's power from an on-site renewable energy source	Supply 100% of the building's power from an on-site renewable energy source
Comply with minimal energy codes	Use zero CFC refrigerants	Utilize alternative air systems with greater individual control	Explore alternative air systems		Use zero HCFC and ozone depleting refrigeration
Allow over-sized HVAC equipment		Monitor lighting, HVAC, water heater and irrigation systems			Operate the building without creating pollution averaged annually
Allow building systems to function independently					Fully monitor and integrate all building systems
Rely on CFC & HCFC refrigerants					Right-size all building systems
Allow equipment efficiency to decrease over time					Reduce the energy cost budget by 60% or more
Rely on non-renewable power from the grid					

Summary Comparison: Building and Site Attributes Based on LEED™ Rating System

MARKET	LEED™ CERTIFIED	LEED™ SILVER All of LEED™ CERTIFIED Rating Plus:	LEED™ GOLD All of LEED™ SILVER Rating Plus:	LEED™ PLATINUM All of LEED™ GOLD Rating Plus:	LIVING All of LEED™ PLATINUM Plus:
MATERIAL					
Total MATERIAL Points Possible = 13 Estimated LEED™ V. 2.0 Points:	6 out of 13	7 out of 13	8 out of 13	10 out of 13	10+ out of 13
Process workplace waste without recycling	Reduce and recycle workplace waste	Specify 20% post-consumer recycled content for 50% of the total materials used by cost	Specify salvaged material for 10% of the total materials used by cost	Specify regionally extracted raw materials for 10% of the materials regionally manufactured	Design for deconstruction
Specify materials based on initial cost and availability rather than environmental impacts over their life cycle	Recycle or salvage 50% of construction waste			Salvage 75% of the construction waste	Reduce the life-cycle impact of building materials
Recycle construction waste only if it reduces initial cost	Use certified wood for 50% of the wood used				Minimize transportation and energy used during construction
Specify wood without knowledge of the impacts on forest health	Specify 20% post-consumer recycled content for 25% of total materials used by cost				Specify materials based on their social, environmental, and economic impacts over their life cycle
Specify materials that may require chemical maintenance	Specify regionally manufactured materials (500 miles) for 20% of the materials used by cost				
Specify materials without knowledge of their recycled content or recyclability	Specify rapidly renewable materials for 5% of the total materials used by cost				
Design for demolition rather than deconstruction	Specify salvaged materials for 5% of total materials used by cost				
Use some certified wood					
INDOOR ENVIRONMENTAL QUALITY					
Total IEQ Points Possible = 15 Estimated LEED™ V. 2.0 Points:	6 out of 15	10 out of 15	12 out of 15	15 out of 15	15+ out of 15
Comply with ASHRAE 62-1999 requirements for IAQ	Comply with ASHRAE 55-1992 standards for thermal comfort	Isolate printer and copy equipment	Provide partial natural ventilation	Provide a direct view to daylight for 95% of workspaces	Understand and control the sources of IAQ hazards
Use cleaning products without knowledge of their impact on IAQ	Comply with ASHRAE 62-1999 requirements for IAQ	Conduct a two week flush-out & filter change prior to occupancy	Utilize daylight for ambient lighting	Provide natural ventilation with sensors and controls for humidity and IAQ	Maximize use of integrated daylighting and efficient electrical lighting
Complete construction without monitoring IAQ	Increase effectiveness of ventilation	Provide entryway systems to reduce allergens and particulates	Install permanent temperature and humidity monitors	Monitor carbon dioxide	Specify materials that do not require chemical maintenance
Use materials without knowledge of their VOC emission rate	Allow zero smoking in or near the building	Isolate cleaning products	Specify additional low-emitting materials: paint	Utilize daylight for 75% of all task lighting	Maximize individual control over comfort
Locate copy and printing equipment in workspace	Specify low-emitting materials: adhesives, sealants, carpet, and composite wood	Provide operable windows and individual control over temperature and airflow			Plan landscape that does not require chemicals or polluting equipment to maintain
Allow smoking near the entry of buildings	Manage IAQ during construction	Separate hazardous wastewater drains			
Plan electric lighting without daylight integration	Provide a view to daylight and outdoor space for some common spaces				
Design for zoned comfort areas rather than individual comfort control	Provide a view to daylight and outdoor space for some individual work stations				
MARKET – TOTAL POINTS Less than 26 out of 64 possible	**LEED™ CERTIFIED – TOTAL POINTS** 26 out of 64 possible	**LEED™ SILVER – TOTAL POINTS** 37 out of 64	**LEED™ GOLD – TOTAL POINTS** 46 out of 64	**LEED™ PLATINUM – TOTAL POINTS** 58 out of 64	**LIVING BUILDING – TOTAL POINTS** 58+ out of 64

Scores above do not account for a LEED™ accredited professional or possible innovation credits.

Comparison Summary: Energy Model Backup

Preliminary Energy Simulations

Energy End Use MMBTU/Year	Market	LEED™ Certified	LEED™ Silver	LEED™ Gold	LEED™ Platinum
Lights and Equipment	5650.4	3326.6	2660.6	1552	956.9
Heating	459.8	212.5	33.2	10.5	20.7
Cooling (Chiller)	858.3	565.8	320.5	167.8	108.2
Heat Rejection (Cooling Tower)	26.2	18.3	10	6	4.2
Pumps	149.7	105.5	53.4	33.7	24.7
Fans	1037.6	637.7	611.3	243.3	172.1
Domestic Hot Water	143.3	114.6	114.6	100.3	100.3
Total	**8325.3**	**4981.0**	**3803.6**	**2113.6**	**1387.1**
(MBTU/sf)/year x 100	10450	8220	6560	4360	2750
Approx. % of ASHRAE	100	79	63	42	26

Economics

Energy Source	Market	LEED™ Certified	LEED™ Silver	LEED™ Gold	LEED™ Platinum
Electricity	$309,383	$186,689	$146,595	$80,338	$50,835
Natural Gas	$4,087	$2,298	$1,099	$856	$930
Total	**$313,470**	**$188,987**	**$147,694**	**$81,194**	**$51,765**

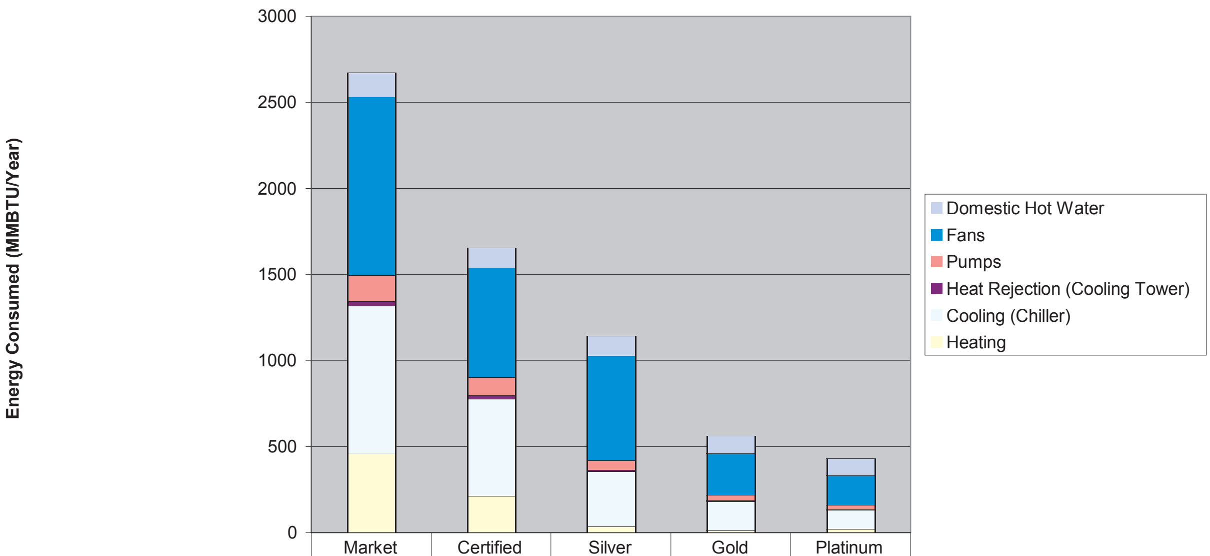
1999 Source Breakdown

Source	GWh	% of Total
Biomass	671	4%
Coal	335	2%
Geothermal	1585	8%
Hydro	4153	22%
Natural Gas	9117	48%
Nuclear	2301	12%
Oil	287	2%
Solar	1	0%
Wind	596	3%
Total	**19,046**	**100%**

This table illustrates the breakdown of electrical generation between different sources.
Source: http://www.energy.ca.gov/electricity/operational_capacity.html

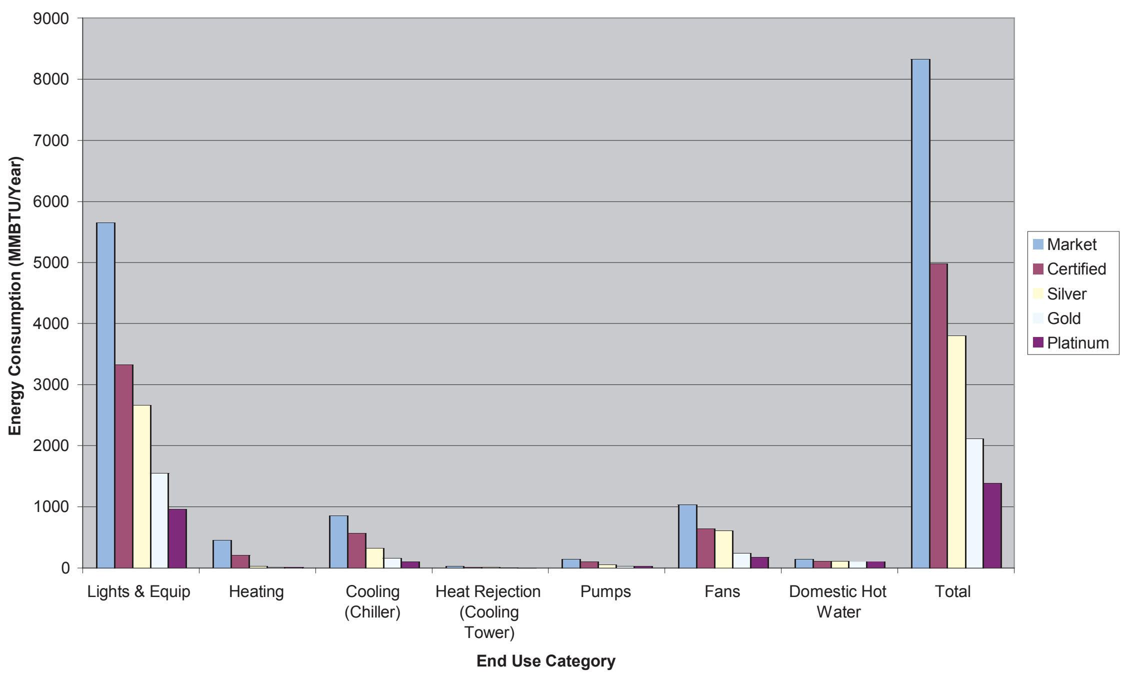
Comparison Summary: Energy Model Backup

Annual Energy Consumption (MMBTU/SF/YR)



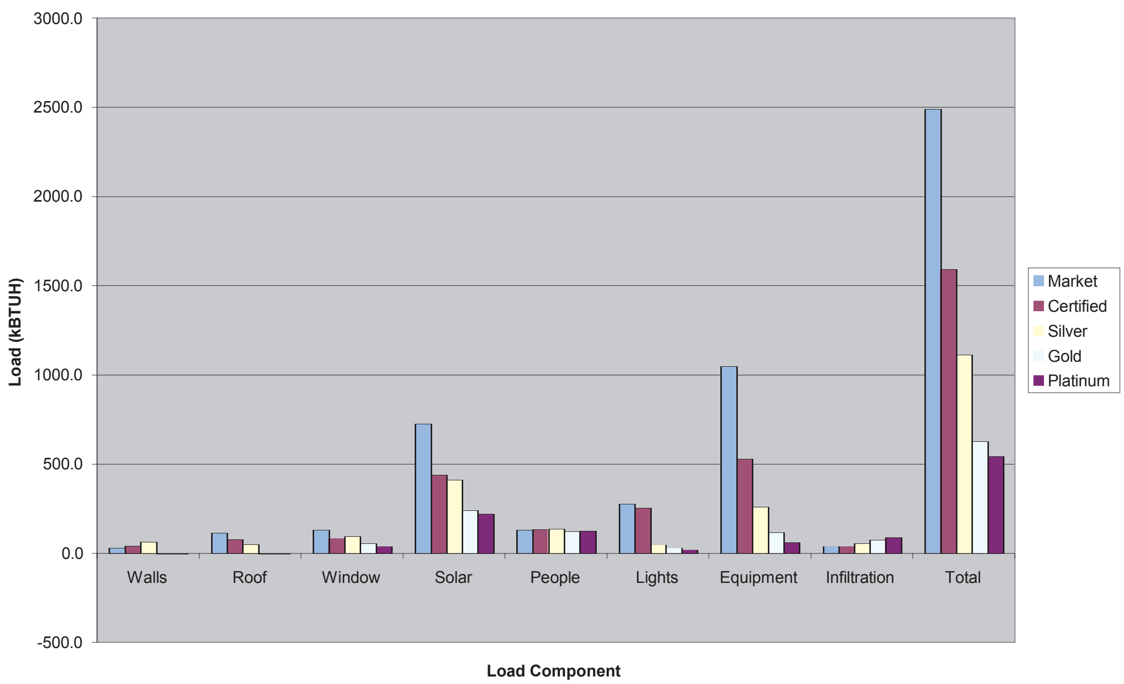
	Market	Certified	Silver	Gold	Platinum
Domestic Hot Water	143.3	114.6	114.6	100.3	100.3
Fans	1037.6	637.7	611.3	243.3	172.1
Pumps	149.7	105.5	53.4	33.7	24.7
Heat Rejection (Cooling Tower)	26.2	18.3	10	6	4.2
Cooling (Chiller)	858.3	565.8	320.5	167.8	108.2
Heating	459.8	212.5	33.2	10.5	20.7

Annual Energy Consumption by End Use (MMBTU/SF/YR)

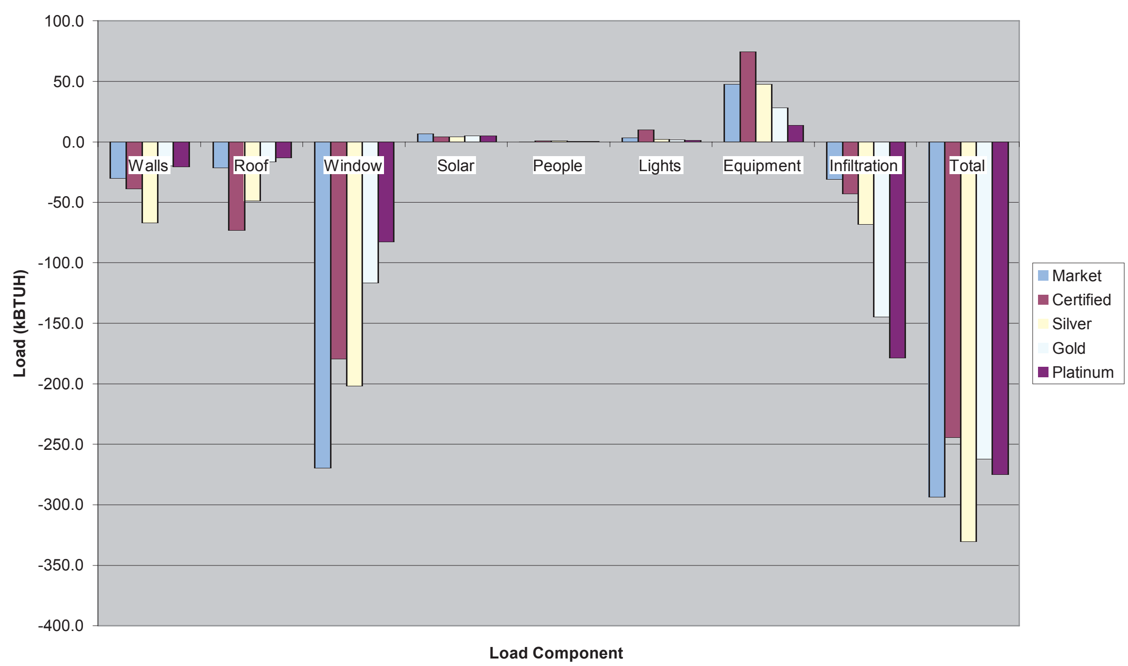


Comparison Summary: Energy Model Backup

Cooling Loads (KBTU/SF/YR)



Heating Loads (KBTU/SF/YR)



Comparison Summary: External Costs to Society

Pollution has an overall negative effect on the economy. It can be said that buildings externalize their costs because the price paid for energy does not reflect the true cost of pollution. Because the Packard Foundation has a broad interest in environmental and social issues, it is appropriate to determine what the external costs to society might be for the operations of its new facilities as pollution is generated.

To derive a figure for the cost of pollution to society, we turned to Jonathon Levy's Harvard dissertation, "Environmental Health Effects of Energy Use: A Damage Function Approach," May 1999, to begin to determine the external costs to society of typical pollutants. For the purpose of this preliminary report we examined the following pollutants: Carbon Dioxide (CO_2), Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Particulate Matter less than 10 microns (PM_{10}). Levy's study includes a survey of the costs to society for several air pollutants done by several utilities and government research entities. An average amount across the studies is assumed for its estimate, based on a report by Gregory Norris in 1994 that did the same. The actual cost to society is likely a much larger number as the other criteria air pollutants were not priced in our report and each of the individual government and utility studies took a conservative approach.

Calculated costs to society due to air pollutants are adjusted for inflation based on a multiplier of 1.05, supplied by the Bureau of Economic Analysis. The costs are then compounded over 20 years. Using emissions data from PG & E and energy use predictions from the energy model created for this report, the following costs to society can be predicted.

It may be possible to extrapolate from these predictions a more comprehensive "cost to society" value, based on the relative share of these air pollution impacts in overall studies of the value of ecosystem services to the economy. Storm water pollutant loading, energy and other impacts of wastewater treatment impacts of community to work are just a few examples of additional "costs to society" not calculated here. Though the project team has chosen to forego this extrapolation, it is worth emphasizing that such a calculation might alter the numbers by orders of magnitude, thus underscoring the limited set of criteria upon which this is based, as well as the potential positive impact of pursuing green measures.

Market

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	838	160	16,760	2,067,765
SO_2	14,310	.68	41,553	13.6	454,436
NO_2	22,815	.47	66,250	9.4	500,779
PM_{10}	35,775	.09	103,883	1.8	150,366
				Total	**$ 3,173,346**

LEED™ Certified Building

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	659	160	13,180	1,626,082
SO_2	14,310	.54	41,553	10.8	360,876
NO_2	22,815	.37	66,250	7.4	394,230
PM_{10}	35,775	.07	103,883	1.4	116,951
				Total	**$ 2,498,140**

LEED™ Silver Building

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	514	160	10,280	1,268,295
SO_2	14,310	.42	41,553	8.4	280,681
NO_2	22,815	.29	66,250	5.8	308,991
PM_{10}	35,775	.06	103,883	1.2	100,244
				Total	**$ 1,958,211**

Note: Includes a 5% renewable energy deduction.

Comparison Summary: External Costs to Society

LEED™ Gold

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	353	160	7,060	871,028
SO_2	14,310	.29	41,553	5.8	193,804
NO_2	22,815	.2	66,250	4.0	213,098
PM_{10}	35,775	.04	103,883	.8	66,829
				Total	**$ 1,344,758**

Note: Includes a 10% renewable energy deduction.

LEED™ Platinum

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	186	160	3,720	458,955
SO_2	14,310	.14	41,553	2.8	93,560
NO_2	22,815	.10	66,250	2.0	106,549
PM_{10}	35,775	.02	103,883	.4	33,415
				Total	**$ 692,479**

Note: Includes a 20% renewable energy deduction.

Living Building

Pollutant	Cost per ton (Year 1996 $)	Pollution per year (tons)	Cost per ton (Year 2024 $)	Pollution 20 years (tons)	Accumulated Cost to Society 20 years ($)
CO_2	41	0	160	0	0
SO_2	14,310	0	41,553	0	0
NO_2	22,815	0	66,250	0	0
PM_{10}	35,775	0	103,883	0	0
				Total	**0**

Note: Because clean renewable energy is used to supply 100% of the energy for the building, the net annual externalized costs to society due to pollution during operation becomes zero for the Living Building.

Building for **Sustainability** An integrated approach to the built environment, sustainable design balances the social, economic and environmental aspects of our lives and enhances the well-being of our communities.

Report: Six Scenarios for The David and Lucile Packard Foundation Los Altos Project

Appendix

Parameters and Assumptions
1 Market
2 LEED™ Certified
3 LEED™ Silver
4 LEED™ Gold
5 LEED™ Platinum
6 Living Building
Technology

Parameters and Assumptions

The Parameters imposed by the particulars of this project and Assumptions made by the design team, in collaboration with the Packard Foundation's Facilities Steering Committee, are included here to further frame the narratives, diagrams and data contained in this Report.

Parameters

As with any building project, there are constraints or conditions that the project team must consider that are imposed by any number of outside influences. Examples of these parameters for The David and Lucile Packard Foundation's Los Altos Project are noted below. These parameters are significant particularly while comparing the results of the *Sustainability Report and Matrix* with any other building project, since even one change in these conditions-- be it related to site, client or timeframe-- may or may not dramatically affect the outcomes. With this in mind, it is the process that this document represents, more so than the actual results it illustrates, that the Foundation finds compelling and interesting to share with others.

For example, one implication of climate on the building design is easily found in the design of the building's skin, or thermal envelope. The team originally considered the use of triple-glazing to provide a higher performing building envelope at the Living Building level, but then reconsidered the appropriateness of this choice in a climate that does not warrant such a move. In truth, all aspects of the energy models created for the six scenarios in this report necessarily reflect the climate of Los Altos, a fact that should be considered when comparing the results of this report to building projects in other regions of the country or world.

Climate

The David and Lucile Packard Foundation is located in Los Altos, California, approximately 40 miles southeast of San Francisco and just west of San Jose at the southern end of San Francisco Bay (37.5°N/ 122.1°W). Considered to be a relatively temperate climate, average temperatures for the area range between 47°F and 67°F. Though extreme highs and lows occur regularly beyond this range, average minimums range between 37°F and 55°F and average maximums between 57°F and 79°F throughout the year. Average rainfall for the year is approximately 15 inches.

Site

Within the town of Los Altos, the Packard Foundation's existing headquarters is located at the corner of Second and Whitney Streets, two blocks off the main commercial district of Los Altos' downtown. Los Altos' downtown is comprised primarily of one- and two-story commercial buildings. The site for their proposed new office building is on this same intersection, with its primary axis parallel to Second Street, which runs approximately 30 degrees west of north. Whitney Street runs perpendicular to Second Street. Because the building site runs roughly along a north-south axis, somewhat unusual modifications to the building footprint were imposed to optimize the building's solar orientation for the higher levels of sustainability. Lower levels of sustainability reflect building footprints that respond solely to street layout and maximizing site area. This is a key distinction for this site as other project sites clearly may not require such unusual building footprints to optimize solar orientation.

Program

Basic programmatic requirements by the Foundation for its proposed facility include a new workplace for 300 employees with accommodations for conference and work rooms, a library and wellness center, a convening center, plus other support spaces. For the purposes of this study, the gross square footage for the new facility is set at 90,000 for each building scenario, with an average occupancy density of 150 square foot per person assumed for workspaces. A three-level underground parking garage to accommodate 300 cars is incorporated into each scenario. Only slight modifications to the parking garage are implemented in various scenarios. Due to existing parking concerns within downtown Los Altos, no reduction in parking spaces is considered for any of the scenarios.

Timeframe

Initial research for this report began in spring of 2001 with a draft report issued in mid-summer of that year. A peer review process was implemented by the Foundation in spring of 2002. Revisions integrated into this report reflect both comments and suggestions by the reviewers as well as adjustments to short- and long-term costs that reflect some transformation within the construction industry as it begins to adopt more sustainable strategies as standard practice.

It is worth noting that the first draft of this report was written at the time that California was experiencing significant fluctuations in its energy supplies and pricing. Energy costs used in this report, based on 2002 prices, reflect both the significant increase in energy prices (approximately 50%) early in 2001 as well as the short-term leveling off of prices since then.

Performance Criteria

The Building Components and Energy Model Performance Criteria outlined on Pages 22-24 also incorporate parameters particular to this site and client. The building envelope used in the Market building scenario reflects changes to California's Title 24 energy code, which were implemented in March 2001 and which are more stringent than most municipalities in the United States.

With regard to material choices, in addition to following LEED™ guidelines, the team also considered that the Packard Foundation's history with incorporating sustainable strategies in earlier renovations of its existing buildings. For example, because of its earlier incorporation of certified wood in building components such as window blinds, partitions and casework, exterior trellis and siding, furniture, the wood ceiling system, and doors and trim, the team included use of certified wood in early scenarios of this study.

Low-Tech Solutions

Further reflecting the Foundation's effort to maintain its commitment to sustainability *and* replicability, a basic strategy of implementing low-tech or simpler solutions is adopted by the design team. In essence, this approach suggests an initial strategy of reducing the real need first, as it relates to water, energy, etc. Then, once the initial "problem" is reduced, the incorporation of a simple design or system solution solves a now smaller supply requirement.

For example, wherever possible, mechanical systems in the more sustainable levels are designed to operate as passively and simply as possible. The choice of the raised access flooring system is a good example of this. Not only is this underfloor system easy to adapt when office layouts are modified, but it also allows users to easily adjust the condition of their space (by adding or removing diffusers) without needing specialized technicians. Also, as the systems become more sustainable, the use of operable windows to regulate temperature and airflow in the space becomes a major design element. Allowing users to regulate their own space means that the users feel more in control of their environment and the building uses less energy.

This same strategy is reflected in the glazing and daylighting design choices. As noted in the performance criteria table, percent glazing decreases as the glazing is "optimized" for daylighting. Traditional building design often uses glass indiscriminately (often too much glass on all sides of the building), but also with large floorplates. Non-mechanical sunshades and light shelves, in conjunction with these other design choices, further reflect the "low-tech" approach.

Similarly, when faced with a choice between a photovoltaic and a solar thermal system to power the building or pieces of the building, the direction of the design team reflects these same replicability goals. That is, though many solutions are available to the team to consider in future design phases, a more reliable and replicable system will tend to be chosen over a demonstration of a new technology.

Designing for the Future; Not Building the Future

Along these lines, one final reflection of this particular client and the parameters they suggest is found in the notion of designing for the future and not building it. Though the Foundation is always considerate of emerging technologies, it is more interested in providing flexibility to incorporate proven strategies in the future, rather than risking significant funds on strategies that may not prove replicable.

Two examples of this attitude include the use of raised access flooring and the incorporation of chaseways for hydrogen delivery to cars in the parking garage. The raised access flooring provides a material-efficient approach while allowing for considerable flexibility when moving workstations and incorporating yet-developed technologies, while the garage chaseways incorporate simple planning to avoid expensive retrofit for possible emerging technologies in the future.

Parameters and Assumptions

Assumptions

While the aforementioned parameters lay the ground rules for the particulars of this study, design decisions for the various building scenarios begin to incorporate a broad range of assumptions made by the design team based on their collective knowledge of the design and construction industry as well as fundamental sustainable design strategies. The following pages attempt to describe the approach taken by the team and the assumptions extrapolated from that approach. The particular approach adopted by the team to incorporating LEED™ guidelines, one of many ways a team can use this tool, is further reflected in the subsequent scenario descriptions. More assumptions that pertain to specific building components and system design choices follow.

