High-performance Building in the Meadowlands

Industrial Green Building
September, 2006

INSTITUTE FOR MEADOWLANDS STUDIES

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The Institute for Meadowlands Studies is a collaboration between the

New Jersey Meadowlands Commission

and the

Center for Urban Policy Research

Edward J. Bloustein School of Planning and Public Policy

Rutgers, The State University of New Jersey

This report is a product of the Institute for Meadowlands Studies (IMS), Center for Urban Policy Research, Edward J. Bloustein School of Planning and Public Policy, Rutgers, The State University of New Jersey, for the New Jersey Meadowlands Commission.

New Jersey Meadowlands Commission

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EXECUTIVE SUMMARY

This report, produced for the New Jersey Meadowlands Commission (NJMC or Commission), is a product of the Rutgers Center for Green Building and the Institute for Meadowlands Studies, both within the Edward J. Bloustein School of Planning and Public Policy at Rutgers, the State University of New Jersey. It identifies opportunities for high-performance building for warehousing and distribution in the Meadowlands, a dominant land use within the Commission's jurisdiction.

The objectives of this research correspond to and support a number of strategies outlined in Chapter 10: System Plans of the NJMC's January 2004 Master Plan. These include the promotion of innovative technology in business and business operations such as the Leadership in Energy and Environmental Design (LEED™) Green Building Rating System developed by the U.S. Green Building Council (USGBC), the promotion of environmental education and awareness, the encouragement of emission reductions from mobile and stationary sources, the development of an intermodal freight transport system, and the strengthening of economic partnerships to encourage a variety of commercial and industrial uses in the Meadowlands District.

Specifically, this work examines whether opportunities exist to increase the performance of warehouses according to key measures as identified by LEED: Sustainable Site, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation in Design Process. While much of this research could be found to apply to high-performance building generally, it makes explicit the unique characteristics of the Warehousing and Distribution land use which, in some cases, present challenges to existing smart growth and green building guidelines.

In collecting data on high-performance (green) buildings, a literature search was performed utilizing existing data from the USGBC, academic journals, and trade magazines. The study team also collected data on the manner in which other governmental entities have implemented green building programs; interviewed the owners of LEED-certified projects that include a warehouse component; and interviewed two of New Jersey's largest warehouse developers and operators to develop a better understanding of issues unique to this land use in this state. These latter interviews should be considered exploratory in nature, and not necessarily representative of all warehouse developers in the state.

This research, which was originally conducted in 2004, suggests that many measures can be implemented in a fashion that is beneficial to building owners, tenants, and area residents. These include the introduction of energy- and water-saving techniques and equipment, renewable energy building systems, an alternative vehicle refueling station, reflective roofs, building commissioning, building material reuse, and the reduction of solid waste. The study also addresses whether a more ambitious undertaking—the creation of one or more eco-industrial parks within the Meadowlands District—might be feasible.

Implementation strategies include educational initiatives aimed at developers and the constituent municipalities, building code changes, tax-share incentives for municipalities, tax increment finance opportunities, and density awards. The associated policy options are explicated in Part III of this report.

The remainder of this report is organized as follows. Part I is an introduction to the role of Warehousing and Distribution in the Meadowlands District. Part II explores green building options for this land use. Part III includes a number of suggestions for the implementation of a green building policy geared primarily for warehouses. Part IV recommends an agenda for future research.

PART I—INTRODUCTION[1]

The founding mandates of the Meadowlands Commission are, "To protect the delicate balance of nature; to provide for orderly development; and to provide facilities for the disposal of solid waste." As such, the Commission strives to achieve a successful balance between environmental preservation and economic growth and development. It does this within its 30.4-square-mile (19,485 acres) district utilizing a variety of powers including, but not limited to:

- the preparation, adoption, and implementation of a master plan, along with zoning and subdivision regulations and/or redevelopment plans to effectuate the intentions of the plan
- the acquisition of land through purchase, lease, easement, or eminent domain
- the establishment of engineering standards for purposes of land reclamation and construction
- the implementation and operation of an inter-municipal tax sharing account.

The activities of the Meadowlands Commission are overseen by a seven-member board of commissioners chaired by the Commissioner of the New Jersey Department of Community Affairs. The Meadowlands District comprises fourteen municipalities in Bergen and Hudson counties. The constituent municipalities are Carlstadt, East Rutherford, Little Ferry, Lyndhurst, Moonachie, North Arlington, Ridgefield, Rutherford, South Hackensack, and Teterboro in Bergen County, and Jersey City, Kearny, North Bergen, and Secaucus in Hudson County. The Meadowlands is located just over 5 miles west of New York City in northern New Jersey and is bordered by Route 46 on the north, Routes 1 and 9 and the freight rail line owned by Norfolk Southern and CSX Corp on the east, the Port Authority Trans Hudson (PATH) commuter rail lines and Pulaski Skyway on the south, and Route 17, the Pascack Valley rail line, and the Kingsland rail line on the west.

In-district intermodal facilities for freight include the Little Ferry Yard (Ridgefield), Resources Warehouse (North Bergen), Croxton Yard (Jersey City/Secaucus) and Kearny Yard (Kearny). Truck terminals are located in Carlstadt, Kearny, Jersey City, North Bergen and Secaucus. Teterboro Airport provides freight delivery. As indicated above, these facilities have access to major highways and railways that in turn provide access to freight origin points at the Port Newark/Elizabeth Marine Terminal and Newark Liberty International Airport.

Warehousing and Distribution is a dominant land use within the Meadowlands (Figure 1), accounting for approximately 2,793.3 acres, or 14.3 percent. The largest group of existing industrial uses is in Carlstadt, consisting of mostly light industrial and trucking. North Bergen hosts warehousing and Ridgefield, a light industry/warehouse mix. Additionally, there is a significant presence of warehouses in Secaucus.

Included mostly in areas zoned Industrial, and secondarily into Commercial zones, Warehousing and Distribution is the largest land use in the District after Transportation

(4,018.4 acres, or 20.5percent) and Wetlands (5,783.6 acres, or 29.5 percent). Less than 2 percent of the District is vacant. Additionally, there are several areas designated for redevelopment, totaling approximately 3,012 acres of which 438 acres are recommended for Warehousing and Distribution.

Economic data suggests that Warehousing and Distribution will continue to grow in the District and surrounding areas. The Port Authority of New York and New Jersey expects imports of consumer goods to grow between 3.7 and 4.8 percent during the period 2000–2010, although this prediction was made in 2001 when the dollar was stronger. This means that port cargo loads could double in ten years and quadruple in forty years. Moreover, a great proportion of the goods arriving in area ports are purchased and consumed within the region, thereby creating an additional component of demand for local warehouse space. As articulated by a logistics consultant in a recent issue of *Development*, "As long as America continues to be the largest consumer of goods in the world, and goods are brought in to the U.S. for consumption, there will need to be warehouses for storage."[2]

The firm of Cushman & Wakefield reports that warehouse availability rates for Bergen and Hudson counties are among the lowest nationally and that the Meadowlands industrial submarket is a preferred location.[3] Of particular note, according to the same firm, is a recent trend toward owning rather than leasing industrial space within this submarket. In the second quarter of 2003, 764,700 SF changed ownership, of which 52 percent was acquired by users.[4] As long as interest rates remain relatively low and capital accessible, this trend can be expected to continue. At the same time, warehouses are increasing in size.[5] Both of these factors could prove significant in considering the benefits and costs, and therefore the case for high-performance green warehouses.

