THE SUSTAINABLE SITES INITIATIVE™

GUIDELINES AND PERFORMANCE BENCHMARKS

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American Society of Landscape Architects

Lady Bird Johnson Wildflower Center, University of Texas at Austin

United States Botanic Garden

THE SUSTAINABLE SITES INITIATIVE™

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THE SUSTAINABLE SITES INITIATIVE

When reading this document electronically, you may click on any item in the table of contents to jump to that section. To return to the Table of Contents, click on the "Home" button at the top of the page. Other navigation buttons are available - position your mouse over the button to see its function.

CONTENTS

Note: Words defined in the Glossary are underlined the first time they occur in a chapter and the first time they occur in a prerequisite or credit in Chapter 5. When reading electronically, you may position your mouse over an underlined term to see its definition.

EXECUTIVE SUMMARY

The Sustainable Sites Initiative™ is an interdisciplinary partnership, led by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center, and the United States Botanic Garden, working to foster a transformation in land development and management practices. Through the creation and implementation of clear and rigorous design, construction, operations, and maintenance criteria, the Initiative aims to supplement existing green building and landscape guidelines as well as to become a stand-alone tool for site sustainability.

The Initiative envisions that sustainable land practices will enable natural and built systems to work together to protect and enhance the ability of landscapes to provide services such as climate regulation, clean air and water, and improved quality of life. For purposes of the Initiative, sustainability is defined as land practices "that meet the needs of the present without compromising the ability of future generations to meet their own needs."

In November 2007, the Initiative released a Preliminary Report on its progress. During the subsequent public review period, more than 450 respondents generated over a thousand pages of comments. Since then, the Steering Committee—made up of members with expertise in multiple fields—along with 37 nationally recognized volunteer experts on the Technical Subcommittees, worked with the Initiative staff to take those comments into account as they continued to develop clear criteria for sustainable land practices.

The result of this prodigious effort is presented in Chapter 5 of this report: 59 draft prerequisites and credits and their associated benchmarks, all based on a comprehensive review of applicable science and best practices in the industries involved. The U.S. Green Building Council, a major stakeholder in the Initiative, anticipates incorporating the benchmarks into future versions of the LEED® (Leadership in Energy and Environmental Design) Green Building Rating System™.

An ecosystem services framework

The Initiative's benchmarks are designed to preserve or restore a site's sustainability within the context of ecosystem services—the idea that healthy ecosystems provide goods and services of benefit to humans and other organisms *(see Chapter 2)*. So interconnected are the elements in a functioning ecosystem, that non-sustainable approaches to land development and management practices can have effects that ripple throughout the system. Yet the central message of the Sustainable Sites Initiative is that any landscape—whether the site of a large subdivision, a shopping mall, a park, an abandoned rail yard, or even one home—holds the potential both to improve and to regenerate the natural benefits and services provided by ecosystems in their undeveloped state.

The value of healthy ecosystems

To be sustainable over the long term, a site needs to address competing demands on three fronts—not only environmental but also economic and social. Establishing sustainable economic feasibility relies on placing an accurate value on a site's natural systems *(see Chapter 3)*. Often, however, the full direct and indirect economic value of the goods and services produced by a healthy environment—and the economic consequences of an impaired ecosystem—are not taken into account. In view of the

pressing need for an economy less reliant on fossil fuels and more attuned to critical environmental challenges such as climate change, habitat loss, and water quality and scarcity issues, the Sustainable Sites Initiative hopes to encourage the land design, development, and management industries to engage in this valuation, so that built landscapes will support natural ecological functions throughout the life cycle of each site.

Describing sustainable practices

Among the first tasks of the Technical Subcommittees during the past year *(see Chapter 4)* was identifying the specific and measurable criteria a site would need to meet in order to be considered "sustainable." The subcommittees deemed it essential to acknowledge that different regions of the country will have different requirements, and to develop performance benchmarks that would shift the market toward sustainability while remaining practical and achievable. The subcommittees also took human health and well-being into account as they developed the measures of sustainability because healthy ecosystems are the source of the many less tangible benefits that humans derive from a relationship with nature. Throughout, the goal was to identify criteria based on performance outcomes rather than prescriptive measures, to encourage innovation, inspire a change in thinking, and provide flexibility.

Next steps

The intents and concepts underlying the guidelines presented in Chapter 5 can be applied right away to support new sustainable practices wherever possible—with the understanding that the benchmarks today are still a work in progress. Public comment and suggestions for improvement will be taken into account for the version to be published in 2009. By 2012, the Initiative expects to have three stand-alone documents that will also supplement existing green building standards and rating systems:

Sustainable Sites Initiative Guidelines and Performance Benchmarks 2009: A compilation of current research, technology, and practices to provide technical guidance and performance benchmarks for sustainable land development and management practices

Sustainable Sites Initiative Rating System (target publication date 2011): Sustainable landscape performance benchmarks with weighted credits and a recognition system

Sustainable Sites Initiative Reference Guide (target publication date 2012): A user guide containing information from pilot projects that will explain credit requirements and provide resources to aid in creative problem solving.

Many local and regional efforts now provide guidelines for improved land development and management practices, and the Initiative is interested in information sharing and partnering on these efforts. The more site designers put sustainable land practices to work, the greater the possibility of creating a profound change in society's approach to stewardship of the land. Market transformation accelerates as more examples of sustainable land practices occur—realizing the benefits of healthy communities, economic prosperity, and functioning ecosystems.

1 SNAPSHOT OF A WORK IN PROGRESS

More than two decades ago, the United Nations World Commission on Environment and Development, headed by Gro Harlem Brundtland, then-Prime Minister of Norway, presented its report to the UN General Assembly. Titled *Our Common Future* but better known as the Brundtland report, it made an eloquent argument for sustainable development, which it defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[1]

We came to see that a new development path was required, one that sustained human progress not just in a few places for a few years, but for the entire planet into the distant future.

~ Gro Harlem Brundtland, 1987

Over the intervening years, this prescription for sustainability has gained wide acceptance. In corporate boardrooms and grade-school classrooms, at neighborhood barbeques and in councils of government, growing numbers of citizens are embracing the opportunity to live sustainably. As people acknowledge that humans are an integral part of the environment, they recognize that human decisions and behavior are in fact components of a global feedback loop: what people do affects the health and well-being of the rest of the natural world, which in turn affects human health and well-being—physical, mental, economic, and social.

The Sustainable Sites Initiative™, founded in 2005, embraced the Brundtland report's forward-looking definition of sustainability.[2] In the Initiative's words, "sustainability is defined as design, construction, operations, and maintenance practices that meet the needs of the present without compromising the ability of future generations to meet their own needs." To foster a transformation in society's approach to stewardship of the land, the Initiative encourages efforts to bridge political differences and develop new ways of doing business.

> ***For purposes of this Initiative, sustainability is defined as design, construction, operations, and maintenance practices that meet the needs of the present without compromising the ability of future generations to meet their own needs.***

This definition of sustainability guides the formulation of the Initiative's voluntary guidelines and performance benchmarks for sustainable land development and management. Throughout the life cycle of each site—from design and construction through operations and maintenance—these guidelines will enable built landscapes to support natural ecological functions by protecting existing ecosystems and regenerating ecological capacity where it has been lost. Not intended as a tool for regional planning, the benchmarks are meant to guide, measure, and recognize sustainable landscape practices on a site-by-site basis and may also inform larger-scale projects or planning efforts. Similarly, although the draft guidelines and benchmarks presented later in this report encourage food gardens as potential components of a site, they do not address sustainable agricultural products or large-scale agricultural or farming practices, primarily because other organizations already do so in detail.

GUIDING PRINCIPLES

The Initiative's guidelines and benchmarks are designed to preserve or restore a site's sustainability within the context of ecosystem services—the idea that healthy ecosystems provide goods and services of benefit to humans and other organisms.[3] As Dr. Brundtland put it, "the 'environment' is where we all live; and 'development' is what we all do in attempting to improve our lot within that abode. The two are inseparable."[4] To that end, the principles on the following page not only inform the work of the Sustainable Sites Initiative but should also inform all aspects of sustainable site development.

GROWING AWARENESS

The Millennium Ecosystem Assessment, a United Nations study completed in 2005, highlighted the need for all development to address considerations in three key arenas: social, environmental, and economic.[5] Unless all three aspects are equally vibrant, true sustainability is not possible.

As with sustainable development in general, a sustainable site also needs to take into account the challenges on all three fronts. A site that does not engage its users on multiple levels—physical, aesthetic, cultural, spiritual—will lose crucial human stewardship. By the same token, creation and maintenance of the site must be economically feasible for the site to exist at all.

Establishing economic feasibility requires placing an accurate value on a site's natural systems *(see Chapter 3)*. In view of the pressing need for an economy less reliant on fossil fuels and more attuned to potential climate change,

Guiding Principles of a Sustainable Site

Do no harm
Make no changes to the site that will degrade the surrounding environment. Promote projects on sites where previous disturbance or development presents an opportunity to regenerate ecosystem services through sustainable design.

Precautionary principle
Be cautious in making decisions that could create risk to human and environmental health. Some actions can cause irreversible damage. Examine a full range of alternatives—including no action—and be open to contributions from all affected parties.

Design with nature and culture
Create and implement designs that are responsive to economic, environmental, and cultural conditions with respect to the local, regional, and global context.

Use a decision-making hierarchy of preservation, conservation, and regeneration
Maximize and mimic the benefits of ecosystem services by preserving existing environmental features, conserving resources in a sustainable manner, and regenerating lost or damaged ecosystem services.

Provide regenerative systems as intergenerational equity
Provide future generations with a sustainable environment supported by regenerative systems and endowed with regenerative resources.

Support a living process
Continuously re-evaluate assumptions and values and adapt to demographic and environmental change.

Use a systems thinking approach
Understand and value the relationships in an ecosystem and use an approach that reflects and sustains ecosystem services; re-establish the integral and essential relationship between natural processes and human activity.

Use a collaborative and ethical approach
Encourage direct and open communication among colleagues, clients, manufacturers, and users to link long-term sustainability with ethical responsibility.

Maintain integrity in leadership and research
Implement transparent and participatory leadership, develop research with technical rigor, and communicate new findings in a clear, consistent, and timely manner.

Foster environmental stewardship
In all aspects of land development and management, foster an ethic of environmental stewardship—an understanding that responsible management of healthy ecosystems improves the quality of life for present and future generations.

the Sustainable Sites Initiative hopes to encourage the land design, development, and management industries to engage in this valuation, so that built landscapes will support natural ecological functions throughout the life cycle of each site.

SEEKING PUBLIC COMMENT

In November 2007, the Sustainable Sites Initiative released a Preliminary Report on its progress for public review. More than 450 respondents generated more than a thousand pages of comments during the review period. Members of the Steering Committee with

expertise in multiple fields, along with the 37 nationally recognized volunteer experts on the Technical Subcommittees and the Initiative staff *(see Acknowledgments, pages 177-78)* took those comments into account as part of the evolution of the guidelines and benchmarks. The result of their prodigious efforts—59 draft prerequisites and credits—are presented in Chapter 5.

As part of the ongoing development effort, the Initiative invites you to join the review process by visiting *www.sustainablesites.org*. The review period will end January 20, 2009, and the *Sustainable Sites Initiative Guidelines and Performance Benchmarks 2009* is slated for release in summer 2009. The U.S. Green Building Council anticipates incorporating the Sustainable Sites benchmarks into future versions of its LEED® (Leadership in Energy and Environmental Design) rating system.

Over the next few years, the Initiative will be working on its next two products: the *Sustainable Sites Initiative Rating System* and the *Sustainable Sites Initiative Reference Guide*. All three documents are intended to supplement existing green building standards and rating systems. Many local and regional efforts now provide guidelines for improved land development and management practices, and the Initiative is interested in information sharing and partnering. At the same time, the Initiative hopes that these three products will be able to serve as stand-alone guidelines for landscape sustainability. Interim drafts of the *Sustainable Sites Initiative*

FIG. 1-1. SUSTAINABLE DEVELOPMENT. Of the three components of sustainability, the primary focus for the Sustainable Sites Initiative is the environment, including those aspects of economic feasibility and social equity that intersect with the environment.

Sustainable Sites Initiative Publications

Sustainable Sites Initiative Guidelines and Performance Benchmarks 2009:
A compilation of current research, technology, and practices to provide technical guidance and performance benchmarks for sustainable land development and management practices

Sustainable Sites Initiative Rating System (target publication date 2011):
Sustainable landscape performance benchmarks with weighted credits and a recognition system

Sustainable Sites Initiative Reference Guide (target publication date 2012):
A user guide containing information from pilot projects that will explain credit requirements and provide resources to aid in creative problem solving

Rating System and the *Sustainable Sites Initiative Reference Guide* will be released throughout the development process to allow members of review committees and the public ample time to provide feedback. In addition, beginning in 2010, a number of pilot projects will help test and refine the *Sustainable Sites Initiative Guidelines and Performance Benchmarks* and the *Sustainable Sites Initiative Rating System*. The Initiative expects to incorporate knowledge gained from working with the pilot projects into development of the *Sustainable Sites Initiative Reference Guide*.

The following two chapters will present further explanation of the concept of ecosystem services and their often underestimated economic value to human society. Chapter 4 will provide some background on the work of the Steering Committee, Technical Subcommittees, and Initiative staff in developing the draft guidelines and per-formance benchmarks presented in Chapter 5.

The intents and concepts underlying these draft benchmarks can be applied right away to support new sustainable practices wherever possible—with the understanding that the guidelines today are still very much a work in progress. For examples of how such practices are already being incorporated in a variety of projects, see the case studies highlighted in Chapters 3, 4, and 5. (Fuller versions and additional studies are available on the Sustainable Sites website *www.sustainablesites.org/cases/.)*

[1] UN General Assembly, *Our Common Future: Report of the World Commission on Environment and Development, 1987*,. http://www.worldinbalance.net/agreements/1987-brundtland.html; Ibid, chap. 2, "Towards Sustainable Development."

[2] For a history of the Initiative, see http://sustainablesites.org/history.html.

[3] G Daily, ed., Nature's Services: *Societal Dependence on Natural Ecosystems* (Washington, DC: Island Press, 1997).

[4] *Our Common Future*, Foreword, http://www.worldinbalance.net/agreements/1987-brundtland.html.

[5] Millennium Ecosystem Assessment, *Ecosystems and Human Well-being: Message from the Board* (Washington, DC: Island Press, 2003), p.3.

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2 AN ECOSYSTEM SERVICES PRIMER

In the late 1990s, work by noted scientists such as Paul Ehrlich, Gretchen Daily, Donald Kennedy, Pamela Matson, and Robert Costanza created awareness in the general public that healthy ecosystems provide goods and services of benefit to humans and other organisms.[2] A few years later, the United Nations commissioned a global study called the Millennium Ecosystem Assessment, which was carried out by an international consortium of governments, non-profit groups, universities, and businesses. The group's report, published in 2005, established that "ecosystems are critical to human well-being—to our health, our prosperity, our security, and to our social and cultural identity."[3] The link between environmental well-being, human well-being, and economic prosperity continues to gain traction in mainstream political conversation.[4]

Human needs and a healthy environment are not opposing claims that must be balanced; instead, they are inexorably linked by chains of cause and effect. We need a healthy environment because we need clean water, clean air, wood, and food.