Approach to LEED™

The team approach to LEED™ is a very particular and methodical approach for the purposes of this study. In practice, LEED™ can be used as a tool in many ways. Often, design teams approach LEED™ from a "lowest hanging fruit" method, by which the easiest and least expensive points are accomplished first. Other projects approach LEED™ from a "greatest impact first" perspective, whereby the points that will achieve the greatest environmental impact/benefit or the greatest payback are accomplished first. For this study, the team selects a modified "low hanging fruit" approach. The easiest, least technology driven and least expensive (first cost) points have been selected for the lower levels of LEED™. With each level, more difficult points are incorporated into the design. However, to ensure a holistic design, the points have been distributed evenly between each of the five categories for each successive level of LEED™. For example, while certain Materials and Resources credits might be more challenging to achieve than certain Sustainable Site credits, the balance of LEED™ points in each category forced certain material credits to appear sooner than they might in an actual project. To be even more specific, rapidly renewable materials and salvaged materials show up in LEED™ Certified when they might typically show up in LEED™ Platinum, or not at all, on an actual project. In most cases, while it is easy to use these materials, it is very difficult to use so many of them that they add up to 5 percent of the total construction cost. It may seem counter-intuitive to those familiar with LEED™ to show those points early, but it was necessary to distribute the points evenly within the Materials and Resources section.

There are certain LEED™ points that were removed from the study because they are not specific to this client. For example, there are no existing buildings on the site that can be reused for their purposes and the site is not a brownfield site. While the client supports public transit and less parking, the Los Altos community wanted more parking that could be used by the other businesses in its downtown. Because the client wanted to use certified wood as an absolute rule, certified wood was moved to the early levels of LEED™ when it might show up later on other projects, as mentioned earlier.

There are also points that appear at later levels though they seem like "easy" points. This has to do with some amount of controversy about the points themselves. Two examples of those points include the non-HCFC refrigerant credit and the low-emitting paint credit. Because HCFC chillers on the market are still the most efficient chillers, and because the newer refrigerant options have controversially harmful implications as well, the team feels it is better to acknowledge that this is a complicated issue. Likewise, because so few paints are actually tested and measured by GreenSeal™ it can be very difficult to verify that paints meet the standards. It is also arguable that the paints that meet these standards are truly the safest paints for the occupants of a building. These examples show that some of the points that may appear on the surface to be easy could actually be very challenging and controversial issues.

Finally, there are some LEED™ points that we anticipate achieving, though these are not necessarily included explicitly in the project narratives or summaries. Strategies that fall under this category include incorporation of showers and bicycle storage in the design.

Basic Distinctions between Sustainability Levels

In order to distinguish successive conceptual models, a basic overall strategy is used to incrementally improve each key building component, from building orientation and footprint, to envelope design and mechanical/electrical systems, to material choices and so on. The selection of the design systems at each level is based on such factors as the cost of the measure or system, the added value and life-cycle cost, the sustainability impact, the ease with which the measure or system could be implemented and the experience that the design team has with the public perception of various technologies. In addition, the amount that a technology or technique deviates from the market norm is considered as well. For example, the use of techniques such as neutralizing the building perimeter with shading devices is not considered to be normal market practice. Finally, the simpler a system or the more passive and permanent the approach, the more sustainable and replicable it is. Therefore, as the sustainability goals increase, each system becomes more passive/simpler and more user-controlled. As suggested in the Parameters, the team acknowledges that the choices made for this particular study may not be appropriate for a similar analysis of a different building type on a different site in a different climate with different client goals. The team believes that it is appropriate to collaboratively study a broad range of form-giving factors and to integrate the best solutions in each category to find the optimal solution.

Market Building

The Market building is designed according to basic requirements for a Class "A" office building per real estate standards in the San Francisco Bay Area and the lowest first costs of building construction. The two-story building uses the entire site, creating deep floor plates and allowing only a small amount of perimeter daylighting to exterior offices. The mechanical system is oversized and works inefficiently based on developer standards for plug and lighting loads. The HVAC distribution system is designed for minimal zones that effect comfort and employee productivity. Structurally, the building is built with lightweight steel that is quick to erect and has lower first costs. Indoor environmental quality is compromised based on material selection that has volatile organic compounds and other health-related toxins. Water usage within the building meets the current Title 24 code requirements, and is dependent on the municipal water supply and waste system. The life expectancy of the Market building is 40 years.

LEED™ Certified Building

The LEED™ Certified building takes the Market building and improves its performance with the lowest first cost requirements from each of the LEED™ categories. The building's HVAC system design is based on reasonable assumptions of lighting and power loads that would be typically associated with standard office equipment. The overall reduction of loads and increased efficiency of the building achieved through additional commissioning would save 30% of the energy consumed by the Market building. Building materials that are easily available in the local area are chosen for their recycled content, low emittance of volatile organic compounds and the embodied energy required to produce and deliver the materials to the site. All of these materials have a small impact on the overall budget based on their ready availability in the local market and help to reduce some of the global impact of the energy and pollutants required to build the building. The landscape materials are selected to reduce irrigation requirements for the project and the demand for potable water usage. Low flow fixtures and waterless urinals further reduce the reliance on the potable water requirements. The process of construction is modified slightly to recycle or salvage some of the construction waste and provide for indoor air quality standards during construction. The life expectancy of the LEED™ Certified building is also 40 years.

LEED™ Silver Building

The design of the LEED™ Silver building incorporates larger moves toward higher levels of sustainability. The building's footprint is a maximum of ninety feet wide to allow for additional daylighting and views from a higher percentage of the building's floor area. This small modulation of the plan forces the building to become three stories in height and have a higher skin-to-floor ratio for additional costs. The amount of glazing on the exterior skin is dropped from sixty percent in the Market building to forty percent of the wall area, which reduces the lowest energy performing component of the building skin. Glazing locations are chosen to optimize views and daylighting potential for the building. Windows are operable to allow for longer periods of natural cooling. Sunshades introduced on the south façade help reduce solar gain and provide glare control for the building occupants. The building mechanical system has transitioned from the typical overhead distribution to an underfloor system. Raised access flooring allows for efficient air distribution at higher temperatures and lower velocity with control points for individual user control. Photovoltaic panels are introduced to accommodate a small percentage of the overall building electrical load. The photovoltaic panels start to reduce the environmental impact of the pollution generated by the local utilities. The building continues to use water more efficiently by using rainwater and low water landscape so that no potable water is required for landscape purposes. Indoor air quality is enhanced by isolating printers, copy equipment and cleaning products, and minimizing exposure to long term volatile organic compounds. The life expectancy of the LEED™ Silver building is increased to 60 years.

Parameters and Assumptions

LEED™ Gold Building

The LEED™ Gold building takes strategies incorporated in the LEED™ Silver building and starts to push towards a higher level of efficiency and building system integration. The building's footprint is a maximum of sixty-five feet wide to allow for daylighting and views for two-thirds of the spaces in the building. This building remains three stories in height, but is oriented so that the majority of the building has its primary orientation in the east-west line, allowing for the integration of sunshades and light shelves to enhance daylight penetration and to protect the building from direct heat gain along the south façade. The east and west elevations have a limited amount of glass, which are partially shaded to control the early morning and late afternoon heat gain and glare. Integration of natural ventilation in a partially mixed mode HVAC system is utilized to gain additional mechanical system efficiency. The building's structural system shifts from the lightweight structural system of steel to concrete to provide a thermal mass that allows the building to be cooled at night with an opportunity to cool the building during the day. The concrete frame utilizes large amounts of flyash instead of Portland cement to reduce the embodied energy in the concrete. Photovoltaic panels are increased to account for ten percent of the overall building electrical load, beginning to be economically viable because of the overall reduced loads in the building. All the landscaping now requires no water (xeriscaping), allowing all storm water to be reused in the toilets within the building. Construction is modified to recycle or salvage most of the construction waste and provide for high indoor air quality standards during construction. The life expectancy of the LEED™ Gold building increases to 80 years.

LEED™ Platinum Building

The design of the LEED™ Platinum building is one that is completely integrated with its site, systems and occupants. The building's footprint is now a maximum of forty-five feet wide to allow for daylighting and views for all spaces within the building. This building remains three stories in height, but is now orientated so that the majority of the building maintains a primary east-west orientation. The east and west elevations are fully shaded to further reduce the amount of morning and afternoon heat gain and glare. The building's HVAC system design is based on lighting and power loads that are created by office equipment that is Energy Star®-rated or better and highly efficient lighting that is controlled by daylight sensors. A full mixed mode strategy is incorporated into the building control system so that the building can switch to a naturally ventilated passive cooling mode whenever external conditions allow it. Additional massing is incorporated into the building to add cooling capacity from lower outside temperatures when conditions allow. Photovoltaic panels are increased to twenty percent of the overall building electrical load, becoming even more economically viable since the building is optimized for maximum efficiency. Water use is reduced again by reusing greywater from sinks and showers to flush toilets. The life expectancy of the LEED™ Platinum building is set at 100 years reflecting the overall commitment to building durability as it relates to sustainability.

Living Building

The Living Building reaches a higher level of sustainable design by creating zero net annual pollution and waste in its daily operation. After minimizing the electrical loads to the greatest extent possible in LEED™ Platinum, the Living Building takes into account all the energy required by the building by providing enough photovoltaic panels to fully supply the electrical needs of the building over a year. All the building materials are selected based on a life-cycle assessment that accounts for the material's embodied energy, manufacturing pollutants, ability to be recycled, effect on indoor air quality and impact on the local economy. This requirement increases the research time required at the LEED™ Platinum. The Living Building becomes self-reliant for its water needs by the introduction of an ecological wastewater treatment system that uses natural processes to clean wastewater for reuse throughout the building. The Living Building also has a life expectancy of 100 years.

Specific Building and System Design Issues

In the case of building width and orientation, a progressive approach to modifying these parameters matches the goal to reduce energy requirements and increase appropriate access to daylight and ventilation for each successive scenario. This strategy provides an increasingly higher performing building with regard to energy, health and productivity, etc. The Market and LEED™ Certified buildings both maximize the site area with building square footage creating a 120-foot wide building with no particular concern for solar orientation. The LEED™ Silver building begins to acknowledge the benefits of access to daylight and views for occupants by keeping the building width to a maximum of 90 feet through the creation of courtyards and a third floor. In the LEED™ Gold scenario, the building width is further reduced to 65 feet while the primary wings of the building are oriented to optimize solar access for daylight control and the photovoltaic arrays. In LEED™ Platinum and the Living Building, the building depth is reduced to 45 feet in order to optimize the daylight factor, natural ventilation and efficient under-floor air distribution for all occupied work areas. As the building design progresses, there will need to be a balance between the energy benefits, environmental benefits, immediate programmatic efficiencies, structural efficiencies and concerns for future flexibility, just to name a few. A narrow footprint is not the only way to optimize daylight and natural ventilation; it is simply the easiest way. To design the optimal building footprint in terms of structural and workplace module, which can influence the long-term usability of the building with respect to accommodating various uses over the course of 100 years, an ideal building width will be determined as the design progresses.

Workplace

Basic assumptions have been made regarding the percentages of open and closed offices for each of the scenarios, based on initial assumptions that an entirely open office plan would benefit energy-efficiency and flexibility over time. During parallel research on workplace effectiveness for the Foundation, it has been determined that a more dynamic workplace will probably be considered in future design work for this particular client. A more dynamic workplace will include "hybrid" work areas that can be closed for individual concentration, open for small group collaboration and arranged near common spaces that will encourage spontaneous collaboration. Acoustics, flexibility, natural ventilation and daylighting will remain driving forces in the design of those work spaces.

Parking Garage

As mentioned in the Parameters, the garage is assumed in all scenarios to have the same car count, which is based on the minimum zoning requirements. Parking has been a particularly sensitive subject in the town of Los Altos and was assumed unchangeable at the time of this study. The garage is entirely underground with light and air wells in some scenarios, which were included to reduce the amount of mechanical exhausting that would be required and provide natural light to improve the subterranean space.

Performance Criteria

In most cases, the design team has assigned performance targets for each scenario rather than choosing particular products. These performance targets, outlined on Pages 22-24, will guide the team in the writing of technical specifications and in the choosing of products such as glazing, roofing, light fixtures and controls.

Building Envelope and Insulation

With each progressive scenario, the building section and insulation properties improve. At conceptual design, this is based on the assumption that by tightening envelope design and increasing insulation R-values, energy performance will also become increasingly more efficient in a climate where some heating and cooling is required. A parametric study has not been done at this stage of design to determine at which point the wall section and insulation values are optimized for the climate and building conditions, though this will be necessary in future design phases.

Approach to ASHRAE + How the Mechanical Systems Exceed It

The mechanical systems are designed to be more efficient as the various scenarios increase in sustainability. As is the case with a truly integrated design, some of the efficiency is gained by making the whole building design more efficient and the user's relationship with the building more active. The mechanical systems will increasingly exceed ASHRAE in two separate ways - more efficient equipment and better overall system design. The first approach involves the purchase of more efficient equipment that exceeds the standards set out in the document. The second approach involves using the design of the building to not only exceed ASHRAE's envelope requirements, but also to accommodate systems such as the underfloor air system, which takes full advantage of natural principles to work more efficiently. In higher levels, the system choices improve even more on the inherent efficiency of the building design, making a system that will scale back its operation when the users do not need it or when the outdoor conditions allow a more passive system to operate.

Temperature (Comfort) Ranges

Title 24, California's Energy Code, mandates a certain temperature band that separates the heating temperature from the cooling temperature. This band not only prevents the system from cycling rapidly between heating and cooling, but also allows the building to take advantage of temperate outdoor conditions for a greater length of time, reducing both the load and the demand placed on cooling and heating equipment. The design team extends this band in the more sustainable schemes because in those schemes greater control over local space conditions is placed in the hands of the occupants. This control is provided through opening windows and adjusting the raised floor diffuser system. (When users have greater control over their environment, some believe that they tend to be more tolerant of wider temperature fluctuations. As a result, the design team incorporated wider fluctuations over the year into the design of the systems, taking advantage of the energy savings that can be achieved with this strategy.) The comfort temperature ranges assumed for the controls system can be seen in the list of the Building Components and Energy Model Performance Criteria.

Daylighting

Though many materials are available for light shelves and sunshades, simple metal sunshades, wire screens and a frosted glass light shelf have been selected for this conceptual design. The light shelves and sunshades would need to be designed and tested in the final daylighting design. Though other material choices may be more appropriate to meet a more developed aesthetic and material palette, the team makes several assumptions about the design for the sunshades. There are so many possible solutions for sunshades and light shelves that the team focused on the most common and straightforward methods at the conceptual level. As the scenarios progress, the shading becomes more and more comprehensive. In LEED™ Certified, no shading is added. In LEED™ Silver, a horizontal shade is added to the south. In LEED™ Gold, horizontal shades remain on the south and an exterior screen wall is added in front of the east and west façades, and so on.

Glazing

As mentioned, the glazing strategies are based on basic rules of thumb and intuition, whereby the percent of glazing at the building's perimeter decreases as the glazing is "optimized" for daylighting. The goal in this facility is to balance heat gain with daylight. While some educated guesses have been made conceptually to design and model different incremental changes, a thorough analysis and modeling would need to be done throughout the design process.

Ceiling Treatment

There are various arguments and counter-arguments for using a suspended acoustical ceiling. If open office planning is part of the design, suspended ceilings can provide needed acoustical treatment. These ceilings can also offer a reflective surface for daylight design. Criticisms of suspended ceilings include the possibility of a monotonous horizontal plane, additional material costs, loss of some height and possibly moisture absorption and dust collection. Furthermore, suspended ceiling systems do not generally last for the life of a 100-year building and so replacement costs would need to be added to the building's upkeep and maintenance. The material limitations and indoor air quality issues related to traditional suspended ceilings are a valid counter-argument in support of the use of exposed ceilings. The exposed concrete surfaces in this building are used to minimize material duplication with the use of raised access flooring, to maximize ceiling height for daylighting and for their thermal mass characteristics. It is acknowledged that acoustics will be addressed in other ways.

Water Efficiency

With each progressive scenario the efficiency of water systems is incrementally increased. Xeriscape landscaping, efficient fixtures including waterless urinals, greywater systems, rain water collection and ecological wastewater treatment technologies are all included at various levels. Composting toilets are not being considered because the client is not particularly interested in pursing this technology due to how they see the building being used. The team believes that with the somewhat transient nature of a large building population the composting toilet would not be ideal, though it is possible to use composting toilets in a multi-level facility. With the additional concern that local governmental agencies may not easily adopt the use of these fixtures, the decision not to use composting toilets seems reasonable.

Emerging Technologies: Fuel Cells and Photovoltaics

Fuel cell technology continues to be promising and exciting, but remains more appropriately on a list of emerging technologies that this client will keep an eye on for now, rather than incorporate into the design of a new facility. Fuel cells have been considered for this study, but have not been found to be a cost-effective technology at this time or for this particular project. Because the fuel cells available today for buildings primarily use natural gas as a source of hydrogen, they continue to rely on non-renewable fuel and add cost to the operating expenses. There is also some pollution produced in refining and processing the natural gas, which adds operating pollution to the building. The current fuel cells are not yet sufficiently mass-produced to reduce their first cost, and have not yet reached the efficiency levels required to allow for a long term payback. While the team continues to believe that fuel cells are important to the building industry in the future, the promise is not yet realized. In addition, the replacement of fuel cell stacks and the maintenance requirements are not yet manageable at the scale of this particular project. The project will probably be designed with a place for a future fuel cell, but at this time the project is excluding the fuel cell from all scenarios, while relying on photovoltaic technology for its varying levels of renewable energy.

Photovoltaic panels in the Living Building are designed to account for the total energy required for the operation of the building in a one-year period, a solution which relies on the net metering principal. More detailed descriptions of fuel cells and photovoltaics are included in the Technology section of the Appendix of this report.

Construction Costs

The cost breakdowns are based on a Systems format, which categorizes job site activities roughly according to their sequence in construction. This approach to cost estimating is more helpful to the project team at this more conceptual stage of design.

5% Annual Energy Inflation Rate

The annual increase in energy costs is assumed to be 5% and is based on the wide fluctuations in the energy market in this area of the country. In a climate where the whole continent is moving towards deregulation, this number appears to represent the best assumptions that can be made at this time.

5% Cost of Capital

The 5% cost of capital is based on The David and Lucile Packard Foundation's perceived average rate of return on its investments in the market at the time of the study. Variables to this number would be explored in the next steps of the project to reflect a wider range of projections.

Construction Schedule Impacts

There are three basic categories illustrated in the project schedules: Additional Research, Design and Construction. Each portion of the schedules acknowledges increased design and construction time required by the team to provide an increasingly effective integrated design and building. The Design schedules shown represent the team's best estimate for an appropriate amount of design time for the various levels, with notes under each calendar suggesting how these schedules would be broken down with respect to the standard phases of Schematic Design, Design Development and Construction Documents. Additional Research refers to extra study required by the design team at each level to provide integrated systems and design that are atypical of the standard design and construction process. This may include investigating emerging technologies or it may involve additional in-depth research into the site or materials that may provide long term payback to the client. The construction schedule shows an increase when the structural system switches from steel to concrete and is compounded by the use of large amounts of flyash within the concrete that will slow the curing process. Exposed concrete work will also factor in to the setup time of formwork as more and more of the building becomes exposed in each subsequent scenario. Additionally, phasing of construction to protect indoor air quality can extend the construction schedule.

External Cost to Society and Pollution of Operation

The team is aware of the tremendous cost that is externalized to society-at-large when construction or building operation results in environmental damage or wasteful use of resources. There is also embodied energy and pollution for every building material used in a building. Trying to quantify those costs proves to be a challenge when there is no standard monetary value assigned to clean air, fresh water, healthy children, biodiversity and natural systems that serve all species. It was, and is, still important to the team to attempt to illustrate this concept and give a comparison of at least one external cost to society that could be quantified. This study limits the negative environmental impacts estimated to air pollutants generated by building operations. While the data used to determine the cost to society may be considered both outdated and conservative, it serves as a constant variable to allow comparisons to be made until more relevant or accurate data is made available. The relative effect of reducing the amount of energy used in a building, and therefore the pollution created, can be easily demonstrated, if not the actual cost to society for pollution.

1 Market: Site Plan

Existing

Proposed

1 Market: Building Narrative

The following narrative was prepared, based on conceptual design work required to flesh out a set of assumptions, so that each building scenario could be adequately priced and its operational impacts (pollution and costs) determined. Reasonable assumptions were made for each scenario based on the team's collective knowledge.

1.0 Site Preparation

The site is 142 feet by 400 feet for a total square footage of 56,400 square feet. Site preparation is to begin with demolition of the existing structures with general haul off to a landfill for all materials.

The site is to be excavated in order to begin construction of the underground parking structure. The lowest level of the parking structure is at an elevation of 35 feet below the existing sidewalk elevation for the three levels of parking. The garage ramp will be excavated outside the footprint of the garage. Retain 35 feet of soil around the entire perimeter of the site for the garage. The primary method for retaining the soil is to use steel sheet piling. The bottom of the excavation is assumed to be in the water table and, therefore, requires extensive dewatering during the construction process.

2.0 Substructure

The perimeter foundation walls are 12-inch thick concrete and are to be placed on a continuous footing bearing on a 2-foot thick matt footing under the entire structure.

3.0 Superstructure

Garage Framing (120 feet x 135 feet x 3 floors =135,000 sf)
The garage framing is to consist of 7-inch cast-in-place concrete beams at 30 feet on center. Interior column size is to vary with larger columns required at building column locations above.

The concrete mix for the garage deck is to consist of a three-percent silica fume admixture with portland-pozzolan cement.

Office Building (120 feet x 375 feet x 2 floors = 90,000 sf)
The office building's second floor structure is assumed to be an eccentrically-braced steel frame structure with bar joist, metal decking and 4-inch concrete slab. The roof deck is assumed to be similar without the concrete topping. The typical bay sizes correspond with the garage structure.

The office building is to be rated Type II-FR, which requires two-hour fireproofing for the structural frame.

4.0 Exterior Enclosure

Office Building
The office building's skin is composed of 60 percent glazing and 40 percent precast or equivalent material. The precast wall consists of 7-inch precast panels with vapor barrier, metal stud backup, a of R-13 insulation and gypsum wallboard sheathing interior. The exterior wall is not thermally broken, leading to a total wall assembly resistance value of R-8.

The glazing system is a Kawneer 451T storefront system. Glazing is to be one-inch insulated units with a conductance value (U-factor) of 0.42, shading coefficient (SC) of 0.60 and visible light transmittance factor (VLT) of 0.71. This glazing applies to all sides of the building. The windows are fixed.

The mechanical units on top of the building are to be screened on four sides by 8-foot high horizontal louver walls in two locations on the roof.

5.0 Roofing and Waterproofing

Garage
The garage is to be waterproofed by a combination system of bentonite clay panels at the exterior walls and below-grade slab, and an under-slab drainage system. The drainage system is to be pumped from a sump within the garage to the city storm sewer.

The thermal barrier between the uppermost garage and the first floor of the office building is to be insulated with a layer of R-16 insulation over a suspended ceiling and would have a total R-value of R-19.

Office Building
The roof is to be a modified bitumen roof over an insulation base of R-30. Perimeter conditions and penetrations at the roof cause the actual roof R-value to be R-20.

6.0 Interior Construction

Office Building

The interior of the office building is predominantly an office environment with minimum lobby space. The ratio of closed offices to open space plan would be 60 percent closed to 40 percent open.

Construction finishes are to be carpet tiles, painted gypsum wallboard, 10-foot high lay-in ceiling, wood trim at windows and doors, hollow metal frames and wood doors. It is assumed that only two percent of the interior partitions would be glass. One-inch metal window blinds provide sun control at the windows.

7.0 Conveying System

There are to be two 3,500-pound passenger hydraulic elevators with five stops each. The building is to have two stairs. Five levels of stairs are to be steel pan with concrete fill. Roof and elevator pit ladders are required.

8.0 Mechanical Systems

Plumbing Garage

There are to be floor drains provided for the parking area. The floor drains are to be collected and routed to a sand/oil trap and sumps located at the lowest level. There are to be 12 drains for each level of the garage. The floor drains are to be routed to separate risers. Each 4-inch riser is to tie into a common 6-inch header at the lowest level. The sump will have two pumps at 10 horsepower each. There are to be three hose bibbs per parking level.

Plumbing Building

There are to be a total of 30 toilet room fixtures, three service sinks, four drinking fountains, and four kitchenette sinks. All plumbing fixtures are to be durable, efficient and low-flow. A 6-inch sanitary riser serves the core toilets. A 4-inch domestic water line provides service to the building. The water service is to be provided with an estimated two-inch water meter. Four 10-gallon, 12-kilowatt electric, point-of-use water heaters located in the garage will furnish the domestic hot water.

Storm water for the building is to be collected in 6-inch roof drains connected to four 6-inch vertical risers to the lower level where they exit the building through a 12-inch line. There are to be approximately 12 roof drains. Overflow scuppers are to be provided.

HVAC Garage

There are to be three exhaust and three supply fans with seven horsepower each for each level of the garage. These supply and exhaust fans are to be controlled by a carbon monoxide monitoring system. There are to be four sensors for each level to control the appropriate fans.

HVAC Building

The building is to be supplied with a variable air volume system. There are to be two roof-top air handling units supplying air to the space. One unit is to serve the north half of the building and one unit is to serve the south half. Each unit is to be 67,500 cubic feet per minute at 55° Fahrenheit supply air temperature. Outdoor air is to be supplied at a minimum rate of 20 cubic feet/minute/person based on ASHRAE 62-1999 standard office occupancy of 150 square feet/person. Each variable air volume box is to serve approximately 1,500 square feet. Heating for the building is to be provided with hot water reheat coils in the variable air volume system.

There is to be an electric, air-cooled, screw-type chiller of 375 tons. An 80 percent efficient, 950 MBH gas-fired, low NO_2 boiler is to be located in the mechanical room and supply the heating water.

Zone level thermostats are to control the supply air volume into each space. The temperature tolerance is to be set at Title 24 minimum (74°/70°F) bibbs.

Distribution ductwork is to convey the air to the spaces. The square cone diffusers are to be standard, lay-in 24-inch by 24-inch steel diffusers. Balancing dampers are to be provided on each branch. A complete DDC control system is to be provided. All HVAC systems in the building are to be commissioned at start-up.

Fire Protection Garage

The parking garage is to be fully sprinkled by using approximately four wet pipe risers located throughout the parking garage. This requires an 8-inch service into a fire protection room for location of the pipe valves and air compressors.

Fire Protection Building

The building is to be served by a 6-inch fire protection water service with a backflow preventer. The building is to be fully sprinkled with a density of 0.15 gallons/minute/square foot for the most remote 1,500 square feet. A standpipe is to be provided in each stairwell.

9.0 Electrical Systems

Site Services

Utilities are to be supplied underground from the property line to the main electrical room in the first level of the parking garage. All services are to run in concrete encased ducts with one spare duct for each three ducts utilized.

Pedestrian sidewalk lighting is to consist of 175 watt decorative luminaires on 8-foot poles. A total of 20 lighting standards is required to light the site.

Electrical Garage

The parking garage is to be illuminated with 175-watt metal halide cutoff luminaires to an average maintained five footcandles. The fixture is to be equal to Gardco GP1 or Kim Parkade Lighter- one fixture for every 900 square feet, for a total of 150 luminaires for all three levels. The lighting will be contactor controlled, with one switch controlling multiple banks of lights. The stairs are to be illuminated with 4-foot strip T-8 fluorescent luminaires with wire guard at each landing.

