

The Construction of a Sustainable Science Building at Smith College:
A Focus on the Sustainable Site and Materials & Resources

Amanda Wenczel
(In collaboration with
Allison Crosby & Jes Hill)
Smith College
May 6, 2004

Abstract

This project was created to examine “green” possibilities for Smith College’s new engineering and chemistry building. We propose that this building can be “green” and have provided sustainable options available for the construction and use of the building. In order to supply the college with options, we conducted interviews and reviewed the LEED certification requirements. As we were gathering information, we were given a LEED scorecard that showed what points Smith could easily gain, what points Smith unattainable for this project, and questionable points. We decided to focus our research on these questionable points because those are the crucial points, which will put sustainability at the forefront of Smith’s decision-making. After reviewing the places where Smith could change, we found the best options for the project and the college. Many of these were based on the location of the college, programs within the building, and the site for construction. We decided that most of the questionable answers could be changed into yes answers raising Smith’s score and level of LEED certification. These results could influence the construction of the building in question, and may also influence further development at Smith College, as well as provide the college with an educational tool for further research. On a wider scale, the results could influence future development at other schools or institutions, providing an example of sustainable building construction.

Introduction

Sustainability as defined by the Bruntland Commission is: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”¹. This definition, although created over a decade and a half ago, still resonates in today’s society. A major opponent of sustainable development is the development process, and the impact that buildings have on the environment. This can include resource use for construction and maintenance, waste disposal, and even demolition. These factors all have an impact on the immediate environment. “The actual creation of the built environment has many negative impacts on the natural systems that are in fact so crucial to its existence: destruction of plants and wildlife habitat, solid waste generation, non-point source pollution, release of toxic materials, alteration of natural drainage systems, and water and air pollution”². At a college or private lab these environmental impacts can be even greater because of the toxic materials used, and the large amounts of waste created.

¹ Bruntland, G. 1987. *Our common future: The World Commission on Environment and Development*.

² Kibert, C.J. 1999. Introduction to *Reshaping the Built Environment: Ecology, Ethics, and Economics*.

Smith College has a great influence on the environment of Northampton, Massachusetts and the Pioneer Valley, because of its large resource consumption and waste and pollution production. The construction of any new building on campus will therefore have an impact on the Smith community and the surrounding community; requiring Smith to consider its best building options before the construction of any new structures. This is where the new engineering and chemistry building comes in. It is going to be a 75,000-square foot center for engineering, chemistry, computer science, molecular biology, and biochemistry, located on the corner of Green Street and Bedford Terrace (figure 1)³. The architecture firm for this project is Bohlin Cywinski Jackson, and is a LEED certified group experienced with the design of sustainable buildings. Groundbreaking for this building is slated for the spring of 2006.

According to the U.S. Green Building Council, “the LEED (Leadership in Energy and Environmental Design) Green Building Rating System™ is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings”⁴. To become LEED certified there are registration and certification fees, which for Smith College would be \$750 and \$1,500 respectively, totaling \$2,250. Certification last for the lifetime of the building, so Smith will only have to pay up-front costs and never pay annual fees. Also, in the LEED certification system there is a checklist that the council uses to determine a building’s level of certification. Points are given for specific requirements and need to total at least 26 points for the basic certification. This checklist (see table 1)⁵ was used by the Smith architects to determine the possible level of certification the college could achieve. Smith has dedicated themselves to creating a

³ Bohlin Cywinski Jackson preliminary drawings

⁴ http://www.usgbc.org/leed/leed_main.asp

⁵ <http://www.usgbc.org/Docs/LEEDdocs/LEED-NC%20checklist-v2.1.xls>

building that will be LEED certified with the college possibly striving for Silver certification, 33 to 38 points⁶.

The purpose of this project is to influence Smith's decision in favor of a "green" building as well as provide information that supports this "green" point of view. As it stands now, Smith is only close to being certified, and it is our belief that this college can attain more than standard certification. Smith College is a prestigious institute that prides itself on being in the forefront of society. In order for the college to attain this goal, we must become a more sustainable campus, which can occur if we begin now. This project is aimed at supporting Smith's continued change towards a more sustainable campus, and by providing recommendations that will enhance the sustainability of the college; we will alter the decision-making of future development projects at Smith College and the surrounding community.