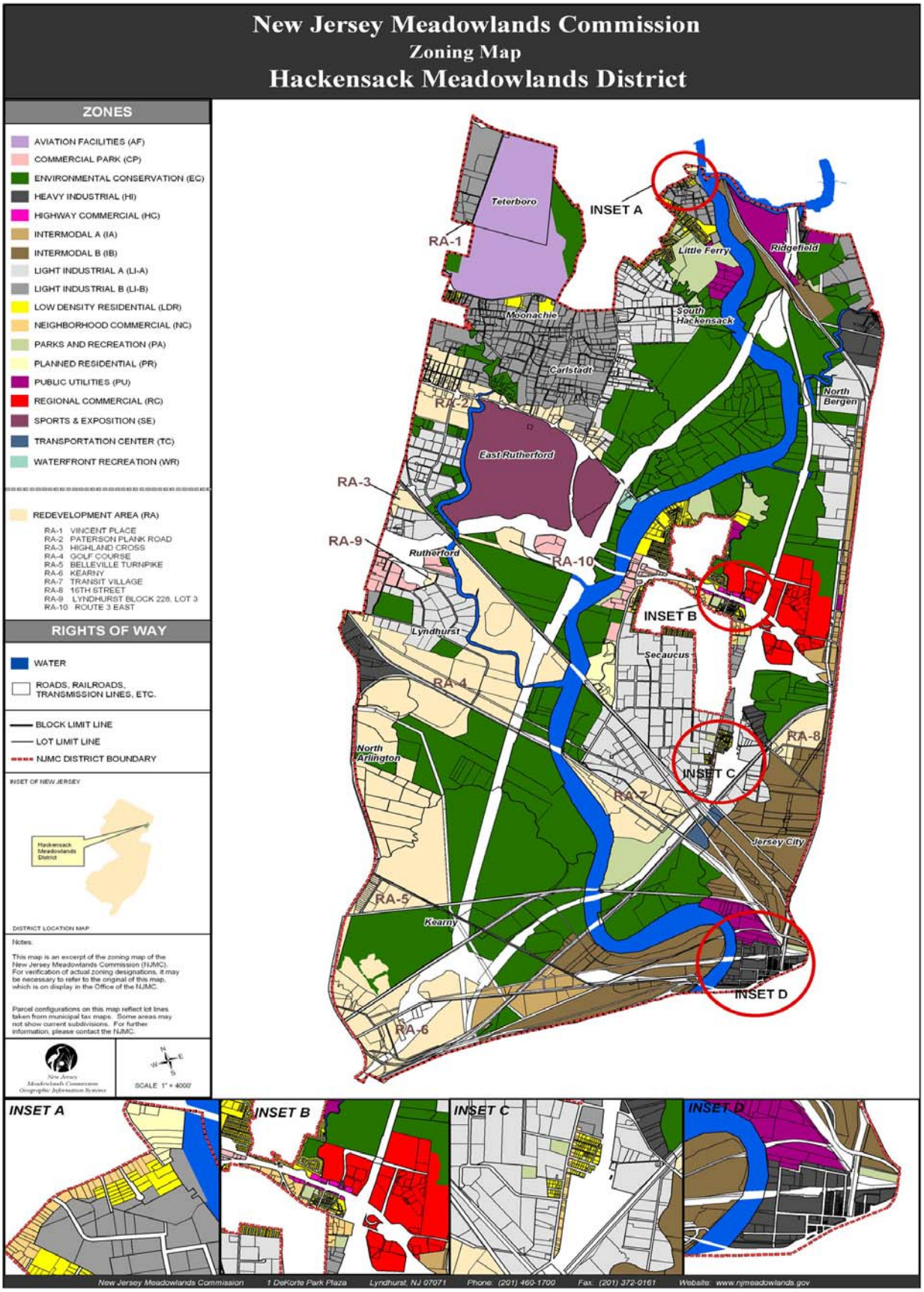


Figure 1. Hackensack Meadowlands District Zoning Map

PART II—HIGH-PERFORMANCE GREEN BUILDING IN WAREHOUSING AND DISTRIBUTION

Buildings have a significant impact on global resources. In the United States, buildings account for nearly 35 percent of total energy consumed and 65 percent of U.S. consumption of electricity overall.[6] Cooling and Refrigeration is the single largest component of energy used by buildings, at 48 percent of total energy. Depending on the type of warehouse and its use, this aspect of the environmental impact of a building can be greatly magnified (e.g., in the case of a refrigerated warehouse). Otherwise, lighting is likely to be the most significant energy usage component in a warehouse.

In the aggregate, buildings intensify climate change by releasing carbon dioxide into the atmosphere, through the use of electricity generated by the burning of non-renewable fossil fuels, or by burning carbon-based fuels within the building, accounting for 30 percent of greenhouse gas emissions. Buildings further account for 30 percent of raw materials use, 12 percent of potable water consumption, 30 percent of waste output, and 28 percent of landfill material.

The introduction of energy- and water-efficient equipment, implementation of energy- and water-saving procedures, and renewable energy generation offer considerable environmental and public health advantages, helping to conserve natural resources. Collectively, they can work to decrease the demand to build more conventional power plants while improving overall system reliability. Decreased waste output and use of raw materials similarly have positive economic and environmental effects, as does improved internal air quality in buildings. Sick Building Syndrome—the result of poor indoor air quality caused by a combination of toxic construction materials, toxic cleaning agents, and energy efficient yet problematic air-tight construction—may affect as many as 30 percent of new and renovated buildings.[7]

High-performance (green) building has been increasing exponentially in the past few years, and between 4 and 7 percent of all new commercial construction is certified as such by the U.S. Green Building Council (USGBC) through its rating system, known as LEED™ (Leadership in Energy and Environmental Design).[8] A comparison of positive energy and environmental impacts of LEED buildings to conventional ones is shown in Figure 2.

Figure 2. LEED Building vs. Conventional Building

Anticipated Energy/Environmental Impact LEED Rating (Energy, Water, Land Improvements, and so on)	
Certified level	**30 percent**
Silver level	**40 percent**
Gold level	**50 percent**
Platinum level	**70 percent+**

Source: U.S. Green Building Council

A number of available resources have been used in preparing this report. These include the U.S. Green Building Council (USGBC), which currently does not provide rating guidance specific to warehouses,[9] but whose existing products—especially New Construction, Existing Building, and Core and Shell—are relevant; technical and academic journals; and trade magazines. Owners of LEED-certified warehouses and two of New Jersey's largest warehouse developers and operators were interviewed to gain their views regarding green building processes and outcomes.

As noted above, this work utilizes LEED building components as an organizing framework. For reference, Figure 3—the LEED–NC 2.1 (New Construction) Checklist—follows, providing information on how the point system works as well as details on applicable design element or practices. LEED-NC 2.2 was released in November 2005 and is expected to be replaced by LEED-NC 3, which may contain regionally weighted credits and other improvements.

Figure 3. The LEED-NC 2.1 Checklist

Category/ Possible Points	Summary
Sustainable Sites / 14	Requires the design of a sediment and erosion plan. Site must not be: on prime farmland; on land lower than 5 ft. above a 100-year flood plain; on a protected habitat; within 100 feet of wetlands; on public parkland. Offers points for: channeling development to urban areas (equivalent to two-story downtown development); brownfield redevelopment; locating near rail or bus lines; providing bicycle storage and showers for 5 percent of occupants; providing preferred parking and alternative-fuel vehicles for 3 percent of occupants, or installing refueling stations for alternative-fuel vehicles for 3 percent of occupants; setting aside preferred parking for vanpool and carpool vehicles for 5 percent of occupants; limiting site disturbance; reducing the development footprint by 25 percent; implementing a stormwater management plan and system; reducing light pollution; providing shaded, light-colored, or open-grid paving, underground or structured parking (50 percent of spaces), and "cool" or vegetated roofs.
Water Efficiency / 5	Reduce water consumption for irrigation by 50 percent; use only captured rain or gray water for irrigation, or do not install landscape irrigation systems; reduce use of city water for sewage by 50 percent or treat 100 percent of wastewater on site to tertiary standards; use 20 percent or 30 percent less water (not including irrigation) compared to Energy Policy Act fixture performance requirements.
Energy and Atmosphere / 17	Must use best practice commissioning procedures. Must design to comply with ASHRAE/IESNA 90.1-1999 or more stringent local code. Zero use of CFC-based refrigerants in HVACR systems. Points for: reducing design energy costs vs. ASHRAE/IESNA 90.1-1999 by 10 percent, 20 percent, 30 percent, 40 percent, 50 percent, or 60 percent; supplying 5 percent, 10 percent, or 20 percent of total energy use via on-site renewable systems; using an independent commissioning authority; providing the owner with a manual for recommissioning building systems; contracting to review building operation with O&M staff; installing HVACR and fire-suppression systems that contain no HCFCs or halons; providing 50 percent of electricity from renewable sources over a two-year contract.
Materials and Resources / 13	Points for: providing an area for recycling waste materials; diverting 50 percent or 75 percent of construction, demolition, and land-clearing waste from landfill; using 5 percent or 10 percent of salvaged or reused materials; using 5 percent or 10 percent of total value of materials from reused materials and products; using 5 percent or 10 percent of total value of materials from post-consumer recycled content; using 20 percent or 50 percent of building materials that are manufactured within 500 miles; using products made from plants that are harvested within a 10-year cycle for 5 percent of the value of all building materials; using 50 percent of wood-based materials from Forest Stewardship Council-certified forests. For reused buildings, maintain 75 percent or 100 percent of existing building structure and shell or 100 percent of shell/structure and 50 percent of non-shell areas (interior walls, doors, etc.).
Indoor Environmental Quality / 15	Must meet minimum requirements of ASHRAE 62-1999. Must prohibit smoking in the building or provide ventilated smoking rooms verified by tracer gas testing (ASHRAE 129-1997). Points for: installing a permanent CO2 monitoring system; designing ventilation systems that result in air-change effectiveness of at least 0.9 (ASHRAE 129-1997); developing an IAQ management plan for construction and pre-occupancy phases; using adhesives and sealants with VOC content less than that required by SCAQMD Rule #1168 and sealants used as fillers that meet or exceed Bay Area Quality Management District Reg. 8, Rule 51; using paints and coatings whose VOC/chemical component limits do not exceed Green Seal Standard GS-11; using carpet systems that meet or exceed Carpet & Rug Institute Green Label IAQ Test Program; using wood and agrifiber products containing no added urea-formaldehyde resins; designing to minimize pollutant cross-contamination of occupied areas; providing an average one operable window and one lighting control zone per 200 sq. ft. for occupied areas within 15 ft. of the perimeter wall; providing individual controls for airflow, temperature, and lighting for 50 percent of occupants; complying with ASHRAE 55-1992, Addenda 1995, for thermal comfort standards; installing a permanent temperature/humidity monitoring system; achieving a Daylight Factor of 2 percent (excluding direct sunlight penetration) in 75 percent or 90 percent of all space occupied for critical tasks.
Innovation and design process / 5	Points for: exceptional performance above the requirements set by LEED or for innovative performance in green building categories not addressed by LEED; having a LEED-accredited professional as a principal participant.

