City of Burlington, Vermont Sustainability Pilot

Recommendations for Sustainable Infrastructure

Final Report

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FINAL REPORT

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Introduction

Vita Nuova LLC, subcontractor to SRA, an EPA contractor, is assigned the task of assessing plans for the redevelopment of the Moran Center at Waterfront Park, prepared by the Community and Economic Development Office (CEDO), Burlington, Vermont. The site was formerly an electricity generating facility, which included fuel storage tanks. The property was transferred to the Burlington City Council in 1986 and is considered a brownfield.

This Final Report summarizes consultant recommendations related to:

I Green infrastructure of the Moran Center site plan
II Green building design of the proposed Moran Building
III Wetland restoration and enhancement

These topics represent the primary assignment and opportunities listed in the Scope of Work (**Appendix A**). Recommendations in this report are based on the concept plans depicted in *Moran Center at Waterfront Park: Guide to the Redevelopment of the Moran Plant* (Ref. 1).

This report represents the outcome of several site visits and consultative discussions. Donald Watson, FAIA, CIP, Vita Nuova architect and planner, is author of Part I, Green Infrastructure, and Part II, Green Building Design. Eric Rothstein, M.S, Vita Nuova ecological engineer, is author of Part III, Wetland Restoration.

EPA brownfields program

EPA's brownfields program enables local communities to assess, clean up and revitalize key community properties through collaboration between relevant stakeholders. EPA's Brownfields Sustainability Pilots are intended to facilitate and encourage sustainable redevelopment of brownfields sites through technical assistance on sustainability practices. EPA defines brownfields sites as real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant.

Site description and environmental background

The Moran Center at Waterfront Park was formerly the generating plant for the Burlington Electric Department. Built in 1953, the plant was decommissioned in 1987 and has remained virtually vacant since that date. Prior to 1953 the site was used for a variety of industrial endeavors; including railroad and lumber mill uses, as well as the storage and transportation of petroleum and petroleum-related products. Currently the Community Sailing Center occupies a portion of the site.

Using EPA funds, the CEDO conducted Phase I and Phase II Environmental Site Assessments (ESA) on the site. The Phase II ESA indicated that Trichloroethylene (TCE) was detected in the soil, as well as in the groundwater, in the northern portion of the site. Various polycyclic aromatic hydrocarbons (PAHs) were found in the soil immediately to the south, north and northeast of the former Moran Plant. Investigation of the building interior revealed that lead paint was used while the plant was in operation. Asbestos was also found in the exterior window caulk, corrugated window panels and exterior roof flashing (Ref. 1).

Summary of recommendations

This report outlines recommendations for green infrastructure and green building design. It serves as guide to the schematic design of the Moran Building and as a longer-term guide to development of the site.

The schematic design for the Moran Building is in the very early phases. This presents an opportunity to commit the project to a model of sustainable design for both the building and the site. Tenant requirements may indicate opportunities for energy and resource efficiency. The tenant "plug load" and utility requirements establish the demand for energy and resources (water and waste services). These figures are needed for any specific recommendations related to achieving LEED™ rating.

The Moran Center at Waterfront Park proposal focuses on green design amongst many project objectives. These objectives include "green focused and environmentally friendly" and "utiliz[ing] the highest standards in energy conservation and green building construction" (Ref. 2). Going forward it will be helpful to define green goals explicitly in terms that can be used to measure design alternatives—energy and water savings, low environmental impact and carbon footprint reduction. The LEED rating system provides one measure of performance. This and related measures of green building and site design are discussed in this report.

The primary recommendations of this report are represented by three goals:

VISITOR DESTINATION: A visitor destination has to meet very high standards to attract use from within and beyond the community (and thus build economic development) and to succeed as a destination for mixed uses appropriate to the site's wateredge location. Green goals in site and building features help "brand" the site as a location worth visiting and supporting.

COST-EFFECTIVE GREEN INFRASTRUCTURE & SITE PLAN OPPORTUNITIES: Many cost effective and environmentally beneficial elements of green design are in landscape and site infrastructure. In addition, many measures reduce the cost of infrastructure construction and maintenance. "Green infrastructure" represents the best design and management opportunities for the site.

COST-EFFECTIVE GREEN BUILDING OPPORTUNITIES: Energy-efficient building design and operation must be identified through the integrated design process. Daylighting and integrated HVAC and passive architectural features, such as sun-tempering and natural ventilation, are promising and cost-effective options.

Green infrastructure and green building design will help establish the Moran Center at Waterfront Park and its tenant partnerships as a leading model of sustainable design.

Three overarching goals of green design

The objective of sustainable design, or green design, is to enhance and sustain a high quality of community values and environmental health in the design and construction of built infrastructure, transport, landscape, and buildings. Sustainable design applies the principles and practices of resource conservation and renewable energy design.

In the General Services Administration (GSA) publication *Sustainability Matters*, sustainable design goals are defined as, "reduc[ing] consumption of non-renewable resources, minimiz[ing] waste, and creat[ing] healthy, productive environments. Such an integrated approach positively impacts all phases of a building's life-cycle, including design, construction, operation and decommissioning" (Ref. 3).

The practices of sustainable design have been communicated to design professionals and the public through a number of checklists and performance standards. Two of the most well-known are *The Sustainable Sites Initiative: Guidelines and Performance Benchmarks* and the U.S. Green Building Council's *LEED™ Checklist for New Construction* (Ref. 4 and Ref. 5).

The Sustainable Sites Initiative represents a high quality standard in site planning through water conservation, stormwater management and surface covering and landscape that cleans and restores water quality. This document is the best reference for site planning and landscape design.

The U.S. Green Building Council's LEED Rating System defines the basis for rating environmental performance of buildings and systems. It emphasizes energy design analysis and building commissioning and is recommended for architectural design and construction.

The Sustainable Sites Initiative and the LEED Rating System require that planning and design incorporate (1) an integrated design process and (2) a well-defined program plan with explicit environmental performance goals.

In an "integrated design process" all design and engineering specializations are incorporated early on in the program and design decisions through an iterative process. Initiating the process early in programming and design has the greatest potential for program efficiencies and cost reduction. In this process, all consulting architects and engineers develop integrated design concepts (building envelope, mechanical systems, lighting, controls, maintenance, and operation) and typically use simulation models of energy performance to compare alternatives.

Through a "well-defined program plan with explicitly environmental performance goals," environmental performance standards are quantified and measured, with commitments to exceed "minimum code compliance." These items are used to assign points and establish the building's rating. The performance goals become benchmarks of evaluation of schematic design choices and all subsequent reviews of design, including building commissioning.

Sustainable infrastructure goals
The following goals are proposed for the Moran Center (program, site and building) for the purposes of framing recommendations put forward in this report:

Goal 1
Design of the Waterfront Center should meet very high standards of service to succeed as a destination for mixed uses appropriate to the site's wateredge location.
The waterfront development's goal of serving as a regional (and national/international) attraction establishes a very high level of service in traffic circulation, parking, pedestrian safety, and accessibility. Investing in a high level of visitor service and amenities is recommended in order to establish and "brand" the site as a highly attractive tourist and community attraction.

Goal 2
Design and management of the site and landscape should represent the best design and management practices of environmental and water resource protection.
The Moran Center Waterfront Development is proposed as a site for public recreation and waterfront appropriate businesses. The development of the site will employ green guidelines to protect and enhance Burlington's unique cultural and natural resources. The site plan and park maintenance should demonstrate "best practices" of riparian and wetland restoration, watershed management, stormwater retention, and water conservation. EPA has created a series of publications that document the cost effectiveness and viability of green infrastructure (Ref. 6).

Goal 3
Energy-efficient and resource-efficient building design and operation must be identified through an integrated design process.
The Moran Building reuse presents special challenges due to its historic elements. A particular challenge is the restoration and preservation of its brick exterior. This decision alone can increase construction and operational costs more than any other efficiency measure. The investment in adaptive reuse of the building is itself a "greening strategy" and should serve as a model for the City of Burlington.

The economic viability of energy-efficient design and operation must be assessed in terms of the current and projected electric-generation rates. The City's electric power is generated from a wood-burning power plant, ostensibly a renewable resource, which contributes to greenhouse gas emissions (albeit, less than coal). The peak production limit to the plant's generating capacity is during summer daytime peak. When the peak is reached, a back-up power plant next to the Moran Building is placed in operation at great cost and, reportedly, at great disruption due to noise and pollution. As a result, a prime objective of energy conserving measures is to reduce (and eliminate) summer daytime peak-hour demand.

The energy requirements of the proposed Ice Factor operation have great influence on the energy-efficient design and operation of the Moran Building. There are possible heat recovery opportunities from the ice making operation in winter, as well as shaving peak-hour loads for its operation in summer. These are as significant on building operation and performance as any of the other opportunities defined by the LEED checklist. The Ice Factor has received recognition in Europe for its environmental operations, which indicate that as an "anchor" tenant, its participation can positively contribute to the green goals of the Waterfront Plan.

Part I - Green Infrastructure

The terms "sustainable infrastructure" and "green site design" describe water resource protection concepts that are combined with public services, including roadways, parking, walkways, lighting, and stormwater networks.

Green infrastructure features in site planning are cost effective and in some cases less expensive than conventional landscaping. They provide the appropriately high level of appearance and service required for sustainable tourist and public venues. For many maritime centers, the green (and blue) infrastructure is promoted as the core theme of the venue.

In addition to citations listed in Ref. 6, **Appendix B** provides a glossary of representative green infrastructure practices, with definitions and references.

Preliminary recommendations for designing green infrastructure as part of the Moran Center Waterfront Plan are shown in **Appendix C, Plates 00-05**. The recommendations are based on review of the "Draft Conceptual Site Plan of Moran Center at Waterfront Park," depicted in the *Guide to the Redevelopment of the Moran Plant.*

- **Plate 00 Site Zones and Parcels**
- **Plate 01 Phase I plan**
- **Plate 02 Long Range Plan**
- **Plate 03 Roads and Parking**
- **Plate 04 Pedestrian Walkways**
- **Plate 05 Tree and Bioswale Plan**

Plate 00 illustrates how the following principles of sustainable infrastructure could apply to the entire Waterfront Center site.

NATURAL AND CULTURAL CONSERVATION

- Restore and protect shoreline buffer and wetland zones
- Remediate/reuse valued site and building features

SAFE ROAD AND WALKWAY INFRASTRUCTURE

- Place access road and parking at the periphery for minimal intrusion
- Separate vehicular, bike and pedestrian circulation

WATER RETENTION AND FILTRATION

- Use porous paving and tree structural cells to reduce runoff
- Create ponds for water retention and recreational uses

SITE MAINTENANCE

- Use native planting to minimize watering and mowing
- Limit salting and sanding of roads and walks
- Practice recycling

PROGRAM

- Promote watershed education/demonstrations
- Provide long-term options for program additions

Plates 01-05 illustrate recommended practices of sustainable infrastructure in the following ways:

- Traffic and parking are at the periphery, in order to protect and restore the site for appropriate wateredge uses.
- The lakefront is a continuous car-free pedestrian zone, connected to bikeways and trails.
- Planted swales and water-retaining cells (structural soil cells) at tree basins store rainwater for native tree and plant landscaping.
- A pond basin—a scaled version of Burlington's waterfront across Lake Champlain—is the focus of a civic garden.
- The pond provides water retention and offers all-season uses, including ice-skating, water play and a model boat basin.
- The entire waterfront site demonstrates best practices of watershed and park management.

The recommendations incorporate the following elements of green infrastructure (see **Appendix B** for definitions and web resources):

- **Riparian buffers/wildlife corridors**
- **Native planting**
- **Alternatives to pesticide use in landscape maintenance**
- **Alternatives to salt use for de-icing**
- **Reconstructed wetlands**
- **Tree planting/urban forestry**
- **Structural soil cells**
- **Porous paving**
- **Bioswales/rain gardens**
- **Water art and play features**
- **Rainwater harvesting**

Discussion of green infrastructure illustrated on Plate 00.

Buffer zone and setbacks preserve, protect and enhance the 100-foot buffer, as a minimum, along Lake Champlain and around the restored wetland (see Section III of this report for description of this restoration). The paved parking area along the lakefront to the west of the Pump Station deserves remediation to prevent non-point pollution from paved parking and to extend the vegetated buffer area planting and bioswale. A vegetated buffer along the shoreline (ideally approximately 100-feet wide) serves to absorb and filter rapid storm runoff into the lake in conformance to “best practice” riparian buffers. Sand and salt used on roads eventually finds its way into watercourses. Filtration of runoff from paved areas is especially desirable to reduce sand and salt infiltration into the lake.

An access road located at the periphery in accordance with long-established park planning principles to minimize site intrusion of traffic. There is one-way traffic flow with drop off to Moran Building. The proposed programs for the building include “peak arrival and departure” events of busses and cars, for which the one-way flow provides space for drop-off and pick up without undue delays. Each parking area provides option for one-way flow towards the exits. Exit turns are right-hand turns and minimize cross traffic intersections.