Methods

Interviews:

The research for this project began with interviews conducted in late March to early April of 2004. At that time we were directed to a number of professors and administrators at Smith College. We sent out an email to five professors that were on the programming committee for the new building, and interviewed one of the five. Our first interview was with John Brady of the Geology Department on April 2nd. We asked him questions about budget, costs, timing, courses, and references for additional interviews. From there we went to Tom Litwin, head of the Smith College science center and someone who was on the programming panel with John Brady, to gain exact information about the project's timing and information about the architects. About a week later, April

⁶ Bob McCullough- personal communication

8th, we interviewed Margaret Rakas, the hazardous waste disposal manager for the science center. She was asked about the holding, removal, and dumping of hazardous wastes. Our final interview was conducted at Smith's physical plant on April 12th, where we asked Bob McCullough questions about physical plant's involvement in the construction and maintenance of the building. This information included energy production, emissions, costs, heating and cooling, and ventilation. Bob McCullough also provided us with information about LEED certification, which was followed by further research on our behalf. A few questions were later discussed with Tom Litwin, however those issues were for background information, and not necessarily information pertinent to our recommendations for this building.

Research:

A few books were consulted to provide background information about alternatives and examples of other green buildings. This research was done throughout the information gathering process and continued even after interviewing had finished. Other research was conducted mainly online at the LEED webpage, Labs21 webpage and at other sites that provided information about resources and sustainable options that would be available for Smith College. This research was mainly performed after the information was gathered from all the interviews, but a small amount was conducted during the interviewing phase.

Lecture:

Supplemental information was gathered at the Clean Air Cool Planet lecture held on April 14, 2004, in the Neilson Browsing Room at Smith College. The information gathered at the lecture included global warming and alternative energy sources.

LEED Sections:

The final part of this project was the division of labor among the three members of the group. We decided to focus our project around the LEED score sheet that was provided by Bob McCullough. The score sheet is broken down into six categories: Sustainable Site, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, and Innovation & Design Process. Those six categories were then divided amongst the three of us, with the focus of this paper, including the recommendations, being the first, Sustainable Site, and the fourth, Materials & Resources, categories. (Allison Crosby covered the second section, Water Efficiency, and the last two sections, Indoor Environmental Quality and Innovation & Design. Jes Hill covered the third section, Energy & Atmosphere, which was a large focus of the project therefore she only reported on one section.) Even though the work was divided, each member of the group was informed about the other categories she did not research.

Results

Overall, the interviews provided us with background information about the project, and led us to places where we could obtain further information. In the interview with Bob McCullough, we were given the LEED checklist that was already filled out by the architects (described earlier). According to the preliminary guesses, Smith could obtain basic certification with 28 points⁷. The question marks were numerous in some sections leading to our further research, which is provided below according to category. For most of the check sheet, we found that sustainable options were possible to change the questionable sections into yes answers. Those places where we were unable to

⁷ <http://www.usgbc.org/Docs/LEEDdocs/LEED-NC%20checklist-v2.1.xls> and architect's information

provide a better option for the college were places where the alternative options were unrealistic, out of our hands, or too costly. The sections in which we found sustainable options, however, outweighed the number of sections where we could not produce a change.

Along with the information about each section of the check sheet, we found out that the building is going to be used as an educational tool. The workings of the building are going to be studied, mainly by engineering students, and a few features were added as a result of this. The examples of research additions were the grass roof, and a system that would allow all functions of the building to be monitored.

Sustainable Site:

In this category we found information regarding the site location, transportation available within close proximity to the site, and the management of green spaces. The first question is whether or not there are two bus stops within a quarter-mile of the building. According to Bob McCullough, there is a possibility that the PVTA bus stop at John M. Green Hall on Elm Street is too far away, and further calculations must be made. Along with transportation we found that all energy and fuel is located at physical plant, therefore any refueling stations, credit 4.3, will need to be located at that site.

Along with transportation, the college questioned parking capacity. The parking on Green Street and Belmont Avenue will still be available after the completion of the building. There are also spaces in the parking garage off of West Street that are currently not in use.

In order to restore open spaces the college is questioning turning Dickinson lot into a green space after the construction is complete. During construction the lot will be

used to hold worker's vehicles and building materials, as well as any on-site necessity⁸. This transformation of the lot will remove parking spaces, which will again place a strain on the parking capacity. The parking garage would still be able to hold the handful of staff parking spots that would be removed with the conversion of Dickinson lot.

