Site Resource Optimization SEQ-1

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Purpose: To draft and implement the requirements of a Site Resource Optimization Plan.

Action: The Site Resource Optimization Plan provides a tool for an integrated consideration of water, material and energy resources with the goal of identifying, evaluating and optimizing utilization of all resources on the site. The plan overlays information from the individual water, material and energy management plans and identifies integrated opportunities for resource conservation.

Related Guidelines: UEQ-8, SEQ-2, SEQ-3, SEQ-5, SEQ-6, SEQ-7, SEQ-11, WEQ-1, WEQ-2, WEQ-3, WEQ-4, EEQ-1, EEQ-3, EEQ-5, MEQ-1, MEQ-2, MEQ-3, MEQ-4, MEQ-5, MEQ-7, IEQ-1, IEQ-6

Introduction/Context

The observation of natural ecosystems offers a unique means to understanding resource flows, and through the emulation of these models, how these flows may be interpreted to inform a sustainable approach to the built environment.

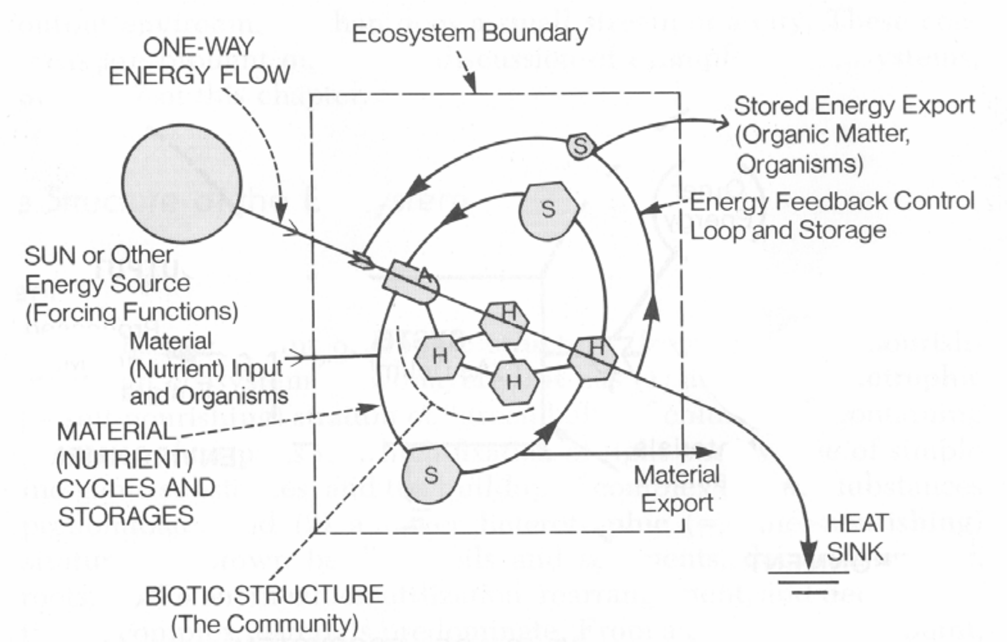
Ecosystem is a term that was first used in 1935 by an English botanist, Sir Arthur Tansley, to demonstrate how the living world is tied to the non-living world. Ecosystems came to be understood as organized conceptual units with interdependent living and non-living components. Ecosystems are never closed or entirely balanced systems. While internal ecosystem components may work toward equilibrium, inputs, outputs, and the external environment often work against it. The goal of sustainable design is to minimize these imbalances, and studying how ecosystems have evolved to sustain themselves provides us with a model for integrated resource management. Energy, water, material and air resources are interrelated in important ways and an integrated consideration of these elements is an essential process of sustainable design.

Energy moves through an ecosystem in a linear way, using the sun as its primary source. As energy moves through the system, it is both slowly dissipated and transformed into more highly ordered forms. Plants 'fix' solar energy, concentrating it in the form of food or plant matter, through the process of photosynthesis. Organisms that cannot synthesize their own food consume this plant matter, creating even more concentrated forms of energy and dispersing energy through heat loss to the external world.

These simple relationships are relatively clear in a pond or prairie ecosystem. They become more complex in an urban industrial ecosystem. Existing urban ecosystems have a much higher appetite for energy and more demanding appetite for materials than pre-industrial systems. Cities, for instance, are largely constituted of materials that originated in distant mines and quarries and which were processed in distant factories, before being transported over great distances, all at large energy cost. Food is manufactured in energy intensive agro-ecosystems and transported by ship, rail and truck to inner city dwellers. All cities are dependent upon thousands of miles of electric cable, gas lines, water mains, sewer pipes, roads and rails, stretching across bridges and through tunnels, together with vast fleets of cars, trucks, buses, trains and planes, all essential to move energy and nutrients through the system. Without this infrastructure, cities would not be able to maintain their complex, highly ordered structures. The major source of this energy is currently non-renewable fossil fuel, which is extracted from the Earth, transported long distances and burned, with concomitant environmental consequences.

Among contemporary American urban industrial ecosystems, New York City is a model of efficiency because of its density and closely integrated transit systems. Urban industrial ecosystems rely on concentrated inputs of energy in the form of fossil fuels to maintain largely industrialized life support systems. This is in contrast to natural plant or forest communities, which are primarily sustained by a renewable and non-polluting source of energy, the sun.

This guideline requires that the complex relationships between energy, water, material and air resources on the World Trade Center Site be studied to maximize opportunities for resource conservation.



A functional diagram of an ecosystem. Energy flow, material cycles, the community and feedback control loops are the four major components. (Odum 1983)

Relevant Issues

Ecological

Good resource management is essential to sustainable design and when resources are considered in an integrated way, many opportunities which might normally not be apparent become visible.

Industrial ecology is a new field which attempts to provide this framework for industry. Ecologists working in this field look for opportunities to bring different industries together in symbiotic relationships. This paradigm departs from the traditional linear method for the industrial process which begins with the input of raw materials and ends with a finished product, while byproducts are sent to a landfill. Instead it promotes a more circular process where the waste from the manufacturing of one particular object becomes raw material for another. This sets up and maintains a cradle-to-cradle resource conservation approach, where there is no waste and materials are used indefinitely. It contributes to sustaining the Earth's limited material resources.

Economic

The re-use of natural resources and the recycling of end-products for use elsewhere reduce the capital spent on obtaining and processing virgin resources. The ratio of energy saved by doing so can be significant. For example, only 5% of the energy used to obtain and process raw materials associated with the manufacturing of aluminum is expended in the recycling of that metal. The capture of "free" resources such as daylight, solar energy, wind and rainwater saves capital that would otherwise be spent on the purchase of replacement resources or services. The re-use of free and/or salvaged resources often eliminates disposal costs and can save on the construction capital associated with the use of such materials.

Neighborhood

When overall resources are conserved and used efficiently, it is more likely that a community will have more resources available and not be forced to cope with a shortage (e.g. brown-outs during the hottest days of summer, and drought conditions when the reservoirs run low).

Methodology

Design Strategies

Develop a method for identifying potentials for resource reuse based upon the individual management plans developed for site water resources, energy, and materials.

Seek to close resource loops in designing systems that use available resources in a highly efficient manner, and capitalize on the re-use potential of waste outputs from one part of the system by other parts.

Include life cycle analysis considerations in material, equipment and systems decisions.

Means and Methods

Use rainwater catchment and wastewater recycling systems to reduce the outflow of tainted water from the site and provide graywater for use on the site and in its buildings. (refer to SEQ-2 and WEQ-2) Explore the potential for waste-to-energy conversion systems to reduce the amount of material sent to landfills while exploiting this renewable source of power. (see SEQ-11) Compost biodegradable materials to obtain free fertilizer for the maintenance of site landscaping and reduce trash hauling and tipping fees. Develop renewable energy programs to promote the site's ability to generate electricity, save money on utility bills, and contribute less pollution to the surrounding environment. (see EEQ-5) Use energy and heat recovery technologies to recover used power and heat for use throughout the site. Incorporate daylight dimming and occupancy sensors to further save energy and money. (refer to EEQ-1 and EEQ-3) Material recovery technologies, cradle-to-cradle purchasing plans, and local/regional purchasing can all further contribute to site efficiency both economically and ecologically. (see MEQ-1)

Case Studies

Kalundborg Industrial Park, Kalundborg, Denmark

This industrial park has been in operation since the 1970's and includes a power plant, an oil refinery, a plaster board manufacturing plant, fish farms, a large pharmaceutical plant and a district heating, power and water system for the municipality of Kalundborg. The coal-fired power plant pipes surplus steam to both the pharmaceutical plant and oil refinery and waste heat to a district heating system for 3,500 nearby homes. Additional waste heat is used in the operation of on-site fish farms. The power plant also recovers fly ash and gypsum from the coal-to-energy process and sells these materials to a cement manufacturing facility and a wallboard plant, respectively. Sulfur, a waste product from the refinery's processing of natural gas is sold to a sulfuric acid manufacturer. Sludge from the pharmaceutical plant is used as fertilizer for local agriculture. (Garner 1995)

Reference

Definitions

Industrial Ecology is the study of the physical, biological and chemical interactions and interrelationships both within and between industrial and ecological systems (Garner 1995).

Life Cycle Analysis involves the examination of the manufacture, use, and disposal of a product, from raw material extraction to the end of its useful life in order to identify and evaluate all of its environmental impacts.

Standards

Standards have not been included for this Guideline.

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Site Resource Optimization Plan SEQ-1-P

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Objective

The Site Resource Optimization Plan provides a tool for an integrated consideration of water, material and energy resources with the goal of identifying, evaluating and optimizing utilization of all resources on the site. The plan overlays information from the individual water, material and energy management plans and identifies integrated opportunities for resource conservation (i.e. high capture and utilization of stormwater at upper levels of tower reduces pump energy required for lifting equivalent amount of water).

Plan Components

I. Project Description (Plan Summary)

A. Based on the basic plan provided by the PANYNJ and LMDC, provide a physical description of each specific project site with emphasis on energy, water and material system interconnections.

II. Resources Inventory

A. Provide a detailed inventory of site resources.
B. Provide a detailed description of site resource interconnections.

III. Site Resource Management Strategies

A. Develop the following resource management plans in an integrated way.
   1. Water Management Plan
   2. Material Management Plan
   3. Construction Waste Management Plan
   4. Energy Management Plan
   5. Renewable Energy Transition Plan

B. For each Resource, describe the plan to utilize it on-site in terms of consumption, distribution, process, regulatory controls, economic concerns, reuse, etc. To the extent plausible, implement a resource recovery strategy to reclaim as much of the resources as possible on site and integrate them to optimize their use.
   1. How are these resources used?
   2. How do they get to the site?
   3. What happens to the resource while on site?
   4. What is the intended end use of the resource and is this the best/highest use?
   5. Are resources leaving the site under-utilized?
   6. Can the amount of resources leaving the site be minimized or eliminated?

C. Describe resource flows and interactions in relationship to the larger urban ecosystem. Identify opportunities to increase urban ecological sustainability. Include matrix of trade-offs in optimizing one resource over another.

IV. Targets

Establish and describe project targets for the following

A. First year of operation.
B. 5 year and 10 year plans.

V. Evaluation

A. Outline the ways that the resources are being handled and the ways in which they have been optimized.
B. Implement ongoing monitoring for all systems.
C. Document the systems and the results after the plan has been implemented.

Site Resource Optimization

SEQ-1-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	●	●	●	●	●

☐ **Required Component:**
A Site Resource Optimization Plan is attached. This plan includes specific information regarding the interrelationship of the individual water, material, and energy management plans that are part of the overall Sustainable Guidelines Reference Manual. Examples and calculations are attached to quantify the positive environmental and economic benefits as required by the Optimization Plan.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Storm Water Use SEQ-2

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Purpose: To capture and utilize site storm water flows, thereby reducing storm water volume and surges through the system.

Action: Implement a plan for stormwater management as part of the Water Management Plan that reduces the post-development flow of stormwater by a minimum of 25% from the site pre-9/11 base. Construct treatment systems to remove 80% of total suspended solids (TSS) and 40% of total phosphorous (TP) per EPA Document (840-B-92-002) Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (based on the average annual loadings from all storms less than or equal to the 2 year/24 hour storm).

Site/Parcel: Design site surfaces to allow collection of site storm water flows from other than street surfaces. Provide storage and filtration infrastructure. Fully use captured water as appropriate and in conjunction with Water Management Plan.

Towers: Consider towers with ledges, roofs and setbacks, which will assist in capturing water sheeting off buildings at high elevations to capture potential energy of water and reduce water pump energy requirements. Provide storage and filtration infrastructure near point of capture. Use water, as appropriate, for toilet flushing and as part of building water systems.

Related Guidelines: UEQ-1, UEQ-8, EEQ-1

Potential LEED™ 2.1 Credits: 2 possible with SS cr. 6.1, and SS cr. 6.2. (see Submittal Template)

Introduction/Context

Precipitation averages 47.25 inches a year in New York City, including 23" of snow (Central Park Weather Station). This means over 20 million gallons of water [(696, 960 ft^2 x 3.9375 ft = 2,744,280 cubic feet) x 7.481 gallons/ft3 = 20,529,958] will fall on the 16 acre World Trade Center Site over the course of a year. Much of this water can be captured and reused at the site as gray water for irrigation purposes and/or the flushing of toilets and urinals, following appropriate treatment. Pre 9/11, this water was funneled into the city's combined storm/sewage system. This system often becomes overwhelmed during storms, releasing combined, untreated storm water/sewer outflows into the Harbor estuary.

There are more than 450 combined sewer outfalls in New York City therefore, capturing storm water at all possible locations is an important sustainable strategy. Collecting this water, for reuse on the project site, will be a significant positive contribution to the local marine ecology.

Relevant Issues

Ecological

Reducing site storm water discharges reduces the likelihood that untreated sewage will enter the harbor or the river estuaries. Stormwater captured on site can be used, after treatment to tertiary standards, for irrigation, maintenance purposes, in cooling towers and for toilet and urinal flushing, reducing the need for, and pressure on, potable water. Capturing stormwater run-off at rooftops and high terraces, and using it at these elevations near where it is collected, will save on pump energy, while minimizing environmental pollution from conventional power generation.

Economic

The use of captured stormwater lessens the demand for potable or first use water, and supports water 'cascading' – where all water is used at the optimum quality necessary and appropriate for each task -- and reduces water utility costs. Maximizing use of this resource at the site generates considerable savings by lessening the need for potable water, thereby lowering water rates.

Cleanup and liability from untreated storm/sewer outflows can be expensive for the city. By retaining the stormwater portion as a resource at the site, the need for these costs may well be averted. Additionally, this strategy begins to establish a city-wide approach to conserving water, which will eventually reduce the current pressure on infrastructure. Both water supply mains and storm/sewer pipes and tunnels will be less pressured, reducing the need for maintenance and repairs, and for the construction of new infrastructure. Concentrated sewage is more easily handled and requires less treatment than the mixed volumes of stormwater and sewage which is typically delivered to the treatment plants after a heavy rainfall in Manhattan.

Neighborhood

Reducing the damage to natural waterways by reducing stormwater/sewer pollution preserves the quality of receiving water bodies for wildlife, fishing and recreational enjoyment.

Sites requiring minimal stormwater processing by the municipality are also economical to manage. There are precedents for these reduced operating costs being passed on to community members in the form of reduced taxes.

Enhanced handling of stormwater, and retention on-site, reduces the potential liabilities related to flooding, and for outflows of untreated biological materials with their resulting unsanitary conditions and threat to community health.

Methodology

Design Strategies

Implement a stormwater management plan (as part of the Comprehensive Water Management Plan) that reduces the post-development flow of stormwater from the site (9/11 base) by a minimum of 25%.

Design systems that make visible the storm water collection and re-use process to aid in site user education and tell a story about natural processes.

Means and Methods

Site/Parcel:

Design surfaces to allow collection of site stormwater flows from other than street surfaces, (i.e. water from pedestrian sidewalks and plazas) Provide storage tanks or cisterns at high elevations and at ground or basement level. Install on-site filtration infrastructure. Include an on-site treatment facility to treat gray water (storm water and, if applicable, water from sinks, showers, etc.) to tertiary standards. Re-use captured stormwater/gray water for irrigation and maintenance applications.