Surface parking is grouped near the site entrance and planted with trees and landscape in order to create a “green oasis.” Combined surfacing for parking (porous pavers and/or gravel and grass) and trees with structural soil cells hold stormwater runoff. The CEDO *Guide to the Redevelopment of the Moran Plant* indicates that surface parking was rejected for aesthetic reasons in favor of a structured parking garage. This decision should be revisited; structured parking normally costs four to six times more than surface parking per parking unit. An appropriately placed and accommodating parking “green oasis” can be created with structural soil cells allowing more abundant tree planting within surface parking.

A pond basin with a naturalized edge is shown on the west of the Moran Building as a suggestion for a water play feature. At the center of the entire site, it affords all season uses, including skating for winter, water spray play in summer and a model boat basin in other seasons. The model boat basis can supplement the Green Mountain Children’s Museum programs. Both winter sunshine and wind protection is highly desirable for use of outdoor areas for exposed waterfront locations. By placing this feature on the east of the Moran Building, it can capture sun while enjoying wind protection in the winter. It also creates a welcoming public face to the Moran Center and provides for traffic drop-off, accessible parking and queuing for high attendance events.

Pedestrian safe zone: The provision for parking and pedestrian connections, handicap accessible parking and simultaneous bus drop-off and pick-up, with traffic and circulation flow, is consistent with a high level of service for public visitor venues. The areas for parking can be phased without disrupting the basic car and pedestrian flow.

Long-term expansion and options: Master planning for sites must provide the maximum number of options for future program expansion. This expansion area is indicated to the north of the Moran Building. Additional expansion should be provided to the north if possible. This is recommended because maritime venues, in particular, have expansion requirements as programs grow and/or additional related venues are attracted to the site. For a maritime center, for example, outdoor areas for boat storage and renovation are a very typical need/opportunity.

Currently, the proposed regeneration of a potential wetland is indicated. This would normally be an attractive program feature for an environmental education center, including programs for the

Green Mountain Children's Museum. However, if it were to be made a truly viable wetland, the space requirements, including a minimum 100 foot setback, and protected/regulated buffer, would limit expansion of the site for its primary program—maritime venues. Given this choice, preserving the area north of the site for possible longer term maritime use expansion appears to be the better option to achieve long-term economic viability of programs.

This does not prevent the skillful integration of a shoreline strip within an approximately 100 foot setback to be developed and protected as naturalized and vegetated buffers. This ensures that both the natural and cultural features of the site are recognized and strengthened.

Connection to waterfront, open space and nature trails: Remediation of the buffer alongside Lake Champlain creates opportunities for the enhancement of waterfront recreation and education programs for the Community Sailing Center, the Ice Factor and the Green Mountain Children's Museum. Direct connection to the natural landscape and open space to the north adds value for programs related to all of the tenant operations. There are several locations for the bike path. The Site Plan indicates one option, along the access road, which has the advantage of the most direct bike route to the extension north of the property, with crossings at each driveway where there are car stops. Service and emergency right-of-way access is provided to all areas, including the lakefront.

Part II - Green Building Design

Green building design concepts worth considering in the present schematic design are illustrated on **Plate A1 Plan** and **Plate A2 Section**.

Integration of architectural and technical options for long-term building structure and tenant requirements must be included in the schematic design in order to identify cost reductions through conservation, program efficiencies and shared heating and cooling opportunities.

The following recommendations (highlighted on the 1st Floor Plan, **Plate A1**) address functional requirements of the three tenant operations currently anticipated and those that may be required in the future:

- Controlled access to the three separate areas of the building, with separate arrival and departure areas in order to avoid conflicting circulation flow.
- All outdoor walkways, from handicapped drop-off to public entries, must be maintained free and clear of ice and snow at all hours of public use. For this reason a covered portico is indicated at the main entry. Wet floor conditions in public circulation walks and hallways require special attention to materials, finishes and maintenance requirements.
- The south patio/deck, with trellis shading and easy indoor/outdoor access and outdoor gathering, creates an orientation area for the Community Sailing Center and similar lakeshore programs.
- Easy indoor/outdoor access from the Green Mountain Children's Museum to the protected outdoor courtyard. The area to the north requires cover for outdoor terrace patio uses in inclement weather. Access and view to the lakeshore are provided for sunlight and orientation to the lake, as well as for nature program activities to the north.
- Direct visual supervision and access control from the Green Mountain Children's Museum drop-off and departure to the receptionist desk for security, safety and convenience of children and parents. This requirement is normally a mandatory requirement for similar facilities.

- Controlled access and departure from the Ice Factor.
- Public access to the interior, including bathrooms, should be considered for public safety and maintenance, based upon staff and leasing agreements.

The following green design recommendations are highlighted on **Plate A2**. These recommendations are for consideration, subject to details of mechanical requirements of the tenant spaces and operations. The natural lighting options reduce and possibly eliminate electric lighting during daylight hours. The practicality of utilizing return airflow in preheating the plenum/greenhouse variations is subject to mechanical engineering design.

Atrium design
Plate A1 Plan and **A2 Section** indicate a narrow atrium running the entire length of the central hall, which accommodates the stairwell. Two options are shown on **Plate A2**, *Atrium with Skylight and Plenum* (top), and a "stretch idea," *Atrium below with Roof Terrace Greenhouse* (bottom). In both cases, the atrium offers natural lighting and ventilation.

Natural lighting
The skylight configuration shown in the upper section of **Plate A2** utilizes a relatively small glazed area (**B**) augmented by reflection from the vertical wall (**C**).

- *Atrium geometry* bounces and diffuses southern light off of the masonry wall. Atrium sky lighting utilizes a relatively small glass area to capture direct and reflected daylight. An alternative to a glass skylight is translucent insulated plastic panels, such as Kalwall or equal. In the stretch concept, adding adjustable reflective fabric panels can reflect the sunbeam to the lower floors and function as an insulating curtain at night.
- *Natural lighting of other areas.* There is significant exterior wall area facing south, which creates an opportunity for controlled natural lighting. Natural lighting is indicated for the Ice Factor space (**H and I**). Increasing daylight (from many directions and sources) in the Ice Factor space will increase visual acuity and safety. The Green Mountain Children's Museum occupies the darkest location, in terms of natural light. This is alleviated by a skylight strip (**J**) and translucent patio roof (**K**).
- *Sky lighting* **(H and J)** *and windows* **(I**) using translucent insulated panels (Kalwall or equal) can provide full natural lighting for the Ice Factor space. Small openings are indicated (**G**) to admit south light to the Ice Factor. This allows small beams of sunlight for light variability and balance.
- *Light shelves* **(O)** provide shading and reflected ceiling light, sufficient to provide full ambient daylight for an area up to a 30-foot perimeter zone. Light shelves added on the outside of a building—while ideal both for effectiveness as reflectors and for control of summer shading—are costly and a concern for ice damage. Venetian blinds offer a similar light reflective and sun control option.
- *Sun control and insulation of the atrium skylight*. In the lower cross section of **Plate A2**, greenhouse option, a variation of shading and sunlight controls is indicated as **S** (applicable to either option). These can be a reflective fabric that is tilted on a monthly schedule to reflect direct sunlight vertically to the lower floors and closed for summer shading and for winter night insulation.

Natural ventilation
Combining the vertical air plenum with mechanical ducts allows preheating and heat recovery during winter (and summer periods) and whole building ventilation in summer (when natural air ventilation could be supplemented by solar-electric powered fans).

- With warm air provided by sun tempering of the vertical plenum, natural ventilation flow is vertical and is further assisted by mechanical ventilation. A photovoltaic array (**E**)

provides summer peak-load power (ventilation fans and refrigerant pump loads).
- In summer, the air is exhausted to the outside. In winter, the return air can be recalculated, with fresh air added to the air stream. An alternative is to use Energy Recovery Ventilation (ERV) to recover some of the heat by flywheel transfer to the incoming fresh air stream.
- Depending on mechanical engineering, heat can be recovered from the ice making machine to top-off the heated air stream and/or a heat pump can supplement the difference.
- Warm air delivered to the perimeter can assist in moisture condensation control.

Greenhouse (R)
Indicated in the lower section on **Plate A2**, a standard greenhouse can serve as a skylight and ventilator, as well as provide a productive growing area on the roof terrace. It could also be used as a garden conservatory event space. In addition, the costs may be comparable to other options (e.g., green roof, insulation, special skylight glazing).

Energy-efficient mechanical heating and cooling
As mentioned throughout the discussion above, energy design options have to be evaluated in terms of mechanical requirements of tenant spaces. This allows identification of opportunities to reduce summer peak operation and to use heat reclamation where possible. Air conditioning requirements should be kept to minimum and possibly eliminated by natural ventilation. Summer cooling requirements for the Ice Factor and the Green Mountain Children's Museum are possibly minimized by location on the north of the building and proximity to lakeside breezes. Thermal mass of the existing structure assists in reducing cooling requirements, especially if insulated on the outside of the structure.

Heat reclamation from ice making may (or may not) be a significant opportunity. Mechanically controlled airflow to the exterior wall will be critical for moisture and condensation control and occupant comfort. As a result, air exchange requirements may dominate. In most conventional uses, creating a vertical flow atrium for air circulation and utilizing heat from the return airflow is a significant energy conserving strategy. Such applications can utilize the solar assist via a south facing air plenum (an air space behind an insulated translucent panel such as Kalwall or equal).

In any case, radiant heating of the Green Mountain Children's Museum may be a very desirable amenity to create a warm floor for children activities. This provides floor zone comfort without having to fully heat a high ceiling space.

Increasing insulation levels beyond those required by code would be advisable in most cases in order to reduce reliance upon fossil fuels. Fuel combustion efficiencies are achieved with modular gas boilers. Wood pellet boilers utilize a renewable resource but do not significantly reduce carbon emissions. Heat pump options utilizing lake water may be efficient, depending on demand and special requirements.

The special requirements of the Ice Factor as an anchor tenant could overrule any aspect of the above outlined recommendations. The unpredictable variability of tenant requirements (over the life of the building structure) makes any definitive design only conjecture. In the case of many tenant uses over the life of the building, easy fit-up and variable options are the dominant requirements.

Reduction of carbon footprint
Carbon footprint tracking presents, for many organizations and municipalities, an entirely new set of issues over and above the familiar terms of energy conservation. To meet international goals

for reduction of carbon and related greenhouse gas emissions, agreed upon at the 2008 United Nations Climate Change Conference in Bali, there is increasing attention to reducing greenhouse gas (GHG) emissions and carbon footprint. In building and site operation maintenance, this translates to reduction and possible elimination of fossil fuel and other greenhouse gas emitting sources, including wood as a fuel.

Carbon emissions data for the power plant operated by Burlington Electric Department are available on the web from the Carbon Monitoring for Action (CARMA) at www.carma.org. The plant uses a mix of sources, principally wood-pellets (wood waste), a greenhouse gas-emitting biomass fuel source, with approximately 25% hydro and 6% of fossil fuels. At a future date, carbon capping may impose additional costs to electric generation, sufficient to dictate energy conservation measures at a regional power scale.

There are similar and larger efficiencies to be addressed in both energy conservation and carbon footprint production in all aspects of municipal and business operations. They may be subject to "cap and trade" regulatory requirements. GHG emission reporting and reduction could be required within a few years.

Three "scopes" of GHG emissions are typically reported. The first two are generally required by most reporting programs, while the third is optional.

Scope 1 - Emissions from company-owned or controlled equipment (e.g., power generation, boilers, furnaces, vehicles). Emissions from physical or chemical processing.

Scope 2 - Emissions from the generation of purchased electricity (emissions from both transmission and distribution), gas and fuel used in company operations.

Scope 3 - Indirect emissions, excluding those already included in Scope 2 (e.g., employee commuting/travel, leased assets, waste disposal). The variability of considerations in this scope is the reason that it is optional. Nevertheless, a good rationale for reporting on such activities is that this scope might identify "easy wins" from which to start emission reductions.

Of the sustainable infrastructure and green building features recommended above, the following represent easily implemented and cost effective means to accomplish the combined goals of reducing fossil fuel energy sources and carbon footprint:

- Curtailing landscape maintenance through reduction and elimination of lawnscape that requires regular mowing (and in some cases pesticides) and replacing large lawn areas with native planting.
- Replacement of gas-fired mowers and blowers with electric options.
- Gravity flow stormwater infrastructure with retainage basins, rain gardens and structural soil cells for trees and planting areas.
- Passive design for natural lighting, sun tempering and ventilation to reduce HVAC and electric lighting requirements.
- Photovoltaic panels for electric generation, especially to reduce and eventually eliminate need for peak-power plan operation.

Notes

The following notes respond to initial queries posed in correspondence prior to the site visit.

Insulating the brick walls from the interior poses special concerns in order to prevent moisture from condensing within the wall structure. Cost competitive insulation strategies (the level of insulation in walls and roof) have to be compared with various mechanical system requirements.

