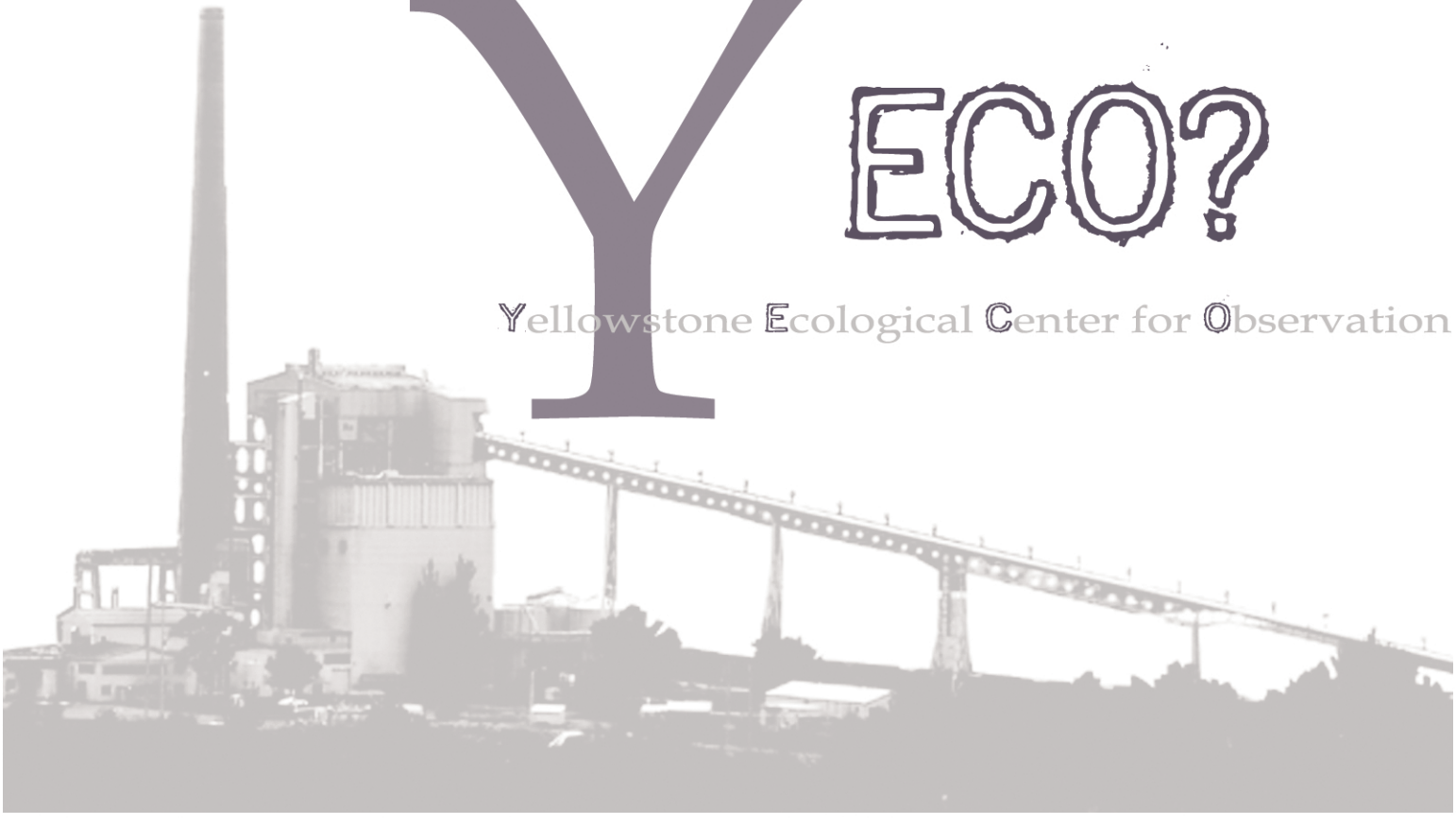
Y ECO?

Yellowstone Ecological Center for Observation



Y ECO: YELLOWSTONE ECOLOGICAL CENTER FOR OBSERVATION

by

Bradley Scott Kahler

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Architecture

in

Architecture

MONTANA STATE UNIVERSITY
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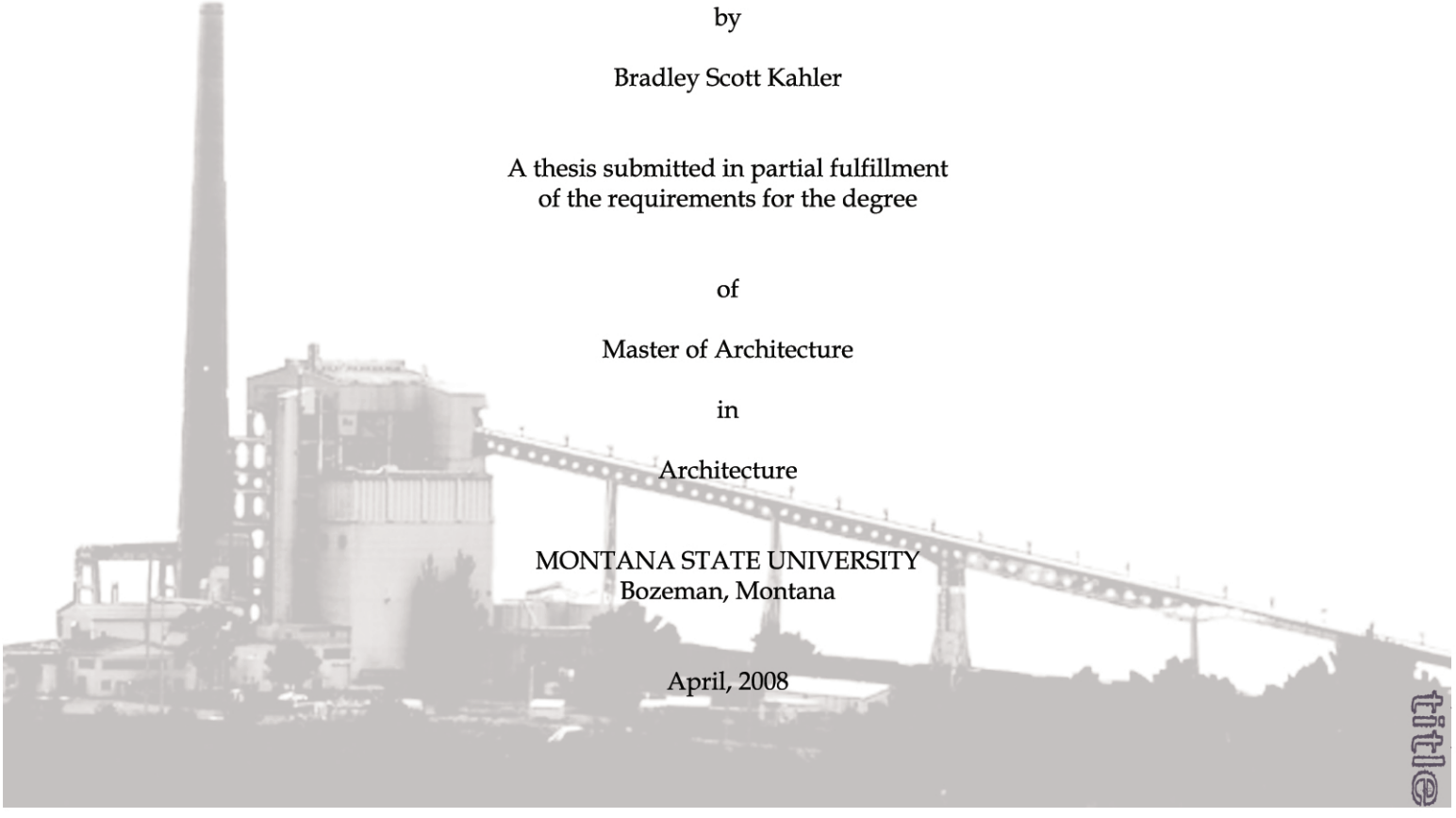

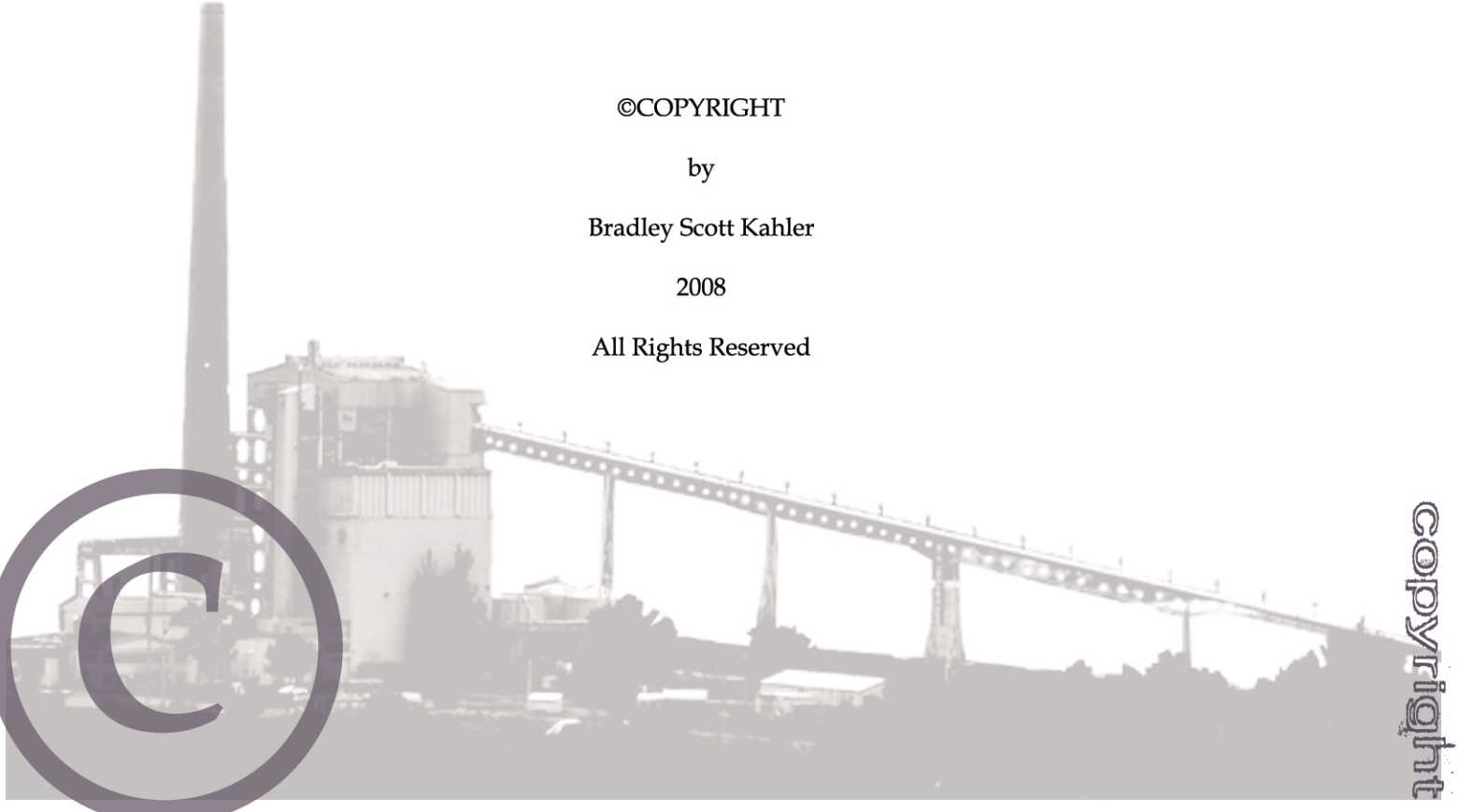

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This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citation, bibliographic style, and consistency, and is ready for submission to the Division of Graduate Education.

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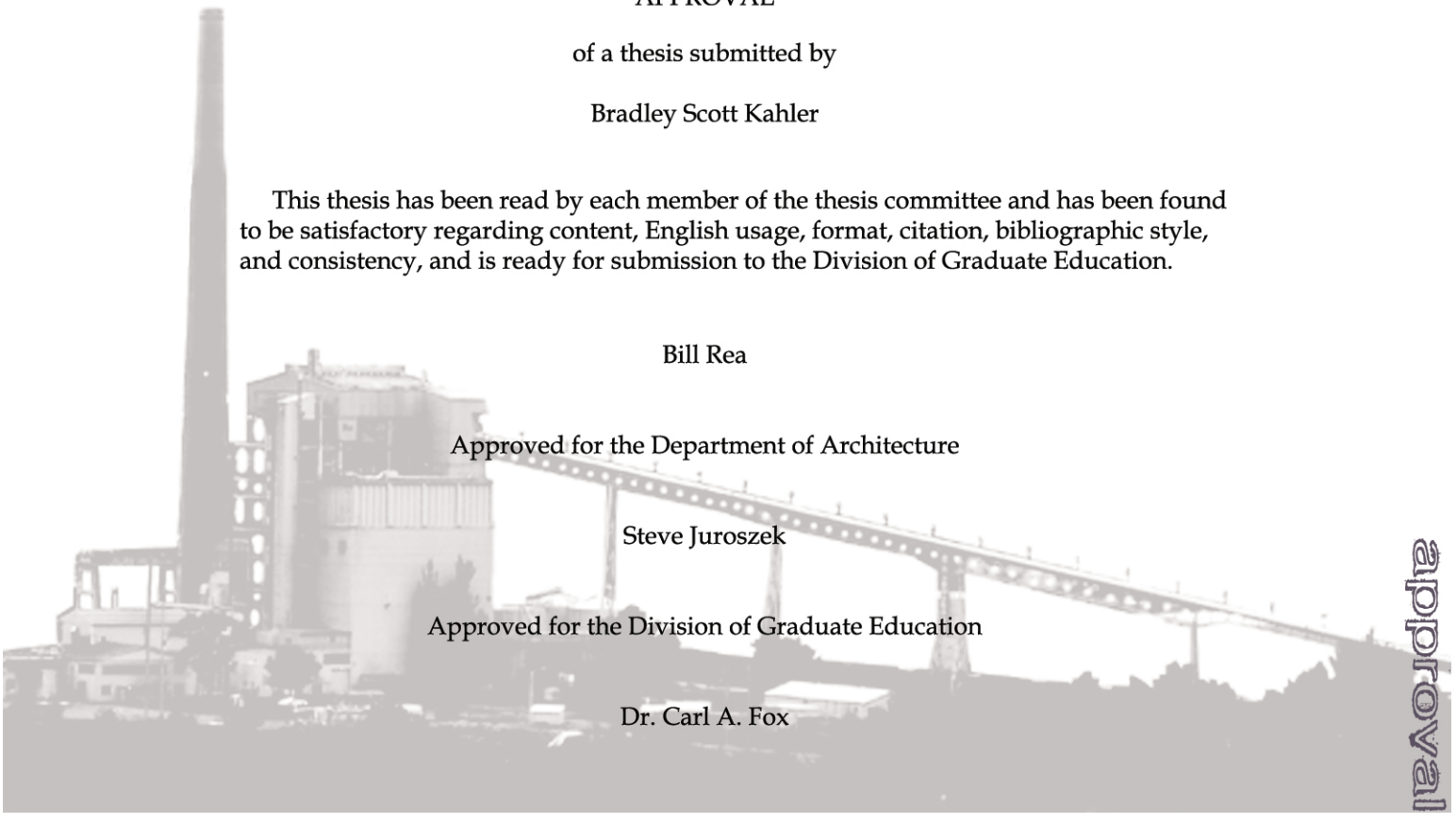