~Jared Diamond, biologist, 2003[1]

2

AT WORK IN THE BACKGROUND

Humans share the planet with other species and although people are not its only beneficiaries, humanity's perspective is often anthropocentric. Earth's various ecosystems provide a multitude of services that people need and want—food and water, timber, fiber, energy, biochemicals, and genetic resources. And then there are the intangible benefits that human beings derive from a relationship with and access to the natural world. As places for contemplation or recreation, healthy ecosystems offer us respite and restore our minds, bodies, and spirits. Nature in all its forms is a profound source of inspiration for culture, art, science, and education.[5]

The services people enjoy from healthy ecosystems are the unobtrusive foundation of daily life. Trees help regulate local climate by providing shade and acting as windbreaks. Through evaporation, transpiration, and the uptake and storage of carbon, trees and other vegetation moderate the climate of the world and provide a breathable atmosphere. Thousands of different pollinator species visit their

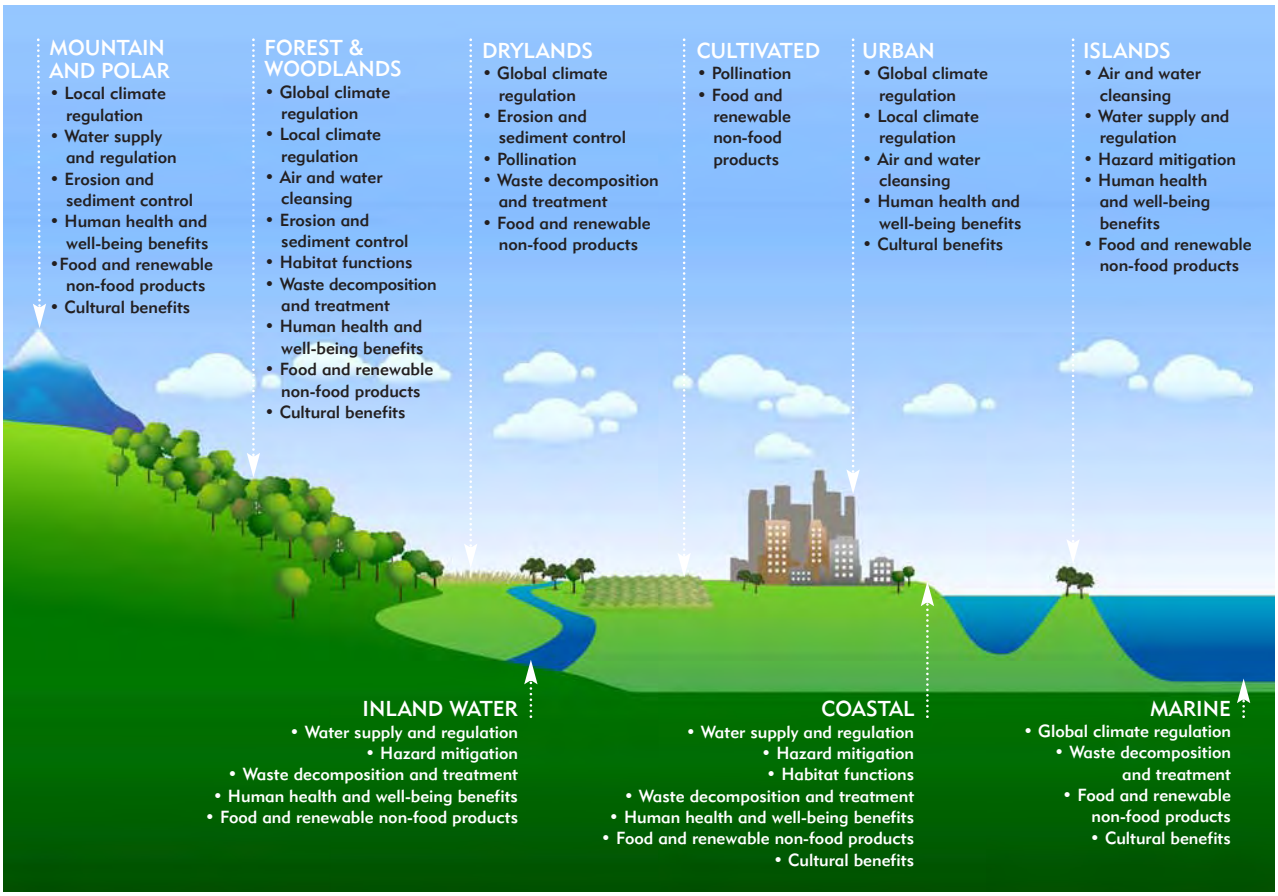

FIG. 2-1. THE BOUNTY OF ECOSYSTEMS. As illustrated here, no one type of ecosystem has a monopoly on the goods and services it can provide. The services listed for given ecosystems above represent only a few of the many services available from each type of ecosystem. *(See page 12 for the complete list of ecosystem services.)*

Ecosystem Services

Ecosystem services are goods and services of direct or indirect benefit to humans that are produced by ecosystem processes involving the interaction of living elements, such as vegetation and soil organisms, and non-living elements, such as bedrock, water, and air.

Various researchers have come up with a number of lists of these benefits, each with slightly different wording, some lists slightly longer than others. For the purpose of developing performance criteria for practices that will protect or regenerate these benefits, the members of the Sustainable Sites Technical Subcommittees and staff have reviewed and consolidated the research into the list below of services provided by natural ecosystems. The goal of a sustainable site is to protect, restore, and enhance such ecosystem services wherever possible through sustainable land development and management practices.

1. **Global climate regulation**
   Maintaining balance of atmospheric gases at historic levels, creating breathable air, and sequestering greenhouse gases
2. **Local climate regulation**
   Regulating local temperature, precipitation, and humidity through shading, evapotranspiration, and windbreaks
3. **Air and water cleansing**
   Removing and reducing pollutants in air and water
4. **Water supply and regulation**
   Storing and providing water within watersheds and aquifers
5. **Erosion and sediment control**
   Retaining soil within an ecosystem, preventing damage from erosion and siltation
6. **Hazard mitigation**
   Reducing vulnerability to damage from flooding, storm surge, wildfire, and drought
7. **Pollination**
   Providing pollinator species for reproduction of crops or other plants
8. **Habitat functions**
   Providing refuge and reproduction habitat to plants and animals, thereby contributing to conservation of biological and genetic diversity and evolutionary processes
9. **Waste decomposition and treatment**
   Breaking down waste and cycling nutrients
10. **Human health and well-being benefits**
    Enhancing physical, mental, and social well-being as a result of interaction with nature
11. **Food and renewable non-food products**
    Producing food, fuel, energy, medicine, or other products for human use
12. **Cultural benefits**
    Enhancing cultural, educational, aesthetic, and spiritual experiences as a result of interaction with nature

respective flowers and promote the growth of myriad plants and crops. Healthy wetlands protect against floods. Soils and vegetation purify stormwater seeping through to groundwater and underground aquifers.

All of these services take place in functioning ecosystems whether anyone is paying attention or not. And because these services occur largely in the background, governments and businesses don't include them in their conventional cost

accounting. In the United States, for example, native pollinators are critical to the production of more than 150 food crops, from apples, alfalfa, and almonds to cranberries, melons, and squash. In one year, a single native southeastern blueberry bee visits about 50,000 blueberry flowers, assisting in the production of more than 6,000 marketable blueberries.[6]

Yet people often underestimate or simply ignore these values when making land-use decisions—only to realize later how difficult, expensive, and sometimes impossible it is to replicate services once they are lost.

CYCLES THAT PROTECT AND SUSTAIN

In a natural ecosystem, soils, vegetation, and water function together in processes that regulate the gases in the atmosphere, clean the world's water, create food (by producing carbohydrates), and provide all the other goods and services humans depend on. These benefits are the byproducts of the workings of natural biogeochemical cycles, such as the hydrologic cycle *(below)*, the carbon cycle, or the nitrogen cycle. For example, the leaf stomata of plants

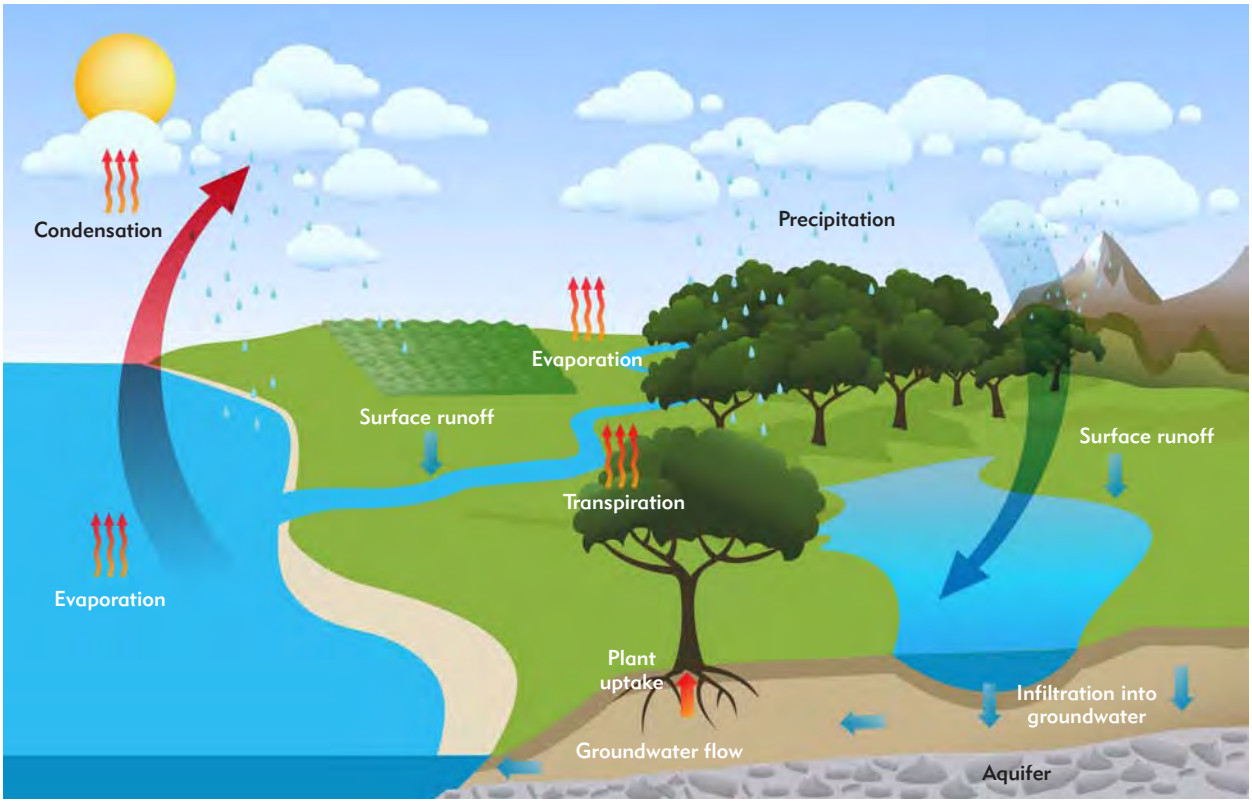

FIG. 2-2. THE NATURAL HYDROLOGIC CYCLE. Water exists on Earth as a solid, liquid, or gas and is in a frequent state of change. Surface water evaporates, cloud water precipitates, and rain infiltrates through the ground and into aquifers. Plants take up water and release water vapor during transpiration. Through all of these processes, the total amount of Earth's water remains constant as it is circulated and conserved in the hydrologic cycle. In the course of the cycle, rain collects pollutants from the atmosphere or from surface contamination. As rain falls on plants and infiltrates the ground, such pollutants can be removed by vegetation and soil biota, as well as by rock and sediment.

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can absorb gaseous pollutants from the air, removing such common pollutants as nitrogen oxides, sulfur oxides, particulate matter, and ground-level ozone.[7] Some of this cleansing occurs in the course of the natural hydrologic cycle. Over short and long time scales, great quantities of water circulate through Earth's atmosphere, oceans, land, and biosphere. This vast cycling of water shapes the world's weather and climate, supports plant growth, and makes life itself possible.

THE CARBON CYCLE

The global carbon cycle has a geological component that operates on a time scale of millions of years. Over eons, carbon circulates through the atmosphere, land, and ocean, spending large portions of that time residing in ocean sediments and forming limestone. As tectonic forces draw the ocean floor deeper into the Earth, the seafloor carbon is heated, melts, and eventually rises to the surface where it is released back to the atmosphere as carbon dioxide (CO_2) through vents, seeps, hotsprings —or violent volcanic eruptions.[8]

The biological component of the carbon cycle operates on a scale ranging from days to thousands of years. Through the processes of photosynthesis and respiration, biota play a key role in the circulation of carbon over this timeframe. During photosynthesis, plants take in carbon dioxide, water, and light to produce carbohydrates (food for growth) and oxygen, thus helping to regulate the balance of oxygen and carbon dioxide to maintain a livable atmosphere. Indeed, about a thousand times more carbon is taken up by photosynthesis and released back to the atmosphere by respiration each year than moves through the geological cycle on an annual basis.[9]

Meanwhile, the pool of organic carbon in the soil is approximately twice as large as that of the atmosphere,[10] and soils can contain as much as or more carbon than living vegetation. For example, 97 percent of the 335 billion tons (304 billion metric tonnes) of carbon stored in grassland ecosystems is held in the soil.[11] Soil carbon storage can help offset the release of carbon dioxide, a greenhouse gas that contributes to global climate change.

THE NITROGEN CYCLE

Nitrogen, which makes up nearly 79 percent[12] of breathable air, is an essential component of protein, DNA, RNA, and chlorophyll.[13] However, most of the nitrogen in the atmosphere is in its gaseous form (N_2), which is not a form organisms can use; it must first be converted to more a chemically available form such as ammonium, nitrate, or organic nitrogen,[14] which plants can take up as a nutrient.[15]

The processes that cycle nitrogen through the atmosphere, biosphere, and geosphere are nitrogen fixation, nitrogen uptake, nitrogen mineralization (decay), nitrification, and denitrification.[16] Soil biota play major roles in all of these transformations. In nitrogen fixation, for example, nitrogen gas is converted to ammonium through the metabolic processes of bacteria such as those among the genus *Rhizobium*. These nitrogen-fixing bacteria often form symbiotic relationships with host plants, such as legumes, inhabiting their root nodules.

The nitrogen taken up by plants eventually makes its way into other organisms higher up the food chain. When organisms die, other bacteria and fungi consume the organic matter, converting some of the nitrogen back into ammonium, where it becomes available for

plant use again or is converted to nitrate through the process of nitrification.

Nitrification can happen only in an oxygen-rich environment, such as in free-flowing waters or in the very top layers of soils and sediments. One consequence of nitrification is that, unlike positively charged ammonium ions, the negatively charged nitrate ions cannot stick to soil particles and thus can be washed away. This loss leads to decreased soil fertility and to excess nitrate downstream.[17]

In denitrification, the fifth stage of the nitrogen cycle, anaerobic bacteria convert nitrate into the gaseous form of nitrogen (N_2), which escapes back into the atmosphere. Two byproducts of that process are nitric oxide (NO), which contributes to smog, and nitrous oxide (N_2O), a greenhouse gas that absorbs 310 times more heat per molecule than carbon dioxide.[18]

ECOSYSTEMS AT RISK

The natural biogeochemical cycles that underlie the functions and services of healthy ecosystems are increasingly at risk. For example, anyone who lives along flood-prone rivers and coastal areas that have lost their wetlands can attest to the wholesale destruction that can occur when these unheralded natural services disappear. Wetlands defend against hurricanes by limiting the storms' access to the warm open ocean water that fuels them and by creating a physical barrier to the powerful storm surges they generate. But natural barriers need a steady supply of sediment and nutrients to keep from eroding—a supply that comes from the periodic flooding of rivers.

Unfortunately, levees built over the centuries to protect coastal communities from seasonal flooding cut off that kind of supply. With all the levees built to contain the Mississippi River, for example, Louisiana has lost some 2,000 square miles of wetlands—an area the size of Delaware—in the last 70 years.[19]

And according to the National Wetlands Research Center, wetlands in the Gulf region are eroding at the speed of 1 acre every half hour; an area roughly the size of Manhattan vanishes each year.[20] Most experts knew—long before Hurricane Katrina drove the lesson home—that the loss of wetlands boded ill for New Orleans and its sister communities along the Gulf Coast. But knowledge is not always widely disseminated, nor does it always go hand in hand with a mandate for action.

THE NEED FOR ACTION

Another part of the difficulty, of course, is that it often takes many decades before people are aware of a problem—and even more time before its cause or causes are understood. A hundred years of poor land management practices exacerbated a long period of drought in the southern Great Plains, resulting in the devastation known as the Dust Bowl of the 1930s.[21]

Nor are such crises a thing of the past. In 2006 and 2007, the southeastern part of the United States experienced the worst drought in more than a hundred years,[22] bringing to a head nearly two decades of unresolved competition for water among the inhabitants of Georgia, Alabama, and Florida.