Due to special uses (Ice Factor), ventilation may be a dominant energy requirement, rather than insulation. If production of ice and water vapor generates interior moisture in a way similar to that of indoor gymnasiums and swimming pools or water parks, then the insulation strategy, as well as ventilation, will be dictated by these special concerns, Interior moisture must be ventilated so that it does not condense within an inaccessible wall or ceiling cavity. All potential paths for thermal bridging (and moisture freeze and thaw in isolated locations) have to be accounted for, to prevent mold, rust, moisture freeze/thaw, and structural and aesthetic damage. After the Ice Factor program and operation criteria are documented and HVAC options are configured, the various insulation strategies can be evaluated. This can be done with computer simulations that represent local climate and building loads.

There appears to be little advantage to the green roof as proposed in the Concept Plan, *Guide to the Redevelopment of the Moran Plant***.** The roof area is small and has little site impact, especially when compared to the lower cost opportunities in landscape design (in terms of reducing and/or deferring site impact of stormwater flow).

Any insulation or evaporative cooling advantages of a green roof diminish to zero as insulation values of the roof and ceiling envelope are increased. At the same time, the roof surface is a viable "green opportunity" due to its exposure on the south side of the building.

The "stretch idea" recommendation on **Plate A1** proposes a greenhouse or conservatory. A factory-standard single-glazed greenhouse could provide the same winter insulation and summer shading advantage as a green roof and would provide a climatically and economically viable use.

Part III – Wetland Restoration

Existing wetland conditions were assessed in a report produced by Heindel and Noyes, titled "Former Moran Plant, Burlington, Vermont, Wetlands Report, January 31, 2006" (Ref. 8). Vita Nuova's assessment, as well as this report, are intended to complement the Heindel and Noyes Report. Vita Nuova's task was to complete an initial evaluation of the restoration/enhancement opportunities for the wetland area. Vita Nuova's evaluation is based on a field visit on October 23, 2008, conversations with CEDO staff, and background reports.

Determining perspective and defining enhancement and restoration - general

Within the field of ecosystem restoration, there are a wide range of definitions for "restoration" and "enhancement." In its strictest definition, restoration is defined as returning an area to its condition prior to human development and impacts. This narrow definition of restoration is typically partnered with the term "enhancement," which is defined as improvements to an ecosystem. "Improvements" to an ecosystem are most commonly associated with improved habitat value, but can also be associated with water management capabilities and educational opportunities. For this report, a more liberal definition of restoration will be applied. Restoration will be viewed as a return of habitat value following a human disturbance. This definition is especially applicable to the Moran Center wetland site (wetland site) as it was historically part of Lake Champlain. "Restoration" and "enhancement" will heretofore be used interchangeably.

When planning a wetland restoration at a redevelopment site, it is useful to take into account the many perspectives that make up a typical design team. This paper considers four perspectives: (1)

the Ecologist, (2) the Engineer, (3) the Planner/Developer, and (4) the User. Considering these different perspectives helps to outline parallel goals, as well as identify competing interests.

Ecologist

The ecologist perspective focuses on maximizing habitat value. Habitat value can be improved on multiple scales: (1) within the restoration footprint; (2) within the restoration footprint and adjacent habitats; and (3) on a regional level. Within the project footprint, the typical goal is to establish the greatest diversity of native species that attract native fauna. When factoring in adjacent habitats, the goal is to maximize ecosystem function between the restoration site and existing, adjacent habitat. For example, many native faunal species require more than one ecosystem during their life cycle. When evaluating a target species' needs (a species that is considered in the restoration process as a preferred user of the restored habitat) the restoration specialist first evaluates habitat components that are present in adjacent areas and then focuses on establishing habitat components that best fill-out the essential requirements to support a species. On the regional level, an ecologist attempts to complement the regional ecosystems by creating a specific habitat niche and/or considers the geographical placement of a restoration. An example of this would be restoring a foraging area for migratory birds in a stretch of the flyway far from other foraging grounds.

Engineer

The engineer perspective focuses on making changes to the wetland that assist in meeting infrastructure goals and often regulatory requirements for a site. This usually takes the form of modifying a wetland to maximize its stormwater management capabilities. Storage volumes are typically maximized, especially the extended detention volume—the volume between the base water volume during dry periods and an overflow structure. The process includes better defining outfalls from wetlands, including a low flow orifice that determines the base water level in the wetland and the rate that stormwater can be released, in addition to an overflow to control flows when the wetland reaches its full capacity. Plant selection focuses on species' capacity to filter water, as well as their tolerance of sudden changes to water levels.

Developer/Planner

The developer/planner has two primary focuses: (1) having agreement between the restored wetland and the programming needs for the larger site and (2) weighing the costs and benefits from an overall site investment perspective. If wetlands are impacted as a result of the larger site development, frequently a third focus is added—a regulatory requirement to restore wetlands on a site. For programming needs, at a minimum, the developer/planner avoids detracting from the larger site. Typical concerns include mosquito breeding, bad odor, drowning hazard, and public safety concerns if wetland vegetation creates secluded areas. All of these concerns can be mitigated with proper design. From a value-add perspective, the developer/planner seeks programming from the restored wetland. This can take the form of nature trails, interpretive trails and educational and stewardship programs. From a cost perspective, the developer/planner seeks to minimize wetland construction costs and/or avoid conventional engineering costs for stormwater management. Minimizing soil removal in the wetland design, particularly contaminated soil, leads to maximum cost savings.

User

The user, similar to the planner, focuses on obtaining a positive experience. In urban areas, this frequently takes the form of what people refer to as "getting close to" or "back to nature." This includes strolling along a nature trail with interpretive signage, youth nature programs, stewardship programs where volunteers plant and maintain an area, among other activities. Unintended uses must also be considered in the design process. Measures need to be taken to prevent dogs from entering restored wetlands and viewing areas from becoming secluded gathering points when the area is closed to the public.

The foundations of ecosystem formation and restoration - general

While habitat value is typically assessed by species composition within wetlands, restoration design must focus on the underlying foundations that support a biodiverse ecosystem. The three most critical interrelated elements are: soil condition, hydrologic regime and light conditions. When restoring a wetland, a designer should not only seek to establish the optimal conditions for the plants they select. Ecosystem restoration is as much about designing *FOR* something as it is designing *AGAINST* something. Therefore, the designer should seek to establish site conditions that give the desired plants the competitive advantage over invasive, exotic species.

Soil

Most dominant, invasive, exotic wetland species found in Northeast United States thrive in disturbed soils that are high in nutrients and have a high pH. Such soils are typical at fill sites, like the Moran Center site. High pH is frequently a product of construction debris, specifically concrete, acting as a parent material. Nutrient loading in excess of concentrations typically found in nature have a multitude of causes in developed areas. Urban runoff that reaches wetlands can carry nutrient rich sediments from eroded areas within the watershed, as well as nutrient rich lawn fertilizer and bird and dog fecal matter. Additionally, fill soils can include nutrient rich sediments from dredged areas or scraped topsoil from upland zones. To counter these conditions, soil should either be replaced or amended to lower the pH (5.0 to 6.5) and nutrient levels in order to give the competitive advantage to native species. The degree of practicality of this approach is highly site specific. If soils only require amending, additional costs would not be significant in terms of the entire budget. An example of such an amendment would be the addition of pine mulch to reduce pH. Importing of clean soils becomes more expensive. Actual costs are dependent on required soil depth and distance between the soil source and site. The most expensive alternative occurs when soils need to be removed from a site. The costs associated with soil removal are dependent on the soil quality, depth of removal and distance to disposal location. Soil removal can account for upwards of 80% of project budgets.

Hydrology

Under ideal conditions, fluctuating water levels within wetlands leads to a diversity of vegetation zones—open water, floating leaf aquatics, deep water emergents, shallow water emergents, floodplain species, upland transitional species, and upland species. Creating such zonation requires hydrologic evaluations that insure that water levels will fluctuate throughout the growing season in a predictable and controlled manner. When all or most of these zones are present and have a multitude of native species, habitat value is high. However, when water level fluctuations are drastic, biodiverse zonation can be replaced with a monoculture of invasive exotic species that are better adapted to unnatural water level fluctuations. Significant water level fluctuation, for example, can lead to an area that supports emergent plants in one month and upland transitional species the next month. By controlling one or both boundary conditions (the low water mark and the high water mark), proper zonation can be established. If necessary, a float system can be installed to trigger lake water input during drought periods, thereby setting the lower boundary condition. Such a system would require a float in the wetland that triggers a pump in Lake Champlain when water levels are approaching minimal allowable depth levels. The same float would trigger a pump shut-off once proper water levels were re-established. By controlling water levels, a diverse range of planting zones may be established.

Light regime
Varied light conditions across a site, from full sun to full shade, can lead to increased biodiversity as different native species have the competitive advantage under different light conditions. Full sun conditions favor the greatest variety of native wetland species. Alternatively, native wetland tree species can be used as a canopy stratum, resulting in shaded areas that can be enhanced with native understory species. In the Northeast United States, native wetland tree species include, but are not limited to, swamp white oak (*Quercus bicolor*), pin oak (*Quercus palustris*), red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), river birch (*Betula nigra*), black willow (*Salix nigra*), and green ash (*Fraxinus pensylvanica*). During the design phase, all species should be evaluated for the specific climate constraints and localized pest risk, such as ash borers and Asian longhorn beetles.

Choosing a design direction - site specific
Considering the aforementioned perspectives and foundations, Vita Nuova began initial design discussions with CEDO staff on October 23, 2008.

Identifying key components
The existing wetland zone comprises two basic ecosystem types: (1) a willow (*Salix sp.*) dominated forested zone to the north and (2) a *Phragmites australis* zone to the south. Because the willow area is dominated by native species, conversations regarding restoration focused on the *Phragmites australis* dominated areas. Additionally, there was discussion regarding the potential for encroachment into the southern portion of the wetland to fully realize the programming planned for the redevelopment of the site.

Combating Phragmites australis
Phragmites australis eradication without altering soil, hydrology or light conditions would require intensive long-term maintenance, including annual herbicide treatment in perpetuity. *Phragmites australis* monocultures form dense rhizospheres that partially persist despite multiple herbicide treatments. In theory, a multi-year *Phragmites australis* eradication program, coupled with establishment of 100% cover of native wetland plants, could be successful. In practice, however, restorations completed in soil, hydrologic, and light conditions that favor *Phragmites australis* fail. Therefore, it is recommended to alter at least one primary factor (soil, hydrology, light regime) that is conducive to *Phragmites australis* growth.

Phragmites australis, especially an established stand, can tolerate a wide range of hydrologic conditions, from free water to upland conditions. Taking this into consideration, changing the hydrologic regime to eradicate *Phragmites australis* was eliminated as an option.

Excavating the top three feet of soil and replacing it with low nutrient, low pH soils in conjunction with an initial herbicide treatment and dense, spring planting of native wetland species would be a technically feasible way to restore the wetland. The majority of the rhizosphere would be removed under such a strategy and new soil conditions could be created that would favor native species. However, in initial conversations, this option was eliminated due to cost concerns. While not having been tested, the soil likely exceeds soil clean-up standards and would be considered hazardous. Between excavation, transport and disposal costs of existing soils, in addition to transport and placement of clean soils, costs on a soil-based solution would likely exceed $750,000 per acre of restoration.

The final alternative for sustainable eradication of *Phragmites australis* at the site is to shade it out. The best strategy for achieving this alternative, while improving habitat value, is to **establish**

a swamp forest ecosystem. In discussions with CEDO, this alternative was selected for further exploration as the preferred option, should CEDO decide to use the location for ecosystem restoration. Some potential design and construction procedures for swamp forest restoration are discussed below in addition to preliminary cost estimates.

The competing interest
In this report, Vita Nuova recommends and puts greater emphasis on the ecologist's perspective (creating habitat) rather than the engineer's perspective (using the wetland as a water management tool). Under ideal conditions, all design perspectives are addressed. However, at the Moran Center site, the ecological perspective and engineer's perspective yield competing interests—habitat value versus water management. It should be noted that by constructing flow control structure(s) that directly connect the wetland to Lake Champlain, the wetland could be designed as a stormwater management system that takes site runoff and both improves water quality and flow rates leading to Lake Champlain. This alternative, however, would prohibit significant improvements to the wetland's habitat value without radical changes to the soil conditions, which were already deemed too expensive by CEDO. Therefore, restoring a swamp forest in the wetland was selected as the preferred restoration alternative. CEDO has emphasized that all perspectives will be considered for the final site plan and that there is no commitment at this time to completing ecological restoration at the site.