Combination starter/disconnects are to be used in a fourplex motor control center for the ventilation fans. A carbon-monoxide detection system is to interface with the starters for control of the fans.

A 150-amp, 480/277-volt, 3-phase, 4-watt service is required to service the parking garage and is to consist of a central distribution panel in the main electrical room to supply 100 amperes to each level of the parking garage. Each level of the parking garage is to have a splitter trough and disconnect switches to supply a 70-amp 480/277 volt lighting panelboard and a 480-volt modular MCC for the mechanical loads. On level one of the garage, a 15,000-volt amps, 120/208-volt dry transformer is to supply power to a panelboard for 120-volt convenience outlets (a total of 15 per floor) is to be located in service areas and perimeter walls throughout the parking garage.

Electrical Building

The building's interior lighting is to consist of direct/indirect extruded aluminum luminaires using two T-8 lamps. A total of 6,400 lineal feet of this type of lighting is required. Occupancy sensors are to control the lighting in the washrooms and storage rooms. Low voltage switching for lighting control with local switching capability as well as tie-in to the building management system is to be provided.

A 1200-kilowatt, 480/277-volt, 3-phase electrical service is to be provided. The service entrance is to consist of a 2,000-amp fused switch with 1,600-ampere HRC fuses and a 2,000-amp distribution board. A main electrical room is to be located on level one of the parking garage.

An emergency generator room is to be located adjacent to the main electrical room. A 200-kilowatt generator is to supply the building life safety systems, critical mechanical loads, and an uninterruptible power supply for essential computer circuits.

On each floor there are to be three sub-electrical/communication rooms, approximately 9-feet by 12-feet each of which is to be supplied with a 200-ampere, 480-volt feeder. These sub-electrical rooms are each to contain a communications backboard, 45,000-volt amp transformer for 120-volt loads, 277-volt lighting panel, motor starters to supply mechanical equipment. One sub-electrical room on each floor is to have a 277-volt emergency panelboard.

The building requires a microprocessor-based fire alarm system to meet current code requirements. A total of four remote alphanumeric annunciator panels are required.

Telephone and data to category 5E standards is to be distributed using a ridged cable tray system above the ceiling. A total of 300 workstations are to be provided with one outlet each. Allow for 150 workstations with two data outlets each and an uninterruptible power supply (UPS) system.

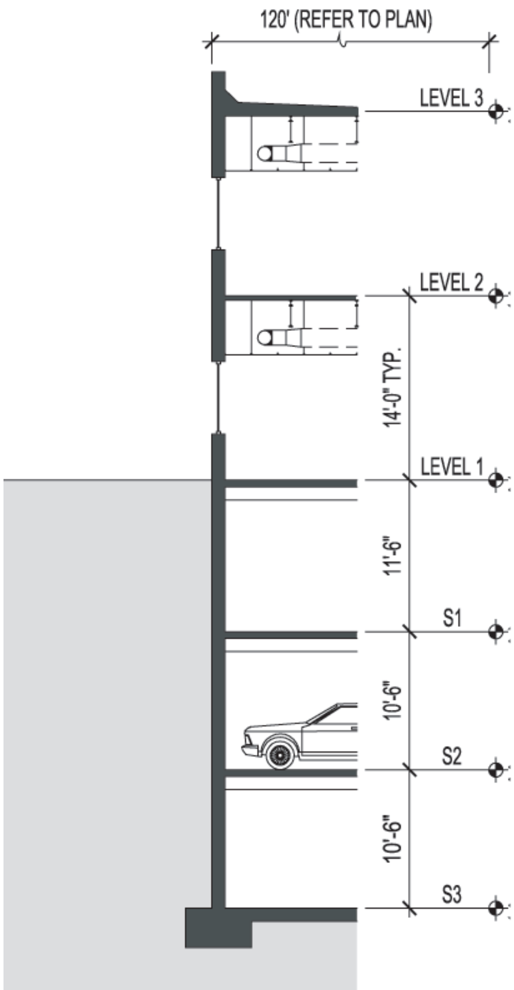
A fiber optic backbone and cable TV distribution system are to be provided to each communications room.

An electronic security system is to be provided consisting of a PC-based management system, door contacts, card access control with varying levels of security throughout the building, and closed circuit TV monitoring of the parking garage, public areas and data rooms.

10.0 Sitework

The remaining site is to be sodded, with an irrigation system. Street trees are to be 1-1/2 inch caliper trees along the two city streets at 30 feet on center. New sidewalks and landscaped islands between the sidewalk and street are required.

1 Market: Wall Section and Description



Office: 2 floors @ 45,000 square feet
Garage: 3 floors @ 45,000 square feet

- Roof top mechanical unit with louvered screen
- Modified bitumen roof over R-30 insulation and metal roof deck; total R-value for the roof assembly is R-20

Office Structure

- Steel eccentrically-braced frame with bar joists
- Metal floor deck with concrete floor

- 60 percent of the envelope is to be Kawneer store-front glazing system; all orientations of glazing:
  - 1" insulated glazing - fixed
  - .42 U-factor
  - .60 shading coefficient
  - .71 visible light transmittance

- 40 percent of envelope is:
  - 7" precast or equivalent
  - Vapor barrier
  - Metal stud backup
  - R-13 insulation
  - Gypsum interior wall board

- Total R-value for wall assembly is R-8

Garage

- Garage roof contains R-16 insulation and a suspended ceiling; total R-value for the roof/floor assembly is R-19
- Garage structure: 30' on center cast-in-place concrete frame
- Bentonite clay waterproofing at wall and slabs
- Underslab and foundation wall drain system

1 Market: Detail Cost Summary

Project Cost Summary

Construction Cost		
Building		$4,797,132
Parking		$4,062,226
Subtotal Construction Cost		$8,859,358
Construction Contingency	7.5%	$664,452
Escl to Constr Start May 2002	5.0%	$476,190
Total Hard Cost		**$10,000,000**
Soft Cost		
Design & Management Fees		$1,300,000
Fixtures Furnishings & Equipment		$804,575
Permits, Fees & Other Services		$500,000
Owner Administrative Fee		
Subtotal Soft Cost		$2,604,575
Soft Cost Contingency	10.0%	$260,457
Soft Cost Escalation on FF&E	9.0%	$72,412
Total Soft Cost		**$2,937,444**
Other Costs		
Artwork		Excluded
Fundraising/Financing		Excluded
Land Acquisition		Excluded
Total Project Cost		**$12,937,444**

1 Market: Detail Cost Summary

Building Construction Cost Summary

			Cost	Cost/SF
1.0	Site Preparation		$49,041	$0.54
2.0	Substructure		$128,349	$1.43
3.0	Superstructure		$710,069	$7.89
4.0	Exterior Closure		$574,415	$6.38
5.0	Roofing & Waterproofing		$115,578	$1.28
6.0	Interior Construction		$890,958	$9.90
7.0	Conveying Systems		$60,381	$0.67
8.0	Mechanical Systems		$667,226	$7.41
9.0	Electrical Systems		$504,928	$5.61
10.0	Finish Sitework		$127,710	$1.42
Subtotal Costs			$3,828,655	$40.58
	General Conditions	9.0%	$344,579	$0.00
	Contractor's Fee	4.5%	$187,796	$0.00
	Design Contingency	10.0%	$436,103	$0.00
Total Building Construction Cost			**$4,797,132**	**$53.30**

Note: Cost above excludes construction contingency, escalation and soft costs.

1 Market: Detail Cost Summary

1.0 Site Preparation		
Earthwork		
Clearing and Grading	$9,195	
Erosion Control	$1,277	
Demolish Existing Building	$16,858	
Utilities		
Utility Connection	$19,157	
Miscellaneous	$2,554	
Subtotal 1.0 Site Preparation		$49,041
2.0 Substructure		
Foundations	$38,313	
Slab on Grade	$80,457	
Miscellaneous		
Elevator Pit	$3,831	
Mechanical Pads	$1,916	
Concrete Curbs	$1,916	
Miscellaneous	$1,916	
Subtotal 2.0 Substructure		$128,349
3.0 Superstructure		
2nd Floor Structure - Braced Frame	$344,818	
Roof Structure - Braced Frame	$357,589	
Miscellaneous	$7,663	
Subtotal 3.0 Superstructure		$710,069
4.0 Exterior Closure		
Exterior Wall Assembly	$214,553	
Windows & Glazing	$284,513	
Doors Frames & Hardware	$15,964	
Exterior Miscellaneous		
Louvers	$1,916	
Signage	$3,831	
Soffits	$9,578	
Fascia & Trim	$13,410	
Trellises & Sunshades	None	
Mechanical Screen	$17,879	
Misc. Exterior Work	$12,771	
Subtotal 4.0 Exterior Closure		574,415

1 Market: Detail Cost Summary

5.0 Roofing & Waterproofing		
Roofing & Insulation	$89,397	
Skylights	None	
Sheet Metal	$22,349	
Caulking & Sealants	$1,916	
Miscellaneous Roof Accessories	$1,916	
Subtotal 5.0 Roofing & Waterproofing		$115,578
6.0 Interi or Construction		
Partitions		
Typical	$149,421	
Operable	$16,602	
Dropped Soffits & Fascia - Allow	$10,217	
Interior Glazing - Allow	$22,988	
Railings	$7,663	
Miscellaneous	$12,771	
Doors, Frames & Hardware - Wood	$153,252	
Floor Finishes	$137,927	
Wall Finishes	$35,759	
Ceiling Finishes	$137,927	
Millwork		
Kitchen	$9,195	
Storage & Workrooms	$14,048	
Conference Rooms	$26,819	
Chair Rail & Trim	$21,711	
Other Built-in Casework	$15,325	
Rough Hardware & Backing	$14,048	
Workstations	Inc. in FF+E	
Window Blinds	$36,321	
Specialties & Equipment	$68,964	
Subtotal 6.0 Interior Construction		$890,958
7.0 Conveying Systems		
Stairs & Ladders		
Stairs	$10,216.82	
Stairs	$20,433.64	
Roof Ladder	$204.34	
Elevator Pit Ladder	$408.67	
Elevators		
Passenger	$44,443.17	
Deduct Stops Assigned to Parking	($15,325.23)	
Subtotal 7.0 Conveying Systems		$60,381

1 Market: Detail Cost Summary

8.0 Mechanical Systems

HVAC	
Equipment Wet	
Boiler-Gas 950mbh w/SS Flue	$4,725.28
Chiller 375Tns Screw	$39,590.18
Pump-HW	$2,809.63
-CHW	$3,065.05
Equipment Air	
Air Handling Unit -w/S Fan/C HW&HW coil /pre&final filts/Exterior VFD/45000cfm:	$88,120.07
AC Unit for Tel/Elect	$12,132.47
Exhaust Fans	$5,108.41
VAV Box w/RH 1500sf/Box	$15,095.35
Miscellaneous Equipment	$6,385.51
Ductwork & Accessories	
Duct-GSM	$143,035.47
-Insulation/External	$20,433.64
Dampers & Accessories	$6,385.51
Fire & Smoke Dampers	$8,684.30
Registers & Grilles	$12,771.02
Misc Duct & Accessories	$5,108.41
Pipework & Accessories	
Pipe-HW w/ Insl.	$31,927.56
Pipe-CHW w/ Insl.	$7,662.61
Misc Valves & Specs.	$12,771.02
Controls & Testing	
Control-System/DDC-EMCS	$53,638.30
Commissioning	$8,939.72
Test & Balance	$12,771.02
Plumbing	
Fixtures & Equipment	
Water Heater-Elect 12kw/10gal.	$1,839.03
Tank-Expansion	None
Tank-Oil/Water Separator	Inc. in parking estimate
Pump-Elev.Sump	$1,072.77
Pump-DHW Recirc.	None
Pump-Sewer	None
Toilet Rooms Fixtures	$7,854.18
Sink Service	$463.59
Sink-Kit. Single	$587.47
Drinking Fountain	$3,473.72
Drains-Floor & Roof	$2,873.48
Backflow Preventer	$1,021.68
Misc Equip. & Fixtures	$1,277.10
Pipework & Accessories	
Pipe-Waste & Vent	$26,206.14
Drains-Floor & Roof	$2,873.48
Backflow Preventer	$1,021.68
Misc. Equip. & Fixtures	$1,277.10

Pipework & Accessories		
Pipe-Waste & Vent	$26,206.14	
Pipe-Storm	$15,631.73	
Pipe-CW w/Insl.	$19,156.54	
Pipe-DHW w/Insl.	$3,831.31	
Pipe-Gas	$1,596.38	
Misc Valves & Specs.	$10,216.82	
Fire Sprinkler System		
Wet System-Bldg w/ Standpipe System	$68,963.53	
Subtotal 8.0 Mechanical Systems		$667,226
9.0 Electrical Systems		
Primary Power		
Main Switchboard 2000A 1600 KW	$10,216.82	
Distribution Board 2000A	$1,787.94	
Panelboards	$7,049.61	
Emergency Power - 200KW Generator	$38,313.07	
Feeders - Allow	$13,792.71	
Equipment Power	$45,975.69	
User Power	$76,626.15	
Lighting	$172,408.83	
Lightning Protection	None	
Signal & Communications		
Fire Alarm	$45,975.69	
Telephone/Data Rough-In	$37,993.80	
Telephone/Data Cabling	Inc. in FF+E	
Security	$41,378.12	
Cable TV	$7,024.06	
Audio Visual Rough-In	$6,385.51	
Subtotal 9.0 Electrical Systems		$504,928
10.0 Finish Sitework		
Subtotal 10.0 Finish Sitework		$127,710

1 Market: Detail Cost Summary

Add for Underground Parking

Deduct Building Foundations	($38,313)
Deduct Building Slab on Grade	($80,457)
New Mat Slab	$298,523
Mechanical Pit	$3,831
Slab on Grade	$57,470
Underslab Drainage	$22,988
Shoring	$294,244
Excavation	$466,142
Dewatering	$25,542
Permanent Perimeter Drainage	$11,494
Retaining Walls	$294,244
Interior & Stem Walls	$14,304
Floor Structure	$664,093
Roof Structure	$344,818
Water Detention Basin	None
Pads, Curbs & Bollards	$5,108
Columns	$36,781
Ramp Slab	Included above
Ramp Walls	Included above
Waterproofing	$78,670
Topping Slab @ Roof	Inc. in sitework estimate
Partitions	$32,566
Insulation @ Roof	$22,988
Doors	$10,217
Painting, Striping, Mi sc.	$7,663
Signage	$3,831
Parking Equipment	$6,386
Stair Towers	None
Stairs	$22,988
Elevator - Additional Stops	$15,325
Mechanical Systems	$344,818
Electrical Systems	$275,854
Finish Sitework	Inc. in building estimate
Subtotal Cost	$3,242,116
General Conditions	$291,790
Contractor's Fee	$159,026
Design Contingency	$369,293
Total Parking Construction Cost	**$4,062,226**

2 LEED™ Certified: Site Plan

2 LEED™ Certified: Building Narrative

The following narrative was prepared, based on conceptual design work required to flesh out a set of assumptions, so that each building scenario could be adequately priced and its operational impacts (pollution and costs) determined. Reasonable assumptions were made for each scenario based on the team's collective knowledge.

1.0 Site Preparation

The site is 142 feet by 400 feet for a total square footage of 56,400 square feet. Site preparation is to begin with the deconstruction of the existing structures with a requirement that 50 percent of the materials by weight are to be recycled or salvaged. This includes the structure of the buildings and the soil that is excavated. The wooden structure at the corner of Whitney and Second Streets is to be salvaged and/or mulched.

The site is to be excavated in order to begin construction of the underground parking structure. A large amount of soil is to be diverted from the landfill in order to meet the requirements above. The lowest level of the parking structure is at an elevation of 35 feet below the existing sidewalk elevation for the three levels of parking. The garage ramp will be excavated outside the footprint of the garage. Retain 35 feet of soil around the entire perimeter of the site for the garage. The primary method for retaining the soil is to use steel sheet piling. The bottom of the excavation is assumed to be in the water table, which requires extensive dewatering during the construction process.

2.0 Substructure

The perimeter foundation walls are 12-inch thick concrete and are to be placed on a continuous footing bearing on a 2-foot thick matt footing under the entire structure. The concrete is to be 20 percent fly ash content.

3.0 Superstructure

Garage Framing (120 feet x 375 feet x 3 floors = 135,000 sf)

The garage framing is to consist of 7-inch cast-in-place concrete beams at 30 feet on center. Interior column size is to vary, with larger columns required at building column locations above.

The concrete mix for the garage deck is to consist of portland-pozzolan cement and local aggregate.

Office Building (120 feet x 375 feet x 2 floors = 90,000 sf)

The office building's second floor structure is assumed to be an eccentrically-braced steel frame structure with bar joist, metal decking and 4-inch concrete slab. The roof deck is assumed to be similar without the concrete topping. The typical bay sizes correspond with the garage structure.

The office building is to be rated Type II-FR, which requires two-hour fireproofing for the structural frame.

4.0 Exterior Enclosure

Office Building

The office building's skin is composed of 50 percent glazing and 50 percent precast or equivalent material. The precast wall consists of 7-inch precast panels with vapor barrier, metal stud backup, R-13 insulation and gypsum wallboard interior. Exterior wall is thermally broken, leading to a total wall assembly resistance value (R-value) of R-13.

The glazing system is a Kawneer 451T storefront system. The glazing is to be one-inch insulated units with a conductance value (U-factor) of 0.32, shading coefficient (SC) of 0.46 and visible light transmittance factor (VLT) of 0.70. This glazing applies to all sides of the building. The windows are to be fixed.

The mechanical units on top of the building are to be screened on four sides by 8-foot high horizontal louvers walls in two locations on the roof.

5.0 Roofing and Waterproofing

Garage

The garage is to be waterproofed by a combination system of bentonite clay panels at the exterior walls and below-grade slab, and an under-slab drainage system. The drainage system is to be pumped from a sump within the garage to the city storm sewer.

The thermal barrier between the uppermost garage and the first floor of the office building is to be insulated with a layer of R-16 insulation over a suspended ceiling and would have a total R-value of R-19.

Office Building

The roof is to be a modified bitumen roof over an insulation base of R-30. Perimeter conditions and penetrations at the roof cause the actual roof R-value to be R-30.

6.0 Interior Construction

Office Building

The interior of the office building is predominantly an office environment with minimum lobby space. The ratio of closed offices to open space plan is to be 50 percent closed to 50 percent open.

Construction finishes are to be carpet tiles, painted gypsum wallboard, 10-foot high lay-in ceiling, wood trim at windows and doors, hollow metal frames and wood doors. Two percent of the interior partitions would be glass. One-inch metal window blinds provide sun control at the windows.

Materials are to be selected with the overall LEED™ goals in mind. Twenty-five percent of the materials are to have recycled content. Fifty percent of the wood is to be certified. Twenty percent of the materials are to be regionally manufactured. Five percent of the materials are to be rapidly renewable. Five percent of the materials are to be salvaged. Volatile organic compounds (VOCs) emissions are to be limited for indoor air quality (IAQ).

7.0 Conveying Systems

There are to be two 3,500-pound passenger hydraulic elevators with five stops each. The building is to have two stairs. Five levels of stairs are to be steel pan with concrete fill. Roof and elevator pit ladders are required.

8.0 Mechanical Systems

Plumbing Garage

There are to be floor drains provided for the parking area. The floor drains are to be collected and routed to a sand/oil trap and sumps located at the lowest level. There are to be 12 drains for each level of the garage. The floor drains are to be routed to separate risers. Each 4-inch riser is to tie into a common 6-inch header at the lowest level. The sump will have two pumps at 10 horsepower each. There are to be three hose bibbs per parking level.

Plumbing Building

There are to be a total of 30 toilet room fixtures, three service sinks, four drinking fountains, and four kitchenette sinks. All plumbing fixtures are to be durable, efficient, and low-flow. All toilets shall be dual flush and all urinals shall be waterless. A 6-inch sanitary riser serves the core toilets. A 4-inch domestic water line provides service to the building. The water service is to be provided with an estimated 2-inch water meter. A 75-gallon, 75,000 BTU/h input gas fired, induced draft, glass-lined water heater will furnish the domestic hot water.

Storm water for the building is to be collected in 6-inch roof drains connected to four 6-inch vertical risers to leading to a 12,500 gallon tank in the lower level where they exit the building through a 12-inch line. There are to be approximately 12 roof drains and overflow scuppers. Storm water stored in the tank is to be used for 50% of the landscape irrigation.

HVAC Garage

There are to be three exhaust and three supply fans with 7-horsepower each for each level of the garage. These supply and exhaust fans are to be controlled by a carbon monoxide monitoring system. There are to be four sensors for each level to control the appropriate fans.

HVAC Building

The building is to be supplied with a variable air volume system. There are to be two rooftop air-handling units supplying air to the space. One is to serve the north half of the building and one unit is to serve the south half. Each unit is to be 45,000 CFM at 55° Fahrenheit supply air temperature. Outdoor air is to be supplied at a minimum rate of 20 cubic feet/minute/person based on ASHRAE 62-1999 standard office occupancy of 150 square feet/person. Each variable air volume box is to serve approximately 1500 square feet. Heating for the building is to be provided with hot water reheat coils in the variable air volume system.

There is to be an electric, air-cooled, screw-type chiller of 250 tons. The chiller is to have a rating of 0.62

kilowatts/ton at full load. An 80 percent efficient, 850 MBH, low NO2, gas-fired boiler is to be located in the mechanical room and supply this hot water.

Zone level thermostats are to control the air volume into each space. The temperature tolerance is to be set beyond Title 24 minimum (74°/68°F).

Distribution ductwork is to convey the air to the spaces. The square cone diffusers are to be standard, lay-in 24-inch by 24-inch steel diffusers. Balancing dampers are to be provided on each branch. A complete DDC control system is to be provided. All HVAC systems in the building are to be commissioned at start up and additional commissioning is to happen in the first year of occupancy. The energy use of the building is to reduce those standards set out in ASHRAE 90.1-1999 by 30 percent.

Fire Protection Garage

The parking garage is to be fully sprinkled by using approximately two wet pipe risers located throughout the parking garage. This requires a 3-inch service into a fire protection room for location of the pipe valves and air compressors.

Fire Protection Building

The building is to be served by a 6-inch fire protection water service with a backflow preventer. The building is to be fully sprinkled with a density of 0.15 gallons/minute/square foot for the most remote 1,500 square feet. A standpipe is to be provided in each stairwell.

9.0 Electrical

Site Services

Utilities are to be supplied underground from the property line to the main electrical room in the first level of the parking garage. All services are to be run in concrete encased ducts with one spare duct for each three ducts utilized.

Pedestrian sidewalk lighting is to consist of 250-watt metal halide cut-off decorative luminaires as manufactured by Kim or Gardco on 25-foot poles. A total of 20 lighting standards are required to light the site. Light trespass from the site is to be minimized.

Electrical Garage

The parking garage is to be illuminated with 175-watt luminaires on 8-foot poles. The fixture is to be equal to Gardco GP1 or Kim Parkade Lighter- one fixture for every 900 square feet for a total of 150 luminaires for all three levels. The lighting will be contactor controlled, with one switch controlling multiple banks of lights. The stairs are to be illuminated with 4-foot strip T-8 fluorescent luminaires with wire guard at each landing.

Combination starter/disconnects are to be used in a fourplex motor control center for the ventilation fans. A carbon-monoxide detection system is to interface with the starters for control of the fans.

A 150-amp, 480/277-volt, 3-phase, 4-watt service is required to service the parking garage and consist of a central distribution panel in the main electrical room to supply 100 amperes to each level of the parking garage. Each level of the parking garage is to have a splitter trough and disconnect switches to supply a 70-amp, 480/277-volt lighting panelboard and a 480-volt modular MCC for the mechanical loads. On level one, a 15,000 volt amps, 120/208-volt dry transformer is to supply power to a panelboard for 120-volt convenience outlets (a total of fifteen per floor) to be located in service areas and perimeter walls throughout the parking garage.

Electrical Building

The building's interior lighting is to consist of direct/indirect extruded aluminum luminaires using two T-8 lamps. A total of 6400 lineal feet of this type of lighting is required. Occupancy sensors are to control the lighting in the washrooms and storage rooms. Low voltage switching for lighting control with local switching capability, as well as tie-in to the building management system, is to be provided.

An 800-kilowatt, 480/277-volt, 3-phase electrical service is to be provided. The service entrance is to consist of a 1,600-ampere fused switch with 1,200-ampere HRC fuses and a 1,600-amp distribution board. A main electrical room is to be located on level one of the parking garage.

An emergency generator room is to be located adjacent to the main electrical room. A 200-kilowatt generator is to supply the building life safety systems, critical mechanical loads, and an uninterruptible power supply system to supply essential computer circuits.

On each floor there are to be three sub-electrical/communication rooms approximately 9-feet by 12-feet each of which is to be supplied with a 150-ampere 480-volt feeder. These sub-electrical rooms are to each contain a communications backboard, 45,000-volt amp transformer for 120-volt loads, 277-volt lighting panel, motor starters to supply mechanical equipment. One sub-electrical room on each floor is to have a 277-volt emergency panelboard.

The building requires a microprocessor-based fire alarm system to meet current code requirements. A total of four remote alphanumeric annunciator panels are required.

Telephone and data to category 5E standards are to be distributed using a ridged cable tray system in the ceiling. A total of 300 workstations are to be provided with one outlet each. Allow for 150 workstations with two data outlets each and uninterruptible power supply (UPS) system.

A fiber optic backbone and a cable TV distribution system are to be provided to each communications room.

An electronic security system is to be provided and consist of a PC-based management system, door contacts, card access control with varying levels of security throughout the building, and closed circuit television monitoring of the parking garage, public areas and data rooms.

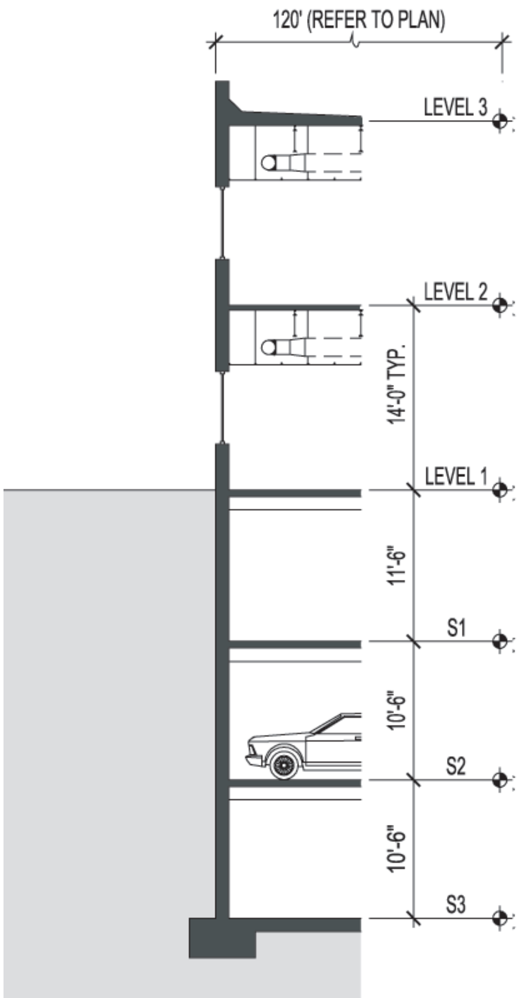
10.0 Sitework

The remaining site is to be landscaped with native materials requiring small amounts of irrigation. Street trees are to be 1-1/2 inch caliper trees along the two city streets at 30 feet on center. New sidewalks and landscaped islands between the sidewalk and street are to be provided.

11.0 General Conditions

Manage the construction process to provide means for recycling or salvaging 50 percent of the construction waste.