All three states rely on waters from Lake Lanier, a reservoir created in the 1950s when the Army Corps of Engineers built Buford Dam, blocking the flow of the Chattahoochee River. The

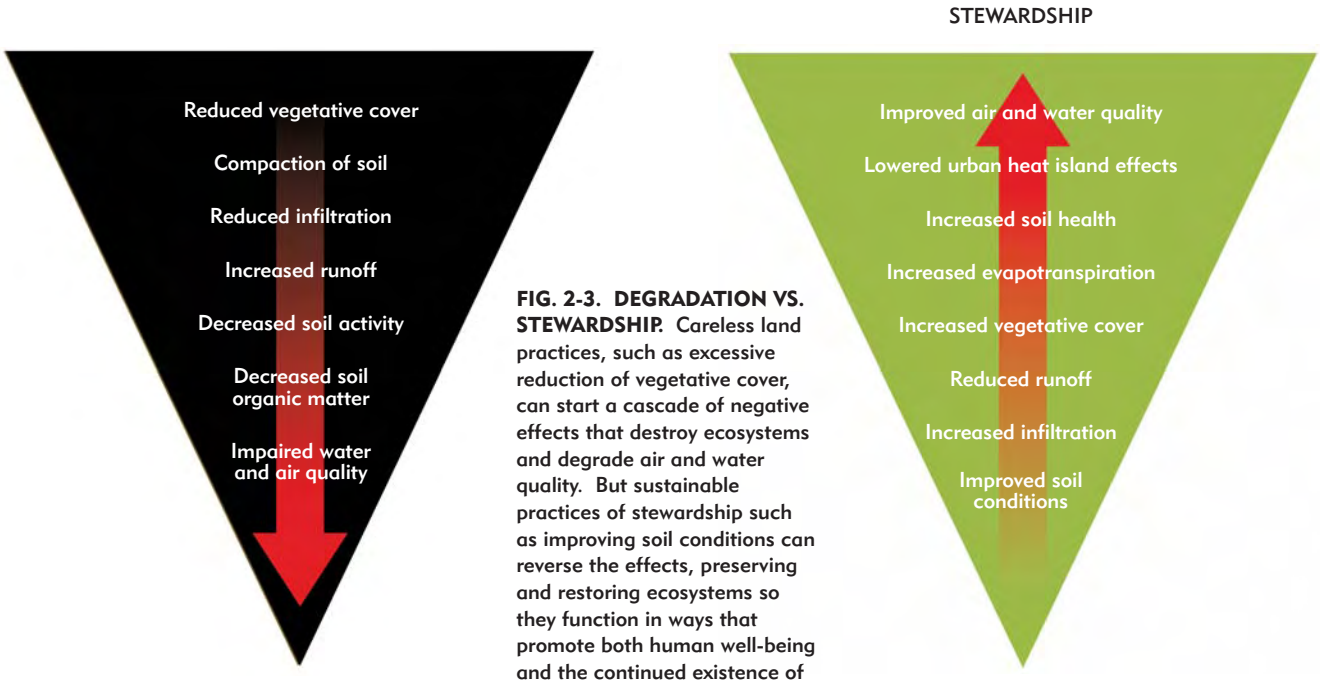

FIG. 2-3. DEGRADATION VS. STEWARDSHIP. Careless land practices, such as excessive reduction of vegetative cover, can start a cascade of negative effects that destroy ecosystems and degrade air and water quality. But sustainable practices of stewardship such as improving soil conditions can reverse the effects, preserving and restoring ecosystems so they function in ways that promote both human well-being and the continued existence of other species on the planet.

reservoir supplies water for the four million residents of the greater Atlanta metropolitan area, and the flow of water through the dam generates electricity and serves downstream utilities and industrial plants, and fisheries in Florida's Apalachicola River and Bay.[23] As lake water levels shrank daily, governors of the three states appealed to the White House, each requesting larger shares of the flow.

By the following spring, winter rains had eased the two-year drought, but Lake Lanier was still 10 feet below normal levels, and a water-sharing deal brokered among the three states had collapsed. As Robin Craig, a law professor and water expert at Florida State University's College of Law, put it, "The Southeast has not yet come to grips with the fact that it has a water problem, that it needs to plan for its water usage, that it can't take for granted that all the water it needs will always be there."[24]

GLOBAL INTERDEPENDENCE

In fact, freshwater resources are under duress all over the world. In contrast to the southeastern United States, which historically could rely on plentiful rain, cyclical drought has long been a fact of life in southeast Spain. In the last 30 years, however, climate change seems to have made drought a permanent condition. Despite this reality, many in the region continue inefficient irrigation practices and the planting of water-intensive landscapes. Chronic water shortages have spawned a black market for water as the region increasingly comes to resemble Saharan Africa.[25]

Today, three major rivers—the Yellow in China, the Amu Darya in Central Asia, and the Colorado in the United States—sometimes no longer reach the sea because their waters are entirely consumed by human demand.[26] According to the Millennium Ecosystem Assessment, approximately 60 percent of the world's ecosystem services (15 of the 24

services examined)—not only fresh water, but air and water purification, and fisheries, to name only a few—are being degraded or exploited unsustainably.[27]

Yet unsustainable practices cannot be blamed on local policies alone. Just as increased demand for shrimp in Europe or the United States can lead to destruction of mangroves in Southeast Asia or Brazil, so too can demand for timber in China or India lead to loss of rainforest in Indonesia and Cambodia.[28] As by far the most dominant species on the planet, humans have an enormous impact on ecosystems, for good or ill. Collectively, human decisions and practices can either continue to degrade the world that nurtures all living entities—or begin to restore it.

FIG. 2-4. RESTORING ECOSYSTEM SERVICES. A schematic flower suggests how well different types of sites provide ecosystem services, as indicated by the amount of dark green along each petal. In an abandoned and likely contaminated brownfield site *(below left)*, ecosystem services are virtually nonexistent, except for what is provided by the scrubby grass and marginal soils. Adding vegetation and healthy soil to a developed, or greyfield, site that would otherwise be dominated by impervious cover, as in a business office parking lot *(below center)*, restores nearly all ecosystem services to some degree. The goal of Sustainable Sites is to rehabilitate all sites—including brownfields—so they approach the levels of ecosystem services provided by a natural ecosystem, or greenfield *(below right)*.

[1] J Diamond, "The Last Americans: Environmental Collapse and the End of Civilization," *Harper's Magazine*, (June 2003), http://www.mindfully.org/Heritage/2003/Civilization-Collapse-EndJun03.htm.

[2] G Daily, ed. *Nature's Services: Societal Dependence on Natural Ecosystems* (Washington, DC: Island Press, 1997).

[3] Millennium Ecosystem Assessment, *A Toolkit for Understanding and Action: Protecting Nature's Services. Protecting Ourselves* (Washington, DC: Island Press, 2007), p. 1.

[4] SA Mainka, JA McNeely, and WJ Jackson. "Depending on nature: ecosystem services for human livelihoods," *Environment* 50, no. 2 (March/April 2008).

[5] RS de Groot, MA Wilson, and RMJ Boumans. "A typology for the classification, description and valuation of ecosystem functions, goods and services," *Ecological Economics* 41, no. 3 (2002): pp 401-402.

[6] http://www.esa.org/ecoservices/poll/body.poll.keyp.html (accessed July 15, 2008).

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3 THE ECONOMICS OF HEALTHY ECOSYSTEMS

The central message of the Sustainable Sites Initiative is that any landscape—whether the site of a large subdivision, a shopping mall, a park, an abandoned rail yard, or even one home—holds the potential both to improve and to regenerate the natural benefits and services provided by ecosystems in their undeveloped state. However, efforts to preserve and restore healthy ecosystems face a signifcant challenge—namely, persuading decision-makers that the cost of changing conventional methods of landscape design, development, and maintenance is money well spent.

The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value.

~Theodore Roosevelt

Making the business case means presenting an accurate valuation of the benefits of ecosystems. It also means explaining how sustainable practices can be cost effective for both public and private entities and can often leverage additional costs and multiple benefits. This chapter offers a review of how certain land practices affect the interrelated operations of functioning ecosystems, followed by a description of the benefits of adopting sustainable practices.

THE COST OF UNSUSTAINABLE PRACTICES

As described in Chapter 2, so interconnected are the elements in a functioning ecosystem, that unsustainable approaches to land development and management practices can have a ripple effect throughout the system. The compaction of soil during construction is one example, as are the removal of existing vegetation, the treatment of water as a waste product rather than a resource, and a similar undervaluing of material resources.

UNDERVALUING SOILS

The undervaluing of soils is one of the singular failings of the conventional development approach. For example, a frequent consequence of standard construction practices is compaction of the soil, which seriously damages soil structure by shrinking the spaces between soil particles available for air and water. If not restored, compacted soil can start a spiral of degradation:

Damage to vegetation: Compacted soil particles restrict a plant's root growth and its access to nutrients. If soil compaction continues, vegetation eventually dies and soils become vulnerable to erosion.

Reduced infiltration: Compacted soils are less able to absorb water, which reduces the recharge of groundwater and aquifers.

Excess runoff: Reduced infiltration leads to increases in the volume of runoff and the probability of flooding. On developed sites where there is widespread use of impervious material such as concrete and asphalt, even more runoff is likely.

Water pollution: Without a sustainable approach to on-site water management, excess runoff damages soils and vegetation in one area, and also creates further hazards downstream—exponentially so during heavy rains or storm events. Water leaving developed sites can contain a host of pollutants, depending on the type of development. These pollutants may range from excessive nutrients, oil, grease, and heavy metals to contaminants such as *E. coli*, hepatitis A, and persistent bioaccumulative toxic (PBT) chemicals. Most pollutants and contaminants come from farming and agriculture runoff, or from combined sewage overflows. However, many pollutants leach into soil and water from materials and products used as part of conventional landscape development and management. Taken together, such pollutant loads can be devastating to natural systems. Throughout the Mississippi River watershed, for example, increased surface runoff and nutrient delivery have created levels of dissolved oxygen that have caused fish and shrimp catches in parts of the Gulf of Mexico to drop to zero.[1]

Around the country, polluted and contaminated stormwater runoff accounts for 70 percent of water pollution in urban areas and is the leading cause of poor water quality and the degradation of aquatic habitat.[2] According to the U.S. Environmental Protection Agency's Wadable Streams Assessment (WSA) in 2006, 42 percent of U.S. stream miles are in poor condition compared to the best available reference sites in their ecological regions. The WSA found that the most widespread stressors across the country are nitrogen, phosphorus, excess sedimentation, and riparian disturbance (i.e., evidence of human disturbance in or alongside streams).[3]

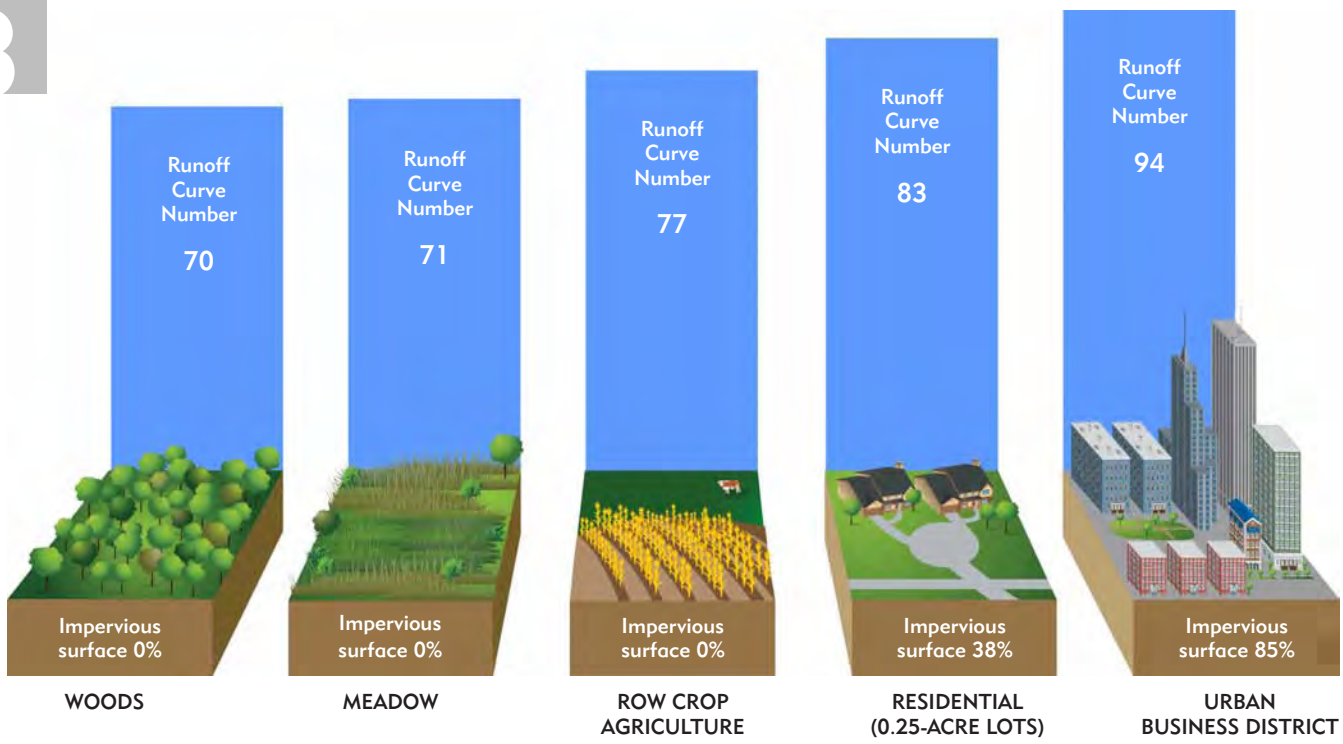


FIG. 3-1. RUNOFF CURVE NUMBERS FOR DIFFERENT SITE TYPES. The runoff curve number is a product of empirical data from many sites across the country. It takes into account the amount of rainfall that is intercepted by vegetation, stored in surface depressions, and infiltrated. Any rainfall not retained on-site becomes runoff. All sites in the illustration above are assumed to have similar slopes and similar soils. However, as development increases—from woods to row crop agriculture to residential and urban landscapes—so does soil compaction. Compaction and increasing amounts of impervious area result in less water being retained on-site and more of it running off, thus raising a site's curve number. A higher curve number, in turn, corresponds to a greater predicted runoff volume *(see Fig. 3-2)*. [Curve numbers from TR-55 Manual, Tables 2.2a-d]

Oftentimes this pollution in water bodies stems from breaches in combined sewer overflow systems, when stormwater runoff overwhelms sanitary sewers and raw sewage is released. In New York State in 2006, such instances caused a total of 1,280 combined beach closure or advisory days for all state beaches.[4]

REMOVING VEGETATIVE COVER

Digging up existing vegetation disturbs soils and has other consequences as well. Without vegetation, a site loses its natural capacity for stormwater management, filtration, and groundwater recharge. Reduced vegetative cover also affects soil health, because vegetation maintains soil structure, contributes to soil organic matter, and prevents erosion.

Excess sedimentation: Removing vegetation increases the likelihood of erosion, which contributes to increased sedimentation. Sedimentation is a major cause of polluted rivers and streams in the United States, second only to pathogens.[5] Sediment runoff rates from construction sites can be up to 20 times greater than agricultural sediment loss rates and 1,000 to 2,000 greater than those of forested lands.[6]

Increased greenhouse gases: Because so much organic carbon is stored in soils, significant amounts of carbon dioxide can be emitted when soils are disturbed. Disturbed soils also release substantial amounts of methane and nitrous oxide, both gases that trap heat even more effectively than carbon dioxide.[7] Although all

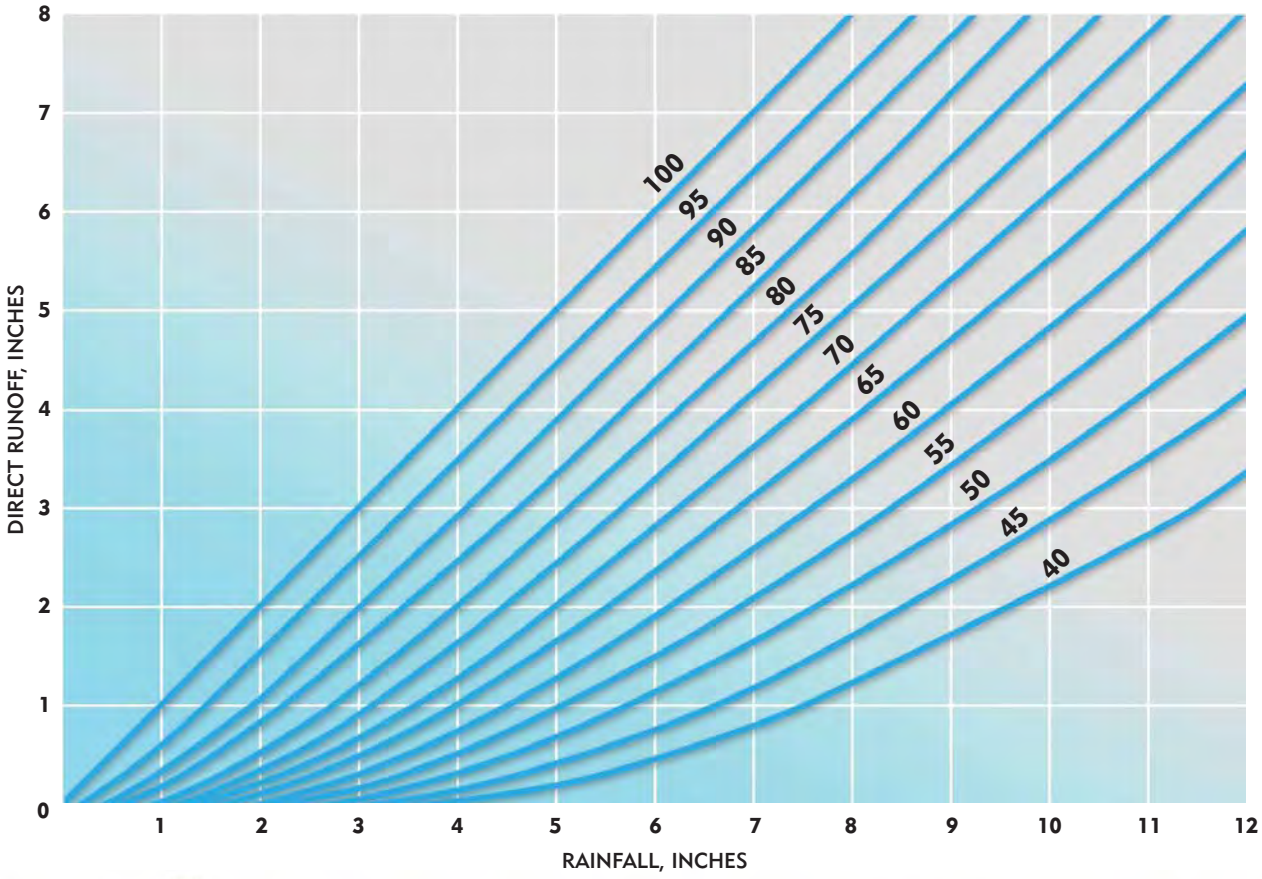
of these greenhouse gases are emitted as part of natural nutrient cycling, the natural balance is upset by increased soil erosion and by activities such as tillage and fertilizer application, all of which increase the natural emission rates.