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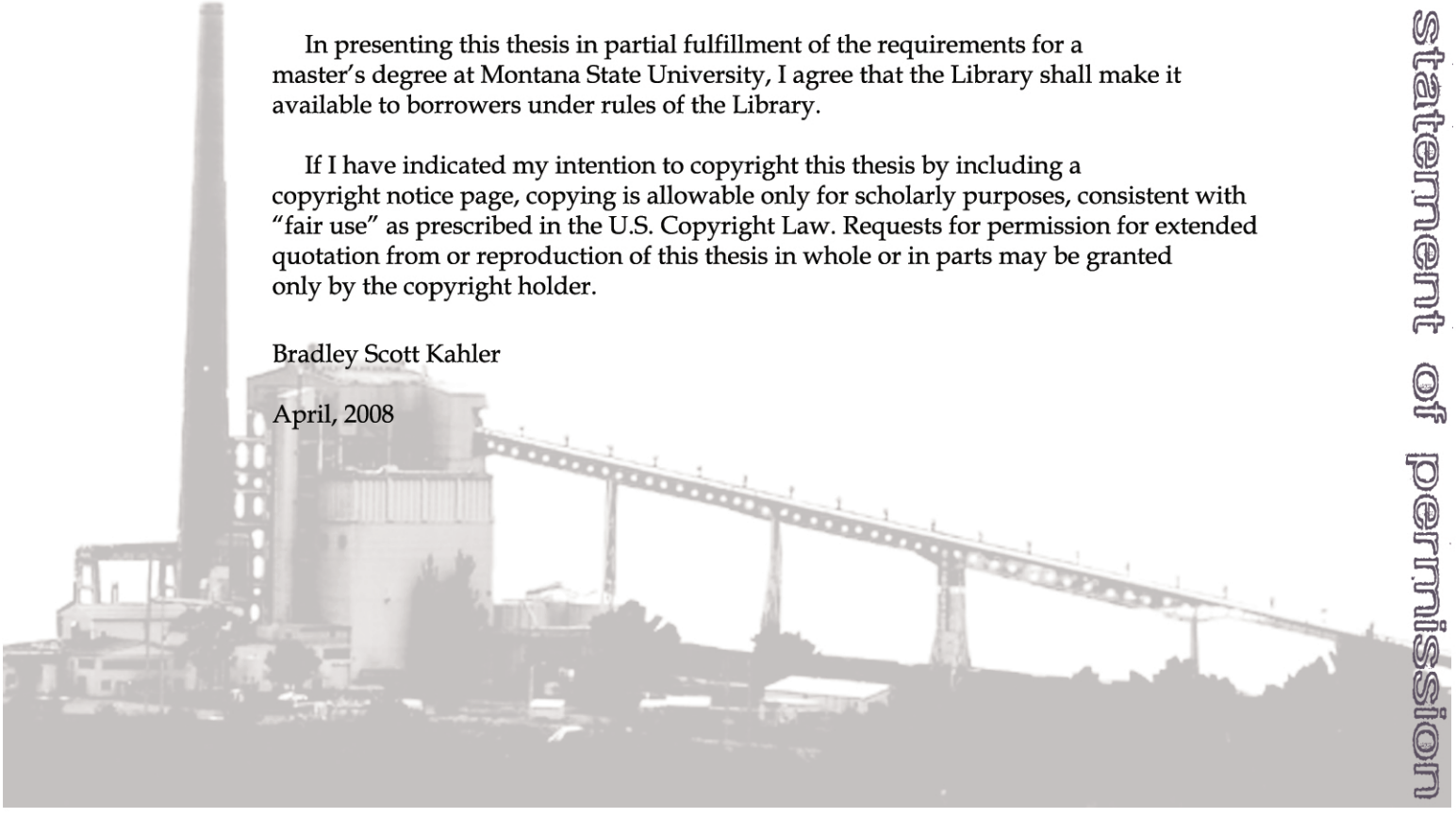

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Table of Contents:

Y Eco. 1
Educating the Public 2
Counteracting an Industrial Mentality. 4

Stuart Cowan on Bioneers and Industrialism 5
Ecological Design 6
McDonough's Fundamental Laws
Sustainability. 8

Instrumental Components. 10

The Living Machine 11
4 Basic Types
Six Principle Components
Disadvantages & Setbacks

LEED Certification 18
BREEAM System
CASBEE System
Photovoltaics. 20
Crystalline Cells
Thin-film Cells
Grid-tied vs. Standalone
Addressing Myths
Park Revitalization 22
Coulson Park

Visibility of Sustainable Methods. 23
Interior & Exterior

User Analysis. 24

Benefits of Affiliation 24
Additional Patrons 25

Precedent Analysis. 26

BP/Amaco Oil Remediation Site. 26
Merrill Center 27
Ethel M Chocolates Living Machine. 28
MOSI Butterfly House. 29
Eden Project 30

Site Analysis 32

Bikenet 32
Characteristics. 33
Site Context 34
Traffic Analysis 35
Images. 36

Program. 38
Design Development. 40



table of contents

Table of Contents:

Appendices 50

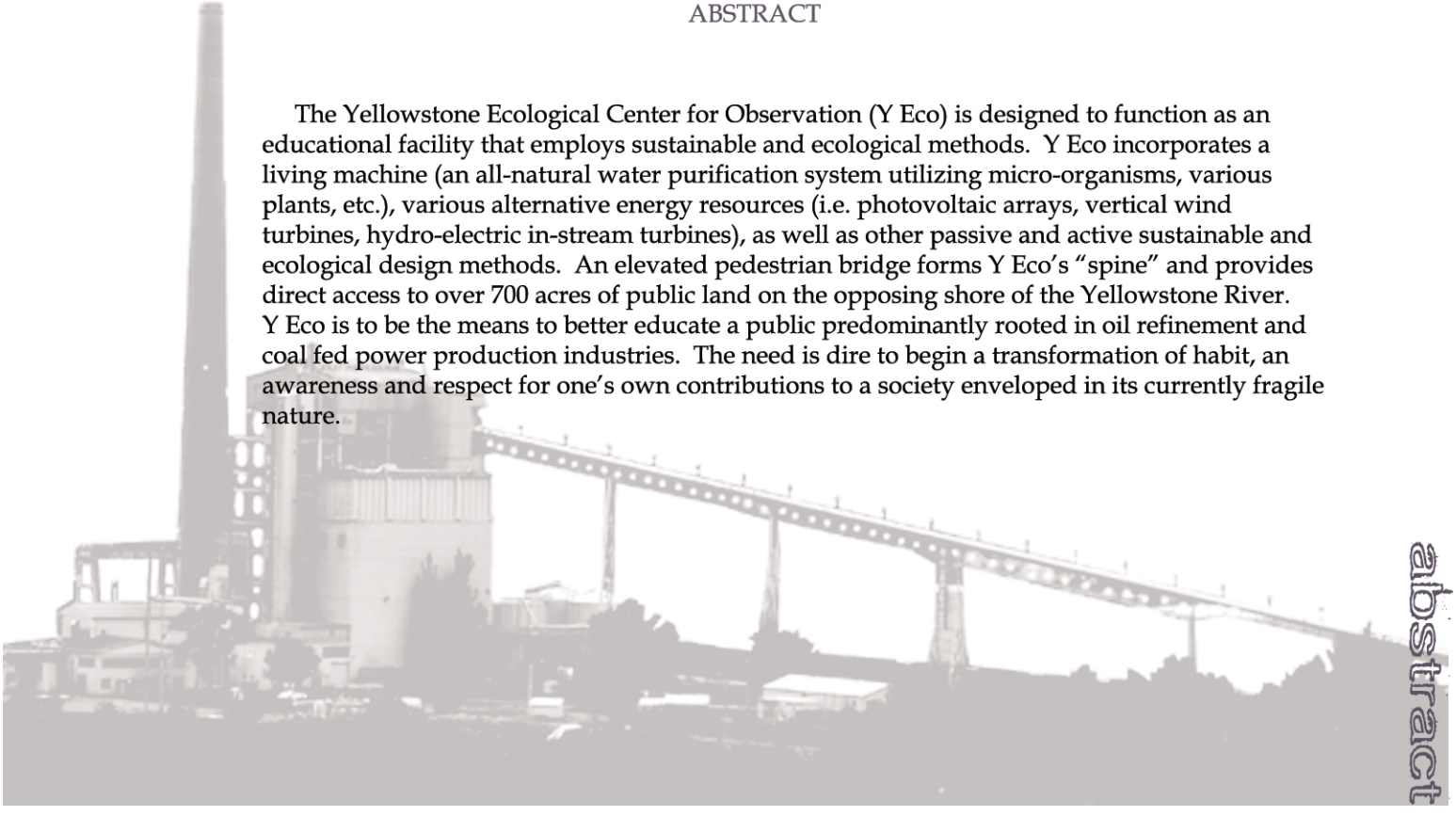
Appendix A - Vince Larson Interview 50
Appendix B - Correlating Energy Facts. 54
Appendix C - Correlating Water Facts 56

Image Index. 57
Bibliography. 60



ABSTRACT

The Yellowstone Ecological Center for Observation (Y Eco) is designed to function as an educational facility that employs sustainable and ecological methods. Y Eco incorporates a living machine (an all-natural water purification system utilizing micro-organisms, various plants, etc.), various alternative energy resources (i.e. photovoltaic arrays, vertical wind turbines, hydro-electric in-stream turbines), as well as other passive and active sustainable and ecological design methods. An elevated pedestrian bridge forms Y Eco's "spine" and provides direct access to over 700 acres of public land on the opposing shore of the Yellowstone River. Y Eco is to be the means to better educate a public predominantly rooted in oil refinement and coal fed power production industries. The need is dire to begin a transformation of habit, an awareness and respect for one's own contributions to a society enveloped in its currently fragile nature.



The question has been raised. . . Y eco? Ecological design is fast becoming a revolution in architectural engineering and design. It is a fresh and environmentally sound means of design and cooperation with local ecosystems: additionally it utilizes recycled and reusable materials and functions derived from existing ecological systems and processes. Designing in this manner is a necessity if we are to preserve the world of tomorrow. Harnessing solar, wind, and hydraulic energies in an efficient manner benefits the environment, the community, and local ecosystems as well. The future of architecture lies with this "sleeping giant" that is ecological design.

The field of ecological design can be wielded as a powerful tool in matters of public motivation and education. An educational facility designed and engineered under ecological methods leads by example and becomes a means of opening the public's eyes. They will experience first hand tangible proof to the immense possibilities and benefits inherent in ecological design. Imagine a high school biology class witnessing an operational living machine, all its stages of purification, the ecosystems contained within it, then being able to test the water and arrive at their own conclusions via onsite laboratories. University courses can be taught on site, public lectures can be given, books can be read, and tours can be taken. Lecture halls, interactive media centers, a library and research center, facility tours, and countless other elements included in a facility of this magnitude have the ability to convey the revolutionary principles and characteristics of ecological design. In addition, patrons would also have access to state lands on the opposing river bank to observe wildlife and natural ecosystems flourishing in such close proximity to not only the Yellowstone Ecological Center for Observation (Y Eco), but two oil refineries, a coal-fired power plant, and the city water treatment plant as well!



image 2

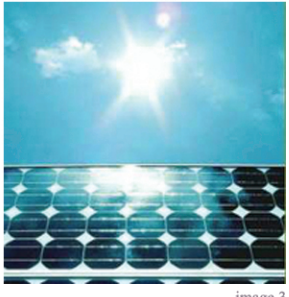


image 3



[1]Wilson, Alex, J.L. Seal, L. McManigal, L. Lovins, M. Cureton, W. Browning. Green Development: Integrating Ecology and Real Estate C1999-2005. Snowmass, Co: Rocky Mountain Institute. pp. 137, 316, 387

[2]http://www,wordreference.com/definition/effluent

Educating the Public:

A pairing of sustainable practices, ecological design, educational facilities, and a living machine (a natural means of water purification via micro-organisms, various plant species, etc.) seems to be a pertinent avenue to increase public awareness. In today's society it becomes increasingly difficult to reach the population's majority. And, concerning the apparent lack of awareness, or the common case of "out of sight, out of mind," industrial practices appear to carry on without question or concern from the populous. Have we become so oblivious to our immediate surroundings that even in a community overrun with industries, we are able to function on a daily basis without an instance of hesitation, even brief thought, on how these ominous industries may be aiding in the degradation of our environment and its fragile ecosystems? Public awareness and concern seems to halt the moment EPA (Environmental Protection Agency) standards are met. As members of a community, citizens should demand more than EPA norms. We're all aware that in this day and age, waging war with "Industry" is futile, so why not devise a means or solution that counteracts industry through cooperation. The Yellowstone Ecological Center for Observation (Y Eco) intends to do just that.

University programs, along with every other educational arena will flock to this facility when it is adequately equipped. Architects, engineers, professors, teachers, students and the public alike all will benefit from the opportunities a facility of this magnitude offers to an eager community. A Living Machine with lab facilities for testing water treatment efficiencies, computer monitoring technologies, a library, ecological and sustainable elements of construction, revitalized recreational areas, and offering tours and forums has an all but irresistible appeal. It becomes a highly tangible means of educating the public. Once the educational community is convinced, it becomes a simple manner of propagation, whether by word of mouth or notoriety. Notoriety can be obtained via LEED (Leadership in Energy and Environmental Design)[1] certification concerning Y Eco's overall composition, operational efficiency, as well as its sustainability. However, LEED certification is not the only means through which certification can be obtained. Other processes exist not developed in the U.S. that are gaining similar momentum worldwide. CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)[2] and the BREEAM (Building Research Establishment Environmental Assessment Method)[3] methods are also viable sources for certification. Notoriety through certification can be utilized as a powerful public motivator. Through the simple observation of success, pride can be evoked, and in that pride lays a crucial tool for educating the public as a whole.



[1] www.usgbc.org

[2] http://www.ibec.or.jp/CASBEE/english/methodE.htm

[3] http://www.breeam.org/

Educating the Public:

This pride will not solely be seeded in Y Eco's operational qualities and successes, but in its ability to cooperate and function unhindered with the local industries. "The biggest blockade to the emergence of living technologies could be the very phenomenon living machines are intended to solve, namely, the estrangement of modern cultures from the natural world."[4] As long as a portion of all bodies concerned is satisfied with the result, obstacles become virtually non-existent and the "living technologies" will be allowed to unfold in a natural manner.

Communities have a subliminal tendency toward pride in their local parks which in itself is a "counteraction" to the industrial mentality. To further this counteraction, incorporating a revitalization of Coulson Park, complete with wetlands and ample pedestrian circulation, has a high probability of gaining additional public support.

"Nature is invisible to many people in our culture. It is [a] hope that the aesthetic and emotional feelings that living machines can generate in us will yet carry the day. These machines can be made beautiful and evocative of a deep harmony that is nature."[4]

Therefore, it's only natural to assume that if a living machine, coupled with an educational facility, functions independently then its ecological contributions will be amplified. In this manner, site specificity is crucial to Y Eco's ability to succeed, not only in its immediate ecosystem, but within natural, industrial and community contexts as well.

Now, where to test this notion of ecological design? Site is an imperative element in determining any project's success or failure and in Billings, Montana's Coulson Park lays a vision of success. Billings is the largest city in the state of Montana. Not long after its founding in 1882, it was dubbed the "Magic City" due to the city's immediate and phenomenal growth. With an area in excess of 125,000 square miles, the city's primary trade territory is one of the largest in the United States. [5] Billings has become the medical and educational center for the region, with two large hospitals, a university and private college continuing to grow within the community. [5] The city has also become a regional center for the agricultural, energy, and oil industries and Coulson Park just happens to be situated at the heart of it all. With such a prominent industrial presence and a population 100,000 strong, Billings sits… poised for an ecological renovation. A facility such as Y Eco's purpose is to bring about such renovation. Operating in the face of industry Y Eco has the potential to abate a thriving industrial mentality that is both community and regionally based.