General procedure for designing and constructing a swamp forest at the site

Feasibility analysis
Prior to completing a conceptual design, the following three elements should be further investigated. The investigations will inform the design process through documenting existing conditions. With this knowledge, proper soil specifications can be developed and flow control measures can be sized. In severe cases, soil test results can lead to the requirement of remedial efforts prior to any restoration development:

1. **Test soil for human and ecological health constraints:** A successful restoration leads to increased use of a site by both people and animals. To ensure that restoration does not become an attractive nuisance (the technical term for a site that is restored but leads to human and/or animal contamination), the soils should be tested for potential contamination. A qualified engineer would develop a sampling plan and the actual sampling and testing would be conducted by a state certified laboratory. The sampling plan should be approved by all regulatory agencies prior to sampling. A complete screening would include testing for volatile organic contaminants, semi-volatile organic contaminants, organic pesticides/herbicides and PCBs, and heavy metals. It should be noted that these are not the same tests that would be required for removing soil from the site. This review assumes that no soil is to be removed from the site. Should an alternative be developed that includes soil removal, the Toxic Characteristic Leaching Procedure (TCLP) would need to be used for soil testing. A TCLP is used for characterizing waste for the determination of disposal requirements. The test determines what can leach from soil (and would need treatment at a landfill) rather than what is actually contained in the soil.

2. **Test soil for horticultural constraints:** The soil should be tested to determine its qualities as a planting medium. Testing should include, but not be limited to, pH, nutrients, and salinity. The results of the testing will help determine what soil amendments are required and/or what plant species will thrive at the site.

3. **Water level data:** According to CEDO and its consultants, water levels in the wetland are directly linked to the fluctuating water levels in Lake Champlain. Water levels should be recorded and tied to a land survey of the wetland area. Groundwater monitoring wells will be required. Lake levels should also be recorded to determine the relationship between the hydrologic regime in the wetland and the Lake. The results will help with proper plant species selection and also help to determine if soil elevations will require manipulation in the wetland area and/or a direct overflow connection should be constructed between the wetland and Lake Champlain.

Conceptual/schematic ecosystem restoration design phase
While the feasibility analysis determines site constraints that guide the design process, investigations and work in the conceptual/schematic design phase are more qualitatively driven. The primary steps are:

1. **Complete a survey:** The land survey will serve as the foundation for the eventual design plans. All investigations should be tied to the survey, including soil sample locations, groundwater well locations, existing vegetation mapping, etc.

2. **Develop an existing vegetation map:** One central tenet of ecosystem restoration is to prioritize the preservation of good habitat elements prior to enhancing or restoring. A thorough vegetation map should be completed and tied to the survey. Any areas deemed to have high habitat value should remain intact to the greatest extent possible.

3. **Study a reference site:** At least one reference site should be selected to guide the restoration design. The reference site should share as many of the site's characteristics as possible, including soil conditions, hydrology, light regime, and climate, and ideally be within the same watershed as the site. Equally as critical, the reference site's ecosystem should share as many similarities with the site's desired ecosystem—a swamp forest. The reference site study should help to inform the selection of plant species for the restoration.

4. **Target species determination:** Target species are animal species that restorations are designed to attract. The restoration's planting plan will include species that provide foraging and/or breeding grounds for the target species. Animal species that are rare or endangered due to habitat loss are typically selected as target species. Many species require multiple ecosystem types throughout their life cycle. Restorations can be designed to provide an ecosystem type that is the limiting factor to a species' survival in a region.

5. **Development of the initial planting plan:** Based on the feasibility and other studies, the ecosystem designer would develop an initial design and plant list.

Design development and construction documents
Following production of the schematic design plans, the designer must prepare documents that focus on implementation. The design development and construction document phases also provide an opportunity for client review and revisions.

These two phases typically represent at least half of the designer's work. The plans will need to include a sheet for existing conditions, a demolition plan, a planting plan, and any and all details, including, but not limited to, a waterfowl exclusion fence, individual plant installation, overflow weir(s), and erosion control practices. Additionally, a specification must be written that details each and every element of the design. It is typical that each item in the specifications book is included in the bid document to potential contractors. This helps determine cost changes during construction due to under or over runs on items.

There are two alternatives to development of construction documents. First, the project can be completed as a design-build, meaning that one entity is responsible for both design and construction. Design documents do not require significant details when one entity is responsible for all elements. When the designer and contractor are de-coupled, a greater level of detail in the construction documents is required to both inform the contractor and determine culpability should the restoration not be successful. Design-builds are useful in reducing design costs. The drawbacks include a limited pool of designers and contractors for a competitive bid process and lack of opportunity to release the firm for poor performance following completion of the design work without incurring significant additional re-design expenses.

A second alternative would be to complete the project as a community-based restoration project. This alternative would significantly increase design costs, as the designer would be the lead on organizing volunteers and directing fieldwork. Construction costs would be significantly decreased. One such project was conducted at an abandoned concrete plant on the Bronx River, Bronx, New York.

Schedule and staging

The following is an ideal schedule for a swamp forest restoration. Alternative scheduling is also possible:

1. **First summer and autumn:** *Phragmites australis* eradication. *Phragmites australis* should be eradicated to the greatest extent possible. The best way to eradicate *Phragmites australis* is a three step process: (1) apply herbicide in the early growing season; (2) cutting in mid-summer to weaken the plant; and (3) autumn herbiciding. Autumn is when the plants maximize the transport of resources from the above ground biomass to the below ground biomass to store over winter.

2. **Second season:** (1) All detritus from the previous season should be cut and removed in early spring. (2) During the dormant period, trees should be planted. (3) Throughout the growing season, all weed species should be cut, pulled or spot herbicided to provide full sun to the trees. (4) Additional trees should be planted in the fall to replace any dead specimens. The species selection should be based on the survival rates of the spring plantings.

3. **Third through sixth season:** Weeds should continue to be removed throughout the growing season. This should be completed until the trees have reached a closed canopy condition and produce a shaded condition throughout the restoration site.

4. **Seventh and eighth season:** With the achievement of full canopy, native, shade-tolerant understory herbaceous plants and shrubs should be planted in order to maximize habitat value and biodiversity. Under fortunate circumstances, these species will naturally establish. Under unfortunate circumstances, non-native, shade-tolerant species establish. An adaptive management plan should be developed to address these issues and determine the proper course of action.

Estimated budgets

The estimated budgets below require many assumptions including, but not limited to, soil is not to be removed from the site and no soil is to be brought to the site. Estimates are on a per acre restored basis.

Separate designer and contractor: approximately $295,000 per acre

I. **Design:** $79,000 per acre

A. Feasibility: $16,000
1. Soil testing: Assumes 8 samples per acre and no composite sample. Includes in-field soil sampling, laboratory testing and analysis of results. $10,000
2. Groundwater monitoring: Assumes installation of 10 wells per acre, specialized drilling equipment, monitoring plan, data collection, and synthesis. $6,000

B. Conceptual and Schematic Design: $23,000
1. Survey: $3,000
2. Vegetation mapping: $5,000
3. Reference site evaluation: $5,000
4. Target species evaluation: $2,000
5. Initial site and planting plan development: $8,000

C. Design Development and Construction Documents: $40,000
1. Design Development: Includes existing plan, removals plan, planting plan, detail sheets, and draft specifications. $20,000
2. Construction Documents: Includes finalizing existing plan, removals plan, planting plan, detail sheets, specifications book, and bid document. $20,000

II. **Construction:** $216,750 per acre

A. Season 1: $10,000 (*Phragmites* control)

B. Season 2: $145,500
1. Clearing: $3,000
2. Tree planting: Assumes 2 gallon containers, 3 feet on-center, planted, $25 per tree, and 5,000 trees. $125,000
3. Weeding: $5,000
4. Additional tree planting: Assumes 10% mortality, $25 per tree, planted, and 500 trees. $12,500

C. Seasons 3, 4, 5, and 6: $20,000 (Weeding, $5,000 per season)

D. Seasons 7 and 8: $41,250 (Understory plantings)
1. Herbaceous plugs: Assumes 2 feet on-center, planted, and 2 inch plugs. $30,000
2. Shrub plantings: Assumes 10 feet on-center, planted, 2 gallon pots, $25 per shrub, and 450 shrubs. $11,250

Design-build: approximately $275,000 per acre
This option is the same as the separate designer and contractor, except the construction documents are eliminated.

Community volunteer and stewardship restoration organized by designer: approximately $230,000 per acre

I. **Design:** $59,000 per acre

A. Feasibility: $16,000
   1. Soil testing: Assumes 8 samples per acre and no composite sample. Includes in-field soil sampling, laboratory testing and analysis of results. $10,000
   2. Groundwater monitoring: Assumes installation of 10 wells per acre, specialized drilling equipment, monitoring plan, data collection, and synthesis. $6,000

B. Conceptual and Schematic Design: $23,000
   1. Survey: $3,000
   2. Vegetation mapping: $5,000
   3. Reference site evaluation: $5,000
   4. Target species evaluation: $2,000
   5. Initial site and planting plan development: $8,000

C. Design Development: $20,000
   1. Design Development: Includes existing plan, removals plan, planting plan, detail sheets, and draft specifications: $20,000

II. Construction: $170,500 per acre

A. Season 1: $10,000 (*Phragmites* control, contracted out and not completed by volunteers)

B. Season 2: $124,000
   1. Designer organizing, education programs and field leadership. $65,000
   2. Clearing volunteer day: $1,000
   3. Tree planting: Assumes 2 gallon containers, 3 feet on-center, planted, $10 per tree, and 5,000 trees. $50,000
   4. Weeding, 3 volunteer days: $3,000
   5. Additional tree planting: Assumes 10% mortality, $10 per tree, planted, and 500 trees. $5,000

C. Seasons 3, 4, 5, and 6: $12,000 (Weeding, $3,000 per season, including organizing)

D. Seasons 7 and 8: $24,500 (Understory plantings)
   1. Herbaceous plugs: Assumes 2 feet on-center, planted and 2 inch plugs, including organizing. $15,000
   2. Shrub plantings: Assumes 10 feet on-center, planted, 2 gallon pots, $10per shrub, and 450 shrubs, plus organizing. $9,500

References cited

Ref. 1
Waite Environmental Management, LLC
Phase II Environmental Site Assessment Report, Moran Generating Plant
May 17, 2005

Ref. 2
City of Burlington Vermont Community & Economic Development Office (CEDO)
Moran Center at Waterfront Park: Guide to the Redevelopment of the Moran Plant
Revised January 7, 2008.

Ref. 3
Government Services Administration (GSA)
Sustainability Matters
www.gsa.gov/sustainabledesign
2008
This reference is the first comprehensive overview by a federal agency related to sustainable design of building, operating and maintaining facilities, including six case studies.

Ref. 4
American Society of Landscape Architects, et al.
The Sustainable Sites Initiative: Guidelines and Performance Benchmarks
Public Comment Draft, 2008
This report focuses on measuring how a site can protect, restore and regenerate ecosystem services and benefits provided by natural ecosystems such as cleaning air and water, climate regulation and human health benefits. This report defines prerequisites and credits for site development process from selection to landscape maintenance.

Ref. 5
U.S. Green Building Council
LEED™ Checklist for New Construction
LEED Document #3998
Version 2.2, issued 2008

Ref. 6
Environmental Protection Agency (EPA)
Green Infrastructure Municipal Handbook
www.epa.gov/npdes/greeninfrastructure/munichandbook.cfm
2009
Four Handbooks include Funding Options, Retrofit Policies, Green Streets, and Rainwater Harvesting.

Ref. 7
SRA International/Vita Nuova LLC
Comparative Analysis of Maritime Centers
Report prepared for Bay City MI Maritime Heritage Center.
July 2008
This reference lists business and program data for over forty maritime centers and museums.

Ref. 8
Heindel and Noyes, Inc.
Former Moran Plant, Burlington, Vermont, Wetlands Report
January 31, 2006

Reference to comparable examples

Beczak Environmental Education Center
Yonkers, New York
Restoration of prior industrial piers for wetland creation.
www.beczak.org/contactus.htm

Save the Sound
Providence, Rhode Island
Restoration of prior industrial waterfront to naturalized buffers.
www.savebay.org

Morgan Building Harvard Business School
Cambridge, Massachusetts
Narrow atrium/light shaft with adjustable sun reflector at the apex.
www.hbs.edu/about/visit.html

Dynamo House
Providence, Rhode Island
Waterfront power plant redevelopment (hotel and museum).
Project Website - http://www.thedynamohouse.com/
Museum Website - http://www.heritageharbor.org/
News Article from Jan. 18, 2009 - http://www.projo.com/news/content/DYNAMO_HOUSE_01-18-09_K3CVEB4_v72.3aca12b.html

Appendix A

Statement of Work
for
City of Burlington, Vermont Sustainability Pilot

The following statement of work details the activities to be conducted by Vita Nuova under contract with the EPA for an assessment of the Moran Center project at Waterfront Park, in Burlington, Vermont. Vita Nuova will work closely with the City of Burlington, the A&E firm selected by the City, as well as other parties involved in the redevelopment effort. Vita Nuova proposes to complete a **Sustainable Infrastructure Plan** for the brownfields redevelopment of the power plant and associated contaminated wetlands.