At the time this checklist was produced the architects were questioning the development footprint. For this first project in a set of new buildings, the footprint will encompass an area that has already been developed. As seen on the map (figure 1)⁹, later phases of building may create a larger footprint, but the only building in question is this current project.

The last two questions deal with landscaping around and next to the building. The first of these questions relates to storm water management. For this section, we found that conversion of Dickinson parking lot would not only increase green spaces, but would also create a space where water would be absorbed at a higher rate. This is compared to the absorption of water from the current paved lot and other paved areas. This creation of a green space also relates to the reduction of heat Islands, credit 7.1. The difference with this credit is that it relates to the landscaped area around the building. For this credit, trees and plantings around the building must provide a cooling effect on the building after five years¹⁰. This can also include reducing paved areas near the building, to reduce heat absorption.

Water Efficiency:

Water efficiency is a small category, but any changes in this section can alter other sections of the score sheet. We found that Smith is thinking of using a mini-turbine

⁸ Bohlin Cywinski Jackson, *Programming Master Plan*

⁹ Bohlin Cywinski Jackson preliminary drawings

¹⁰ LEED checklist provided by architects

that would transport rainwater from the roof, collected in the basement, throughout the building. This graywater would be used in the toilettes and possibly landscaping, and because the mini-turbine is still new Smith could receive a grant to use the device in its science building¹¹. By using graywater, Smith would also reduce its water use, and would be able to change the two questions in this section into “yes” answers. Along with the mini-turbine, Smith can also use low-flow toilettes that use six liters of water as opposed to the traditional toilettes, which use twenty-three liters of water¹². One more device we found when reviewing the web is a central vacuum system to be implemented into the basement of the new building. This device would be used for all filtration in the laboratories, a site of great water use.

Energy & Atmosphere:

The major items in this section are related to energy use, renewable energy, and the purchasing of green power. The first question mark, optimizing energy by 30% new/20% existing, was a possibility early in the review process, however with the addition of chemistry and the molecular sciences, this credit is not achievable because of the long pay-back time for the investment¹³. Renewable energy research included solar power, wind power, and biomass as possible alternative energy sources. For each of the alternative source the initial cost, annual cost, and the benefits were recorded. Along with energy, we found a few minor devices, light bulbs, motion sensor lighting, and hand-dryers, which will reduce energy use greatly and consequently reduce energy purchasing.

¹¹ Bob McCullough- personal communication

¹² <http://www.epa.gov/owm/water-efficiency/toilets.htm#top>

¹³ Bob McCullough- personal communication

In credit 5, measurement and verification, we found that in order to achieve a point for this section Smith would have to incorporate a device, likely a computer system, which would have continual readings of the buildings systems¹⁴. This would include heating and cooling, electricity, and water. Along with the building systems, is the green power credit, which calls for the purchasing of green power from the electric company. For Smith, physical plant would ask MassElectric to provide the college with electricity that was generated through “green” means¹⁵.

During our interview with Bob McCullough, we were informed that Smith was thinking about installing a co-generation system at physical plant. This would allow natural gas, a source of power with a higher efficiency than fossil fuels, to be used for energy production. By keeping this system centralized, energy can be generated at one place and sent to various satellite areas at the new construction site.

Materials & Resources:

This section provided information regarding the reuse of building materials and the possibility for rapidly renewable resources to be used. For this category, the first question reviewed was the utilization of reused materials. Bob McCullough informed us that this includes building materials taken from the buildings that are currently on the site where the new science building is going to be constructed. This reuse of materials involves “deconstruction” of the old buildings as opposed to demolition. In the deconstruction process, buildings will be torn down in a manner that leaves materials with minimal harm, allowing for future use. This will provide the

¹⁴ http://www.usgbc.org/leed/leed_main.asp

¹⁵ Bob McCullough- personal communication

builders with on-site, recycled materials, minimizing the transportation and acquisition of resources.

Along with reusing materials, Smith is unsure about the prospect of rapidly renewable resources. These resources can be harvested and the crop will renew itself within a matter of years. One source that Smith was questioning is bamboo. Bamboo is mainly grown and used as building material in China, requiring the material to be shipped from over seas. A common issue with bamboo is that it can be attacked by bugs and fungus, and is known to decompose quickly when untreated. The stock however grows back to harvest height within four to five years¹⁶.

Indoor Environmental Quality:

This is the most remarkable category because out of fifteen possible points Smith has twelve “yes” points, and only two questionable points. The only questions are as to whether the occupants will be able to control things such as windows, ventilation, and sunlight within their personal space. Measures have been taken to ensure that windows in offices will be able to open and as much natural light as possible will be let into these non-teaching spaces¹⁷.