[4]Guterson, Mary. "Living Machines: Putting human waste back in its place: at the bottom of the food chain" Designing a Sustainable Future. 4 Sept. 2005 www.context.org/ICLIB/IC35/Guterson.htm

[5]www.lee.net/walk/visit/billings.htm

Counteracting an Industrial Mentality:

counteract—to act against; neutralize [6]
industrial—having to do with industry or its workers, products, etc. [6]
mentality—mental attitude or outlook i.e. comprehension, reasoning [7]

The majority of today's lifestyles seem to revolve around an industrial based mentality. Whether through the production of fuel, energy, or steel, we thrive on these products no matter how conscientious we think ourselves to be. The average person requires transportation, heat, electricity, even treated water. How many of these "average" people think twice when the price of electricity takes an unexpected hike. Which individual is left pondering, "If the price of electricity increases, is there a greater demand; how does this affect the depletion of fossil fuels such as coal; if the power plant increases production, how does that contribute to its current pollution outputs; what matter of effluents (contaminated water by-products) [8] are being released into local ecosystems and to what degree is such effluent being treated?" These are the types of inquiries that not only concerned individuals should pose, but all citizens. When living in, or near, a highly industrialized area or region such as Billings, posing questions becomes a crucial and conscientious necessity and should be a relentless process.

Inquiring after the state of one's own "backyard" should not be met with disdain but rather with an open mind. If we choose to remain blind to our surroundings, we will most likely walk blindly into the nearest wall, only to go nowhere. Nowhere is a destination the human race cannot afford to venture. The need is dire to begin a transformation of habit, an awareness and respect for one's own contributions to a society enveloped in a currently fragile nature. The question one hopes would arise pertains simply to a prompt and efficient solution, in what manner, and to what degree, are we able to counteract our tendencies, our habits our inherent industrial mentalities in order to contribute to, and preserve a degrading natural environment? A viable solution to this pressing dilemma is not only born from the devastation of an over-industrialized society but is rooted in the elements of sustainability and ecological design as well.



image 4

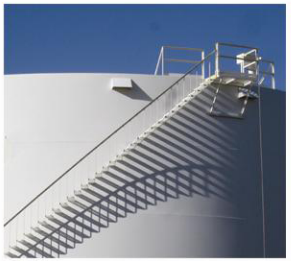


image 5



[6] Webster's New World Dictionary & Thesaurus. 1996. New York, NY: Hungry Minds, Inc.

[7] Wilson, Alex, J.L. Seal, L. McManigal, L. Lovins, M. Cureton, W. Browning. Green Development: Integrating Ecology and Real Estate 1999-2005. Snowmass, Co: Rocky Mountain Institute. pp. 137, 316, 387

[8] http://www.wordreference.com/definition/effluent

Stuart Cowan on Bioneers and Industrialiasm:

An emerging organization of biological pioneers is one of the first groups to address industry's present course and the general public's blind acceptance with the severity it deserves. These pioneers are offering a response, though it may carry with it an unconventional connotation that is predicated on human interaction and cooperation in order to reduce detrimental industrial impacts.

bioneer—"biological pioneers," united by their desire to honor the full complexity and integrity of nature in their work. [9]



image 6

Bioneers claim that conventional industrial practices requiring vast inputs of energy and materials are eroding the health of both ecosystems and human communities at a staggering pace. In response, the Bioneers are developing methods of agriculture, architecture, commerce, and engineering that are frugal, resilient, and responsive to local conditions. [9]

According to Paul Hawken, "The reason industrialism is over is that it succeeded." Industrialism raised productivity and mobilized unprecedented quantities of materials and energy. The existing industrial system we stand to inherit wastes 94 percent of all materials before the product reaches consumers. [9]



image 7

Our current industrial system is predicated on cheap resources and expensive labor. The promising news from the Bioneers is that resource productivity (extracting an increasing amount of useful products and services out of each molecule) requires more people, not less. [9]

The Bioneers offer a more optimistic outlook of the human presence on the planet. They encourage us to move beyond despair and seek new forms of symbiosis. (Cowan, Bioneering) Y Eco requires this "symbiosis" in order to stand as a testament to our ability to adapt, to redirect an inherent industrial mentality. We, as a race, as a species, are capable of so much more. . . why not prove it?

[9]Cowan, Stuart. "Bionerring-Bioneers Conference Focuses on Ecological Restoration." 8 Aug. 2005 http://www.findarticles.com/p/articles/mi_ml510/is_n89/ai_18109951/pg_2

ecological design—the effective adaptation to and integration with nature's processes; a form of engagement and partnership with nature that is not bound to a particular design profession.[10]

Ecological design exists as a means to combine innovative technologies with nature's "technology" in order to reduce environmental impact and increase awareness among mankind. Fossil fuels are becoming scarce and sprawl, along with overpopulation, threaten the very earth from which we were conceived. Ecological design is a solution to these taxing dilemmas. A conscious effort must be made in order to preserve that which we have not yet destroyed. The sometimes chaotic and haphazard distribution associated with sprawl and overpopulation can be detrimental to both local and global ecosystems. As a result, ecology implores "…communities [to] strive to "fit" within and nurture their ecological home… within which [they] are inherently situated." [11]

"One of the beautiful things about using ecology as a model is this concept of balance, this concept of all kinds of strange things that technologists don't think about, pulses—day and night, seasons, cold warm—how to design all these things so that they dance with each other to create a whole system that self-designs, that becomes intelligent. All of a sudden you are talking about a technology that is alive, a living machine." [12]

Perhaps it is out of these pretenses that the term "Whole-Systems Thinking" arises. Whole-Systems Thinking refers to a very literal process "…through which the interconnections between systems are actively considered and solutions are sought that address multiple problems [simultaneously]" [13] An inability to consider the entire spectrum of interrelated articles can result in drastic complications, and ultimately, system failure. [13]



image 8



image 9

[10]Cowan, S., & Van Der Ryn S., Ecological Design, 1996, Island Press, Washington, DC

[11]Beatley, T., Manning K., The Ecology of Place, 1997, Island Press, Washington DC

[12]Todd, John. "The New Alchemists." 10 Sept. 2005 www.ratical.org/ co-globalize/DO_JohnTodd.html

[13]Wilson, Alex, J.L. Seal, L. McManigal, L. Lovins, M. Cureton, W. Browning. Green Development: Integrating Ecology and Real Estate. ©1999-2005. Snowmass, CO: Rocky Mountain Institute.

Ecological Design:

"…[H]uman endeavors are bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other. Since we are a part of that lacework ourselves, it's doubly hard to see the whole pattern of change. Instead, we tend to focus on snapshots of isolated parts of the system, and wonder why our deepest problems never seem to get solved" [14] (Wilson, p.37).

"…[T]hrough ecological design, it is theoretically possible to have a high civilization using only one tenth of the world's resources that industrial societies use today. We can reduce the negative human footprint by ninety percent and thrive as a culture…Ecological design allows us to link human life support systems in a symbiotic way to the rest of the biosphere" [15] (Ecological Design in the 21st Century, pp.4-5).

McDonough's Fundamental Laws of Nature for the purpose of informing design:

- There is no such thing in nature as waste: "All materials given to us by nature are constantly returned to the earth without even the concept of waste as we understand it."
- These natural cycles rely upon and are powered by the energy of the sun; in this way, nature operates on "current solar income."
- Nature Functions the way it does, and is able to sustain itself, because of the diversity of life. [16]



image 10



image 11

Two simple elements in this diversity, drawn from infinite possibilities, are that of wetlands and green corridors. Constructed wetlands aid in the ecological cleansing of wastewater and have proven quite effective in the majority of implementations [16] (Beatley, p. 39). "A wetland treatment system can also be used as an attractive, low cost way to store water for later use." In addition, "[p]eople relate very positively to the creation of wetland environments especially when they foster human interaction" [17] (ecological restoration, p.1). Green corridors, when successfully incorporated, become "…active landscapes, which can introduce open, green space to various parts of the city; intensify topographic features, rivers, ridges; offer a soft surface capable of absorbing rainwater; and let people escape the car-dominated hardscape" "They can also provide critical migration corridors for animals through urban areas" [18] (White Papers, p.20).



[14]Wilson, Alex, J.L. Seal, L. McManigal, L. Lovins, M. Cureton, W. Browning. Green Development: Integrating Ecology and Real Estate. ©1999-2005. Snowmass, CO: Rocky Mountain Institute.

[15]Todd, John. "Ecological Design in the 21st Century." Schumacher 2000 Lecture.

[16]Beatley, T., Manning K., The Ecology of Place, © 1997, Island Press, Washington, DC

[17]Dharma Living Systems. ©2005. "Ecological Restoration." p.1. www.dharmalivingsystems.com

[18]Hoffman, Leslie, Sustainable Architecture White Papers, ©2000, Quebecor Printing Inc., Laval, Quebec

sustainability—a means of configuring civilization to allow society to satisfy its present needs and express its optimal potential, while preserving biodiversity and natural ecosystems and executing a plan to maintain these ideals indefinitely. [19]



image 12

architectural def.—an architectural property of a program which allows continued viability [20]

Accompanying the recent "re-emergence" of sustainable practices is a tone of optimism where there should be disgust. Some perceive this sustainability movement as something new and revolutionary when in reality, it's quite the opposite. In layman's terms sustainability is a record of awareness of the cycle of human impact on the natural world where then the natural world imparts its reaction upon us. [21] Under this premise sustainability has existed for over 4,000 years. The fact that evidence of sustainable practices and their benefits has been at our disposal for 4,000 years and that we are just now deciding to "perhaps" correct the situation should disgust us. We have selfishly chosen to neglect our impact on the natural world until its state was in such disrepair that we felt it prudent to "implement" sustainable methods. Our degree of implementation or recognition of the severity is miniscule when compared to nature's demand for restoration.


image 13

As a result of the natural demand, sustainability, where architecture is concerned, is fast becoming "…a kind of mantra…offering the possibility of balance and performance in a world where we experience precisely the opposite" [22] (Cowan, Van der Ryn, p.3). This "mantra" or "emergence of the sustainability movement is deeply inspiring, for it potentially offers a holistic response to the environmental crisis that makes much-needed connections between nature, culture, values, power relationships, and technology" [22] (Cowan, Van der Ryn, p.3,4). Once again, the characteristic of holistic approaches reiterates the importance of interaction amongst sustainable practices and their ecological and human counterparts. "The concept of sustainability also implies that our cities, towns, and communities should strive to function as ecosystems do" [23] (Beatley, p.87). When cooperation and cohesion are not present among these elements, their potency fades and they merely exist as clever concepts and cease to be effective at an optimal level.



[19] http://en.wikipedia.org/wiki/Sustainability

[20] http://web.mit.edu/oki/learn/gloss.html

[21] http://www.worldenergy.org/wec-geis/publications/reports/liow/the_concerns/sustainability.asp

[22] Cowan, S., & Van Der Ryn S., Ecological Design, © 1996, Island Press, Washington, DC

[23] Beatley, T., Manning K., The Ecology of Place, © 1997, Island Press, Washington, DC

Sustainability:

Sustainable architectural methods and elements span a range that is too numerous to list. However, all of these elements can be categorized under two approaches, active and passive. Passive methods are basically architectural elements that once implemented need minimal or no maintenance whatsoever. Such elements include but are not limited to: building orientation, vegetation management, water conservation, composting toilets, triple pane argon windows, day-lighting, energy efficient appliances and fixtures, etc.



image 14

The active method incorporates sustainable elements that are, more often than not, mechanized and require moderate to substantial maintenance and regulation. Elements considered to be active measures include but are not limited to: living machines, photovoltaic arrays (solar panels), electrochromic glass ("smart glass" that alters its transparency depending on intensity of sunlight or sensor settings) [24], ground-source heat pumps, automatic shades and ventilation louvers, graywater toilets, etc. Y Eco's design intends to incorporate a combination of both methods. However, due to society's fixation on the evolution of technology, a greater emphasis will most likely be placed on active sustainable elements to ensure a majority of the target audience is reached.

Additional benefits to sustainable practices in architecture, aside from those concerning nature and contributions to environmental preservation, lay within the U.S. Green Building Council's LEED system (Leadership in Energy and Environmental Design). Providing a structure's efficiency LEED rating is acceptable, zoning boards can opt to increase the project's allotted square footage as opposed to the overall square footage granted to developers who have no desire to meet LEED standards. [25] (White Papers, p.37). LEED ratings also play a crucial role in procuring government funds to aid in a project's completion. Added funding and square footage can then be utilized to enhance a project's already effective operations.



image 15

[24] http://www.smartglass.com

[25] Hoffman, Leslie, Sustainable Architecture White Papers, ©2000, Quebecor Printing Inc., Laval, Quebec

Instrumental Components:

Y Eco's main elements offer just that, a symbiosis, a cohesive relationship that is not only viable, but effective and environmentally pro-active as well. The elements comprising Y Eco's nucleus include the incorporation of a Living Machine, LEED certification, photovoltaic arrays, an extensive park revitalization and striving to create public awareness by making these sustainable measures highly visible. Additional wind and hydro-electric aspects were considered but factors such as an abundant bird population and prior river encroachment issues prevented their implementation. As solitary elements, only the Living Machine possesses a definitive symbiotic nature. However, as all four elements are brought together as a single cohesive entity, a true symbiosis then flourishes.



image 16

The Living Machine:

def.— " 'Living Machines' are whole systems approaches to treating wastewater. They are solar-powered, accelerated versions of the water treatment facilities found in mature natural systems. Incorporating helpful microbes, plants, snails and fish into diverse, self-organizing and responsive communities, Living Machines are site-specific, biological solutions that re-route waste streams into resources." [26]

"All…ecosystems have overriding attributes in common. They have the ability to self-organize and to self-design. They all have the ability to self-repair when damaged or perturbed. This attribute can be weakened or altered by human interference, but never destroyed. And the all have the ability to self-replicate and perpetuate themselves through time…Powered by sunshine alone they accomplish so much and utilize resources with incomparable efficiency. They are models humanity must emulate in order to change the course of history." [27] (Ecological Design 21st Century, p.3)



[26]Funch, Flemming. "Living Machines." Ming the Mechanic: Living Machines. 13 Sept. 2005 http://ming.tv/flemming2.php/__show_article/_a000010-000264.htm.

[27]Todd, John. "Ecological Design in the 21st Century." Schumacher 2000 Lecture.

Instrumental Components:

The Living Machine becomes an engineered ecosystem, a catalyst of cohesion, a solution which encompasses sustainability, ecological design, and the counteraction of an industrial mentality. These Living Machines become microcosms of nature's own ecological systems. William McDonough states that, "[w]hat prevents living systems from running down and veering into chaos is a miraculously intricate and symbiotic relationship between millions of organisms, no two of which are alike." [28] They utilize and function under nature's laws and the energy of the sun and have been employed "…to grow foods, transform wastes, treat sewage, generate fuels, provide climate regulation in buildings, detoxify harmful chemicals, link industrial processes and repair damaged environments." [28]
(Ecological Design 21st Century, p.3)

Living Machine systems' sizes can fluctuate anywhere between 600 to 750,000 gallons per day, depending on the circumstances, and functions related to its integration. [29] Some of their characteristics and benefits include, but are not limited to the following:

Living Machines:

- are biologically diverse, making them resistant to problems resulting from "shock loads" in the incoming waste stream
- allow their operators to minimize or even eliminate environmental impact and the liability related to environmental impact
- are aesthetically pleasant and do not promote strong, unpleasant odors, making them much better neighbors than many conventional wastewater treatment facilities
- through the incorporation of green principals and the promotion of sustainability, coupled with high treatment standards and the opportunity for reuse of treated wastewater, Living Machines are widely accepted by the public and regulators alike
- provide an enjoyable space where people can gather
- can provide a community with independence from a municipal wastewater treatment facility and promote smart growth
- can be designed and expanded in a modular fashion so that wastewater treatment is consistent with the needs of a growing community
- users experience reduced costs relating to wastewater surcharges, water purchases, sludge disposal and chemical treatment, and storage
- work largely without the addition of dangerous chemicals. Fewer chemicals stored and used in a community means a lower potential for an adverse impact and less liability overall for the community[30]



[28]Todd, John. "Ecological Design in the 21st Century." Schumacher 2000 Lecture.