Buildings:

Consider using ledges, roofs, terraces, and all applicable setbacks to assist in capturing water sheeting off building surfaces at high elevations. Capture the potential energy of this high elevation rainwater to reduce water pump energy requirement. Provide storage, filtration and treatment near the point of water capture, when possible. Use captured water for such applications as at toilet flushing, urinals, and for cooling tower make-up and in building mechanical systems where appropriate.

Case Studies

The Solaire, New York, New York

A storage tank located in the building's basement is used to capture stormwater as it runs off the building and falls on the site. The system was designed to meet the irrigation load of the site thus saving material resources by not over sizing the tank. Consequently, 100% of the stormwater captured on the site is used to irrigate the gardens on the building's roof. The roof itself was also designed to retain rainwater, about 70% of the amount that falls on it. This water is used by the roof plantings and is prevented from becoming stormwater runoff. It is estimated that roughly 170,000 gallons of rainwater will be collected and used on the site each year. (USGBC 2004)

Philip Merrill Environmental Center, Annapolis Maryland

The prevention of stormwater runoff on this site was critical because of its proximity to Chesapeake Bay. The rainwater collection system begins with the building's roof, designed as a shed to allow rainwater to runoff in one direction and be captured by a single gutter. This gutter directs the water through a series of filters and into cisterns. Sand filters are used to condition the rainwater and make it suitable for use in washing hands and equipment, laundry, irrigation, and fire suppression. This natural source of water was much welcomed because the existing city infrastructure was not capable of supplying the volume of water that a building without rainwater harvesting would need. The majority of parking needs for the building are accommodated underneath it. However a small outdoor parking lot was also needed. This lot was designed with a permeable surface that permits stormwater to be collected and directed through a bioretention system for treatment before being expelled into the bodies of water adjacent the site. The manmade wetlands that comprise this filtration system remove particulate matter and oils from the runoff. (USDOE 2005)

Reference

Definitions

Site Stormwater is any water that falls on site surfaces from a precipitation event.

Total Phosphorous (TP) consists of organically bound phosphates, poly-phosphates and orthophosphates in stormwater, mostly originating from contamination by fertilizer. The standard method for removing phosphorous from water is by chemical precipitation.

Total Suspended Solids (TSS) are particles that are so small and light that they do not fall settle out of stormwater under gravity alone. Filtration is a common way to correct this condition.

Gray Water Gray water is made up of two typical components: recycled water from non-sanitary appliances, such as lavatories, showers, washing machines, and captured stormwater. Either, or a mixture of both, may be called gray water. All gray water must be treated to tertiary standards prior to reuse for building purposes e.g. as cascaded water in toilets and urinals, or in cooling towers.

Tertiary Standards for wastewater treatment produces higher quality effluent through the further removal of contaminants such as nitrogen, phosphorus, heavy metals, residual suspended and dissolved solids, and synthetic organic chemicals. Tertiary treatment can involve processes such as carbon adsorption, reverse osmosis, micro-filtration, and biological nitrogen and phosphorus removal.

Standards

United States. Environmental Protection Agency. Guidance Specifying Management Measures for Sources of Non-Point Pollution in Coastal Waters. January 1993. 29 September 2004 <http://www.epa.gov/owow/nps/MMGI>

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United States Green Building Council. “LEED Certified Project Case Study : 20 River Terrace – The Solaire.” USGBC – LEED Case Study. 2003. USGBC. 22 September 2004. <http://leedcasestudies.usgbc.org/overview.cfm?ProjectID=273>

Storm Water Use SEQ-2-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	◉	◉	◉	◉	◉
		Ⓔ	Ⓔ		

☐ **Required Component:**
A stormwater management plan is attached and outlines how stormwater will be captured on the site and subsequently used to reduce potable water dependence.

☐ **Required Component:** (*Note: this will satisfy LEED™ 2.1 Sustainable Sites Credit 6.1: Stormwater Management – Rate and Quantity)*
Supporting calculations are attached and verify that stormwater runoff from the site has been reduced by 25% or greater from a pre-9/11 base.

☐ **Required Component:** *(Note: this will satisfy LEED™ 2.1 Sustainable Sites Credit 6.2: Stormwater Management – Treatment)*
The attached outline describes the specific methodology that will be used to treat site stormwater and includes calculations that demonstrate this treatment is effective at removing 80% of total suspended solids (TSS) and 40% of total phosphorus (TP). (In accordance with EPA Document 840-B-92-002 Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters and based on the average annual loadings from all storms less than or equal to the 2 year/24 hour storm).

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Purpose: Reduce site development contributions to "heat island" effects in Lower Manhattan. Seek to maximize areas of landscape planting (green infrastructure) coupled with high albedo surfaces at other areas to mitigate thermal loading of site surfaces and building roofs.

Action: Provide green infrastructure coupled with high albedo surfaces to mitigate thermal loading of site surfaces and building roofs.

Site/Parcel: Provide shade and/or use light-colored/high-albedo materials (reflectance of at least 0.3) or open reinforced grid pavement for at least 30% of the site's walkways, plazas and open spaces.

Tower: Use ENERGY STAR® compliant AND high emissivity roofing (emissivity of at least 0.9 when tested in accordance with ASTM 408) for a minimum of 75% of the roof surface; OR install a "green" (vegetated) roof for at least 50% of the roof area. Combinations of high albedo and vegetated roof can be used providing they collectively cover 75% of the roof area.

Related Guidelines: UEQ-5, UEQ-6, UEQ-8, SEQ-1, SEQ-9, EEQ-1, IEQ-1

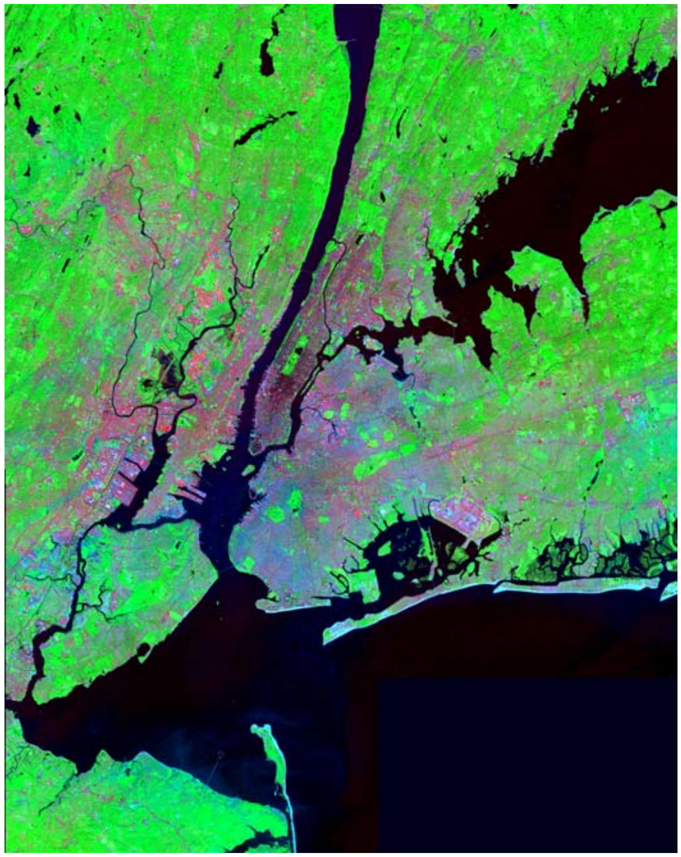
Potential LEED™ 2.1 Credits: 2 possible with SS cr. 7.1, and SS cr. 7.2. (see Submittal Template)

Introduction/Context

"Urban Heat Islands" are phenomena in which dense urban environments, like New York City, create microclimates, which are significantly warmer than regional patterns. These microclimates result from a combination of factors, including waste heat from buildings and vehicles, reduced evaporative cooling (hard, absorptive surfaces vs. vegetated areas) and most importantly, the trapping of solar radiation. Heat island effect is foremost a problem in New York City in the summer months and can vary across the city depending upon the local microclimate.

The infrared satellite view of Manhattan and its surrounding areas (shown on the next page) indicates zones of heat build-up, which affects human comfort, air quality and building energy loads. The darker shades of red and purple indicate higher temperatures, which are most evident in midtown and lower Manhattan. These areas stand in sharp contrast to the cooler, vegetated areas around the dense urban core of the region. The build-up of heat increases air conditioning loads, levels of pollutants and environmental stress. In contrast, parks, gardens and grasslands have lower thermal mass allowing for the rapid loss of daytime heat gains to the cooler night air. Therefore, areas of a city with more open green space have cooler microclimates.

(Note: there is an intelligent application of the reverse effect to crate an "outdoor room" that can remain comfortable during cooler periods of spring and fall. Here you select masonry or stone surfaces that will store solar energy and re-radiate the warmth for enhanced comfort.)



Infrared Satellite View of NYC (© 2002 Christopher Small)

Relevant Issues

Ecological

Reducing heat island effect greatly decreases energy demand for cooling. Since the predominant means used to generate electricity in the United States -- fossil fuels and nuclear fission -- both pollute the environment, fewer heat islands will lessen emissions of SO_2 and NO_X, as well as reducing the amount of highly toxic nuclear wastes generated.

The presence of higher temperatures in urban environments stimulates chemical reactions that turn airborne pollutants into ground-level ozone (smog). A reduction of heat islands can lead to lower ambient temperatures and lessen the potential for smog, with its associated health problems.

One of the most effective methods for reducing urban heat island effect involves increased use of vegetation, such as gardens or green roofs, which also provide positive contributions to site ecology.

Economic

Reducing the amount and intensity of urban heat islands can lower the ambient air temperature in a city by anywhere from 3 – 7 ºF, in turn reducing the amount of money spent on energy for cooling buildings. (For cost benefit see Rosenfeld 1996) Monetary savings may also be realized by the electric utilities that would otherwise need to increase their power generation and infrastructure to meet higher peak energy demands.

Smog, which is generated as a direct result of sunlight mixing with hydrocarbon fumes and particles, and heat, are ubiquitous in any major urban center. Any reduction in smog has the potential to diminish respiratory and other health complaints that are known to be, in part, a result of heat island effect. Reduced costs for health insurance premiums, along with increased worker productivity and less absenteeism resulting from a healthier workforce, are significant. The reduction of smog-related illness among the city's workers, and especially among the uninsured, contributes to keeping the cost of *all* health insurance down. Vegetated areas used to replace surfaces that create heat island effects also reduce the need for stormwater infrastructure.

A more comfortable outdoor urban environment is attractive to both shoppers and businesses. It provides a means for corporate and retail employees to refresh themselves at breaks and lunchtime. New studies, such as the Heschong Mahone Group's study on views to green spaces, indicate that a connection to nature is critical for human well-being.

Neighborhood

The potential reduction of ground level ozone commensurate with a reduction in heat islands and ambient air temperature can have positive health effects on neighborhood air quality and reduced respiratory problems.

An improved and more pleasant outdoor environment will also encourage people to spend time outside, increasing opportunities for exercise and social interaction. Busy streets with lots of human activity increase security and diminish opportunities for street crime.

Methodology

Design Strategies

Incorporate vegetated surfaces wherever possible, including areas of "green" roof where appropriate.

Use ENERGY STAR ® compliant AND high emissivity roofing (emissivity of at least 0.9 when tested in accordance with ASTM 408) for a minimum of 75% of the roof surface

OR install a "green" roof for at least 50% of the roof area. Combinations of the two types of roof may be used, providing that they collectively cover 75% of the total roof area.

Provide shading, especially that which is created by trees, for at least 30% of non-vegetative site surfaces, such as walkways and open plazas. Where shading or vegetated surfaces are not used, specify light-colored, high emissivity materials (a reflectance of at least 0.3).

Means and Methods

There are two areas of endeavor within this chapter: Roof and non-roof surfaces must both be considered.

<u>Roof</u>

Consider the inclusion of green or garden roof systems wherever possible for the buildings within the complex. To achieve compliance, at least 50% of the roofing area of any project in question must be vegetated. There are two main types of green roofs – those planted with low-growing grasses and plants that require little maintenance and no watering after becoming established, and those that are more garden-like, with plants and shrubs, etc. that provide the multiple benefits of being aesthetically pleasing and retaining stormwater at the site, while providing the humanitarian benefits of open green space. Some roof-gardens include public or building occupant access, with walkways and benches as well as flowering plants. Such roof gardens must be equipped with appropriate safety railings in accordance with New York City code requirements.

On roofs where vegetation is inappropriate, use high albedo roofing solutions with a reflectance value of at least 0.3 maintained, and an emissivity of 0.9 minimum when tested in accordance with ASTM 408, for 75% of the roof area. There are several options available, such as an Energy Star membrane or a high reflectance coating over a polymer substrate. Concrete tiles may also be considered, and for steep roofs, white asphaltic shingles may be applicable.

A combination of green roof and high albedo roofing can be used as long as the two together cover 75% of the roof area.

<u>Non-Roof</u>

In high traffic areas, where planted areas are inappropriate, use high albedo paving solutions with a reflectance value of at least 0.3 maintained for a minimum of 30% of the site's impervious surfaces. There are several options available, including use of white concrete mix, light gravel and/or reflective pavement coatings, or a combination of these materials. Also, high albedo areas may be interspersed with open grid pavement of more than 50% perviousness.

Three other options may be considered to achieve this initiative, however, on a busy commercial site such as the World Trade Center, they present a greater challenge than those listed above:

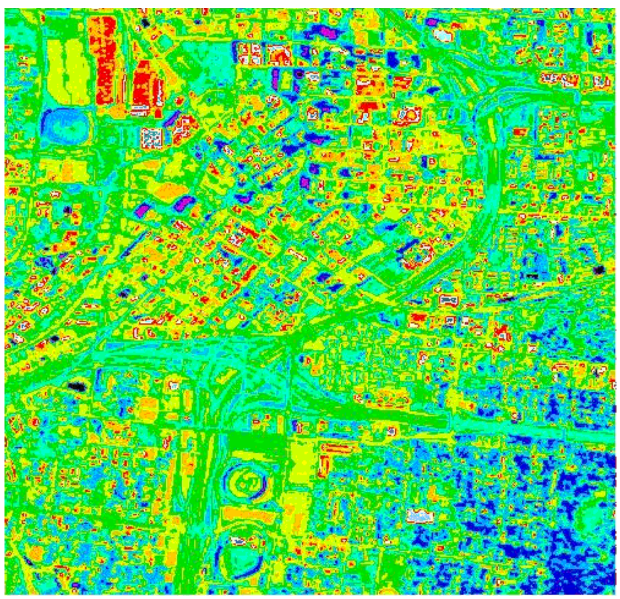
- Plant trees so that 30% of the site's impervious areas are fully shaded within five years. Trees that line roadways, walkways and parking areas, or that provide shade in public plazas, etc, may all be considered. This requires coordination with both the site Master Planners and Landscape Architects.

- Include pervious materials such as plastic or concrete open-grid paving systems, or porous concrete or asphalt, for a minimum of 30% of the site's typical non-pervious surfaces: i.e. roadways, parking areas.
- Provide underground parking for 50% of the building's parking requirements, or provide parking areas with an open-grid pervious surface for a minimum of 50% of the parking requirements.