Figure 4. Where the Points Are in LEED

Category	Possible Points (% of total)	
Sustainable sites	**14**	(20 percent)
Water efficiency	**5**	(7 percent)
Energy/atmosphere	**17**	(25 percent)
Materials/resources	**13**	(19 percent)
IEQ	**15**	(22 percent)
Innovation	**4**	(6 percent)
Accredited professional	**1**	(1 percent)
Total	**69**	(100 percent)

Source: U.S. Green Building Council

Figure 5. LEED Certification Levels

Rating	Earned Points
Certified	**26–32**
Silver	**33–38**
Gold	**39–51**
Platinum	**52–69**

Figure 6. Top LEED Point-Getters (of 38 LEED-NC Projects)

Number of Projects Earning This LEED Point (of 38)	Description
38 ID 2	Employ a LEED accredited professional
38 MR 5.1	Use 20 percent of building materials manufactured within 500 miles
35 EQ 4.3	Use low-emitting carpets
34 WE 1.1	Install high-efficiency irrigation or reduce potable water use for waste by 50 percent
33 SS 4.2	Provide bicycle storage and changing facilities for x percent of occupants
33 MR 4.1	Recycled content
33 EQ 4.1	Use low-emitting adhesives
33 ID 1.1	Various innovations to enhance sustainability
30 SS 1	Site selection
30 EA 1.1	Reduce design energy cost by 15 percent
30 MR 2.1	Recycle or salvage 50 percent of construction and land debris waste
30 EQ 4.2	Use low-emitting paints and coatings
30 EQ 8.2	Provide a direct line of sight to windows from occupied spaces
28 SS 5.2	Exceed local zoning open-space requirements by 25 percent
28 WE 1.2	Utilize water-efficient landscaping
28 EA 1.1	Reduce design energy cost by 30 percent

Source: Rob Bolin, P.E., LAP, Syska Hennessy Group, August 2003

Figure 7. Least-Employed LEED Points (of 38 LEED-NC Projects)

Number of Projects Earning This LEED Point (of 38)		Description
1	EA 1	Reduce design energy cost by 60 percent
1	MR 3.2	Use salvaged or reused materials for 10 percent of materials usage
2	MR 6	Use rapidly renewable materials
2	EA 1	Reduce design energy cost by 55 percent
2	EA 1	Reduce design energy cost by 50 percent
3	EA 2.1	Supply 5 percent renewable energy
3	EA 2.2	Supply 10 percent renewable energy
3	EA 2.3	Supply 20 percent renewable energy
7	SS 2	Meet local urban development density goals
3	SS 3	Brownfield redevelopment
7	EQ 6.2	Provide individual IEQ controls for 50 percent of occupants
8	WE 2	Innovative waste-water technology

Source: Rob Bolin, P.E., LAP, Syska Hennessy Group, August 2003

According to this data, the most achievable point categories in LEED-NC, and across LEED products, are the hiring of a LEED professional and local procurement of products from within 500 miles. All 38 of the projects considered in Figure 6 met these LEED goals. Interestingly, the least employed LEED points in this sample of 38 early projects—the "use of salvaged or reused material for 10 percent of materials"—is not a big hurdle for developments in the Meadowlands District given that such materials are available. Likewise, the "brownfield redevelopment" point should be readily attainable.

Two major warehouse developers and operators in New Jersey, each of whom is familiar with LEED, believe that many points are attainable and/or make sense in a warehousing and distribution environment; others do not. Below, comments of the interviewees are integrated with findings about best professional practices and the opinions of the authors of this paper with regard to specific LEED points or categories.

Although both interviewees made comments based on LEED v2.1 for New Construction, it was acknowledged that new building would take place on existing sites and could involve the demolition of an existing structure.

In summary, one interviewee explained that the first 17–19 LEED points can be attained without any "real significant capital investment." Yet, deciding to "build green" is considered just one of many variables in a project's feasibility analysis. By his calculations, the added cost for LEED construction and certification is 1 to 2 percent, with a positive return-on-investment realized in approximately 7 to 8 years. The

interviewee explained that generally this would be considered too long a payout time and too uncertain, especially since the average lease period for a warehouse is 5 years and the average investment "hold" period is between 3 and 5 years.[10] An additional challenge in tenanting is that rental rates have been flat for years, making it difficult to charge higher rents for green buildings and to structure a deal so that LEED expenditures show up quickly in a net rent benefit, as the tenant pays for the operating costs.

As the New Jersey Board of Public Utilities (BPU) sets forth more stringent requirements for renewable energy targets, the expectation is that utilities will provide more incentives to their customers to enable them to meet the requirements. The interviewee speculated that, if this occurs, in two to three years green warehouses that meet the Board of Public Utilities (BPU) energy requirements may make economic sense. Other incentives that this developer suggested could play a role in increasing interest in green building markets include a redevelopment model permitting tax increment financing (TIF) and changes to the tax code permitting accelerated depreciation of the green asset or green portion of an investment.

The following discussion of green building strategies for warehouses includes many recommendations adapted from the LEED-NC 2.1 Rating System. Where LEED project possibilities are mentioned, they are numbered according to their corresponding LEED categories for easy reference. Specific point categories are not necessarily grouped in order of the LEED manual. Green Building Strategy suggestions by the authors are indicated by a four-point star. Information based on interviews appears in italics.

SUSTAINABLE SITE

Green development (and the USGBC LEED model for it) impacts an area beyond the building envelope, including treatment of the building site and the design and operation of site-related infrastructure. Several LEED point categories relate to the sustainability of a site for warehouse and distribution land use. These include the following prerequisite and credit areas which, in application to warehouses, essentially reduce to stormwater management and parking lot design.

- Erosion and Sediment Control
- Site Selection
- Development Density
- Brownfield Redevelopment
- Alternative Transportation
- Reduced Site Disturbance
- Stormwater Management
- Heat Island Effect and
- Light Pollution Reduction

Specifically, the LEED system proposes that developers of a building "limit disruption and pollution of natural water flows by managing stormwater runoff, increasing on-site

infiltration, and eliminating contaminants." Similarly, as a result of the drought conditions in 2002 and of erratic precipitation patterns during the following year, the New Jersey Department of Environmental Protection (NJDEP) has taken strong measures to protect the state's water resources, including adoption of the 2004 Stormwater Management Rules (N.J.A.C. 7:8). In reviewing the NJDEP 2004 Best Management Practices for Wet Ponds (also known as retention basins), the authors did not find any specific impediments to this LEED credit, notwithstanding one interviewee's impression that there is an inhibiting "distance from structure" requirement for a retention basin on a project site.

Warehouse developers face a unique situation in designing the project site to maintain natural stormwater flows by promoting infiltration. Because warehouses need to be accessed by large trucks, pervious paving technologies may not be suitable for constant travel by such heavy motor vehicles. The highly variable ratio of employees to square footage in a warehouse building type (1:1,000 to 1:10,000) is challenging to address. When building a warehouse speculatively, the developer may be economically compelled to include the maximum allowed parking to meet the needs of most prospective tenants. This makes reducing the overall development footprint (impervious area) through a decrease in paved parking area difficult. Moreover, some developers apparently wish to avoid the need to obtain a variance and therefore comply with parking standards, even if this means overbuilding the parking component.

> Interviewee:
> *It would be difficult to replace impervious surfaces with native or adaptive vegetation in the case of previously redeveloped sites as large paved areas are required for truck courts (need 110 feet) and for a potentially large number of employees.*

> Interviewee:
> *Warehouses are large buildings and getting larger. Increased density for a warehouse means greater lot coverage. Isn't this smart growth? While preferred parking can be provided for vanpools, as many warehouse employees are delivered to work via caravan, downsizing overall parking capacity is not feasible for reasons cited above. Also, locating near mass transit seems less a priority compared to locating near an intermodal transport system/grid.*

While acknowledging these challenges, a survey of relevant literature gives rise to the following Green Building suggestions that may be implemented on a case-specific basis:

Green Building Strategies for Stormwater Management

- Design mechanical or natural treatment systems such as constructed wetlands, vegetated filter strips, and bioswales to treat the site's stormwater
- Promote infiltration through pervious paving (if applicable and where possible)
- Reuse stormwater quantities produced for non-potable uses such as landscape irrigation, toilet flushing and custodial uses
- Protect areas that provide water quality benefits and areas particularly susceptible to sediment loss
- Minimize impervious surfaces and/or break up or disconnect the flow of runoff over impervious surfaces
- Maximize the protection of natural drainage features and vegetation
- Minimize the decrease in the "time of concentration"[†] from pre-construction to post-construction
- Minimize land disturbance, including clearing and grading
- Minimize soil compaction
- Provide low-maintenance landscaping that encourages precipitation retention and planting of native vegetation and minimizes the use of lawns, fertilizers, and pesticides
- Provide vegetated open-channel conveyance systems discharging into and through stable vegetated areas
- Provide other source controls to prevent or minimize the use or exposure of pollutants at the site in order to prevent or minimize the release of those pollutants into stormwater runoff.[11] (*Note*: A promising new development trend combining "green" site development techniques with brownfields remediation is emerging and is currently championed by the U.S. Environmental Protection Agency [USEPA]).

Green Building Strategies for Parking Surfaces

- Consider whether areas designated for warehouse (re)development could implement a shared parking plan
- Consider rezoning to maximum rather than minimum parking standards
- Plant or maintain shade trees in parking lots

While one interviewee notes that shade trees for parking lots are impractical to install or maintain, most design professionals would disagree. The real issue is more likely to be that this feature takes a bit of time and money. However, in the long run this attribute of design will be an environmental asset and create aesthetic appeal.

[†] Time of concentration is defined as time for the precipitation (rain or other) runoff to collect.

Green Building Strategies for Alternative Transportation

- An alternative-fuel vehicle for the caravan may be viable
- Locate an alternative-fuel filling station somewhere in the District
- Use alternative-fuel forklifts

WATER EFFICIENCY AND CONSERVATION

The availability of a practically limitless and inexpensive supply of water has long been taken for granted in many areas of the United States. As a consequence, warehouse developers, engineers, and maintenance managers have had few incentives to conserve water. That situation is changing, including in New Jersey. Even in times of adequate water supply, the increase in water usage stresses the capacity of waste treatment plants and results in a water supply that is more costly and less abundant than in the past. Developers of warehouses have the ability to reduce the burden on municipal water supply and wastewater systems by maximizing water efficiency within the buildings as well as by creating water-efficient landscaping around the building. Furthermore, it makes increasingly good business sense to take advantage of new strategies that promote water conservation because they benefit both the bottom line and the environment.

LEED credits in this area address Water Efficient Landscaping, Innovative Wastewater Technologies, and Water Use Reduction.