[29]Dharma Living Systems. ©2005. "A New Source." p.1.

[30]Dharma Living Systems. ©2005. "Benefits." pp.1-3

Instrumental Components:

Living Machines Continued:

- offer significant educational opportunities and resources for school age children, university students and adults alike
- provide communities with an opportunity to enhance public awareness for sustainability and the promotion of green principals
- are designed to conserve water through the reuse of treated wastewater; they save potable water, money, and resources
- can achieve tertiary treatment of wastewater to consistently meet tough discharge requirements
- can provide cost effective and smart growth alternative to extending existing municipal sewer lines
- designs incorporate the principals of efficiency, sustainability and ecological engineering [30]



image 1 /

4 Basic Types of Living Machines:

Hydroponic Living Machine

"The Hydroponic Living Machine is a biological nutrient removal system and the use of plants are a key treatment component. It is specifically designed to use large terrestrial plants and their roots to provide a unique aquatic zone and fixed-film to begin the treatment process. Plant roots grow directly into aerated wastewater from racks fixed at the water surface of the treatment basin. Biofilms growing on plant roots and biosolids retained on plant roots are key treatment mechanisms. A diverse and abundant community of invertebrate organisms thrives in the plant roots by grazing on biofilms and retained biosolids. The difference begins with the elimination of the clarifier and ends with a vertical flow wetland that finishes the treatment process." [31]

[30] Dharma Living Systems. ©2005. "Benefits." pp.1-3

[31] Dharma Living Systems. ©2005. "Products." p.2.

Instrumental Components:

Tidal Wetland Living Machine

"The Tidal Wetland Living Machine is one of the "Fourth Generation Constructed Wetland" designs developed by Living Machines, Inc. to overcome the limitations of conventional constructed wetlands for wastewater treatment. Most notably, this advanced water reclamation system has superior nitrogen removal and a compact footprint compared to conventional wetland systems.

The Tidal Wetland Living Machine incorporates a series of tidal flow cells, which are alternately flooded and drained with cycle periods of a day or less to achieve up to tertiary treatment. These systems are designed to be both cost and energy efficient and incorporate the latest in Living Machine technology.

The Tidal Wetland Living Machine provides the highest level of treatment combined with energy efficiency of any of the systems offered by Living Machines." [31]



image 18



image 19

Hybrid Wetland Living Machine

"The combination of Horizontal and Tidal Flow Wetland Living Machines forms a hybrid "Fourth Generation Constructed Wetland" design developed by Living Machines to overcome the limitations of conventional constructed wetlands for wastewater treatment. Most notably, this advanced water reclamation system has superior nitrogen removal."

[31]Dharma Living Systems. ©2005. "Products." p.2.

Instrumental Components:

Living Lab Living Machine

"The Living Lab is an engineered learning space with curriculum designed to demonstrate the most innovative concepts in sustainable building, ecological design and environmental stewardship.

The core of the Living Lab is a unique "living classroom" that will implement hands-on lessons in ecology, agriculture, aquaculture, engineering and environmental restoration. This center, and the associated curriculum, will illustrate the mutually beneficial relationships existing between different organisms in natural ecosystems and show how students can harness them to provide clean water, food, and shelter.

The Living Lab is self-sustaining, generating a portion of its own power from the sun, while collecting rainwater and reclaiming wastewater." 31

Y Eco intends to incorporate one of two living machine versions, a tidal wetland system or a living lab sytem. It is possible to retrofit the educational aspects of the living lab to the tidal flow system but future design decisions and principles will determine the final selection.



[31]Dharma Living Systems. ©2005. "Products." p.2.

Instrumental Components:

Six Principle Components:

1) Anaerobic Reactor [32]
   - Similar in appearance and operation to a septic tank, usually buried below grade.
   - Reduces concentrations of BOD5 (The amount of dissolved oxygen consumed in five days by biological processes breaking down organic matter) [33] and solids prior to treatment via plastic mesh netting, which provides filtration and surface for colonization of anaerobic bacteria
   - When necessary, gases are passed through an activated carbon filter to control odor

2) Anoxic Tank [32]
   - Controlled aeration to prevent anaerobic conditions and encourage floc-forming and microorganism growth
   - Removes significant portion of incoming BOD5
   - Vented via planted biofilter
   - Settled biosolids from Clarifier (5) recycled back to this reactor

3) Closed Aerobic Reactor [32]
   - Reduces dissolved wastewater BOD5
   - Removes further odorous gases
   - Stimulates nitrification
   - Odor control via planted biofilter
   - Vegetation intended to control moisture levels in filter material



[32]"Wastewater Technology Fact Sheet, The Living Machine." EPA. ©2002. 20 July 2005. http://www.epa.gov/owm/mtb/living_machine.pdf

[33]www.teachmefinance.com/Scientific_Terms/BOD5.html

Instrumental Components:

Six Principle Components Continued:

4) Aerobic Reactors [32]
   - Covered w/ vegetation supported racks (no biofilter) which provide surface area for microbial growth, perform nutrient absorption, serve as habitat for beneficial insects and microorganisms
   - Complete nitrification process
   - Size and number of reactors is determined by influent (wastewater input) characteristics, effluent (treated water output) requirements, flow conditions, and design water and air temperatures

5) Clarifier [32]
   - Settling tank allows remaining solids to separate from treated wastewater
   - Settled solids pumped back to closed aerobic reactor (3) or transferred to holding tank and removed for disposal
   - Surface often covered w/ duckweed which prevents algae growth in the reactor

6) "Ecological Fluidized Beds" (EFB's) [32]
   - Polishing filters that perform final treatment of wastewater
   - One to three are used in series to reduce BOD5, TSS (total suspended solids) and nutrients to meet final effluent requirements



[32]"Wastewater Technology Fact Sheet, The Living Machine." EPA. ©2002. 20 July 2005. http://www.epa.gov/owm/mtb/living_machine.pdf

Disadvantages & Setbacks:

Every system, however, has its setbacks and disadvantages. The most common setback concerning living machines pertains to cost. When located in a warm climate (a greenhouse not being necessary), living machines are typically cost competitive with conventional water treatment systems having flow volumes of 1 million gallons per day. However, construction costs increase due to greenhouse requirements for colder climates. The inclusion of a greenhouse structure results in the living machine being cost competitive with a conventional system with flow rates up to 600,000 gpd. At flow rates of 80,000 gallons per day, a living machine (with greenhouse) differs in construction costs from that of a comparable flow conventional facility by less than twenty percent. At flow rates of 1 million gpd, the cost difference is greater than twenty percent, in favor of the Living Machine with its greenhouse. [34]

Other disadvantages to living machines pertain to effective phosphorous removal. Living machines have only been proven to effectively reduce phosphorous levels by 50%. Influents with these high phosphorous levels are primarily associated with incoming solid waste and are not relevant to living machines which do not concern the treatment of solid waste material.[34]



[32]"Wastewater Technology Fact Sheet, The Living Machine." EPA. ©2002. 20 July 2005. http://www.epa.gov/owm/mtb/living_machine.pdf

Instrumental Components:

LEED Certification:

LEED (Leadership in Energy and Environmental Design) certification is the recognized standard measuring building sustainability utilized in the U.S. and other foreign countries. A project or building that obtains LEED certification possesses the characteristics and qualities required to be declared "truly" green.[34] The LEED green building rating system recognizes building performance in five key areas of human and environmental health: sustainable site development, energy efficiency, water savings, material selection, and indoor environmental quality. [35]

The LEED certification process consists of a variety of stages. The first of these stages is to establish eligibility. In Y Eco's case as a commercial structure (as outlined by standard building codes) it is eligible for certification. Project registration is next. Registering a project or building during the preliminary design phases ensures a maximum potential for obtaining certification. The following stage of the certification process concerns credit interpretations. Credit interpretations occur when a design team has difficulty in the application of LEED prerequisites or credits to a specific project. A credit interpretation request (CIR) enables a review board to ensure that rulings maintain their consistency and are made available to other projects. The application documentation submittal stage is next and can be rigorous for design teams due to the bulk of documentation, fee summaries, all project application materials, etc. required. LEED techinical reviews follow and involve evaluations and audits of the above submittals and credit alotments. Providing all the above meets LEED standards and deadlines, certification is then awarded and the project or building can now declare its LEED certification status. An appeal process also exists if a dispute over the number of credits awarded arises. Failure to obtain the minimum credits pertaining to a project's type results in a failure to obtain LEED certification.[35]

The ability to declare a building LEED certified enables the stifling of any public scepticism as to the project's performance, sustainability and/or environmental impact. A project's LEED certification can be utilized as a compelling testament to not only the public but clients and peers alike. Taking into consideration the general population immediately effected by Y Eco's presence is industrially rooted and therefore already sceptical, LEED certification becomes a crucial element in Y Eco's success. This leveraging of the public or tactical/factual persuasion proves to be of great benefit and a necessary asset to any building or project.



[34]http://www.nrdc.org/buildinggreen/leed.asp

[35]www.usgbc.org

Instrumental Components:

LEED Certification:

Other methods of certification not developed in the U.S. also exist but certain aspects or measures of each method have to be taken into consideration. BREEAM (Building Research Establishment Environmental Assessment Method), a UK based system of certification, is striving to establish environmental assessment methodology that is region specific. [36] This takes into account climatic discrepancies other systems may have failed to consider. CASBEE (Comprehensive Assessment System for Building Environmental Efficiency), a method developed in Japan, relies on a series of complex equations designed to calculate a buildings qualitative elements (Q) and its environmental loadings (L). [37] It focuses on a building's internal and external spaces. Separating the two is a hypothetical boundary defined by site borders and other elements. CASBEE's mathematical approach, though highly advanced and taking into consideration a building's impact on spaces beyond its "boundaries", is still not without its flaws. All of the above systems possess similar if not the same target fields but not all systems necessarily agree upon the same concepts with which to evaluate their related fields. Each of these systems has specific benefits but ultimately no single system of evaluation is without its biases. Whether pertaining to material selection, CO2 emissions, or climate regions, all of the above systems vary on final evaluations.

Not seeking certification, though a more radical approach is also an option to be considered. Obtaining certification requires additional staff being incorporated into a building's design process and carries with it monetary expenses. The excess in man hours and expenditures can ultimately be categorized as a waste of energy and resources. To remain loyal to the ideologies of sustainability and ecological design, certification becomes a strain on a building's ability to truly demonstrate its sustainable and ecological construct. For Y Eco's specific purpose, obtaining certification proves to be a greater asset than strain. LEED certification has been established and developed locally (in the U.S.) and carries with it a greater public recognition other methods have yet to establish. Therefore, in remaining true to further educating a specific public, obtaining LEED certification becomes Y Eco's optimal choice.



[36]http://cat.inist.fr/?aModele=afficheN&cpsidt=2280018

[37]http://www.ibec.or.jp/CASBEE/english/methodE.htm

Instrumental Components:

Photovoltaics:

Photovoltaics (PV cells), or solar cells, are fast becoming a reliable source for on-demand power. Their integration into building design and sustainable practices has gained substantial momentum in the past decade. Considered an active sustainable element, the development of these solar cells has made harvesting the sun's energy increasingly efficient. Technological advancements have lead to valuable innovations in how photovoltaics are manufactured as well as the means in which they are applied. Crystalline cells are among the more prevalent cells used and tend to convert sunlight in a more efficient manner requiring smaller arrays and therefore utilizing less overall square footage. Photovoltaics are also manufactured in thin-film form. This thin-film format (usually less than one ten-thousandth of an inch thick)[38] becomes very versatile when considering a BIPV system (Building Integrated Photovoltaics). This PV film can be integrated as portions of window panes, skylights, window shades, roof applications (common w/ standing seam metal roofs) along with many other creative design elements. [39] Thin-film photovoltaics require a greater surface area than the standard crystalline cells, depending on the manner of integration desired, one form may serve your purpose more efficiently than the other. Ruling out a combination of the two systems simply limits possible design options and in order to successfully integrate any system into a building, all options should be considered.

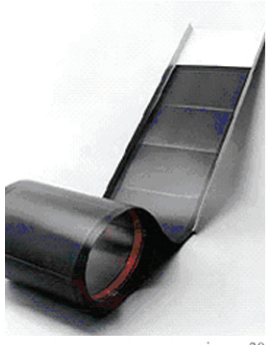


image 20

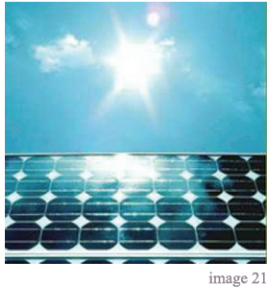


image 21

Two overall system categorizations exist: a grid-tied system, and a stand alone system. A grid-tied system is simply a photovoltaic array that is connected directly to a local utility grid. While the array is generating electricity the electrical meter is essentially running backwards providing the photovoltaics are generating more electricity than the building demand at that specific time. A stand alone application is more suitable for remote areas. In this case, the array is utilized in conjunction with a battery bank (a series of deep cycle batteries for storing generated electricity) [38] and possibly a back up generator if need be. Y Eco intends to implement a grid-tied system due to its proximity to the PPL coal-fired power plant. With PPL basically being on the "other side of the fence", power exchange efficiencies between Y Eco's PV array and the power plant increase dramatically.



[38]PVFG excerpt www.srmi.biz

[39]http://www1.eere.energy.gov/solar/myths.html

Instrumental Components:

Photovoltaics:

As with any system, a certain amount of criticism can be expected in addition to those who simply remain skeptical. A few myths derived from such critics and skeptics can easily be laid to rest giving photovoltaics the optimistic outlook they deserve. The first myth, and arguably the most common, states that solar generated electricity cannot account for any significant portion of U.S. or world electricity demands. [39] In all actuality, PV technology is capable of meeting electricity demands no matter the scale. A single array erected in a 100 square mile area of Nevada is capable of satisfying the electricity load for the entire United States (approximately 800 gigawatts) utilizing only modestly efficient (10%) commercial photovoltaic modules. [39] On a more realistic scale, distributed among the 50 states, an average area of approximately 17x17 miles would account for the same energy output. [39] Alternatively, constructing photovoltaic systems in "brownfields" (an estimated 5 million acres of abandoned industrial sites in the nation) can generate 90% of the United States current electricity demand. 39 This form of reclamation is both a prospect and a solution for the implementation of further ecological and sustainable measures. [39]

A second myth states that photovoltaics are incapable of significantly reducing or offsetting environmental emissions.[39] This myth is easily disproved with simple facts. First, photovoltaic systems produce energy; they do not produce greenhouse gases or atmospheric emissions. Concerning the offsetting of environmental emissions, a single kilowatt of photovoltaic electricity, when compared to electricity generated via fossil fuels, annually offsets approximately: 9 kilograms of sulfur oxides, 16 kilograms of nitrogen oxides, and 2,300 kilograms of carbon dioxide.[39] Providing the PV industry expands 25% per year as estimated, photovoltaics in the U.S. alone will offset 10 million metric tons of CO2 per year by 2027! [39]

Myth number three labels PV manufacturing processes as a polluting industry. PV production is by no means a "spotless" process nor does it pose any major health, safety, or environmental risks.39 Approximately 80% of the photovoltaic industry is silicon based. 39 Specific codes, regulations, and methods of control have been instituted in manufacturing operations to ensure safety. Under constant scrutiny, testing is implemented to ensure the rapid evolution of manufacturing techniques remains safe. 39

Having addressed some of the prevalent opposition to photovoltaic integration, the bottom line is it is a rapidly evolving technology that does not produces atmospheric emissions, offsets harmful emissions due to electricity generated via the burning of fossil fuels, and illustrates and establishes a direct cooperation amongst industry, ecology, and sustainability.