Case Studies

NASA's Project ATLANTA (Atlanta Land use Analysis: Temperature and Air Quality)

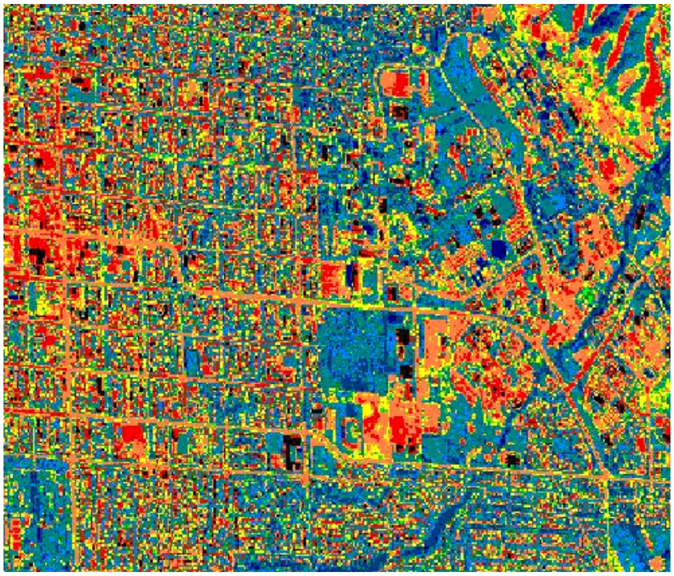
In 1997, NASA's project ATLANTA was created to study urban heat islands and their relation to changes in land usage over several decades in Atlanta, a city experiencing air quality concerns at the time. NASA is using remote sensing technology to identify areas of significant heat. The image below shows one of these analyses, with hot areas shown in red and cool areas in blue. The study of the materials and surfaces that corresponded to these areas is intended to provide design input for how to mitigate the urban heat island effect during the future development of Atlanta. The data and its implications for public policy making will be investigated by a team comprised of various agencies other than NASA including the US EPA, The Environmental Office of the City of Atlanta, and the National Park Service over an ongoing 20 year period that began in 1997. Further results have not yet been published at this time. (Estes 2004)



1997 NASA Thermal Image of Atlanta (Estes 2004)

Salt Lake City Cool Communities Program and the Urban Heat Island Pilot Project

In 1995 Salt Lake City, Utah joined the Cool Communities Program, a collaboration between local and federal agencies targeted at improving urban air quality through heat island reduction. As part of this program, the city began to heavily promote the use of light-colored roof and street surfaces. It also began to deploy vegetative matter in specific locations to provide shading and enhance evaporative cooling. By joining the Urban Heat Island Project in 1998, the parties involved were able to see the effectiveness of their strategies. At the time, the UHIPP, a partnership between *the US EPA, US Dept. of Energy, and NASA (among various other local partners), was using remote sensing to study heat islands from high above the earth. By comparing the thermal imagery taken with the locations of light-colored surfaces and plantings, the effectiveness of the Cool Communities Program could be evaluated. The image below shows hotter surfaces in red and cooler surfaces in blue. Large blue areas throughout the image are most likely green spaces such as parks and cemeteries. This is an ongoing project and additional data is will be published by its stakeholders as the study progresses. (Estes 2004)*



1998 NASA Thermal Image of Salt Lake City (Estes 2004)

Reference

Definitions

Albedo or Solar Reflectance is the ratio of reflected solar radiation to incident solar radiation (within wavelengths of 0.3 to 2.5 micrometers). For example, a reflectance of 100% would indicate that all of the energy striking a particular surface is reflected, with none being absorbed by the surface.

Emissivity describes the amount of energy that is re-radiated from an object as long-wave radiation (heat), as compared to the amount of short-wave radiation (solar, U.V.) that originally fell upon the surface.

The Heat Island Effect describes the phenomenon where urban areas experience higher ambient temperatures than adjacent rural areas. This is a result of the absorption of solar energy that is re-radiated as heat from constructed surfaces, particularly those that are dark in color.

Standards

ASTM. ASTM E408-71(1996)e1: Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques. ASTM International, 1996.

ENERGY STAR. ® "Energy Star® Program Requirements for Roof Products: Eligibility Criteria." ENERGY STAR ® 30 Sep 2004 <http://www.energystar.gov/ia/partners/product_specs/eligibility/roofs_elig.pdf>

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Heat Island Effect Mitigation **SEQ-3-T**

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	◉	◉ Ⓔ	◉ Ⓔ	◉	◉

Site/Parcel:

☐ **Required Component:** *(Note: this will satisfy LEED™ 2.1 Sustainable Sites Credit 7.1: Heat Island Effect – Non-roof)*
The attached documentation and calculations demonstrates that a minimum of 30% of the site's open space has been covered by vegetation, is comprised of materials of at least 0.3 reflectance, or is shaded.

Buildings:

☐ **Required Component:** (*Note: this will satisfy LEED™ 2.1 Sustainable Sites Credit 7.2: Heat Island Effect – Roof)*
The attached documentation and calculations demonstrates that a minimum total of 75% of the roof area of all building coverage on the site consists of vegetated surfaces OR roofing that is ENGERY STAR® compliant AND has an emissivity of at least 0.9 when tested in accordance with ASTM 408.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Light Pollution Reduction SEQ-4

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Purpose: To reduce light pollution and glare to surrounding sites and night sky.

Action: Satisfy Illuminating Engineering Society of North America (IESNA) recommended practice per manual (RP-33-99) for exterior illumination. Design exterior lighting such that all exterior luminaires with more than 1000 initial lamp lumens are shielded and all luminaires with more than 3500 initial lamp lumens meet the Full Cutoff IESNA Classification. The maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property. Tower tops will not be constrained by these requirements. Minimize glare from reflected sunlight by minimizing use of highly reflective materials on building facades. Incorporate lighting controls to minimize energy use during unnecessary periods.

Related Guidelines: EEQ-1, EEQ-3

Potential LEED™ 2.1 Credits: 1 possible with SS cr. 8. (See Submittal Template)

Introduction/Context

Some thirty years ago, 'good' quality lighting, both indoors and outdoors was judged on the *quantity* of luminance (light output), rather than on the *quality* or appropriateness of light levels provided. Fortunately, since then, much has changed in New York City and across the country, and designers, as well as those who benefit from well-designed indoor and outdoor lighting, have become more sensitive to the critically important role played by supplemental lighting. Today, consideration is given to how such lighting can best be used to augment natural day-light levels, enhance mood, enliven spaces and most importantly, provide appropriate levels of illuminance wherever supplemental lighting is needed. While outdoor lighting is still seen as a necessary visual enhancement and safety strategy, this consideration is now understood to be only one of many factors that address personal security. Over-lighting, or outdoor light pollution as it is often called, affects the night sky, where the artificial brightness of the city at night limits visual access to the stars and astronomical phenomena. Further, over-lighting is known to adversely affect the natural habitat surrounding the site and to create imbalance in the lives of birds and animals.

Relevant Issues

Ecological

Light pollution, at its most simple, is wasted light. The energy used to produce unneeded light releases environmental pollutants as byproducts of its generation and contributes to the depletion of natural resources. Abnormal amounts of light can obstruct growth in certain types of vegetation and negatively alter natural behavioral patterns in some animals. This can cause major disruptions to the ecosystem and is even known to lead to premature death in extreme cases.

Economic

As misused energy, light pollution wastes available power, spends money needlessly and consumes resources. One of the primary objectives of a sustainable approach to the built environment is the 'conservation' of energy and available natural resources. While nighttime lighting of outdoor facilities such as streets, parking lots, pathways and plazas is a vital function for any urban complex, over-lighting these facilities is simply self-defeating.

Subtle, well-placed luminaires, with shielded lamps of a luminance matched to their function, can save on both energy and maintenance costs. In addition, when less electrical power is used, the fossil fuel base is conserved for future use, while less pollution is generated at the utility. Any reduction in pollution contributes to cleaner air quality in the city and opportunities for enhanced human health, with all of the associated monetary benefits.

Neighborhood

The extreme contrast created between an over-lit location and the dark night sky, when light levels at ground level are completely unshielded, adversely affects visibility and denies visual access to the night sky. Increased ambient brightness caused by light pollution may also interfere with sleeping patterns.

Luminance values which are higher than those comfortable to the human eye generate a condition known as 'glare'. Glare has two common forms, the first being reflections off specular surfaces, such as shiny metal panels on a building façade. The second form of glare results from an intense contrast between low, ambient light levels and the artificial brilliance of an over-lit area, such as a shopping mall or flood-lit parking lot. Exposed, unshielded light sources are a typical source of glare. This can be especially problematic in an urban setting where street lights are found in greater quantity and closer together. Glare is another form of light pollution and can cause serious both visual discomfort and loss of visual acuity.

High levels of light outdoors at night attract insects, including those which represent potential health-risks, such as mosquitoes.

Some studies have shown a relationship between extended periods of darkness and the production of hormones critical to human health and well-being. The reduction of these periods of darkness in the presence of light pollution may have adverse health effects. (BuildingGreen.com 2004)

The over-lighting of a site has aesthetic implications. The interplay of light and shadow – chiaroscuro -- does much to create a sense of depth and render buildings, urban landscaping, and street objects in a dramatic and appealing manner. In the presence of too much light, all of these 'objects' tend to appear flat and washed-out, less visually compelling and inherently uninviting.

Methodology

Design Strategies

Design site-lighting to satisfy the recommended practice of the Illuminating Engineering Society of North America (IESNA) as specified in their manual for exterior illumination (RP-33-99). Specify the minimum light levels necessary to ensure site safety and security as well as specific aesthetic goals.

Consider the lighting design of a site in relation to the light levels of surrounding areas. Extreme contrast in light levels and bright light spilling from one area into a darker one create many of the conditions known as light pollution. A site which requires a certain level of bright lighting, and which is located in a dark neighborhood, for instance, should attempt to provide light levels that meet the minimum requirements for the safety and function of that specific area, while observing a respect for the surrounding neighborhoods. Avoiding light 'spillage' is also an important consideration.

Many of the buildings at the World Trade Center are being designed with highly reflective skins, usually of metal and glass. Every effort must be made to mitigate the potential glare from these buildings, especially at ground level. Designs should avoid the creation of glare from both reflected sunlight during the day and reflected artificial light at night. Where possible, use landscaping, low-reflective ground cover and trees to soften views across open spaces and deflect direct reflectance and glare from these building facades. Make sure that all night lighting luminaires selected meet the criteria described in IESNA RP-33 and RP-22 for the minimum recommended illuminance values and appropriate shielding to prevent light trespass, while enhancing visual acuity. Fixtures located close to a building with a reflective skin should be of lower wattage than those that are free-standing in an open area.

Means and Methods

Precisely aim the optics of all site fixtures so that light falls exactly where required and does not spill over into neighboring areas. Specify luminaires with shielding devices, and where appropriate, full cut-off technology. Provide shielding on all luminaires with more than 1000 initial lamp lumens. When using luminaires with more than 3500 initial lamp lumens, be sure they satisfy IESNA's classification for full cut-off. Incorporate control devices in all site luminaires, such as photocells and timers, so that they are weather and time-of-day responsive, in order to conserve energy. Motion sensors should be considered so that site lighting devices which are automatically turned off late at night may be responsive to the presence of people at the site by providing fail-safe lighting, even after a pre-determined curfew.

Wherever possible, use down-lighting instead of up-lighting as a strategy to prevent extraneous light from escaping skyward. Consider internal edge lighting, or shielded downward illumination for signs, to prevent light leakage to the night sky. Use solid building canopies with incorporated down lighting or fully shielded up/down-lighting within the canopy itself, to minimize sky glow.

In landscaped areas, lighting should be minimal. Shielded luminaires on standards can provide soft, uniform, ambient light, and walkways can be lit with low, bollard-type fixtures that clearly indicate the path by providing local bright spots without lighting large tracts of garden or lawn. Planting beds with ground cover have naturally low reflectance and will absorb much of the glare of landscaping illuminance, while still offering a brighter glow to indicate the path.

Design fenestration and interior building lighting to insure that the points of maximum luminous intensity (measured in Candelas) occur within the building envelope (rather than spilling out through the windows).

While the Guidelines permit lighting the tops of the towers of WTC site buildings, the preferred environmental approach is to do so only on the rarest of occasions in order to avoid night glow. Every effort needs to be made to manage this high level, tower top lighting plan by not permitting light to escape above the buildings, minimizing the direct view into light sources when looking up from the plaza and maintaining an even, non-glare wash rather than bright spots of light on all exterior walls.

Refer to ASHRAE 90.1 2001 for information concerning façade lighting, which should be minimal if used at all. This standard also provides guidance for lighting controls and minimum lamp efficiency and power limits. Site lighting is part of the commissioning process and must be considered in order to comply with EO-111 and the NYSGBTC requirements, as well as the LEED Prerequisite EAp1, Fundamental Building Systems Commissioning.

Case Studies

<u>Sundeck Restaurant at Aspen Skiing Company, Aspen, Colorado</u>

As part of the sustainable goals of the Aspen Skiing Company, this restaurant is outfitted with various light pollution control measures. Both the building and site plans were designed to help contain light to its target areas. Specific luminaires were specified for their ability to eliminate direct and indirect glare from anticipated viewing angles. Interior surface reflections are limited to a 40 degree viewing angle for people off-site. Blackout curtains help prevent interior light from escaping during the nighttime. Dark colored materials used under the windows prevents any interior light that does escape from being reflected off the ground and up to the sky. The building's roof was designed with large overhangs to prevent snow from accumulating under the windows, reflecting light upward. Exterior lighting was limited to that which was required to satisfy local codes. None of the exterior lighting fixtures can be seen from adjacent sites. A lighting control system shuts all exterior lighting off at 11 P.M. (National Ski 2004)

Reference

Definitions

A Candela is the basic unit for measuring luminous intensity from a light source in a given direction.

A Footcandle is a measure of the amount of lighting falling on a surface, with one footcandle being equal to the amount of light falling on a one-square foot area from a one candela light source that is one foot away from the surface.

A Full Cutoff Luminaire has a zero value for luminous intensity at and above an angle of 90 degrees above the vertical axis. In addition, the candela per 1000 lamp lumens does not numerically exceed 100 at an angle of 80 degrees above the vertical axis. This applies to all lateral angles around the luminaire.

Glare is a sensation that causes visual discomfort. It occurs when the field of vision has a significantly higher level of luminance than that to which the human eye is adapted.

Illuminance is the amount of light falling on a surface. This is measured in either footcandles or lux.

Light Pollution refers to stray light that is escaping from luminaires or reflecting off of surfaces and not serving a lighting purpose. The term also refers to light that falls without its intended target area, often onto surfaces or areas where it causes disturbance and is not desirable. This condition is known as ‘light trespass’, and is essentially wasted light.

Luminaire is the trade term for what is more commonly called a lighting fixture.

Luminance, commonly referred to as “brightness”, is a measure of the light coming from a surface or light source, also called the ‘out-put’ of light from a fixture. Luminance, measured in footlamberts (or candela per square meter) measures the amount of light that is directed towards the eye from a surface or light source with respect to its initial intensity.

Luminous Intensity is a measure of the energy emitted by a light source in a particular direction. It is measured in candelas.

Lux is the International System unit of illumination, equal to one lumen per square meter.

Sky Glow is a condition where lighting escapes upwards, reflecting of water vapor and debris in the air, and polluting the night sky. It cuts down on visibility, dimming the stars and astrological events, and causes an adverse impact on wildlife, and nocturnal ecosystems. Sky Glow wastes energy and does not contribute to the quality or amount of light available at a site.

A Specular Surface has the qualities of a speculum, or mirror; a smooth, reflecting surface.

Standards

Illuminating Engineering Society of North America (IESNA). Lighting for Parking Facilities (RP-20-98). IESNA, 1998.

Illuminating Engineering Society of North America (IESNA). Recommended Practice Manual: Lighting for Exterior Environments (RP-33-99). IESNA, 1999.

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The International Dark Sky Association. <http://www.darksky.org>

The Lighting Research Center at Rensselaer Polytechnic Institute. <http://www.lrc.rpi.edu/>

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Light Pollution Reduction SEQ-4-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	◉	◉ Ⓔ	◉ Ⓔ	◉	◉

☐ **Required Component:**
Measures have been taken to mitigate uncomfortable glare, caused by highly reflective materials used on a building façade or site surface, for site/building occupants or neighbors.

☐ **Required Component:**
A lighting control diagram and schedule demonstrating that lighting will be minimized during unnecessary periods is attached.