2 LEED™ Certified: Wall Section and Description



Office: 2 floors @ 45,000 square feet
Garage: 3 floors @ 45,000 square feet

- Roof top mechanical unit with louvered screen
- Modified bitumen roof over R-40 insulation and metal roof deck; total R-value for the roof assembly is R-30

Office Structure

- Steel eccentrically-braced frame with bar joists
- Metal floor deck with concrete floor

- Fifty percent of the envelope is to be Kawneer store-front glazing system; all orientations of glazing:
  - 1" insulated glazing - fixed
  - .32 U-factor
  - .46 solar heat gain coefficient
  - .70 visible light transmittance

- Fifty percent of envelope is:
  - 7" precast or equivalent
  - Vapor barrier
  - Metal stud backup
  - R-13 insulation
  - Gypsum interior wall board

- Total R-value for wall assembly is R-13

Garage

- Garage roof contains R-16 insulation and a sus-pended ceiling; total R-value for the roof/floor assembly is R-19
- Garage structure: Cast-in-place concrete floor slab and beams
- Bentonite clay waterproofing at wall and slabs
- Underslab and foundation wall drain system

2 LEED™ Certified: Detail Cost Summary

Project Cost Summary

Construction Cost		
Building		$4,874,516
Parking		$4,062,226
Subtotal Construction Cost		$8,936,741
Construction Contingency	7.5%	$670,256
Escl to Constr Start May 2002	5.0%	$480,350
Total Hard Cost		**$10,087,347**
Soft Cost		
Design & Management Fees		$1,311,355
Fixtures Furnishings & Equipment		$919,514
Permits, Fees & Other Services		$504,367
Owner Administrative Fee		
Subtotal Soft Cost		$2,735,236
Soft Cost Contingency	10.0%	$273,524
Soft Cost Escalation on FF&E	9.0%	$82,756
Total Soft Cost		**$3,091,516**
Other Costs		
Artwork		Excluded
Fundraising/Financing		Excluded
Land Acquisition		Excluded
Total Project Cost		**$13,178,863**

2 LEED™ Certified: Detail Cost Summary

Building Construction Cost Summary

			Cost	Cost/SF
1.0	Site Preparation		$88,375	$0.98
2.0	Substructure		$128,349	$1.43
3.0	Superstructure		$710,069	$7.89
4.0	Exterior Closure		$570,226	$6.34
5.0	Roofing & Waterproofing		$115,578	$1.28
6.0	Interior Construction		$884,904	$9.83
7.0	Conveying Systems		$60,381	$0.67
8.0	Mechanical Systems		$687,059	$7.63
9.0	Electrical Systems		$517,763	$5.75
10.0	Finish Sitework		$127,710	$1.42
Subtotal Costs			$3,890,415	$40.83
	General Conditions	9.0%	$350,137	
	Contractor's Fee	4.5%	$190,825	
	Design Contingency	10.0%	$443,138	
Total Building Construction Cost			**$4,874,516**	**$54.16**

Note: Cost above excludes construction contingency, escalation and soft costs.

2 LEED™ Certified: Detail Cost Summary

1.0 Site Preparation		
Earthwork		
Clearing and Grading	$9,195	
Erosion Control	$1,277	
Deconstruct Existing Building	$56,193	
Utilities		
Utility Connection	$19,157	
Miscellaneous	$2,554	
Subtotal 1.0 Site Preparation		$88,375
2.0 Substructure		
Foundations	$38,313	
Slab on Grade	$80,457	
Miscellaneous		
Elevator Pit	$3,831	
Mechanical Pads	$1,916	
Concrete Curbs	$1,916	
Miscellaneous	$1,916	
Subtotal 2.0 Substructure		$128,349
3.0 Superstructure		
2nd Floor Structure - Braced Frame	$344,818	
Roof Structure - Braced Frame	$357,589	
Miscellaneous	$7,663	
Subtotal 3.0 Superstructure		710,069
4.0 Exterior Closure		
Exterior Wall Assembly	$252,228	
Windows & Glazing	$252,228	
Doors Frames & Hardware	$15,964	
Exterior Miscellaneous		
Louvers	$1,916	
Signage	$3,831	
Soffits	None	
Fascia & Trim	$13,410	
Trellises & Sunshades	None	
Mechanical Screen	$17,879	
Misc. Exterior Work	$12,771	
Subtotal 4.0 Exterior Closure		$570,226

2 LEED™ Certified: Detail Cost Summary

5.0 Roofing & Waterproofing		
Roofing & Insulation	$89,397	
Skylights	None	
Sheet Metal	$22,349	
Caulking & Sealants	$1,916	
Miscellaneous Roof Accessories	$1,916	
Subtotal 5.0 Roofing & Waterproofing		$115,578
6.0 Interior Construction		
Partitions		
Typical	$149,421	
Operable	$16,602	
Dropped Soffits & Fascia - Allow	$10,217	
Interior Glazing - Allow	$22,988	
Railings	$7,663	
Miscellaneous	$12,771	
Doors, Frames & Hardware - Wood	$153,252	
Floor Finishes	$137,927	
Wall Finishes	$35,759	
Ceiling Finishes	$137,927	
Millwork		
Kitchen	$9,195	
Storage & Workrooms	$14,048	
Conference Rooms	$26,819	
Chair Rail & Trim	$21,711	
Other Built-in Casework	$15,325	
Rough Hardware & Backing	$14,048	
Workstations	Inc. in FF+E	
Window Blinds	$30,267	
Specialties & Equipment	$68,964	
Subtotal 6.0 Interior Construction		$884,904
7.0 Conveying Systems		
Stairs & Ladders		
Stairs	$10,217	
Stairs	$20,434	
Roof Ladder	$204	
Elevator Pit Ladder	$409	
Elevators		
Passenger	$44,443	
Deduct Stops Assigned to Parking	($15,325)	
Subtotal 7.0 Conveying Systems		60,381

2 LEED™ Certified: Detail Cost Summary

8.0 Mechanical Systems	
HVAC	
Equipment Wet	
Boiler-Gas 850mbh w/SS Flue	$4,214
Chiller 250 tons Screw	$30,650
Cooling tower 1 cell 250 tons	$11,494
Pump-HW	$2,656
-CHW	$2,810
-CW	$2,810
Equipment Air	
Air Handling Unit -w/S Fan/CHW&HW coil /pre&final filts/Exterior VFD/ 45000cfm:	$58,747
ACUnit for Tel/Elect	$12,132
Exhaust Fans	$5,108
VAV Box w/RH 1500sf/Box	$15,095
Miscellaneous Equipment	$6,386
Ductwork & Accessories	
Duct-GSM	$143,035
-Insulation/External	$20,434
-Dampers & Accessories	$6,386
/Fire & Smoke	$8,684
Registers & Grilles	$12,771
Misc Duct & Accessories	$6,386
Pipework & Accessories	
Pipe-HW w/ Insl.	$31,928
Pipe-CHW w/ Insl.	$7,663
Misc Valves & Specs.	$12,771
Controls & Testing	
Control-System/DDC-EMCS	$63,855
Commissioning	$11,494
Monitoring-1 year	Inc. in operating costs
Test & Balance	$12,771
Plumbing	
Fixtures & Equipment	
Water Heater-Elect 75gal/75MBTU	$3,193
Tank-Expansion	$179
Tank-Oil/Water Separator	Inc. in parking estimate
Tank-Storm Water 12500gal. 50% irrig	$10,217
Pump-Elev.Sump	$1,073
Pump-DHW Recirc.	$383
Pump-Sewer 140gpm:0hp	$4,725
Pump-Storm Water/Irrig	$4,214
Filtration-Storm	$3,831
Pump-Storm Water/Irrig	$4,214
Filtration-Storm	$3,831
Toilet Room Fixtures	$7,854
Sink Service	$464
Sink-Kit. Single	$587
Drinking Fountain	$3,474
Drain-Floor & Roof	$1,379
Backflow Preventer	$1,022
Misc. Equip. & Fixtures	$2,554

Pipework & Accessories		
Pipe-Waste & Vent	$26,206	
Pipe-Storm	$18,390	
Pipe-CW w/Insl.	$19,157	
Pipe-Storm Recirc to Irrig.	$1,992	
Pipe-DHW w/ Insl.	$3,831	
Pipe-Gas	$1,596	
Misc Valves & Specs.	$11,494	
Fire Sprinkler System		
Wet System-Bldg w/ Standpipe System	$68,964	
Subtotal 8.0 Mechanical Systems		$687,059
9.0 Electrical Systems		
Primary Power		
Main Switchboard 1600A 800 KW	$8,940	
Distribution Boards 1600A	$1,533	
Panelboards	$7,050	
Emergency Power - 200KW Generator	$38,313	
Feeders - Allow	$13,793	
Equipment Power	$45,976	
User Power	$70,241	
Lighting	$195,397	
Lightning Protection	None	
Signal & Communications		
Fire Alarm	$45,976	
Telephone/Data Rough-In	$35,759	
Telephone/Data Cabling	Inc. in FF+E	
Security System	$41,378	
Cable TV	$7,024	
Audio Visual Rough-In	$6,386	
Subtotal 9.0 Electrical Systems		$517,763
10.0 Finish Sitework		
Subtotal 10.0		$127,710

2 LEED™ Certified: Detail Cost Summary

Add for Underground Parking

Deduct Building Foundations	($38,313)
Deduct Building Slab on Grade	($80,457)
New Mat Slab	$298,523
Mechanical Pit	$3,831
Slab on Grade	$57,470
Underslab Drainage	$22,988
Shoring	$294,244
Excavation	$466,142
Dewatering	$25,542
Permanent Perimeter Drainage	$11,494
Retaining Walls	$294,244
Interior & Stem Walls	$14,304
Floor Structure	$664,093
Roof Structure	$344,818
Water Detention Basin	Included in building estimate
Pads, Curbs & Bollards	$5,108
Columns	$36,781
Ramp Slab	Included above
Ramp Walls	Included above
Waterproofing	$78,670
Topping Slab @ Roof	Included in sitework estimate
Partitions	$32,566
Insulation @ Roof	$22,988
Doors	$10,217
Painting, Striping, Misc.	$7,663
Signage	$3,831
Parking Equipment	$6,386
Stair Towers	None
Stairs	$22,988
Elevator - Additional Stops	$15,325
Mechanical Systems	$344,818
Electrical Systems	$275,854
Finish Sitework	Included in building estimate
Subtotal Cost	$3,242,116
General Conditions	$291,790
Contractor's Fee	$159,026
Design Contingency	$369,293
Total Parking Construction Cost	**$4,062,226**

3 LEED™ Silver: Site Plan

3 LEED™ Silver: Building Narrative

The following narrative was prepared, based on conceptual design work required to flesh out a set of assumptions, so that each building scenario could be adequately priced and its operational impacts (pollution and costs) determined. Reasonable assumptions were made for each scenario based on the team's collective knowledge.

1.0 Site Preparation

The site is 142 feet by 400 feet for a total square footage of 56,400 square feet. Site preparation is to begin with the deconstruction of the existing structures. Fifty percent of the materials by weight are to be recycled or salvaged, including the structure of the buildings and the soil that is excavated. The wooden structure at the corner of Whitney and Second Streets is to be salvaged and/or mulched.

The site is to be excavated in order to begin construction of the underground parking structure. A large amount of soil is to be diverted from the landfill in order to meet the requirements above. The lowest level of the parking structure is at an elevation of 35 feet below the existing sidewalk elevation for the three levels of parking. The garage ramp will be excavated outside the footprint of the garage. Retain 35 feet of soil around the entire perimeter of the site for the garage. The primary method for retaining the soil is to use steel sheet piling. The bottom of the excavation is assumed to be in the water table and will require extensive dewatering during the construction process.

2.0 Substructure

The perimeter foundation walls are to be 12-inch concrete and are to be pulled away from the exterior wall location of the garage approximately 6 feet and supported at the beam lines from the garage. The retaining walls are to be placed on a continuous footing bearing on a 2-foot thick matt footing under the entire structure. The concrete is to be of 20 percent fly ash content.

3.0 Superstructure

Garage Framing (120 feet x 375 feet x 3 floors = 135,000 sf)

The garage framing is to consist of 7-inch cast-in-place concrete beams at 30 feet on center. Interior column size is to vary, with larger columns required at building column locations above.

The concrete mix for the garage deck is to consist of portland-pozzolan cement and local aggregate.

The framing under the courtyards is to be 3-foot deep beams at three feet on center post-tensioned. This structure is to be recessed down two feet from the building floor lines.

Office Building (3 floors x 30,000 sf = 90,000 sf)

The office building's second floor structure is assumed to be an eccentrically-braced steel frame structure with bar joist, metal decking and 4-inch concrete slab. The concrete slabs are to use 40 percent fly ash for cement and 20 percent recycled aggregate. The roof deck is assumed to be similar without the concrete topping. The typical bay sizes correspond with the garage structure and the floor to floor height would be 13'-6".

The office building is to be rated Type II-FR, which requires two-hour fireproofing for the structural frame.

4.0 Exterior Enclosure

Office Building

The office building's skin is composed of 40 percent glazing and 60 percent precast or equivalent material on the north and south and smaller windows (30 percent of the wall) on the east and west. The precast wall consists of 7-inch precast panels with vapor barrier, 2 inches of rigid insulation over 6-inch metal stud backup with R-30 insulation, and gypsum board sheathing on the interior. Additional care is taken to insulate at the structure's frame with rigid insulation to minimize thermal bridging. The total resistance value (R-value) for the exterior wall is R-20.

The glazing system is to be Kawneer 45IT storefront system. The glazing units will be one-inch insulated glass with some operable windows in the lower three feet of the window area. On the north and south, the conductance value (U-factor) is to be 0.29, the shading coefficient (SC) is to be 0.43 and the visible light transmittance (VLT) is to be 0.70. On the east and west walls, the U-value is to be 0.31, the shading coefficient is to be 0.40 and the visible light transmittance is to be 0.47. A horizontal exterior aluminum louvered sunshade 3-foot 8-inches in depth protects all 50% of the south facing glass.

The mechanical units on top of the building are screened on four sides by an 8-foot high horizontal louver wall in two locations on the roof.

5.0 Roofing and Waterproofing

Garage

The garage is to be waterproofed by a combination system of bentonite clay panels at the exterior walls and below-grade slab, and an under-slab drainage system. The drainage system is to be pumped from a sump within the garage to the city storm sewer.

The thermal barrier between the uppermost garage and the first floor of the office building is to be insulated with a layer of R-16 insulation over a suspended ceiling and would have a total R-value of R-19.

Office Building

The roof is to be a white, Energy Star roof over an insulation base of R-40. Perimeter conditions and penetrations at the roof cause the actual roof R-value to be R-30.

6.0 Interior Construction

Office Building

The interior of the office building is predominantly an office environment with minimum lobby space. The ratio of closed offices to open space plan is to be 40 percent closed to 60 percent open.

Construction finishes are to be carpet tiles, painted gypsum wallboard, wood trim at windows and doors, hollow metal frames and wood doors. Twenty percent of the interior partitions would be glass. Wood blinds are to be used. The entire floor area is to be on a raised access floor 16-inches tall.

Materials are to be selected with the overall LEED™ goals in mind. Fifty percent of the materials are to have recycled content. Fifty percent of the wood is to be certified. Twenty percent of the materials are to be regionally manufactured. Five percent of the materials are to be rapidly renewable. Five percent of the materials are to be salvaged.

Volatile organic compounds (VOC) emissions are to be limited for better indoor air quality (IAQ). Provide full height walls around copy/print areas, custodial rooms and maintenance rooms where chemical contaminants occur. Provide dedicated air filters to remove the pollutants.

7.0 Conveying Systems

There are to be two 3,500-pound passenger Kone Ecosystem gearless elevators with five stops each. The building is to have two stairs. Five levels of stairs are to be steel pan with concrete fill. Roof and elevator pit ladders are required.

8.0 Mechanical Systems

Plumbing Garage

There are to be floor drains provided for the parking area. The floor drains are to be collected and routed to a sand/oil trap and sumps located at the lowest level. There are to be 12 drains for each level of the garage. The floor drains are to be routed to separate risers. Each 4-inch riser is to tie into a common 6-inch header at the lowest level. The sump will have two pumps at 10 horsepower each. There are to be three hose bibbs per parking level.

The drains under the courtyard are combined with the roof drains from the building. A 4-inch drain is required for every 400 square feet of planter area.

Plumbing Building

There are to be a total of 36 toilet room fixtures, three service sinks, six drinking fountains, and four kitchenette sinks. All plumbing fixtures are to be durable, efficient, and low-flow. All toilets shall be dual flush and all urinals shall be waterless. A 6-inch sanitary riser serves the core toilets. A 4-inch riser is to carry water from the service sinks to a tank in the garage for disposal by a chemical removal truck. A 4-inch domestic water line provides service to the building. The water service is to be provided with an estimated 2-inch water meter. The central boiler is to heat the domestic hot water tanks. One 80-gallon IAPMO certified, stainless steel tank is to be provided in the mechanical room.

Storm water for the building is to be collected in 6-inch roof drains connected to four 6-inch vertical risers leading to a 25,000-gallon tank in the lower level. There are to be approximately 12 roof drains and overflow scuppers. Storm water stored in the tank is to be reused for landscape irrigation.

HVAC Garage
There are to be three exhaust and three supply fans with 7-horsepower each for each level of the garage. These supply and exhaust fans are to be controlled by a carbon monoxide monitoring system. There are to be four sensors for each level to control the appropriate fans.

HVAC Building
An under floor supply system is to serve the building's heating and cooling needs. The 16-inch access floor serves as a distribution plenum for the air. Two 63,000-cubic feet/minute, central air handling units on the roof supply the air down-shafts at the core. Air is to be supplied onto each floor from the central risers. Modulating dampers control the airflow into each interior zone. The supply air temperature is to be 63° Fahrenheit. The five-foot deep perimeter zones are separated from the main plenum space with a plenum wall in the floor. Air to these zones is supplied with heating-only fan coil units in the floor. Fan coil units provide air at a rate of 6.5 cubic feet/minute/square foot. One unit is required for every 25 feet of building perimeter. Stratified air from the floor below is mixed with primary air from the floor plenum at these perimeter units during heating season to minimize the reheat required. Outdoor air is supplied to the space at a rate of at least 20 cubic feet/minute/person at 150 square feet/person occupancy. Where internal conference rooms are enclosed rooms with potential for higher internal heat loads, variable speed fans in the floor are directly ducted to the room's diffusers and increase the airflow accordingly.

The heating is supplied by hot water coming from a central, high efficiency, condensing-type boiler. This boiler has an efficiency rating greater than 90 percent, a capacity of 950 MBH and provides the heat to the domestic hot water system through immersion-type hot water tanks. Cooling comes from a 200-ton screw-type chiller and cooling tower. The performance on the chiller must be at least 0.52 kilowatts/ton at full load.

Wall-mounted thermostats control each fan coil unit and modulating volume damper. The temperature tolerance is to be set at (74°/68°F), with the assumption that people will use the operable windows and adjustable floor diffusers to control their space temperature. Thermostat control provides for each 3,000 square feet in the interior zones. Air is delivered to the space through swirl-type floor diffusers complete with adjustable dust collection baskets. The diffusers are similar to the Trox or Krantz type of diffuser and are to be flush with the floor.

A complete DDC control system is to be provided. All the HVAC systems in the building are to be commissioned at startup. Additional commissioning will happen for the first year of occupancy. Prior to occupancy, a two-week flush of the building is to be performed using 100 percent outdoor air and new filter media on all air handling units. The energy use of the building will reduce that set out in ASHRAE 90.1-1999 by 40 percent.

Fire Protection Garage
The parking garage is to be fully sprinkled by using approximately two wet pipe risers located throughout the parking garage. This requires a 3-inch service into a fire protection room for location of the pipe valves and air compressors.

Fire Protection Building
The building is to be served by a 6-inch fire protection water service with a backflow preventer. The building is to be fully sprinkled with a density of 0.15 gallons per minute per square foot for the most remote 1,500 square feet. A standpipe is to be provided in each stairwell.

9.0 Electrical

Site Services
Utilities are to be supplied underground from the property line to the main electrical room in the first level of the parking garage. All services are to run in concrete encased ducts with one spare duct for each three ducts utilized. Five percent of the building's electricity is to be supplied by photovoltaics.

Pedestrian sidewalk lighting consists of 175-watt decorative luminaires on 8-foot poles. A total of 20 lighting standards are required to light the site. Light trespass from the site is to be minimized.

Electrical Garage
The parking garage is to be illuminated with T-5 fluorescent strip lights with a wire guard. Painting the parking garage ensures an average maintained lighting level of five footcandles. One fixture is to be supplied

for every 500 square feet for a total of 270 for all three levels. The lighting will be contactor controlled, with one switch controlling multiple banks of lights. The stairs are to be illuminated with 4-foot strip T-5 fluorescent luminaires with wire guard at each landing.

Combination starter/disconnects are to be used in a fourplex motor control center, to be used for the ventilation fans. A carbon-monoxide detection system interfaces with the starters for control of the fans.

A 100-amp, 480/277-volt, three phase, 4-watt service is required to service the parking garage and consists of a central distribution panel in the main electrical room to supply 70 amperes to each level of the parking garage. Each level of the parking garage is to have a splitter trough and disconnect switches to supply a 70-amp, 480/277-volt lighting panelboard and a 480-volt modular MCC for the mechanical loads. On level one, a 15,000-volt amp, 120/208-volt dry transformer is to supply power to a panelboard for 120-volt convenience outlets (a total of fifteen per floor), to be located in service areas and perimeter walls throughout the parking garage.

Electrical Building

The building's interior lighting consists of indirect extruded aluminum luminaires using single T-5 lamps. A total of 7,000 lineal feet of this type of lighting is required. Occupancy sensors control the lighting in the washrooms and storage rooms. Low voltage switching for lighting control with local switching capability, as well as tie-in to the building management system, is to be provided. A 20-foot perimeter zone incorporates daylight sensing for automatic lighting control. The area for each individual control zone within the perimeter zone is to be 200 square feet.

A 600-kilowatt, 480/277-volt, 3-phase electrical service is to be provided. The service entrance consists of a 1,200-amp fused switch with 1,000-ampere HRC fuses and a 1,200-amp distribution board. A main electrical room is to be located on level one of the parking garage.

An emergency generator room is to be located adjacent to the main electrical room. A 200-kilowatt generator supplies the building life safety systems, critical mechanical loads, and an uninterruptible power supply for essential computer circuits.

Five percent of the building's power is to be supplied by roof mounted photovoltaic panels.

On each floor there are to be three sub-electrical/communication rooms approximately 9-feet by 12-feet, each of which is to be supplied with a 100-ampere, 480-volt feeder. These sub-electrical rooms each contain a communications backboard, 120 -volt panelboard, 277-volt lighting panel and motor starters to supply mechanical equipment. One sub-electrical room on each floor is to have a 277-volt emergency panelboard. On level two, each sub-electrical room is to contain a 75,000-volt amp high efficiency, transformer to supply 120-volt power to the electrical rooms above and below this level.

The building requires a microprocessor-based fire alarm system to meet current code requirements. A total of four remote alphanumeric annunciator panels are required.

Telephone and data to category 5E standards are to be distributed using a rigid cable tray system under the floor. A total of 300 workstations are to be provided with one outlet each. Allow for 150 workstations with two data outlets and an uninterruptible power supply (UPS) system.

A fiber optic backbone and a cable TV distribution system is to be provided to each communications room.

An electronic security system is to be provided consisting of a PC-based management system, door contacts, card access control with varying levels of security throughout the building, and closed circuit TV monitoring of the parking garage, public areas and data rooms.

10.0 Sitework

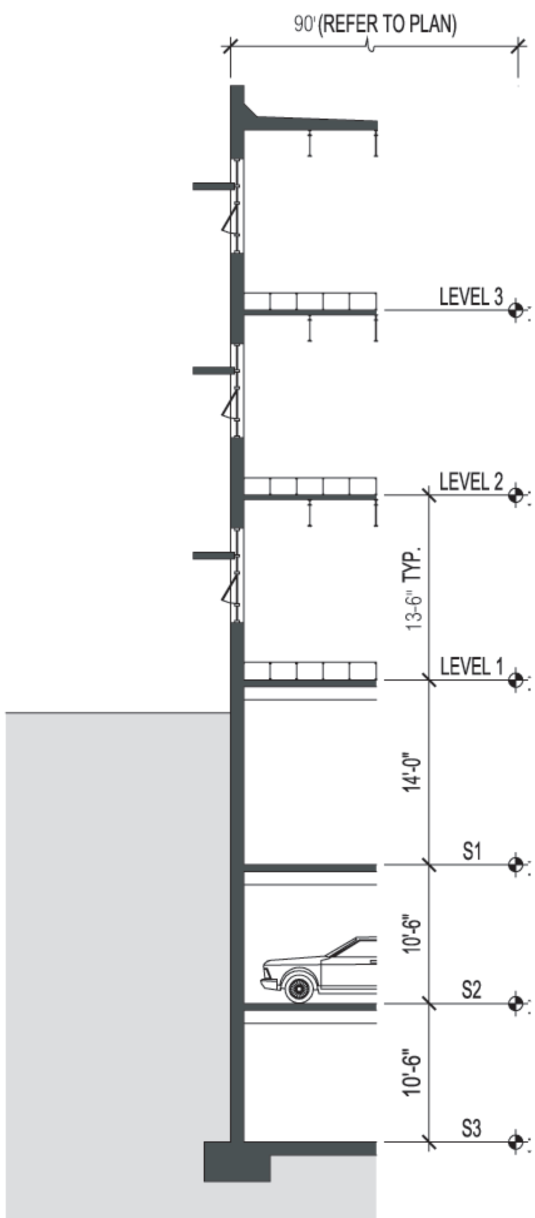
The remaining site is to be landscaped with native materials requiring small amounts of irrigation. Street trees are to be 3-inch caliper trees along the two city streets at 15feet on center. Additional trees are to be provided on the site. New sidewalks and landscaped islands between the sidewalk and street are to be provided.

At the interior courtyards over the garage a 2-foot layer of soil is to be placed over the structure. At tree locations, an additional one-foot of soil is required. A site retaining wall is to create a minimum 10-foot ring around the trees and be constructed from rock that was removed during excavation. Walkways are to be brick pavers set on sand at the courtyards.

11.0 General Conditions

Manage the construction process to provide means for recycling or salvaging 50 percent of construction waste.

3 LEED™ Silver: Wall Section and Description



Office: 3 floors @ 30,000 square feet
Garage: 3 floors @ 45,000 square feet

- Photovoltaic panels mounted on a flat roof
- Roof top mechanical unit with louvered screen
- Energy Star reflective roof over R-40 insulation and metal roof deck; total R-value for the roof assembly is R-30

Office Structure

- Steel eccentrically-braced frame with bar joists
- Metal floor deck with concrete floor
- 16-inch access flooring for office floors
- Exterior sunshade on all south facing glass

- Forty percent of the envelope on the north and south face is to be Kawneer storefront glazing system.
  - 1" insulated glazing - some operable
  - .29 U-factor
  - .43 solar heat gain coefficient
  - .70 visible light transmittance

- Thirty percent of envelope on the east and west is to be Kawneer storefront glazing system:
  - 1" insulated glazing - some operable
  - .31 U-factor
  - .40 solar heat gain coefficient
  - .47 visible light transmittance

- Sixty percent of envelope on north and south and 70 percent on the east and west
  - 7" precast or equivalent
  - 2" rigid insulation
  - 6" metal stud backup
  - R-30 Insulation
  - Gypsum interior wall board

- Total R-value for wall assembly is R-20.