Innovation & Design Process:

The one question in this section is about an innovative design incorporated into the project. These innovations are items that go above and beyond what is required by LEED certification, and for this project could include the mini-turbine¹⁸.

¹⁶ http://www.inbar.int/publication/txt/INBAR_Technical_Report_No16.htm

¹⁷ Bob McCullough- personal communication

¹⁸ http://www.usgbc.org/leed/leed_main.asp

Discussion

After reviewing our results, we have determined that Smith College should not only strive for LEED certification, but should go for the silver level of certification. Steps have already been taken by the college to ensure that the new science building will have some level of “green”, but what we propose is the highest level the college can achieve with this current project. It should be the mission of the college to be at the forefront of environmental issues.

With regards for the two LEED certification categories reviewed in this paper, the college can obtain all but one of the questionable credits within those sections, giving their score a boost of eight points. First, in the Sustainable Site section, the PVRTA bus stop near John M. Green Hall needs to be measured again from the closest point on the building site, and if the stop is still too far away move the bus stop closer. There is space on the opposite side of the college drive that will take away a number of feet and will still be reasonable for the buses to fit within the space provided. Parking, a key issue is not a problem with this phase of the project. There are still open spaces within the parking garage that will be available for the staff members whose spots will be removed by the conversion of Dickinson lot. As for the parking spaces on Green Street and Belmont Avenue, those spaces will still be available after the building is constructed. Also, in association with the conversion of Dickinson lot, Smith will be creating a large green space that will help with open space restoration, and storm water management. This space will be an attractive compliment to the new building, which will draw attention to that part of campus.

The landscaping around the building will reduce heat islands, as well as create an aesthetically attractive façade. Trees, shrubs, and grass will reduce the amount of heat absorption around the building, reducing the amount of heat that is transferred into the inside. This will reduce cooling costs, a benefit for reducing energy and college spending.

In the second section, Materials & Resources, Smith should follow through with their plans to deconstruct the current buildings on Green Street and Belmont Avenue. By reusing as much of the old buildings materials, the college will be able to reuse materials that do not need to be shipped to the construction site. This will reduce not only the cost of transporting materials, but also reduces the environmental impacts associated with the harvesting, manufacturing, and transportation and materials and resources. As Charles J. Kibert states, “The unsustainable use of land, energy, water, and materials that is characteristic of construction industry must be changed from the present-day open-loop, cradle-to-grave model to a closed-loop system integrated with an overall industrial system that focuses on dematerialization, deenergization, decarbonization, and detoxification”¹⁹. Smith College would be taking one step in the right direction by deconstructing rather than demolishing the old buildings. The rapidly renewable resource of bamboo, however should not be used for this project. There are still too many hazards with the use of this product, as well as high transportation costs, both financially and environmentally. The transportation of the bamboo would also cancel out another credit on the checklist, credit 5.2, causing the score to lower unnecessarily. Even though the bamboo is not a viable option for this phase of the project, Smith should look for a more locally grown source of rapidly renewable resources for future development.

¹⁹ Kibert, C.J. 1999. Introduction to *Reshaping the Built Environment: Ecology, Ethics, and Economics*

After adding together the points from each section, there is a possibility that Smith could gain about fifteen credit points. This would boost the college's score from twenty-eight to forty-three, or the gold level of certification. The heightened level of certification would show Smith's dedication to sustainability, as well as provide a beginning to the formation of a sustainable campus.

On a more global scale, the new building would reach the status of buildings similar to the Pharmacia Building Q, Skokie, Illinois, a Gold certified building²⁰. This is a research laboratory for chemistry and biology, which is around 176,000 square feet and contains wet labs with lab tools (i.e. fume hoods) similar to the Smith College labs. In a recent case study by Labs 21, the Pharmacia Building Q reduced their expected energy costs through simple innovations in the fume hoods, and lighting designs. This building also incorporated sustainable design features such as 100% recycled steel for the building's frame. For the construction of this building, materials were only shipped in from a radius of 300 miles, reducing the emissions and transportation costs. Overall, this building was constructed with a green conscience from the start, which is reflected in the design²¹.