Captured Rainwater

Most roofing materials are suitable for rainwater collection, except for redwood, cedar or treated wood shingles and shakes, which may contaminate water and soil by leaching toxic materials when wet. Food-producing gardens should not be watered with rainwater from roofs with these materials or asphalt shingles.[12]

Manufactured rain barrels are widely available in sizes that range from 36 to 75 gallons. Rain barrels are also easily made from commercial plastic barrels; recycled food-grade PVC barrels are often available free. The larger the container, the more potable water will be saved. Large or commercial buildings can incorporate filter systems and cisterns to capture stormwater runoff and provide the building's water supply (see Case Study #2).[13]

Rain barrels should incorporate a "roof washer" or "first flush" device, to avoid storing water contaminated with bird droppings and dust. They should also incorporate an inlet screen and an overflow outlet. Overflow and drain valves should include hose couplings and discharge at least 6 feet from foundations.[14]

Water-Efficient Landscaping

LEED recommends limiting (or eliminating) the use of potable water for landscaping needs by 50 percent. Warehouse facilities are less likely to construct high-maintenance landscaping than an office building or park and therefore may not need water for irrigation. However, encouraging the use of native vegetation in landscaping and

xeriscaping—landscaping with slow-growing, drought tolerant plants to conserve water and reduce yard trimming—should aid in the rehabilitation of the Meadowlands. Warehouses can also use captured non-potable water to hose off equipment, trucks, and other machinery.

Greywater

The capacity to use greywater for landscape irrigation offers several benefits, including longer lifetimes for in-ground septic systems, reduced tap water requirements for irrigation, and an ability to irrigate during droughts. Installation of a greywater system to provide irrigation allows a second use of water drained from baths, showers, bathroom sinks, and washing machines. Greywater collection and irrigation systems must be considered early in the design process, since they will affect landscaping design and the size and placement of mechanical equipment. This is especially true for gravity-flow greywater systems, since they must be higher than the irrigation systems they service.[15]

Consideration should be given to installing wastewater plumbing piping to capture "greywater" drain water from lavatory sinks and shower facilities (the greywater from washing machines in which chlorine bleach, borax, or washing soda have not been used can also be captured) for subsurface irrigation of outdoor landscaping. Greywater piping should be labeled to distinguish it from other sanitary piping.

A simple non-pumped gravity system is appropriate if leaching chambers or box troughs can be located downhill from the building and maintenance staff are available for regular inspections and filter changes. Where maintenance staff are not available, pumped systems equipped with automatically backwashed sand filters are more appropriate, though an added expensive. These systems, unlike other greywater systems, can be used for drip irrigation of lawns and require minimal service.[16]

Green Building Strategies for Water Efficiency and Conservation

- Estimate the potable and non-potable water needs for the building
- Perform a soil/climate analysis to establish suitable landscape types and design the landscape with indigenous plants to reduce or eliminate irrigation requirements
- Refrain from installing permanent landscape irrigation systems (or do so using greywater)
- Use only captured rain or recycled site water for irrigation
- Specify high-efficiency fixtures
- Consider reuse of stormwater and greywater for non-potable applications such as toilet flushing, mechanical systems, and custodial uses[17]
- Ensure greywater will not be exposed on the ground surface, even after prolonged rain
- Ensure occupants are made aware of obvious signals, such as a visible overflow, signaling the need for system maintenance or a filter change
- Post permanent signage above sinks to ensure occupants use appropriate cleansers and soaps[18]

Interviewee:
While these are largely attainable, they may require significant capital investment.

ENERGY EFFICIENCY AND CONSERVATION

New Jersey has made a strong commitment to greater energy efficiency and to the use of alternative energy. There are multiple resources available to developers of warehouses and commercial structures to construct energy-efficient building and implement energy-saving strategies. New Jersey's Board of Public Utilities, through the Office of Clean Energy, has developed a program called *SmartStart Buildings* which offers a variety of assistance for new construction and additions, renovations, remodeling, and equipment replacement. "Comprehensive Design Support" is a part of the SmartStart Buildings program geared toward large commercial projects (over 50,000 square feet), whereby design assistance is provided at an early stage of project development, offering considerable potential for energy savings. If a project meets the criteria, design incentives from $1,000 to $5,000 are available for pre-design brainstorming, design simulation, and detailed analysis of energy-saving measures.[19]

For projects smaller than 50,000 square feet, up to eight hours of technical assistance per project is offered, and supplementary assistance may be approved when utility representatives identify sufficient energy-savings potential. Services can include plan review and analysis of energy-efficiency options, design assistance, or aid with incentive applications and program compliance.

In addition to the design incentives and technical support available through New Jersey SmartStart Buildings, certain equipment also merits financial incentives. The categories of equipment range from boilers and chillers to ground source heat pumps to lighting control sensors.[20]

The initial costs associated with developing green buildings—design and construction costs—vary significantly depending on the specific project goals. While there are many significant design opportunities that can be implemented at no additional cost, such as proper solar orientation, some features will cost more initially, both in design and material costs (e.g., highly efficient HVAC and lighting systems, and thermally selective windows to reduce heat gain). Green buildings also may incur higher initial costs than other buildings as a result of ancillary design analysis, computer energy modeling, product research, limited product availability, and life-cycle cost analysis for alternative materials or building systems. In traditional green buildings, these higher up-front costs are recaptured over the long term through lower energy, water, materials, and waste management costs; improved health and productivity of occupants; lower debt service; decreased liability claims and building insurance; longer use of buildings and materials; and better communities. Thus, significant benefits for building owners and operators in the Meadowlands can be achieved through reduced operating costs. However, it must be realized that making an up-front investment generally reaps these gains. Developers who set out to turn a quick profit by immediately selling a building, or owner-builders who

wish to reap a profit in less than five years, may shy away from some of the higher-cost energy initiatives since they are looking for a short-term gain on their investment.

LEED guidelines in the area of "Energy & Atmosphere" contain a number of prerequisites as well as credits. Prerequisites include Building Systems Commissioning, Minimum Energy Performance, and CFC Reduction in HVAC&R Equipment. These are examined on an individual basis below.

Prerequisite 1—Fundamental Building Systems Commissioning

Building commissioning is the systematic process of ensuring that a building's complex array of systems is designed, installed, and tested to perform according to the design intent and the building owner's operational needs. The commissioning of new buildings will be most effective when considered throughout the planning stages, including early schematic design. Commissioned buildings are more energy efficient, more comfortable, and easier to maintain, assuming that good systems have been purchased.

LEED guidelines require the employment of a commissioning team that is not composed of individuals directly responsible for project design and/or construction supervision. Commissioning requirements should be incorporated into the construction documents, and a commissioning plan should be created and followed. Best commissioning procedures ensure that installation, functional performance, training, and operation and maintenance documentation are all borne out.

Green Building Strategies for Building Commissioning

- Commissioning requirements should be integrated in bid documents
- A commissioning agent should be required to produce a report upon the completion of all commissioning activities [21]

Interviewee:
Building commissioning is a great idea; most people do not know how to work their equipment.

Prerequisite 2—Minimum Energy Performance

Designing to the American Society of Heating, Refrigeration and Air Conditioning Engineers' (ASHRAE) and the Illuminating Engineers Society of America's (IESNA) ASHRAE/IESNA Standard 90.1-1999 (without amendments) is the LEED requirement for all buildings for compliance with minimum energy performance.

Green Building Strategies for Minimum Energy Performance

- Design building envelope to maximize energy performance
- Use computer models to assess energy performance and cost effectiveness
- Compare potential energy performance to baseline building[22]

- Conduct an industrial assessment[†]
- Optimize the overall building footprint to reduce total space that will necessitate heating and/or cooling (note: this requires modeling of economic benefit of warehouse activity)
- Lower temperature design standards to allow for a wider range of acceptable indoor temperatures
- Install sensor equipment to automate the turning off of equipment when building (or parts of building) not being utilized[23]
- Install reflective roofs/glazing [24]

The Rutgers University Industrial Assessment Center (IAC) team (see note below) typically conducts a survey of the eligible plant, followed up by a one- or two-day site visit at which engineering measurements are taken to establish a basis for assessment recommendations. The team then performs a comprehensive analysis culminating in a confidential report that details the analysis, findings, and specific recommendations with related estimates of costs, performance, and payback timeframes. Within six months, an IAC team member follows up with the plant manager to determine which recommendations will be implemented.

Prerequisite 3—CFC Reduction in HVAC&R Equipment

In order to reduce ozone depletion, LEED requires zero use of CFC-based refrigeration in new base-building HVAC&R systems; in reusing existing-base building HVAC equipment, a CFC phaseout conversion should be fulfilled.

Green Building Strategies for CFC Reduction

- Conduct an inventory to identify equipment that uses CFC refrigerants
- Approve a replacement schedule for any CFC refrigerant equipment
- Specify that new construction HVAC equipment must use no CFC refrigerants[25]

[†]*Industrial Assessment*

LEED-NC (New Construction) focuses on high performance within new buildings. LEED-EB (Existing Buildings) improves performance of existing buildings while reducing overall operating costs and environmental impact. However, neither of these programs attempts to scrutinize the production or distribution processes and operations employed within the structure in order to make the actual purpose of the building more efficient. To obtain the highest performance (and therefore save energy and costs), businesses can conduct an industrial assessment, which is simply an in-depth assessment of a plant site, its facilities, services and manufacturing operations. The process involves a thorough examination of potential savings from improvements in energy efficiency, waste reduction, and pollution prevention; and advancement in productivity. The Department of Energy (DOE) sponsors the Industrial Assessment Center (IAC), which provides assessments executed by local teams of engineering faculty and students from 26 participating universities across the country. Conveniently for businesses in the Meadowlands, Rutgers University is one of the participants.

Interviewee 1:
Don't make HVAC and other existing building systems non-conforming.

Interviewee 2:
The real issue is electricity use, not HVAC.

Similarly, LEED energy credits focus on the additional optimization of energy performance as well as its measurement and verification. A strong area of intersection in the LEED guidelines and New Jersey State Energy Policy is in renewable energy—green power. Specifically, the Renewable Energy Task Force created by Governor James McGreevey produced a detailed report that advanced specific recommendations for the establishment of a renewable portfolio standard (RPS) to advance the development of renewable energy in New Jersey. An RPS requires the retail electricity supplier or generator to deliver a specified minimum amount of electricity from renewable sources of energy. Renewable sources typically include solar power, wind power, geothermal heat, wave or tidal energy, some hydropower, and biomass emissions from capped landfills.