Task 1: Review existing data and development plans
Vita Nuova will complete a review of all design documents and other materials associated with the Moran Center project, including the "Guide to the Redevelopment of the Moran Plant." This will include reviewing all conceptual plans, all potential energy features, and all sustainable features related to the site and power plant building.

Task 2: Conduct on-site project assessment
Vita Nuova will visit the site to continue the assessment process. A Green Architect and Ecosystem Engineer will visit the site to assess potential for integration of sustainable infrastructure and wetlands restoration on the brownfields site. Vita Nuova will work closely and coordinate with the A&E firm selected by the City. During a guided site assessment, Vita Nuova will confer with representatives of the Burlington Community and Economic Development Office and other local contacts as well as view the site and building for sustainable restoration potential. The basis for the assessment will be the "Green Building Plan" as outlined in the "Guide to the Redevelopment of the Moran Plant."

Task 3: Analyze options
With a comprehensive overview of the project based on the site visit and the review of existing plans and associated documents, Vita Nuova will evaluate different options that can contribute to sustainable redevelopment of the site and the long-term success of the project. These include:

- Sustainable energy features
- Green building features
- Stormwater, landscape, and site design elements
- Contaminated wetland restoration
- Green finance- reduction of costs due to improvement in performance of green features.

Whenever possible, Vita Nuova will emphasize proven technologies, provide a cost benefit analysis for the recommendations made, and will include product specifications (cut sheets, operations and maintenance histories, references, etc.)

Task 4: Review Conclusions with Client

Vita Nuova will review the options identified in the previous task. In addition to explaining the details of different options, Vita Nuova will capture feedback from the client in order to more effectively produce a Final Report. Vita Nuova may do this in a conference call or webinar.

Task 5. Complete Final Report

Deliverable: Final Report –Sustainable Infrastructure Plan for the Moran Brownfields Redevelopment Site

The Report will consist of analysis and recommendations in support of the goals and objectives of the project, to include all related energy and environmental opportunities in site and building remediation and renovation. Items to be reviewed include: sustainable energy features, green building features, stormwater, water quality and landscape details, site design for sustainable transportation and linkage to downtown, proposed building uses, program opportunities presented by community and tourism programs, other sustainable community requirements, long-term property management and promotion of green features. Green elements will be prioritized in terms of cost and promise to demonstrate lessons that can be replicated. The Final Report will also outline guidelines for restoring contaminated wetlands.

DELIVERABLES	**DATES**
Site Visit	Within one month of receiving all background documents or notices to proceed from SRA.
Analysis Completed	One month from Site Visit
Review Analysis with Client via Conference call or Webinar	Within two weeks of Analysis Completion
Final Report	Within two weeks of Conference call

Appendix B

Appendix B lists the features of sustainable infrastructure, with definitions and web-based resources. Each of the features may be considered in a comprehensive approach to sites and building integration.

Riparian buffers/wildlife corridors

A **riparian buffer** is a landscaped area, planted or left natural, alongside streams, ponds and wetlands. A buffer strip to preserve water quality is typically, at minimum, 100-feet wide. Where species protection is appropriate, larger buffer areas are required. The buffer preserves the stream's natural characteristics, protects water quality and improves habitat for plants and animals on land and water. It filters sediments, nutrients, and chemicals from surface runoff and shallow groundwater. The buffer holds water, allowing percolation to deeper water aquifers, replenishing groundwater supplies. Wateredge buffers also provide **wildlife corridors** for animals and plants. Birds and other animals find protective cover, water, food, and nesting sites and pathways between areas. Native plants require continuous areas to extend their reseeding. For resources on buffer zone design, see www.nrcs.usda.gov/FEATURE/buffers.

Native planting

A cost-effective measure to reduce municipal costs and improve environmental benefits is to replace traditional lawn planting and maintenance with native planting. Native planting conserves water and eliminates the need for pesticides and chemical fertilizers. Native plants grow well together—they evolved growing along side one another—and to predictable sizes. They do not need watering (except during initial planting), nor do they require chemical fertilizers or any of the commercial biocides, herbicides, insecticides, and fungicides. They are adapted to local conditions and resistant to local insects. In contrast, manicured lawns and bark-mulch beds (typical of commercial landscapes) rely upon synthetic chemicals, pesticides and fertilizers. Additional negative impacts of traditional landscape include noise and air pollution from lawn cutting, exhaust fumes and air-borne chemicals. Mowers emit 10-12 times as much pollution as a typical auto, string trimmers 21 times and blowers 34 times. See www.nps.gov/plants.

Alternatives to pesticide use in landscape maintenance

Part of watershed management is to reduce pollutants from stormwater surges, especially those that flood lawn and agricultural areas that carry fertilizers, chemical pesticides and other toxins into adjacent water bodies. Reducing and eliminating the source pollutants increases the effectiveness of native planting, riparian buffers and access to water for recreation. Extensive web-based resources include www.epa.gov/pesticides and www.nrdc.org/health/pesticides/.

Alternatives to salt use for de-icing

The common practice of salting roadways for snow-ice melting creates significant harmful pollution of surface and groundwater, with negative effects on the environment, human health and groundwater systems. Salt may attract deer, increasing accident hazards. The abrasives—sand, gravel, pumice—are acceptable but messy and degrade to dust, which can create low visibility conditions and make dry roads slippery. Studies by Vladimir Novotny, Northwestern University, address these alternatives. See www.epa.gov/owm/mtb/ice.pdf.

Reconstructed wetlands

A wetland is an exquisitely complex biological system that cleans water and air, provides a natural sponge for varying water flows, and an ideal habitat for wildlife, that in and of itself offer natural means of insect and pest control. An appropriate vegetation design is needed in order to optimize hydraulic behavior, water quality improvement and biodiversity. Moderate vegetation density does not hinder the flow, but rather increases the dispersion number. A proper design must avoid hydraulic short-circuiting and provide a good distribution of the flow, especially in the vegetated zones. Reconstructed wetlands can be part of a nature park, available to schools for science-based educational programs and available to the entire community for passive recreation. A portion of the wetland can be connected to innovative wastewater treatment. See www.epa.gov/owow/wetlands/wqual/bcproc.htm.

Tree planting/urban forestry

Trees are indicators of a community's ecological health. When trees are large and healthy, the ecological systems that support them—soil, air and water—are also healthy. Healthy trees provide valuable environmental benefits. The greater the tree cover and the less the impervious surface, the more ecosystem services are produced. This reduces stormwater runoff and increases air and water quality, storing and sequestering atmospheric carbon and reducing energy consumption due to direct shading of residential buildings. An ideal design strategy is to combine urban parking with porous paving water storage, which allows trees to have sufficient water without a large soil bulb. For discussion of benefits of urban trees, see www.walkable.org/download/22_benefits.pdf.

Structural soil cells

Structural soil cells are modular interlocking plastic frameworks placed around landscaped tree roots, originally developed by Dr. James Urban, landscape architect. The cells provide support for paving and contain soil and loose aggregate to store water for urban tree root systems. They are commonly used to create a "green oasis" for parking and streetscapes. They permit closer spacing of trees and use less soil while also directing stormwater to tree roots. There are a number of reference examples. See www.toronto.ca/environment/pdf/james_urban and www.deeproot.com/pdfs/PNW_Trees_article.pdf.

Porous paving

Porous pavement allows rainwater to seep through the surface to a subsurface layer, where it may be absorbed into the ground or stored. This increases groundwater recharge, reduces pollutants in stormwater runoff, and helps alleviate flooding and contamination to streams. Porous pavement is a permeable pavement surface with a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating into the subsoil. Porous pavement often appears the same as traditional asphalt or concrete, but is manufactured without "fine" materials, and instead incorporates void spaces that allow for infiltration. This is ideal for low traffic, parking areas and walkways. In extremely dense urban areas, porous pavement has been used in redevelopment projects, where it treats and stores stormwater without consuming extra land. Porous pavement can also be used on individual sites where a parking lot is being resurfaced. See www.epa.gov/OWM/mtb/porouspa.pdf.

Bioswales

A bioswale is a landscape swale designed as a water filter in order to remove silt and pollution from surface runoff water. It consists of a swaled drainage course with gently sloped sides (less than 6%) and is filled with vegetation, compost and/or riprap. It is typically planted with hardy grasses and moisture-tolerant plants and wildflowers. The water's flow path, winding within the wide and shallow ditch, is designed to maximize the time water spends in the swale, which aids in the trapping of pollutants and silt. Plants act as biofilters, removing phosphorous, soil sediments and other pollutants. Several classes of water pollutants may be arrested with bioswales: silt, inorganic contaminants, organic chemicals and pathogens. Water leaving a bioswale is cleaner than when it came in. See www.ia.nrcs.usda.gov/news/brochures/bioswale.

Rain gardens
A variation of a "bioswale" is a rain garden. A rain garden is a natural or shallow depression designed to capture and soak up stormwater runoff from roofs or other impervious areas around buildings, driveways, and walkways, including compacted lawn areas. Rain gardens can be used as a buffer to wateredge buffers and shoreline areas in order to capture runoff from the landscape before it enters a lake, pond or river. The rain garden is planted with suitable trees, shrubs, flowers, and other plants, providing bird habitat and a natural filter for runoff to soak into the ground and protect water quality. There are many websites on the topic. See, for example, dnr.wi.gov/org/water/wm/nps/rg/index.htm.

Water art and play features
Conferees discussed means by which water can become an aesthetic, recreational and educational amenity, in addition to managing water flow from sky to ground. Puddles, spray bottles, garden sprinklers, water tables, and wading pools naturally fascinate young children. Water is one of the basic raw materials for learning mathematics and science, developing language and fostering social skills. While playing with water is developmentally appropriate regardless of the child's age or abilities, family members and caregivers should always consider safety factors when children are anywhere near water. Children can enjoy water play with great abandon, but adults need to be aware that young children can drown in less than an inch of water.

Water for fountains, sculpture courts and elements of community landscape provide opportunity to reveal water as a living element. In most instances, such water can be recycled, provided that concerns of public health are address where water is touchable. Water is an effective means of climate conditioning. A spray fountain in a public space can reduce temperature to comfortable levels. Water sprays are increasingly popular as an urban amenity. Similar uses of water can be used in interiors, such as atrium spaces. See the National Association for the Education of Young Children Washington, DC 20036-1426 and www.kidsource.com/kidsource/content4/water.play.learn.html.

Rainwater harvesting
Rainwater harvesting is the collection and storage of rain from roofs or a surface catchment for future use. The water is generally stored in rainwater tanks or directed into mechanisms that recharge groundwater. This is appropriate where there is enough rain for collection and conventional water resources either do not exist or are at risk of being over-used in order to supply a large population. Rainwater harvesting can provide lifeline water for human consumption and reduce water bills and the need to build reservoirs, which may require the use of valuable land. Rainwater harvesting has been practiced in arid and semi-arid areas and has provided drinking water, domestic water, water for livestock, water for small irrigation, and a way to replenish groundwater levels. Rainwater harvesting in urban areas adds means to collect supplemental water for landscape watering requirements, to increase soil moisture for greenery, to increase the groundwater table through recharge, to mitigate urban flooding, and to improve the quality of groundwater. At a household level, harvested rainwater can be used for flushing toilets and washing laundry. There are many web-based resources, such as www.twdb.state.tx.us/publications/ reports/RainwaterHarvestingManual_3rdedition.pdf.

Green roofs
A green roof is a flat or sloped roof of a building that is partially or completely covered with vegetation and soil, or a growing medium, which is planted over a waterproofing membrane. It may include additional layers, such as a root barrier and drainage and irrigation systems. Plant size and selection depends on the depth of the roof overburden (growing medium) and local climate, but the plants are almost always drought tolerant. Low growing plants such as grasses,

sedums and other cactus-like plants are used where the depth is only a few inches. Where the medium depth is several feet, shrubs and even small trees can be used. Green roofs represent a significant niche market for horticulturists, especially propagators, who supply plants for these roofs. For research at Pennsylvania State Green Roof Center, see hortweb.cas.psu.edu/research/ greenroofcenter/history.html.

Gray water systems

Fresh water is a precious resource. Its uses should be restricted to potable water. Any water that has been used once, except water from toilets, is called graywater. It can be reused for many other purposes, especially landscape irrigation. Plants thrive on used water containing small bits of compost. Dish, shower, sink, and laundry water comprise 50-80% of residential "waste" water. The benefits of gray water recycling include:

- Lower fresh water use, and related costs of supply.
- Less strain on septic tank or treatment plant capacity.
- Graywater treatment in topsoil is highly effective.
- Less energy and chemical use.
- Reclamation of otherwise wasted nutrients, helping to improve land fertility.

The Gray Water Policy Center provides guidelines for code-compliance of various systems. See www.oasisdesign.net/graywater/law/index.htm.

Water-saving fixtures

Water costs can be significantly reduced. Using simple water saving measures can save fresh water. Approximately 70 % of the total water used in homes and offices is for toilet flushing, laundry and baths. Water-saving fixtures are standard options on such appliances and are indicated by EPA Energy Star ratings. Water use can be cut as much as 90 % in some cases. See www.epa.gov/OW/you/chap3.html.