Garage

- Garage roof contains R-16 insulation and a suspended ceiling; total R-value for the roof/floor assembly is R-19
- Garage structure: Cast-in-place concrete floor slab and beams
- Bentonite clay waterproofing at wall and slabs
- Underslab and foundation wall drain system

3 LEED™ Silver: Detail Cost Summary

Project Cost Summary

Construction Cost		
Building		$5,633,527
Parking		$4,291,335
Subtotal Construction Cost		$9,924,862
Construction Contingency	7.5%	$744,365
Escl to Constr Start September 2002	6.0%	$640,154
Total Hard Cost		**11,309,380**
Soft Cost		
Design & Management Fees		$1,470,219
Fixtures Furnishings & Equipment		$919,514
Permits, Fees & Other Services		$565,469
Owner Administrative Fee		
Subtotal Soft Cost		$2,955,202
Soft Cost Contingency	10.0%	$295,520
Soft Cost Escalation on FF&E	9.0%	$82,756
Total Soft Cost		**$3,333,479**
Other Costs		
Artwork		Excluded
Fundraising/Financing		Excluded
Land Acquisition		Excluded
Total Project Cost		**$14,642,859**

3 LEED™ Silver: Detail Cost Summary

Building Construction Cost Summary

			Cost	Cost/SF
1.0	Site Preparation		$88,375	$0.98
2.0	Substructure		$147,505	$1.64
3.0	Superstructure		$839,312	$9.33
4.0	Exterior Closure		$911,213	$10.12
5.0	Roofing & Waterproofing		$166,981	$1.86
6.0	Interior Construction		$924,290	$10.27
7.0	Conveying Systems		$90,010	$1.00
8.0	Mechanical Systems		$653,710	$7.26
9.0	Electrical Systems		$496,001	$5.51
10.0	Finish Sitework		$178,794	$1.99
Subtotal Costs			$4,496,192	$46.99
General Conditions		9.0%	$404,657	
Contractor's Fee		4.5%	$220,538	
Design Contingency		10.0%	$512,139	
Total Building Construction Costs			$5,633,527	$62.59

Note: Cost above excludes construction contingency, escalation and soft costs.

3 LEED™ Silver: Detail Cost Summary

1.0 Site Preparation		
Earthwork		
Clearing and Grading	$9,195	
Erosion Control	$1,277	
Deconstruct Existing Building	$56,193	
Utilities		
Utility Connection	$19,157	
Miscellaneous	$2,554	
Subtotal 1.0 Site Preparation		$88,375
2.0 Substructure		
Foundations	$30,650	
Slab on Grade	$62,578	
Miscellaneous		
Raised Access Floor	$44,699	
Elevator Pit	$3,831	
Mechanical Pads	$1,916	
Concrete Curbs	$1,916	
Miscellaneous	$1,916	
Subtotal 2.0 Substructure		$147,505
3.0 Superstructure		
Upper Floor Structure - Braced Frame	$459,757	
Roof Structure - Braced Frame	$264,616	
Raised Access Floor	$107,277	
Miscellaneous	$7,663	
Subtotal 3.0 Superstructure		$839,312
4.0 Exterior Closure		
Exterior Wall Assembly	$480,446	
Windows & Glazing	$320,297	
Doors Frames & Hardware	$17,879	
Exterior Miscellaneous		
Louvers	$1,916	
Signage	$3,831	
Soffits	None	
Fascia & Trim	$17,879	
Trellises & Sunshades	$38,313	
Mechanical Screens	$17,879	
Misc. Exterior Work	$12,771	
Subtotal 4.0 Exterior Closure		$911,213

3 LEED™ Silver: Detail Cost Summary

5.0 Roofing & Waterproofing		
Roofing & Insulation	$66,154	
Premium for Photovoltaic Panels	$80,457	
Skylights	None	
Sheet Metal	$16,538	
Caulking & Sealants	$1,916	
Miscellaneous Roof Accessories	$1,916	
Subtotal 5.0 Roofing & Waterproofing		$166,981
6.0 Interior Construction		
Partitions		
Typical	$124,517	
Operable	$16,602	
Dropped Soffits & Fascia - Allow	$10,217	
Interior Glazing - Allow	$45,976	
Railings	$7,663	
Miscellaneous	$12,771	
Doors, Frames & Hardware - Wood	$137,927	
Floor Finishes	$160,915	
Wall Finishes	$35,759	
Ceiling Finishes	$149,421	
Millwork		
Kitchen	$9,195	
Storage & Workrooms	$14,048	
Conference Rooms	$26,819	
Chair Rail & Trim	$21,711	
Other Built-in Casework	$15,325	
Rough Hardware & Backing	$14,048	
Workstations	Inc. in FF+E	
Window Blinds	$52,412	
Specialties & Equipment	$68,964	
Subtotal 6.0 Interior Construction		$924,290
7.0 Conveying Systems		
Stairs & Ladders		
Stairs	$20,434	
Stairs	$30,650	
Roof Ladder	$204	
Elevator Pit Ladder	$409	
Elevators		
Passenger	$53,638	
Deduct for Stops Assigned to Parking	($15,325)	
Subtotal 7.0 Conveying Systems		$90,010

8.0 Mechanical Systems	
HVAC	
Equipment Wet	
Boiler-Gas 950mbh w/PVC Flue	$4,725
Chiller 200 tons Screw	$26,053
Cooling tower 1 cell 200 tons	$7,663
Pump-HW	$2,810
-CHW	$2,810
-CW	$2,810
Miscellaneous Accessories	$6,386
Equipment Air	
Air Handling Unit -w/S Fan/CHW&HW coil /pre&final filts/Exterior VFD/ 65000cfm	$86,843
AC Unit for Tel/Elect	$16,985
Exhaust Fans	$5,108
Fan-coil w/ Reheat	$19,731
Var Sp Fan @ Int Encl Spaces	$9,195
Control Dampers @ Shafts	$6,590
Filters for Enclosed Rooms	$2,299
Miscellaneous Equipment	$6,386
Ductwork & Accessories	
Duct-GSM	$64,366
-Insulation/ External	$2,554
-Dampers & Accessories	$6,386
Registers & Grilles	$26,819
Misc Duct & Accessories	$8,940
Pipework & Accessories	
Pipe-HW w/ Insl.	$38,313
Pipe-CHW w/ Insl	$7,663
Misc Valves & Specs.	$15,325
Controls & Testing	
Control-System/DDC-EMCS	$53,638
2 Week Air Flush & Filter Change	$5,108
Commissioning	$10,217
Monitoring-1 year	Inc. in operating costs
Balancing-1 year	Inc. in operating costs
Test & Balance	$12,771
Plumbing	
Fixtures & Equipment	
Water Heater Storage Tank	$1,022
Tank-Expansion	None
Tank-Oil/Water Separator	Inc. in parking estimate
Tank-Storm Water 25000gal. 100% Irrig.	$16,602
Tank-Service Sink Waste Rem 000g.	$2,554
Pump-Elev.Sump	$1,073
Pump-DHW Recirc.	$252
Pump-Sewer 140gpm:0hp	$4,725
Pump-StormWater/Irrig	$4,214

Fixtures & Equipment (cont'd)		
Filtration-Storm/Irrig	$3,831	
Toilet Room Fixtures	$9,425	
WC-Wall/ADA w/Rough-In	$1,762	
Sink Service	$464	
Sink-Kit. Single	$587	
Drinking Fountain	$5,211	
Drains-Floor & Roof	$1,149	
Misc Equip. & Fixtures	$2,554	
Pipework & Accessories		
Pipe-Waste & Vent	$27,585	
Pipe-Storm	$13,793	
Pipe-CW w/ Insl.	$19,157	
Pipe-Storm Recirc to Irrig	$1,992	
Pipe-DHW w/ Insl.	$3,831	
Pipe-Gas	$1,916	
Misc Valves & Specs.	$2,554	
Fire Sprinkler System		
Wet System-Bldg w/ Standpipe System	$68,964	
Subtotal 8.0 Mechanical Systems		$653,710
9.0 Electrical Systems		
Primary Power		
Main Switchboard 1200A 600KW	$7,663	
Distribution Boards 1200A	$1,533	
Panelboards	$7,050	
Emergency Power - 200KW Generator	$38,313	
Feeders - Allow	$13,103	
Equipment Power	$45,976	
User Power	$56,193	
Lighting	$195,397	
Lightning Protection	None	
Signal & Communications		
Fire Alarm	$45,976	
Telephone/Data Rough-In	$30,650	
Telephone/Data Cabling	Inc. in FF+E	
Security	$41,378	
Cable TV	$6,386	
Audio Visual Rough-In	$6,386	
Subtotal 9.0 Electrical Systems		$496,001
10.0 Finish Sitework		
Subtotal 10.0 Finish Sitework		$178,794

3 LEED™ Silver: Detail Cost Summary

Add for Underground Parking

Deduct Building Foundations	($30,650)
Deduct Building Slab on Grade	($62,578)
New Mat Slab	$298,523
Mechanical Pit	$3,831
Slab on Grade	$57,470
Underslab Drainage	$22,988
Shoring	$326,938
Excavation	$497,112
Dewatering	$25,542
Permanent Perimeter Drainage	$11,494
Retaining Walls	$388,239
Interior & Stem Walls	$14,304
Floor Structure	$603,431
Roof Structure	$398,047
Water Detention Basin	Included in building estimate
Pads, Curbs & Bollards	$5,108
Columns	$36,781
Ramp Slab	Included above
Ramp Walls	Included above
Waterproofing	$82,245
Gratings	$40,229
Railings	$71,837
Topping Slab @ Roof	Included in sitework estimate
Partitions	$32,566
Insulation @ Roof	$17,879
Doors	$10,217
Painting, Striping, Misc.	$7,663
Signage	$3,831
Parking Equipment	$6,386
Stair Towers	None
Stairs	$22,988
Elevator - Additional Stops	$15,325
Mechanical Systems	$275,854
Electrical Systems	$241,372
Finish Sitework	Included in building estimate
Subtotal Cost	$3424,971
General Conditions	$308,247
Contractor's Fee	$167,995
Design Contingency	$390,121
Total Parking Construction Cost	**$4,291,335**

4 LEED™ Gold: Site Plan

Existing

Proposed

4 LEED™ Gold: Building Narrative

The following narrative was prepared, based on conceptual design work required to flesh out a set of assumptions, so that each building scenario could be adequately priced and its operational impacts (pollution and costs) determined. Reasonable assumptions were made for each scenario based on the team's collective knowledge.

1.0 Site Preparation

The site is 142 feet by 400 feet for a total square footage of 56,400 square feet. Site preparation is to begin with the deconstruction of the existing structures. Fifty percent of the materials by weight are to be recycled or salvaged, including the structure of the buildings and the soil that is excavated. The wooden structure at the corner of Whitney and Second Streets is to be salvaged and/or mulched.

The site is to be excavated in order to begin construction of the underground parking structure. A large amount of soil is to be diverted from the landfill in order to meet the requirements above. The lowest level of the parking structure is at an elevation of 35 feet below the existing sidewalk elevation for the three levels of parking. The garage ramp will be excavated outside the footprint of the garage. Retain 35 feet of soil around the entire perimeter of the site for the garage. The primary method for retaining the soil is to use steel sheet piling. The bottom of the excavation is assumed to be in the water table and will require extensive dewatering during the construction process.

2.0 Substructure

The perimeter foundation walls are to be 12-inch concrete and are to be pulled away from the exterior wall location of the garage approximately 6 feet and supported at the beam lines from the garage. The retaining walls are to be placed on a continuous footing bearing on a 2-foot thick matt footing under the entire structure. The concrete is to consist of 50 percent fly ash content and 20 percent recycled aggregate.

3.0 Superstructure

Garage Framing (120 feet x 375 feet x 3 floors = 135,000 sf)

The garage framing is to consist of 7-inch cast-in-place concrete beams at 30 feet on center. Interior column size is to vary, with larger columns required at building column locations above. The light wells at the perimeter of the garage are to be covered at the sidewalk locations with a steel and glass block panels. The other sides of the garage are to be covered with metal grating.

The concrete mix for the garage deck is to consist of 50 percent fly ash content and 20 percent recycled aggregate.

The framing under the courtyards is to be 3-foot deep beams at three feet on center post-tensioned. This structure is to be recessed down two feet from the building floor lines.

Office Building (3 floors x 30,000 sf = 90,000 sf)

The office building structure is a concrete moment frame building with 6-inch wide joists six feet on center and 27-inch beams that are to be post-tensioned. The concrete frame is to consist of 50 percent fly ash for cement and 20 percent recycled aggregate. The typical bay sizes correspond with the garage structure. The frame and ceiling of the building are to be exposed architectural concrete.

The roof structure is to be sloped to accommodate the photovoltaic panels on the roof. The roof is to be divided into two sloped sections to decrease the height of the building.

4.0 Exterior Enclosure

Office Building

The office building's skin is composed of 40 percent glazing and 60 percent precast or equivalent material on the north and south elevations and smaller windows (25 percent of the wall area) on the east and west elevations. The precast wall consists of 7-inch precast panels with vapor barrier, three inches of rigid insulation, 6-inch metal studs with six inches of batt insulation, and gypsum interior wallboard. Additional care is to be taken to insulate at the structure's frame with rigid insulation to minimize thermal bridging. The total resistance value (R-value) for the exterior wall assembly is R-25.

The glazing system is a Kawneer 451T storefront system. The glazing is a one-inch insulated unit with a conductance value (U-factor) of 0.29, shading coefficient (SC) of 0.43 and visible light transmittance factor (VLT) of 0.70 on the north and south sides. The glazing on the east and west is a one-inch insulated unit with a U-value of 0.31, shading coefficient of 0.40

and visible light transmittance factor of 0.47. The windows are to be operable at the lower three feet of the window area. An exterior aluminum louvered sunshade 3-foot 8-inches in depth protects all south facing glass. The east and west elevations are to have a stainless steel fabric supported three feet away from the building frame for 80% of the glass area. An internal light shelf 2-foot-6 inches deep is to be constructed of translucent glass supported by steel brackets at the south elevations only.

The mechanical units on top of the building are to be enclosed in locations within the additional ceiling space at the top floor of the building.

5.0 Roofing and Waterproofing

Garage

The garage is to be waterproofed by a combination system of bentonite clay panels at the exterior walls and below-grade slab, and an under-slab drainage system. The drainage system is to be pumped from a sump within the garage to the city storm sewer.

Waterproofing for the courtyards over the uppermost garage level is to be bentonite clay panels, under a drainage mat, under a water retention "egg crate".

The thermal barrier between the uppermost garage and the first floor of the office building is to be insulated with a layer of R-18 insulation over a suspended ceiling and would have a total R-value of R-23.

Office Building

The roof is to be a white Energy Star standing seam metal roof over an insulation base of R-42. Perimeter conditions and penetrations at the roof cause the actual roof R-value to be R-33.

6.0 Interior Construction

Office Building

The interior of the office building is predominantly an office environment with minimum lobby space. The ratio of closed offices to open space plan is to be 30 percent closed to 70 percent open.

Construction finishes are to be carpet tiles, painted gypsum wallboard, wood trim at windows and doors, hollow metal frames and wood doors. Thirty percent of the interior partitions would be glass. Wood blinds are to be used. The entire floor area is to be on a raised access floor 16 inches tall. Corridor walls at the center of the building are to be constructed of 12-inch exposed architectural concrete for thermal mass.

Materials are to be selected with the overall LEED™ goals in mind. Fifty percent of the materials are to have recycled content. Fifty percent of the wood is to be certified. Twenty percent of the materials are to be regionally manufactured. Five percent of the materials are to be rapidly renewable. Ten percent of the materials are to be salvaged.

Volatile organic compounds (VOC) emissions are to be limited for better indoor air quality (IAQ). Provide full height walls around copy/print areas, custodial rooms and maintenance rooms where chemical contaminants occur. Provide dedicated air filters to remove the pollutants.

7.0 Conveying Systems

There are to be two 3,500-pound, passenger, Kone Ecosystem gearless elevators with five stops each. The building is to have two stairs. Five levels of stairs are to be steel pan with concrete fill. Roof and elevator pit ladders are required.

8.0 Mechanical Systems

Plumbing Garage

Floor drains are required throughout the parking area. The floor drains are collected and routed to a sand/oil trap and sumps located at the lowest level. There are to be six drains per 45,000 square feet of garage. The floor drains are to routed to separate risers. Each riser is to be approximately four inches and tie into a common header at the lowest level of approximately six inches in size. The sump is to have two pumps of 10-horsepower each. There are to be three hose bibbs per parking level for general clean up.

The roof drains under the courtyard are to be combined with the roof drains from the roof of the building. A 4-inch drain is required for every 400 square foot of planter area.

Plumbing Building

There are to be a total of 36 toilet room fixtures, three service sinks, six drinking fountains, and four kitchenette sinks. All plumbing fixtures are to be durable, efficient and low-flow. All toilets shall be dual flush and all urinals shall be waterless. A 6-inch sanitary riser serves the core toilets. A 4-inch riser is to carry water from the service sinks to a tank in the garage for disposal by a chemical removal truck. A 4-inch domestic water line provides service to the building. The water service is to be provided with an estimated 2-inch water meter. The central boiler is to heat the domestic hot water in immersion tanks. One 80-gallon IAPMO certified, stainless steel tank is to be provided in the mechanical room.

Storm water for the building is to be collected in 6-inch roof drains connected to four 6-inch vertical risers leading to a 25,000-gallon tank in the lower level. There are to be approximately 12 roof drains and overflow scuppers. Storm water stored in the tank is to offset 30 percent of the buildings water use. There is to be a separate water riser from the storage tank to the water closets.

HVAC Garage

There are to be three exhaust and three supply fans with 7-horsepower each for each level of the garage. These supply and exhaust fans are to be controlled by a carbon monoxide monitoring system. There are to be four sensors for each level to control the appropriate fans. Provide additional greywater lines from the sinks to a 20,000 gallon tank water is then filtered and added to the greywater line feeding the water closets.

HVAC Building

An under floor supply system is to serve the building's heating and cooling needs. The 16-inch access floor is to serve as a distribution plenum for the air. Two 33,750 cubic foot/minute, central air handling units on the roof supply the air downshafts at the core. These air handling units shall be sized to reduce static pressure drop through coils and filter sections. Air is to be supplied onto each floor from the central risers. Modulating dampers are to control the airflow into each take-off. The supply air temperature is to be 63° Fahrenheit. The 5-foot deep perimeter zones are to be separated from the main plenum space with a plenum wall in the floor. Air to these zones is to be supplied with heating-only fan coil units in the floor. Fan coil units are to provide air at a rate of 6.5 cubit feet/minute/square foot. One unit is required for every 35 feet of building perimeter. Stratified air from the floor below is mixed with primary air from the floor plenum at these perimeter units during heating season to minimize the reheat required. Outdoor air is to be supplied to the space at a rate of at least 20 cubic feet per minute per person, at 150 square feet/person occupancy. Where internal conference rooms or enclosed rooms with a potential for higher internal heat loads are likely, variable speed fans in the floor are to be directly ducted to the room's diffusers and increase the airflow accordingly.

The heating is to be supplied by hot water coming from a central, high-efficiency, condensing-type boiler. This boiler is to have an efficiency rating greater than 90 percent, a capacity of 600 MBH and provide the heat to the domestic hot water system through immersion-type hot water tanks. Cooling is to come from a 150-ton screw type chiller and cooling tower. The performance on the chiller must be at least 0.52 kilowatts/ton at full load.

Wall-mounted thermostats are to control each fan coil unit and modulating volume damper. The temperature tolerance is to be set at (76°/68°F). Occupants will be trained to use the operable windows and adjustable floor diffusers to control their space temperature. A partial mixed mode strategy will be incorporated into the building control system where areas of the building that can use their operable windows can have the mechanical system off when outdoor temperatures allow it. Thermostat control is to be provided for each 3,000 square feet in the interior zones. Air is to be delivered to the space through swirl-type floor diffusers complete with adjustable dust collection baskets. The diffusers are to be similar to the Trox or Krantz type diffusers and are to be flush with the floor.

A complete DDC control system is to be provided. All the mechanical systems in the building are to be fully commissioned at start-up. Additional commissioning will happen for the first year of occupancy. Prior to occupancy, a two-week flush of the building is to be performed using 100 percent outdoor air and new filter media on all air handling units. Provide temperature and humidity monitoring system for key areas in buildings. The energy use of the building is to reduce standards set out in ASHRAE 90.1-1999 by 50 percent.

Fire Protection Garage
The parking garage is to be fully sprinkled by using approximately two pipe risers located throughout the parking garage. This requires a 3-inch service into a fire protection room for location of the pipe valves and air compressors.

Fire Protection Building
The building is to be served by a 6-inch fire protection water service with a backflow preventer. The building is to be fully sprinkled with a density of 0.15 gallons/minute/square foot for the most remote 1,500 square feet. A standpipe is to be provided in each stairwell.

9.0 Electrical

Site Services
Utilities are to be supplied underground from the property line to the main electrical room in the first level of the parking garage. All services are to be run in concrete encased ducts with one spare duct for each three ducts utilized. Ten percent of the electricity is to be supplied by photovoltaics.

Pedestrian sidewalk lighting consists of 150-watt decorative luminaires on 8-foot poles. A total of 20 lighting standards are required to light the site. Light trespass from the site is to be minimized.

Electrical Garage
The parking garage is to be illuminated with T-5 fluorescent strip lights with a wire guard. Painting the parking garage ensures an average maintained lighting level of five footcandles. One fixture is to be supplied every 500 square feet for a total of 270 for all three levels. The lighting will be contactor controlled, with one switch controlling multiple banks of lights. The stairs are to be illuminated with 4-foot strip T5 fluorescent luminaires with wire guard at each landing.

Combination starter/disconnects are to be used in a fourplex motor control center, to be used for the ventilation fans. A carbon-monoxide detection system is to interface with the starters for control of the fans.

A 100-amp, 480/277-volt, 3-phase, 4-watt service is required to service the parking garage and consists of a central distribution panel in the main electrical room to supply 70 amperes to each level of the parking garage. Each level of the parking garage is to have a splitter trough and disconnect switches to supply a 70-amp, 480/277-volt lighting panelboard and a 480-volt modular MCC for the mechanical loads. On level one, a 15,000-volt amp, 120/208-volt dry transformer is to supply power to a panelboard for 120-volt convenience outlets (a total of fifteen per floor) to be located in service areas and perimeter walls throughout the parking garage. Twelve locations for electric car charging stations in the garage at dedicated spaces are to be provided.

Electrical Building
The building's interior lighting consists of indirect extruded aluminum luminaires using single T-5 lamps. A total of 7,000 lineal feet of this type of lighting is required. Occupancy sensors are to control the lighting in the washrooms and storage rooms. Low voltage switching for lighting control with local switching capability, as well as tie-in to the building management system is to be provided. A 20-foot perimeter zone incorporates daylight sensing for automatic lighting control. The area for each individual control zone within the perimeter zone is to be 200 square feet.

A 600-kilowatt, 480/277-volt, 3-phase electrical service is to be provided. The service entrance is to consist of a 1,200-amp fused switch with 1,000-ampere HRC fuses and a 1,200-amp distribution board. A main electrical room is to be located on level one of the parking garage.

An emergency generator room is to be located adjacent to the main electrical room. A 100-kilowatt generator is to supply the building's life safety systems, critical mechanical loads, and an uninterruptible power supply (UPS) system.

Ten percent of the building's electricity will be supplied by roof mounted photovoltaics.

On each floor there are to be three sub-electrical/communication rooms approximately 9-feet by 12-feet, each of which is to be supplied with a 100-ampere 480-volt feeder. These sub-electrical rooms are to each contain a communications backboard, 120-volt panelboard, 277-volt lighting panel and motor starters to supply mechanical equipment. One sub-electrical room on each floor is to have a 277-volt emergency panelboard. On level two, each sub-electrical room is to contain a 75,000-volt amp high-efficiency transformer to supply 120-volt power to the electrical rooms above and below this level.

The building requires a microprocessor-based fire alarm system to meet current code requirements. A total of four remote alphanumeric annunciator panels are required.

Telephone and data to category 5E standards are to be distributed using a rigid cable tray system in the floor. A total of 300 workstations are to be provided with one outlet each. Allow for 150 workstations with two data outlets and an uninterruptible power supply (UPS) system.

A fiber optic backbone and a cable TV distribution system are to be provided to each communications room.

An electronic security system is to be provided consisting of a PC-based management system, door contacts, card access control with varying levels of security throughout the building, and closed circuit TV monitoring of the parking garage, public areas and data rooms.

10.0 Sitework

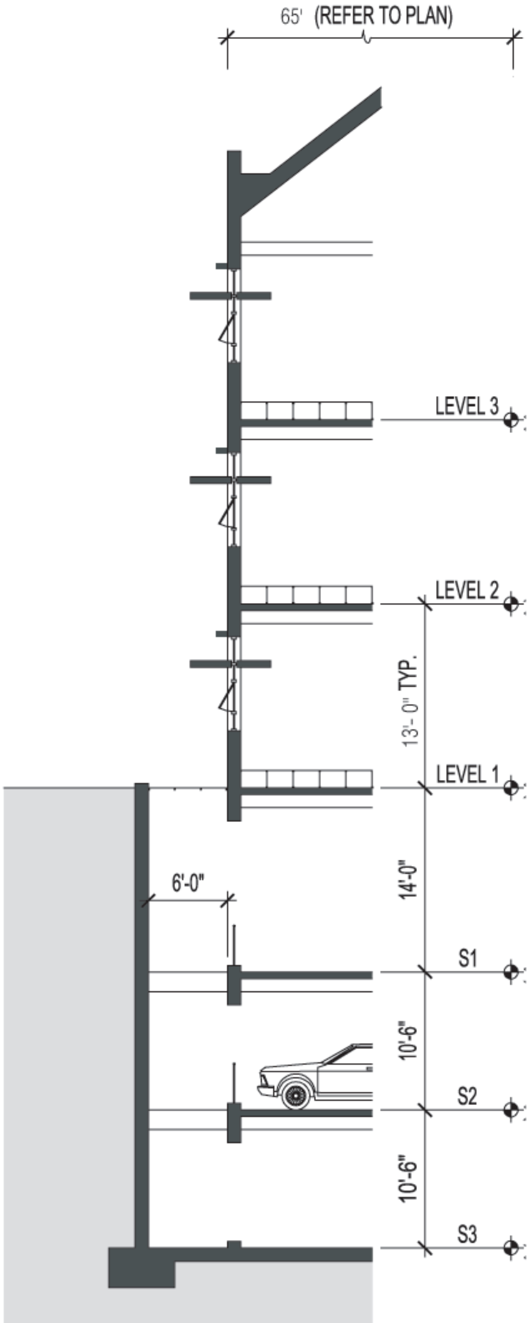
The remaining site is to be landscaped with native materials requiring small amounts of irrigation. Street trees are to be 3-inch caliper trees along the two city streets at 15-feet on center. Additional trees are to be provided on the site; new sidewalks and landscaped islands between the sidewalk and street are required.

At the interior courtyards over the garage, a 2-foot layer of soil is to be placed over the structure. The tree locations require an additional one foot of soil. A site retaining wall is to create a minimum 10-foot ring around the trees and be constructed from rock that was removed during excavation. Walkways are to be brick pavers set on sand at the courtyards.

11.0 General Conditions

Manage the construction process to provide means for recycling or salvaging 50 percent of the construction waste.