TREATING WATER AS WASTE, RATHER THAN A RESOURCE

At a time when demand for water in the United States is up 209 percent since 1950,[8] irrigation of unsustainable landscapes accounts for more than a third of residential water use—more than 7 billion gallons per day nationwide.[9] Exacerbating the wastefulness, soil compaction common in developed areas significantly reduces infiltration rates. This reduced infiltration, in turn, causes much of the water used to irrigate lawns to end up as runoff or evaporation instead of filtering down into the water table.

Meanwhile, in many older cities and towns around the country, rainfall is treated as waste, to be funneled directly from roof gutters to sewers, leading to increased costs in stormwater management. Rather than

FIG. 3-2. PREDICTING STORMWATER RUNOFF. The runoff potential of sites varies with their runoff curve numbers, which characterize a site's response to long-term patterns of precipitation. Sites with higher curve numbers will have more runoff than sites with lower curve numbers for the same amount of rainfall. For example, with 6 inches of rain, a site with a curve number of 40 yields just over 0.5 inch of runoff, while a site with a curve number of 90 loses nearly 5 inches as runoff.



getting rid of stormwater as quickly as possible, a sustainable approach to stormwater management would find ways to harvest it on site, using it for irrigation, ornamental water features, and groundwater recharge.

DEVALUING MATERIAL RESOURCES

From extraction of materials through processing, manufacturing, use, and ultimate disposal, the conventional approach to materials in the land development and management industries has not been aimed at conserving either resources or energy. Yard and landscape trimmings are a significant contributor to landfills, for example. In 2007, approximately 33 million tons of yard waste entered the municipal waste stream, representing 13 percent of total municipal waste in the United States.[10]

A sustainable approach to materials use in landscapes begins with an assessment of the existing site—both built and non-built features—and a design that seeks to incorporate and reuse as much of the existing site materials as practicable. One way of evaluating a product's sustainability is to look at the energy and resource consumption involved, from the extraction of raw materials, through processing and manufacturing, to the product's use and disposal. Ideally, sustainable products would be designed so that reuse and recycling could take place at each stage along the way, resulting in zero waste ending up in landfills. In this kind of "cradle-to-cradle" recycling, new, identical products (such as glass bottles from collected glass bottles) or different products (such as aluminum car parts from recycled aluminum cans) could be produced.

ACCOUNTING FOR DIRECT AND INDIRECT BENEFITS

Those who make spending decisions—whether for governments, businesses, or individual households—are accustomed to looking at the trade-offs needed among economic, environmental, and social needs and constraints. Often, however, the full direct and indirect economic value of the goods and services produced by a healthy environment—and the economic consequences of an impaired ecosystem—are not taken into account.

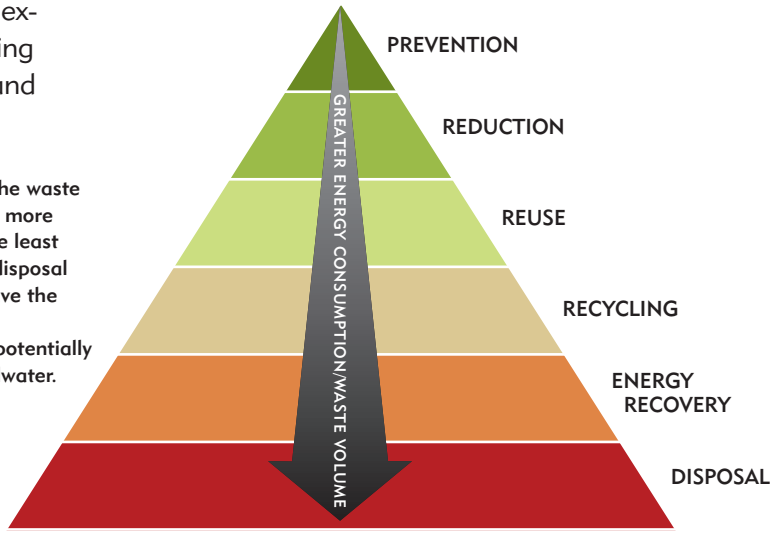
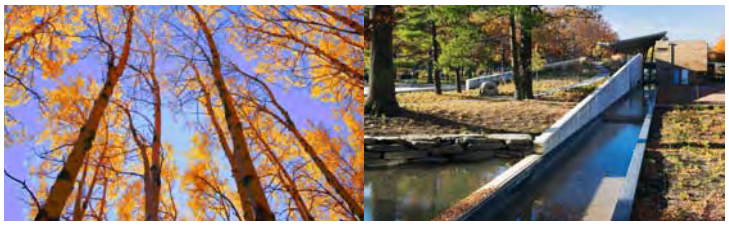


FIG. 3-3. THE WASTE HIERARCHY. The concept of the waste hierarchy is that the more sustainable the practice, the more efficient the use of resources. Prevention consumes the least energy and produces the least volume of waste, while disposal is the most wasteful practice. Sustainable practices have the added benefits of reducing greenhouse gas emissions, protecting public health through safe management of potentially hazardous substances, and protecting soils and groundwater.



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DIRECT ECONOMIC VALUES

The economic value of benefits for which markets currently exist is relatively easy to quantify, as is the case with the commercial harvest of fish or timber, for example. However, even these relatively straightforward market prices do not usually include such external effects as the artificial price elevation for timber and agricultural products that results from government subsidies[11] or the cost of cleaning up pollution, no matter who pays for it.

INDIRECT ECONOMIC VALUES

Measuring the economic significance of benefits for which markets do not exist is even more challenging. What is the economic value of an aesthetic or cultural or educational experience of nature, for example? Or the value of an endangered species? However, in recent decades economists have developed and tested techniques that can approximate the economic values of some of these benefits, with methods and results subjected to peer review in academic journals and presentations at scholarly conferences.[12]

Energy savings: Many ecosystem services have values that take the form of cost savings, which a number of studies have begun to quantify. The local climate regulation provided by shade trees, for example, results in an avoided cost for summertime electricity usage for the residence or commercial building that is cooled by that shade. Trees also block wind, which can contribute to increased demand for heating during the winter months.

When development results in an overall reduction in tree canopy cover, buildings are more exposed to both direct sunlight and wind. This exposure increases the demand for air-conditioning in the summer and for heating in winter. Studies conducted by *American Forests* found that tree canopy reduces residential home cooling costs, saving an average of between $11 per household per year in Portland, Oregon, and $28 per household per year in Atlanta, Georgia.[13] Multiplied across the region, this household benefit can add up: in the Atlanta region, savings in home cooling costs amount to $2.8 million per year.

Water treatment savings: Similarly, when an urban forest prevents thousands of gallons of stormwater runoff from flowing into a municipal sewer system, that municipality saves money in water treatment. A study by the U.S. Environmental Protection Agency, for instance, found that a 2,500-acre wetland in Georgia saves $1 million in water pollution abatement costs each year.[14] In New York City, urban trees intercept almost 890 million gallons of rainwater each year, preventing that much runoff from entering storm sewers and saving the city an estimated $35 million annually in stormwater management costs alone.[15]

Air cleansing: There is also the air-cleansing benefit that trees provide. In the Chicago area, urban trees filter an estimated 6,000 tons of air pollutants each year, providing air cleansing valued at $9.2 million.[16]

TAKING THE LONG VIEW

On a broader scale, New York City took a long-term ecosystem view of protecting its drinking water supply. Starting in 1992, the city began acquiring thousands of acres of watershed lands and working with communities in the watershed on their need for development that was environmentally sensitive.

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The city's planned investment—approximately $1.5 billion over the course of ten years—saved it anywhere from $4 billion to $6 billion in construction costs and an estimated $300 million in annual operations costs for a new water filtration plant that it no longer had to build. The new treatment plant would have doubled or tripled rate payers' bills; by contrast, the provisions of the watershed protection plan increased the average residential customer's water bill by only $7 per year.[17]

RESPONDING TO THE CARBON ECONOMY

As the serious consequences of global climate change have become more apparent, the benefits associated with reducing atmospheric concentrations of carbon dioxide and other greenhouse gases have led markets to place an economic value on sequestered carbon. The Sustainable Sites Initiative urges sites to be carbon neutral, by eliminating net carbon emissions throughout the life of the site. This goal may be achieved by reducing emissions through decreased energy consumption, using renewable energy, and by providing carbon sinks to effectively offset the site's carbon balance. When these options are unavailable or insufficient, another avenue is purchasing carbon credits from a legally binding trading system that provides independent third-party verification, although the Initiative views buying carbon credits as a last resort.

Currently, several markets throughout the world set a price on each ton of carbon dioxide emitted or sequestered. The Chicago Climate Exchange (CCX), for example, is a trading system for reducing greenhouse gas emissions through offset projects around the world.[18] Members make a voluntary but legally binding commitment to meet annual emission reduction targets. Those who reduce greenhouse gas emissions below the targets have surplus allowances to sell or bank; those who emit above the targets meet their commitment by purchasing CCX Carbon Financial Instrument® (CFI®) contracts, each of which represents 100 metric tons of CO_2. In this way the group as a whole meets the annual target.

As of July 2008, CCX valued carbon dioxide about $4 per ton. In places where government regulations restrict the emissions of carbon dioxide, such as in Europe, a tonne of carbon dioxide trades for about $40.[19] This amount is consistent with the prices at which western electrical utilities expect carbon dioxide to trade once mandatory emissions restrictions come into effect in the United States.[20]

In the Chicago area alone, urban trees sequester roughly 155,000 tons of carbon a year—currently worth $620,000 on the Chicago Climate Exchange. And by providing energy savings in residential heating and cooling, the same trees help reduce carbon emissions from power plants by about 12,600 tons annually.[21] In the continental United States, carbon sequestration alone provided by urban trees is estimated to be about 25 million tons per year,[22] which is equivalent to the carbon emitted by almost 18 million cars annually.[23]

VALUING THE HUMAN RELATIONSHIP WITH NATURE

In addition to performing these biogeochemical functions, healthy ecosystems are the source of the many less tangible—but very real and measurable—benefits that humans derive from

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a relationship with nature. These benefits are especially important to the more than 80 percent of Americans who live in cities and towns. Research by social scientists and psychologists shows, for example, that for both adults and children, encounters with everyday nature—a green view from an office window, a lunchtime stroll through a nearby park, well-tended landscapes around schools—restore the ability to concentrate, calm feelings of anxiety, and reduce aggression.[24] Views of natural settings reduce the number of sick days taken by office workers and decrease hospital patient recovery time.[25] According to several studies in the United States and elsewhere, trees and green space generally are good for property values, increasing them from around 4 percent to as much as 10 percent.[26]

Access to nature also encourages physical activity, which can result in weight loss and overall improvements in health. According to the U.S. Surgeon General's office, moderate physical activity, even taken in 10-minute increments, reduces the risk of coronary heart disease, stroke, colon and breast cancer, osteoarthritis, high blood pressure and hypertension, non-insulin dependent diabetes, obesity, and fall-related injuries.[27] One study suggests that when inactive adults increase their participation in regular moderate physical activity, annual mean medical costs are reduced by $865 per person.[28]

COMPARING COSTS

Direct comparisons of the cost of using sustainable land practices instead of traditional land practices are just beginning to be made. The case study on page 27—of two gardens in Santa Monica, California—is one of the few projects that attempts to track costs for both a sustainable site and a control site that uses traditional practices. Although initial installation costs of the sustainable native garden were higher than the traditional garden, the native garden, according to one Santa Monica city official, requires "80 percent less water, half the maintenance, and has half the green waste of the traditional."

By examining a number of projects of different sizes and types that illustrate sustainable landscape practices at various stages of development, the Sustainable Sites Initiative hopes to demonstrate the feasibility of creating sustainable sites virtually anywhere. Whether on many acres of a former brownfield or in one family's backyard, a sustainable site has the capacity to regenerate many of the natural benefits and services provided by ecosystems in their undeveloped state and also conserve energy and resources for the larger community.

GARDEN\GARDEN:
A Comparison in Santa Monica

In 2003, the City of Santa Monica, California, initiated a project to encourage residents and the local landscaping community to adopt sustainable garden practices. The city wished to promote practices that would conserve water, energy, and waste and also reduce urban runoff, the single largest source of pollution in Santa Monica Bay. The challenge was to persuade homeowners and landscape professionals that sustainable gardening was not only better for the environment than traditional gardening, but was just as attractive and also made good economic sense. The city installed two gardens in adjacent residential front yards, completing construction in 2004. Results of monitoring have demonstrated that a native landscape can yield significant reductions in resource consumption and waste production as compared to a traditional landscape.

Native garden

Traditional garden

SIZE/TYPE OF PROJECT
Approximately 1,900 square feet in each garden

SITE CONTEXT
Santa Monica is in the southern and central California chaparral and oak woodlands ecoregion. Its climate is coastal Mediterranean, with salty air and average annual rainfall ranging from 11 to 20 inches. The project properties are side-by-side bungalows in an urban residential neighborhood.

ISSUES/CONSTRAINTS OF THE SITE
- Soil type in both gardens was sandy loam (moderate permeability), highly compacted, and poor in organic matter, with high alkalinity and high levels of heavy metals, including zinc and copper.
- The existing landscape was completely demolished, with all waste exported for recycling.
- Unusually high vehicular traffic results in air pollution

SUSTAINABLE PRACTICES IN THE NATIVE GARDEN
- No chemical herbicides or insecticides (per Santa Monica City policy).
- Climate-appropriate California native cultivars, designed to replicate the chaparral of the Santa Monica Mountains
- Low-volume drip irrigation with a weather-sensitive controller
- System for capturing stormwater runoff for groundwater recharge
- Wildlife habitat for local and migratory fauna

PRACTICES IN THE TRADITIONAL GARDEN
- No chemical herbicides or insecticides; occasional use of blood meal
- Exotic plants from northern Europe and the eastern United States
- Standard, user-controlled sprinkler irrigation system
- No provision for runoff mitigation

CONSTRUCTION COSTS

Traditional garden	**$12,400**
Native garden	**$16,700**

The higher cost of the native garden included demolition and replacement of an existing access ramp, installation of permeable paving, and installation of a rainwater recovery system—rain gutters that tie into an underground infiltration pit.

MONITORING FROM 2004-2008	
Water use (gallons)	
Traditional garden	283,981 gallons
Native garden	64,396 gallons
Difference	219,585 fewer gallons for native garden
Green waste (pounds)	
Traditional garden	647.5 pounds
Native garden	219.0 pounds
Difference	428.5 fewer pounds from native garden
Maintenance labor (U.S. dollars)	
Traditional garden	$223.22
Native garden	$ 70.44
Difference	$152.78 less required by native garden

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4 TOWARD MEASURES OF SUSTAINABILITY

High Point, Seattle, Washington

The first rule of sustainability is to align with natural forces, or at least not try to defy them.