The annual RPS requirement for Class I renewable energy would be increased to 4 percent by 2008 in New Jersey, doubling the previous target of 2 percent. By 2020, the task force recommended an RPS requirement of 20 percent.[26] As presently conceived, all renewable energy must be derived from renewable energy generators in the Pennsylvania, New Jersey, and Maryland region (PJM Interconnection LLC, the regional transmission organization serving New Jersey, Pennsylvania, Maryland, and all or parts of several other states). The task force also recommended creating a certificate-based program in order to promulgate the progressive renewable energy goals in "an efficient, enforceable, market-based manner."[27] This allows for the renewable attributes of the energy to be "unbundled" from the energy itself; the renewable power generator then sells the energy to one energy supplier and the renewable energy certificate (REC) to any energy supplier in need of the certificate to meet its RPS requirement. Buildings or industrial complexes in the Meadowlands that are generating their own energy supply, or adding to it, on-site could create revenues through the REC program.

New Jersey offers financial incentives to all ratepayers through the New Jersey Clean Energy Program. Direct financial incentives are available to reduce the initial cost of renewable generation systems. These incentives are paid incrementally, based on the magnitude of the system installed. The incentive levels, which can defray installation, equipment, and interconnection costs, are shown in Figure 8, created by the Office of Clean Energy within New Jersey's Board of Public Utilities.

Figure 8. New Jersey Clean Energy Program Incentives

Wind and Sustainable Biomass Systems	
2004	***Incentive Level[a]***
Systems up to 10 kW	$5.00/watt
Maximum incentive as percentage of eligible system costs	60 percent
Systems Greater than 10 kW	
1 to 10 kW	$3.00/watt
> 10 to 100 kW	$2.00/watt
> 100 to 500 kW	$1.50/watt
> 500 kW, up to 1000 kW	$0.15/watt
Maximum incentive as percentage of eligible system costs	30 percent
Solar Electric Systems	
2004	***Incentive Level***
Systems up to 10kW	$5.50/watt
Maximum incentive as percentage of eligible system costs	70 percent
Systems greater than 10kW	
1 to 10 kW	$5.50/watt
> 10 to 100 kW	$4.00/watt
> 100 to 500 kW	$3.75/watt
> 500 to 1,000 kW	$0.30/watt
Maximum incentive as percentage of eligible system costs	60 percent
Incentive Available	

Note: a. Rebate levels have changed; see www.njcleanenergy.com/index.html.
Source: New Jersey Board of Public Utilities, Office of Clean Energy

LEED guidelines suggest supplying from 5 percent to 20 percent of the building's energy through on-site renewable energy self-supply, reducing environmental impacts associated with fossil fuel energy use. There is a good fit between warehouses, which have a large unobstructed roof space, and their ability to accommodate photovoltaic systems (PVs). In some cases, there may be a load-bearing capacity issue, but this should not be the case for well-designed buildings (particularly newer structures). In addition to providing a renewable energy source, PVs also create shade, a benefit in keeping the building cool. Whether or not a PV system is economically viable depends in part on the displacement

that can be achieved, a function of what the building load is, and lighting and other energy costs—but mostly on the payback period.[28]
Our interviewees believed that LEED points in this area were largely attainable although still too expensive, notwithstanding New Jersey's generous financial incentives.

Green Building Strategies

- Review the project for non-polluting and renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass and bio-gas technologies[29]
- Take advantage of net-metering and REC programs

Another strategy for warehouses is the installation of reflective roofs and/or Energy Star®–labeled roof products. White or metal roofs essentially add no extra costs in construction but can lower energy use through their ability to reflect heat as well as lower cooling costs by as much as 20 percent.[30]

Beyond this, in order to promote continuing accountability and optimization of building energy and water-consumption performance, LEED recommends measuring and verifying the building through installation of continuous metering equipment for the following:

- Lighting systems and controls
- Constant and motor loads
- Variable frequency drive (VFD) operation
- Chiller efficiency at variable loads (kW/ton)
- Cooling load
- Air and water economizer and heat recovery cycles
- Air distribution static pressures and ventilation air volumes
- Boiler efficiencies
- Building-related process energy systems
- Indoor water risers and outdoor irrigation systems[31]

MATERIALS AND RESOURCES

The process of selecting materials for a building project is normally a complex undertaking, but warehouse developers have a more basic set of components from which to build. Ideally, the evaluation of building materials should begin with a life-cycle assessment, considering all effects of the extraction and manufacturing phases. To reduce demands on nonrenewable resources, warehouse developers should attempt to use local supplies to the greatest extent possible in order to decrease fossil fuel usage in transportation; employ juvenile timber products and toxin-free wood alternatives instead of old growth timber; and use recycled materials.[32]

To this end, LEED Regional Materials and Rapidly Renewable Materials credits reward the use of materials from within a radius of 500 miles and building products formulated from plants that are harvested, on average, within a 10-year cycle, or an even shorter length of time, such as bamboo flooring, wool carpets, linoleum flooring, and WheatGrass™ cabinetry, for example. Opportunities for using rapidly renewable materials are greater in office buildings and homes, but warehouse developers can look to possible uses of these products, especially as their growing presence in the market makes them cheaper over time.[33]

LEED further recommends using salvaged, refurbished, or reused materials and products for 5 to 10 percent of building materials (Resource Reuse and Recycled Content credits). LEED uses the Federal Trade Commission's "Guides for the Use of Environmental Marketing Claims" (available at www.ftc.gov/bcp/grnrule/guides980427.htm) to determine recycled content. Beams, posts, flooring, paneling, doors and frames, cabinetry and furniture, brick, and decorative items are all possible incorporations of reused materials in typical buildings.[34] For warehouses, the choices may be more limited:

> Interviewee 1:
>
> *Concrete is relatively easy to crush up and use in a parking lot. Brick is reusable only if it is high-end; otherwise, it too can be crushed up and used for fill, but this is not ideal. There is a trade-off between materials and delivery. LEED awards local product points for concrete poured on-site but ignores the fact that 10 concrete trucks traveled to the site, polluting the atmosphere along the way and tearing up the roads. "LEED does not go far enough up the food chain."*
>
> Interviewee 2:
>
> *How about awarding points for tilt-up panels? This is done on-site and so there is no transit involved. In any case, it is better that trucks come from a local plant than farther away.*

Although this may apply less in the area of warehouses than other building types, developers are encouraged to maintain some of the existing building structure and shell. The Building Reuse credit conserves between 50 percent and 100 percent of existing walls, floors, and roof. However, LEED also recommends the removal of elements that pose a risk of contamination to future occupants and the upgrading of inefficient components, such as windows, plumbing fixtures, and mechanical systems.

According to the U.S. Environmental Protection Agency (EPA), approximately 136 million tons of construction and demolition waste are generated in the United States annually. LEED recommends deflecting 50 to 75 percent of construction waste from going to a landfill through recycling or salvaging of the construction, demolition, and land-clearing waste (Construction Waste Management Credit).[35]

The Construction Waste Management Database maintained by the U.S. General Services Administration (GSA) has recently updated its online database to aid builders and

developers in reducing construction and demolition waste. Recyclers of construction and demolition waste advertise their services free on this site. GSA's Construction Waste Management program encourages the responsible removal of this waste, including concrete, asphalt, masonry, wood, and other materials, much of which can be recycled or processed for reuse if dealt with appropriately.

Finally, LEED requires decreasing the waste generation from building occupants that is hauled away and disposed of in landfills (Prerequisite 1, Storage and Collection of Recyclables), primarily by creating an easily accessible area dedicated to separating, collecting, and storing of materials for recycling (including, but not limited to, paper, corrugated cardboard, glass, plastics, and metals).

Green Building Strategies

- Create a construction waste management proposal that includes setting objectives for landfill diversion
- Select a location on the construction site for recycling and monitor recycling efforts throughout the process[36]
- Encourage developers and construction companies to utilize the Construction Waste Management Database (http://www.wbdg.org/ccbref/cwm.php) to search for recycling and salvage companies by zip code or material(s) recycled

In addition, developers should be made aware of GreenSpec, the leading national directory of green building products, which lists 1,800-plus products selected by editors of *Environmental Building News*, an authority on the subject. Manufacturers of these green products do not pay to be included, and *Environmental Building News* does not accept advertising. (More information can be found at www.BuildingGreen.com.)

INDOOR ENVIRONMENTAL QUALITY

> Interviewee:
> *Most air quality works. Application makes sense depending on number of employees.*

Indoor air quality (IAQ) has recently become a major concern in all types of buildings with regard to mold, asthma, and other health-related issues that can cause absenteeism and hurt productivity. Nearly half of all commercial buildings in the United States were built after the 1970s, during which time they were designed to be more airtight. As a result, they employed in their construction greater amounts of synthetic building material. Indoor air quality suffered, and building-related symptoms (BRS) became more common.[37] Fortunately, in this respect, warehouses tend to be naturally ventilated (LEED Credit 2.0, Ventilation Effectiveness), and the open structure of the warehouse is different from the typical office structure and HVAC system. Nevertheless, commissioning, in addition to helping with energy efficiency, can also offer improved indoor air quality.[38]

Warehouse building components that have potential IAQ problems include:

Roofing—Flat roofs typically entail applications of asphalt and tar that contain volatile organic compounds (VOCs) and are a considerable source of odors. Some membrane roofing systems used on shopping malls and commercial office buildings can give off emissions of formaldehyde, VOCs, ammonia, and amines. Emissions from these materials can penetrate the structure through open cracks and fissures.