4 LEED™ Gold: Wall Section and Description



Office: 3 floors @ 30,000 square feet
Garage: 3 floors @ 45,000 square feet

- Photovoltaic panels mounted on a sloping roof
- Mechanical units installed under sloping ceiling of the third floor
- Energy Star reflective roof over R-42 insulation and metal roof deck; total R-value for the roof assembly is R-33

Office Structure

- Post-tension moment braced framing forming floor and ceiling
- 16” access flooring for office floors
- Exterior sunshades on all south, east and west facing glass
- Light shelves

- Forty percent of the envelope on the north and south face is to be Kawneer storefront glazing system
  - 1” insulated glazing - some operable
  - .29 U-factor
  - .43 solar heat gain coefficient
  - .70 visible light transmittance

- Twenty-five percent of envelope on the east and west is to be Kawneer storefront glazing system:
  - 1” insulated glazing - some operable
  - .31 U-factor
  - .41 solar heat gain coefficient
  - .47 visible light transmittance

- Sixty percent of envelope on north and south and 75 percent on the east and west
  - 7” precast or equivalent
  - 3” rigid insulation
  - 6” metal stud backup
  - 6” batt insulation
  - Gypsum interior wall board

- Total R-value for wall assembly is R-25.

Garage

- Garage roof contains R-18 insulation and a suspended ceiling; total R-value for the roof/floor assembly is R-23
- Garage structure: Cast-in-place concrete floor slab and beams
- Bentonite clay waterproofing at wall and slabs
- Underslab and foundation wall drain system

4 LEED™ Gold: Detail Cost Summary

Project Cost Summary

Construction Cost		
Building		$5,829,401
Parking		$4,305,417
Subtotal Construction Cost		$10,134,818
Construction Contingency	7.5%	$760,111
Escl to Constr Start September 2002	6.0%	$653,696
Total Hard Cost		**$11,548,625**
Soft Cost		
Design & Management Fees		$1,501,321
Fixtures Furnishings & Equipment		$1,034,453
Permits, Fees & Other Services		$577,431
Owner Administrative Fee		
Subtotal Soft Cost		$3,113,206
Soft Cost Contingency	10.0%	$311,321
Soft Cost Escalation on FF&E	9.0%	$93,101
Total Soft Cost		**$3,517,627**
Other Costs		
Artwork		Excluded
Fundraising/Financing		Excluded
Land Acquisition		Excluded
Total Project Cost		**$15,066,252**

4 LEED™ Gold: Detail Cost Summary

Building Construction Cost Summary

			Cost	Cost/SF
1.0	Site Preparation		$88,375	$0.98
2.0	Substructure		$147,505	$1.64
3.0	Superstructure		$919,514	$10.22
4.0	Exterior Closure		$927,815	$10.31
5.0	Roofing & Waterproofing		$287,029	$3.19
6.0	Interior Construction		$897,037	$9.97
7.0	Conveying Systems		$90,010	$1.00
8.0	Mechanical Systems		$636,687	$7.07
9.0	Electrical Systems		$479,756	$5.33
10.0	Finish Sitework		$178,794	$1.99
Subtotal Costs			$4,652,523	48.72614
	General Conditions	9.0%	$418,727	
	Contractor's Fee	4.5%	$228,206	
	Design Contingency	10.0%	$529,946	
Total Building Construction Cos t			**$5,829,401**	**$64.77**

Note: Cost above excludes construction contingency, escalation and soft costs.

4 LEED™ Gold: Detail Cost Summary

1.0 Site Preparation		
Earthwork		
Clearing and Grading	$9,195	
Erosion Control	$1,277	
Deconstruct Existing Building	$56,193	
Utilities		
Utility Connection	$19,157	
Miscellaneous	$2,554	
Subtotal 1.0 Site Preparation		$88,375
2.0 Substructure		
Foundations	$30,650	
Slab on Grade	$62,578	
Miscellaneous		
Raised Access Floor	$44,699	
Elevator Pit	$3,831	
Mechanical Pads	$1,916	
Concrete Curbs	$1,916	
Miscellaneous	$1,916	
Subtotal 2.0 Substructure		$147,505
3.0 Superstructure		
Upper Floor Structure - Concrete	$521,058	
Roof Structure - Concrete	$283,517	
Raised Access Floor	$107,277	
Miscellaneous	$7,663	
Subtotal 3.0 Superstructure		$919,514
4.0 Exterior Closure		
Exterior Wall Assembly	$483,256	
Windows & Glazing	$317,488	
Doors Frames & Hardware	$17,879	
Exterior Miscellaneous		
Louvers	$1,916	
Signage	$3,831	
Soffits	None	
Fascia & Trim	$26,819	
Trellises & Sunshades	$63,855	
Misc Exterior Work	$12,771	
Subtotal 4.0 Exterior Closure		$927,815

4 LEED™ Gold: Detail Cost Summary

5.0 Roofing & Waterproofing		
Roofing & Insulation	$113,407	
Premium for Photovoltaic Panels	$153,252	
Skylights	None	
Sheet Metal	$16,538	
Caulking & Sealants	$1,916	
Miscellaneous Roof Accessories	$1,916	
Subtotal 5.0 Roofing & Waterproofing		$287,029
6.0 Interior Construction		
Partitions		
Typical	$116,216	
Operable	$16,602	
Dropped Soffits & Fascia - Allow	$10,217	
Interior Glazing - Allow	$68,964	
Railings	$7,663	
Miscellaneous	$12,771	
Doors, Frames & Hardware - Wood	$122,602	
Floor Finishes	$160,915	
Wall Finishes	$38,313	
Ceiling Finishes	$114,939	
Millwork		
Kitchen	$9,195	
Storage & Workrooms	$14,048	
Conference Rooms	$26,819	
Chair Rail & Trim	$21,711	
Other Built-in Casework	$15,325	
Rough Hardware & Backing	$14,048	
Workstations	Inc. in FF+E	
Window Blinds	$57,725	
Specialties	$68,964	
Subtotal 6.0 Interior Construction		$897,037
7.0 Conveying Systems		
Stairs & Ladders		
Stairs	$20,434	
Stairs	$30,650	
Roof Ladder	$204	
Elevator Pit Ladder	$409	
Elevators		
Passenger	$53,638	
Deduct for Stops Assigned to Parking	($15,325)	
Subtotal 7.0 Conveying Systems		$90,010

8.0 Mechanical Systems	
HVAC	
Equipment Wet	
Boiler-Gas 950mbh w/PVC Flue	$4,725
Chiller 150 tons Screw	$20,434
Cooling tower 1 cell 150 tons	$7,024
Pump-HW	$2,810
-CHW	$2,810
-CW	$2,810
Miscellaneous Accessories	$6,386
Equipment Air	
Air Handling Unit -w/S Fan/CHW&HW coil /pre&final filts/Interior VFD/ 60000cfm:	$79,180
ACUnit for Tel/Elect	$16,985
Exhaust Fans	$5,108
Fancoil w/ Reheat	$15,785
Var Sp Fan @ Int Encl Spaces	$9,195
Control Dampers @ Shaft	$6,590
Filters for Enclosed Rooms	$2,299
Miscellaneous Equipment	$6,386
Ductwork & Accessories	
Duct-GSM	$64,366
-Insulation/Ext ernal	$2,554
-Damper/Manual	$6,386
Registers & Grilles	$26,819
Misc Duct & Accessories	$8,940
Pipework & Accessories	
Pipe-HW w/ Insl.	$38,313
Pipe-CHW w/ Insl.	$7,663
Misc Valves & Specs.	$8,940
Controls & Testing	
Control-System/DDC-EMCS	$53,638
2 Week Air Flush & Filter Change	$5,108
Commissioning	$10,217
Monitoring-1 year	Inc. in operating costs
Balancing-1year	Inc. in operating costs
Test & Balance	$12,771
Plumbing	
Fixtures & Equipment	
Water Heater Storage Tank	$1,022
Tank-Expansion	None
Tank-Oil/Water Separator	Inc. in parking estimate
Tank-Storm Water 25000gal	$16,602
Tank-Service Sink Waste Rem 000g.	$2,554
Pump-Elev.Sump	$1,073
Pump-DHW Recirc.	$252
Pump-Sewer 140gpm:0hp	$4,725
Pump-Storm Water	$4,214
Filtration-Storm	$7,663

Toilet Room Fixtures	$9,425	
Sink Service	$464	
Sink-Kit. Single	$587	
Drinking Fountain	$5,211	
Drains-Floor & Roof	$1,149	
Misc Equip. & Fixtures	$2,554	
Pipework & Accessories		
Pipe-Waste & Vent	$27,585	
Pipe-Storm	$9,961	
Pipe-CW w/ Insl.	$19,157	
Pipe-Storm Recirc to WC's	$4,598	
Pipe-DHW w/ Insl.	$3,831	
Pipe-Gas	$1,916	
Misc Valves & Specs.	$8,940	
Fire Sprinkler System		
Wet System-Bldg w/. Standpipe	$68,964	
Subtotal 8.0 Mechanical Systems		$636,687
9.0 Electrical Systems		
Primary Power		
Main Switchboard 1200A 600KW	$7,663	
Distribution Boards 1200A	$1,533	
Panelboards	$7,050	
Emergency Power - 100KW Generator	$25,542	
Feeders - Allow	$12,184	
Equipment Power	$45,976	
User Power	$53,638	
Lighting	$195,397	
Lightning Protection	None	
Signal & Communications		
Fire Alarm	$45,976	
Telephone/Data Rough-In	$30,650	
Telephone/Data Cabling	Inc. in FF+E	
Security System	$41,378	
Cable TV	$6,386	
Audio Visual Rough-In	$6,386	
Subtotal 9.0 Electrical Systems		$479,756
10.0 Finish Sitework		
Subtotal 10.0 Finish Sitework		$178,794

4 LEED™ Gold: Detail Cost Summary

Add for Underground Parking

Deduct Building Foundations	($30,650)
Deduct Building Slab on Grade	($62,578)
New Mat Slab	$298,523
Mechanical Pit	$3,831
Slab on Grade	$58,747
Underslab Drainage	$26,564
Shoring	$326,938
Excavation	$497,112
Dewatering	$25,542
Permanent Perimeter Drainage	$11,494
Retaining Walls	$388,239
Interior & Stem Walls	$14,304
Floor Structure	$603,431
Roof Structure	$398,047
Water Detention Basin	Included in building estimate
Pads, Curbs & Bollards	$3,831
Columns	$36,781
Ramp Slab	Included above
Ramp Walls	Included above
Waterproofing	$82,245
Gratings/Bridging	$40,229
Railings	$71,837
Topping Slab @ Roof	Included in sitework estimate
Partitions	$32,566
Insulation @ Roof	$17,879
Doors	$10,217
Painting, Striping, Misc.	$7,663
Signage	$3,831
Parking Equipment	$6,386
Electric Vehicle Charging	$7,663
Stair Towers	None
Stairs	$22,988
Elevator - Additional Stops	$15,325
Mechanical Systems	$275,854
Electrical Systems	$241,372
Finish Sitework	Included in building estimate
Subtotal Cost	$3,436,210
General Conditions	$309,259
Contractor's Fee	$168,546
Design Contingency	$391,402
Total Parking Construction Cost	**$4,305,417**

5 LEED™ Platinum: Site Plan

Existing

Proposed

5 LEED™ Platinum: Building Narrative

The following narrative was prepared, based on conceptual design work required to flesh out a set of assumptions, so that each building scenario could be adequately priced and its operational impacts (pollution and costs) determined. Reasonable assumptions were made for each scenario based on the team's collective knowledge.

1.0 Site Preparation

The site is 142 feet by 400 feet for a total square footage of 56,400 square feet. Site preparation is to begin with the deconstruction of the existing structures and requires that 75 percent of the materials by weight is to be recycled or salvaged. This includes the structure of the buildings and the soil that is excavated. The wooden structure at the corner of Whitney and Second Streets is to be salvaged and/or mulched.

The site is to be excavated in order to begin construction of the underground parking structure. A large amount of soil is to be diverted from the landfill in order to meet the requirements above. The lowest level of the parking structure is at an elevation of 35 feet below the existing sidewalk elevation for the three levels of parking. The garage ramp will be excavated outside the footprint of the garage. Retain 35 feet of soil around the entire perimeter of the site for the garage. The primary method for retaining the soil is to use steel sheet piling. The bottom of the excavation is assumed to be in the water table and, therefore, requires extensive dewatering during the construction process.

2.0 Substructure

The perimeter foundation walls are to be 12-inch concrete and are to be pulled away from the exterior wall location of the garage approximately six-feet and supported at the beam lines from the garage. The retaining walls are to be placed on a continuous footing bearing on a 2-foot thick matt footing under the entire structure. The concrete is to consist of 50 percent fly ash content and 20 percent recycled aggregate.

3.0 Superstructure

Garage Framing (120 feet x 375 feet x 3 floors = 135,000 sf)

The garage framing is to consist of 7-inch cast-in-place concrete beams at 30 feet on center. Interior column size is to vary, with larger columns required at building column locations above. The light wells at the perimeter of the garage are to be covered at the sidewalk locations with a steel and glass block panels. The other sides of the garage are to be covered with metal grating.

The concrete mix for the garage deck is to consist of 50 percent fly ash content and 20 percent recycled aggregate.

The framing under the courtyards is to be 3-foot deep beams at three feet on center, post-tensioned. This structure is to be recessed down two feet from the building floor lines.

Office Building (3 floors x 30,000 sf = 90,000 sf)

The office building structure is a concrete moment frame building with 6-inch wide joists six feet on center and 27-inch beams that are to be post tensioned. The concrete frame is to consist of 50 percent fly ash for cement and 20 percent recycled aggregate. The typical bay sizes correspond with the garage structure. The frame and ceiling of the building are to be exposed architectural concrete.

The roof structure is to be sloped to accommodate the photovoltaic panels on the roof. The roof is to be divided into two sloped sections to decrease the height of the building. The roof decking is to be constructed from salvaged wood from the deconstruction of the existing buildings and additional salvaged wood from other locations.

4.0 Exterior Enclosure

Office Building

The office building's skin is composed of 40 percent glazing and 60 percent precast or equivalent material on the north and south elevations and smaller windows (20 percent of the wall area) on the east and west elevations. Additional clerestory glass is to be provided at the midline of the building with the same requirements as the north glazing. The precast wall consists of 7-inch precast panels with vapor barrier, three-inches of rigid insulation, eight-inch metal studs with 8 inches of batt insulation, and interior gypsum wallboard.

Additional care is to be taken to insulate the structure's frame with rigid insulation to minimize thermal bridging. The total resistance value (R-value) for the exterior wall assembly is R-33.

At the access floor line, an additional set of operable windows with automated controls is to be provided every ten feet along the perimeter of the building.

The glazing system is a storefront system with double-glazed insulated units with a conductance value (U-factor) of 0.29, shading coefficient (SC) of 0.43 and visible light transmittance factor (VLT) of 0.70 on the north and south sides. The glazing on the east and west is a double-glazed insulated unit with a U-value of 0.31, shading coefficient of 0.40 and visible light transmittance factor of 0.47. The windows are to be operable at the lower three feet of the window area. Electronic control devices are to override manually operable windows when conditions are not favorable. An exterior aluminum louvered sunshade, 3-foot 8-inches in depth, protects all south facing glass. The east and west elevations are to have a stainless steel fabric supported three feet away from the building on a steel frame. Vertical aluminum fins protect all north facing glass. An internal light shelf, of 2-foot 6-inches deep, is to be constructed of translucent glass supported by steel brackets at the south elevations only. An additional 1-foot 6-inch deep aluminum sunshade protects all glass above the light shelves.

The mechanical units on top of the building are to be enclosed in locations within the additional ceiling space at the top floor of the building.

5.0 Roofing and Waterproofing

Garage

The garage is to be waterproofed by a combination system of bentonite clay panels at the exterior walls and below-grade slab, and an under-slab drainage system. The drainage system is to be pumped from a sump within the garage to the city storm sewer.

Waterproofing for the courtyards over the uppermost garage level is to be bentonite clay panels, under a drainage mat, under a water retention "egg crate".

The thermal barrier between the uppermost garage and the first floor of the office building is to be insulated with a layer of R-24 insulation over a suspended ceiling and would have a total R-value of R-27.

Office Building

The roof is to be an Energy Star, white, standing seam metal roof over an insulation base of R-48. Perimeter conditions and penetrations at the roof cause the actual roof R-value to be R-40.

6.0 Interior Construction

Office Building

The interior of the office building is predominantly an office environment with minimum lobby space. The ratio of closed offices to open space plan is to be 20 percent closed to 80 percent open.

Construction finishes are to be carpet tiles, painted gypsum wallboard, wood trim at windows and doors, hollow metal frames and wood doors. Forty percent of the interior partitions would be glass. Wood blinds are to be used for interior partitions. Blinds on exterior windows will not be required. The entire floor area is to be on a raised access floor 16 inches tall. Corridor walls at the center of the building are to be constructed of 12-inch exposed architectural concrete for thermal mass.

Materials are to be selected with the overall LEED™ goals in mind. Fifty percent of the materials are to have recycled content. Fifty percent of the wood is to be certified. Twenty percent of the materials are to be regionally manufactured. Half of the regionally manufactured materials are to be made from regionally extracted raw materials. Five percent of the materials are to be rapidly renewable. Ten percent of the materials are to be salvaged.

Volatile organic compounds (VOC) emissions are to be limited for better indoor air quality (IAQ). Provide full height walls around copy/print areas, custodial rooms and maintenance rooms where chemical contaminants occur. Provide dedicated air filters to remove the pollutants.

7.0 Conveying Systems

There are to be two 3,500-pound passenger, Kone Ecosystem gearless elevators with five stops each. The building is to have two stairs. Five levels of stairs are to be steel pan with concrete fill. Roof and elevator pit ladders are required.

8.0 Mechanical Systems

Plumbing Garage

There are to be floor drains provided for the parking area. The floor drains are to be collected and routed to a sand/oil trap and sumps located at the lowest level. There are to be 12 drains for each level of the garage. The floor drains are to be routed to separate risers. Each 4-inch riser is to tie into a common 6-inch header at the lowest level. The sump will have two pumps at 10-horsepower each. There are to be three hose bibbs per parking level.

The drains under the courtyard are combined with the roof drains from the building. A 4-inch drain is required for every 400 square feet of planter area.

Plumbing Building

There are to be a total of 36 toilet room fixtures, three service sinks, six drinking fountains, and four kitchenette sinks. All plumbing fixtures are to be durable, efficient and low-flow. All toilets shall be dual flush and all urinals shall be waterless. A 6-inch sanitary riser serves the core toilets. A 4-inch riser is to carry water from the service sinks to a tank in the garage for disposal by a chemical removal truck. A 4-inch domestic water line provides service to the building. The water service is to be provided with an estimated two-inch water meter. The central boiler is to heat the domestic hot water in immersion tanks. One 80-gallon IAPMO certified, stainless steel tank is to be provided in the mechanical room.

Storm water for the building is to be collected in 6-inch roof drains connected to four 6-inch vertical risers leading to a 25,000-gallon tank in the lower level. There are to be approximately 12 roof drains and overflow scuppers. Storm water stored in the tank is to offset 30 percent of the buildings water use. There is to be a separate water riser from the storage tank to the water closets.

Provide additional greywater lines from the sinks to a 20,000 gallon tank. Water is then filtered and added to the greywater line feeding the water closets.

HVAC Garage

There are to be three exhaust and three supply fans with 7-horsepower each for each level of the garage. These supply and exhaust fans are to be controlled by a carbon monoxide monitoring system. There are to be four sensors for each level to control the appropriate fans.

HVAC Building

An underfloor supply system is to serve the building's heating and cooling needs during peak seasons. During off-peak seasons, wherever possible, the building is to be naturally ventilated. The 16-inch access floor is to serve as a distribution plenum for the air. Two 27,000 cubic feet/minute central air-handling units on the roof are to supply the air downshafts at the core. These air handling units shall be sized to reduce static pressure drop through coils and filter sections. Air is to be supplied onto each floor from the central risers. Modulating dampers are to control the airflow into each take-off. The supply air temperature is to be 63 F. The 5-foot deep perimeter zones are to be separated from the main plenum space with a plenum wall in the floor. Air to these zones is to be supplied with heating-only fan coil units in the floor. Fan coil units are to provide air at a rate of 6.5 cubic foot/minute/square foot such that one is required for every 35 feet of building perimeter. Stratified air from the floor below is mixed with primary air from the floor plenum at these perimeter units during heating season to minimize the reheat required. Outdoor air is to be supplied to the space at a rate of at least 20 cubic feet/minute per person at 150 square feet/person occupancy. Carbon dioxide monitors are to be provided for each 5,000 square feet to monitor the indoor air quality of the building. Where internal conference rooms or enclosed rooms with a potential for higher internal heat loads are likely, variable speed fans in the floor are to be directly ducted to the room's diffusers and increase the airflow accordingly.

The heating is to be supplied by hot water coming from a central, high efficiency, condensing-type boiler. This boiler is to have an efficiency rating of greater than 90 percent, a capacity of 650 MBH and provide heat to the domestic hot water system through immersion-type hot water tanks. Cooling is to come from a 100-ton screw-type chiller and cooling tower. The performance on the chiller must be at least 0.52 kilowatts/ton at full load. The chiller's refrigerant is to be R134a.

Wall-mounted thermostats are to control each fan coil unit and modulating volume damper. The temperature tolerance is to be set at (78°/68°F). Occupant's thermostat control is to be provided for each 3,000 square feet in the interior zones. In addition, six in-slab sensors are to be provided (two per floor) so that the effect of the dynamic thermal storage can be monitored. A night purge is to be written into the control sequence during cooling season so that the building's structure is cooled in the occupants' absence. Air is to be delivered to the space through swirl-type floor diffusers complete with adjustable dust collection baskets. The diffusers are to be similar to the Trox or Krantz diffusers and are to be flush with the floor.

A complete DDC control system is to be provided. All the mechanical systems in the building are to be fully commissioned at start up. Additional commissioning will happen for the first year of occupancy. Prior to occupancy, a two-week flush of the building is to be performed using 100 percent outdoor air and new filter media on all air handling units. Provide temperature and humidity monitoring system for key areas in building. The energy use of the building is to reduce that set out in ASHRAE 90.1-1999 by 60 percent.

Fire Protection Garage
The parking garage is to be fully sprinkled by using approximately two wet pipe risers located throughout the parking garage. This requires a 3-inch service into a fire protection room for location of the pipe valves and air compressors.

Fire Protection Building
The building is to be served by a 6-inch fire protection water service with a backflow preventer. The building is to be fully sprinkled with a density of 0.15 gallons/minute/square foot for the most remote 1,500 square feet. A standpipe is to be provided in each stairwell.

9.0 Electrical

Site Services
Utilities are to be supplied underground from the property line to the main electrical room in the first level of the parking garage. All services are to be run in concrete encased ducts with one spare duct for each three ducts utilized. Twenty percent of the electricity is be supplied by photovoltaics.

Pedestrian sidewalk lighting consists of decorative luminaires on 8-foot poles. A total of 12 lighting standards are required to light the site. Light trespass from the site is to be minimized.

Electrical Garage
The parking garage is to be illuminated with T-5 fluorescent high-efficiency industrial luminaires with a specular alzack reflector. Painting the parking garage ensures an average maintained lighting level of five footcandles. One fixture is to be supplied every 700 square feet for a total of 200 luminaires for all three levels. Lighting is to be low voltage, controlled with motion sensors and manual override. The stairs are to be illuminated with 4-foot strip T-5 fluorescent luminaires with acrylic lens at each landing.

Combination starter/disconnects are to be used in a fourplex motor control center to be used for the ventilation fans. A carbon monoxide detection system is to interface with the starters for control of the fans.

A 100-amp, 480/277-volt, 3-phase, 4-watt service is required to service the parking garage and consist of a central distribution panel in the main electrical room to supply 70 amperes to each level of the parking garage. Each level of the parking garage is to have a splitter trough and disconnect switches to supply a 70-amp 480/277-volt lighting panelboard and a 480-volt modular MCC for the mechanical loads. On level one, a 15,000-volt amp, 120/208-volt dry transformer is to supply power to a panelboard for 120-volt convenience outlets (a total of 15 per floor) to be located in service areas and perimeter walls throughout the parking garage. Provide 12 locations for electric charging stations in the garage.

Electrical Building
The building's interior lighting is to consist of indirect extruded aluminum luminaires using single T-5 lamps. A total of 5,000 lineal feet of this type of lighting is required. Occupancy sensors are to control the lighting in the washrooms and storage rooms. Low voltage switching for lighting control with local switching capability, as well as tie-in to the building management system, is to be provided. A 20-foot perimeter zone incorporates daylight sensing for automatic lighting control. The area for each individual control zone within the perimeter zone is 200 square feet.

Interior zones are to be illuminated using daylight harvested from the roof and transmitted to the lower floor using light pipe or similar technology. In addition to the perimeter zones, a total of 30,000 square feet require daylighting control zones.

A 400-kilowatt, 480/277-volt, 3-phase electrical service is to be provided. The service entrance consists of a 800-amp fused switch with 800-ampere HRC fuses and an 800-amp distribution board. A main electrical room is to be located on level one of the parking garage.

An emergency generator room is to be located adjacent to the main electrical room. A 75-kilowatt generator is to supply the building life safety systems, critical mechanical loads, and a uninterruptible power supply (UPS) for essential computer circuits.

Twenty-five percent of the building power is to be supplied by a roof-mounted photovoltaic panels.

On each floor, there are to be three sub-electrical/communication rooms approximately 9-feet by 12-feet each of which are to be supplied with a single 200-ampere 480-volt feed through distribution. These sub-electrical rooms each contain a communications backboard, 120-volt panelboard, 277-volt lighting panel motor starters to supply mechanical equipment. One sub-electrical room on each floor is to have a 277-volt emergency panelboard. On level two, each sub-electrical room is to contain a 45,000-volt amp high efficiency, transformer to supply 120-volt power to the electrical rooms above and below this level.

The building requires a microprocessor-based fire alarm system to meet current code requirements. A total of four remote alphanumeric annunciator panels are required.

Telephone and data to category 5E standards are to be distributed using a rigid cable tray system under the floor. A total of 300 workstations are to be provided with one outlet each. Allow for 150 workstations with two data outlets and uninterruptible power supply (UPS) system.

A fiber optic backbone and a cable TV distribution system are to be provided to each communications room.

An electronic security system is to be provided consisting of a PC-based management system, door contacts, card access control with varying levels of security throughout the building, and closed circuit TV monitoring of the parking garage, public areas and data rooms.

10.0 Sitework

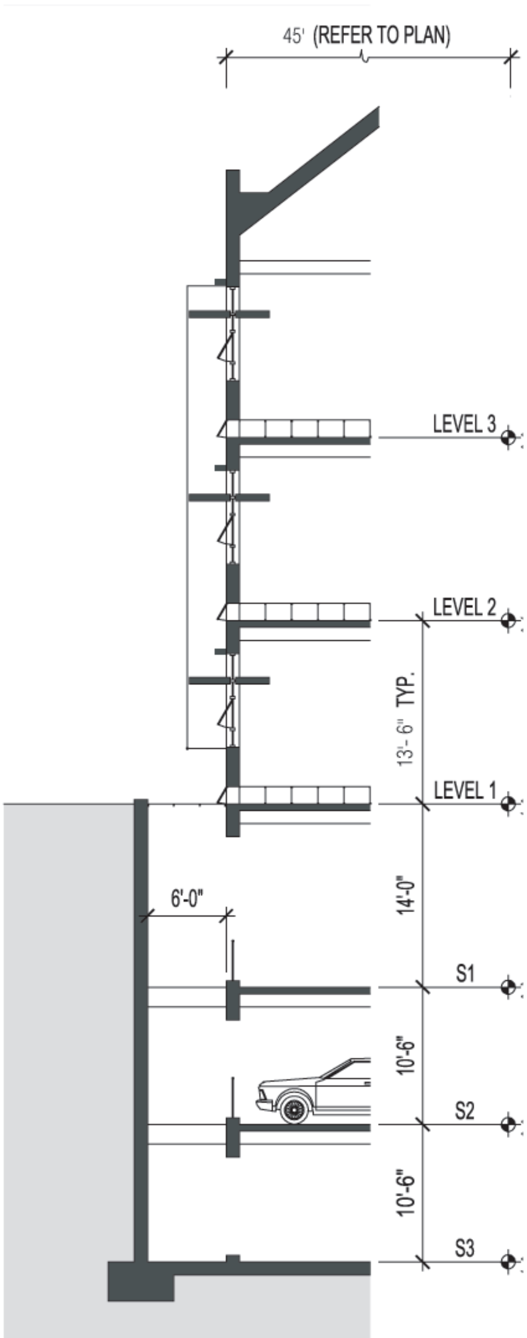
The remaining site is to be landscaped with native materials requiring small amounts of irrigation. Street trees are to be 3-inch caliper trees along the two city streets at 15-feet on center. Additional trees are to be provided on the site. New sidewalks and landscaped islands between the sidewalk and street are required.