~Paul Hawken

By aligning land development and management practices with the functions of healthy ecosystems, developers, property owners, and site managers can restore or enhance the ecosystem services provided by their landscapes. The goals are straightforward: Water on the site can be managed to imitate natural water cycles; appropriate vegetation can be planted strategically to cool the area, filter water, and provide habitat; and soils can be restored to support healthy vegetation and filter pollutants. Selecting sustainable materials for use in the landscape can strengthen many of these services as well as protect human health.

Yet developing specific guidelines for achieving these goals is an ongoing challenge. In the months after publication of the Preliminary Report in 2007, members of the Sustainable Sites Initiative's Technical Subcommittees, the Steering Committee, and Initiative staff continued efforts to devise guidelines that are grounded in rigorous science and can be applied on a site-by-site basis nationwide. At the same time, all participants in the Initiative recognized that different regions of the country will have different requirements.

4

IDENTIFYING CRITERIA FOR A SUSTAINABLE SITE

Among the first tasks was to identify the specific and measurable criteria that a site would need to meet in order to be deemed "sustainable." These metrics would need to address the various aspects of land development and management that affect the ability of a site to provide a variety of ecosystem services.

The Technical Subcommittees were given the bulk of responsibility for developing the metrics. Originally formed in 2007, the subcommittees address five key topic areas: soils, vegetation, hydrology, materials selection, and human health and well-being. Each subcommittee consists of six to ten volunteer experts representing a range of backgrounds, diverse focus areas, and different geographic locations. They have provided expertise and direction on sustainable land practices using the framework of ecosystem services as a foundation for building metrics.

In the year since the release of the Preliminary Report in 2007, the subcommittees relied on an iterative and collaborative process, working and re-working draft credits and prerequisites over many hours of conference calls and face-to-face meetings. To produce the 59 credits and prerequisites in Chapter 5, members of the subcommittees drew on feedback received from more than 450 reviewers of the Preliminary Report, research from peer-reviewed references, their own professional experience, support from graduate research assistants, and existing green rating systems.

MAKING TRANSFORMATION PRACTICAL AND ACHIEVABLE

The task was not an easy one: the subcommittees needed to develop credits that would shift the landscape development and management market toward sustainability while still being practical and achievable. Their goal was to describe sustainable benchmarks based on outcomes rather than prescriptive measures, in hopes of encouraging innovation, inspiring a change in thinking, and providing flexibility.

With each credit and prerequisite for a sustainable site, the subcommittees worked to address numerous considerations: Can this credit apply to a variety of projects—large and small, public and private, with buildings and without? Does this credit measure sustainability in various regions and climates, from the arid southwest to the humid northeast? Are there ways to document the success of this credit that aren't too onerous and costly? For instance, how does one determine whether a sustainable outcome is achieved (such as clean water or physically active occupants) if the most accurate methods to gauge the outcomes (such as monitoring or post-occupancy evaluations) are expensive and difficult?

Describing specific and measurable conditions that are "sustainable" is a learning process, and the answers to the questions, "How much can be done?" and "How much is enough?" are not always clear. Recognizing that gaps in current research exist, the subcommittees relied on the best available data and will continue to work on improving the credits. However, because the goal of this Initiative is to shift land development and management toward more sustainable approaches, credit requirements tend to err on the side of setting the bar too high, rather than

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too low. With that tendency in mind, reviewers should look for "Notes to Readers" within Chapter 5—these notes are often specific questions for which the technical experts of the Sustainable Sites Initiative still seek answers.

INTERRELATED CREDITS

In drafting the credits for Chapter 5, the members of each subcommittee reviewed the metrics crafted by their counterparts on each of the other subcommittees as those metrics related to their own topic areas. This consultative and iterative approach attests to the interrelatedness of all the components of a healthy ecosystem—and of a sustainable site.

It is important to recognize that no single credit results in a sustainable site. Rather, the shift toward sustainability depends on—and is the product of—the many interactions between and among the credits. For instance, the prerequisite "Reduce potable water consumption for irrigation" limits the types of vegetation that can thrive on a particular site, which may encourage site designers to seek out plants tolerant of the local climate and precipitation patterns. Using appropriate plants, including natives, will also help a site meet the requirements for the "Use appropriate, non-invasive plants" prerequisite, and maybe even credits such as "Promote a sense of place with native vegetation" and "Preserve and restore native wildlife habitat."

Because these credits, like ecosystem services themselves, are tightly interwoven, it is useful to approach each project with a holistic perspective, maintaining a view of the project as a whole, rather than focusing on its many component parts. To that end, achieving a sustainable site begins with establishing an integrated design process, which relies on a multidisciplinary team working collaboratively from the pre-design phase through construction and on into the occupation and operation of the site.

An integrated design team is typically made up of individuals critical to the overall design, construction, and operation of the site, as well as members of the community and others who will be using the site. The size and composition of the team depends on the project. Potential members of a project team include, for example, landscape architects, horticulturists, architects, restoration ecologists, civil engineers, mechanical engineers, electrical engineers, the client's professional and maintenance staff, and representatives from the community of potential site users.

The credits in Chapter 5 are organized into categories to guide an integrated design team through the project phases. The first sections of prerequisites and credits include the processes of site selection and pre-design assessment, followed by sections that address the various considerations during site design, and ends with sections that pertain to the construction phase as well as operations and maintenance. The credits also include an entire section for evaluating various aspects of human health and well-being. Considerations for human health inform many other guidelines as well, of course, but fostering an ethic of environmental stewardship is central to the idea of sustainability.

4

THE BIG PICTURE

The guidelines and benchmarks presented for review in Chapter 5 can be thought of as incremental steps to help guide traditional land development and management practices toward sustainability. However, it is important to recognize that these credits are not all-inclusive and they are not perfect—they will continue to be re-evaluated and improved as time goes on. Rather than "chasing" individual credits, the Sustainable Sites Initiative encourages site designers to adopt a big-picture approach, one that allows natural and built systems to work together to improve the long-term health of the environment and of socially and economically viable human communities.

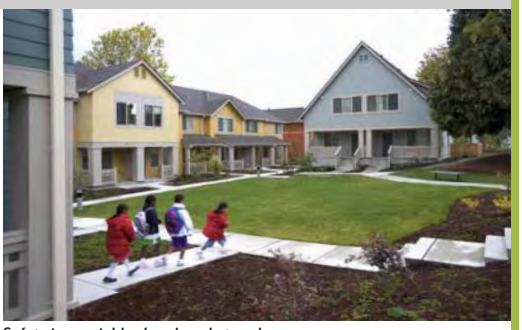
One example of how sustainable practices can be put into operation right now is the High Point community in Seattle, Washington, which has reconnected an isolated 1940s-era neighborhood to the larger community even as it has protected and restored one of the city's existing urban salmon-bearing streams. A brief overview of the project may be seen on the following page.

HIGH POINT:
Restoring Habitat in an Urban Neighborhood

Seattle's High Point project combines ecological and social goals to transform an isolated and distressed 34-block residential neighborhood into a vibrant, sustainable community. The redevelopment is in the Longfellow Creek watershed, one of four urban salmon-bearing streams remaining in the city. Seattle Public Utilities realized that the redevelopment of the 1940s-era site provided the potential to mitigate a significant area of contaminated urban runoff.

Stormwater management using native vegetation

© Roger Williams



Safety in a neighborhood pocket park

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SIZE/TYPE OF PROJECT
120 acres /residential greyfield redevelopment

SITE CONTEXT
Seattle is in the Central Puget Lowland (or Puget trough) ecoregion. Its mild climate is classified as marine west coast, with dry summers and cool wet weather the rest of the year.

ISSUES/CONSTRAINTS OF THE SITE
- The site topography slopes to the northeast with an elevation change of more than 170 feet in approximately 1 mile. The developed area drains to a single discharge point that is piped to Longfellow Creek.
- Residents did not want the stigma of "public housing" to continue in the new development. Connectivity to surrounding neighborhood was important.

FEATURED SUSTAINABLE PRACTICES
Stormwater management and protection of watershed and habitat: Natural riparian corridors are an integral part of Seattle's drainage system, with more than 20 percent of the city's runoff flowing into local creeks. The project team focused on restoring and protecting the salmon habitat with systems to preserve and clean the watershed. Although the site is a greyfield developed in the 1940s, the design should allow the site to process stormwater as effectively as the pastures presumed to exist prior to the original development.
- Roof runoff is directed to splashblocks that drain to furrows, dispersion trenches, raingardens, and pervious pavements.
- Stormwater that does not infiltrate on housing sites is directed to a 22,000-foot system in which swales constructed with gravel and compost are graded with periodic berms to allow water to pond and filter into the soil.
- Overflow from the system during extraordinary storm events is piped to a single stormwater pond for detention.

Native and adapted vegetation: Native and adapted plants were used to reflect the local ecosystem and to minimize maintenance needs. More than 80,000 ground covers are planted in the streetscape, and the addition of more than 3,000 trees effectively tripled the number of trees on the site. Swale plantings vary to create an interesting year-round experience for residents.

Irrigation efficiency: Native, drought-tolerant, and site-suitable plants were used to minimize the need for irrigation and pesticides. Amended soils improve water retention, while a computerized irrigation management system adjusts water supply based on plant needs, solar orientation, and local weather information.

CONSTRUCTION COSTS
Complete project costs are not available. For specific cost-saving aspects of the plan, see *www.sustainablesites.org/cases/*.

MONITORING
Flow rate monitoring has begun but results were not yet available at time of publication. The Phase I area of the project did manage two 100-year storm events in the 2006-2007 season without flooding.

LESSONS LEARNED
- Working with permitting agencies, interdisciplinary planning, collaboration, contractor education, public communication, and community celebrations were key to the project's success.
- Protection of natural drainage system during construction needs to be emphasized for the contractor, as the whole system needs to be functioning successfully prior to issuance of the certificate of occupancy. This requirement has schedule implications for the contractor who must plan ahead.

More project details: http://www.sustainablesites.org/cases/

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5

SUSTAINABLE SITES INITIATIVE
GUIDELINES AND PERFORMANCE BENCHMARKS
DRAFT 2008

Kresge Foundation Headquarters, Troy, Michigan

In the current structure of many green rating systems, certification is awarded shortly after construction is complete. However, landscapes are dynamic systems—vegetation grows and matures, maintenance practices evolve, and adjacent land uses change over time. Therefore, an assessment of post-construction conditions provides an incomplete snapshot of site sustainability. Given this dynamic character, the certification process for a sustainable site may extend from post-construction into the operations and maintenance phase. The Sustainable Sites Initiative will explore opportunities for initial certification after construction, with re-certification requirements to verify that the site performs as anticipated over time.

The draft prerequisites and credits presented here are intended to supplement the U.S. Green Building Council's LEED® (Leadership in Energy and Environmental Design) certification programs and those of other green rating systems. As a major stakeholder in the Initiative, the U.S. Green Building Council anticipates incorporating these benchmarks into future versions of the LEED Green Building Rating System. Partly adapted from credits in existing green rating systems, the benchmarks were developed by technical experts and, where possible, are supported by references published through a vetted, transparent process and accepted by stakeholders. The intents and concepts underlying the prerequisites and credits can be applied right away to support sustainable practices wherever feasible—with the understanding that the benchmarks themselves are still a work in progress, presented here so that public reviewers may provide suggestions for improvement.

5

CONSIDERATIONS

Prerequisites are benchmarks that must be met in order for a site to qualify as a sustainable site. Credits are benchmarks that are optional. Not all prerequisites and credits are applicable to all site locations and site types. Credit weights will be determined in the next phase of the project, and the Initiative anticipates subtracting credits that do not apply to a specific site from the available credit total.

On some sites, low baselines due to contamination or local restrictions may prevent a site from meeting the requirements of a credit. For example, brownfield sites may be required to adhere to specific guidelines for remediation that may not be compatible with certain credits. Similarly, in some regions, meeting the requirements of a credit may compromise certain environmental conditions. For example, increased infiltration may help achieve the "Manage water on-site" credit but may negatively affect local ecology. In these unique instances, a site can still achieve credit if the intent of the credit can be met using an alternate path. In submittal documentation, describe the conditions or restrictions of the site, the alternative strategies taken to meet the intent of the credit, and the monitoring results or outcomes of the alternative strategy.

STRUCTURE OF PREREQUISITES AND CREDITS

For each credit or prerequisite, please note the following subheadings and their purposes.

Intent
This section summarizes the goal that the credit or prerequisite aims to accomplish.

Requirements
This section describes the benchmark(s) a site must meet to achieve the credit or satisfy the prerequisite. For certain credits, the requirements section is split into multiple benchmarks that represent incremental improvements toward fully achieving the intent of the credit. In other words, a "low point value" represents the minimum benchmark a site must meet to achieve the credit, while a "high point value" represents the ultimate benchmark for success for that credit.

Ecosystem services addressed:
In achieving a credit or prerequisite, a site may help preserve or restore one or more ecosystem services. (Note: Please find on the following pages a matrix summarizing the ecosystem services that may be achieved by each credit and prerequisite.)

Economic and social benefits:
This section includes examples of the range of economic and social benefits associated with ecosystem services that a credit or prerequisite could provide. The economic benefits may take the form of avoided costs—such as avoided health-care costs from improved air quality, avoided stormwater treatment and infrastructure costs from increased interception and infiltration of rainwater, and avoided energy expenditures for air-conditioning and heating when buildings are shaded and protected from wind by trees. Some economic benefits of ecosystem services are apparent in existing financial markets—for instance, clean water is a factor in a range of benefits from enhanced recreational and ecotourism opportunities to improved fisheries. Ecosystem services also provide benefits to human health by contributing to physical, mental, and social well-being.

Suggested submittal documentation

This section summarizes the materials a site should prepare and submit to demonstrate that the requirements of the credit or prerequisite have been met. In some cases, additional materials may be required to prove that the intent of the credit has been achieved.

Technologies and strategies

This section provides example methods or site practices that could be used to help achieve the credit or prerequisite. The technologies and strategies listed in this section are not all-inclusive and sites are encouraged to use creative solutions to meet the requirements and intent of a credit or prerequisite.

Resources

This section provides example resources to give readers additional guidance. These resources were suggested by technical experts and, where possible, include references published through a vetted, transparent process and accepted by regional stakeholders.

ECOSYSTEM SERVICES MATRIX

Credits or prerequisites that may achieve the selected ecosystem service

Credits or prerequisites that have little or no chance of achieving the selected ecosystem service

PREREQUISITES AND CREDITS		ECOSYSTEM SERVICES: GLOBAL CLIMATE REGULATION	LOCAL CLIMATE REGULATION	AIR AND WATER CLEANSING	WATER SUPPLY AND REGULATION	EROSION AND SEDIMENT CONTROL	HAZARD MITIGATION	POLLINATION	HABITAT FUNCTIONS	WASTE DECOMPOSITION AND TREATMENT	HUMAN HEALTH AND WELL-BEING BENEFITS	FOOD AND RENEWABLE NON-FOOD PRODUCTS	CULTURAL BENEFITS
1 SITE SELECTION **Select locations to preserve existing resources and repair damaged systems**													
1.1 Prerequisite	**Preserve threatened or endangered species habitat**	■	■	■	■	■	■	■	■	■	■	■	■
1.2 Prerequisite	**Protect and restore floodplain functions of riparian and coastal zones**	□	□	■	■	■	■	■	■	■	■	■	■
1.3 Prerequisite	**Limit disturbance of prime farmland soils, unique soils, and soils of statewide importance**	■	□	■	■	■	□	■	■	■	□	■	□
1.4 Credit	Select brownfields or greyfields for redevelopment	■	□	■	□	□	□	□	□	■	■	□	■
2 PRE-DESIGN ASSESSMENT AND PLANNING **Plan for sustainability from the onset of the project**													
2.1 Prerequisite	**Conduct a pre-design site assessment**	■	■	■	■	■	■	■	■	■	■	■	■
2.2 Prerequisite	**Use an integrated design process**	■	■	■	■	■	■	■	■	■	■	■	■
2.3 Prerequisite	**Develop a program plan with site performance goals**	■	■	■	■	■	■	■	■	■	■	■	■
2.4 Credit	Engage users and other stakeholders in meaningful participation in site design	■	■	■	■	■	■	■	■	■	■	■	■
3 SITE DESIGN—ECOLOGICAL COMPONENTS **Protect and restore site processes and systems**													
3.1 Prerequisite	**Control and manage invasive species**	■	□	■	□	□	□	■	■	■	■	■	■
3.2 Prerequisite	**Use appropriate, non-invasive plants**	■	□	■	□	□	□	■	■	■	■	■	■
3.3 Prerequisite	**Preserve special status trees**	■	■	■	■	■	□	■	■	□	■	■	■
3.4 Prerequisite	**Reduce potable water consumption for irrigation**	■	■	■	■	□	□	□	□	□	□	□	□
3.5 Credit	Minimize or eliminate potable water consumption for irrigation	■	■	■	■	□	□	□	□	□	□	□	□
3.6 Credit	Preserve and restore plant biomass on-site	■	■	■	■	■	■	■	■	■	■	■	■
3.7 Credit	Minimize building heating and cooling requirements with vegetation	■	■	■	■	■	■	■	■	■	■	■	■
3.8 Credit	Reduce urban heat island effects	■	■	■	■	■	■	■	■	■	■	■	■
3.9 Credit	Promote a sense of place with native vegetation	■	■	■	■	■	■	■	■	■	■	■	■
3.10 Credit	Preserve and restore native wildlife habitat	■	■	■	■	■	■	■	■	■	■	■	■
3.11 Credit	Protect and restore riparian and wetland buffers	■	■	■	■	■	■	■	■	■	■	■	■