Smith College can be a building with similar results to the Pharmacia Building Q lab in Illinois, if we chose to take green construction as far as possible. This includes using recommendations that may cost the college a large initial fee, but will produce huge benefits in the years to come. The benefits of a green building are creating an environmentally sustainable building, as well as creating a structure that will cost the college less in annual costs.

²⁰ Labs 21 Case Study

²¹ Same Labs 21 Case Study

Recommendations

For Smith College to obtain the level of LEED certification proposed, I have provided a list of recommendations. These are the main recommendations from the two LEED checklist categories that were the focus of this paper.

Sustainable Site Recommendations:

- Review the PVRTA bus stop distance from the new building site. If the site is still too far away, move the bus stop closer.
- Move all parking to the new parking garage, and create plans for a future parking garage early to ensure the construction is sustainable. This will occur with the later phases of the project.
- Convert Dickinson lawn into a green space after it is used to house the construction equipment.
- Use landscaping to reduce storm water run-off and heat islands. This includes trees, shrubs, and increased green spaces.

Materials & Resources Recommendations:

- Deconstruct the current buildings for reuse of the materials. This limits the new resources necessary and recycles the old.

A few other key recommendations (in addition to those already listed) for the entire project are as follows:

Water Efficiency:

- Use the mini-turbine for the collection and distribution of graywater to toilettes and irrigation.
- Install low-flow toilettes.
- Install a centralized vacuum system.

Energy & Atmosphere:

- Solar energy should be used on the roof of the building to provide supplemental energy, as well as provide a renewable energy source for the building.
- Install energy reducing devices: light bulbs, motion sensor, hand-dryers.
- Look at purchasing green power-possibly not for this project, but for use in future phases of development.

Indoor Environmental Quality:

- Allow the occupants to control the interior environment by installing operational windows in private offices. Install skylights, and utilize windows to allow natural light to enter the inside of the building.

Innovation & Design Process:

- Install the mini-turbine as already described.