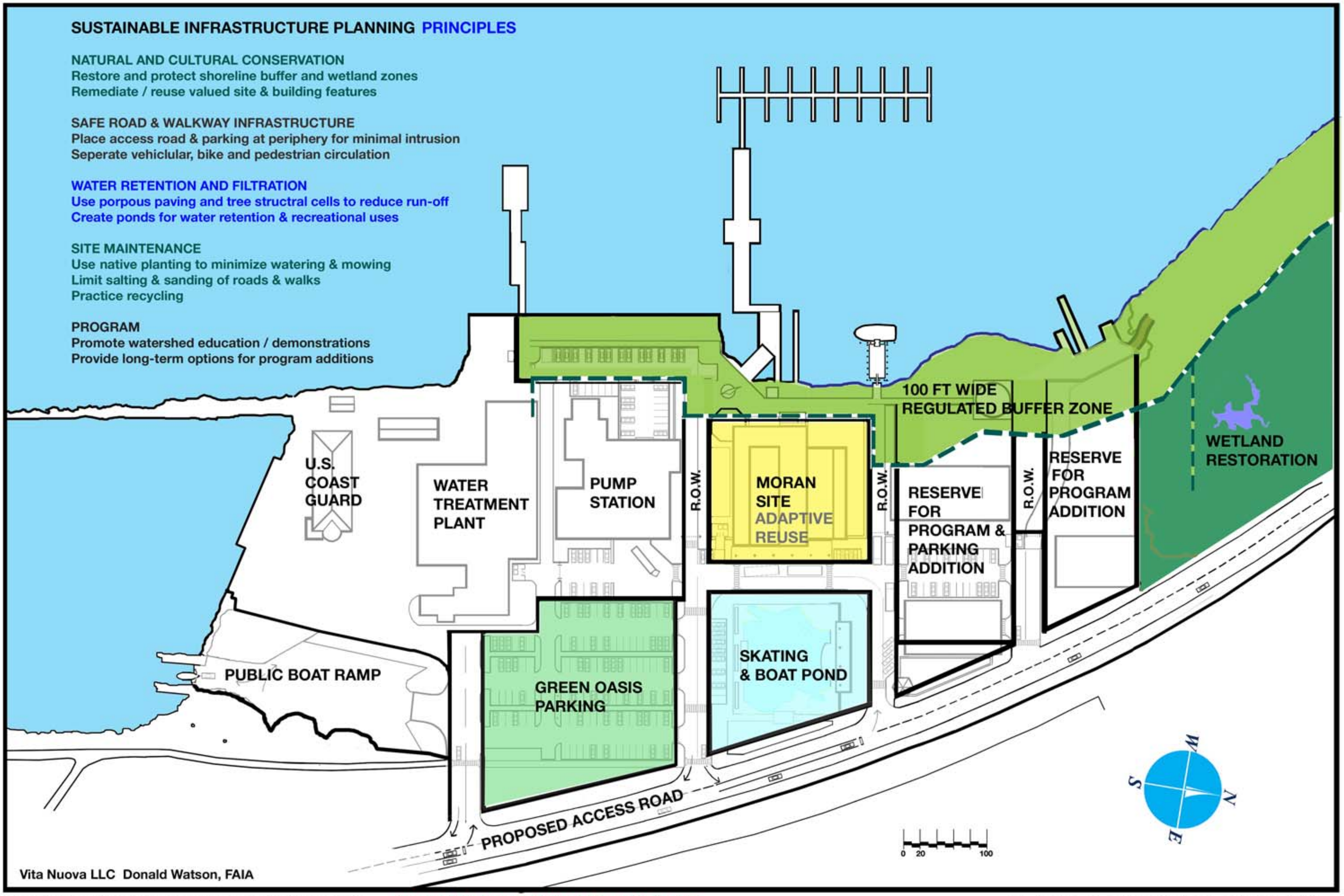
Appendix C

Sustainable Infrastructure

- Plate 00 Site Zones and Parcels
- Plate 01 Phase I Plan
- Plate 02 Long Range Plan
- Plate 03 Roads and Parking
- Plate 04 Pedestrian Walkways
- Plate 05 Tree and Bioswale Plan

Green Building Design

- Plate A1 Concept Plan Review
- Plate A2 Section Concept Plan Review



MORAN CENTER at WATERFRONT PARK SUSTAINABLE INFRASTRUCTURE

PLATE 00 SITE ZONES & PARCELS

EXAMPLE CONCEPT FEB. 20, 2009

SUSTAINABLE INFRASTRUCTURE PLANNING PRACTICES

Traffic and parking is at the periphery, to protect and restore the site for appropriate wateredge uses.

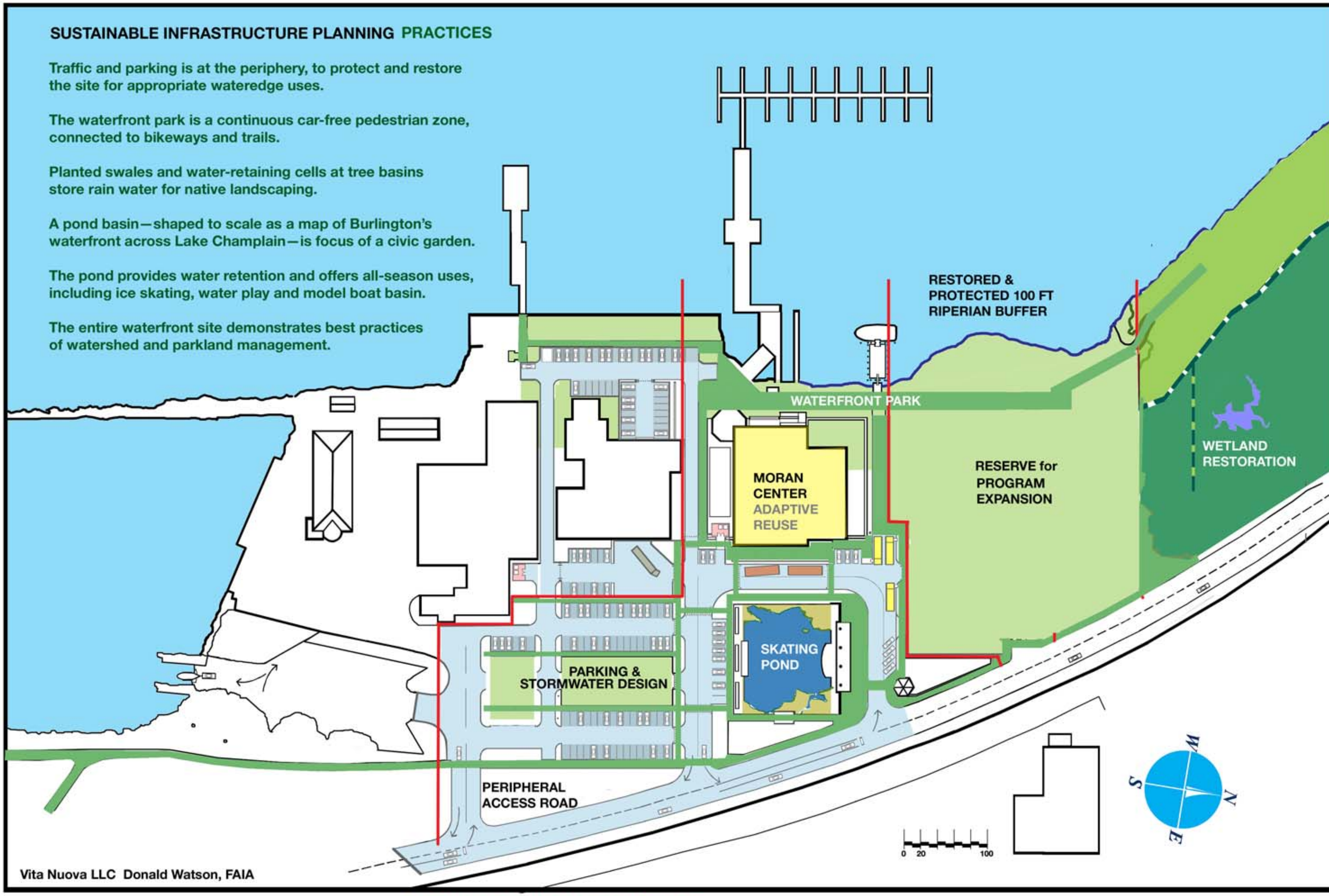
The waterfront park is a continuous car-free pedestrian zone, connected to bikeways and trails.

Planted swales and water-retaining cells at tree basins store rain water for native landscaping.

A pond basin—shaped to scale as a map of Burlington's waterfront across Lake Champlain—is focus of a civic garden.

The pond provides water retention and offers all-season uses, including ice skating, water play and model boat basin.

The entire waterfront site demonstrates best practices of watershed and parkland management.