CONTINUED ON PAGE 39

ECOSYSTEM SERVICES MATRIX

■ **Credits or prerequisites** that may achieve the selected ecosystem service

□ **Credits or prerequisites** that have little or no chance of achieving the selected ecosystem service

PREREQUISITES AND CREDITS		ECOSYSTEM SERVICES											
		GLOBAL CLIMATE REGULATION	LOCAL CLIMATE REGULATION	AIR AND WATER CLEANSING	WATER SUPPLY AND REGULATION	EROSION AND SEDIMENT CONTROL	HAZARD MITIGATION	POLLINATION	HABITAT FUNCTIONS	WASTE DECOMPOSITION AND TREATMENT	HUMAN HEALTH AND WELL-BEING BENEFITS	FOOD AND RENEWABLE NON-FOOD PRODUCTS	CULTURAL BENEFITS
3 SITE DESIGN—ECOLOGICAL COMPONENTS (continued) **Protect and restore site processes and systems**													
3.12 Credit	Repair or restore damaged or lost streams, wetlands, and coastal habitats	■	■	■	■	■	■	■	■	■	■	■	■
3.13 Credit	Preserve existing healthy soils	■	□	■	■	■	□	□	■	■	□	■	□
3.14 Credit	Preserve existing topography	■	□	■	■	■	□	□	■	■	□	■	□
3.15 Credit	Restore soils disturbed by previous development	■	□	■	■	■	□	□	■	■	□	■	□
3.16 Credit	Manage water on-site	□	■	■	■	■	□	□	■	□	■	□	■
3.17 Credit	Cleanse water on-site	□	□	■	■	■	□	□	■	□	■	■	■
3.18 Credit	Eliminate potable water use in ornamental or stormwater features	■	□	□	■	□	□	□	□	□	□	□	□
3.19 Credit	Minimize use of potable water in water features designed for full human contact	■	□	□	■	□	□	□	□	□	□	□	□
3.20 Credit	Mitigate potential wildfire risks	■	□	□	□	□	■	□	□	■	□	□	□
4 SITE DESIGN—HUMAN HEALTH COMPONENTS **Build strong communities and a sense of stewardship**													
4.1 Credit	Promote equitable site design, construction, and use	□	□	□	□	□	□	□	□	□	■	□	■
4.2 Credit	Promote sustainability awareness and education	■	■	■	■	■	■	■	■	■	■	■	■
4.3 Credit	Provide for optimum site accessibility, safety, and wayfinding	□	□	□	□	□	□	□	□	□	■	□	□
4.4 Credit	Provide views of the natural environment to building occupants	□	□	□	□	□	□	□	□	□	■	□	■
4.5 Credit	Provide opportunities for outdoor physical activity	□	□	□	□	□	□	□	□	□	■	□	□
4.6 Credit	Connect site to surrounding resources, amenities, and services	■	□	□	□	□	□	□	□	□	■	□	□
4.7 Credit	Provide outdoor spaces for mental restoration	□	□	□	□	□	□	□	□	□	■	□	■
4.8 Credit	Provide outdoor spaces for social interaction	□	□	□	□	□	□	□	□	□	■	□	■
4.9 Credit	Design stormwater management features to be a landscape amenity	□	□	■	■	□	□	□	■	□	■	■	■
4.10 Credit	Prevent and abate sensory stress	□	□	□	□	□	□	□	■	□	■	□	■
4.11 Credit	Protect and promote unique cultural and historical site attributes	□	□	□	□	□	□	□	□	□	■	□	■

CONTINUED ON PAGE 40

ECOSYSTEM SERVICES MATRIX

■ **Credits or prerequisites** that may achieve the selected ecosystem service

□ **Credits or prerequisites** that have little or no chance of achieving the selected ecosystem service

PREREQUISITES AND CREDITS		ECOSYSTEM SERVICES											
		GLOBAL CLIMATE REGULATION	LOCAL CLIMATE REGULATION	AIR AND WATER CLEANSING	WATER SUPPLY AND REGULATION	EROSION AND SEDIMENT CONTROL	HAZARD MITIGATION	POLLINATION	HABITAT FUNCTIONS	WASTE DECOMPOSITION AND TREATMENT	HUMAN HEALTH AND WELL-BEING BENEFITS	FOOD AND RENEWABLE NON-FOOD PRODUCTS	CULTURAL BENEFITS
5 SITE DESIGN—MATERIALS SELECTION **Reuse/recycle existing materials and support sustainable production practices**													
5.1 Prerequisite	**Eliminate use of lumber from threatened tree species**	■	■	■	■	■	■	■	■	■	■	■	■
5.2 Credit	Support sustainable practices in plant production	■	□	■	■	□	□	□	■	□	■	□	□
5.3 Credit	Support sustainable practices in materials manufacturing	■	□	□	■	□	□	□	□	□	□	□	□
5.4 Credit	Reuse on-site structures, hardscape, and landscape amenities	■	□	□	□	□	□	□	□	□	□	□	■
5.5 Credit	Use salvaged and recycled content materials	■	□	□	□	□	□	□	■	□	□	□	□
5.6 Credit	Use certified wood	■	■	■	■	■	■	■	■	■	■	■	■
5.7 Credit	Use products designed for reuse and recycling	■	□	□	□	□	□	□	□	□	□	□	□
5.8 Credit	Use adhesives, sealants, paints, and coatings with reduced VOC emissions	■	□	□	□	□	□	□	□	□	■	□	□
5.9 Credit	Conduct a life cycle assessment	■	□	■	□	□	□	□	■	■	■	□	□
6 CONSTRUCTION **Minimize effects of construction-related activities**													
6.1 Prerequisite	**Create a soils management plan**	■	□	■	■	■	□	□	■	■	□	■	□
6.2 Prerequisite	**Restore soils disturbed during construction**	■	□	■	■	■	□	□	■	■	□	■	□
6.3 Credit	Achieve a carbon-neutral site	■	■	■	□	□	□	□	□	□	■	□	□
6.4 Credit	Divert construction and demolition materials from disposal	■	□	□	□	□	□	□	□	□	□	□	□
6.5 Credit	Control and retain construction pollutants	□	□	■	■	■	□	□	■	□	■	■	■
6.6 Credit	Use excess vegetation, rocks, and soil generated during construction	■	□	□	□	□	□	□	□	■	□	□	□
7 OPERATIONS AND MAINTENANCE **Maintain the site for long-term sustainability**													
7.1 Prerequisite	**Plan for sustainable landscape maintenance**	■	■	■	■	■	■	■	■	■	■	■	■
7.2 Credit	Minimize exposure to localized air pollutants	■	□	■	□	□	□	□	□	□	■	□	□
7.3 Credit	Recycle organic matter generated during site operations and maintenance	■	□	□	□	□	□	□	□	■	□	□	□
7.4 Credit	Provide for storage and collection of recyclables	■	□	□	□	□	□	□	□	□	□	□	□
7.5 Credit	Use renewable sources for site outdoor electricity	■	□	□	□	□	□	□	□	□	□	□	□

5 DRAFT PREREQUISITES AND CREDITS

1 SITE SELECTION

Select locations to preserve existing resources and repair damaged systems

2 PRE-DESIGN ASSESSMENT AND PLANNING

Plan for sustainability from the onset of the project

3 SITE DESIGN—ECOLOGICAL COMPONENTS

Protect and restore site processes and systems

4 SITE DESIGN—HUMAN HEALTH COMPONENTS
Build strong communities and a sense of stewardship

5 SITE DESIGN—MATERIALS SELECTION
Reuse/recycle existing materials and support sustainable production practices

6 CONSTRUCTION
Minimize effects of construction-related activities

7 OPERATIONS AND MAINTENANCE
Maintain the site for long-term sustainability

1 SITE SELECTION

Select locations to preserve existing resources and repair damaged systems

1.1 Prerequisite Preserve threatened or endangered species habitat

Intent
Avoid development of areas that contain habitat for species identified on federal or state threatened or endangered lists to promote biodiversity.

Requirements
On portions of sites specifically identified as habitat for any species on federal or state threatened or endangered lists, restrict development activities to those with limited disturbance (e.g., trails or pathways).

Suggested submittal documentation
The site assessment *(see 2.1 Prerequisite)* will document locations of potential threatened or endangered species habitat. Provide documentation (e.g., habitat assessment) that the site does or does not contain habitat for species listed as threatened or endangered on federal or state lists. If the site contains habitat for listed species, provide site plans to demon-strate that only limited disturbance development will be allowed in the habitat area.

Technologies and strategies
During the site selection process, give preference to sites that do not include habitat for threatened or endangered species. Design the site to minimize disruption to existing habitats.

Resources
For state and federal lists of threatened and endangered species, see *http://ecos.fws.gov/tess_public/StateListing.do?state=all*.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Species extinctions can disrupt the interactions and feedback mechanisms of natural ecosystems that have developed over time to be relatively stable and resistant to pests and diseases. Stable natural ecosystems control more than 95 percent of the potential crop pests and carriers of human diseases.[1]

Ecosystems that contain wildlife habitat also support recreational and ecotourism activities, such as hiking and birdwatching, and opportunities for environmental education.[2]

1.2 Prerequisite Protect and restore floodplain functions of riparian and coastal zones

Intent

Avoid development and disturbance in sites with high risk of flooding to protect the floodplain functions of landscapes adjacent to rivers, lakes, and coastal zones.

Requirements

- **For sites that have not been previously developed or graded and remain in a natural state:** Designate 100 percent of the baseline setback width, as defined in Table 5-1 below, as a buffer protection zone.
- **For sites that have been previously developed or graded and/or do not remain in a natural state:** Expand the existing setback to cover an additional 25 feet or 20 percent (whichever is greater) of the baseline setback width, as defined in Table 5-1 below. This area must be designated a buffer protection zone and restored.
- **Note:** *Structures may be built within buffer protection zone as long as the structure maintains or enhances the functionality of the floodplain. The functions that a floodplain provides include: water cleansing, flood storage, flood conveyance, infiltration, maintenance of base flow and peak flow, wildlife habitat, and opportunities for cultural and recreational uses. Conduct a Functional Impact Assessment (such as those conducted by the U.S. Army Corps of Engineers, or USACE) to demonstrate that functions have been maintained or enhanced.*
- **Note:** *The average width of the buffer protection zone shall meet the requirements of this prerequisite. Average buffer width can be calculated using perpendicular transects every 50 feet along a water body. For sites with existing development or paved areas, determine average buffer width to edge of the impervious surface.*[3]

TABLE 5-1 BASELINE SETBACK WIDTH REQUIREMENTS

Landscape feature (located either on-site or adjacent to the site)	Baseline setback width
Rivers, streams, and tributaries of any size, including ephemeral and intermittent streams, and lakes	100-year floodplain as defined by FEMA or 100 feet, whichever is greater
Wetlands, including isolated wetlands	50 feet (minimum setback to protect wetland from human disturbance)[4]
Coastal shoreline	Whichever is greater of the following: 1. Zones V and A (100-year floodplain) as defined by FEMA 2. Setback based on shoreline erosion: a. For areas where erosion data is available: 70 times the annual erosion rate plus 25 feet (minimum of 125 feet) b. For areas where erosion data is not available, or where erosion is not occurring: 125 feet from the natural boundary of the sea c. For areas with coastal bluffs with erosional toe: three times the vertical height of the bluff

- **Note:** *For sites that require restoration, use the Riparian and Wetland Buffer Function Assessment Worksheet in Appendix A for the existing site buffer to identify restoration opportunities and help develop a restoration plan. A restoration plan should outline ways to restore the ability of buffers to: 1) minimize property damage from flooding and provide water quality services, 2) stabilize soils to control erosion, and 3) provide habitat function.*
- **Note:** *Setback widths for rivers, streams, and tributaries are measured on each side of the stream from the top of each stream bank for third-order or higher streams, or from the stream centerline for second-order or lower streams.*[5]
- **Note:** *Setback widths for wetlands are measured from the edge of the delineated wetland.*
- **Note:** *Protection of riparian, wetland, or coastal buffers beyond the requirements of this prerequisite may provide additional protection from floods while enhancing water quality and habitat function. See "Protect and restore riparian and wetland buffers" credit.*

Ecosystem services addressed:
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Protecting floodplain functions reduces flood risks to property owners and local ecosystems. It also minimizes risks associated with flooding to the health and safety of the general public. In addition, water-quality improvements as a result of setback protection can lead to increased recreational opportunities and improved fisheries.

Suggested submittal documentation
Provide contour maps showing boundaries of the baseline setback width (as determined using Table 5-1 on page 44), the existing setback, and, if applicable, the additional areas that will be included in the buffer protection zone. On the contour map, show the locations of new and existing development and impervious surfaces. Describe how buffer protection zones will be preserved during construction (e.g., high visibility construction fencing or silt fencing if buffer protection zone is downslope of construction). Provide a description of the restoration plan, and describe how the restoration opportunities identified in the Riparian and Wetland Buffer Function Assessment Worksheet will be addressed. Provide a narrative describing any special circumstances or non-standard compliance paths taken by the project.

Technologies and strategies
Design the site to avoid development in high-risk flood areas. Contact local and regional governmental agencies, consultants, and educational facilities as resources for the most appropriate and effective restoration techniques and vegetation for the site. Plant appropriate native vegetation, re-grade soils where necessary, and use soft engineering techniques to restore floodplain functions.

Resources
- For regional erosion rates, see USGS coastal erosion mapping resources, *http://coastalmap.marine.usgs.gov/regional/contusa/index.html*.
- For more information on FEMA flood maps, see the online Map Service Center *(http://msc.fema.gov/)*.
- For guidance on protecting riparian and/or wetland buffers during construction, see local sediment and erosion control regulations. If no local guidance is available, refer to the resources at Delaware's Sediment and Stormwater Management Program, *http://www.swc.dnrec.delaware.gov/Pages/SedimentStormwater.aspx* or Stormwater Management Manual for Western Washington (2005), *http://www.ecy.wa.gov/biblio/0510030.html*.

- For guidance on restoring riparian and/or wetland buffers, see Federal Interagency Stream Restoration Working Group, Stream Corridor Restoration: Principles, Processes, and Practices (1998), *http://www.nrcs.usda.gov/Technical/stream_restoration*
  and Center for Watershed Protection resources (including T Schueler "The architecture of urban stream buffers," *Watershed Protection Techniques* 1 (1995): pp.159-163), *http://www.cwp.org*.
- For guidance on delineating wetlands, see U.S. Army Corps of Engineers resources, *www.usace.army.mil/cw/cecwo/reg/rw-bro.htm*.

1.3 Prerequisite Limit disturbance of prime farmland soils, unique soils, and soils of statewide importance

Intent
Protect soils designated by the USDA Natural Resources Conservation Service as prime farmland, unique soils, or soils of statewide importance to ensure that land could be easily converted back to farmland for agricultural food production if necessary.

Requirements
- No soils defined as prime farmland, unique soils, or soils of statewide importance are imported to the site.
- For sites with existing soils defined as prime farmland, unique soils, or soils of statewide importance, less than 5 percent of the total surface area of these soils on-site may be graded, compacted or covered with new impervious surfaces.
- **Note:** *Do not place restrictions on prime farmland, unique soils, or soils of statewide importance that may prevent land from being easily converted back to farmland for agricultural food production if necessary.*

Suggested submittal documentation
Provide site plans showing the location of any on-site soils designated as prime farmland, unique soils, or soils of statewide importance, and demonstrate that areas of impervious surface, grading, and compaction are limited to less than 5 percent of the total surface area of these soils. For any imported soil, provide documentation indicating the source location of the soil and proof the soil is not designated as prime farmland, unique soils, or soils of statewide importance.

Technologies and strategies
Refer to local soil survey data to determine if soils defined as prime farmland, unique soils, or soils of statewide importance are present on-site.