[39]http://www1.eere.energy.gov/solar/myths.html

Instrumental Components:

Park Revitalization:

Coulson Park (former site of the city of Coulson and the future site of Y Eco) at present is 45 acres of scrub grass with a bike path and a single boat ramp providing access to the Yellowstone River. Random ruts and a dirt road carve away at its surface. If not for the sparse but majestic oak trees and shrubs lining the river's edge, its appearance would resemble a barren wasteland. Coulson Park's present visitors include a few patron dog-walkers from a nearby neighborhood, those merely passing through on the bike path (or Bikenet) , a few hundred patrons one day a year for an annual Boat Float, oblivious passers by on Interstate 90, and the rare history buff only to view the lonely plaque at the park's northern end. This particular plaque so eloquently illustrates the brief but "vibrant" 5 year history (1877-1882) of the city of Coulson;

"Born by the river and killed by the railroad, giving to Billings her best citizens, to Boothill her residue, and to the Yellowstone her memories."

-Yellowstone Historical Society 1982-

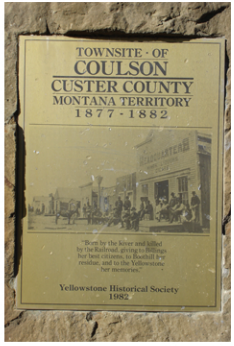


image 22

If Coulson Park is truly a city park it should resemble a city park. A lush green riverside park with meandering walkways, towering oak trees, an amphitheatre for outdoor concerts, all can aid in the revitalization of this dilapidated scrub land. Constructed wetlands will provide water purification, irrigation, and additional habitat for some of the 80 plus species of birds already on site. An incorporated park revitalization is a crucial component to Y Eco's ability to reinforce a public's ties to a nature they have seemingly divorced themselves from. Irrigation of Coulson Park requires 814,600 gallons of water per week. [40] Y Eco is capable of producing 1.05 million gallons of purified water per week, leaving almost 240 thousand gallons per week to be reintroduced into Yellowstone River, stored in holding tanks, or used in the operation of graywater toilets. Combining Y Eco's capabilities with the rebirth of the 45 acre Coulson Park possesses a greater potential to reach an audience distanced from nature, and enveloped in industry than any standalone facility could aspire to offer.



image 23

[40] http://www.mass.gov/dep/water/golfpol.doc

Instrumental Components:

Visibility of Sustainable Methods:

Y Eco must be designed in a fashion that allows the exhibition of its sustainable and ecological methods and components to be highly visible. Monitoring systems and displays, photovoltaic integrations, all systems must be presented in a manner that optimizes the educational experience of the facility's occupants and visitors. Portions of each element must be visible throughout the facility's interior as well as exterior. Their symbiosis or relationship to one another must be made apparent in order to optimize their ability to affect the public. Exterior visibility is necessary in order to take full advantage of patrons enjoying the park, to pique their curiosity, to draw them in to experience all that Y Eco has to offer. The same principal is applicable to those already on the interior, design decisions and visibility issues are instrumental in drawing visitors through the facility and releasing them into the park. It is necessary that this flow, this passage throughout be as captivating and educational as possible. As the flow of water throughout is effortless so must be the act of imparting knowledge. Seeing, experiencing first-hand, the inherent tangibility will eventually result in believing. The knowledge, processes and principles Y Eco aspires to impart ultimately rest with the public's ability to accept what has been laid before them. Understanding and comprehension cannot be forced, evidence can only be presented and the community and the individual must choose the most beneficial application of that material.



image 24

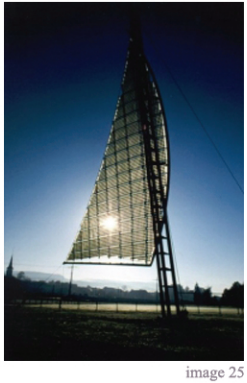


image 25



User Analysis:

User Analysis

It is in Y Eco's best interest to have a direct association with an educational institution. An affiliation with Montana State University Billings best suits Y Eco's prospects. The University assumes a proprietary role and to further emphasize cooperation with industry, a partnership or cooperative may ensue to ensure Y Eco's viability. In accepting Y Eco as an ally, and realizing the opportunities for public recognition, local industries will not hesitate to offer their contributions and or expertise. The three most prominent of these industries vying for partnership being the Conoco-Phillips oil refinery, the PPL power plant, and perhaps the City Water Treatment Facility. Whether one or all of the industries choose to seize the opportunity, all will benefit from Y Eco's success.



image 26

A university affiliation not only reinforces Y Eco's mission to educate the public but also offers a lucrative opportunity for Montana State University Billings to further expand its curriculum. Students can obtain internships or workstudy through lab work, monitoring the living machine and photovoltaic power generation, or simply by giving tours. These opportunities breed involvement and the key to educating begins with simply getting involved.



image 27



User Analysis:

User Analysis

Other users or patrons of the Y Eco facility include but are not limited to:

Students: Y Eco is first and foremost an educational facility to be utilized by students from all academic categories.

-On site facilities will accommodate entire classroom operations
-Advanced labs will accommodate collegiate courses, as well as advanced high school courses
-An auditorium will house lectures, Yellowstone Valley Citizens Council meetings, etc.
-A "green" library will house endless volumes on sustainability, ecological design, theory, architecture, etc.



image 28

Recreationalists: Park-goers, bicyclists, joggers and walkers alike need to be drawn in and captivated instantly for their experiences are less likely to be extended. The active nature of their activities requires movement, therefore Y Eco will respond to that movement in order to optimize their interaction.

Motorists: Those primarily traveling via Interstate 90 necessitate an immediate and powerfully persuasive vision in order to create enough intrigue to cause a slight detour in their travel plans.

The Architectural & Scientific Communities: Due to the nature of the project and its endeavors to bridge industry and environment, its ability to attract those involved in related practices is only natural.

The Local Community: The overall goal is to truly connect with this User. Only when there is large scale community involvement, will Y Eco be truly successful.


image 29



Precedent Analysis:

BP (British Petroleum) / Amaco Oil Remediation site (Platte River Commons)

def. remediation – the cleanup (by removal, attenuation, or degradation) of environmental contaminants from soil and groundwater to meet an endpoint agreed with regulatory authorities and communities.

Project Data
Cost: $20 million (wetland construction alone), overall cost unknown
Client: City of Casper
Design Team: BP, State, Federal, and Community Officials
Location: Casper, Wyoming

Program Overview
Former site of one of Amoco Oil's oldest refineries in the northwest (78 years of operation, 1913-1991), the 4,000 acre remediation site is now home to an 18 hole championship golf course (Three Crowns), a commercial office park, a light industrial park, a thrilling whitewater park, and a serene bird sanctuary. [41] The transformation from wasteland to wetland required the removal of 200 miles of pipe and over 600,000 cubic yards of impacted soil. BP then installed a water-treatment system that processes 1,000 gallons of contaminated groundwater per minute and retrieves 40,000 gallons of oil per month! BP will oversee operations for an additional 80 years after which natural biological processes will be self-sustaining. The "complete" remediation is estimated to take at least 400 years for groundwater to be returned to a pristine state. [42]



image 30



image 31



image 32

[41]http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets/downloads/B/BP_magazine_issue1_2006_casper_wonderland.pdf

[42]www.bp.com

Precedent Analysis:

Merrill Center

Project Data
Cost: $6.4 Million
Client: Chesapeake Bay Foundation
Design Team: SmithGroup, Thomas Eichbaum, FAIA
Location: Annapolis, Maryland

Program Overview
The 32,000 square foot building employs mechanized natural ventilation, active solar arrays accounting for approximately 30% of the building's energy demand, solar water heating, composting toilets, constructed wetlands, a geothermal heat pump (system of 48 wells each 300 feet deep for heating and cooling), and rooftop cisterns for rainwater collection and fire suppression supply. Along with numerous other sustainable material selections, the building was constructed over the footprint of previous buildings to reduce site impact. Eighty-five percent of the original site remains untouched. The Merrill Center utilizes 50% less energy than comparable office buildings and 1/10th the water. [43]



image 33



image 34

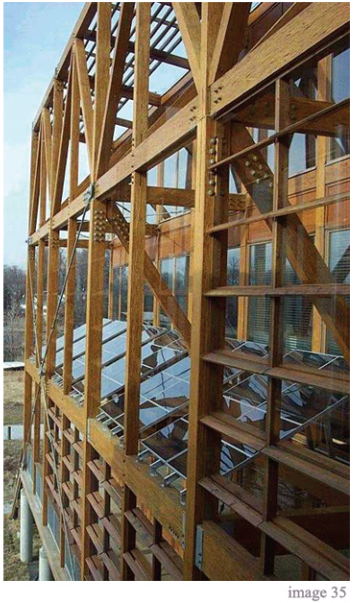


image 35

[43] http://www.eere.energy.gov/buildings/highperformance/projects_list.html#chesapeake

Precedent Analysis:

Ethel M Chocolates Living Machine

Project Data
Cost: $1.1 Million
Client: Ethel M Chocolates/M&M Mars Candy ompany, Henderson, Nevada
Design team: GroundSwell Architects, Living Technologies, Servidio Engineering, H.B.Daugherty

Program Overview
The Ethel M Chocolates project is sited in Henderson, Nevada and requires strict attention to a harsh desert climate. The facility treats water used in the manufacturing process, rendering it suitable for irrigation purposes. An educational display has been installed under the canopy. The project has been working well in its nine years of service and requires moderate maintenance.[44]

Design Features
The Ethel M Chocolates facility organizes various storage tanks, retractable shading, and walkways into user friendly living machine. The full-time canopy was designed to withstand the Nevada climate and winds.[44]

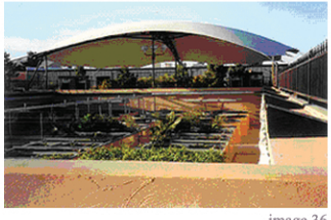


image 36



image 37



image 38

[44]http://www.groundswellarchitects.com/liv_mach_ethel.htm

Precedent Analysis:

MOSI Butterfly house

Project Data
Cost: $1.2 Million est.
Client: Museum of Science & Industry, Tampa, Florida
Design team: Indiana Architecture & Design, Living Technologies, and John Todd Research and Design

Project Description
A water treatment facility for a newly remodeled museum using lily ponds, marshes and planted landscaping to support an ongoing community of butterflies of many species. [45]

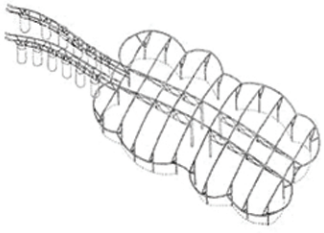
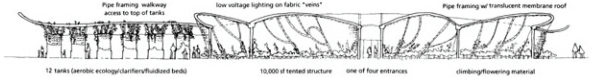


image 42

Design Features
The project is the shape of a butterfly, using custom pipe frame trusses, a translucent membrane roof, netting, water tanks, lighting, marshes, ponds, walkways, and landscaping to provide the effect. The butterflies are raised nearby and live year round within the enclosure. [45]



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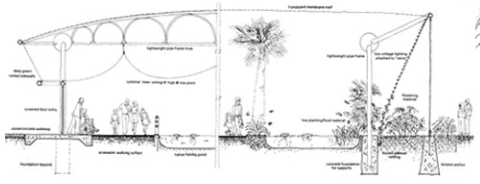

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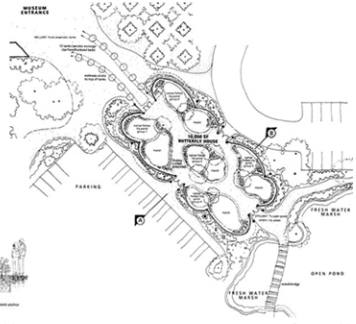


image 41

[45]http://www.groundswellarchitects.com/liv_mach_mosi.htm



Precedent Analysis:



image 43

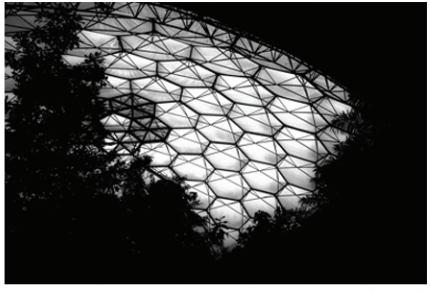


image 44

Eden Project

Project Data
Cost: €80 Million (approx. $96 Million)
Client: Eden Trust
Design Team: Sir Nicholas Grimshaw
Location: Bodelva, Cornwall, UK

Description
Built as a showcase for global bio-diversity, and one of the high-profile Millennium Projects, it is the largest plant enclosure in the world. The Eden Project consists of eight connected transparent geodesic domes that encapsulate humid tropic and warm temperate regions. These 'Bucky Balls' (after Buckminster Fuller) range in radius from 60 to 215 feet (18 to 65 meters) to accommodate the varying plant heights. This is an example of form following function, say the architects, a tangible expression of the client's aim to draw global attention to human dependence upon plants. [46]



image 45

Waste Neutral
The Eden Project incorporates resource and waste management into its sustainable stratagem. Simply put, the Eden Project aims to purchase a greater weight of products made from recycled materials than the weight of materials it ships out to be recycled and thus become 'waste neutral'. [47]

[46] www.architectureweek.com/2001/0214/news_1-2.html

[47] www.edenproject.com

Precedent Analysis:

Eden Project

Design Features

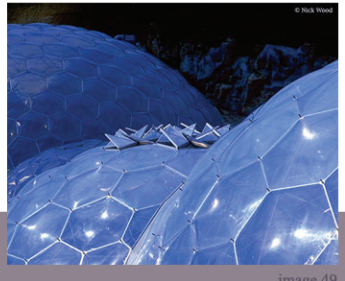
The Eden Project is comprised of 23,000 square meters of "linked, climate-controlled transparent capsules (biomes) set in a design landscape." The domes are derived from lightweight structures (lighter than the scaffolding used to erect them) with the highest possible volume vis-à-vis their surface. The cladding is made up of "optically clear air inflated foil (ETFE) pillows." This system allows the building to easily adapt to the topography of the former china clay pit in which it is set. The complex of geodesic domes of various sizes "gives the impression of a biomorphic organism." [48]



image 46



image 47



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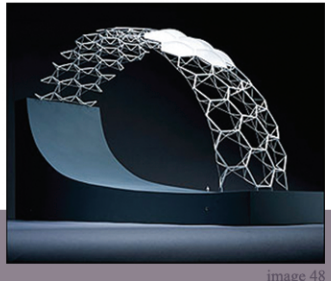


image 48

[48]Jodidio, Philip, Architecture Now Vol. 2, © 2002, Taschen GMBH, Printed in Italy

Bikenet:

Federal transportation funding is helping Billings take the initial steps in making its Bikenet plan, adopted in 1995, a reality. Seven miles of concrete bike/pedestrian paths in three segments have been built, laying the groundwork for a planned 70-plus mile-long network. [49]

A local Kiwanis club contributed $10,000 to the first section, the Kiwanis Trail, which follows an abandoned railroad right-of-way through the Heights residential section of Billings, connecting the popular Rimrocks area (sandstone bluffs along Billings' North and Eastern borders), with the river itself. Yellowstone River Parks Association partially funded the next section, the MetraPark Trail, which runs along the Rimrocks with spectacular views of the river. Montana Community Foundation and Bikes Belong aided with the third section, built in 2002 to extend the existing trail along the future Yellowstone River Greenway and link with Billings' historic downtown. [49]

Trail projects in progress include the first phase of a north-south connector route that will eventually link residential neighborhoods, commercial districts, a school, and parks on the west end of Billings, and a trail along the Rims to connect with the existing MetraPark Trail. [49]



image 46



image 47



image 48

[49]www.americabikes.org/images/resources/stateinfo/MontanaHighlight.pdf

Site Analysis:

Characteristics:[50]

Elevation: 3,648 feet

Wind: Primarily out of the SW @ average speed of 6.0 mph

Latitude: 45.77753435

Longitude: -108.48339169

Vegetation: Oak, Elm, Maple, Evergreen, Aspen, Sagebrush, Cactus, Scrub Grass, Lilac, Russian Olive, etc.