Concrete—Concrete is typically one of the best materials for people who are chemically sensitive; however, chemicals such as fungicides, germicides, and insecticides are sometimes added, which could possibly emit gas into the building.[39]

Green Building Strategies

- Prohibit smoking within the building (required by LEED)
- Monitor for carbon dioxide (LEED Credit 1)
- Use low-emitting materials in adhesives and sealants, paints and coatings, carpets, and composite wood (LEED Credit 4.1-4.4)

INNOVATION AND DESIGN PROCESS

The Meadowlands Commission may be in a unique position to take advantage of the last LEED credit category. For example, it can promote and advocate for the establishment of an eco-industrial park, an outgrowth of the industrial symbiosis movement. Industrial symbiosis is a system of planned materials and energy exchanges that seek to minimize energy and raw materials use, minimize waste, and build sustainable economic, ecological, and social relationships. Eco-industrial parks (EIPs) connect traditionally separate industries in a collective approach to competitive advantage, by linking the physical exchange of materials, energy, water, and/or by-products. As one example, the Cape Charles Sustainable Technology Park includes businesses as diverse as poultry processors, community health-care services, and a National Aeronautics and Space Administration (NASA) facility (http://www.sustainablepark.com/park.html).

The fundamentals of industrial symbiosis include collaboration and the synergistic possibilities offered by geographic proximity. EIPs have not taken any one shape or form, and they are unlikely to, given their long-term goals, the need for large capital investment, and multiple parties with numerous objectives. Given several of the attributes of the Meadowlands (diverse land use, transportation infrastructure, shared services, tax-sharing), it would not be unreasonable to see the development of EIPs in the area.

The U.S. EPA has commissioned several tools to aid in the development of EIPs and attempts to “match up” symbiotic partners. These input/output matching models are known as FaST (Facility Synergy Tool), DIET (Designing Industrial Ecosystems Tool), and REaLiTy (Regulatory, Economic, and Logistics Tool).

CASE STUDIES

The following highlights two case studies along with supporting interviews by representatives of a green warehouse and analogous projects. These reviews of actual projects bring together both the benefits and costs of green warehouse projects.

Case Study #1:
Big Horn Home Improvement Center, Silverthorne, Colorado
Completed April 2000; 44,400 square feet (4,130 square meters)

Building Types: Commercial Office, Industrial, Retail New Construction

Indoor Spaces (percentage): Warehouse, 59; Retail general, 33; Office, 7; Restrooms, 1

Outdoor Spaces (percentage): Parking, 74; Other, 26

ENVIRONMENTAL ASPECTS

Energy

Extensive daylighting and natural-ventilation cooling systems reduce energy demand. Big Horn has a standing-seam roof-integrated photovoltaic system, the largest commercial PV array in the state, and has established a net-metering agreement to sell electricity back to the utility company.

Aggressive daylighting and smart envelope design in the retail zone allow use of natural ventilation to meet all cooling loads. Daytime lighting load is met by daylighting, except times when there are very cloudy conditions. Cluster arrangements of eight compact fluorescent lamps per fixture further reduce electric-lighting load.

Retail area is heated by a hydronic radiant floor system with natural gas-fired boilers. The warehouse is partly heated by a transpired solar collector. The natural ventilation, lights, and heating system are operated by an energy management system to optimize efficiency. The percentage of the total building electrical load met by the photovoltaic system peaked at 6.5 percent in April 2001 (see Figure 9).[40]

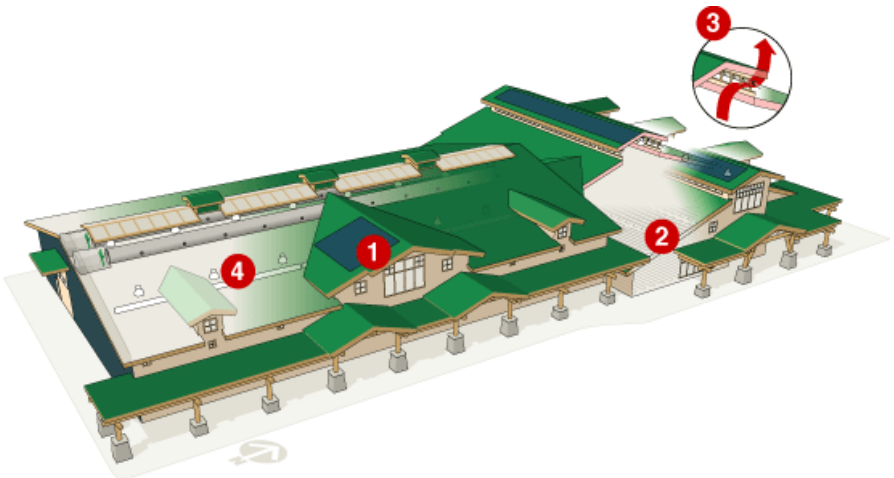
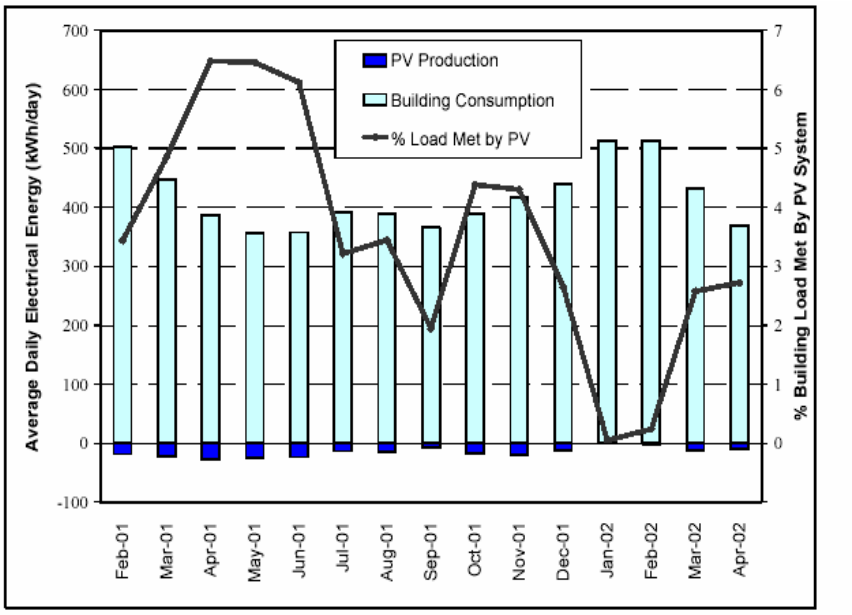


Illustration Key: 1. roof-integrated PV panel; 2. radiant floor heating; 3. computer-controlled operable windows; 4. compact fluorescent lighting combined with daylighting

Figure 9. Big Horn Center Normalized Monthly Energy Summary



Water

Existing on-site wetland areas were expanded and utilized in the development of Big Horn's stormwater management plan.

Finance and Cost

The Big Horn Center was financed traditionally through private equity and loans using no incentives, rebates, or other unconventional methods. Green building tax credits and accelerated depreciation were minor additional considerations. The building cost about 10 percent more than conventional construction. Overall payback is expected approximately 13 years after completion.

Cost Data

Cost data in U.S. dollars as of date of completion.

Total project cost (land excluded):	$5,200,000
Property cost:	$600,000
Soft cost:	$29 per square foot
Hard cost:	$87 per square foot

Design/Process

The owners' initial ambition was to create an energy-efficient green building. Typical pre-design steps were taken, including purchasing property, financing the project, securing tenants, and obtaining entitlements. Site selection was limited since very few sites were available for a retail/warehouse use of this size. Orientation of the building was limited to a rectangular site that ran north and south.

The environmental design of the new construction is in keeping with Big Horn's commitment to green building. The center specializes in green building products, technologies, and advice. It was built in three phases. Phase I adopted the use of clerestory daylighting in a retail setting. Phase II included the addition of PV panels. Through Phases I and II, the design team familiarized themselves with the concepts of daylighting and solar energy. Having confirmed the advantages of daylighting, in-floor radiant heating, and PV operation, the owners decided to expand upon the energy conservation features in Phase III, and the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) was contacted for participation. Big Horn did not employ an independent commissioning agent, partly because in Phase III, a number of commissioning functions were carried out under NREL supervision and there was a high level of collaboration among design and construction teams. A large regional mechanical contractor was selected to independently evaluate the plans and determine when modifications were needed.

Design team members were chosen based upon their willingness to create a sustainable green building. Working with NREL, Big Horn designers took a whole-building approach, examining ways for the building's site, windows, walls, floors, electrical systems, and mechanical systems to work together most efficiently.

Computer-simulations of energy use were utilized throughout the design process. (DOE2.1e was used for energy simulation. SUNREL, a derivation of SERIRES [5,2,6], was used for energy simulation to fine-tune the thermal modeling of the building.) The windows and overhangs were modeled to collect the right amount of light and heat throughout the year. Natural ventilation was included into the design of the warehouse and retail spaces, eliminating the necessity of a central air cooling/distribution system. Natural daylighting allowed for a decrease in the recommended number of overhead light fixtures.

Incorporating many of the sustainable/energy-efficient features at Big Horn was problematic at times. Innovative approaches were met with skepticism by the contractors and mechanical and electrical engineers. Uncertainties were addressed by extensive meetings between the design and construction teams.

Construction

Construction team members were educated toward the goal of creating a sustainable building. They willingly participated in a program to recycle and reuse construction waste. The design and construction team were integrated throughout all aspects of construction; weekly conferences with all team members, including architects, trade contractors, general contractor, and mechanical and electrical engineers, allowed for issues to be addressed on an ongoing basis.

Operations/Maintenance

Big Horn operations managers were individually taught to operate the mechanical, electrical, solar, wind, and computer systems. Mechanical engineers provided instruction on the building energy management computer program. The significance of energy conservation, building maintenance, and waste recycling are continuously reinforced at staff meetings.