Resources
Online soil surveys are available at *http://websoilsurvey.nrcs.usda.gov/app/*.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Food and renewable non-food products

Economic and social benefits:
Prime farmland soils, unique soils, or soils of statewide importance have important biological, physical, and chemical characteristics needed to produce high yields of crops.[6] Prime farmland soils may produce high yields of food, fiber, feed, forage, and oil seed crops.

1.4 Credit Select brownfields or greyfields for redevelopment

Intent
Channel development to urban areas with existing infrastructure and rehabilitate damaged sites to reduce pressure on undeveloped land and restore ecosystem services.

Requirements
- **Option 1 Brownfield redevelopment:** Select a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local Voluntary Cleanup Program) OR a site defined as a brownfield by a local, state, or federal government agency.
  OR
- **Option 2 Greyfield redevelopment:** Select a site that has been previously developed or graded.

Suggested submittal documentation
- **Option 1:** Provide confirmation that the existing site was documented as contaminated or defined as a brownfield, and provide a detailed narrative describing the site contamination.
  OR
- **Option 2:** Provide a site vicinity plan (e.g., sketches, block diagrams, maps, and aerial photographs) showing the project site and the surrounding sites and buildings.

Technologies and strategies
During the site selection process, give preference to previously developed or brownfield sites. Coordinate site development plans with remediation activity and use of existing infrastructure and materials, as appropriate.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Waste decomposition and treatment
- Human health and well-being benefits
- Cultural benefits

Economic and social benefits:
Brownfield and greyfield redevelopment reduces pressure on undeveloped land, thereby protecting habitat and preserving natural resources. Using existing infrastructure and on-site materials as resources can reduce project costs for new materials.

The rehabilitation of a site with environmental contamination is an opportunity to improve the environmental quality and resources available to local communities. Such properties may also cost less and be offered for sale with tax incentives.

CLINTON BEACH PARK: A Sustainable Park for a Waterfront Community

Responding to community calls for public access to Puget Sound, the Port District of South Whidbey Island transformed a greyfield site next to the Clinton ferry terminal into a new beach park that promotes ecological awareness, resource efficiency, and storm-water management. The park accommodates the needs of diverse visitors with improved accessibility to the Port's Fishing Pier and small boat dock.

Seating with water views, recycled plastic lumber decking

Green roof on picnic shelter

SIZE/TYPE OF PROJECT
0.68 acre/greyfield redevelopment

SITE CONTEXT
The site is adjacent to a busy commercial ferry terminal on Whidbey Island, Washington, 30 miles north of Seattle, at the northern boundary of Puget Sound. The island is partially in the rain shadow of the Olympic Mountains and has a variety of climate zones. The climate of the greater Seattle area is classified as marine west coast, with dry summers and cool wet weather during the rest of the year. A restaurant and parking lot were on the site when it was acquired.

ISSUES/CONSTRAINTS OF THE SITE
No construction activities were permitted on the protected beach adjacent to the project.

FEATURED SUSTAINABLE PRACTICES
Materials reuse: Existing footings and substructure were reused. Salvaged or recycled materials were used throughout the project, including salvaged wood from old logging sites, recycled plastic lumber, and concrete containing fly ash. Wood from deconstruction of the prior structure was sold to a local materials outlet to reduce landfill waste.

Stormwater management: By implementing several sustainable water management strategies, the team was able to avoid catch basins and detention ponds.

- All existing impervious surfaces were removed.
- The parking area consists of 3,100 square feet of porous pavers.
- The picnic shelter has an extensive green roof.
- A bioswale collects and filters excess stormwater.

Native and adapted vegetation: All existing invasive plants were removed and the park was re-vegetated with drought-tolerant natives and adaptive species. Turf areas were seeded with a special low-water mix that requires no irrigation or mowing once established and stays green throughout the year.

CONSTRUCTION COSTS
The project's total cost was $520,000.

MONITORING

- Precipitation is infiltrating through the pavers; no evidence of flooding has been observed. This is consistent with the infiltration rate, which exceeds the average two-year storm event of 1.65 inches in 24 hours.
- Monitoring of the green roof determined that periodic watering is required during the summer months, but not at other times. Weeding has been required in late spring and midsummer. It is assumed that both watering and weeding can be phased out when the green roof is fully established.

LESSONS LEARNED

- The sustainable strategies used in the project did not increase costs.
- Involving volunteers in design review and planting operations both reduced costs and engaged the community.
- Planned sustainable strategies need to be carefully reviewed with contractors in the planning phase to ensure that they can be achieved. Although the design team had identified a reuse for the existing building, which was to be relocated, the contractor was unable to find a means of moving the building across adjacent mudflats. The building was demolished, but heavy timbers and beams were salvaged and sold to a local outlet.

2 PRE-DESIGN ASSESSMENT AND PLANNING

Plan for sustainability from the onset of the project

2.1 Prerequisite Conduct a pre-design site assessment

Intent
Conduct an accurate and detailed assessment of existing site conditions prior to design to inform decisions and guide the design, construction, operation, and maintenance phases.

Requirements
Assess existing site conditions and resources prior to site design. Use the site assessment guidance *(see Appendix B)* to help identify and prioritize opportunities to utilize sustainable strategies.

Suggested submittal documentation
Provide a map or series of maps documenting findings of the site assessment. Using the site assessment guidance table in Appendix B, provide the relevant information and describe how the site design responds to information collected during the site assessment. While the site assessment guidance is provided as an outline for sites to identify sustainable strategies, not all topics apply to all sites and each site may contain additional important unique elements that are not explicitly addressed here.

Ecosystem services addressed:
Various ecosystem services can be evaluated in a site assessment.

Economic and social benefits:
A site assessment evaluates resources and opportunities that can be incorporated into site design. For instance, social gathering spaces can be sited near existing large trees to take advantage of their shade, or existing materials can be reused saving money and resources.

Technologies and strategies
Consult with local experts to evaluate existing site conditions and identify sustainable strategies prior to design.

2.2 Prerequisite Use an integrated design process

Intent
Gather experts from multiple disciplines to work together as a team to guide the design, construction, operations, and maintenance of the site.

Requirements
At the outset of the project, form an integrated design team made up of qualified professionals from multiple disciplines. This team shall follow an integrated design process, including the viewpoints and perspectives of all team members, to guide decision-making for site development and management.

Suggested submittal documentation
Provide documentation that outlines the process of integrated decision-making throughout the development of the site, with signatures and professional titles and credentials from all members of the integrated design team.

Technologies and strategies
Form a team of qualified professionals as early as possible; team members will coordinate with one another throughout the life of the project.

Ecosystem services addressed:
Various services can be preserved, restored, or enhanced through an integrated design process.

Economic and social benefits:
Innovative solutions are more likely to emerge when experts from several disciplines pool their talents and expertise. Sustainable goals and practices are easier and often less expensive to achieve when different perspectives are brought to bear on common goals.

Resources
For more information on integrated design process, see Whole Building Design Guide resources *(http://www.wbdg.org/design/engage_process.php)*.

2.3 Prerequisite Develop a program plan with site performance goals

Intent
Prior to site design, the integrated design team, client, and property owner (and community, when appropriate) will develop a program plan* to ensure that everyone is working toward common goals.

Ecosystem services addressed:
When the integrated design team and the client agree upon desired outcomes at the outset of the project, sustainable goals and practices are easier, less contentious, and often less expensive to achieve.

Requirements
Develop a program plan that includes the following four components:

1) **Integrated design team**: List team members' roles and responsibilities for the project. Outline the communications process for team members.
2) **Project principles and goals**: Identify the principles and goals** of the project. Include short- and long-term sustainability goals. It is important that the owner and entire design team commit to working together to meet the goals.
3) **Project description:** Provide general project parameters and constraints, and outline the purpose and the design intent. Diagram or describe the potential arrangement and relationship of features and approximate dimensions of the design.
4) **Stakeholders and user groups:** Identify project stakeholders and the full range of users for the site. List the primary and secondary user groups. Describe the process by which stakeholders were identified.

Suggested submittal documentation
Provide a copy of the program plan that includes the four required components in the list above. The submitted program plan must be signed by all members of the integrated design team.

Technologies and strategies
The integrated design team, the client, and the property owners, will work together as early as possible to identify the program plan and sustainability goals for the project.

NOTES TO READERS:
* The program plan provides a mechanism for clearly stating the vision and desired outcomes of the project and setting the direction of the design team.
** In this context, principles and goals are defined as follows: principle—guiding overarching concept; goal—observable and measurable end result having one or more objectives to be achieved within a more or less fixed time frame.

2.4 Credit Engage users and other stakeholders in meaningful participation in site design

Intent
Encourage stakeholders (e.g., site users, interest groups, and nearby residential and commercial neighbors) to participate in the site design process to supplement professional expertise with local knowledge and needs.

Requirements
- Positively engage a diverse group of site users and stakeholders early in the design process. Provide multiple opportunities for participation, including informal methods. Communicate a range of design alternatives and their associated outcomes using visual representations (e.g., sketches, models, or photosimulations).
- Document feedback from stakeholders, and outline the needs of various groups.
- Give participants opportunities to provide feedback on the process.
- Demonstrate how feedback was incorporated into site design, or illustrate why it was not incorporated.
- **Note:** *Engaging local groups during the design phase of the project may help identify particular needs on-site and incorporate responses to them. This effort may help achieve additional credits such as "Promote equitable site design, construction, and use" and "Provide outdoor spaces for social interaction."*

Suggested submittal documentation
Provide a narrative describing opportunities for site users and stakeholders to participate. Describe how site users and stakeholders were identified and recruited to participate. Provide copies of the design alternatives and associated outcomes shared with the user groups. Describe and summarize the feedback and needs of stakeholder groups. For each of the major recommendations from stakeholders, describe how site design reflects stakeholder feedback, or if feedback was not incorporated, describe the reasons.

Ecosystem services addressed:
Various services can be addressed during the community participation process. Local knowledge may help provide a better understanding of the site conditions and its surroundings.

Economic and social benefits:
Users and other stakeholders can contribute ideas resulting in designs that better serve the people most affected by the site, maximizing benefits and minimizing adverse effects. Involving the public in such decision-making builds social ties among neighbors and trust between the community and planning organizations.[7 8 9 10] Public participation enhances stewardship, sense of place, and feelings of ownership for site users, providing shared expectations for the project's results. Public input often results in innovations that enhance community economic development.[11]

Technologies and strategies*
Solicit input and feedback in imaginative and flexible ways, such as surveys, visual preference questionnaires, field visits and tours, workshops, GIS modeling and mapping, and facilitated, interactive exercises. Engage a wide variety of community members by providing food, child care, transportation, mediators, interpreters, and written translations during public meetings. Take meetings to people at churches, community development centers, and other local social gathering places. Also use web-based approaches to garner more widespread public participation.

NOTES TO READERS:
* Are these technologies and strategies appropriate for both large- and small-scale sites? What techniques should be included that are specifically applicable for smaller sites?

Resources

For additional information on identifying, engaging, and planning with the community, see Project for Public Spaces resources *(http://www.pps.org/parks_plazas_squares/info/community)* and the National Charrette Institute *(http://www.charretteinstitute.org)*.

Other references include H Sanoff, *Community Participation Methods in Design and Planning* (1999), B Lennertz and A Lutzenhiser, *The Charrette Handbook* (2006), C Schively, *Enhancing Transportation: The Effects of Public Involvement in Planning and Design Processes* (2007), and RT Hester, Jr., *Community Design Primer* (1990).

3.1 Prerequisite Control and manage invasive species

Intent
Develop and implement an active management plan for control and removal of invasive species to limit damage to local ecosystems.

Requirements
Develop and implement an active management plan for control and removal of any species currently listed on any of the following lists as invasive: State Noxious Weeds laws, Federal Noxious Weeds laws, or regional lists (when listing occurs through a vetted, transparent process and has been accepted by the regional stakeholders).

Suggested submittal documentation
The site assessment will document locations and species of invasive plants (as listed by federal, state, and regional entities). Refer to documentation from the landscape maintenance plan *(see 7.1 Prerequisite)* that describes the plan to address invasive species on-site; the plan should include initial treatment, follow-up treatments, long-term control including monitoring, and methods to dispose of invasive plant materials on-site to prevent spread. The plan should also include a procedure for identifying and monitoring for new invasive species as they are recognized by local authorities.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Invasive species compete with and harm plant and animal communities. Some 5,000 plant species have escaped into natural ecosystems, resulting in millions of dollars in control costs.[12]

Technologies and strategies
Contact local and regional governmental agencies, consultants, and educational facilities as resources for the most appropriate and effective management techniques for invasive species identified on-site.

Resources
- For help identifying invasive plants in your area, see USDA Natural Resources Conservation Service's web page *(http://plants.usda.gov/)*, specifically the page on invasive and noxious weeds *(http://plants.usda.gov/java/noxiousDriver)*.
- Another good sources is the Plant Conservation Alliance (PCA) website *(http://www.nps.gov/plants/alien/factmain.htm#pllists)*.
- For additional links, management tools, etc., see The Nature Conservancy's Global Invasive Species Team *(http://tncweeds.ucdavis.edu/index.html)*, including the Weed Control Methods Handbook *(http://tncweeds.ucdavis.edu/ handbook.html)*.

3.2 Prerequisite Use appropriate, non-invasive plants

Intent

Use native and non-native plants adapted to site conditions, climate, and design intent to support biodiversity, reduced pesticide use, and water conservation. Use only non-invasive plants that are nursery grown, legally harvested, or salvaged for reuse from on- or off-site.

Requirements

- Use only native and non-native appropriate plant species.
- Use only species that are not currently listed on any of the following lists as invasive: State Noxious Weeds laws, Federal Noxious Weeds laws, or regional lists (when listing occurs through a vetted, transparent process and has been accepted by regional stakeholders).
- Use only plants that are nursery grown, legally harvested, or salvaged for reuse from on- or off site.

Suggested submittal documentation

Provide species lists of plants, including scientific names, that will remain on-site and those that will be brought to the site. Document how the plants used are adapted to site conditions and meet the program needs and design intent of the site. Attach federal, state, and regional lists (e.g., from a regional Invasive Plant Council) of invasive plants to confirm that no plant on these lists currently exists on-site and none will be brought to the site. Show that the list includes no species listed in Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Provide documents to demonstrate that all plant materials were lawfully collected by a state-licensed plant collector.

Technologies and strategies

Select plants that will thrive in the climate and conditions of the site, avoiding invasive species that may jeopardize local ecosystems. Contact local and regional governmental agencies, consultants, educational facilities, and native plant societies as resources for the selection of plants appropriate for the site.

Ecosystem services addressed:

- Global climate regulation
- Air and water cleansing
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:

Native and non-native plants adapted to site conditions and climate need fewer resources and less maintenance. Plants that are sited correctly should need little to no irrigation once established.

Invasive species compete with and harm plant and animal communities. Approximately 5,000 plant species have escaped into natural ecosystems, resulting in millions of dollars in control costs. For example, purple loosestrife (*Lythrum salicaria*), an invasive herbaceous species introduced as an ornamental plant in the United States, has aggressively spread to 48 states, resulting in control costs of almost $45 million per year nationwide.[13]

Illegal harvesting can reduce both the numbers and genetic diversity of wild plant populations, threatening their survival. Illegal harvesting of wild plants also harms ecosystems, through damage during collection and by removal of species upon which natural communities depend.

Resources

- For information on native and appropriate plants, see North American Native Plant Society (*http://www.nanps.org*).
- For information on invasive species, see regional and local sources as well as national sources such as National Invasive Species Information Center (*http://www.invasivespeciesinfo.gov/*) or National Invasive Species Council (*http://www.invasivespecies.gov/*).
- For information on Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), see *http://www.aphis.usda.gov/publications/plant_health/content/printable_version/fs_cites3-06.pdf* and *http://www.cites.org/eng/ app/appendices.shtml*.

3.3 Prerequisite Preserve special status trees

Intent
Identify and preserve trees designated as important by local, state, or federal entities; designations may be for tree size, species, age, historic significance, ecological value, aesthetics, location, or other unique characteristics.

Requirements
Designate appropriate "no-disturbance zones" to protect special status trees.

Suggested submittal documentation
The site assessment will document locations of trees that may qualify as special status trees. If special status trees exist on-site, describe protection measures and provide site plans to show the extent of the "no-disturbance zone."

Technologies and strategies
Consult with local tree experts to determine appropriate protection measures, and design the site to minimize harm to special status trees.

Resources
See resources such as *http://www.isa-arbor.com/publications/tree-ord/heritage.aspx* to identify heritage, historic, or landmark trees.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Pollination
- Habitat functions
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Mature trees are significant community resources because of their cultural, aesthetic, or historic relevance. Special status trees may be deemed important because they are associated with a significant historic event or place, are located in a place that provides critical functions (such as soil stability along a stream), or are species that are relatively rare in an area.[14]

3.4 Prerequisite Reduce potable water consumption for irrigation

Intent

Reduce the use of potable water, or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation after installation.