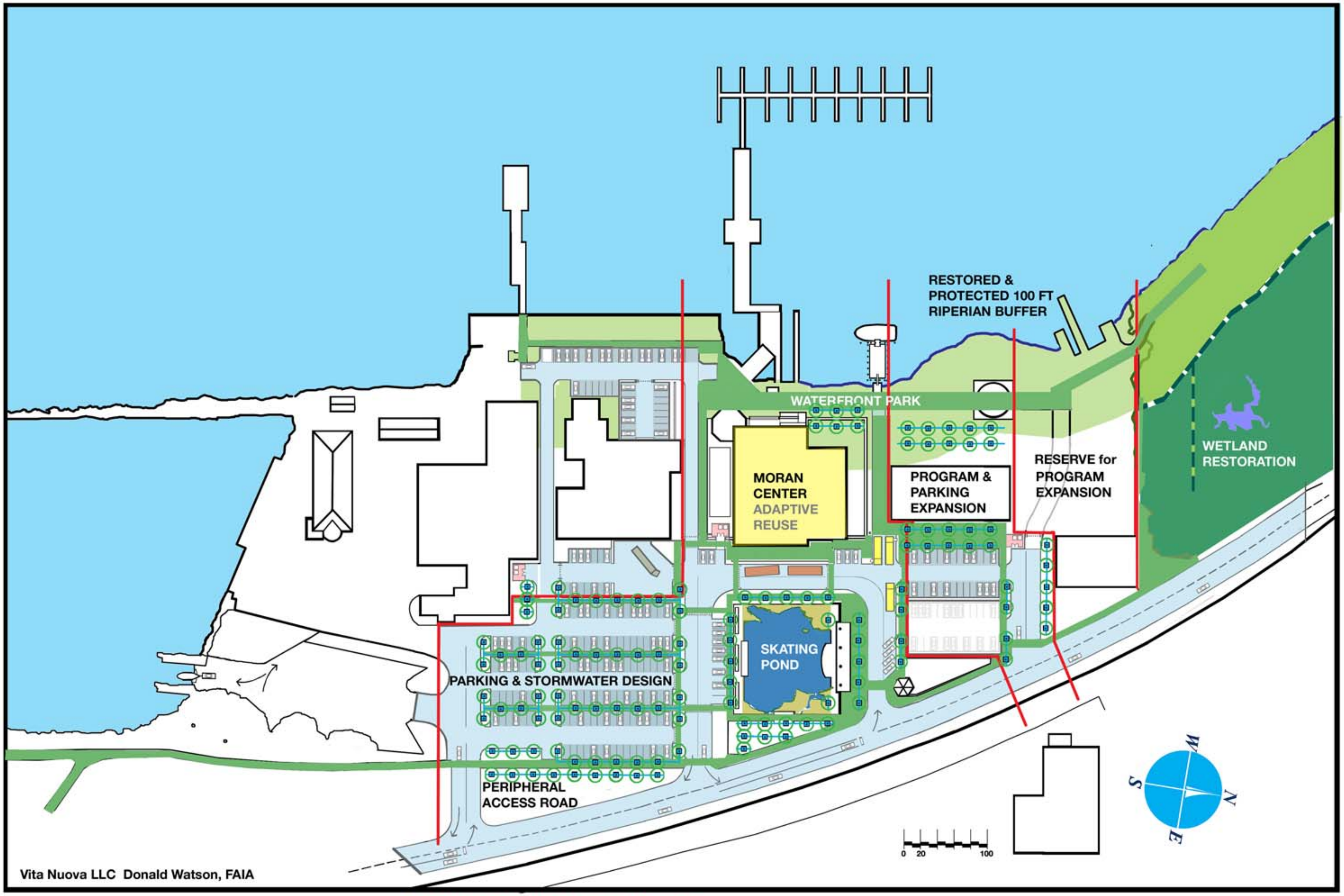


Vita Nuova LLC Donald Watson, FAIA

MORAN CENTER at WATERFRONT PARK SUSTAINABLE INFRASTRUCTURE

PLATE 01 PHASE I PLAN

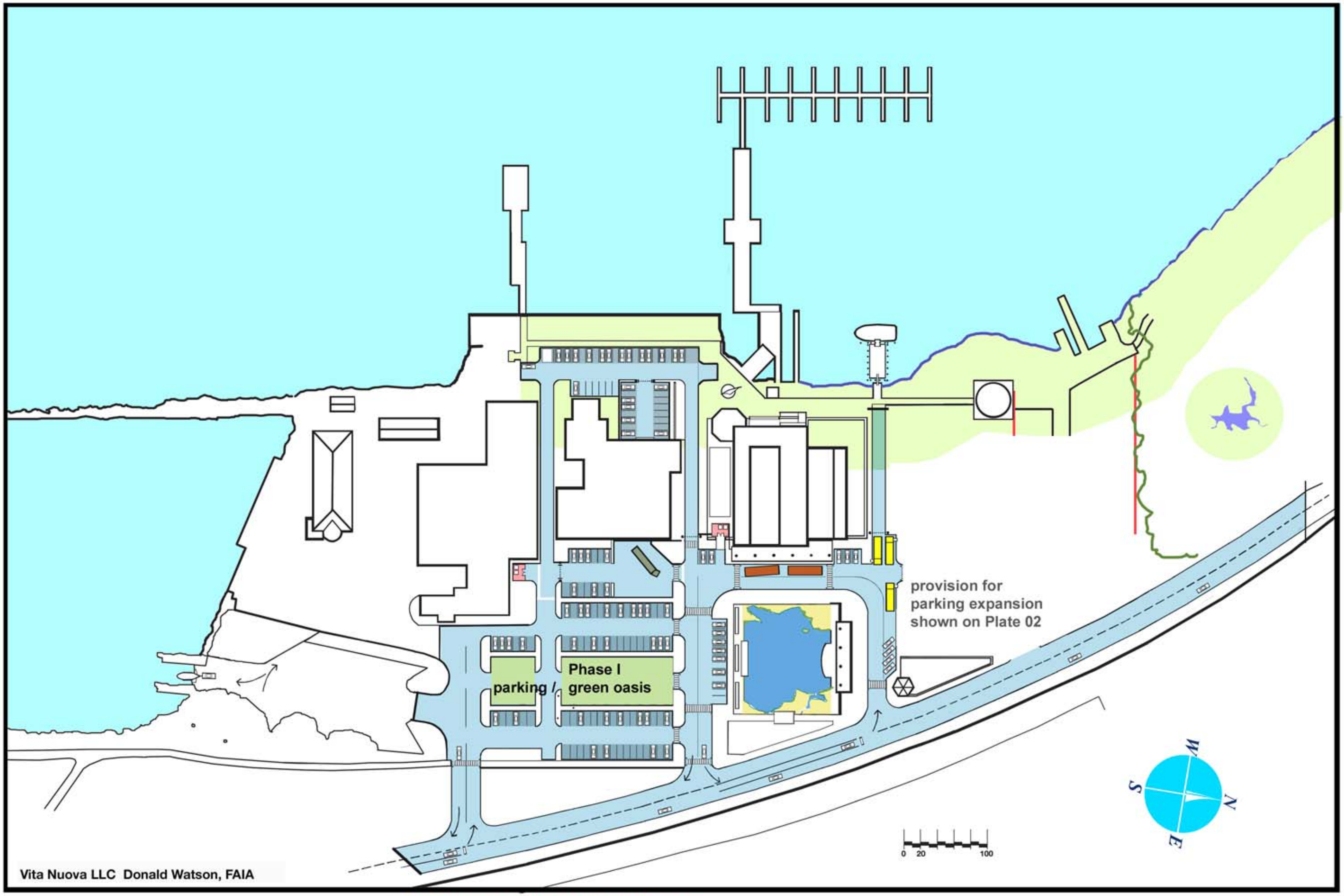
EXAMPLE CONCEPT FEB. 20, 2009



MORAN CENTER at WATERFRONT PARK **SUSTAINABLE INFRASTRUCTURE**

PLATE 02 LONG RANGE PLAN

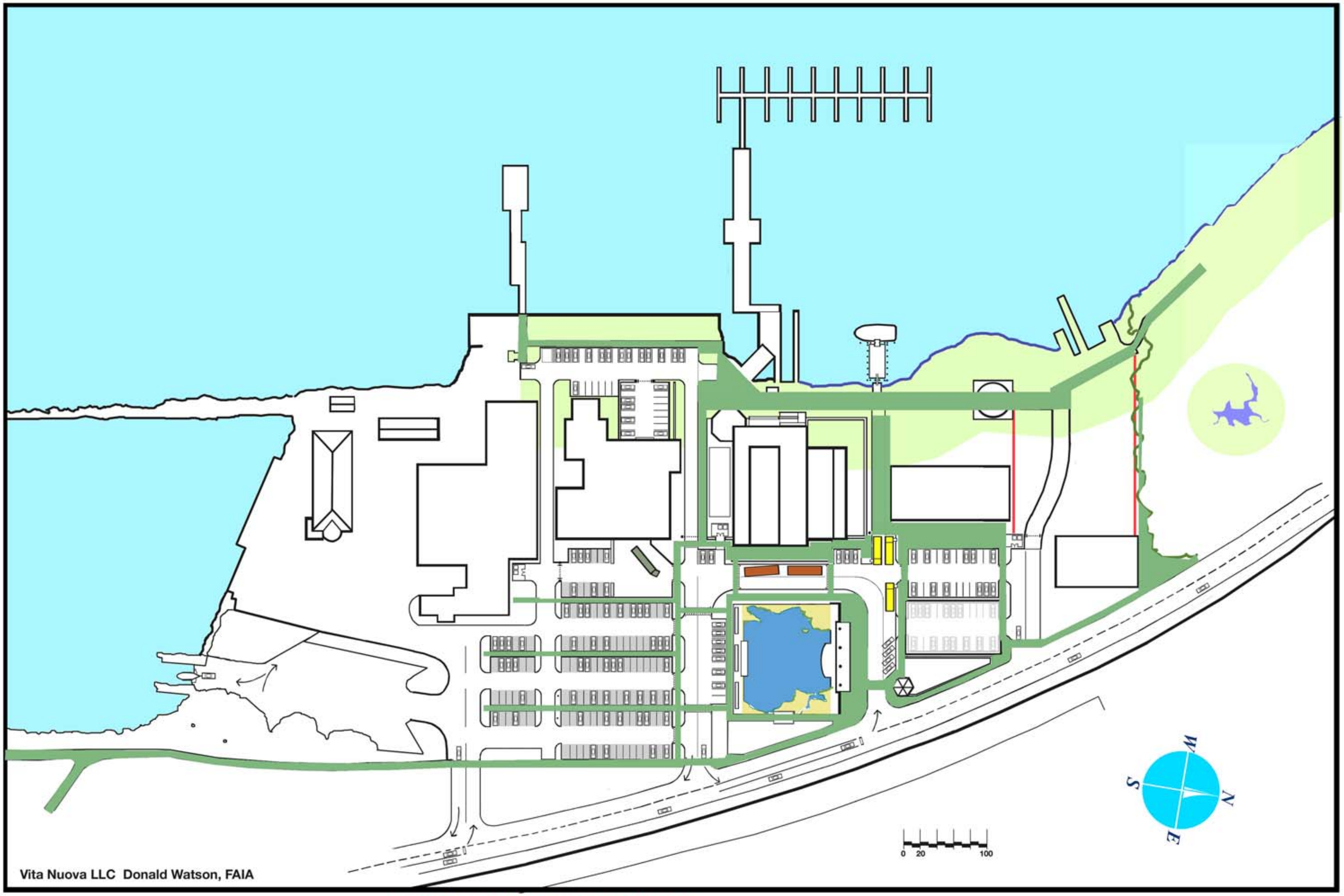
EXAMPLE CONCEPT FEB. 20, 2009



MORAN CENTER at WATERFRONT PARK SUSTAINABLE INFRASTRUCTURE

PLATE 03 ROADS & PARKING

EXAMPLE CONCEPT FEB. 20, 2009

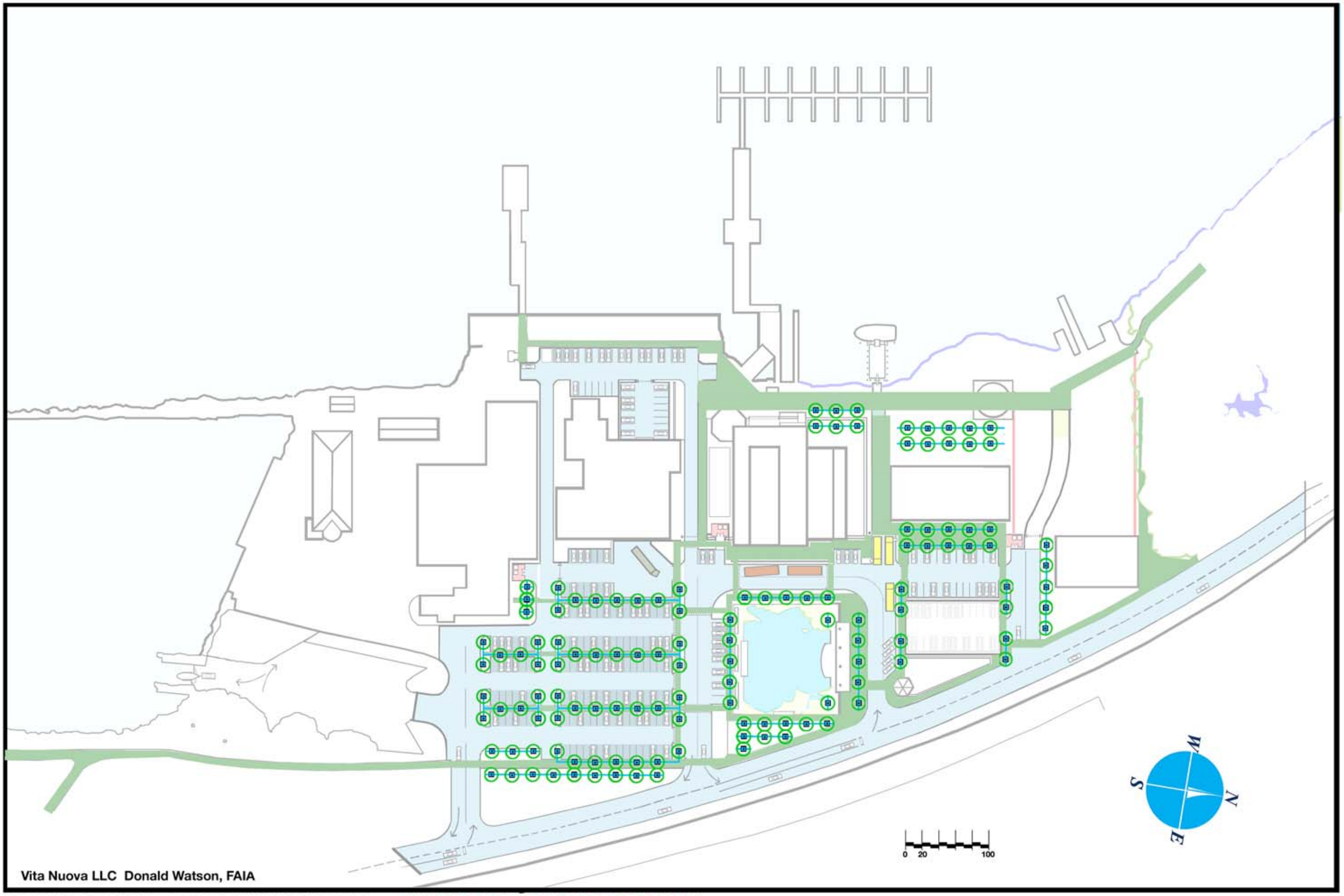


MORAN CENTER at WATERFRONT PARK

SUSTAINABLE INFRASTRUCTURE

PLATE 04 PEDESTRIAN WALKWAYS

EXAMPLE CONCEPT FEB. 20, 2009

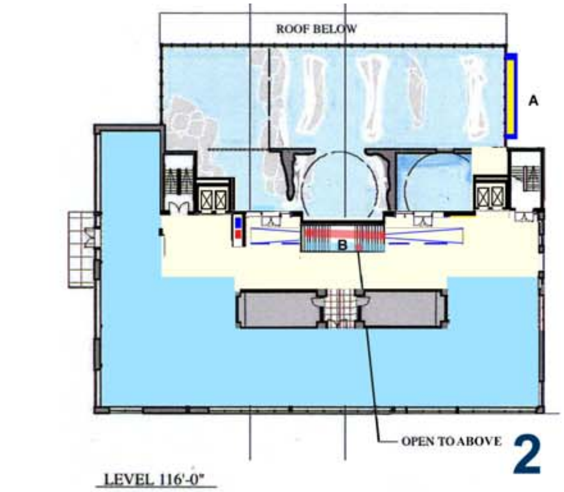


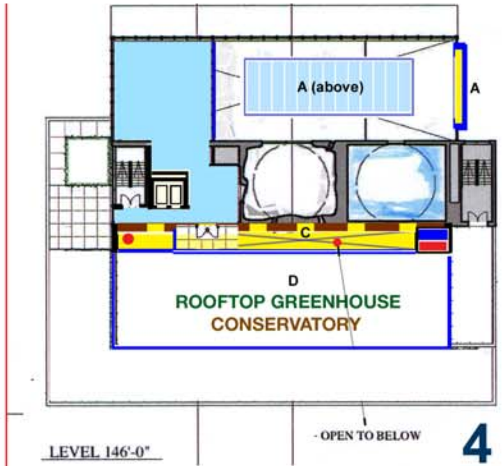
MORAN CENTER at WATERFRONT PARK

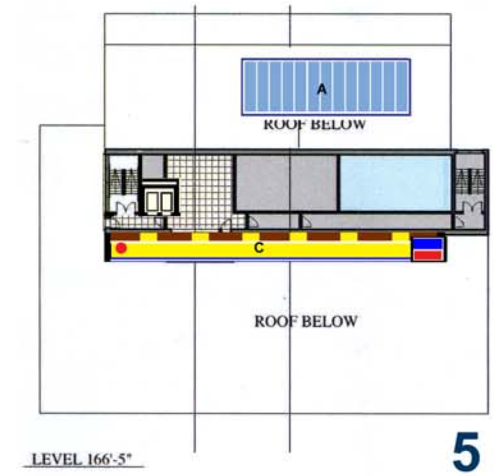
SUSTAINABLE INFRASTRUCTURE

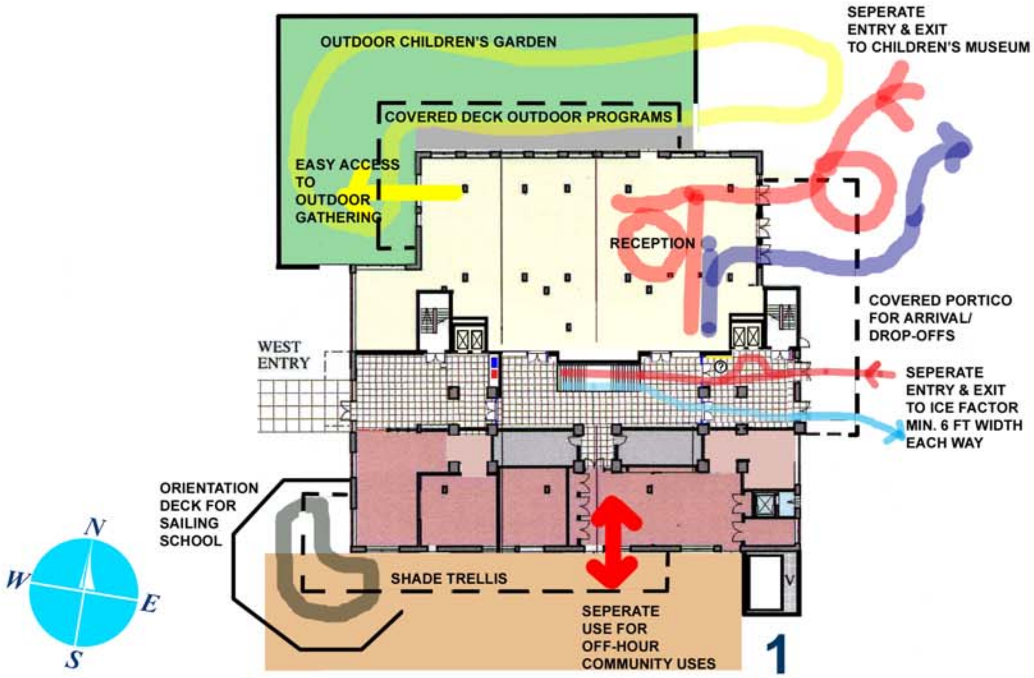
PLATE 05 TREE & BIOSWALE PLAN

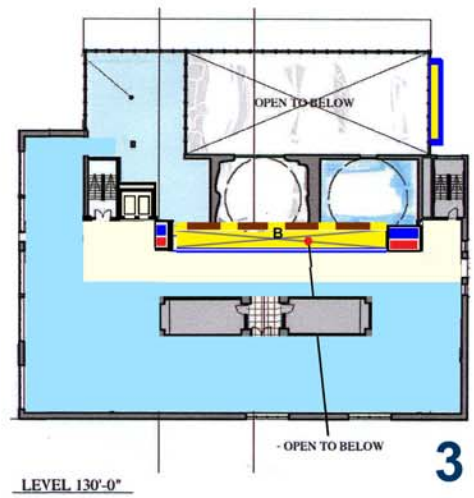
EXAMPLE CONCEPT FEB. 20, 2009











GREEN DESIGN OPTIONS

The following options take advantage of the large south-facing wall that extends from Floors 5 down to the center of Floor 1 to provide a natural lighting (narrow skylight) and natural ventilation (air plenum). It provides options for solar preheating and heat recovery to assist indoor ventilation in winter and ventilation exhaust in summer.

To enclose the shed for the Ice Factor, Kalwall (or equal) insulated transluscent panels can be considered to provide full daylighting. of this volume.