Post-Occupancy

An elaborate buildings systems management and monitoring program continues to measure building performance. Aspects of this system are still being adjusted to help improve energy efficiency. Recently, Big Horn converted from a wet to a dry sprinkler system in the warehouse space. This eliminated the need to heat the wet sprinkler system in the warehouse, resulting in a 50 percent reduction in natural gas consumption.

Sources: Big Horn Home Improvement Center Case Study, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy

Case Study #2:
CBF Merrill Environmental Center
Chesapeake Bay Foundation (CBF) Headquarters, Annapolis, Maryland

Lot Size: 31.50 acres

Building Footprint: 13,700 square feet

Water Measures

Water use at the CBF Merrill Environment Center is estimated to be approximately 90 percent less than that of a similar-size, typical office building. This is achieved by a number of innovative measures. The facility employs composting toilets and a rainwater catchment system that reduces the need to draw water from wells. A shed roof, covered in galvanized metal, allows for a single rain gutter, which drains the water through filters and into cisterns, averting the need to upgrade the city infrastructure. The first half-inch of stormwater is collected in every rainfall and stored in rain barrels. A sand filter treats the rainwater, allowing employees to use it for washing gear, hands, laundry, irrigation, and fire suppression.

Stormwater from the parking lot (beneath building) passes through a bioretention stormwater treatment system in the form of man-made wetlands to filter water and treat

oils before the water enters the bay or the adjacent Black Walnut Creek. Drought-tolerant native plants curtail irrigation, and mowing of meadow and grasslands only once a year diminishes fuel use and pollution on-site.

Energy Measures

The building was formed utilizing structurally insulated panels (SIPs) consisting of foam core 4 to 8 inches thick, and oriented strand board (an engineered wood panel). The project used less wood than conventional framing, resulting in higher R-value (a unit of thermal resistance used for comparing insulating values of different materials. The higher the R-value of a material, the greater its insulating properties and the slower the heat flows through it.)

Renewable energy sources provide approximately 30 percent of the building's energy load. Solar hot-water heating provides all the domestic hot water for the building, saving approximately 120 kilowatt-hours (kWh) of electricity daily. A 4 kWh photovoltaic system offsets a small fraction of the building's electrical load.

A ground source heat pump heats and cools the building. Forty-eight 300-feet-deep geothermal wells allow the building's heat to sink in the summer, and provide a heat source in winter, using the constant 54-degree temperature of the ground.

A desiccant dehumidifier and heat-recovery wheel on the heat pump ventilation system provide more energy efficiency. Glazed windows on the south side of the building contribute daylight and passive solar heating. Light sensors automatically dim lights when daylighting is robust.

Figure 10. Key Energy Efficiency Features—Merrill Environmental Center

	Base Case	Chesapeake Bay Foundation
Wall Insulation	R-value = 13	Wall SIPs R-value = 23.5
Roof Insulation	R-value = 15	Ceiling SIPs R-value = 30
Floor Insulation	R-value = 19	R-value = 20
Windows		
–Solar heat gain coefficient	0.39	0.49
–U-Values	0.57	0.32

Process

Charles Foster, chief of staff at CBF, explained that the foundation's mission was to construct a green building, yet do so without violating local planning and safety codes:

> *One of our standards when designing the property was to build without any waivers or variances to any codes. This was much more challenging than anticipated. In the end, we were able to complete the project with just one waiver, what we call a "positive variance." We were able to get by with building a smaller parking lot than was previously there by preserving in perpetuity the ability to expand parking spaces, if needed, and creating a transportation management plan of how we would get our employees to the building.*
>
> *What it did entail in order to get through without variances was on Day Six of the project, we met with all the code and zoning officials—it must have been a meeting with thirty to forty people. We explained what we were trying to do, and then listened for months to them saying, "You can't do that," or "You're doing it the wrong way." The one official said, well just pay the extra money so you don't have to do composting toilets, and I don't know what he would have said if he knew we were actually paying a premium for them.*
>
> *But this process became a two-way education, and we were able to educate the code officials as to what better practices were. The participants, instead of adhering to the letter of the law, actually "took the bait," and we were able to build it the way we wanted, with no other waivers or variances.*

Foster maintains that not only did the CBF project change behavior locally, but it has probably changed the way sustainable buildings are done worldwide. While it was the fourth "green" building the foundation has created since its founding, none of the others received the same amount of publicity. As Foster says, "We were in the right place at the right time, and our efforts have been well publicized."

The CBF gives daily tours of the building, which educate visitors on materials used in the building and about all its sustainable features; on most weekends, the $10 two-hour tour is sold out. A function room can also be rented out for conferences and weddings, creating another source of word-of-mouth advertising.

Benefits Since Occupying the Building

As far as the greenness of the building, no systemic failures have occurred, according to Foster. There are minor details he would change, given 20/20 hindsight, but all the large-scale systems continue to work well. The foundation saves 50 percent on its energy bill and 90 percent on its water bill, pocketing $50,000 a year from those savings.

Costs

Foster admits that the foundation was "extremely lucky, in that we had an individual donor who was very generous." He admits there is no payback from some of the recycled and reused materials. They cost a premium, and they don't pay anything back over time, such as the cork flooring. He says that while the reduced utility bills tend to be the biggest draw for other developers, energy and water-use efficiency isn't the biggest monetary benefit of going green. Foster explains, "The utility bills, that's just nibbling at the edges. If you can increase productivity in your workers by just 1 percent, than you've really achieved something, and that payoff is a very real benefit." Foster has seen greater integration and communication among the staffers, high retention rates, and a virtual waiting list of top talent vying to work in the building.

Beyond that, Foster says the outreach the foundation has accomplished through the building has been extraordinary: "We've developed relationships with people we never dreamed about connecting to. Greening a building or a warehouse is part of marketing yourself, and it's another very real benefit. I don't think it's a stretch to say that a company can market a green roof or a green warehouse, and reach a whole new group of customers."

His advises getting developers out of the "first costs" mentality, starting with warehouse owners. He suggests establishing a focus group of potential warehouse owners or buyers and asking them what 50 percent in energy savings means to them. Find out what they're willing to pay for increased water efficiency. Even though warehouses tend to be out of sight, and companies may not want to spend the extra money on green initiatives, there are benefits to being able to label a facility as a "green" product. As Mr. Foster notes, buyers may be "more willing to pay for cost savings than developers think. They can sell the green story to their constituents. Then you could set the parameters at what the market would bear. You can't believe the benefits that can come from being able to tell a customer that 'I'm a good guy.'"

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Sources: Interview with Charles Foster, Chief of Staff, Chesapeake Bay Foundation, 12/03/04; National Renewable Energy Laboratory, U.S. Department of Energy; Chesapeake Bay Foundation website: http://www.cbf.org

PART III—IMPLEMENTATION

The Meadowlands Commission, through its regionally based zoning and land-use regulations, accompanied by its inter-municipal tax sharing formula, is an example of a government entity that actively pursues a smart growth agenda with ample tools to institute a high-performance green building policy. In so doing, the Commission can further advance state and local goals, including the attainment of annual incremental reductions in ozone and carbon dioxide emissions, an increase in the state's renewable energy portfolio, and conservation of water resources.

While green building ultimately benefits everyone, implementation strategies for the NJMC can be broken down into two target market segments—public and private.[41] In many areas, the implementation of a green building policy should be very similar across these two markets; however there are some areas in which differences arise. For example, a challenge for a [private-sector] warehouse developer is that the value of improvements s/he makes may or may not be transferable to, and thus recoverable from, tenants or investors. In the case of a public building, however, this problem does not exist as building ownership will most likely remain public, and incremental first costs and life-cycle benefits are therefore aligned.

The green building strategic recommendations of this report correspond to and support the Systems Plans identified in the NJMC Master Plan of 2004 and include:

- The promotion of innovative technology in business and business operations such as the LEED™ Green Building Rating System (System 2: Strategy 4)
- Promotion of environmental education and awareness (System 1: Strategy 4)
- Encouragement of emission reductions from mobile and stationary sources (System 1: Strategy 3)
- Strengthening of economic partnerships to encourage a variety of commercial and industrial uses (System 2: Strategy 3)
- Fostering development of an integrated intermodal freight system (System 3: Strategy 6)
- Consideration of support capacity of community facilities and private utilities when planning or reviewing types and levels of development (System 5: Strategy 2)

Public- and Private-Sector Strategies

S1: Conduct or host workshops on the costs and benefits of green building.

One of these workshops should be on the role of building commissioning. The NJMC should decide how active a role it can play in this area. NJMC may consider soliciting the services of the IAC at Rutgers University for this task (discussed in Part II). Although this is not the current role of the IAC, the Center should be able to offer considerable technical expertise to the commissioning process and could partner with the Rutgers Center for Green Building to manage process and policy concerns.

In pursuing an educational outreach approach, the NJMC will build upon the successes of its existing educational programs and facilities.

S2: Develop the capacity to serve as a clearinghouse for information on high-performance building incentives, or partner with Rutgers University to do so. Serve as an advocate for accessing these incentives.

Green building incentives are offered by the New Jersey Clean Energy Council, New Jersey Board of Public Utilities. A partnership could be formed with the Rutgers Center for Green Building at the Edward J. Bloustein School of Planning and Public Policy to monitor, disseminate, and evaluate these incentives.

S3: Consider an alternative vehicle-fueling center for municipal and private vehicles.

This would allow developers to attain the alternative vehicle credit in LEED—e.g., recall that many warehouse workers are delivered to their workplaces by caravan. In general, this would facilitate NJMC System 1: Strategy 3.

S4: Implement plans for the development of an integrated intermodal freight system.

Recognizing that there may be funding challenges in pursuing this strategic objective outlined in the NJMC Master Plan, this is a public–private sector win-win, as it would be economically positive for warehousing and distribution and for its public environmental consequences.

S5: Conduct a feasibility analysis of a public–private Eco-Industrial Park.

EIPs were discussed in Part II of this report. Given their unique combination of assets, this highly advanced form of industrial symbiosis could work well in the Meadowlands District.