☐ **Required Component:**
Catalog cut sheets are attached for all exterior luminaires with more than 3500 lumen lamps. These demonstrate that the luminaires meet the Full Cutoff IESNA Classification and indicate lamp type, distribution type, and any additional shielding provided. Catalog cut sheets are also attached for all exterior luminaires with more than 1000 lumen lamps. These demonstrate that the luminaires are appropriately shielded for the project's Environmental Zone (as defined by IESNA)

☐ **Required Component:**
Interior lighting design drawings are attached showing the building's perimeter areas and demonstrating that the maximum luminous intensity of interior lighting (measured in Candelas) falls within the building and not out through the windows.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Purpose: To reduce pollution, noise and vibration from construction activities and vehicles.

Action: Implement a Construction Environment Plan, which reduces pollution, noise and vibration from construction activities and vehicles to adjoining neighborhoods.

Develop a materials staging and construction access plan prior to start of construction. Truck staging zones are to be placed for minimum disruption and impact. Limit unnecessary idling times on diesel powered engines to 3-minutes. Consider bio-diesel fuel as an alternative to pure diesel.

Non-road construction equipment of 50hp or greater to include diesel emissions control technology according to EPA diesel retrofit recommendations, unless not technically feasible. All non-road diesel equipment to utilize ultra low sulfur diesel fuel (limit sulfur levels to 15ppm). Explore accelerated implementation of proposed EPA emission standards for non-road diesel equipment. Locate fixed diesel powered exhausts away from fresh air intakes.

Reduce noise and vibration impacts through scheduling and coordination with adjacent construction activities. Consider noise barriers where practicable.

Consider condition of surrounding buildings, structures, infrastructure and utilities where appropriate. Coordinate construction activities in adjacent and nearby locations to avoid or minimize impacts and communicate plans with the public.

Prepare contingency measures in the event established limits are exceeded

Related Guidelines: UEQ-8, SEQ-1, SEQ-5, SEQ-6, MEQ-2, IEQ-1, IEQ-3, IEQ-5, IEQ-11

Introduction/Context

Construction sites are notoriously dirty and noisy. Yet with some forethought, much of the pollution generated and noise associated with construction activities can be averted. This becomes increasingly important as the aging infrastructures and built environment of most American cities begins to reach the end of their useful lifespan, and are in need of major renovation or replacement. It is also a critical consideration at the World Trade Center site, where most of the infrastructure and all of the buildings will be new, involving heavy construction phased over several years. For the benefit of those who live and work nearby, for early occupants of the site, and for the construction workers themselves, every effort needs to be made to make the construction process less wearing, less stressful and quieter, while also reducing the dust, pollution and toxic emissions usually associated with work on a project of this unprecedented scale.

Many of the strategies intended to make a construction site more humane are just now being developed and brought into the mainstream. These include mufflers on all engine driven equipment, quieter methods of construction through the use of equipment that reduces both noise and vibration, and a more extensive use of alternative fuels, which generate much less pollution. The EPA has proposed changing their standards in order to reduce pollution via the use of bio-diesel and compressed gas for all non-road construction vehicles. Intended to reduce the devastation caused by diesel fumes, this proposal offers the World Trade Center site a prime opportunity to advance market transformation by adopting the new standards ahead of a legislative requirement.

Relevant Issues

Ecological

Exhaust from diesel engines contains particulate matter, soot, nitrogen and sulfur oxides, and toxic air pollutants in large quantities. These pollutants contribute to decreased air quality, acid rain and global warming. According to Mark Z. Jacobson, Associate Professor of Civil and Environmental Engineering at Stanford University: "Soot exacerbates global warming. Reducing soot emissions will slow global warming faster than by reducing carbon dioxide, methane or other greenhouse gases". It is, he maintains, the second largest contributor to global warming after CO_2.

Use of emissions control technologies and ultra-low sulfur fuel for construction vehicles is important, as it lessens the amount of air pollution at the site and in the surrounding neighborhood. Limiting idling times for these vehicles further reduces air pollution. Restricting their operation to staging areas located away from site occupants and fresh air intakes decreases people's exposure to exhaust fumes. The negative contribution of a construction site to neighborhood air pollution can be decreased further by operating equipment on alternative fuels such a bio-diesel and compressed natural gas.

Excessive noise is a form of pollution. Efforts to manage noise by using state-of-the-art equipment and scheduling activities that are acoustically disturbing at the least disruptive time of day, will help to alleviate this condition.

Economic

According to the National Biodiesel Board, one of the great advantages of bio-diesel fuel is that it can be used in existing engines and fuel injection equipment with little impact to operating performance. It costs little more than regular diesel fuel and offers enormous benefits in terms of human health and well-being, as well as environmental quality. In using a low-blend of bio-diesel fuel, any increase in cost will be off-set by an increase in diesel quality, since low-blend levels of bio-diesel greatly enhance the lubricity of diesel fuel.

Other alternative fuel vehicles are also available. In order to minimize pollution and noise, alternatives such as electric and hybrid cars and vans, compressed natural gas buses (already successfully running on New York's streets), etc. should be considered for use at this site. While there is still a premium in first cost for these vehicles, looking at the larger picture, the cost savings in avoided health impacts such as respiratory, cardiovascular and pulmonary disease, as well as asthma, which can be directly linked to fuel emissions, will be significant, and strongly uphold the intent of these guidelines.

Beyond these impacts, the emissions associated with diesel and other fuels affect buildings, layering their facades with a sticky residue of soot that is difficult to remove, and eating into the fabric of the building materials themselves. The nitrogen (NOx) and sulfur oxides (SOx) generated in diesel fuel emissions represent two of the most damaging acid rain components, often carried on the wind so that they fall in the North Eastern United States, where they are responsible for the stripping of trees and foliage. These oxides are also active at the most local level, where they can destroy architectural stonework and pit aluminum surfaces. The costs of cleaning and repairing building facades that have been affected by such emissions are enormous – consider the recent clean-up that the City of Paris has had to undergo for just this reason.

Neighborhood
Excessive noise and vibration from construction activities can be greatly disturbing to the community. Use of newer equipment with appropriate mufflers, and the provision of adequate warnings when any especially noisy or disruptive work is planned at the site, and maintenance of the established schedule for its completion, can help community residents to plan around any necessary disruptions, which will in turn, help to alleviate concern. Changes in traffic patterns and disruptions in utility services are also likely to negatively affect people who live and work in the area surrounding the World Trade Center construction site. Careful planning to limit these disturbances will provide a safer, healthier and more tranquil environment. All the emission control strategies mentioned above will be key to the maintenance of the most valuable neighborhood asset: clean air.

Methodology

Design Strategies
Perform an analysis of the vulnerabilities of buildings, structures, and the utility infrastructure surrounding the site. Make provisions to protect these elements from damage during the construction process.

<u>Noise</u>
Implement measures to reduce noise from construction activities. Scheduling should be the first step of this process. Combining noisy activities into a limited time period reduces the total number of hours of sound disturbance. The simultaneous scheduling of noisy activities does not create a significantly louder environment during concurrent hours (Harris, 1995). Attempt to schedule the noisiest construction operations during the least offensive time period. In neighborhoods with residential buildings, nighttime will be the period in which to avoid the loudest construction activity. However, in a strictly commercial neighborhood with limited evening occupancy, nighttime may be the least disruptive period .

Another important strategy to reduce sound pollution on the construction site is to avoid major noise-generating, building methods whenever possible. For example, drilling piles or driving them with a sonic or vibratory pile driver is a quieter approach than using impact machines. Also, certain alternative demolition methods, such as sawing or disassembly rather than impact demolition, can limit noise production. Construction equipment itself can also be altered to limit noise and particulate pollution by installing mufflers on all engines. Yet another means for deadening construction noise is through the use of sound barriers. These can be mounds of excavated earth, dense areas of vegetation, or temporary building materials such as sheet piling or concrete barriers. Finally, as part of the construction staging plan, the loudest site machinery and construction tasks should be as "remote" (via scheduling or placement) from noise sensitive areas as possible.

Vibration
Implement construction methods that reduce the impact of vibration on and around the site. Scheduling is the most effective strategy to this end. As in the case of noise management, schedule high-vibration construction operations during the periods when they will be least offensive. In neighborhoods with residential buildings, daytime will be the opportune time, while in a strictly commercial neighborhood with limited evening occupancy, nighttime may be the least disruptive period during which to perform construction activities that cause high vibration. Unlike noise, vibration levels are additive (Harris, 1995), so processes such as ground-impacting and earthmoving should be scheduled in a staggered fashion. Alternative construction methods can also help limit vibration. The avoidance of impact pile-driving and wrecking ball style demolition, when possible, can do much to curtail excessive vibration. Vibratory rollers should also be used sparingly, especially in vibration sensitive areas of the site.

Materials Staging
Develop a materials staging and construction access plan prior to the start of construction. The intent of this plan is to limit disruption to the normal operation of the neighborhood as much as possible. Locate truck staging areas where they will have the least impact on traffic and air quality. Enforce a 3-minute limit on all unnecessary diesel engine idling. Employ road-borne construction and delivery vehicles which use a bio-diesel fuel alternative.

Air Pollution Controls
Air pollution controls are a critical component of the Construction Environment Plan. Less-polluting fuels such as bio-diesel or compressed natural gas for non-road construction equipment provide a means of accelerating the implementation of the proposed EPA emission standards. Any non-road machinery of 50hp or greater must be equipped with diesel emissions control technology according to the standards delineated by the EPA's Voluntary Diesel Retrofit Program, unless not technically feasible. Ultra-low sulfur diesel fuel (15ppm) must be used in all non-road diesel equipment. (Both of these requirements are commensurate in intent with New York City's recently passed, groundbreaking Local Law 77, which is intended to reduce pollution from non-road construction vehicles by up to 90%. It requires the use of ultra-low sulfur diesel and the best available retrofit emissions control technologies on every city-funded construction project. (*League of Conservation*

Voters, 2004). As a planning and operations principle, locate any fixed sources of diesel exhaust away from, and down-wind of, fresh air intakes.

The EPA's Voluntary Diesel Retrofit Program, which was started in September 1998, mandates the installation of an oxidation catalyst on all large off-road diesel construction equipment. (An oxidation catalyst is a device that limits emissions by converting diesel pollutants including particulate matter, hydrocarbons, and carbon monoxide into less harmful emissions such as water and carbon dioxide).

Case Studies

Central Artery/Tunnel Project, Boston, MA.

Several hundred heavy-duty off-road diesel construction vehicles were used during the construction of the Central Artery/Tunnel Project, more commonly known as the "Big Dig", in Boston, Massachusetts. Those in charge of this project implemented a strict plan to control construction pollution which was especially important on a project of this magnitude. The main focus of this particular plan was to mitigate air pollution as a result of construction vehicle emissions. Each contractor was responsible for keeping their machinery properly tuned to reduce emissions. All diesel engines were required to be turned off when not in use for more than five minutes. This included a prohibition on the common practice of letting dump trucks idle while waiting to unload. In addition, a special staging zone was created for trucks waiting to load or unload materials for the project. This area was established in a location where the diesel emissions would not directly affect the public and away from sensitive areas like building air intakes and windows. Many of the vehicles used in this project were operated by companies who also participated in a voluntary diesel retrofit program implemented by the Massachusetts Turnpike Authority and the Massachusetts DEP in September of 1998. This program promoted the retrofit of large off-road diesel construction machines with an oxidation catalyst to transform harmful diesel pollutants such as particulate matter, hydrocarbons, and carbon monoxide to less harmful emissions such as water and carbon dioxide. (Central Artery 2004)

Reference

Definitions

Bio-diesel is a diesel-like fuel made from renewable resources including vegetable, soy, or canola oil. It can even be made from used cooking oil and animal fats. The combustion of bio-diesel produces far fewer air pollutants and greenhouse gases than petroleum diesel. It is also biodegradable.

Ultra-low sulfur diesel (ULSD) is a diesel fuel that has been refined to contain much less sulfur than standard diesel fuels. The sulfur content of today's ULSD fuel ranges from 15-30 parts per million (ppm). This is in contrast to standard diesel fuel which is currently allowed a sulfur content of 500 ppm. Beginning in 2006, diesel fuel sold for on road use must meet the new USEPA requirement for ULSD, which caps sulfur content at 15 ppm. The lower sulfur content of ULSD creates far fewer sulfate emissions during combustion and facilitates the use of further emission-reducing technologies such as particulate traps and catalytic converters to curtail emission of nitrogen oxides and particulates. The use of these fuels has reduced emissions of fine particulate matter by up to 90 percent. (Diesel Technology, 2004)

Standards

NYC Local Law 77 (2003) requires that all diesel engines of more than 50 hp on city construction projects employ ULSD and "best available technologies" (BAT) to reduce emissions. These requirements took effect in Lower Manhattan effective June 19, 2004.
< http://www.nyccouncil.info/pdf_files/bills/law03077.pdf >

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New York City Department of Design and Construction. Local Law 77: DDC Ultra Low Sulfur Diesel Manual. June 2004. <http://www.nyc.gov/html/ddc/html/ddcgreen/documents/lowsulfur.pdf >

Objective

The Construction Environment Plan provides a tool to reduce pollution, noise and vibration from construction activities and vehicles to adjoining neighborhoods.

Plan Components

I. Project Description (Plan Summary)

A. Summarize project construction requirements, ramifications to adjacent buildings and neighborhood traffic patterns and construction timetable.

II. Management strategies

A. Develop a materials staging and construction access plan prior to start of construction. Truck staging zones are to be placed for minimum disruption and impact.
B. Limit unnecessary idling times on diesel powered engines to a maximum of three (3) minutes. Consider bio-diesel or low-sulfur fuels as alternatives to pure diesel.
C. Non-road construction equipment of 50hp or greater should include diesel emissions control technology according to EPA diesel retrofit recommendations, unless not technically feasible. All non-road diesel equipment to utilize ultra low sulfur diesel fuel (limit sulfur levels to 15ppm). Explore accelerated implementation of proposed EPA emission standards for non-road diesel equipment. Locate fixed diesel powered exhausts away from fresh air intakes.
D. Reduce noise and vibration impacts through scheduling and coordination with adjacent construction activities. Consider noise barriers where practicable.
E. Consider condition of surrounding buildings, structures, infrastructure and utilities where appropriate. Coordinate construction activities in adjacent and nearby locations to avoid or minimize impacts and communicate plans with the public.
F. Prepare contingency measures in the event established limits are exceeded.

III. Targets

A. Provide coordinated schedule which includes simultaneous adjacent construction activities.

IV. Implementation

New York City Mayor Michael Bloomberg has put forward legislation, which provides the first comprehensive overhaul of the New York City Noise Code in over 30 years. Noise is the number one complaint to the City's 311 citizen service hotline, currently averaging nearly 1,000 calls a day. As a result of this code, city agencies, including local police have greater authority to 'shut down' a project based on unreasonable level of noise.

For exterior locations, all projects must comply with the New York City Noise Control Code. In accordance with the code requirements:

- Establish uniform best management practices for all work sites.
- Mandate 'noise management plans' that include portable sound barriers and noise jackets for jackhammers at all construction sites.
- Use noise meters and other means to determine the level of noise produced by equipment operation, and cease work immediately if the noise level exceeds the code. Develop a less disruptive and quieter approach before recommencing work.

New York City's Noise Control Code

Ambient noise quality zone	Day-time standards (7am - 10pm)	Night-time standards (10pm - 7am)
Noise quality zone N-1 (Low density residential RL; land-use zones R-1 to R-3	Leq=60 dB(A) measured for any one hour	Leq=50 dB(A) measured for any one hour
Noise quality zone N-2 (High density residential RH; land-use zones R-4 to R-10)	Leq=65 dB(A) measured for any one hour	Leq=55 dB(A) measured for any one hour
Noise quality zone N-3 (All Commercial and manufacturing land-use zones)	Leq=70 dB(A) measured for any one hour	Leq=70 dB(A) measured for any one hour

Construction Environment SEQ-5-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	●	● Ⓔ	● Ⓔ	●	◉

☐ **Required Component:**
A Construction Environment Plan is attached and includes measures to reduce pollution, noise, and vibration from construction activities and vehicles. This plan also highlights specific areas of sensitivity in the surrounding context including neighboring buildings, structures, and utility infrastructure, indicating what protective measures will be taken during construction on their behalf. As part of the plan, a coordination schedule that includes other simultaneous construction activity in the area has been developed to minimize disruption to the neighborhood

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Purpose: Control site erosion and reduce negative impacts on hydrological and atmospheric systems produced by construction activities.