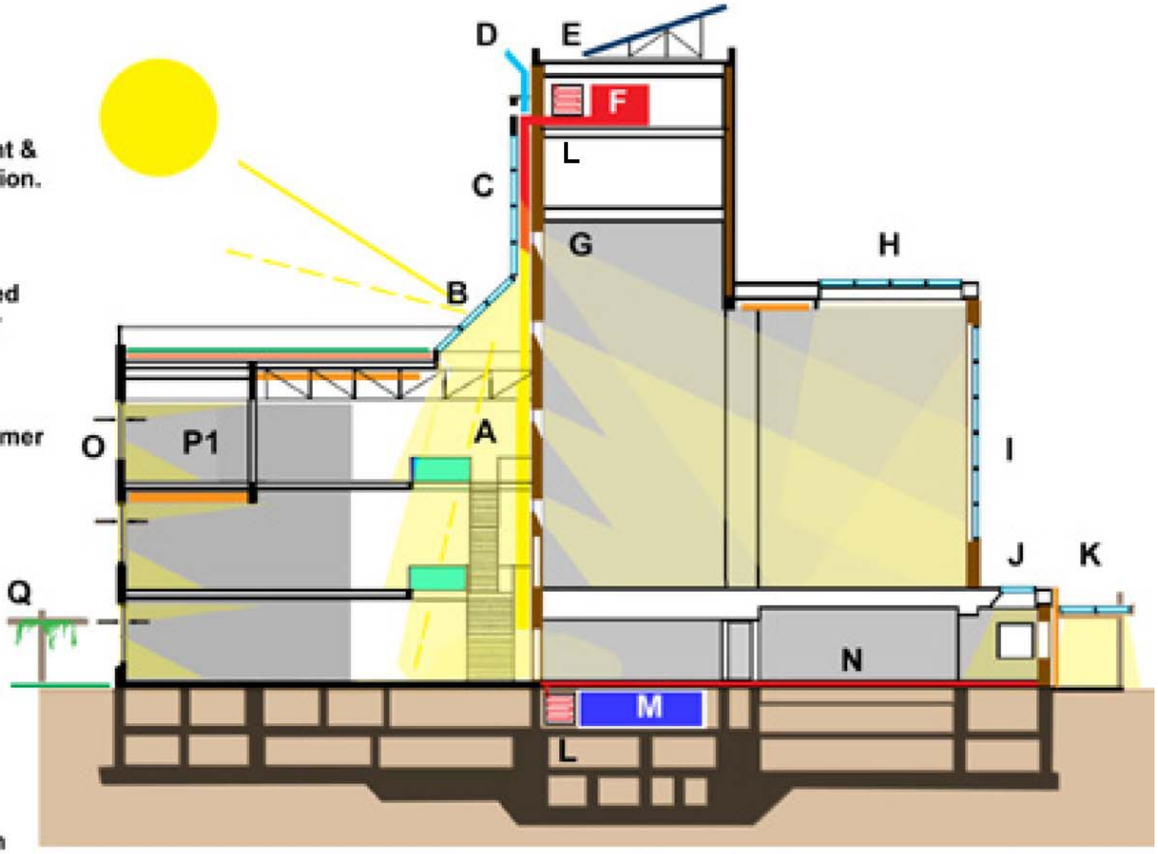
A Daylight Ice Factor Shed with Kalwall (or equal) skylights & east wall.

B Narrow skylight and vertical air plenum provides natural light and vartical air flow for Floors 1 thru 3.

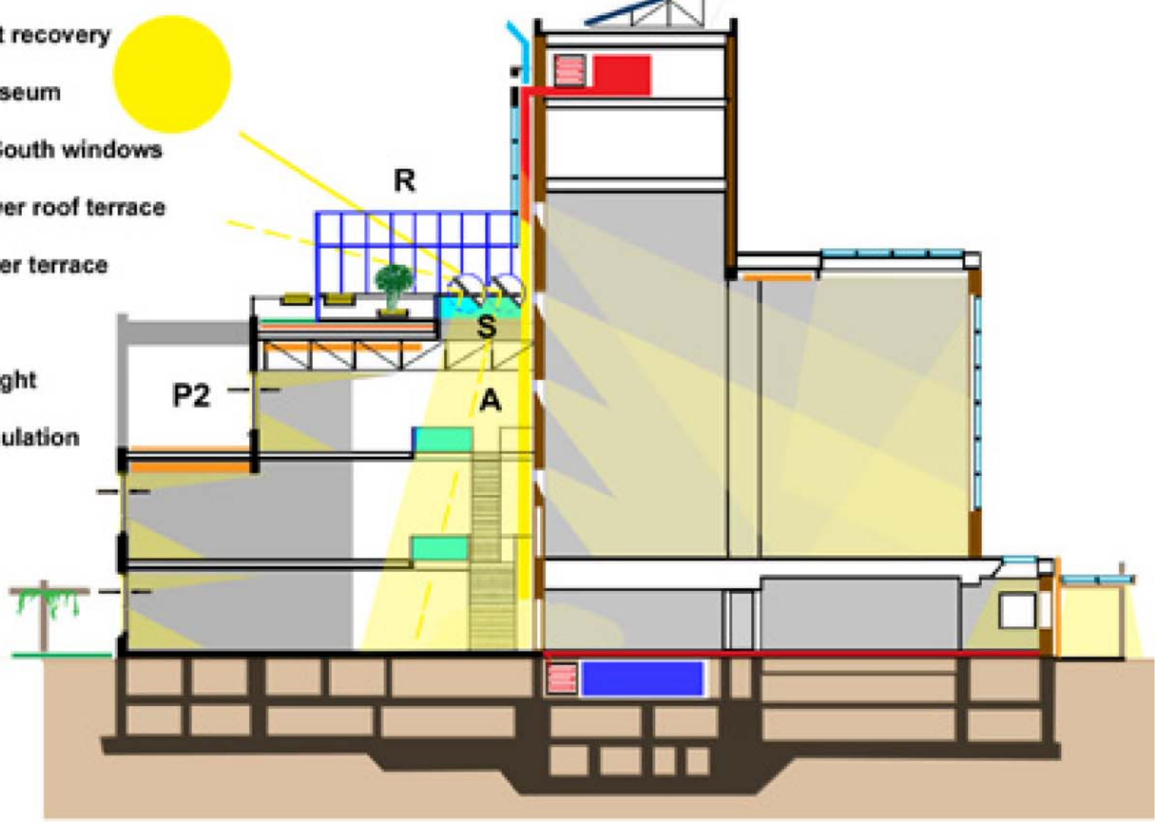
C Narrow skylight extended to south wall of Floors 4 & 5 sufficient to provide natural ventilation vertical air flow with heat recovery from top volume (with exhaust option). North wall of plenum has small openings for south sunlighting (subject to program area opportunities).

D Terrace of Floor 4 could be considered for future greenhouse / conservatory (future program option).

- A Atrium provides natural light & air shaft for vertical ventilation.
- B Kalwall (or equal) skylight
- C Kalwall (or equal) sun-heated plenum pre-heats return air
- D Exhaust air / ERV
- E Photoelectric array for summer (Peak Hour) fan power
- F Heat pump
- G WIndows provide sunlight to Ice Factor space
- H Kalwall (or equal) skylight
- I Kalwall (or equal) window
- J Skylight
- K Transluscent covered porch
- L Heat receovery from ice making machine
- M Ice making machine w/ heat recovery
- N Radiant floor Children's Museum
- O Shading and light shelf on South windows
- P1 Option showing filled in lower roof terrace
- P2 Option showing unbuilt lower terrace
- Q Shading trellis south patio
- R Greenhouse instead of skylight
- S Adjustable sunreflectors/insulation



ATRIUM WITH SKYLIGHT AND PLENUM



ATRIUM BELOW WITH ROOF TERRACE GREENHOUSE