Wildlife: Deer (mule & whitetail), Coyotes, Rabbits (cottontail & jackrabbit), Raccoons, Porcupines, Snakes (bullhead, rattlesnake, and garter), 80-plus documented species of birds, Numerous Fish Species

Yellowstone River: Flow Range = 2,200 to 25,000 cubic feet per second
Width @ site ranges from 160-200 feet
Depth varies

Rimrocks (sandstone cliffs): Range in height from 100-460 feet.



image 53



image 54



image 55

[50]www.americabikes.org/images/resources/stateinfo/MontanaHighlight.pdf

Site Analysis:

Site Context:

1. Site
2. BLM Land
3. Conoco Phillips Refinery
4. Downtown Billings
5. Power Plant
6. Interstate 90
7. Yellowstone River
8. Existing Coulson Park



image 56



Site Analysis:

Site Context Traffic:

1. Charlene Street
2. BLM Land Trails
3. Interstate 90
4. Downtown Billings Streets
   Frontage Road
5. Yellowstone River

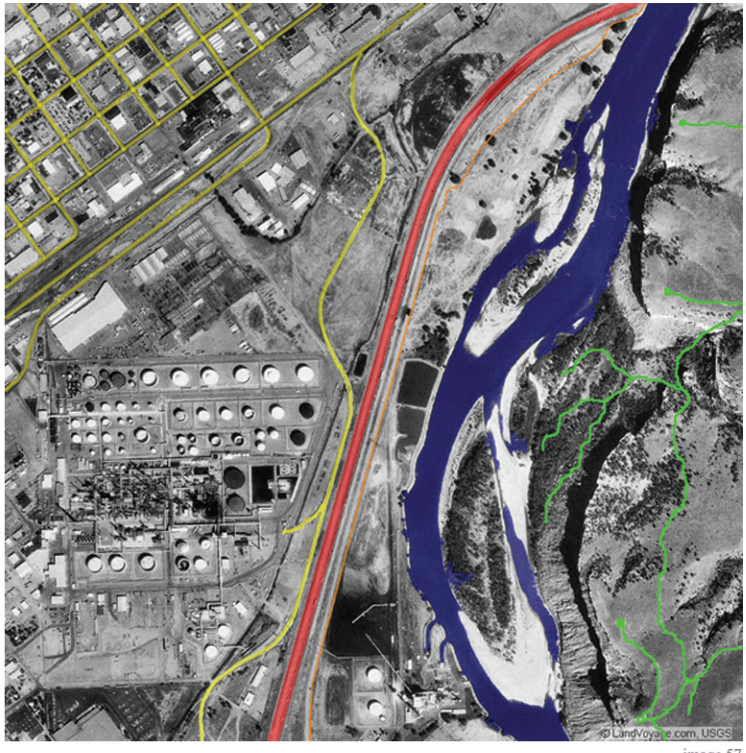


image 57

Site Analysis Images:



image 58



image 59



image 60



image 61



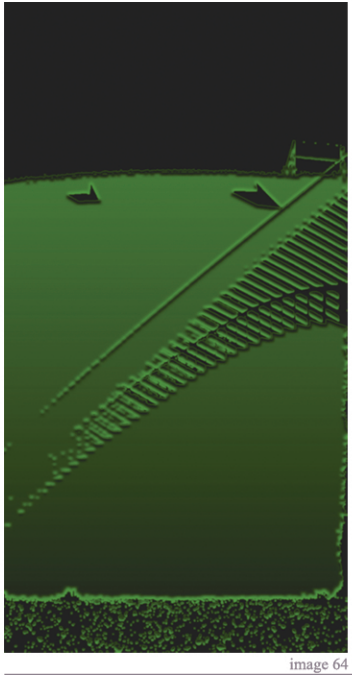
image 62



image 63



Site Analysis Images:



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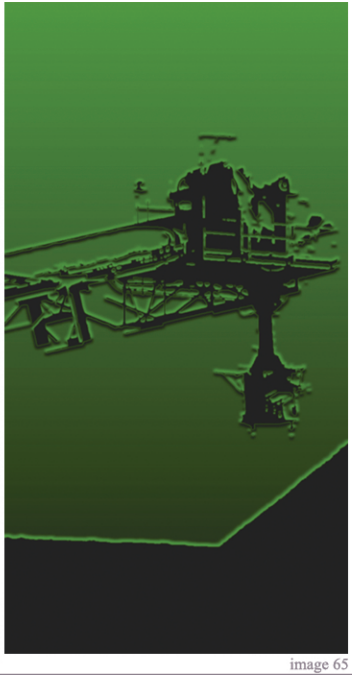


image 65

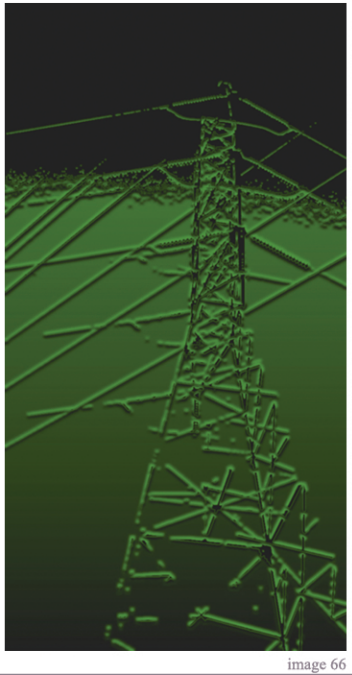


image 66



image 67



Program:

- Wetlands (A Redesign of existing Settling Ponds ≈ 10-12 acres or 522,720 sq. ft)
  a. Also functions as a means of water retention
- Living Machine (Living Lab Greenhouse)- will handle flow of 100-150,000 GPD (gallons per day), 100 kGPD (waste from 1500 people) ≈ 14,520 sq ft (120' x 120') and 150 kGPD (waste from 2,250 people) ≈ 22,500 sq ft (150'x150')[51]
- Photovoltaic Array @ 80kW supplies ≈ 100% of building's electrical demand using maximum sq. footage (tracking or photovoltaic film that is building integrated, tracking @ ≈ 4,500 sq. ft. of surface area, pv film @ ≈ 8,100 sq. ft. of surface area) [51]
- In-Stream Hydro-Electric Turbines - Low Flow (dry season production) produces 5.39 kW
  Heavy Flow (run-off season) produces 19.7 mW
- Vertical Wind Turbines - 68 total generating 160,000 kw per year operating @ 15% capacity
- Mechanical
  a. Natural Ventilation (Cooling Tower)
  b. Passive Solar Heating in combination with a ground source heat pump and partial radiant floor heating
  c. Electrical / Power Storage (PV's) / Wireless Computer Hubs
  d. Plumbing / Valve Room / Water Heater (Boiler?)
- Restrooms (4 @ min. of 100 sq. ft. ea.)
- Monitoring- Computer Systems Analysis (300 sq. ft.)
- Lab Facilities for on site testing (1000 sq. ft.)
- Auditorium / Lecture Hall (6500 sq. ft.)
- Library (5,500 sq. ft.)



[51]www.aceee.org

Program:

- Entrance Lobby / Exhibition & Gallery Space (min. of 800 sq. ft.)
- Storage- supplies, parts, etc. (min. 250 sq. ft)
- Maintenance- custodial, tools (min. 200 sq. ft.)
- Administrative (500 sq. ft.)
- Holding Tanks / Retention Pond - for irrigation and gray water (treated wastewater) and rain water retention ≈ 100,000 gallons or 25 ft. wide x 60 ft. long x 12' deep
- Decks to accentuate vantages of – the Yellowstone River, the Rimrocks, Power Plant, and Living Machine area
- Pedestrian Bridge - to accommodate tours and provide direct access to 750 acre BLM lands on opposing shore
- Circulation
- Revival of existing Coulson Park area (≈ 45 acres)
- Augmentation of existing BikeNet / Pedestrian Path - integrate into Y Eco's Circulation
- Parking (50 vehicles + 10 oversized spaces to accommodate RV's and school buses) ≈ 28,000 sq. ft.

Total Interior Square Footage ≈ 35,000 sq. ft.
Total Square Footage (including parking / Coulson Park /Wetlands) – 58 total acres



Y ECO

YELLOWSTONE ECOLOGICAL CENTER FOR OBSERVATION

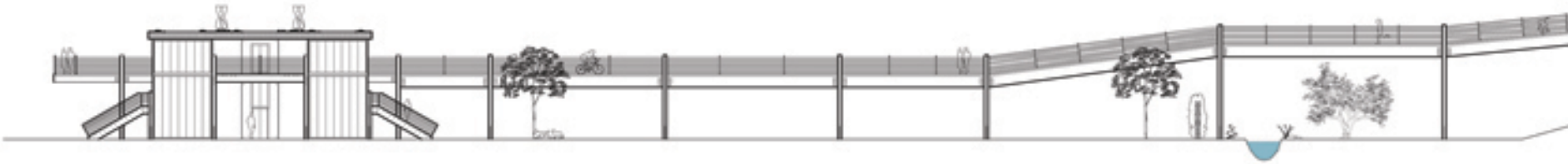
Objective:

To design an educational facility employing sustainable and ecological methods with an integrated living machine (an all-natural water purification system utilizing micro-organisms, various plants, etc.) that will become the means with which to better educate a public predominantly rooted in oil refinement and coal fed power production industries.

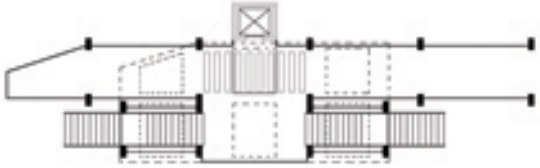
The elements comprising Y Eco's nucleus include:

- incorporation of a living machine
- alternative energy resources such as photovoltaic arrays, vertical wind turbines, and hydro-electric in-stream turbines
- park revitalization including constructed wetlands and direct access to over 700 acres of public lands on the opposing shore of the Yellowstone River
- educational facilities consisting of a library, lecture hall, and multiple laboratories
- utilization and integration of sustainable materials and practices
- striving to create public awareness by making these sustainable measures tangible as well as highly visible.

The need is dire to begin a transformation of habit, an awareness and respect for one's own contributions to a society enveloped in its currently fragile nature.

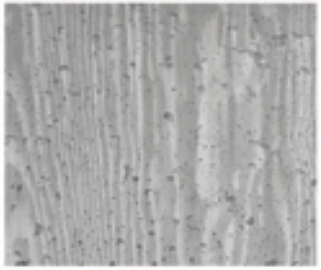


West Pedestrian Bridge Node



100% Recycled Steel Smartbeams

- Primary & Secondary Structure



Board-form Flyash Concrete

- Utilizes Flyash (coal burning by-product)
- Primary Structure

Glulaminated Beams & Columns

- Partially Reclaimed Timbers
- Primary Structure



Kalwall Composite Panels

- High Insulation Efficiency
- Skylight Integration

Vertical Wind Turbines

- Roof & Interstate 90 Median Integrations
- Alternative Energy Resource (wind)

Perforated Steel Panels

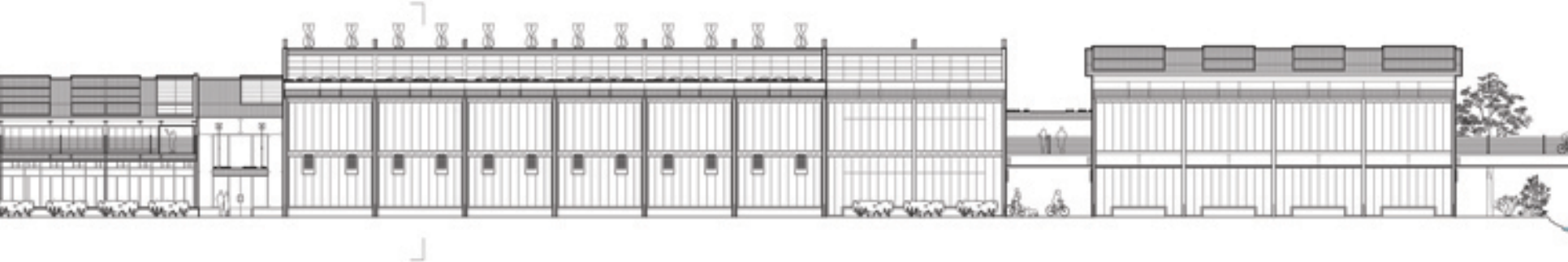
- Louvre & Venting Integrations
- 100% Recycled Steel

Profilit Structural Glass

- Primary & Secondary Structure
- Integrated Vent Control
- High Insulation Value (light transmitting nano-gel)

Photovo

- Alternative (solar)
- Integration



Elevation @ 1/16"=1'

ltaic Panels

Energy Resource

Throughout

Hydro-electric In-Stream Turbines

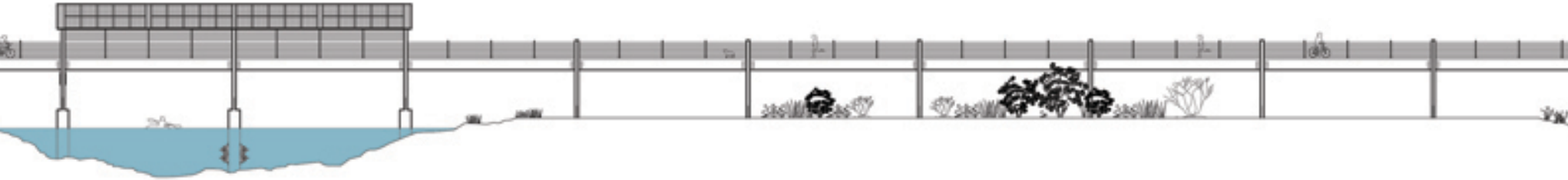
- Alternative Energy Resource (hydro-electric)
- River Integration