At the interior courtyards over the garage, a 2-foot layer of soil is to be placed over the structure. The tree locations require an additional one foot of soil. A site retaining wall creates a minimum 10-foot ring around the trees to be constructed from rock that was removed during excavation. Walkways are to be brick pavers set on sand at the courtyards.

11.0 General Conditions

Manage the construction process to provide means for salvaging 75 percent of the construction waste.

5 LEED™ Platinum: Wall Section and Description



Office: 3 floors @ 30,000 square feet
Garage: 3 floors @ 45,000 square feet

- Photovoltaic panels mounted on a sloping roof
- Mechanical units installed under sloping ceiling of the third floor
- Energy Star reflective roof over R-48 insulation and salvaged wood decking; total R-value for the roof assembly is R-40

Office Structure

- Post-tension moment framing forming floor and ceiling
- 16" access flooring for office floors
- Clerestory glazing and daylight tubes
- Exterior sunshades at south and metal fabric screen at the east and west facing glass
- Light shelves

- Forty percent of the envelope on the north and south face is to be Kawneer storefront glazing system.
  - 1 inch triple glazing unit, operable with controls
  - .29 U-factor
  - .43 solar heat gain coefficient
  - .70 visible light transmittance

- Twenty percent of envelope on the east and west is to be Kawneer storefront glazing system:
  - 1" double glazing unit with operable controls
  - .31 U-factor
  - .40 solar heat gain coefficient
  - .47 visible light transmittance

- Sixty percent of envelope on north and south and 75 percent on the east and west:
  - 7" precast or equivalent
  - 3" rigid insulation
  - 8" metal stud backup
  - 8" batt insulation
  - Gypsum interior wall board

- Total R-value for wall assembly is R-33

Garage

- Garage roof contains R-24 insulation and a suspended ceiling; total R-value for the roof/floor assembly is R-27
- Garage structure: Cast-in-place concrete floor slab and beams
- Bentonite clay waterproofing at wall and slabs
- Underslab and foundation wall drain system

5 LEED™ Platinum: Detail Cost Summary

Project Cost Summary

Construction Cost		
Building		$6,336,221
Parking		$4,283,015
Subtotal Construction Cost		$10,619,235
Construction Contingency	7.5%	$796,443
Escl to Constr Start September 2002	6.0%	$684,941
Total Hard Cost		**$12,100,619**
Soft Cost		
Design & Management Fees		$1,694,087
Fixtures Furnishings & Equipment		$1,034,453
Permits, Fees & Other Services		$605,031
Owner Administrative Fee		
Subtotal Soft Cost		$3,333,571
Soft Cost Contingency	10.0%	$333,357
Soft Cost Escalation on FF&E	9.0%	$93,101
Total Soft Cost		**$3,760,028**
Other Costs		
Artwork		Excluded
Fundraising/Capital Campaign		Excluded
Land Acquisition		Excluded
Total Project Cost		**$15,860,647**

5 LEED™ Platinum: Detail Cost Summary

Building Construction Cost Summary

			Cost	Cost/SF
1.0	Site Preparation		$144,568	$1.61
2.0	Substructure		$147,505	$1.64
3.0	Superstructure		$919,514	$10.22
4.0	Exterior Closure		$1,212,736	$13.47
5.0	Roofing & Waterproofing		$338,113	$3.76
6.0	Interior Construction		$901,379	$10.02
7.0	Conveying Systems		$90,010	$1.00
8.0	Mechanical Systems		$660,916	$7.34
9.0	Electrical Systems		$463,486	$5.15
10.0	Finish Sitework		$178,794	$1.99
Subtotal Costs			**$5,057,022**	**$52.60**
	General Conditions	9.0%	$455,132	
	Contractor's Fee	4.5%	$248,047	
	Design Contingency	10.0%	$576,020	
Total Construction Cost			**$6,336,221**	**$70.40**

Note: Cost above excludes construction contingency, escalation and soft costs.

5 LEED™ Platinum: Detail Cost Summary

1.0 Site Preparation		
Earthwork		
Clearing and Grading	$9,195	
Erosion Control	$1,277	
Deconstruct Existing Building	$112,385	
Utilities		
Utility Connection	$19,157	
Miscellaneous	$2,554	
Subtotal 1.0 Site Preparation		144,568
2.0 Substructure		
Foundations	$30,650	
Slab on Grade	$62,578	
Miscellaneous		
Raised Access Floor	$44,699	
Elevator Pit	$3,831	
Mechanical Pads	$1,916	
Concrete Curbs	$1,916	
Miscellaneous	$1,916	
Subtotal 2.0 Substructure		$147,505
3.0 Superstructure		
2nd Floor Structure - Concrete	$521,058	
Roof Structure - Concrete	$283,517	
Raised Access Floor	$107,277	
Miscellaneous	$7,663	
Subtotal 3.0 Superstructure		$919,514
4.0 Exterior Closure		
Exterior Wall Assembly	$585,807	
Windows & Glazing	$461,545	
Doors Frames & Hardware	$17,879	
Exterior Miscellaneous		
Louvers	$1,916	
Signage	$3,831	
Soffits	None	
Fascia & Trim	$26,819	
Trellises & Sunshades & Scrims	$102,168	
Misc Exterior Work	$12,771	
Subtotal 4.0 Exterior Closure		$1,212,736

5 LEED™ Platinum: Detail Cost Summary

5.0 Roofing & Waterproofing		
Roofing & Insulation	$113,407	
Photovoltaic Panels	$204,336	
Skylights	None	
Sheet Metal	$16,538	
Caulking & Sealants	$1,916	
Miscellaneous Roof Accessories	$1,916	
Subtotal 5.0 Roofing & Waterproof ing		$338,113
6.0 Interior Construction		
Partitions		
Typical	$89,397	
Operable	$16,602	
Dropped Soffits & Fascia - Allow	$10,217	
Interior Glazing - Allow	$91,951	
Railings	$7,663	
Miscellaneous	$12,771	
Doors, Frames & Hardware - Wood	$91,951	
Floor Finishes	$183,903	
Wall Finishes	$40,867	
Ceiling Finishes	$114,939	
Millwork		
Kitchen	$9,195	
Storage & Workrooms	$14,048	
Conference Rooms	$26,819	
Chair Rail & Trim	$21,711	
Other Built-in Casework	$15,325	
Rough Hardware & Backing	$14,048	
Workstations	Inc. in FF+E	
Window Blinds	$71,007	
Specialties	$68,964	
Subtotal 6.0 Interior Construction		$901,379
7.0 Conveying Systems		
Stairs & Ladders		
Stairs	$20,434	
Stairs	$30,650	
Roof Ladder	$204	
Elevator Pit Ladder	$409	
Elevators		
Passenger	$53,638	
Deduct for Stops Assigned to Parking	($15,325)	
Subtotal 7.0 Conveying Systems		$90,010

8.0 Mechanical Systems	
HVAC	
Equipment Wet	
Boiler-Gas 875mbh w/PVC Flue	$4,214
Chiller 100 tons Screw	$14,559
Cooling tower 1 cell 100 tons	$6,002
Pump-HW	$2,656
-CHW	$2,707
-CW	$2,707
Miscellaneous	$6,386
Equipment Air	
Air Handling Unit-w/S Fan/CHW&HW coil /pre&final filts/Interior VFD/ 45000cfm:	$58,747
ACUnit for Tel/Elect	$16,985
Exhaust Fans	$3,831
Fan-Sup./I.L	$639
Fancoil w/ Reheat	$15,785
Var Sp Fan @ Int Encl Spaces	$9,195
Control Dampers @ Shaft	$6,590
Filters for Enclosed Rooms	$2,299
Miscellaneous Equipment	$8,940
Ductwork & Accessories	
Duct-GSM	$64,366
-Insulation/External	$2,554
-Damper/Manual & Accessories	$5,108
Register & Grilles	$26,819
Misc Duct & Accessories	$6,386
Pipework & Accessories	
Pipe-HW w/ Insl	$38,313
Pipe-CHW w/ Insl	$7,663
Misc Valves & Specs.	$6,386
Controls & Testing	
Control-System/DDC-EMCS	$53,638
Slab Sensor System	$7,663
CO2 Monitoring -Building IAQ	$11,494
Monitoring-1 year	Inc. in operating costs
Balancing-1 year	Inc. in operating costs
2 Week Air Flush & Filter Change	$5,108
Commissioning	$10,217
Test & Balance	$12,771
Plumbing	
Fixtures & Equipment	
Water Heater-Solar	$5,108
Tank-Expansion	$106
Tank-Oil/Water Separator	Inc. in parking estimate
Tank-Storm Water 25000gal. 100%	$16,602
Tank-Greywater Stor 20000 gal FG	$15,325
Tank-Service Sink Waste Rem 000g.	$2,554

Fixtures & Equipment (cont'd)		
Pump-Elev.Sump	$1,073	
Pump-DHW Recirc.	$252	
Pump-Sewer	$4,725	
Pump-Storm Water	$4,214	
Pump-Greywater	$4,725	
Filtration-Storm	$7,663	
Filtration-Greywater	$6,386	
Toilet Room Fixtures	$9,425	
Sink Service	$309	
Sink-Kit. Single	$587	
Drinking Fountain	$5,211	
Drain-Floor/Roof	$1,149	
Misc Equip. & Fixtures	$2,554	
Pipework & Accessories		
Pipe-Waste & Vent	$27,585	
Pipe-Greywater	$4,827	
Pipe-Storm	$9,961	
Pipe-CW w/ Insl.	$19,157	
Pipe-Storm Recirc to WC's	$3,525	
Pipe-Greywater Recirc to WC's	$3,831	
Pipe-DHW w/ Insl	$3,831	
Pipe-Gas	$1,596	
Misc Valves & Specs.	$8,940	
Fire Sprinkler System		
Wet System-Bldg.	$68,964	
Subtotal 8.0 Mechanical Systems		$660,916
9.0 Electrical Systems		
Primary Power		
Main Switchboard 800A 400 KW	$6,386	
Distribution Boards 800A	$1,277	
Panelboards	$7,050	
Emergency Power - 100KW Generator	$25,542	
Feeders - Allow	$11,494	
Equipment Power	$45,976	
User Power	$51,084	
Lighting	$183,903	
Lightning Protection	None	
Signal & Communications		
Fire Alarm	$45,976	
Telephone/Data Rough-In	$30,650	
Telephone/Data Cabling	Inc. in FF+E	
Security System	$41,378	
Cable TV	$6,386	
Audio Visual Rough-In	$6,386	
Subtotal 9.0 Electrical Systems		$463,486
10.0 Finish Sitework		
Subtotal 10.0 Finish Sitework		$178,794

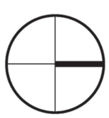
Add for Underground Parking

Deduct Building Foundations	($30,650)
Deduct Building Slab on Grade	($62,578)
New Mat Slab	$298,523
Mechanical Pit	$3,831
Slab on Grade	$58,747
Underslab Drainage	$26,564
Shoring	$326,938
Excavation	$497,112
Dewatering	$25,542
Permanent Perimeter Drainage	$11,494
Retaining Walls	$388,239
Interior & Stem Walls	$14,304
Floor Structure	$603,431
Roof Structure	$398,047
Water Detention Basin	Included in building estimate
Pads, Curbs & Bollards	$3,831
Columns	$36,781
Ramp Slab	Included above
Ramp Walls	Included above
Waterproofing	$82,245
Gratings/Bridging	$40,229
Railings	$71,837
Topping Slab @ Roof	Included in sitework estimate
Partitions	$32,566
Doors	$10,217
Painting, Striping, Misc.	$7,663
Signage	$3,831
Parking Equipment	$6,386
Electric Vehicle Charging	$7,663
Stair Towers	None
Stairs	$22,988
Elevator - Additional Stops	$15,325
Mechanical Systems	$275,854
Electrical Systems	$241,372
Finish Sitework	Included in building estimate
Subtotal Cost	$3,418,331
General Conditions	$307,650
Contractor's Fee	$167,669
Design Contingency	$389,365
Total Parking Construction Cost	**$4,283,015**

6 Living Building: Site Plan

Existing

Proposed



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6 Living Building: Building Narrative

The following narrative was prepared, based on conceptual design work required to flesh out a set of assumptions, so that each building scenario could be adequately priced and its operational impacts (pollution and costs) determined. Reasonable assumptions were made for each scenario based on the team's collective knowledge.

1.0 Site Preparation

The site is 142 feet by 400 feet for a total square footage of 56,400 square feet. Site preparation is to begin with the deconstruction of the existing structures and require that 75 percent of the materials by weight be recycled or salvaged. This includes the structure of the buildings and the soil that is excavated. The wooden structure at the corner of Whitney and Second Streets is to be salvaged and/or mulched.

The site is to be excavated in order to begin construction of the underground parking structure. A large amount of soil is to be diverted from the landfill in order to meet the requirements above. The lowest level of the parking structure is at an elevation of 35 feet below the existing sidewalk elevation for the three levels of parking. The garage ramp will be excavated outside the footprint of the garage. Retain 35 feet of soil around the entire perimeter of the site for the garage. The primary method for retaining the soil is to use steel sheet piling. The bottom of the excavation is assumed to be in the water table and requires extensive dewatering during the construction process.

2.0 Substructure

The perimeter foundation walls are to be 12-inch concrete and are to be pulled away from the exterior wall location of the garage approximately six feet and supported at the beam lines from the garage. The retaining walls are to be placed on a continuous footing bearing on a 2-foot thick matt footing under the entire structure. The concrete is to consist of 50 percent fly ash content and 20 percent recycled aggregate.

3.0 Superstructure

Garage Framing (120 feet x 375 feet x 3 floors = 135,000 sf)

The garage framing is to consist of 7-inch cast-in-place concrete beams at 30 feet on center. Interior column size is to vary, with larger columns required at building column locations above. The light wells at the perimeter of the garage are to be covered at the sidewalk locations with a steel and glass block panels. The other sides of the garage are to be covered with metal grating.

The concrete mix for the garage deck is to consist of 50 percent fly ash content and 20 percent recycled aggregate.

The framing under the courtyards is to be 3-foot deep beams at three feet on center post-tensioned. This structure is to be recessed down two feet from the building floor lines.

Office Building (3 floors x 30,000sf)

The office building structure is a concrete moment frame building with 6-inch wide joists six feet on center and 27-inch beams that are to be post-tensioned. The concrete frame is to consist of 50 percent fly ash for cement and 20 percent recycled aggregate. The typical bay sizes correspond with the garage structure. The frame and ceiling of the building are to be exposed architectural concrete.

The roof structure is to be sloped to accommodate the photovoltaic panels on the roof. The roof is to be divided into two sloped sections to decrease the height of the building. The roof decking is to be constructed from salvaged wood from the deconstruction of the existing buildings and additional salvaged wood from other locations.

Ecological Wastewater Treatment System

The ecological wastewater treatment system is to be housed in a greenhouse constructed of a steel post-and-beam system with steel trusses at the roof for support of the horizontal curtain wall.

4.0 Exterior Enclosure

Office Building

The office building's skin is composed of 40 percent glazing and 60 percent precast or equivalent material on the north and south elevations and smaller windows (20 percent of the wall area) on the east and west elevations. Additional clerestory glass is to be provided at the midline of the building with the same requirements as the north glazing. The precast wall consists of 7-inch precast panels with vapor barrier, 3-inch of rigid insulation, 8-inch metal studs with eight inches of batt insulation, and interior gypsum wallboard. Additional care is to be taken to insulate the structure's frame with rigid insulation and minimize thermal bridging. Exterior walls are to have a total wall resistance value (R-value) of R-33.

At the access floor line, a set of additional operable windows with automated controls is to be provided every 10'-0" along the perimeter of the building.

The glazing system is a storefront system with double-glazed insulated units with a conductance value (U-factor) of 0.29, shading coefficient (SC) of 0.43 and visible light transmittance factor (VLT) of 0.70 on the north and south sides. The glazing on the east and west is a double-glazed insulated unit with a U-value of 0.31, shading coefficient of 0.40 and visible light transmittance factor of 0.47. The windows are to be operable at the lower three feet of the window area. Electronic control devices are to override manually operable windows when conditions are not favorable. An exterior aluminum louvered sunshade 3-foot 8-inches in depth, protects all south facing glass. The east and west elevations are to have a stainless steel fabric supported three feet away from the building on a steel frame. Vertical aluminum fins protect all north facing glass. An internal light shelf, of 2-foot 6-inches deep, is to be constructed of translucent glass supported by steel brackets at the south elevations only. An additional 1-foot 6-inch deep aluminum sunshade protects all glass above the light shelves.

The mechanical units on top of the building are to be enclosed in locations within the additional ceiling space at the top floor of the building.

The ecological wastewater treatment system's greenhouse is to be skinned in a horizontal and vertical 6-inch curtain wall system with insulated translucent glass.

5.0 Roofing and Waterproofing

Garage

The garage is to be waterproofed by a combination system of bentonite clay panels at the exterior walls and below-grade slab, and an under-slab drainage system. The drainage system is to be pumped from a sump within the garage to the city storm sewer.

Waterproofing for the courtyards over the uppermost garage level is to be bentonite clay panels, under a drainage mat, under a water retention "egg crate".

The thermal barrier between the uppermost garage and the first floor of the office building is to be insulated with a layer of R-24 insulation over a suspended ceiling and would have a total R-value of R-27.

Office Building

The roof is to be an Energy Star white standing seam metal roof over an insulation base of R-48. Perimeter conditions and penetrations at the roof cause the actual roof R-value to be R-40.

6.0 Interior Construction

Office Building

The interior of the office building is predominantly an office environment with minimum lobby space. The ratio of closed offices to open space plan is to be 10 percent closed to 90 percent open.

Construction finishes are to be carpet tiles, painted gypsum wallboard, wood trim at windows and doors, hollow metal frames and wood doors. Forty percent of the interior partitions would be glass. Wood blinds are to be used for interior partitions. Blinds on exterior windows will not be required. The entire floor area is to be on a raised access floor 16 inches tall. Corridor walls at the center of the building are to be constructed of 12-inch exposed architectural concrete for thermal mass.

All construction materials are to be selected based on their overall life cycle impact. Areas of consideration include: impacts on energy consumption by the building; human health and environmental hazards; embodied energy and pollution; resource limitation, and waste management. Construction assemblies are to be designed for a one-hundred-year life and for deconstruction rather than for demolition.

Materials are to be selected with a full understanding of their implications on indoor air quality (IAQ). Provide full height walls around copy/print areas, custodial rooms and maintenance rooms where chemical contaminants occur. Provide dedicated air filters to remove the pollutants.

7.0 Conveying Systems

There are to be two 3,500-pound passenger Kone Ecosystem gearless elevators with five stops each. The building is to have two stairs. Five levels of stairs are to be steel pan with concrete fill. Roof and elevator pit ladders are required.

8.0 Mechanical Systems

Plumbing Garage

There are to be floor drains provided for the parking area. The floor drains are to be collected and routed to a sand/oil trap and sumps located at the lowest level. There are to be 12 drains for each level of the garage. The floor drains are to be routed to separate risers. Each 4-inch riser is to tie into a common 6-inch header at the lowest level. The sump will have two pumps at 10-horsepower each. There are to be three hose bibbs per parking level.

The drains under the courtyard are combined with the roof drains from the building. A 4-inch drain is required for every 400 square feet of planter area.

Plumbing Building

There are to be a total of 36 toilet room fixtures, three service sinks, six drinking fountains, and four kitchenette sinks. All plumbing fixtures are to be durable, efficient and low-flow. All toilets shall be dual flush and all urinals shall be waterless. A 6-inch sanitary riser serves the core toilets. A 4-inch riser is to carry water from the service sinks to the living machine for treatment. A 4-inch domestic water line provides service to the building. The water service is to be provided with an estimated two-inch water meter. The central boiler is to heat the domestic hot water in immersion tanks. One 80-gallon IAPMO certified, stainless steel tank is to be provided in the mechanical room.

Storm water for the building is to be collected in 6-inch roof drains connected to four 6-inch vertical risers leading to a 25,000-gallon tank in the lower level. There are to be approximately 12 roof drains and overflow scuppers. Storm water stored in the tank is to offset 30 percent of the building's water use. There is to be a separate water riser from the storage tank to the water closets.

Provide additional greywater lines from the sinks to a 20,000-gallon tank. Water is then filtered and added to the greywater line feeding the water closets.

Black water is to be directed to a 4,500-gallon/day ecological wastewater treatment system for treatment. The water leaving this system will be stored in a 20,000-gallon tank for re-use in the building's greywater system.

HVAC Garage

There are to be three exhaust and three supply fans with 7-horsepower each for each level of the garage. These supply and exhaust fans are to be controlled by a carbon monoxide monitoring system. There are to be four sensors for each level to control the appropriate fans.

HVAC Building

An under floor supply system is to serve the building's heating and cooling needs during peak seasons. During off-peak seasons, wherever possible, the building is to be naturally ventilated. The 16-inch access floor is to serve as a distribution plenum for the air. Two 27,000 cubic feet/minute, central air handling units on the roof are to supply the air downshafts at the core. These air handling units shall be sized to reduce static pressure drop through coils and filter sections. Air is to be supplied onto each floor from the central risers. Modulating dampers are to control the airflow into each take-off. The 5-foot deep perimeter zones are to be separated from the main plenum space with a plenum wall in the floor. Air to these zones is to be supplied with heating-only fan coil units in the floor. Fan coil units are to provide air at a rate of six cubic feet per minute per square foot so that one is required for every 35 feet of building perimeter. Stratified air from the floor below is mixed with primary air from the floor plenum at these perimeter units during heating season to minimize the reheat required. Outdoor air is to be supplied to the space at a rate of at least 20 cubic feet per minute per person at 150 square feet per person occupancy. Carbon dioxide monitors are to be provided for each 5,000 square feet to monitor the indoor air quality of the building. Where internal conference rooms or enclosed rooms with higher internal heat gains are required, variable speed fans in the floor are to be directly ducted to the room's diffusers and increase the airflow accordingly.

The heating is to be supplied by hot water coming from a central, high-efficiency, condensing-type boiler. This boiler is to have an efficiency greater than 90 percent, a capacity of 650 MBH and also provide the heat to the domestic hot water system through immersion-type hot water tanks. Cooling is to come from a 100-ton screw-type chiller and cooling tower. The performance on the chiller must be at least 0.52 kilowatts per ton at full load. The chiller's refrigerant is to be R134a.

Wall-mounted thermostats are to control each fan coil unit and modulating volume damper. The temperature tolerance is to be set at 78°/68° Fahrenheit. Occupants will be fully trained to use the operable windows and adjustable floor diffusers to control their space temperature. A full mixed mode strategy will be incorporated into the building control system so that the building can switch into a naturally ventilated passive cooling strategy whenever external condition allows it. Thermostat control is to be provided for each 3,000 square feet in the interior zones. In addition, six in-slab sensors are to be provided (two per floor) so that the effect of the dynamic thermal storage can be monitored. A night purge is to be written into the control sequence during cooling season so that the building's structure is cooled in the occupants' absence. Air is to be delivered to the space through swirl-type floor diffusers complete with adjustable dust collection baskets. The diffusers are to be similar to the Trox or Krantz type of diffuser and are to be flush with the floor.

A complete DDC control system is to be provided. All mechanical systems will be continuously monitored and commissioned. All mechanical systems are to be tied together with monitoring systems. The building is to be super-commissioned throughout the lifetime of the building. Equipment is to be balanced as needed to maintain the designed efficiency over time. The energy use of the building is to be less than standards set out in ASHRAE 90.1-1999 by 60 percent.

Fire Protection Garage

The parking garage is to be fully sprinkled by using approximately two pipe risers located throughout the parking garage. This requires a 3-inch service into a fire protection room for location of the pipe valves and air compressors.

Fire Protection Building

The building is to be served by a 6-inch fire protection water service with a backflow preventer. The building is to be fully sprinkled with a density of 0.15 gallons per minute per square foot for the most remote 1,500 square feet. A standpipe is to be provided in each stairwell.

9.0 Electrical

Site Services

Utilities are to be supplied underground from the property line to the main electrical room in the first level of the parking garage. All services are to be run in concrete encased ducts with one spare duct for each three ducts utilized. One hundred percent of the building's power needs are to be supplied by renewable resources.

Pedestrian sidewalk lighting consists of 150-watt decorative luminaires on 8-foot poles. A total of 12 lighting standards are required to light the site. Light trespass from the site is to be minimized.

Electrical Garage

The parking garage is to be illuminated with T-5 fluorescent high-efficiency industrial luminaires with a specular alzack reflector. Painting the parking garage ensures an average maintained lighting level of five footcandles. One fixture is to be supplied every 700 square feet for a total of 200 luminaires for all three levels. Lighting is to be low voltage, controlled with motion sensors and manual override. The stairs are to be illuminated with 4-foot strip T-5 fluorescent luminaires with acrylic lens at each landing.

Combination starter/disconnects are to be used in a fourplex motor control center, to be used for the ventilation fans. A carbon-monoxide detection system is to interface with the starters for control of the fans. Provide 12 locations for electric car charging stations in the garage.

A 100-amp, 480/277-volt, 3 phase, 4-watt service is required to service the parking garage and consists of a central distribution panel in the main electrical room to supply 70 amperes to each level of the parking garage. Each level of the parking garage is to have a splitter trough and disconnect switches to supply a 70-amp, 480/277-volt lighting panelboard and a 480-volt modular MCC for the mechanical loads. On level one, a 15,000-volt amp, 120/208-volt dry transformer is to supply power to a panelboard for 120-volt convenience outlets (a total of 15 per floor) and be located in service areas and perimeter walls throughout the parking garage.

Electrical Building

The building's interior lighting consists of indirect extruded aluminum luminaires using single T-5 lamps. A total of 5,000 lineal feet of this type of lighting is required. Occupancy sensors control the lighting in the washrooms and storage rooms. Low voltage switching for lighting control with local switching capability, as well as tie-in to the building management system, is to be provided. All interior spaces within the building are to be designed to utilize daylight from the perimeter, skylights, light wells and light pipes. Allow for electric lighting and daylighting control zones throughout the building.

A 400-kilowatt, 480/277-volt, 3-phase electrical service is to be provided. The service entrance consists of an 800-amp fused switch with 800-ampere HRC fuses and an 800-amp distribution board. A main electrical room is to be located on level one of the parking garage.

One hundred percent of the net annual building power is to be supplied by roof-mounted photovoltaic panels. The building is to maintain its electric utility connection and not incorporate electric storage capacity.