Action: Provide a Construction Storm Water Pollution Prevention Plan conforming to US EPA document NO. 832/R-92-005. This plan must also take measures to prevent air pollution from dust and particulate matter during the course of construction. Utilize sprayed suppression agents (nonhazardous, biodegradable) for containment of fugitive dust and adjust strategies per meteorological conditions. Coordinate with SEQ-5 Construction Environment Plan.

Related Guidelines: UEQ-8, SEQ-1, SEQ-2, SEQ-5, WEQ-1, WEQ-2, IEQ-1, IEQ-5

LEED™ 2.1 Requirement: SS Prerequisite 1. (See Submittal Template)

Introduction/Context

Construction is an intense, invasive process that inevitably disturbs the site and nearby environment wherever it occurs. Careful planning and management of construction activities can prevent major damage to both the site and surrounding neighborhood. Construction pollution is caused by both natural and anthropogenic forces. As earth is exposed, operations including excavation and water from rain may carry some soil off the site suspended in stormwater runoff. This erosion is harmful to both the site and regional waterways. Runoff can also transport potentially toxic debris from a construction site to neighboring water bodies. Wind plays a significant role in spreading materials such as dust and soil around a site and out into adjacent areas. Two comprehensive sets of strategies can be used to help mitigate pollution during construction. The first layer of defense against construction pollution involves limiting the production of dust and debris in the first place. Less volatile demolition practices (disassembling components rather than using a wrecking-ball) and use of benign building materials are two examples of this. The second tier of strategies for construction pollution control involves methodologies to curtail the spread of the pollution generated. Natural forces such as wind and stormwater flow can be controlled to limit their ability to pick up and carry off dust and debris. Securing piles of excavated earth, wetting or compacting loose soil, and bounding the site with natural filtration barriers such as hay bales are just three examples of control techniques.

Relevant Issues

Ecological

In the absence of protective strategies, stormwater runoff from a construction site will inevitably flush contaminants and sediment into local water bodies. As sediment settles to the bottom of these water bodies, they begin to fill in. If this occurs in large amounts, especially in still water bodies such as lakes, dredging may ultimately be required to maintain the lake or pond. The dredging process causes devastating damage to aquatic ecosystems. Sediment also fills up the deepest pools which occur in the lower reaches of the water, eliminating what typically serves as breeding areas for fish and aquatic insects. Heavy metals, chemicals and other inorganic pollutants carried in site runoff are biohazards to both people and aquatic life that swim in, or drink, the polluted water. Organic pollutants carried by construction site runoff are an additional concern. Nutrients such as nitrogen and phosphorus contribute to the accelerated eutrophication of water bodies, stimulating unnatural algal and vegetative growth, disrupting the biological processes of aquatic life. In addition to all this, the loss of earth from a site through erosion also has negative impacts, disrupting natural processes that occur in the ground such as the burrowing of insects and the formation of root structures by plants.

Air pollution is created by construction dust and soil that becomes windborne when a site is not properly protected. This has negative health effects for people as well as the area's flora and fauna.

Economic

Damage created by contaminated site runoff can have serious financial implications. Deposits of sediment on roadways and in drainage infrastructure must be removed. Build-up of sediment and pollutants in water bodies may require dredging, which is an expensive and disruptive process, in order to maintain their original shape and character. The purchase and transportation of fill and topsoil, as well as the labor to repair erosion-damaged sites, causes an unnecessary and often avoidable financial burden.

Airborne particulate matter on a construction site has negative economic impacts. Debris blowing around a site can cause costly property damage, degraded working conditions for staff, increased cleaning costs and attendant liability.

Neighborhood

Community members are greatly affected by damage to local bodies of water resulting from contaminated construction site runoff. Sediment build-up in these waterways also has negative affects for recreational activities such as fishing and boating. Dust and air-borne pollution from a construction site pollute local air quality and have negative health and comfort impacts for those living and working nearby.

Methodology

Design Strategies

Create and implement a Construction Storm Water Pollution Prevention Plan to limit contaminated construction site runoff, sedimentation, and erosion. This plan must also provide measures to prevent air pollution from dust and particulate matter during the course of construction. The United States Department of Environmental Protection has authored a document entitled Storm Water Management for Construction Activities (US EPA document NO. 832/R-92-005), which is a useful reference guide for preparing a Construction Storm Water Pollution Prevention Plan.

Part of storm water runoff reduction may include the capture, treatment and storage of this water for use in site construction activities such as dust suppression.

Means and Methods
The Pollution Prevention Plan specified may use the following measures to control air pollution from dust and particulate matter:

- Design a strategic plan for construction staging that limits the area of the site that will be impacted during construction.

- When necessary, employ physical barriers to prevent wind from creating airborne dust and debris. These barriers can be vertical, such as fencing, or horizontal screening material that is 50% or less porous.

- Manage earth moving activities. Coordinate excavation with the weather to avoid such activities during periods of heavy wind or rain. Schedule earthmoving to be conducted close in time to when it is needed in order to reduce the amount of time earth is left exposed.

- Another method of preventing dust from becoming airborne is through spraying with either water or a non-hazardous, biodegradable suppressing agent. When wetting soil to prevent dust, it is important to dampen it slightly, but not enough to create runoff.

- Any mounds of soil that must be left on site shall be secured to prevent them from eroding or creating windborne dust.

- When conducting construction tasks that produce high levels of airborne dust, use dust collectors to clean the air. Cyclone collectors or bag collectors with fabric filters can be used to accomplish this task.

- To prevent soil, dust, and particulate matter from being carried off-site onto neighboring streets, equipment should be cleaned before leaving the site. Tires can be sprayed down so as not to lead tracks of dirt into the streets. In the event that soil and debris are deposited in the roadways surrounding a site, use street sweepers to clean the area before traffic propels the material into the air. Graywater, collected from site runoff or recycled from building water use, would be well suited to this purpose.

Case Studies

Construction Management Plan for the Columbia Street Pump Station Replacement Project submitted by the Greater Vancouver Regional District

Section 4.6 of this plan on Air Quality and Dust Mitigation outlines requirements to control construction dust on the site of an expansion project for a critical pump station in Vancouver's wastewater infrastructure. Contractors are required to follow specific guidelines to reduce the negative impacts of construction dust. They must use environmentally acceptable dust suppressants or water, as needed, to control particulate matter on all roads, storage zones, the work site itself, and disposal areas. All dry materials must be secured to prevent dust and debris from becoming airborne. All roads sullied by the construction process must be cleaned as required, at a minimum of at least once per day, at the end of the work day. All dump trucks used for the project must comply with emission standards of 1998 or later. The contractor is responsible for cleaning or repairing any damage done to neighboring buildings. A community liaison officer must be appointed to verify this is accomplished. (Greater Vancouver 2004)

The Donald Bren School of Environmental Management Science & Management in Santa Barbara, California

This LEED Version 1.0 Platinum project employed various protective measures on the construction site to prevent stormwater pollution. The original site was a parking lot and much effort was made to keep the footprint of the construction zone small, preserving surrounding habitats and vegetation. Existing site trees were protected throughout the construction process. All asphalt and concrete removed from the site was recycled and used as base for new paving. Desilting facilities were used at each drainage outlet. Hay bales and fencing were employed to aid soil erosion and sediment control. Following rainfall, silt and debris were cleared and hay bales replaced. All native soil from the site was retained and reincorporated into the project's landscape plan. (US Regents 2004.) (BIPER 2002)

Reference

Definitions

Erosion is a process during which parts of the Earth's surface are worn away and transported to another location.

Eutrophication is the process by which lakes slowly age. Accelerated eutrophication occurs when an excessive amount of organic nutrients are added to a lake due to human activity. This is a form of pollution because it creates unnatural algal and vegetative growth and damages the balance of the ecosystem.

Sedimentation is the deposition of soils in bodies of water and can occur naturally or due to human activities.

Standards

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Objective

The Construction Stormwater Runoff and Pollution Prevention Plan provides a tool to reduce adverse construction impacts to stormwater systems and reduce pollution due to dust and particulate matter. It should be designed to prevent runoff from offsite areas from entering disturbed site areas, slow runoff across site, remove sediment from onsite runoff, meet or exceed local requirements for sediment and erosion control and utilize stormwater onsite if possible. Potential uses for captured stormwater include washing construction vehicle tires and wetting dust for suppression purposes. This plan shall comply with the strategies and goals described in US EPA document NO. 832/R-92-005: Storm Water Management for Construction Activities.

Plan Components

I. Site Evaluation and Initial Plan Development

A. Collect Site Information
   1. Measure the Site Area.
   2. Determine the Drainage Areas.
   3. Existing Runoff Water Quality – Include this information only if it has already been analyzed, if information is available from an adjacent site or if information is available from the state or local government.
   4. Location of Surface Waters – Include location of rivers and bays adjacent to the site.
   5. Name of Receiving Water – Name the body (or bodies) of water that is receiving the runoff water and indicate whether it goes through the municipal water system or discharges directly.

B. Develop Site Plan Design

C. Calculate the Runoff Coefficient – the total rainfall that will appear as runoff expressed as a fraction. Calculate for each material covering the site.

D. Prepare Pollution Prevention Site Map – Indicate the location of surface waters, slopes after grading, disturbed areas and drainage patterns/discharge points.

II. Control Selection and Plan Design

A. Review and Incorporate State or Local Requirements

B. Identify Dust Mitigation measures
   Include areas where the following measures are implemented
   1. Temporary and or permanent seeding and planting (including sod stabilization)
   2. Mulching
   3. Soil retention through structural measures as identified in C below or Geotextiles
   4. Creation of protected buffer zones

5. Regular sweeping and wetting of dust and dry soils

C. Identify Structural Erosion and Sediment Control measures
Include the following measures as appropriate
1. Intercepting dikes and/or swales
2. Temporary Storm Drain protection or diversions
3. Silt Fences or gravel/stone filter berms
4. Sediment Traps and basins

D. Identify opportunities to collect and utilize stormwater for construction activities such as wetting dust for suppression and washing vehicle tires.

E. Include the following additional measures
1. Proper Disposal of Construction Site Waste
2. Compliance with Applicable State or local waste disposal
3. Compliance with Applicable State or local sanitary sewer or septic system regulations
4. Control Offsite Vehicle Tracking
5. Control of Allowable Non-Storm Water Discharges

F. Indicate the Location of Controls on the Site Map

G. Prepare an Inspection and Maintenance Plan

H. Coordinate Controls with Construction Activity

I. Prepare Sequence of Major Activities

III. Implementation and Verification

A. Implement Controls and maintain records of stormwater retained

B. Inspect and Maintain Controls - Inspect every 7 days or within 24 hours of a rainfall of more than ½”

C. Maintain Records of Construction Activity

D. Report Releases of Reportable Quantities

E. Plan Location and Public Access

Construction Storm Water Runoff and Pollution Prevention

SEQ-6-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	●	●	●	●	●

☐ **Required Component:** *(This will satisfy LEED™ 2.1 Sustainable Sites Perquisite 1: Erosion and Sedimentation Control requirements)*
A Construction Storm Water Runoff and Pollution Prevention Plan is attached. This plan conforms to US EPA document 832/R-92-005 and addresses measures to prevent air pollution from dust and particulate matter during construction.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Existing Site Structures SEQ-7

Sustainable Design Guidelines Reference Manual
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Purpose: Encourage the re-use of existing site structures to conserve resources.

Action: Incorporate existing slurry wall, bathtub excavation, elements of Temporary PATH Station and utilities (such as the River Water Pump Station) for re-use in new site development to the extent possible.

Related Guidelines: SEQ-1, MEQ-1, MEQ-2, MEQ-3

Potential LEED™ 2.1 Credits: 3 possible with MR cr. 1.1, MR cr. 1.2, and MR cr. 1.3. (See Submittal Template)

Existing structure and new PATH Temporary Station on WTC Site, Croxton Collaborative Architects, P.C., 2002

PATH tracks on the WTC Site, Croxton Collaborative Architects, P.C., 2002

Introduction/Context

The reuse of existing site structures and portions of infrastructure is a major precept of sustainable design. This strategy preserves resources, reduces site disturbance, conserves energy and prevents additional air pollution through captured (embodied) energy and by avoiding demolition. Adaptive reuse of site elements is also a sound economic policy. By incorporating existing structures into new structures, money may be saved on the purchase of materials and labor. This technique is also positive for a community since it preserves its historic fabric and curtails the disruption that often occurs during demolition. The complex infrastructure at the site of the former World Trade Center presents many opportunities for adaptive reuse in the redevelopment plan. Many of these elements were carefully engineered and represent a significant investment of energy and material resources.

Relevant Issues

Ecological
The incorporation of existing site structures and infrastructure reduces the amount of construction waste produced on a site. The demolition of existing built-form can create large volumes of debris that must be carted away to a land fill. The demolition process can also release contaminants or particulate matter and effect air and water quality. The reuse of existing site elements also has positive implications for resource conservation: it reduces the raw material extraction needed to produce new building materials; it has a positive effect on air pollution as fewer emissions from the production and transport of new building products are released; it conserves the fossil fuel base. Reusing the maximum amount of site elements – in this specific locale, the foundation walls, the bathtub, and transportation infrastructure – allows for a scaling down of potential site disturbance, which benefits natural habitats and the ecosystem of a site.

Economic
In this case, the economic benefits march side by side with the ecological benefits of reusing site elements. Existing site structures are a resource. They reduce the initial project costs for the purchase and transportation of new materials. Labor costs may be less as a result of the reuse of these structures, depending upon the degree of modification necessary to render them suitable for reuse. Significant savings in time to excavate and rebuild major, customized elements such as the huge and costly 'bathtub' will also be realized at the World Trade Center site.

Neighborhood
Certain structures on a site may have historic or sentimental significance for a community. The preservation of these forms or even the act of giving them new life through renovation and reprogramming can be a positive action for the neighborhood. The reuse of site elements or infrastructure will speed up construction and limit disturbance to the neighborhood. Avoiding the potential for air pollution as a result of demolition has positive health effects for community members.

Methodology

Design Strategies
Incorporate existing site structures into new projects wherever possible. Design new structures so that significant elements can be easily disassembled, to facilitate future adaptation or reuse during the evolution of the site. There are a number of existing structures on the WTC site which have already been identified for reuse. Examples should include, but are not limited to, the "Bathtub"/Slurry walls, the existing PATH tracks and the PATH temporary station, the H&M tunnels and the supply and return river water pipes. This initiative should be continued and documented for ongoing best practice.

Case Studies

Temporary PATH station at WTC Site

The creation of the WTC PATH station as a temporary facility includes many of the precepts of good environmental/sustainable design. The key sustainable attribute of temporary facilities is their ability to be disassembled, reused and recycled. The minimization of composite systems will facilitate reuse of building materials. The facility includes many components, which have been designed and specified to support reuse. The most significant of these is the steel structure. Steel columns, beams and decking are all easily recycled. These structural steel components often contain a recycled component of 50-100%. The disassembly is facilitated by ease of access to fittings, bolts, convectors, etc. This strategy dramatically reduces airborne particulates and related air quality impacts associated with a traditional demolition sequence. The reduced use of finishes and the avoidance of composite systems (like the assembly of sheetrock, tape, spackle and paint) in many areas contributes to material reusability. From the exposed structural framework and decks to abundant use of simple sealed concrete floors, the reduction in finishes also simplifies maintenance requirements. Once again, the air quality impacts normally associated with the demolition of such a facility are greatly reduced. (Croxton Collaborative 2003)

NYC Highline Project

State and Federal funding is supporting the development of a master plan to turn a former train trestle by the meat packing industry on Manhattan' s West Side into a public green-space. Friends of The High Line was formed as a non-profit group to promote the conversion of this 22 block long, abandoned elevated railroad running from 34th Street to Gansevoort Street into a public green corridor. They feel it offers an opportunity to create a unique recreational amenity for New York City. As a result of their efforts, New York City has pledged capital support to help push this venture forward. If the vision of this project is realized, it will create a tranquil elevated public green space that offers views of the Manhattan skyline, the Hudson River, and gardens that are currently "hidden" inside various city blocks. This public promenade will also offer various recreation programs. Some potential ideas proposed have been a public urban beach, music venues, and botanical gardens. (Friends of The High Line 2004)

KSBA Architects Office Building in Pittsburgh, PA.