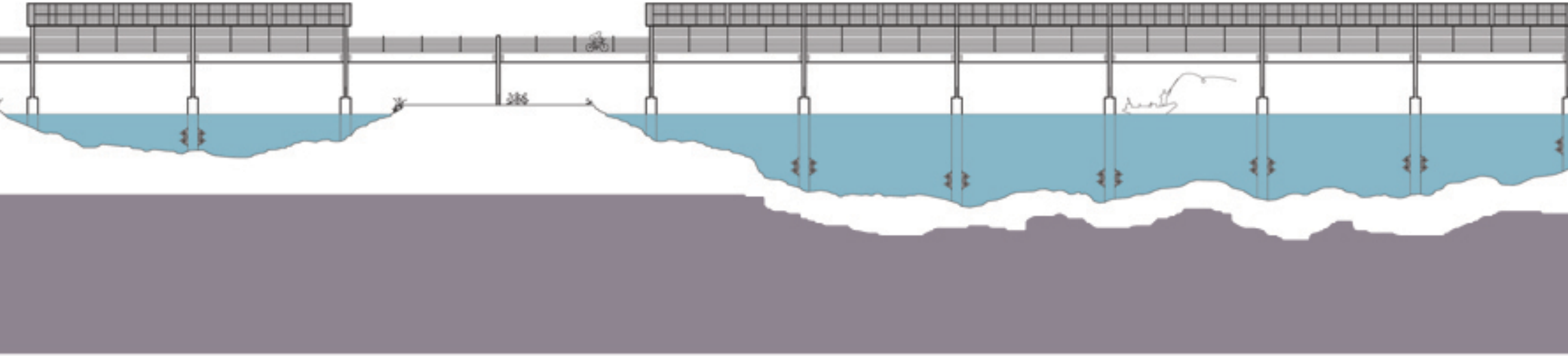
Living Willow Noise Abatement

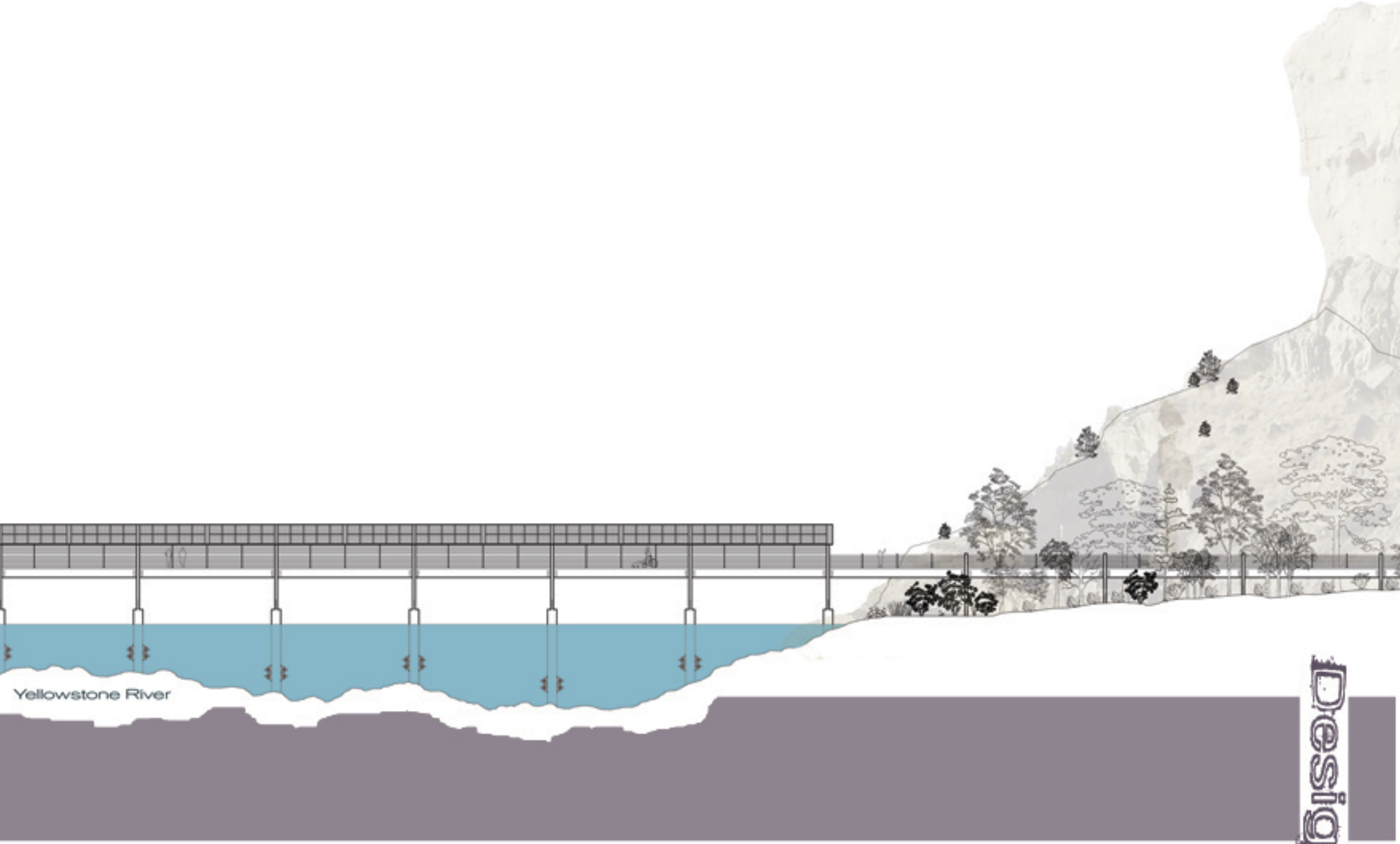
- Efficient Natural Noise Reduction (given proximity to Interstate 90)
- 100% Biodegradable

Integrated Graygraywater Systems

- Fire Suppression System
- Graywater Restrooms
- Site Irrigation





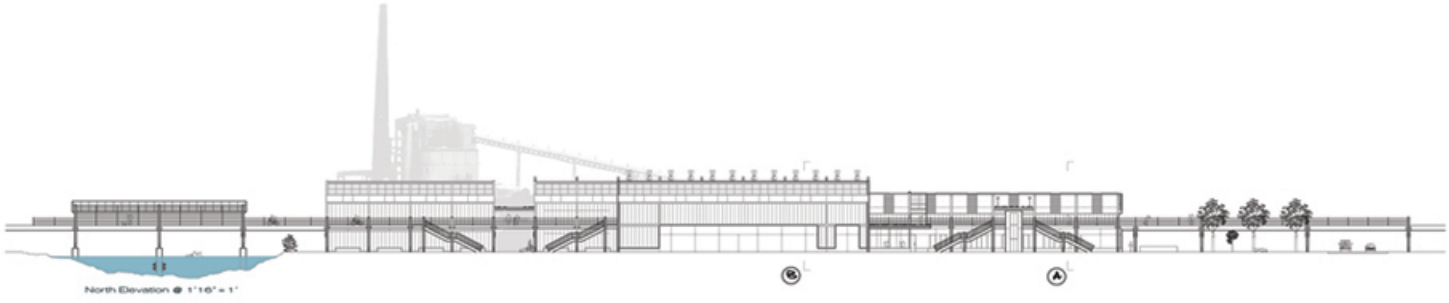


Design



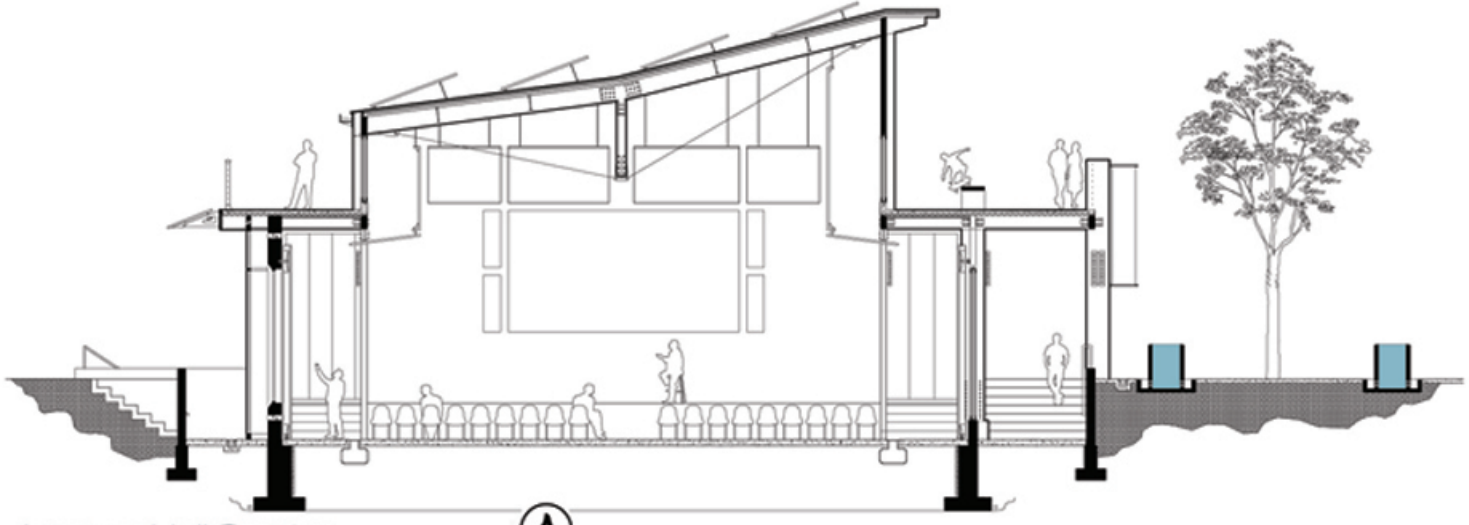
East Pedestrian Bridge Node

Design Development:

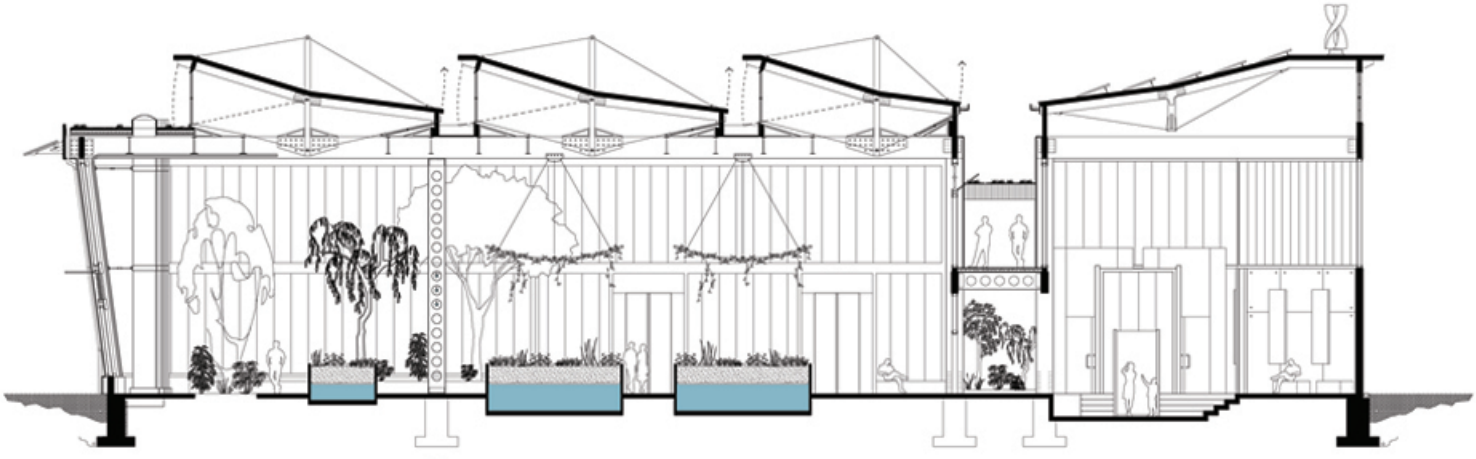






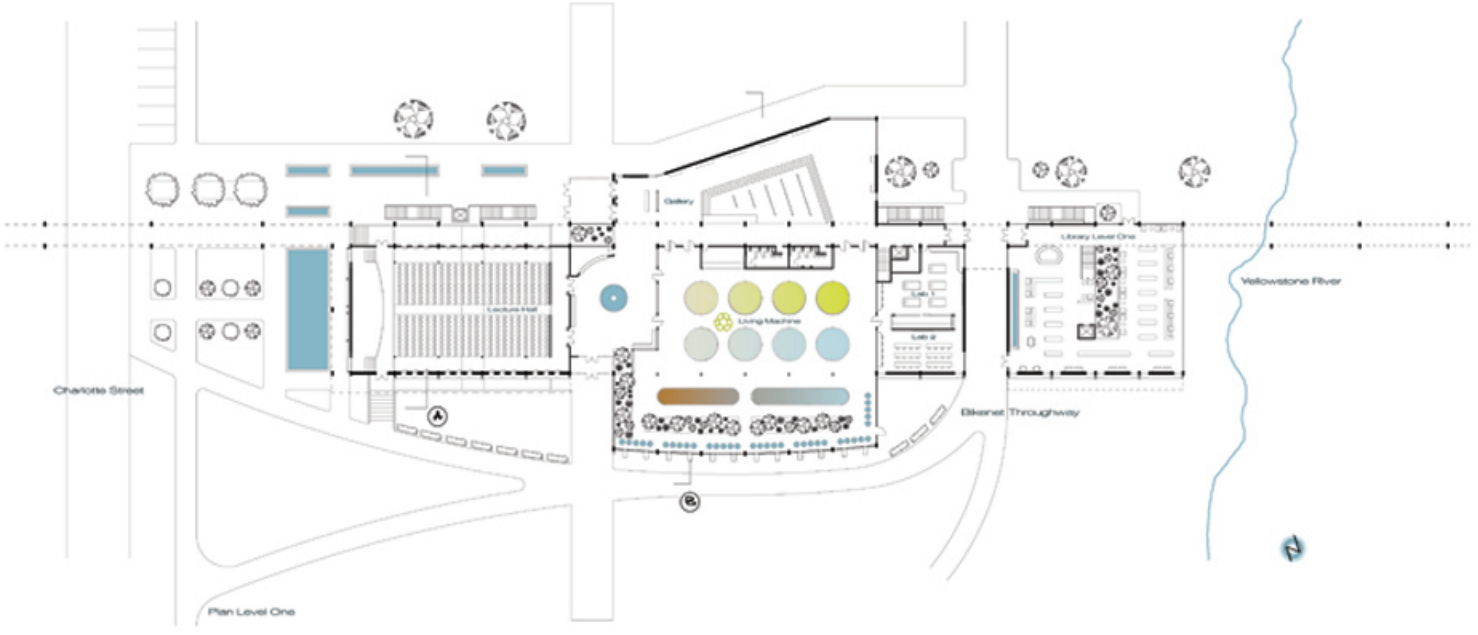


Lecture Hall Section

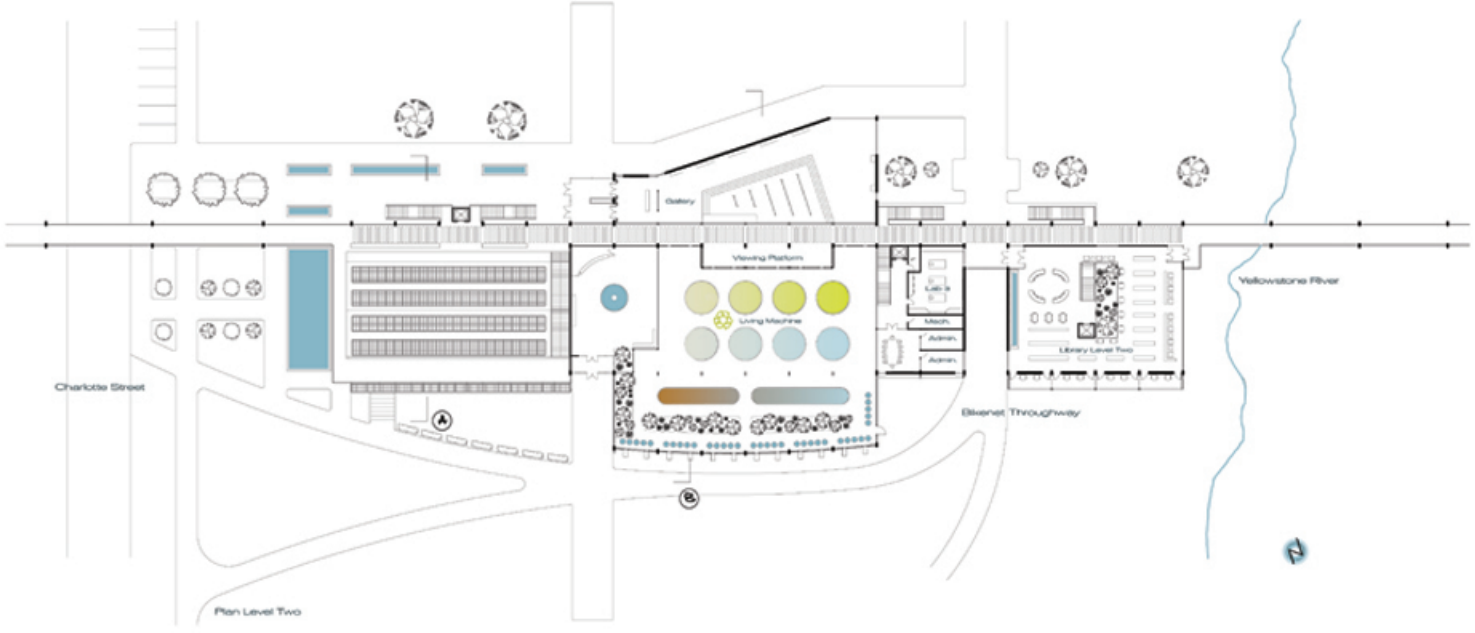


Living Machine Section

Design Development:



Design Development:



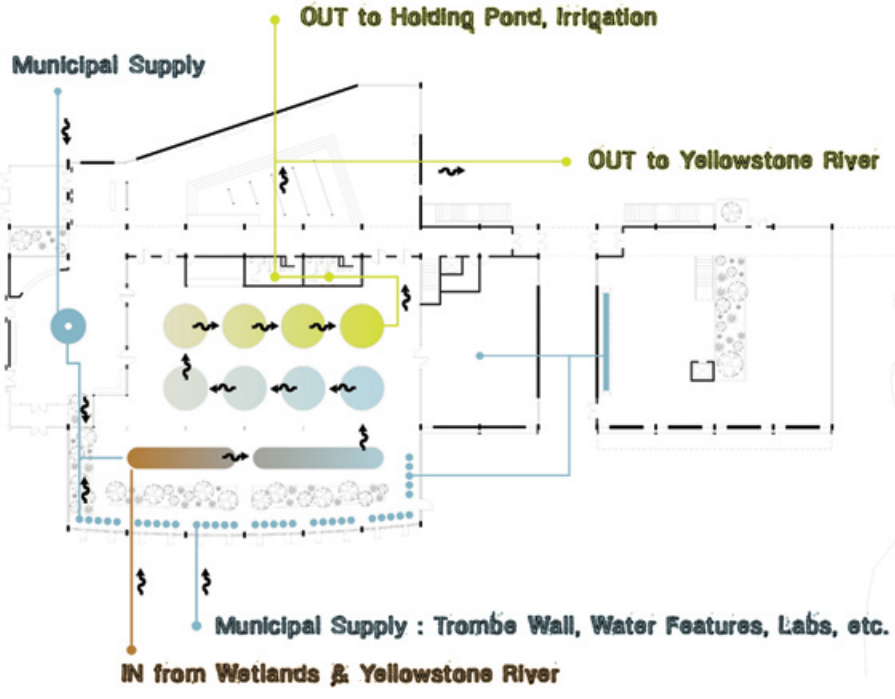
Design Development:



Exhibition Space Perspective

- Etched Glass Display Panels
- Boardform Flyash Concrete Walls
- Cork & Vertical Grain Bamboo Flooring
- Glulaminated Beams & Columns
- 100% Recycled Steel Smartbeams





Water Flow Diagram

Design Development:





Appendix A:

Interview: Vince Larson[52]

Credentials: Bachelors of Science in Petroleum Geology from Texas Tech.

Mr. Larson has 49 years experience operating in the oil industry and in those forty-nine years hea has worked on location in Southeast Asia, Alaska, Indonesia, Haiti and Singapore. Mr. Larson and his wife Louise have been residents of Billings, Montana for the past twenty years. The Larsons are also the former owners of the BLM lands on the shore of the Yellowstone River, opposite the site selected for the proposed Yellowstone Ecological Center for Observation. Mr. Larson's professional experiences, his ties to the Yellowstone Valley Citizens Council (a local organization that strives to improve the community and its people through clean air legislation, land preservation, land reclamation, wetland preservation, etc.) and his extreme proximity to the proposed site make him and invaluable consultant on the matters at hand.

Q. In your opinion, what kind of impact have PPL's (power plant) settling ponds had on the immediate environment (i.e. vegetation, wildlife, the Yellowstone River, etc.)?

A. Positive Impacts: None
Negative Impacts: They have created a riverbed problem. The manner in which the settling ponds were constructed (riverbank interruption) encroached on the Yellowstone River and consequently restricted the river's natural flow. It's also possible that this encroachment may be in violation of the Clear Harbors & Rivers Act. "What industry wants, industry gets, that's just the way it is."



[52]Larson, Vince. Personal Interview. 27 Oct. 2005.

Appendix A:

Interview: Vince Larson[52]

Q. Do you think a constructed wetland (in lieu of existing settling ponds) in conjunction with a high volume living machine and gray water irrigation system cannot only compliment the industrial nature of the region but rejuvenate the immediate Coulson Park as well?

A. Yes.

Q. Do you have any concerns or foresee any drastic complications in implementing a facility that utilizes solar energy as well as possible wind and hydro-electric energy on the specified site?

A. Concerning possible wind energy—yes. The Audobon Society has identified at least 80 species of birds in the general vicinity and wind turbines or a wind farm could interrupt the bird populations.

Q. Being a resident in the immediate vicinity of the proposed site, have you noticed any changes in the quality of air / water / general health of the area over the years?

A. Air quality has improved over the last 20 years due to EPA restrictions on SO2 output as well as actions taken by the Yellowstone Valley Citizens Council.



[52]Larson, Vince. Personal Interview. 27 Oct. 2005.

Appendix A:

Interview: Vince Larson[52]

Q. Can you see a facility such as the Yellowstone Ecological Center for Observation (Y Eco) becoming a cornerstone in our community as well as an educational icon for the world of tomorrow?

A. A facility such as this houses many educational aspects and possibilities for the community.

Q. Are you aware of any facilities of a similar nature and magnitude in operation or being attempted in the state of Montana?

A. To my knowledge, no.

Q. What complications, if any, do you foresee in including a pedestrian bridge that joins both Coulson Park and the state lands on the opposing shore of the Yellowstone River?

A. In reality it's impossible—the expense will not justify the means and liability issues will also arise. Hypothetically, it would be of great benefit to the public to have that kind of recreational access.



[52]Larson, Vince. Personal Interview. 27 Oct. 2005.

Appendix A:

Interview: Vince Larson[52]

Q. Do you believe that the citizens and patrons of Billings and its industrial facilities, are prepared to deal with the revolutionary nature of such a "green" and ecologically sound facility?

A. As long as the facility produces no additional pollution, both the industries and the public would likely be in favor of such a facility.

Q. Concerning the site's geology, do you foresee any road blocks or obstacles that may arise in the construction of such a facility? And if so, what would you suggest be prudent courses of action?

A. I have no immediate concerns. In my opinion, it would be a great improvement to Coulson Park.

Special thanks to Vince Larson for his time, enthusiasm, and input on the Y Eco? project.



[52]Larson, Vince. Personal Interview. 27 Oct. 2005.

Appendix B:

Correlating Energy Facts:[53]

- America uses about 15 times more energy per person than does the typical developing country.
- The United States spends about $440 billion annually for energy. Energy costs U.S. consumers $200 billion and U.S. manufacturers $100 billion annually.
- The United States is the world's largest single emitter of carbon dioxide, accounting for 23 percent of energy-related carbon emissions worldwide.
- Fossil fuels are depleted at a rate that is 100,000 times faster than they are formed.
- Though accounting for only 5 percent of the world's population, Americans consume 26 percent of the world's energy.
- In 1997, U.S. residents consumed an average of 12,133 kilowatt-hours of electricity each, almost nine times greater than the average for the rest of the world.
- The United States consumes about 17 million barrels of oil per day, of which nearly two-thirds is used for transportation.
- Only 7.5 percent of total U.S. energy consumption came from renewable sources in 1998. Of that total, 94 percent was from hydropower and biomass (trash and wood incinerators).
- Within 15 years, renewable energy could be generating enough electricity to power 40 million homes and offset 70 days of oil imports.
- Providing power for villages in developing countries is a fast-growing market for photovoltaics. The United Nations estimates that more than 2 million villages worldwide are without electric power for water supply, refrigeration, lighting, and other basic needs, and the cost of extending the utility grids is prohibitive, $23,000 to $46,000 per kilo meter in 1988.



[53]"Renewable Energy for a Sustainable Future, Energy Fact Sheet" Solar Energy International. 16 July, 2005. http://www.solarenergy.org/resources/energyfacts.html

Appendix B:

Correlating Energy Facts:[53]

- A one kilowatt PV system* each month:
  - o prevents 150 lbs. of coal from being mined
  - o prevents 300 lbs. of CO2 from entering the atmosphere
  - o keeps 105 gallons of water from being consumed
  - o keeps NO and SO2 from being released into the environment

- Solar water heaters offered the largest potential savings, with solar water-heater owners saving as much as 50% to 85% annually on their utility bills over the cost of electric water heating.

- A decrease of only 1% in industrial energy use would save the equivalent of about 55 million barrels of oil per year, worth about $1 billion.



[53]"Renewable Energy for a Sustainable Future, Energy Fact Sheet" Solar Energy International. 16 July, 2005. http://www.solarenergy.org/resources/energyfacts.html

Appendix C:

Correlating Water Facts: [54]

- Four quarts of oil can cause an eight-acre oil slick if spilled or dumped down a storm sewer.
- One gram of 2,4-D (a common household herbicide) can contaminate 2.6 million gallons (10 million liters) of drinking water.
- The average toilet uses 5 to 7 gallons of water per flush.
- A shower can use 25 to 50 gallons (5 gallons per minute)
- Just washing your hands can use up to 3 gallons of water (with tap running at 3 gallons per minute)
- Leaving the water running while you brush your teeth can waste 3 gallons of water (at 3 gallons per minute).
- Outdoor spigots can pump out 5 to 10 gallons per minute.
- Automatic dishwashers use about 15 gallons per load.
- Washing one load of clothes in an automatic washer uses about 45 gallons.
- The average bath takes about 36 gallons of water.
- The average individual uses about 125 gallons of water per day.
- An average residence uses 107,000 gallons of water per year.
- About 340 billion gallons of water are used every day in the United States. This total includes water used in irriga tion, in industry, and in fire fighting and street cleaning.
- It takes about 1 gallon of water to process a quarter pound of hamburger.
- A human can live more than a month without food but only as much as one week without water.
- Forty-eight million people in the United States receive their drinking water from private or household wells.
- There are 58,900 community public water supply systems in the US.
- Chlorine was first used in the United States to sterilize city water in 1908.
- It takes 1,500 gallons of water to process 1 barrel of beer.
- It takes 39,000 gallons of water to manufacture a new car, including tires.
- It takes about 800,000 gallons of water to grow an acre of cotton.
- Ten gallons of water are needed to refine one gallon of gasoline.



[54]http://www.h2o4u.org/facts.html

Image Index :

1. Cover Image PPL Power Plant – photo by Brad Kahler
2. Wind Turbines – http://renewableenergyaccess.com/assets/images/story/2006/1/30/1332_PPM%20use.jpg;jsessionid=alN_fa-_Fh56
3. Photovoltaic Panel – www.cleanenergy.de/companies/airtherm/FOTO/modul1.jpg
4. Conoco-Phillips Refinery – photo by Brad Kahler
5. Conoco-Phillips tank – photo by Brad Kahler
6. Oil Rigs and Cotton – http://www.bazarekar.ir/Picture/Industry%5Coil_ghir.jpg
7. Refinery by night – www.battelle.org
8. Seed Tree –http://www.ecologicaldesign.net/SEEDTREE.png
9. Green Sketch –http://www.ursispaltenstein.ch/blog//images/uploads_1/mitchell_joachim_design.jpg
10. Heron – http://www.oceanarks.org/wetlands/img/bird_in_system.jpg
11. Lily Pad –http://www.attra.org/images/wetlands/wetland.jpg
12. Rock of Change –www.30daysofsustainability.com/.../rock.jpg
13. Leaf Detail –http://www.bergerpartnership.com/images/broadleaf_backlit.jpg
14. Water Droplet –http://faculty.chml.ubc.ca/nellis/sustainability/waterdrop.jpg
15. Curvilinear Photovoltaic Panel – www.theglazine.com/Images26/SolarTecG8SHOWCA.JPG
16. Ecolinks Graphic – http://www.staenglengineering.com/images/ecolinks.jpg
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18. Tidal Wetland – www.dharmalivingsystems.com/ecological/restoration/
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21. Photovoltaic Panel – www.cleanenergy.de/companies/airtherm/FOTO/modul1.jpg
22. Coulson Park Plaque – photo by Brad Kahler
23. Coulson Park at Dusk – photo by Brad Kahler
24. Engine on Water – NA



Image Index :

25. Solar Sail – www.solarsail.ch/images/bild5.jpg
26. Dog Walker – www.killerorange.com/sites/ShaneCummings/walkingsun.jpg
27. Stroller – www.chariotcarriers.com/media/lifestyle/image_files/cx_jog_low.jpg
28. School Bus – www.adventurers.it/images/missouriny2000/School-bus.jpg
29. Bike on Bridge – www.dot.ca.gov/hq/TransEnhAct/Ribbon%20Cuttings/Pics/sac_biker_big.jpg
30. Amaco Refinery - www.bp.com
31. Post Remediation 1 –http://www.threecrownsgolfclub.com/
32. Post Remediation 2 – http://www.threecrownsgolfclub.com/
33. Merrill Center, Kayaks –http://www.cbf.org/images/content/pagebuilder/167438.jpg
34. Merrill Center Elevation –http://www.wbdg.org/images/utilizecost_1.jpg
35. Merrill Center Photovoltaics – http://www.cif.org/Nom2003/Images/photovoltaic.jpg
36. Chocolates 1 – www.groundswellarchitects.com/liv_mach_ethel.htm
37. Chocolates 2 – www.groundswellarchitects.com/liv_mach_ethel.htm
38. Chocolates 3 – www.groundswellarchitects.com/liv_mach_ethel.htm
39. Butterfly House 1 – www.groundswellarchitects.com/liv_mach_mosi.htm
40. Butterfly House 2 – www.groundswellarchitects.com/liv_mach_mosi.htm
41. Butterfly House 3 – www.groundswellarchitects.com/liv_mach_mosi.htm
42. Butterfly House 4 – www.groundswellarchitects.com/liv_mach_mosi.htm
43. Eden Project Green – www.edenproject.com
44. Eden Project Interior BW – www.edenproject.com
45. Eden Project Birdseye – www.edenproject.com
46. Eden Project Exterior Lit – www.edenproject.com
47. Eden Project Interior Lit – www.edenproject.com
48. Eden Project Sectional Model – www.edenproject.com
49. Eden Project Ventilation – www.edenproject.com
50. Bike on Bridge – www.dot.ca.gov/hq/TransEnhAct/Ribbon%20Cuttings/Pics/sac_biker_big.jpg



Image Index :

51. Stroller – www.chariotcarriers.com/media/lifestyle/image_files/cx_jog_low.jpg
52. Bikes on Path – www.cbs.umn.edu/eeb/graduateprogram/prospective/admission/bicyclists_sm.jpgjpg
53. Sacrifice Cliff (Billings, MT) – photo by Brad Kahler
54. Downtown Billings w/ Refinery in foreground – photo by Brad Kahler
55. Conoco-Phillips Refinery w/ Yellowstone River in foreground – photo by Brad Kahler
56. Site Context Map – www.terraserver.com
57. Traffic Context Map – www.terraserver.com
58. Conoco-Phillips Refinery w/ Yellowstone River in foreground – photo by Brad Kahler
59. PPL plant from opposing shore – photo by Brad Kahler
60. PPL and the Yellowstone River – photo by Brad Kahler
61. Coulson Park at Dusk – photo by Brad Kahler
62. Refinery from vacant lot on site – photo by Brad Kahler
63. Coal Conveyor – photo by Brad Kahler

64 – 67. Independent Photo Series for Site – by Brad Kahler



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