On each floor, there are to be three sub-electrical/communication rooms approximately 9-feet by 12-feet each of which is to be supplied with a single 200-ampere, 480-volt feed-through distribution. These sub-electrical rooms each contain a communications backboard, 120-volt panelboard, 277-volt lighting panel and motor starters to supply mechanical equipment. One sub-electrical room on each floor is to have a 277-volt emergency panelboard. On level two, each sub-electrical room is to contain a 45,000-volt amp high-efficiency transformer to supply 120-volt power to the electrical rooms above and below this level.

The building requires a microprocessor-based fire alarm system to meet current code requirements. A total of four remote alphanumeric annunciator panels is required.

Telephone and data to category 5E standards are to be distributed using a rigid cable tray system under the floor. A total of 300 workstations are to be provided with one outlet each. Allow for 150 workstations with two data outlets and an uninterruptible power supply (UPS) system.

A fiber optic backbone and cable TV distribution system are to be provided to each communications room.

An electronic security system is to be provided consisting of a PC-based management system, door contacts, card access control with varying levels of security throughout the building, and closed circuit TV monitoring of the parking garage, public areas and data rooms.

10.0 Sitework

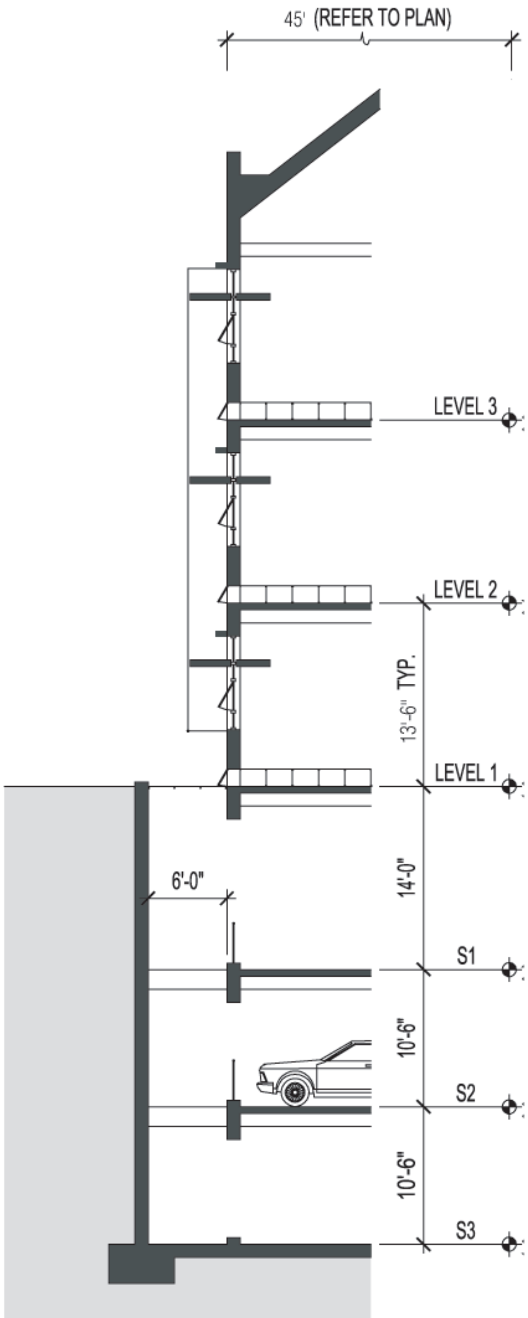
The remaining site is to be landscaped with native materials requiring no irrigation. Street trees are to be 3-inch caliper trees along the two city streets at 15 feet on center. Additional trees are to be provided on the site. New sidewalks and landscaped islands between the sidewalk and street are required.

At the interior courtyards over the garage, a 2-foot layer of soil is to be placed over the structure. The tree locations require an additional one foot of soil. A site retaining wall creates a minimum 10-foot ring around the trees and be constructed from rock that was removed during excavation. Walkways are to be brick paved set on sand in the courtyards.

11.0 General Conditions

Manage the construction process to provide means for salvaging 75 percent of the construction waste.

6 Living Building: Wall Section and Description



Office: 3 floors @ 30,000 square feet
Garage: 3 floors @ 45,000 square feet

- Photovoltaic panels mounted on a sloping roof
- Mechanical units installed under sloping ceiling of the third floor
- Energy Star reflective roof over R-48 insulation and salvaged wood decking; total R-value for the roof assembly is R-40

Office Structure

- Post-tension moment framing forming floor and ceiling structure
- 16" access flooring for office floors
- Clerestory glazing and daylight tubes
- Exterior sunshades at south and metal fabric screen at the east and west facing glass
- Light shelves

- Forty percent of the envelope on the north and south face is to be Kawneer storefront glazing system.
  - 1" double glazing unit, operable with controls
  - .29 U-factor
  - .43 Shading coefficient
  - .70 visible light transmittance

- Twenty percent of envelope on the east and west is to be Kawneer storefront glazing system:
  - 1" double glazing unit with operable controls.
  - .31 U-factor
  - .40 shading coefficient
  - .47 visible light transmittance

- Sixty percent of envelope on north and south and 75 percent on the east and west:
  - 7" precast or equivalent
  - 3" rigid insulation
  - 8" metal stud backup
  - 8" batt insulation
  - Gypsum interior wall board

- Total R-value for wall assembly is R-33

Garage

- Garage roof contains R-24 insulation and a suspended ceiling; total R-value for the roof/floor assembly is R-27
- Garage structure: Cast-in-place concrete floor slab and beams
- Bentonite clay waterproofing at wall and slabs
- Underslab and foundation wall drain system

6 Living Building: Detail Cost Summary

Project Cost Summary

Construction Cost		
Building		$6,853,262
Parking		$4,305,417
Subtotal Construction Cost		$11,158,678
Construction Contingency	7.5%	$836,901
Escl to Constr Start November 2002	7.5%	$899,668
Total Hard Cost		**$12,895,248**
Soft Cost		
Design & Management Fees		$1,934,287
Fixtures Furnishings & Equipment		$1,034,453
Permits, Fees & Other Services		$644,762
Owner Administrative Fee		
Subtotal Soft Cost		$3,613,503
Soft Cost Contingency	10.0%	$361,350
Soft Cost Escalation on FF&E	10.0%	$103,445
Total Soft Cost		**$4,078,298**
Other Costs		
Artwork		Excluded
Fundraising/Financing		Excluded
Land Acquisition		Excluded
Total Project Cost		**$16,973,546**

6 Living Building: Detail Cost Summary

Building Construction Cost Summary

			Cost	Cost/SF
1.0	Site Preparation		$144,568	$1.61
2.0	Substructure		$147,505	$1.64
3.0	Superstructure		$919,514	$10.22
4.0	Exterior Closure		$1,235,597	$13.73
5.0	Roofing & Waterproofing		$646,980	$7.19
6.0	Interior Construction		$887,586	$9.86
7.0	Conveying Systems		$90,010	$1.00
8.0	Mechanical Systems		$755,639	$8.40
9.0	Electrical Systems		$463,486	$5.15
10.0	Finish Sitework		$178,794	$1.99
Subtotal Costs			**$5,469,679**	**$57.18**
General Conditions		9.0%	$492,271	
Contractor's Fee		4.5%	$268,288	
Design Contingency		10.0%	$623,024	
Total Construction Cost			**$6,853,262**	**$76.15**

Note: Cost above excludes construction contingency, escalation and soft costs.

6 Living Building: Detail Cost Summary

1.0 Site Preparation		
Earthwork		
Clearing and Grading	$9,195	
Erosion Control	$1,277	
Deconstruct Existing Building	$112,385	
Utilities		
Utility Connection	$19,157	
Miscellaneous	$2,554	
Subtotal 1.0 Site Preparation		$144,568
2.0 Substructure		
Foundations	$30,650	
Slab on Grade	$62,578	
Miscellaneous		
Raised Access Floor	$44,699	
Elevator Pit	$3,831	
Mechanical Pads	$1,916	
Concrete Curbs	$1,916	
Miscellaneous	$1,916	
Subtotal 2.0 Substructure		$147,505
3.0 Superstructure		
2nd Floor Structure - Concrete	$521,058	
Roof Structure - Concrete	$283,517	
Raised Access Floor	$107,277	
Miscellaneous	$7,663	
Subtotal 3.0 Superstructure		$919,514
4.0 Exterior Closure		
Exterior Wall Assembly	$561,925	
Windows & Glazing	$481,468	
Doors Frames & Hardware	$15,964	
Exterior Miscellaneous		
Louvers	$639	
Signage	$3,831	
Soffits	None	
Fascia & Trim	$31,289	
Trellises & S unshades & Scrims	$127,710	
Misc. Exterior Work	$12,771	
Subtotal 4.0 Exterior Closure		$1,235,597

6 Living Building: Detail Cost Summary

5.0 Roofing & Waterproofing		
Roofing & Insulation	$113,407	
Premium for Photovoltaic Panels	$510,841	
Skylights	None	
Sheet Metal	$18,901	
Caulking & Sealants	$1,916	
Miscellaneous Roof Accessories	$1,916	
Subtotal 5.0 Roofing & Waterproofing		$646,980
6.0 Interior Construction		
Partitions		
Typical	$89,397	
Operable	$16,602	
Dropped Soffits & Fascia - Allow	$10,217	
Interior Glazing - Allow	$91,951	
Railings	$7,663	
Miscellaneous	$12,771	
Doors, Frames & Hardware - Wood	$91,951	
Floor Finishes	$160,915	
Wall Finishes	$38,313	
Ceiling Finishes	$114,939	
Millwork		
Kitchen	$9,195	
Storage & Workrooms	$14,048	
Conference Rooms	$26,819	
Chair Rail & Trim	$30,395	
Other Built-in Casework	$15,325	
Rough Hardware & Misc Backing	$14,048	
Workstations	Inc. in FF+E	
Window Blinds	$74,072	
Specialties & Equipment	$68,964	
Subtotal 6.0 Interior Construction		$887,586
7.0 Conveying Systems		
Stairs & Ladders		
Stairs	$20,434	
Stairs	$30,650	
Roof Ladder	$204	
Elevator Pit Ladder	$409	
Elevators		
Passenger	$53,638	
Deduct for Stops Assigned to Parking	($15,325)	
Subtotal 7.0 Conveying Systems		$90,010

8.0 Mechanical Systems	
HVAC	
Equipment Wet	
Boiler-Gas 875mbh w/PVC Flue	$4,214
Chiller 100 tons Screw	$14,559
Cooling tower 1 cell 100 tons	$6,002
Pump-HW	$2,656
-CHW	$2,707
-CW	$2,707
Miscellaneous Accessories	$6,386
Equipment Air	
Air Handling Unit -w/S Fan/CHW&HW coil /pre&final filts/Interior VFD/ 35000cfm:00hp	$45,976
AC Unit for Tel/Elect	$16,985
Exhaust Fans	$4,470
Fan-Sup./I.L	$1,277
Fancoil w/ Reheat	$15,785
Var Sp Fan @ Int Spaces	$9,195
Control Dampers @ Shaft	$6,590
Filters for Enclosed Rooms	$2,299
Living Machine Greenhouse & Equip.	$63,855
Miscellaneous Equipment	$8,940
Ductwork & Accessories	
Duct-GSM	$57,214
-Insulation/External	$2,043
-Damper & Accessories	$6,386
Register & Grilles	$26,819
Misc Duct & Accessories	$6,386
Pipework & Accessories	
Pipe-HW w/ Insl. RH	$38,313
Pipe-CHW w/ Insl. AHU	$7,663
Misc Valves & Specs.	$10,217
Controls & Testing	
Control-System/DDC-EMCS	$53,638
Slab Sensor System	$7,663
CO2 Monitoring Building IAQ	$11,494
Monitoring-1 year	Inc. in operating costs
Balancing-1 year	Inc. in operating costs
2 Week Air Flush & Filter Change	$5,108
Commissioning	$10,217
Test & Balance	$12,771

Plumbing	
Fixtures & Equipment	
Water Heater -Solar	$5,108
Tank-Expansion	$106
Tank-Oil/Water Separator	Inc. in parking estimate
Tank-Storm Water 25000gal. 100%	$16,602
Tank-Greywater Stor 20000g FG	$15,325
Tank-Black Water Stor 20000g FG	$15,325
Tank-Service Sink Waste Rem000g.	$2,554
Pump-Elev.Sump	$1,073
Pump-DHW Recirc.	$252
Pump-Sewer	$4,725
Pump-Storm Water	$4,214
Pump-Greywater	$4,725
Pump-Black Water	$4,725
Filtration -Storm	$7,663
Filtration -Greywater	$6,386
Filtration -Black Water	$6,386
Toilet Room Fixtures	$9,425
Sink Service	$309
Sink-Kit. Single	$587
Drinking Fountain	$5,211
Drain-Floor/Roof	$1,149
Misc Equip . & Fixtures	$6,386
Pipework & Accessories	
Pipe-Waste & Vent	$27,585
Pipe-Greywater	$4,827
Pipe-Black Water	$5,721
Pipe-Service Sink	$2,222
Pipe-Storm	$9,961
Pipe-CW w/ Insl.	$19,157
Pipe-Storm Recirc to WC's	$3,525
Pipe-Greywater Recirc	$3,831
Pipe-Black Water Recirc	$3,831
Pipe-DHW w/ Insl.	$3,831
Pipe-Gas	$639
Misc Valves & Specs.	$12,771
Pipe-Gas	$639
Misc Valves & Specs.	$12,771
Fire Sprinkler System	
Wet System -Bldg w/ Standpipe	$68,964

Subtotal 8.0 Mechanical Systems	$755,639

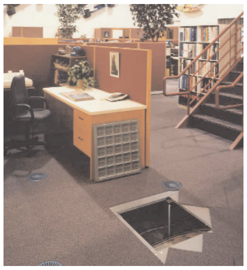
9.0 Electrical Systems		
Primary Power		
Main Switchboard 800A 400KW	$6,386	
Distribution Boards 800A	$1,277	
Panelboards	$7,050	
Emergency Power - 100KW Generator	$25,542	
Feeders - Allow	$11,494	
Equipment Power	$45,976	
User Power	$51,084	
Lighting	$183,903	
Lighting Protection	None	
Signal & Communications		
Fire Alarm	$45,976	
Telephone/Data Rough -In	$30,650	
Telephone/Data Cabling	Inc. in FF+E	
Security System	$41,378	
Cable TV	$6,386	
Audio Visual Rough -In	$6,386	
Subtotal 9.0 Electrical Systems		$463,486
10.0 Finish Sitework		
Subtotal 10.0 Finish Sitework		$178,794

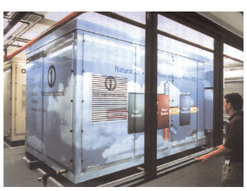
6 Living Building: Detail Cost Summary

Add for Underground Parking

Deduct Building Foundations	($30,650)
Deduct Building Slab on Grade	($62,578)
New Mat Slab	$298,523
Mechanical Pit	$3,831
Slab on Grade	$58,747
Underslab Drainage	$26,564
Shoring	$326,938
Excavation	$497,112
Dewatering	$25,542
Permanent Perimeter Drainage	$11,494
Retaining Walls	$388,239
Interior & Stem Walls	$14,304
Floor Structure	$603,431
Roof Structure	$398,047
Water Detention Basin	Included in building estimate
Pads, Curbs & Bollards	$3,831
Columns	$36,781
Ramp Slab	Included above
Ramp Walls	Included above
Waterproofing	$82,245
Gratings/Bridging	$40,229
Railings	$71,837
Topping Slab @ Roof	Included in sitework estimate
Partitions	$32,566
Insulation @ Roof	$17,879
Doors	$10,217
Painting, Striping, Misc.	$7,663
Signage	$3,831
Parking Equipment	$6,386
Electric Vehicle Charging	$7,663
Stair Towers	None
Stairs	$22,988
Elevator - Additional Stops	$15,325
Mechanical Systems	$275,854
Electrical Systems	$241,372
Finish Sitework	Included in building estimate
Subtotal Cost	$3,436,210
General Conditions	$309,259
Contractor's Fee	$168,546
Design Contingency	$391,402
Total Parking Construction Cost	**$4,305,417**

Technology





Introduction

Through the process of generating the *Sustainability Report and Matrix*, several technologies were discussed by the design team that warranted further explanation to the Facilities Steering Committee and others at the Packard Foundation. Four building specific technologies were researched in more detail, the results of which are explained in this Technology section of the Appendix. The technologies include: (1) raised access flooring and the use of under-floor HVAC systems; (2) photovoltaic panels to produce electricity for the building; (3) ecological wastewater treatment systems to process wastewater for the building; and (4) fuel cells to provide a clean, uninterrupted power supply. Some of these are emerging technologies and have not been significantly tested in the marketplace. Others have been successfully integrated into the market so that more information is available about their performance. The following paragraphs outline the approach used to research these technologies.

Raised Access Flooring

The design team has been successfully using raised access flooring in energy-efficient projects for many years. Raised access flooring is not a new technology, but the use of an under-floor HVAC system integrated with access flooring is what makes this technology innovative when used in a green building. The success of this system depends on the mechanical engineer's knowledge and abilities.

Photovoltaics

Photovoltaic (PV) panels have been on the market for more than 40 years, but they are still considered to be in their early stage of development. There are currently 20 million square feet of photovoltaic panels installed in the United States (Wilson & Yost, Environmental Building News, Volume 10 Number 3 March 2001). The use and development of photovoltaic technology has increased dramatically in recent years as the demand for renewable energy sources increases. There are, therefore, a number of green buildings that incorporate photovoltaic panels.

Ecological Wastewater Treatment Systems

Ecological wastewater treatment systems are an emerging technology with relatively few comparable test cases in the marketplace. One particular system is called a Living Machine®, designed by Living Machines, Inc., out of Taos, New Mexico. Working examples of Living Machines® can be found in Florida, Missouri, Nevada, New Mexico, New York, Ohio, Vermont and Washington.

Fuel Cells

The concept of fuel cells has been around since the 1800's. While PEM (proton exchange membrane) technology served as part of NASA's Project Gemini in the early days of the U.S. piloted space program, it has only been in recent years that fuel cell products have been available for commercial building use. There have been relatively few test projects utilizing fuel cells. This research focuses on projects incorporating fuel cells manufactured by International Fuel Cell.

Technology: Raised Access Flooring

Summary

Raised access flooring is an elevated floor system that provides a space (or plenum) under the finished floor for electrical wires, communication cables and air distribution. It is a modular frame system made of steel or aluminum that is bolted together to support concrete or lay-in tiles usually with a modular floor finish system such as carpet tile, linoleum or cork. It is a flexible system that allows for easy reconfiguration of office spaces, computer cables and wiring systems. Raised access flooring eliminates the need for overhead ductwork and lay-in ceiling systems. In this case the ceiling can be designed to optimize daylighting.

Under-floor HVAC systems are an efficient way to supply heating, cooling and fresh air directly to the occupant. The entire floor plenum is pressurized and air is delivered to occupied spaces through floor-mounted diffusers. The conditioned supply air is delivered at a low pressure and rapidly mixes with the room air. Warm air quickly rises to carry excess heat and air pollutants to the return ducts at the ceiling level. Less fan energy is required to distribute air because it is not being forced at high velocities through ducts at the ceiling level. Conditioned air does not need to be as cold when using a raised access floor system because it does not have to pass through the heat created by lighting or pass through warm pockets of air in the room. The upward flow of air carries the cool air directly past the occupant and carries unwanted heat directly away. The temperature difference between supply and return air is less than typical HVAC systems so chillers can be smaller and more efficient. However, because the air is warmer, dehumidification is more challenging with under-floor cooling systems.

The floor diffusers that are part of the raised access flooring system provide individuals with control over the airflow in their space. The diffusers can be relocated, or twisted open and closed, to vary air flow. The flexibility of the system allows the perimeter condition to be regulated differently than the core spaces as necessary.

Implications

Properly designed, raised access flooring can allow for efficiency in material use and systems design. The energy savings resulting from an efficient heating and cooling system offer a short-term payback. The ease of maintenance and flexibility allow a continual operating cost savings over time. The potential for individual control of thermal comfort is a factor in occupant productivity and satisfaction.

Technology: Photovoltaics

Summary

Photovoltaic (PV) collectors produce clean, renewable electricity from sunlight. Today, they come in either the rigid crystalline form or the more ductile amorphous silicon forms. PV panels assembled in modules, and then into arrays, can be mounted independently or integrated with building materials such as roofing, sunshades, or glazing. The amorphous silicon PV can be used as the roof membrane in a variety of products entering the marketplace. Amorphous silicon roof-integrated PV arrays can be used in conjunction with solar thermal generation systems to produce hot water as well as electricity. Crystalline PV panels can function as part of a skylight or glazing system by spacing the cells apart or using the new semi-transparent cells. Crystalline PV arrays can be mounted on a roof, sunshade or in a freestanding structure on the site.

To be most effective, PV panels need to be facing roughly due south and angled to face the sun for as much of the year as possible. The optimum altitude angle for year-round electricity production is typically equal to the latitude of the project site. A PV panel tilted 15 degrees more or less than the latitude will optimize the production in either the winter or the summer months respectively.

As of this writing, amorphous silicon PV produces about 5 watts per square foot of panel area while the crystalline PV produces 10 watts per square foot. Both are comparative in cost per watt of power produced. PV is not yet competitive with traditional energy generation technologies (approximately near $8-12 per watt installed), but will allow a long-term payback in energy savings.

PV can be power-grid-interactive or the power can be stored in batteries for future use. With a grid interactive system, there is a potential to trade surplus electricity back to the power grid if the state has effective net-metering legislation in place. Battery storage can be environmentally undesirable and expensive.

Implications

The pollution and waste inherent in conventional centralized power distribution systems makes a clean, on-site, renewable power generation source environmentally desirable. Energy and fossil fuel consumption is a tremendous threat to the environment. PV technologies can greatly reduce the energy use and pollution created by the building. Because PV panels rely only on sunlight they will help to reduce society's dependence on fossil fuels. The building's electrical and mechanical systems should be designed first to be as efficient as possible - reducing the demand for power - and then to be as flexible as possible in allowing clean power technology. Because PV technology will continue to improve and evolve over time, it would be best to design a system with enough flexibility to allow for upgrades over time. As energy prices continue to increase and as the demand for alternatives grows, it appears that PV technology will become more competitively priced.

Technology: Ecological Wastewater Treatment Systems

Summary

Ecological wastewater treatment systems are designed to replicate and accelerate the natural purification process of nature's fresh water system. Living Machines® is a trade name for systems designed by Living Machines, Inc. They are attractive and inspiring examples of the power of natural systems to treat waste. With the help of sunlight and a managed environment, a diversity of organisms including bacteria, plants, snails and fish break down and digest organic pollutants. These systems can recycle water for non-potable uses such as irrigation or toilet water. With minimal chemical treatment at the end of the process the water could also be recycled for potable uses. This becomes part of a responsible water management system. A Living Machine®, in particular, can function as a utility as well as a teaching tool. It could be an aesthetic, pedagogical and systemic centerpiece for the building.

Ecological wastewater treatment systems vary greatly from one building to the next. The greenhouse component, for example, must have enough sunlight available to support plant life. It is sized based on the number of occupants and the number of fixtures in the building, which determines a design load in gallons per day. When comparing the capacity and the size of existing Living Machines® around the country, greenhouse sizes average between .75 and 1.25 square feet per person. A rule of thumb for wastewater generated per person is 15 gallons per day.

While each of these systems requires a custom design specific to the quantity and type of waste, they all have similar components. The influent flows from the building fixtures into an anaerobic reactor where bio-solids are digested without oxygen so there will be no odor. The effluent then travels from the anaerobic reactor to a closed aerobic reactor where oxygen is introduced. The closed aerobic reactors begin the bacterial process and scrub odor and gasses out through vegetation filters at the top of the tank. From the closed aerobic reactor the flow passes to a series of open aerobic cells each with a specific ecological filter system. A clarifier then allows bio-solids to settle while the remaining wastewater flows through a UV disinfecting apparatus to the ecological fluidized beds (EFB) for final polishing. Solids from the clarifier and back washing of the EFB's are recycled back to the anaerobic reactor for further digestion. When the process is complete the water is ready for reuse as irrigation and for non-potable use. If chemically treated the water could be potable as well. The amount of chemical needed for the final processing is miniscule compared with that used by municipal wastewater treatment plants. Chemical treatment is only necessary to balance the phosphorus level in the water, which would take years to alter with biological processes.

The cost of an ecological wastewater treatment system varies depending on its complexity and size. Generally, it is competitive with, or at most 10 percent more expensive than, other on-site wastewater treatment systems. The operating costs generally do not decrease over time because personnel will be needed to maintain the systems. There are not necessarily any cost savings or long-term payback because, at the present time, the price of water supply or wastewater removal is relatively low compared to other utilities. As the price of water removal increases, however, these systems will become more affordable.

Technology: Ecological Wastewater Treatment Systems

Implications

The primary benefits of an ecological wastewater treatment system are responsible on-site wastewater management and a reduction in the overall demand for potable water from a municipal water supply. They also relieve the high environmental cost of chemically treating wastewater in municipal plants and maintaining expensive wastewater infrastructure. Better understanding of bio-remediation as a science also has great promise in the future remediation of hazardous waste.

Technology: Fuel Cells

Summary

Fuel cells generate consistent, clean, alternating current power without noise, power surges or pollution. Fuel cells are similar to batteries in that they both use an electrochemical process to convert energy to power. Both have electrodes, an electrolyte, and positive and negative terminals. Unlike a battery, however, a fuel cell never runs down as long as it is supplied with fuel. Fuel cells in their purest form utilize hydrogen from water to create electricity while producing only distilled hot water as a by-product. The hot water can be used for heating or it can be electrolyzed back into hydrogen and oxygen for reuse in the fuel cell. Some fuel cell systems are designed to utilize other fuels rich in hydrogen such as methanol, ethanol, natural gas, gasoline or diesel fuel. When hydrogen is extracted from other fuels, low levels of carbon dioxide are emitted as a by-product of the reformer process. This reforming, however, does not produce NO_2, SO_2, PM_{10} particulate, or other smog-producing agents. More attractively, it is possible to use photovoltaics, wind turbines and other renewable energy technologies to electrolyze water without producing emissions.

Currently on the market, 200-kilowatt natural gas units are available for stand alone on-site generation, or power grid-integrated supplemental generation. They are also popular for use as backup power generation where the building codes have been re-written to allow their use. These units currently cost about $3,000 per kilowatt. This is about twice as expensive as they need to be to saturate the market. Because fuel cells are not yet mass-produced, they are still expensive to manufacture. However, the operating cost of producing power once a fuel cell is installed is about 25 to 40 percent lower than conventional energy because fuel cells convert a low-cost energy source to high value electricity with little transmission loss. This allows a long-term payback for fuel cell installations.

Fuel cells can be located anywhere in the building due to their low noise output, but they do require considerable space. Each fuel cell requires eight feet of clearance on all sides for a total of 700 square feet per fuel cell. They also require a 9000-pound replacement part every five years, which most freight elevators cannot handle. Fuel cells can also be located outside of the building, but should be in a secure location.

Implications

Because energy used during a building's lifetime has the single greatest environmental impact for any given building, using a fuel cell provides many positive environmental benefits. However, its high initial cost investment makes it difficult to bear the longer-term payback that will result from lower operating expenses. Ironically, the major factor keeping fuel cells from coming down in price is that they are not yet widely used or mass-produced. Taking the risk to incorporate a fuel cell into a building project will move that building into a realm of self-sufficiency that is rarely achieved by buildings today. Meanwhile the building will produce minimal or zero emissions. Such a move would also make it easier for future buildings to afford such technology. At a minimum, ideally, today's buildings could be designed to accommodate fuel cell technology in the near future as energy prices rise and the price of fuel cell production comes down. Long before energy market forces make fuel cells affordable, the environmental cost of pollution make fuel cells and other clean technologies imperative.

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