In a classic example of "adaptive reuse," the design team transformed a historic building from 1888 in downtown Pittsburgh into a functional office for their architecture practice. They performed a 100% rehabilitation of the existing building and kept the entire shell intact. The team also reused 90% of the building's architectural millwork and furniture. These design strategies helped them earn credits toward a LEED™ Version 1.0 Certification. (Green Building 2004) (USGBC 2004)

Reference

Definitions

Definitions have not been included for this Guideline.

Standards

Standards have not been included for this Guideline.

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Use Existing Site Structures SEQ-7-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	●	●	●	●	●

☐ **Required Component:**
This certifies and documents that existing site structures have been incorporated in new site development. A list of retained elements is attached.

☐ **Optional Component:** *(To satisfy the requirements of LEED™ 2.1 Materials and Resources Credit 1.1: Building Reuse – Maintain 75% of Existing Walls, Floor and Roof)*
This certifies that at least 75% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material) has been maintained. A list of the retained elements is attached.

☐ **Optional Component:** *(To satisfy the requirements of LEED™ 2.1 Materials and Resources Credit 1.2: Building Reuse – Maintain 100% of Existing Walls, Floor & Roof)*
This certifies that at least 100% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material) has been maintained. A list of the retained elements is attached.

☐ **Optional Component:** *(To satisfy the requirements of LEED™ 2.1 Materials and Resources Credit 1.3: Building Reuse – Maintain 100% of Shell/Structure and 50% of Non-Shell/non-Structure)*
This certifies that at least 100% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material) has been maintained AND at least 50% on non-shell areas (interior walls, doors, floor coverings and ceiling systems) have been maintained. A list of the retained elements is attached.

Name	Signature
Company	Role in Project
Date	

Purpose: Use indigenous or acclimatized plants to reduce irrigation and maintenance requirements.

Action: Specify naturalized or indigenous plant materials, which will promote biodiversity and support site ecological systems, as well as reduce maintenance requirements. Use plantings that can be sustained by natural rainfall levels to reduce irrigation requirements.

Related Guidelines: UEQ-5, WEQ-4

Introduction/Context

The plant community of New York City has changed a great deal in the last 400 years. It has responded to urbanization and an evolving environment and as a result of the introduction of new species, either by intent or inadvertently. In some cases new species have become invasive, colonizing large areas and competing with local plants for limited resources. What's worse is that many of these foreign plants require large amounts of water and fertilizer to survive. This guideline strives to improve the ecological health of local plant communities, reduce plant maintenance requirements, restore the natural biodiversity of the area and minimize the negative ecological and health impacts associated with high-maintenance landscapes.

Native vegetation, which has evolved with the New York climactic conditions, has lower irrigation requirements and will reduce the need to waste potable and other water sources for landscape maintenance. Acclimatized plants typically need little or no fertilizer and pesticides to thrive, thus lessening the potential for environmental pollution from these sources. The specification of indigenous or acclimatized plants will contribute to the reinforcement of ecological systems, including fauna, which have evolved over time as appropriate to this locale and climate.

Relevant Issues

Ecological

The specification of native or adapted vegetation reduces the need for fertilizers or pesticides. Avoiding these chemicals reduces pollution to both stormwater and air. Fertilizers and pesticides in stormwater runoff taint neighborhood bodies of water and cause damage to aquatic habitats. Pesticides also inadvertently kill organisms other than those targeted, reducing ecological health and affecting biodiversity.

Acclimatized plants have evolved over time to thrive in the natural climatic conditions of a given location. Accordingly, they require less or no irrigation water.

Alternatives to indigenous plants, such as turf lawns, require mechanical maintenance in addition to chemical support. Activities such as mowing, typically performed by equipment that burns fossil fuels, produce toxic emissions that affect air quality and contribute to both global warming and the destruction of the ozone layer. The need to fuel these machines depletes natural resources such as petroleum. In addition, the loud engines of maintenance equipment cause noise pollution on and around a site. While it is recognized that certain areas should be turf lawns, for the pleasure of people who will frequent the site, it is recommended that other types of local groundcover be used wherever lawns are not considered essential to the well-being of the population. This variety of ground cover will contribute to supporting local biodiversity, while meeting the needs of all residents and site occupants.

Hearty, acclimatized plants have a root structure that is much more robust than planted grasses that are alien to a region. The network of roots present when indigenous vegetation is planted helps bind the soil and reduce erosion. Stormwater runoff is also reduced because a healthy mix of natural plants absorbs much more rainwater than a field of manicured grass.

The use of indigenous vegetation is also important to the support of natural habitats. Native plants enhance the populations of insects and birds that comprise a healthy and balanced ecosystem.

Economic
The reduced maintenance needs of acclimatized vegetation yield lower operational costs. Money can be saved by not having to purchase potable water for irrigation, fertilizers, pesticides, herbicides and the constant, cyclical round of labor associated with their application, as well as the labor that would be required for grooming.

Because deep-rooted native vegetation contributes significantly to stabilizing the land and stormwater management, its use can create financial savings by reducing or eliminating the need to build stormwater control infrastructure. If some measure of stormwater is, in fact needed, natural conveyance and detention systems (such as bioswales and bioretention ponds) are less expensive to build and maintain than engineered alternatives.

Neighborhood
The use of indigenous plants for landscaping has many benefits for a community. The resulting reduced maintenance requirements helps curtail air, water, and noise pollution, making the environment of a neighborhood healthier and more pleasant. The added aesthetic value is also significant. The specification of native vegetation that varies seasonally ensures that there will always be an interesting and diverse landscape for community members to enjoy.
There are also educational benefits to using indigenous vegetation. The habitats created by these plants are ideal “laboratories” for scientific study, as well as conservation education.

Methodology

Design Strategies
Specify vegetation that is indigenous to the North East United States. Select specific plants that are well adapted to site conditions and are known to thrive in an urban locale, with little maintenance. For example, use plants that can be sustained by the natural rainfall levels in the area. Consider such factors as a plant’s size and shape

while locating it in a landscape design. Avoid any plants that are considered invasive, as they frequently dominate and destroy the balance of an ecosystem as they mature. Employ a selection of plant types that thrive during different seasons to ensure continuing interest, color and variety in the landscape plan. This will also provide textural interest during the course of the year. Select perennial plants with long life spans to reduce maintenance requirements. Plant the site densely and in layers to promote water retention and air pollutant absorption. This strategy is also important in combating heat-island effect. Design a rainwater catchment and delivery system to accommodate irrigation needs at times of low-rainfall, without the use of potable water.

Means and Methods

There is a wealth of information available to aid in the selection of vegetation that will thrive in New York City. The Brooklyn Botanical Garden has created a highly useful source for this data as part of its New York Metropolitan Flora Project. As part of this effort, the Garden has documented the flora in all counties within a 50-mile radius of New York City. Their website (http://www.bbg.org/sci/nymf/) provides a list of local, natural vegetation by county. Another group called 'Trees New York' maintains a website with information including which trees are best suited for street-side applications in this climate. The United States Environmental Protection Agency provides useful guidelines for landscaping with native plants.

An opportunity exists here to consider the work of Alan Sonfist's Greenwich Village 'Time Landscape' Park, which uses only native species present before mankind's arrival in Manhattan, to demonstrate the original ecology, flora, fauna and soils of the area. The case study data is included below and in the Natural History section SEQ-13.

Case Studies

IBM Tivoli Systems, Inc. Headquarters, Austin, TX

The campus of this project consists of 6 buildings and 2 parking garages. The development of the site preserved much of its hilly terrain and existing oak and elm trees. The design includes natural stormwater processing infrastructure consisting of a four-acre pond and a series of smaller retaining ponds that are planted with native vegetation to naturally clean stormwater runoff before it leaves the site. The design team actually removed non-native cedars and replaced them with native trees, shrubs, wildflowers, and grasses to restore the site to a true natural condition. The use of these indigenous plants reduces the amount of water needed for irrigation. (BuildingGreen.com 2004)

National Wildlife Foundation Headquarters, Reston, VA`

As part of the design process for this building, a site inventory was performed, cataloging the natural features and wildlife on the wooded site and surrounding areas. When selecting plants for the site design, the inventory was used as a reference and more plants of the same species that already existed on the site as well as additional species that would compliment the existing site vegetation were selected. Because a portion of the site contained a thriving, mature ecosystem containing valuable vegetation, a plan was enacted to prevent disruption of that area. This resulted in the protection of one half-acre of the site on which 30 mature trees of over 30" caliper and related undergrowth was saved. The site uses a natural *stormwater management system which helps promote biodiversity. Native trees, shrubs, and ground covers that can handle the ebb and flow of water are used as natural filters. The site also provided a great opportunity to showcase diverse habitats. The development included design measures to accommodate various wildlife habitats including meadow, woodland, and aquatic. The landscape architects designed each ecosystem to provide shelter, food, and water for the creatures in each divergent habitat. The site-design also includes various deciduous, native vines that are popular with wildlife and which provide shading for the building during the warmer parts of the year. (BuildingGreen.com 2003)*

Time Landscape, Greenwich Village, New York City
In the nineteen sixties, artist Alan Sonfist conceived of a plan to regress small portions of cities throughout the world to their pre-human ecosystem. He called these proposed park-like spaces Time Landscapes because they would celebrate the unspoiled land that existed before human intervention. In 1978, working with the Metropolitan Museum of Art and New York City Planners, Sonfist was able to realize his vision in Greenwich Village, between Houston and Bleeker Streets. This park uses species of trees that existed in the same location before man arrived. As these plants take hold, they transform the soil and animal life within it to their pre-human state as well. The result is a place where people can experience an almost pre-historic portion of the New York Ecosystem. (ArtsEdNet 1999)

Reference

Definitions

Acclimatized vegetation is that which can be sustained naturally and thrive in the conditions specific to a site's microclimate.

Indigenous or Native plants are those that occur naturally in a particular region.

Standards

Standards have not been included for this guideline.

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Plant / Vegetation Selection

SEQ-8-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
	●	●	●	●	●

☐ **Required Component:**
A planting plan and schedule is attached and demonstrates that the site vegetation selected is indigenous or adapted to New York City. This also certifies that an effort has been made to specify plantings that can be sustained by natural rainfall levels to reduce irrigation requirements.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Daylight Exterior Public Spaces SEQ-9

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Purpose: Design buildings and site structures to consider available daylight for public open spaces and green areas (within the context of the established massing guidelines).

Action: Determine critical open spaces and green areas. Utilize shadow studies to determine available sunlight. Consider available sunlight in planning outdoor public spaces and site plantings.

Related Guidelines: UEQ-6, SEQ-3, SEQ-10

Introduction/Context
In the planning of a project such as the World Trade Center Redevelopment, there is a great opportunity to consider the positive and negative elements that will form the fabric of the completed complex in several, not necessarily conventional, ways. One of these, important in any sustainable project, is the quality of the negative, or outdoor spaces – those spaces that will fall between and around the built infrastructure. For this site to have a truly sustainable character, the outdoor spaces must offer community residents, building occupants and visitors a memorable experience. This will be accomplished, in part, by views to the series of innovative, contemporary buildings planned for the site and, in part, by providing a variety of landscaped outdoor spaces, including places to relax, eat al fresco, shop and stroll, as well as for contemplative and recreational activities. All of these spaces will be enhanced by the presence of abundant daylight, especially sunlight, in all its forms: bright beam light, diffuse light, sunlight filtered through trees or trellises, gilded early morning light, and slanted evening light, used and modulated as appropriate for each activity.

Providing sheltered, sunny 'outdoor' rooms, making the outdoors more available for longer periods of the year, enriches the site and guarantees its greater use. It adds an element of quality to the entire neighborhood that will be advantageous to businesses, especially retail shops. People are attracted to pleasant outdoor spaces and are more likely to linger, and purchase more, if they are thermally and psychologically comfortable. The strategy can be justified simply in terms of creating value, but it also contributes to human well-being, and potentially to job satisfaction.

It is appropriate to study opportunities to enhance the quality of outdoor spaces through extensive shadow analysis, looking at the impact of the different building profiles on the site throughout the day-lit hours. Wind studies (see UEQ04) must also be considered, as many of these spaces will benefit from more sheltered locales. Only with such research can a definitive plan evolve to will balance the needs of site density with human comfort issues. This accomplishment will make the World Trade Center an exceptional and exemplar model of human-centered design, as well as, a destination for people beyond those who live and work in the vicinity.

Relevant Issues

Ecological
Areas of an urban site that are covered by vegetation such as native grasses and/or ground covers including pachysandra, ivy, and periwinkle, provide environmental benefits including the reduction of urban heat islands and the promotion of biodiversity. Designing a site with daylight in mind will support the growth of these vegetated areas, support environmental comfort and human well-being goals of the project and contribute a measure of quality to the site that is invaluable in terms of visual and sensory pleasure.

Economic
Exterior areas around buildings feel much more pleasant and hospitable when they are designed to capitalize on available daylight. This goal is accomplished by spaces that reflect a clear understanding of the seasonal, traversing patterns of sunlight falling on these open areas. Site spaces appear more welcoming as a result of these strategies, and have the potential to attract businesses and consumers to an area. Day-light responsive urban plazas and open green spaces are well recognized amenities, known to enhance property values.

Neighborhood
More light-filled, open urban spaces adjoining a neighborhood and realized as part of the public domain, provide a great benefit to community members in terms of health and well-being, an expanded sense of community, as well as access to and enjoyment of the outdoors.

Methodology

Design Strategies
Daylighting offers one of the greatest opportunities to take advantage of natural assets such as the dramatic open south-to-west solar traverse that characterizes the site. The incorporation and optimization of daylight strategies requires a thorough understanding this major asset, the behavior of diffuse light and early integration of daylight apertures and diffusing elements into the design process.

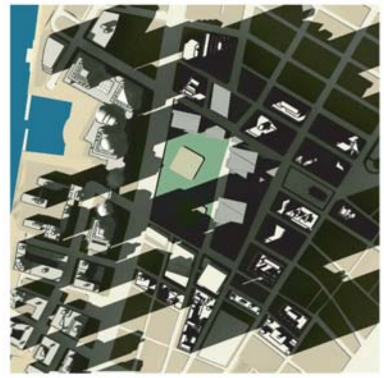
Means and Methods
Determine critical open spaces and green spaces. Utilize shadow studies to determine available sunlight (orientation and duration) and consider it in planning outdoor public space and locating public amenities, site plantings and areas for recreation.

Use diagrams to explore daylight opportunities on the site. These should include shadow studies to map the path of the sun across the site.

Early Conceptual Shadow Studies


Sept. 21 solar noon
(1249hrs)


Sept. 21 +2.0hrs
(1449hrs)


Sept. 21 +4.0hrs
(1649hrs)

Above: The WTC site as shown with an early, theoretical scheme. Building massing is kept to the north and east edges of the site, allowing for direct sunlight access during much of the afternoon and early


June 21 solar noon
(1258hrs)


June 21 +2.0hrs
(1458hrs)


June 21 +4.0hrs
(1658hrs)

Above: The Summer Solstice (June 21), the longest solar day of the year, is chosen as the reference date . The original WTC footprints and most of the remaining plaza are exposed to direct sunlight from solar noon through the early evening.

Case Studies

Temporary PATH Station, World Trade Center Site, New York City

The design of this station created an open-air room flooded with daylight. As light filters through the translucent scrims that define the boundaries of the structure, it reflects off colored mosaic tiles creating an iridescent effect. (Dunlap 2004)

Lighting filtering down into the platform at the WTC Temporary Path Station
©Fred R. Conrad/The New York Times (Dunlap 2004)

Nine new Metro Stations, Copenhagen, Denmark
These stations locate the train platform 18 meters below ground level and yet the station receives daylight through skylights located in the stations' flat roofs. An urban square is formed around the portals that bring light down into the stations. The daylight that reaches the platform is supplemented by artificial light that is coordinated to increase as daylight levels decrease. (Metro 2004)

Reference

Definitions

Definitions have not been included for this Guideline.