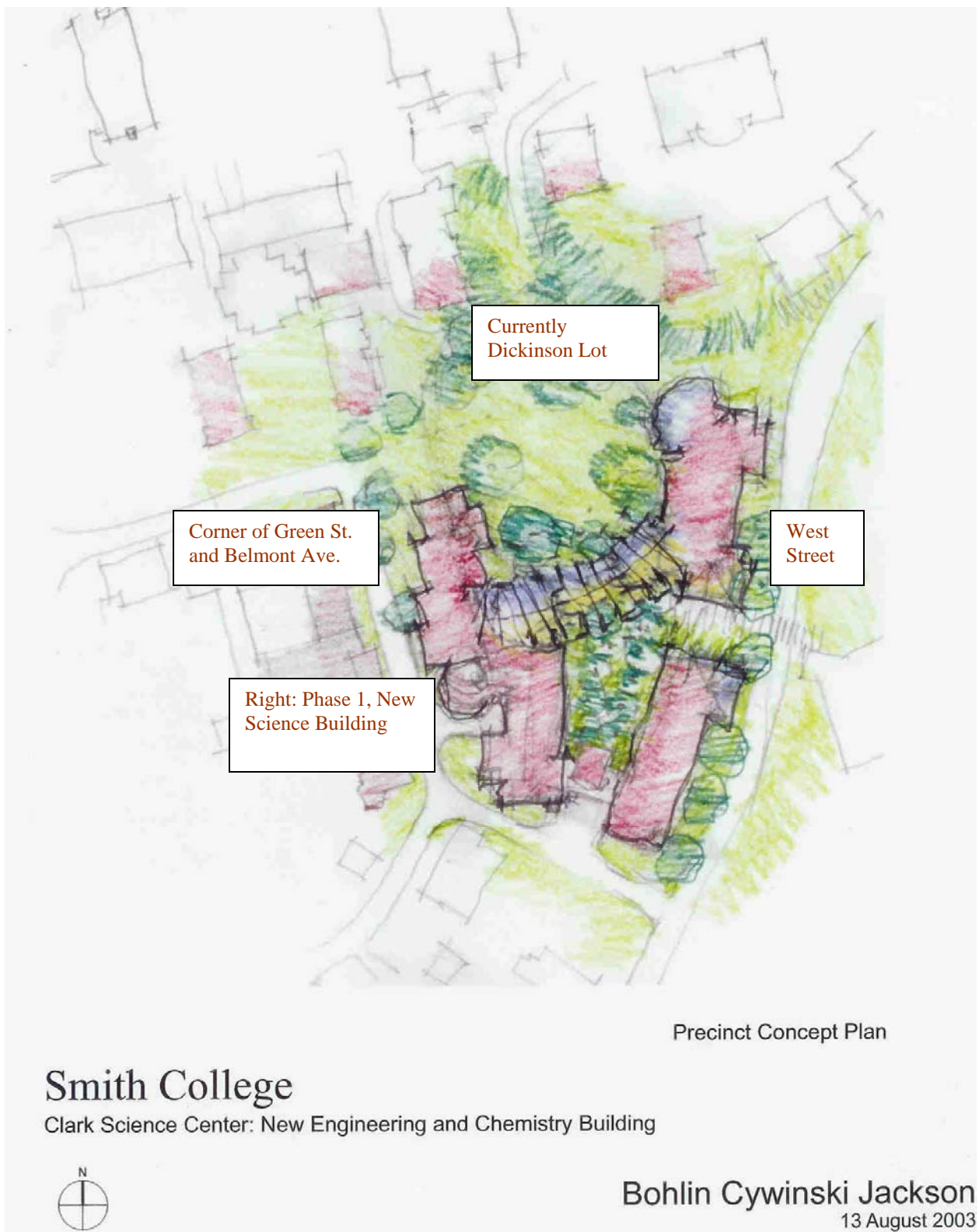


Figure 1: A map of the proposed project site. This includes all three buildings that are proposed to be on this site.

Table 1: The LEED checklist filled out by the architecture firm shows all the assumed credits Smith could achieve, could not achieve, and those that were questionable as of October 3, 2003.



Version 2.1 Registered Project Checklist

Conceptual Design Phase
Smith College Engineering and Chemistry Building

Yes ? No

Northampton , MA

3	7	4	Sustainable Sites	14 Points
----------	----------	----------	--------------------------	------------------

Y					
			Prereq 1 Erosion & Sedimentation Control		Required
Y			Credit 1 Site Selection		1
		N	Credit 2 Development Density		1
		N	Credit 3 Brownfield Redevelopment		1
		?	Credit 4.1 Alternative Transportation, Public Transportation Access		1
Y			Credit 4.2 Alternative Transportation, Bicycle Storage & Changing Rooms		1
		?	Credit 4.3 Alternative Transportation, Alternative Fuel Vehicles		1
		?	Credit 4.4 Alternative Transportation, Parking Capacity and Carpooling		1
		?	Credit 5.1 Reduced Site Disturbance, Protect or Restore Open Space		1
		?	Credit 5.2 Reduced Site Disturbance, Development Footprint		1
		?	Credit 6.1 Stormwater Management, Rate and Quantity		1
		N	Credit 6.2 Stormwater Management, Treatment		1
		?	Credit 7.1 Landscape & Exterior Design to Reduce Heat Islands, Non-Roof		1
Y			Credit 7.2 Landscape & Exterior Design to Reduce Heat Islands, Roof		1
		N	Credit 8 Light Pollution Reduction		1

Yes ? No

2	2	1	Water Efficiency	5 Points
----------	----------	----------	-------------------------	-----------------

Y			Credit 1.1 Water Efficient Landscaping, Reduce by 50%	1
Y			Credit 1.2 Water Efficient Landscaping, No Potable Use or No Irrigation	1
		?	Credit 2 Innovative Wastewater Technologies	1
		?	Credit 3.1 Water Use Reduction, 20% Reduction	1
		N	Credit 3.2 Water Use Reduction, 30% Reduction	1