Public-Sector Strategies

S1: Offer gap funding for public building-system improvements (i.e., energy-efficient heating/cooling, water-saving devices, solar panels).

Thirty to 70 percent of the cost of these systems may be rebated by the New Jersey Clean Energy Council. Additional funding may be provided through the inter-municipal tax share formula for the year or years that the initial cost is incurred. Note that once these systems are installed, the municipality will realize significant budgetary savings and thus will not require continued tax benefit.

This program could be extended to schools within the Meadowlands District and houses of worship.

S2: Create a measurement and verification (M&V) system for green building.

This can build upon the LEED requirement and tie into other M&V protocols in use in New Jersey while supporting an ongoing effort by NJMC to develop a framework to track sustainability within the District. The Master Plan refers to establishing measurable indicators to assess the progress of Master Plan–promoted initiatives.

Private-Sector Strategies

S1: Amend the building code (or zoning regulations as appropriate) such that when building heating/cooling or water systems are retired, they are replaced by more efficient equipment per LEED. New construction should specify HVAC equipment that does not use CFC refrigerants.

S1A: Develop a phaseout plan for existing systems.

S2: Amend the building code or zoning regulations such that new and replaced warehouse roofs will be reflective and/or Energy Star–approved.

S3: Add a LEED Scorecard requirement to the Project Impact Assessment regulation.

This will allow both the Commission and developers to gain experience of what works and doesn't work in LEED and to continue in the spirit of this research toward developing more appropriate guidance for the Warehouse and Distribution land use, as well as other uses, within the District.

S3A: Require a minimum of 8 credits in the Energy and Atmosphere category, a minimum of 4 credits in Storm Water Management and Water Efficiency, and a minimum of 10 percent recycled building and site content.

Whereas some of the Sustainable Site and Indoor Environmental Quality points in LEED may not work well with warehouses (explored in Part II above), the Energy and Atmosphere, Water Efficiency, and Materials and Resources categories appear to fit fairly well. These benchmarks are based on case studies, best practices, and existing guidelines in use elsewhere.

S4: Have developers contribute to a green building fund for District-wide education and outreach activities.

The contribution could be refunded if projects earn LEED certification or an equivalent.

S5: For existing buildings, offer owners and tenants the benefit of an Industrial Assessment.

S5A: Conduct an inventory to identify equipment that uses CFC refrigerants.

As noted above, the Rutgers University IAC provides evaluations of existing equipment and processes.

S6: For new and existing buildings, establish a project review of potential renewable energy opportunities.

This review could include non-polluting and renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass and bio-gas technologies, and instruction on how to take advantage of net-metering and renewable energy certificate

programs. Review of such elements could be added to existing NJMC site plan and environmental performance standard reviews.

S7: Integrate commissioning requirements in bid documents.

A commissioning agent should be required to produce a report upon the completion of all commissioning activities.

S8: Consider a density bonus for warehouse developers willing to build or retrofit to the LEED Silver standard or its equivalent.

As was previously discussed, not all LEED points make sense for warehouses, and over time the NJMC will develop a better understanding of what an equivalent green building policy would look like. In particular, increased density regarding a warehouse and LEED guidance to minimize the building footprint and soil disturbance may be at odds since warehouses are getting larger and are most commonly 1-story structures. One suggestion to accommodate both imperatives may be to devise a system of shared parking for otherwise separate warehouse/distribution buildings in an effort to preserve land or, perhaps, a "back-to-back" site condo arrangement, which would eliminate a double setback.

S9: Consider requiring LEED Silver or Gold (or an acceptable equivalent) for more environmentally sensitive but also commercially valuable areas.

S10: Consider utilizing Tax Increment Financing (TIF) to encourage green building and tie it to LEED level (or equivalent) achieved.

A policy based on TIF would take a portion of the incremental property tax revenue and use it to create a "Green Bond Fund" to provide capital for improvements.

Although there are undoubtedly many other policy options one could choose to implement a green building policy, it is believed that those discussed within this document (or some subset thereof) should prove sufficient to catalyze interest in green building and promote its further development.

Other Strategies

Additional policy options that are beyond the scope of the NJMC were mentioned by interviewees. These include:

- Preferential tax-treatment (especially at the federal level)

  > *Indeed, building owners across the country just got a $1.5 billion tax break in the American Jobs Creation Act of 2004, signed into law on October 22. It lets commercial landlords deduct the cost of improvements on leased property over 15 years rather than 39 years. This may be something that not all warehouse owners and developers are aware of yet, but which makes green building improvement more economically feasible.*

- Benchmarked variable energy cost (e.g., reduce cost to bottom, increase cost to top)

- Green Bonds, as included in the Final Foreign Sales Corporation-Extraterritorial Income FSC-ETI bill approved recently by Congress.

PART IV—FUTURE RESEARCH AGENDA

This work has analyzed technical and policy options for green building of warehouse and distribution facilities within the Meadowlands District. Whereas many of the suggestions contained within this document apply to green building in general, future studies may address characteristics more specific to residential, office, and/or retail building types. Additionally, there are other aspects of green building that could augment the analysis provided herein, including topics in green building that are presently being explored by colleagues and students at the Rutgers University Edward J. Bloustein School of Planning and Public Policy, some of which are:

- Productivity Gains and Green Buildings
- Marketing and Green Buildings
- Security and Green Buildings
- Barriers to Green Buildings
- Historical Preservation vs. Greening of Urban Buildings
- SWOT Analysis of Green Building Market
- Windmills

The following are recommendations for additional work pertaining to industrial green buildings:

- Discussion and refinement of policy options pertaining to potential "green building" credits in the inter-municipal tax sharing program, and implementation of tax increment financing

- Conducting about six additional interviews with warehouse developer/owners in New Jersey and perhaps some warehouse tenants to gain further insight from existing operations

- Developing a strategic implementation plan for industrial green building in the Meadowlands District

Endnotes

1. Unless otherwise noted, facts and figures are drawn from the New Jersey Meadowlands Commission Master Plan, as adopted January 2004.
2. Sheila Vertino and Kathryn George, "Warehouses: Endangered Species or Growing Gargantuans?" *Development* (Summer 2004).
3. Master Plan, op. cit., p. 8-8.
4. Op. cit.
5. Sheila Vertino and Kathryn George, op cit.
6. *Environmental Building News*, Volume 10, Number 5 (May 2001). These statistics exclude industrial buildings. See also, U.S. Green Building Council Web site, www.usgbc.org; Hayter et al. 2000, 1.
7. K. Yeang, *The Green Skyscraper*. Munich: Prestel-Verlag, 1999.
8. This was announced at the November 2004 USGBC conference in Portland, Oregon, attended by one of the authors.
9. Target and Home Depot, members of the USGBC, are pushing for more-specific LEED guidance for warehouses (USGBC conference in Portland, Oregon, November 2004.)
10. In a separate interview, it was learned that the expected life cycle of a warehouse building is "forever" in that it is much more likely that an existing warehouse will be upgraded rather than a new one built.
11. "Low Impact Development Techniques," *New Jersey Stormwater Best Management Practices Manual*, ch.2.
12. Water Systems Guidelines in "Green Building Design and Construction Guidelines," Santa Monica Green Building Program.
13. U.S. Environmental Protection Agency, Office of Water and the Low Impact Development Center, *Low Impact Development (LID); A Literature Review*, EPA-841-B-00-005, Washington, DC, October, 2000.
14. "Conserving Water," Santa Barbara County Green Building Guidelines, The Sustainability Project.
15. Alex Wilson, "Using Greywater for Landscape Irrigation," *Environmental Building News* 4:2. BuildingGreen.com
16. Wilson, op. cit.
17. U.S. Green Building Council, LEED Rating System Version 2.1.
18. U.S. Green Building Council, LEED Rating System Version 2.1.
19. <http://www.njsmartstartbuildings.com/main/design_support1.html>
20. <http://www.njsmartstartbuildings.com/main/design_support1.html>
21. U.S. Green Building Council, LEED Rating System Version 2.1.
22. U.S. Green Building Council, LEED Rating System Version 2.1.
23. U.S. Green Building Council, LEED Rating System Version 2.1.
24. Patterson, op. cit.
25. U.S. Green Building Council, LEED Rating System Version 2.1.
26. The RPS, in fact, has been increased to 20 percent by 2020 for Class 1 renewables through rulemaking that was done in April 2006.

27. Renewable Energy Task Force, "The Renewable Energy Task Force Report Submitted to Governor James E. McGreevey," April 24, 2003.
28. Interview with Pam Frank, Sunfarms Network, December 14, 2004.
29. U.S. Green Building Council, LEED Rating System Version 2.1.
30. Patterson, Kelly. "The Environment-Facilities Connection." *Maintenance Solutions.* May 2001
31. U.S. Green Building Council, LEED Rating System Version 2.1.
32. "Green Building Material Options," Santa Barbara County Green Building Guidelines, The Sustainability Project.
33. "Green Building Material Options," Santa Barbara County Green Building Guidelines, The Sustainability Project; U.S. Green Building Council, LEED Rating System Version 2.1
34. U.S. Green Building Council, LEED Rating System Version 2.1.
35. U.S. Green Building Council, LEED Rating System Version 2.1.
36. U.S. Green Building Council, LEED Rating System Version 2.1.
37. AERIAS, Air Quality Sciences Web site.
38. David Kozlowski, "Preventive Health Care for Buildings," *Buildings Operation Management* (December 2004).
39. AERIAS, "Commercial Building Materials."
40. S. Hayter, P. Torcelllini, and M. Deru, "Photovoltaics for Buildings: New Applications and Lessons Learned." Conference paper presented at the American Council for an Energy Efficient Economy (ACEEE) Summer Study on Energy Efficiency in Buildings, August 18-23, 2002.
41. There is also a significant third-market segment in green building. This is the not-for-profit sector, which often partners with the for-profit sector to enable the latter to obtain dedicated grants and loans.

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