Standards

Standards have not been included for this Guideline.

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Daylight Exterior Public Spaces

SEQ-9-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
	●	●	●	●	●

☐ **Required Component:**
This certifies that site structures, plazas and amenities were designed to capture traversing daylight which has been quantified by duration, inclination, and seasonal variance. Attached daylight studies and designs of public spaces confirm an early examination of this guideline.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Solar Access SEQ-10

Purpose: To optimize solar access for utilization of solar energy.

Action: Determine maximum available photovoltaic potentials for all building surfaces. Develop a strategy for possible future transition to capture this potential. Quantify and document this strategy and any other “near threshold” renewable technologies in the Renewable Energy Transition Plan.

Related Guidelines: UEQ-5, UEQ-6 SEQ-9

Introduction/Context

The photovoltaic generation of electricity is on the cusp of becoming a cost-effective alternative to electricity purchased through a local utility and has many environmental advantages, which do not necessarily translate directly into dollars saved. The purpose of this guideline is to ensure that building forms and envelopes have been shaped to anticipate future integration of photovoltaic panels as the cost equations change and solar electricity becomes a clear choice based on economics alone. Based on current market trends this may be in the near future.

The use of renewable technologies for electricity production alleviates a number of environmental concerns including air pollution and fossil fuel depletion. A site that produces all or part of its own power reduces its dependence on the power grid. This self-reliance is significant in light of recent problems with portions of the U.S. power grid such as the major blackout that occurred across the Northeast in August of 2003 or the rolling blackouts that plagued California during January of 2001.

Photovoltaic cells directly convert sunlight into electricity. The PV industry has been experiencing expansive market growth over the last ten years. This is partly due to increased demand for clean energy sources and partly a result of the development of more economical and efficient PV cells. According to the March 2001 issue of PV News, a publication of PV Energy Systems, worldwide shipments of PV modules increased 43% between 1999 and 2000. Growth of this industry has averaged about 23% per year since 1993. According to Solarbuzz, a solar energy research and consultancy group, 37 Megawatts of grid-connected solar photovoltaics were installed in the United States in 2003. That figure is a 32% increase over installations in the previous year.

The development of building integrated photovoltaic (BIPV) systems has provided on-site renewable energy solutions that are more widely accepted since they also function as architectural elements. PV cells are now often integrated into the façade or roof of a building and become part of its design vocabulary. Many buildings erected in the past few years have been designed to include BIPV systems.

Relevant Issues

Ecological

The use of renewable energy has many environmental benefits. The generation of electricity via photovoltaic (PV) cells displaces more traditionally generated power from the energy grid. According to the U.S. Environmental Protection Agency's Power Profiler, the power being displaced in lower Manhattan is comprised of 2% non-hydroelectric renewables, 12% oil, 35% nuclear and 51% natural gas generated. These plants produce air pollution on the order of 1.2 lbs/mWh of Nitrogen Oxide, 0.6 lbs/mWh Sulfur Dioxide, and 1,090 lb/mWh of Carbon Dioxide. Power Profiler does not account for the nuclear waste created from this power generation although it is quite significant. The by-products of nuclear fission, as well as contaminated equipment used in the process, remain highly toxic for thousands of years and must be stored in highly protective assemblies away from people and other biological systems. Both of these non-renewable power plant types also deplete natural resources. The generation of renewable energy on- site also has the advantage of reducing or eliminating the resources needed to construct and maintain transmission equipment to move electricity from its distant point of generation to the project site.

Another benefit of PV electricity generation is the potential to capitalize on waste-heat for other uses such as the making of hot water. Typical PV cells are only 15% efficient with most of the surplus solar energy being converted into heat. Some industry manufacturers of PV systems (Innovative Design and Solar Design Associates) have designed and are currently testing PV/T or photovoltaic/thermal technologies that capture that waste heat for building use.

Some criticism of the PV industry's environmental record has been raised because of the potential for pollution during the manufacturing process of the Crystalline Silicon that comprises the majority of PV cells today. As manufacturing technology has become more sophisticated, the creators of PV cells now have production options that are environmentally benign. These processes include the use of water or glycol-based lubricants and deposition fluids, the replacement of carbon-tetrafluoride in the circuit production process, and the use of lead-free systems for electrical connections.

Economic

On-site renewable energy generation can produce cost savings across various scales. The operator of the site can save on utility costs especially peak-hour demand changes that are typically high. The utility company can also save money because of the reduced need for transmission infrastructure. In locations where net-metering is permitted, the owner of the site can potentially sell extra electricity generated on-site back to the utility company at market rate. This also aids the utility in ensuring that they can provide enough power to the grid during times of excessive demand like the occasional sweltering day that may occur during the summer.

There are a variety of government incentives that a site owner can receive for installing a photovoltaic system. One such incentive is available as part of the New York State Green Building Tax Credit instituted in 2000. Part II of Chapter 63 outlines 6 different program components that can qualify a project for credits. Component 5 covers incentives for photovoltaic systems. The credit is for 100% of the cost of building integrated photovoltaic modules (20% per year x 5 years) or 25% of the incremental cost of non-BIPV modules (5% per year x 5 years) with a cap of $3/ watt. It is important to note, however, that this credit is only available to those projects that also meet all of the other criteria of the NYSGBTC.

In cases where building-integrated photovoltaic arrays are used, money can be saved on other building components since the elements containing the PV cells serve a dual function. (i.e. both a roof and a power generating array) Although the price of PV systems varies greatly depending on the type of PV technology used, they have been steadily gaining efficiency and becoming more cost effective. For instance amorphous silicon PV cells, which are more economical because their production avoids the step of the traditional process where silicon crystals must be grown, cost around $20 to $25 per square foot (not including installation costs) and generate between 4.5 – 6 Peak Watts per square foot.

An important "next generation" form of PV is anticipated to be a transparent unit that could replace the high performance windows currently in use on site. The shading coefficients, visible light transmission, and U.V. rejection characteristics are planned to closely match existing systems, while, the generation of electricity from both direct beam and diffuse light would be possible. Although operating at lower net efficiencies, these units would make "productive" the largest single area of the building envelope and create electricity directly at the point of use.

Neighborhood

The use of renewable energy technologies has major implications for air and water quality across every level from global to local. The displacement of the energy produced via fossil fuels and nuclear methods in a region by clean, renewable technologies will result in cleaner air and water for the entire community.

Methodology

Design Strategies

Determine the maximum available energy generation potential on site via photovoltaic technologies. The first step in this process is analyzing the incident radiation levels on all building surfaces. This activity should be coordinated with studies conducted in response to Guideline SEQ-9. Based on climate and radiation data, and the orientation of the building, one can determine how much solar potential exists for power generation. Next, by investigating various PV technologies that are feasible for the particular application at hand, one can estimate the amount of electricity generation that can be reasonably expected. At that point a cost-benefits analysis may be conducted to determine the most economical strategy for integrating PV technologies into the particular design. The potential for future PV generation based on projected advances in the industry should also be studied and integrated with the Renewable Energy Transition Plan as part of the Sustainable Guidelines requirements of EEQ-5.

Means and Methods

The photovoltaic effect describes the direct conversion of sunlight into electricity. A photovoltaic cell is a composite structure comprised of semiconductor materials assembled in a specific way to control the generation and flow of the electricity. An enormous advantage of this technology is that it does not rely on any moving parts that may frequently require maintenance and repair. Historically, PV cells have been assembled into arrays and mounted on brackets that optimized their orientation to the sun. Building Integrated Photovoltaic systems (BIPV) use PV cells as part of a building element such as its façade or roof. The reduction of power generation that results from the cells not necessarily being placed at an optimized angle with respect to the sun (as with angled or moving PV arrays) is offset by the increased electricity production of the modern PV cells and the increased number of cells that can be purchased economically at decreased costs.

Case Studies

<u>Brewery Block 4, Portland, OR</u>

This office building in downtown Portland, Oregon boasts 23.5% electrical energy savings over ASHRAE 90.1 per year. It was designed to provide solar access for both occupant enjoyment and energy savings. The south side of the building was purposefully designed to allow the sun's rays to penetrate the building for daylighting and strike portions of the façade for renewable energy generation. The southern façade incorporates a BIPV system. It houses an amorphous silicon array of thin-film modules that are incorporated in spandrel panel extensions. A four square array is located at each spandrel to total 192 PV modules. A rooftop PV array is also present on the building. 77 Polycrystalline modules are expected to produce 13,400 kWh per year. The total energy output of the on-site renewable system is 21,600 kWh annually. This represents about 0.4% of the building's annual consumption of electricity. (US DOE 2003)

<u>Greenpoint Manufacturing and Design Center, Greenpoint, Brooklyn.</u>

This building, operated by a nonprofit organization and housing mostly artisans and craftsmen, has a PV system on its roof. The system uses multi-crystalline PV cells and produces 60.4 Peak Kilowatts of electricity which translates to 45,300 kWh per year, about 5% of the building's electrical load. (altPower, Inc. 2002)

<u>AstroPower Headquarters, Newark, Delaware</u>

As a solar cell manufacturer, AstroPower decided to implement as much PV technology as possible into their new headquarters. From the design's inception, the intention was to create a south-oriented BIPV façade for the front of the office complex. A standard aluminum façade system was used with custom sized glass-PV laminates replacing traditional façade panels. This BIPV system generates 30 Peak Kilowatts. A second PV array was installed on the flat roof of the manufacturing portion of the facility The system, which lies flat, generates 310 Peak kilowatts of electricity. The two systems combined produce 255,000 kWh annually and constitute 5% of the building's electricity needs. (Pereira 2003)

Reference

Definitions

<u>Photovoltaic</u> describes the process by which light is converted directly into electrical energy.

Peak Watts (or Peak Kilowatts) indicates the electrical output of a PV device during a period of optimal solar exposure.

Standards

Standards have not been included for this Guideline.

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Solar Access

SEQ-10-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
	●	●	●	●	●

☐ **Required Component:**
This certifies that the potential for generating electricity through the use of photovoltaics has been studied and quantified. Documentation of this study is attached. A plan for the future expansion of on-site photovoltaic power generation as PV technologies evolve has been included in the Renewable Energy Transition Plan of Guideline EEQ-5.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Recovery of Resources SEQ-11

Purpose: To optimize utilization of site material resources and to facilitate the reduction of waste generated by building occupants that would otherwise be hauled to and disposed of in landfills and/or incinerators.

Action: Study large-scale and small-scale opportunities for on-site recovery of waste. Consider opportunities to recover food, paper, plastic, metal and construction waste. Consider composting, biomethanization and other viable "waste to reuse" strategies. Consider in conjunction with Renewable Energy Transition Plan and Co-generation study.

Impacts: SEQ-1, SEQ-2, WEQ-2, MEQ-1, MEQ-2, MEQ-3, EEQ-1, EEQ-5

Introduction/Context

Waste is something that most people don't want to think about. When the topic of garbage does in fact crop-up in people's minds, there tends to be a common misconception that waste has no intrinsic value. In truth there are many valuable components of what is traditionally considered waste. The recycling of some materials, metals, glass, and paper have become common, however many other materials are still not considered valuable and many materials that are recycled are not recycled to their highest best potential.

According to the Comprehensive Commercial Waste Management Study conducted by the New York City Department of Sanitation, the city produced 19,976,815 tons of waste in 2000. 13,207,160 tons (66%) of that total was from commercial sources and 2% of that waste was produced at the former World Trade Center Site. This gives dimension to the scale of resource recovery that could be accomplished on this site.

Throughout its history, New York City has handled 'garbage' in various ways. The city has in part been built upon refuse, discarded to fill in low areas and push riverbanks further outward. More recently, New York has been exporting its trash to landfills outside of the city on Long Island and in Westchester County. Today, the city is searching for landfills in other states for its waste disposal. This is expensive and discards potentially valuable resources. It is important to note that during the two World Wars when resources were scarce, New York City recycled everything possible. This type of thinking, considering the potential for intensively mining trash for useful materials (or energy), can drastically reduce the amount of land needed for disposal. It can also lessen the quantity of resources and energy needed to extract raw materials and manufacture new synthetic materials that might otherwise be recovered from the waste stream.

Knowing that the redevelopment of the world trade center site will largely create commercial office space and include a large retail component, predictions can be made regarding the basic composition of the waste that will be generated on-site. A majority of the waste created is likely to be paper, mostly high-grade and cardboard. Other significant types of waste will be construction waste, organics, metals, plastics, and glass. Typically, these materials would be combined into one dumpster and trucked offsite for disposal at a cost of $156 per ton for the disposal service (2004 rate). There are, however, many buildings in Manhattan that practice robust recycling programs for at least their cardboard, along with some of their paper and metals. Ten million square feet of office space along with an additional 800,000 square feet of retail (including anticipated restaurants) will generate vast amounts of both wet and dry waste, much of which has reuse potential. A comprehensive strategy for resource recovery can institute various methodologies for extracting resources from this waste. An ideal situation would be to create a zero waste stream, one where as many resources as possible are culled from the waste stream to be reused on-site.

Relevant Issues

Ecological

There are many deleterious environmental impacts to traditional waste management. Just the process alone of transporting trash from its point of generation to its point of disposal has negative consequences. In New York City, idling garbage trucks emit 40.2 grams of VOC's, 710 grams of carbon monoxide and 11.0 grams of nitrous oxide per hour. It is well known that these compounds negatively impact air quality and contribute to global warming and acid rain. A typical garbage truck with a 20 cubic yard capacity transports between 3 to 8 tons of material per load. If a site can reduce its waste output by 100 tons/day by using on-site recovery and processing techniques, the number of trucks leaving the site each day could be reduced by 24.

Once waste reaches its final resting place, there are additional negative environmental impacts. Large tracts of open land are set aside for trash disposal. These lands are often removed from healthy local ecosystems. The release of methane into the atmosphere as garbage naturally breaks-down contributes to the greenhouse effect. There are some landfills sites where this methane is collected and used as an energy source, however this is not a usual practice. Harmful substances can leach into groundwater reservoirs. When a majority of a building's trash is combined in one container and not sorted by type nor scrutinized for resources, it is more likely that potentially toxic substances are inadvertently dumped at landfills that are not designed to contain them. These may include disposable batteries or fluorescent light bulbs. This effects both local water and air quality.

Economic

There are two levels of potential economic impact related to on-site resource recovery. The first benefit of reducing a site's waste stream is saving money on trash disposal service. In 2005, tipping fees in New York City are $90/ton plus an additional $66/ton for curbside collection and are projected to rise steeply.

The second layer of financial benefit associated with resource recovery is represented by the value of the resources themselves. These resources possess both material value and embodied energy.

Neighborhood
Efficient use of all available resources, including those found in waste has positive implications for the community surrounding a site. The reduction of environmental pollution associated with the reusing and recycling of materials is of benefit to people across the region. Fewer garbage trucks translates to better air quality, less noise, less wear and tear on local roads and, consequently, a significant improvement in quality of life to communities.

Methodology

Design Strategies
Develop a comprehensive site strategy for on-site resource recovery This can be coordinated with waste treatment methods used on-site as well. Recover paper, plastic, metal and construction waste. Separate this waste into categories based on reuse potential. Some of these items may be directly reusable on-site while some of these items may have value on a salvaged materials market exchange. Other materials can be sent to recycling plants where they will be reintroduced into the manufacturing stream as base materials.

Explore opportunities for waste-to-energy strategies. Organic waste, low-quality paper, and wastewater can be combined in an anaerobic digester to produce biogas for energy generation and compost for landscaping. The potential for energy generation from this type of system should be coordinated with the Renewable Energy Transition Plan outlined in Guideline EEQ-5.

Means and Methods
An opportunity exists to create a system on-site that reuses as much traditional “waste” material as possible to supplement resource recovery and reduce the transport of resources to and from the site. The first stage of such a process is the sorting and separation of various components of solid waste. An emphasis should be placed on finding the highest best use for each type of material. Construction materials such as gypsum wallboard, wood, and metals can be salvaged and either used directly or as ingredients to manufacture new building materials. Mixed and high quality paper can be sent to a local paper recycling mill where it will be added to the raw materials used to make new paper. Lower level mixed recyclables such as plastics, glass, and assorted metals can also be sent to a recycling plant to be reincorporated into various consumer products.