Yes	?	No		
3	5	6	Energy & Atmosphere	17 Points
Y			Prereq 1 Fundamental Building Systems Commissioning	Required
Y			Prereq 2 Minimum Energy Performance	Required
Y			Prereq 3 CFC Reduction in HVAC&R Equipment	Required
Y			Credit 1 Optimize Energy Performance	1 to 10
	?		Credit 2.1 Renewable Energy, 5%	1
		N	Credit 2.2 Renewable Energy, 10%	1
		N	Credit 2.3 Renewable Energy, 20%	1
Y			Credit 3 Additional Commissioning	1
		N	Credit 4 Ozone Depletion	1
	?		Credit 5 Measurement & Verification	1
	?		Credit 6 Green Power	1
Yes	?	N		
7	2	4	Materials & Resources	13 Points
Y			Prereq 1 Storage & Collection of Recyclables	Required
		N	Credit 1.1 Building Reuse, Maintain 75% of Existing Shell	1
		N	Credit 1.2 Building Reuse, Maintain 100% of Shell	1
		N	Credit 1.3 Building Reuse, Maintain 100% Shell & 50% Non-Shell	1
Y			Credit 2.1 Construction Waste Management, Divert 50%	1
Y			Credit 2.2 Construction Waste Management, Divert 75%	1
	?		Credit 3.1 Resource Reuse, Specify 5%	1
		N	Credit 3.2 Resource Reuse, Specify 10%	1
Y			Credit 4.1 Recycled Content, Specify 5% (post-consumer + ½ post-industrial)	1
Y			Credit 4.2 Recycled Content, Specify 10% (post-consumer + ½ post-industrial)	1
Y			Credit 5.1 Local/Regional Materials, 20% Manufactured Locally	1
Y			Credit 5.2 Local/Regional Materials, of 20% Above, 50% Harvested Locally	1
	?		Credit 6 Rapidly Renewable Materials	1
Y			Credit 7 Certified Wood	1

Yes	?	No		
12	2	1	Indoor Environmental Quality 15 Points	
Y			Prereq 1 Minimum IAQ Performance	Required
Y			Prereq 2 Environmental Tobacco Smoke (ETS) Control	Required
Y			Credit 1 Carbon Dioxide (CO₂) Monitoring	1
Y			Credit 2 Ventilation Effectiveness	1
Y			Credit 3.1 Construction IAQ Management Plan, During Construction	1
Y			Credit 3.2 Construction IAQ Management Plan, Before Occupancy	1
Y			Credit 4.1 Low-Emitting Materials, Adhesives & Sealants	1
Y			Credit 4.2 Low-Emitting Materials, Paints	1
Y			Credit 4.3 Low-Emitting Materials, Carpet	1
Y			Credit 4.4 Low-Emitting Materials, Composite Wood & Agrifiber	1
Y			Credit 5 Indoor Chemical & Pollutant Source Control	1
	?		Credit 6.1 Controllability of Systems, Perimeter	1
	?		Credit 6.2 Controllability of Systems, Non-Perimeter	1
Y			Credit 7.1 Thermal Comfort, Comply with ASHRAE 55-1992	1
Y			Credit 7.2 Thermal Comfort, Permanent Monitoring System	1
		N	Credit 8.1 Daylight & Views, Daylight 75% of Spaces	1
Y			Credit 8.2 Daylight & Views, Views for 90% of Spaces	1
Yes	?	No		
1	1		Innovation & Design Process 5 Points	
	?		Credit 1.1 Innovation in Design: Provide Specific Title	1
			Credit 1.2 Innovation in Design: Provide Specific Title	1
			Credit 1.3 Innovation in Design: Provide Specific Title	1
			Credit 1.4 Innovation in Design: Provide Specific Title	1
Y			Credit 2 LEED™ Accredited Professional	1
Yes	?	No		
28	19	16	Project Totals (pre-certification estimates) 69 Points	
Certified 26-32 points Silver 33-38 points Gold 39-51 points Platinum 52-69 points				

Works Cited

Bohlin Cywinski Jackson, Programming Master Plan: Clark Science Center Engineering and Chemistry Building, vol. 1 (working draft), Smith College, Northampton, Massachusetts, September 5, 2003

Kibert, C.J. (ed.). Reshaping the Built Environment: Ecology, Ethics, and Economics. Washington D.C., Island Press, 1999.

McCullough, B., Personal Communication, April 12, 2004.

United States EPA and Department of Energy, Labs 21 Case Study, Pharmacia Building Q, Skokie, Illinois, December 2002.

Web Sources:

Bamboo in Construction, an Introduction:

http://www.inbar.int/publication/txt/INBAR_Technical_Report_No16.htm April 2004

Labs for the 21st Century:

Homepage: <http://www.labs21century.gov/> April 29, 2004

Leadership in Energy & Environmental Design

Homepage: http://www.usgbc.org/leed/leed_main.asp April 2004

LEED Registered Project Checklist:

<http://www.usgbc.org/Docs/LEEDdocs/LEED-NC%20checklist-v2.1.xls>

at Homepage: http://www.usgbc.org/leed/leed_main.asp April 2004

United States Environmental Protection Agency: Low-flow toilets

<http://www.epa.gov/owm/water-efficiency/toilets.htm#top>

at Homepage: <http://www.epa.gov/> April 5, 2004