The potential for extracting valuable resources from organic wastes is also quite high. An anaerobic digestion process (similar to one currently on the drawing boards for 1 Bryant Park, a midtown commercial office tower) can be used to generate bio-gas to power electricity-generating apparatus. A bio-fuel plant is a system by which organic waste is broken down in an anaerobic process to release the embodied energy in the material into a form that can be harnessed. In one type of system, a bio-gas rich in methane is produced and used to create electricity from organic waste. Four main types of waste can be treated: food waste, low-quality paper, bio-degradable plastics and waste water/sewage. It is important to source-separate the waste stream as much as possible by installing special containers in appropriate locations. Any non organic or non-biodegradable items must be removed before the remaining organic solids are ground and inserted into anaerobic digesters. The digesters are large, low-pressure, sealed steel tanks in which the organic waste stays for three to ten days at temperatures of either 95°F or 135°F. In this oxygen-deprived environment, bacteria breakdown the organic waste into a biogas mixture of 65% methane and 35% carbon dioxide which is then pressurized and can be used the same way as natural gas would, for example in a gas-absorption chiller or to create electricity from a generator. Fuel cells would be the best generation option because of their high efficiencies and the heat they produce as a byproduct. This residual heat can be used to supplement the heating of the digester tanks to their operating temperature. Additional byproducts of the digester tanks are water and compost. The compost must go through a finishing aeration process before it can be used for landscaping. The water is very high in mineral content and is excellent for use in irrigation, but it can also be used anywhere that grey water is appropriate.

Case Studies

<u>Canada Composting Incorporated's Newmarket Plant, Newmarket, Ontario, Canada</u>

Newmarket is a bio-fuel facility located 25 miles north of Toronto in Canada. It opened in July of 2000, and has a capacity of 165,000 tons of organic waste. Operating at full capacity, the plant will produce over 66,000 tons of compost and produce up to 5 MWh of electricity. The plant accepts all types of organic waste, including food waste, fiber waste such as paper products like napkins and paper towels, cardboard milk and juice cartons and disposable diapers, agriculture waste and industrial/commercial/institutional waste. The plant uses a German process called BTA developed in the early 1980's. It is a fully enclosed, highly-automated, anaerobic digesting process that uses two sophisticated processes to separate contaminants from the organic waste. The two byproducts of this process are compost and a biogas that is 65% methane and 35% carbon dioxide.

<u>Compost Facility, Riker's Island, New York, NY</u>

Riker's Island, the municipal prison in New York City, has built a composting facility sized to handle 80% of the 20 tons of food waste that is created each day by the 24,000 inmates and officers. The jail has special yellow bins in the kitchens to collect the organic waste so that all of the waste is pre-sorted before arriving at the facility. This waste is mixed with wood chips to add carbon and to provide better airflow through the mixture. The mix is mechanically agitated and ventilated to control the temperature while undergoing an aerobic decomposition. This part of the process takes 14 days. The plant is under negative pressure all of the time to keep odor in, and all exhaust air passes through a biofilter. The biofilter is a mixture of finished compost and wood chips, which contain microorganisms. The organisms reduce odors by removing volatile organic compounds from the air. The final part of the process is a two-step curing process and a final screening for contaminants. The compost produces is used for greening projects on the island.

Reference

Definitions

Definitions have not been provided for this Guideline.

Standards

Standards have not been provided for this Guideline.

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Recovery of Resources

SEQ-11-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED[TM] Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
●	●	●	●	●	●

☐ **Required Component:**
A study of potentials for on-site recovery of waste, both small and large-scale, has been performed and is attached. Feasible opportunities for the recovery of food, paper, plastic, metal, and construction waste have been implemented.

☐ **Required Component:**
Additional waste-to-use strategies such as biomethanization have been considered and coordinated with the Renewable Energy Plan developed as part of the requirements of Guideline EEQ-5.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Use of Undeveloped Parcels SEQ-12

Purpose: Utilize inactive and undeveloped site parcels to provide a positive contribution to site environmental qualities.

Action: Address both the “active” portions of the site under development, as well as, the “inactive” areas of the site, which have a supporting role. At a minimum, apply guidelines Storm Water Use (SEQ-2) and Heat Island Effect Mitigation (SEQ-3) to “inactive” site areas.

Related Guidelines: SEQ-2, SEQ-3, SEQ-5, SEQ-6

Introduction/Context
In large projects which are phased over time, there are often building parcels which serve as staging areas for structures currently under construction or are inactive for significant periods of time. In Manhattan these sites are seldom left completely alone. They may be paved for temporary parking or even receive temporary structures for a variety of uses. Whatever the temporary use may be, the site must still be understood as having an impact on ecological systems. While economics often preclude installing sustainable design measures which would be included in the final build-out, there are a number of important measures which can be instituted at small cost with large environmental benefits.

(Note: In no case should inactive sites fail to address storm water and heat island effect mitigation.)

Relevant Issues

Ecological

Open sites around New York City have experienced a renaissance in recent years. Gone are the weed-filled, abandoned spaces which were catch-alls for the dumping of both construction waste such as concrete blocks, corrugated sheeting, etc. and endless amounts of trash, to be replaced with pocket parks or in-fill gardens. Examples include Paley Park on 53rd Street and a locally, well-known in-fill garden near Greenwich Street. Recycling centers, green markets and other active uses which contribute to the management of the site and to its ecological well-being are also common uses for such spaces around the city, and could be considered as temporary uses for these open areas at the World Trade Center site.

Economic

Both water and solar energy resources offer economic potential. Stormwater might be harvested for use on adjacent construction sites, or to maintain temporary site plantings, reducing the amount and cost of municipal water supplied to the site. Moveable photovoltaic panels could easily be mounted on temporary structures and then re-used later, on building roofs or in another open building lot. The energy harvested could be fed into the grid, or used on-site for temporary energy requirements, or to meet some of the construction functions at nearby sites, with concomitant savings.

Neighborhood

The open sites at the World Trade Center, which are, in all likelihood scheduled for later development, need to be integrated into the overall planning, so that they contribute to the attractive qualities of the neighborhood, and do not detract from security arrangements that are in place. Temporary gardens, in the design of which community members can have an active role, are always popular and offer a satisfactory option, which can be organized at minor expense -- some topsoil and exterior lighting.

These spaces can also be used by the landscape designers as staging for the temporary planting of trees and shrubs, allowing them to acclimatize over time, so that only healthy, established vegetation is eventually installed at the final site location. Maintaining such spaces with porous surfaces and some type of organized activity will contribute to both overall site ecology and the safety of the whole area. Although the porous surfaces may be lost eventually, when scheduled uses for these open spaces are developed, their function as collectors of stormwater might be reallocated to green roofs and the stormwater can at least be harvested to benefit other site activities.

Methodology

Design Strategies

In the planning of each project, consider the options available for temporary use of associated space or spaces scheduled to be developed in later phases. Design temporary exterior lighting layouts to render these open areas safe and useable for any number of activities. If a specific function can be determined for any of the spaces, provide appropriate infrastructure and/or materials to facilitate these activities, so that each such space contributes to the overall World Trade Center site, rather than being an eyesore, and an embarrassment to the developer.

Means and Methods

There are many possibilities for the temporary use of open parcels of land at the site. Depending on the length of time a site will remain unused (not fully built out or lacking its final designated use), each interim plan demands slightly different solutions to make the temporary conditions acceptable.

Among the possible uses of open parcels of land in a busy urban center are stormwater collection and/or in-fill gardens. If the surfaces are paved, provide a stormwater catchment system so that the site becomes an asset, contributing to the overall efficiency of the site. If plantings are considered an option – perhaps to stabilize the soil and prevent erosion -- engage the public in the idea of community gardens, which provide a visually attractive option. Even on a temporary basis, such gardens have been found to be successful, citywide.

Provide appropriate pads for the temporary installation of solar panels, and conduit for the transfer of power generated. If the spaces are to be used for weekend fairs, or for green markets, provide appropriate, general exterior lighting, and porous pathways for public use. In all cases provide recycling bins and garbage disposal facilities, and make sure that these spaces are included in the regular pick-up schedules.

Case Studies

<u>New York City: Parks and Recreation: Operation Releaf</u>

A new initiative called Operation Releaf allowed for the restoration of 117 degraded landscapes in parks and playgrounds with trees, shrubs, and flowers, often using plants grown in the Parks and Recreation's two nurseries and three greenhouses. In 2003, this program was expanded to include "Greeting Gardens," small, decorative planting beds at park entrances, with historical and directional signage that welcome and orient visitors. In the first season, 30 greeting gardens were planted across the city. Through the successful Greenstreets program, 51 barren traffic triangles and roadway medians were converted into pocket parks and tree-lined malls. Local citizens and corporations, including MetLife and Wendy's, adopted many Greenstreets, which now number more than 2,050 in the city. (Project 2005)

<u>Paley Park, 53rd Street, New York</u>

This small, vest pocket park in midtown was created in 1967 and serves as a prime example of a successful privately owned public space. The park was funded by William Paley, former chairman of CBS, who was also involved in planning its specific details. This park illustrates that even a small space can serve as a meeting place and place for a respite from the sometimes chaotic character of the urban environment. (NYC 2003)

Paley Park ©2003 Tom Spencer (Spencer 2005)

Reference

Definitions

Definitions have not been included for this Guideline.

Standards

Standards have not been included for this Guideline.

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Use of Undeveloped Parcels

SEQ-12-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED™ Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
	●	●	●		

☐ **Required Component:**
This certifies that the requirements of Guidelines SEQ-2 (Storm Water Use) and SEQ-3 (Heat Island Effect Mitigation) have been applied to the "inactive" site areas under my authority. It is understood that these provide minimum standards and that techniques that push the possibilities of stormwater use and heat island effect mitigation further are encouraged.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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Purpose: Make tangible the elements of site natural history to educate and inform site users.

Action: Integrate and exhibit site natural features and history to educate site users in interrelationships between built and natural environments and history of the site. A unique opportunity exists through the Memorial to connect visitors with this underlying bedrock, Manhattan Schist, formed 500 million years ago and the adjoining Hudson River which originally overflowed much of the site, forming the original shoreline along the line of the current Greenwich Street. The Hudson River with its four times daily reversal of tidal flows and contribution to cooling effect (river water system) is also a key element of the natural history.

Related Guidelines: UEQ-5, UEQ-7, SEQ-8

Introduction/Context

While the landscape which existed before the Europeans arrived has long since disappeared, the bedrock and underlying site geology remains unchanged. This ancient bedrock, accessible through the deep bathtub excavation, provides an opportunity to connect visitors, not only to the historical underpinnings of past and future buildings, but also to New York's unique geological history. It is our planet's geology, after all, that underpins the very thin layer of surficial life we are working to sustain. These rocks not only determine the soil which supports all plant life, they constitute the interface of the natural and artificial surface of this island.

The Natural History of the World Trade Center site also tells an interesting story about the shoreline of the Hudson River. When this shoreline was first mapped in the early 1600's, its line of demarcation ran almost through the center of the World Trade Center site. This serves to demonstrate just how much mankind has encroached on the river and the harbor since that time. It also highlights how much we have depended on the bedrock as a foundation for the 'fill' that has allowed the expansion of Manhattan's natural contours.

Relevant Issues

Ecological

A ridge of Manhattan Schist starting at more than 100 feet below the World Trade Center site constitutes bedrock and runs undivided, in an undulating manner, for the entire length of Manhattan. As it proceeds north. the ridge rises to within 35 feet of the surface, drops again north of Chambers Street, rises in midtown and emerges on the Upper West Side to create much of the hilly, rough topography north of 100th Street. The schist, formed 500 million years ago in the Cambrian Period, contains quartz, feldspar, hornblende, biotite and muscovite.

The Hudson River, reversing its massive flows four times a day in response to the lunar/tidal rhythm, is the destination for all water moving off the site and is under consideration for a cooling source that may be connected to and performing in concert with the Memorial Fountain.

Economic

The bedrock ridge rises at Lower Manhattan, and again in Midtown. It is for this singular geological reason that the city's famous skyscrapers were able to be built in on this site the first place. This bedrock once again establishes the foundations for the rebuilding of the World Trade Center at this location.

There is an opportunity to increase the number of people who visit the site for cultural and educational reasons by embracing its natural history in a marketable manner. By providing museum-type exhibits and allowing access to the exposed bedrock – a singular opportunity in Manhattan – for those interested in the geology and history of the site..

Neighborhood

Driven by the families of those who lost relatives and friends in the 9/11 disaster, who did not want the footprints of the Twin Towers to be 'covered up' or built over, Master Planning includes some access to the lower levels of the site at the Memorial. Here, the bedrock will remain exposed, as a reminder of the tragedy. However, visual access to this natural element, some depth below grade, also offers educational opportunities, and allows those who are interested in the natural geology of the island a rare opportunity to see a slice of the bedrock face, in situ.

Travelers arriving aboard ship and steaming up the Hudson River to the piers were, and to some extent still are, treated to a spectacular view, unique to New York, perhaps the hallmark of the city. Where the ridge sinks, in areas such as Soho, the Village and Murray Hill, and again North of Midtown, the land is filled with soft alluvial material, upon which skyscrapers could not be built. Lower, squatter structures became the order of the day, and remain so into the 21st Century.

Thus, the unique character of the underlying bedrock accounts for much of the quality and character of Manhattan's neighborhoods. The World Trade Center site and the surrounding neighborhoods originally supported large-scale buildings intended for financial and business endeavors, but leaving little room between these enormously high and rather inhospitable buildings for residential buildings or retail and cultural activities. All that has changed with the new neighborhoods built on the island's extended fill areas, most notably, Battery Park City which is itself extended into and bordering along the last stretch of the Hudson River as it enters New York Harbor.

Methodology

Design Strategies

A powerful statement or interpretation of the two natural systems, the river and the geology or "rock" of Manhattan present themselves in this unique location. This is presented by the possible integration of the flow of water from the river with the fountain design – using the water as a heat rejection medium prior to returning to the Hudson.

A clear opportunity for interpretation/education on the subject of built and natural systems seems to naturally arise out of the striking Memorial Design and its fundamental connection to river and bedrock. (This is an excellent candidate in seeking a potential innovation point for LEED™ and should be explored.)

Case Studies

<u>Time Landscape, Greenwich Village, New York City</u>

In the nineteen sixties, artist Alan Sonfist conceived of a plan to regress small portions of cities throughout the world to their pre-human ecosystem. He called these proposed park-like spaces Time Landscapes because they would celebrate the unspoiled land that existed before human intervention. In 1978, working with the Metropolitan Museum of Art and New York City Planners, Sonfist was able to realize his vision in Greenwich Village, between Houston and Bleeker Streets. This park uses species of trees that existed in the same location before man arrived. As these plants take hold, they transform the soil and animal life within it to their pre-human state as well. The result is a place where people can experience an almost pre-historic portion of the New York Ecosystem. (ArtsEdNet 1999)

Reference

Definitions

Definitions have not been included for this Guideline.

Standards

Standards have not been included for this Guideline.

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Natural History

SEQ-13-T

Sustainable Design Guidelines Reference Manual
WTC Redevelopment Projects

Project Name: ______________________________

Phase:

SD	DD	CD	FINAL
☐	☐	☐	☐

Legend:

- ● Action Required
- ◉ LEED[TM] Equivalency Option allowed
- ○ Action Recommended
- Ⓔ Exemplar model

Project Type:

Transportation Hub	Site/Parcel	Commercial Office	Commercial Retail	Memorial	Cultural
☐	☐	☐	☐	☐	☐
○	○	○	○	○	○

☐ **Required Component:**
This certifies that the natural history and features of the site (such as the underlying Manhattan Schist bedrock and the Hudson River) have been integrated into site development in a manner that exhibits them to site users and works to illustrate the interrelationships between built and natural environments and history.

Name ______________________ Signature ______________________

Company ______________________ Role in Project ______________________

Date ______________________

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