Requirements

- Reduce potable water consumption for irrigation after the establishment phase by 50 percent from a calculated midsummer baseline case. Install flow meters to record and monitor water use in the irrigated areas. Reductions shall be attributed to any combination of the following items:
  - Plant species factor
  - Irrigation efficiency
  - Use of captured rainwater
  - Use of recycled graywater or wastewater
  - Use of water treated and conveyed by a public agency specifically for non-potable uses.
- To calculate the percent reduction in potable water use for this credit, establish a baseline water use rate for your project and then calculate the as-designed water use rate according to the steps outlined in LEED NC WE Credit 1 *(see http://www.usgbc.org/ShowFile.aspx? DocumentID=1095 for LEED NC Rating System v2.2)*.
- **Note:** *Water used during establishment phase is exempt from total site irrigation calculations. The maximum establishment phase is considered three years for trees, two years for shrubs, and one year for herbaceous cover.*
- **Note:** *Water used to irrigate community vegetable gardens is exempt from total site irrigation calculations. Irrigation used on edible plants should not harm human health.*
- **Note:** *Irrigating with potable water only during the establishment period or using only non-potable water sources for irrigation will further reduce usage of potable water. See the "Minimize or eliminate potable water consumption for irrigation" credit for more information.*

Ecosystem services addressed:

- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation

Economic and social benefits:

In the United States, landscape irrigation uses more than 7 billion gallons per day. For the average family of four, approximately 30 percent of the water used daily is devoted to outdoor uses such as watering lawns and gardens,[15] while in drier parts of the country, landscape irrigation can account for an even greater proportion of potable water use—65 percent in Utah, for example.[16]

Typically, half of irrigation water can be wasted as a result of evaporation, wind, improper system design, and overwatering.[17] Selecting efficient irrigation systems, planting vegetation appropriate for site conditions and climate, and using captured rainwater or graywater can reduce water waste and conserve sources of potable water.

Suggested submittal documentation

Using the LEED NC WE Credit 1 equations and worksheets, provide the calculations for the project's calculated baseline total water applied (TWA) and design case TWA in gallons. Include the total non-potable water supply (in gallons) available for irrigation purposes. Provide a narrative describing the landscaping and irrigation design strategies employed by the project. Describe the methodology used to determine that site water use will not exceed the allowable volume for irrigation. For projects using non-potable water, include specific information regarding source and available quantity of non-potable supplies.

Technologies and strategies

Using low-water-demand vegetation; high-efficiency equipment and/or climate-based controllers for irrigation systems; and graywater, captured rainwater, and/or condensate water for irrigation can decrease potable water use for irrigation as well as create a net benefit to the local watershed by making the landscape part of the natural water-treatment process.

Resources

- For more information on efficient irrigation products, refer to the Irrigation Association (*http://www.irrigation.org*).
- For more information on water-efficient landscaping, see resources such as the U.S. Environmental Protection Agency's publication Water-efficient Landscaping: Preventing Pollution and Using Resources Wisely (*http://www.epa.gov/npdes/pubs/waterefficiency.pdf*).
- For more information on collecting and reusing rainwater and graywater, see American Rainwater Catchment Systems Association (*http://www.arcsa.org*).

3.5 Credit Minimize or eliminate potable water consumption for irrigation

Intent
Limit or eliminate the use of potable water, or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation

Economic and social benefits:
Municipal water- and wastewater-treatment facilities account for up to 50 percent of the electricity consumed by cities in the United States.[18] Because a substantial portion of municipal energy demand is used to pump, clean, and process water, a site reduces energy consumption by reducing potable water demand. Reducing water waste and potable water use also reduces utility costs for water pumping and water treatment.

Requirements
- **Low point value:** Reduce potable water consumption for irrigation after the establishment phase* by 70 percent from a calculated midsummer baseline case.** Install flow meters to record and monitor the water use in the irrigated areas. To calculate the percent reduction in potable water use for this credit, establish a baseline water-use rate for your project and then calculate the as-designed water-use rate according to the steps outlined in LEED NC WE Credit 1 *(see http://www.usgbc.org/ShowFile.aspx?DocumentID=1095 for LEED NC Rating System v2.2)*.
- **Mid-point value:** Use no potable water for landscape irrigation beyond the establishment phase. During the plant establishment phase, temporary irrigation systems that use potable water may be used only if they are removed or disconnected within three years of installation for trees, two years for shrubs, and one year for herbaceous cover. After the establishment phase, use only captured rainwater, recycled wastewater, recycled graywater, air-conditioner condensate, or water treated and conveyed by a public agency specifically for non-potable uses.
- **High point value:** Use no potable water for landscape irrigation both during and after the establishment phase. Use only captured rainwater, recycled wastewater, recycled graywater, air conditioner condensate, or water treated and conveyed by a public agency specifically for non-potable uses.
- **Note:** *Water volume used to irrigate community vegetable gardens is exempt from total site irrigation calculations*.

Suggested submittal documentation
Provide a narrative document describing the landscaping and irrigation design strategies employed by the project. For the lowest point value, describe the methodology used to determine that site water use will not exceed the allowable volume for irrigation and provide calculations demonstrating reduction from baseline case, using LEED NC WE Credit 1 equations and worksheets. For projects using non-potable water, include specific information regarding source and available quantity of non-potable supplies. For projects using temporary irrigation systems, describe the type of irrigation system used and the process for decommissioning the system at the end of the specified establishment period.

NOTES TO READERS:
* For the purposes of this report, the maximum establishment phase is considered three years for trees, two years for shrubs, and one year for herbaceous cover.

** Question: Is a 70 percent reduction reasonable for a low point value? Is this goal too difficult or too easy?

Technologies and strategies

Use low-water-demand vegetation, high-efficiency equipment and/or climate-based controllers for irrigation systems, and graywater, captured rainwater, and/or condensate water for irrigation.

Resources

- For more information on efficient irrigation products, refer to the Irrigation Association (*http://www.irrigation.org*).
- For more information on water-efficient landscaping, see resources such as the U.S. Environmental Protection Agency's publication Water-efficient Landscaping: Preventing Pollution and Using Resources Wisely (*http://www.epa.gov/npdes/pubs/waterefficiency.pdf*).
- For more information on collecting and reusing rainwater and graywater, see American Rainwater Catchment Systems Association (*http://www.arcsa.org*).

3.6 Credit Preserve and restore plant biomass on-site

Intent
Maintain or increase vegetative biomass to enhance the ecosystem service benefits provided by vegetation on-site.

Requirements
Determine the biomass density index (BDI) for initial and planned conditions for the site, using the guidelines below. BDI can be thought of as the density of plant layers covering the ground. The calculations are summarized in the Site Biomass Density Index Calculation Worksheet *(see Appendix C)*.

- **Determine initial BDI:** For the existing site, use information gathered during the site assessment to map and calculate the percent area of the distinct zones of land cover or vegetation types on-site from the following eight categories.* All vegetation or land cover zones should fall into only one category and should not overlap.
  - Trees with understory = 5
  - Trees without understory (less than 10 percent herbaceous/shrub cover) = 4
  - Shrubs = 2
  - Herbaceous annuals and perennials, and/or succulents = 2
  - Tall grasslands = 2
  - Turfgrass = 1
  - Green roof = 0.5
  - Impervious cover or bare ground not shaded by vegetation or vegetated structures = 0
- **Determine planned BDI:** For the site at 10 years following landscape installation, use site design and planting plans to map and calculate the percent area of distinct zones of land cover or vegetation types from the eight categories listed above. All vegetation or land cover zones should fall into only one category and should not overlap.
- **Appendix C:** Use the table in the Site Biomass Density Index Calculation Worksheet to calculate the initial and planned BDI values of the site.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Vegetation on a site is associated with increased benefits such as pollutant interception, water absorption, greenhouse gas regulation, and microclimate regulation. The benefits provided by vegetation are tied to plant processes, including photo-synthesis, evapotranspiration, respiration, and mineral up-take from the air and ground. The degree to which these processes occur depends on the amount of green matter on a site.

NOTES TO READERS:
* These BDI values are estimated from mean leaf area index values summarized by biome/cover type in JMO Scurlock, GP Asner, and ST Gower, *Worldwide historical estimates of leaf area index, 1932-2000* (Oak Ridge, TN: Oak Ridge National Laboratory, 2001). Do these BDI values seem reasonable for vegetation cover types? Please provide references to help improve these values.

- **Determine the target BDI**:** Use the cover type of natural, historic, undeveloped ecosystems of the region (large sites may refer to multiple cover types). Target BDI values for selected cover types are listed below:
  - Wetlands = 6
  - Temperate forest = 5
  - Tropical forest = 4
  - Grassland = 2.5
  - Shrublands = 2
  - Desert = 1
- **Appendix D:** Determine point values with the lookup tables in Appendix D. Values vary by target BDI.

Suggested submittal documentation

Provide calculations of the composite initial and planned BDI, as calculated using the guidelines above, and provide a site map or aerial photograph to demonstrate initial and final site conditions. Describe the strategies used to improve plant biomass toward the target BDI. Some land cover or vegetation types may not correlate with the guidelines for calculating composite BDI above. If this is the case, make an argument for a different method of choosing a BDI value, including references that are published through a vetted, transparent process and that have been accepted by the regional stakeholders.

Technologies and strategies

On greenfield sites, carefully design the site to minimize disruption to existing appropriate vegetation. Use trees, green roofs, or vegetated structures (e.g., trellises) to cover non-vegetated surfaces such as walkways, roofs, or parking lots, and select vegetation-based methods to achieve stormwater management goals for the site. To support healthy vegetation, provide adequate soil volume*** to sustain root development.

Resources

See GP Asner, JMO Scurlock, and JA Hicke, "Global synthesis of leaf area index observations: Implications for ecological and remote sensing studies," *Global Ecology & Biogeography*12 (2003): pp. 191-205.

NOTES TO READERS:

** These BDI values are based on mean leaf area index for approximately 1,000 historical estimates of LAI summarized by biome/cover type in JMO Scurlock, GP Asner, and ST Gower, *Worldwide historical estimates of leaf area index, 1932-2000* (Oak Ridge, TN: Oak Ridge National Laboratory, 2001). Do these target BDI values seem reasonable for your region? Future drafts of this report will include target BDI values that are more regionally specific. Please provide references or suggestions to help a site determine its target BDI based on regional characteristics.

*** For trees, provide at least 2 cubic feet of plant-usable rooting soil for each square foot of mature tree canopy, with a minimum depth of 2 feet and a maximum depth of 4 feet. Mature tree canopy is defined as at least 60 percent of the optimal tree canopy predicted by plant references. Structural soils can be used to achieve soil volume requirements.

3.7 Credit Minimize building heating and cooling requirements with vegetation

Intent
Place vegetation or vegetated structures in strategic locations around buildings to reduce energy consumption and costs associated with indoor climate control.

Requirements*
Cooling benefits options:
- **Low point value:** Use vegetation or vegetated structures to shade 30 percent of the surface area of west, southwest, southeast, and east walls and roof area within 10 years of occupancy.
- **Mid-point value:** Use vegetation or vegetated structures to shade 60 percent of the surface area of west, southwest, southeast, and east walls and roof area within 10 years of occupancy.
- **High point value:** Use vegetation or vegetated structures to shade 90 percent of the surface area of west, southwest, southeast, and east walls and roof area within 10 years of occupancy.
- **Note:** *Shade calculations are based on June 21 afternoon conditions.*
- **Note:** *Wall surfaces taller than average 20-year old trees in the region may be excluded from total calculations.*

Heating benefits options:
Use multiple evergreen trees and shrubs of various heights and densities on walls perpendicular to the prevailing wind (usually north or northwest). Design the windbreak to be longer than the building.

Suggested submittal documentation
- **Cooling options:** Provide a site plan showing the cardinal directions, building footprint, and locations of vegetation providing cooling benefits. Include a plant list with scientific names and the estimated mature size (height and width) of the vegetation providing cooling benefits. Use cross-section drawings to demonstrate the anticipated shading of specified wall and/or roof area. Provide calculations documenting that the shaded surface area requirements will be met.
- **Heating option:** Provide a site plan showing the direction of prevailing winds, building footprint, and locations of windbreak vegetation relative to the building. Include a plant list with scientific names and the estimated mature size (height and width) of the windbreak vegetation.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Vegetation provides cooling benefits through shading and evapotranspiration and helps prevent heat loss in buildings by reducing wind speed.[19] A study of street trees in New York City, for example, found that the climate moderating benefits provided by trees resulted in annual energy savings of $27.8 million, or $47.63 per tree.[20]

NOTES TO READERS:
* Tools to assess the effect of trees on actual building performance are forthcoming, and the requirements for this credit may be revised when the appropriate tools become available.

Technologies and strategies
Consult a local tree professional for information on tree placement and tree species that maximize benefits appropriate to the climate. Solar-friendly trees allow access to the sun in winter and provide shade in summer.

Resources
For additional guidance on tree placement, tree selection, and other techniques to maximize energy savings, refer to regional Community Tree Guides by the USDA Forest Service Center for Urban Forest Research at *http://www.fs.fed.us/psw/programs/cufr/tree_guides.php* and "Carbon Dioxide Reduction through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters" at *http://www.fs.fed.us/psw/programs/cufr/products/cufr_43.pdf*.

3.8 Credit Reduce urban heat island effects

Intent
Use vegetation and reflective materials to reduce heat islands and minimize effects on microclimate and on human and wildlife habitat.

Requirements (adapted from LEED-NC SS Credit 7.1)

- **Low point value:** Cover 30 percent of all non-roof site hardscape (including roads, sidewalks, courtyards, and parking lots) using any combination of the strategies below.
- **High point value:** Cover 60 percent of all non-roof site hardscape (including roads, sidewalks, courtyards, and parking lots) using any combination of the strategies below.
- **Non-roof hardscape coverage strategies:**
  - Provide shade from existing tree canopy or within five years of landscape installation; landscaping (trees) must be in place at the time of certification application.
  - Provide shade from structures fully covered by solar photovoltaic panels.
  - Provide shade from architectural devices or structures that have a solar reflectance index (SRI) of at least 29. Implement a maintenance program that ensures these surfaces are cleaned at least every two years to maintain good reflectance.
  - Use paving materials with an SRI of at least 29 and implement a maintenance program that ensures these surfaces are cleaned at least every two years to maintain good reflectance.
- **Note:** *Shade calculations are based on June 21 afternoon conditions.*
- **Note:** *Using vegetation and vegetated structures to achieve this credit may also help to simultaneously achieve credits such as "Minimize building heating and cooling requirements with vegetation."*

Suggested submittal documentation
Provide plans to show the total area of non-roof site hardscape and the total area covered by any combination of the coverage strategies, including current and anticipated shading from vegetation, solar photovoltaic panels, and coverage of materials with an SRI of at least 29.

Ecosystem services addressed:

- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Urban heat island effects can lead to increased air-conditioning costs, air pollution levels, and heat-related illness and mortality.[21] Use of vegetation, shade structures, and other techniques to cool the air can reduce costs associated with urban heat islands. Vegetation provides cooling through shading and evapotranspiration. Evapotranspiration alone can reduce peak summer temperatures by 2 to 9 degrees F.[22]

Shade trees planted in parking lots reduce evaporative emissions of volatile organic compounds (VOCs)—precursors to ground-level ozone—from parked cars.[23] Heat islands may provide winter benefits in colder climates, but these are often outweighed by harmful effects during the summer. Most heat island-reduction strategies can reduce summertime heat islands and still retain wintertime benefits.[24]

Technologies and strategies

Select strategies, materials, and landscaping techniques that reduce heat absorption. Use shade from native or adapted trees and large shrubs, vegetated trellises, or other exterior structures supporting vegetation. Consider the use of new coatings and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop. Position photovoltaic cells to shade impervious surfaces.

Resources

For more information on strategies to minimize heat island effects, see resources available at Lawrence Berkeley National Laboratory *(http://heatisland.lbl.gov/)* and U.S. Environmental Protection Agency *(http://www.epa.gov/hiri/)*.

3.9 Credit Promote a sense of place with native vegetation

Intent
Maintain or restore plants native to the ecosystems of the site to promote a regional identity and sense of place.

Requirements
- **Low point value:** Protect or restore 50 percent of planted areas with native vegetation.
- **Mid-point value:** Protect or restore 75 percent of planted areas with native vegetation.
- **High point value:** Protect or restore 90 percent of planted areas with native vegetation.

Suggested submittal documentation
Provide a planting plan of the total vegetated area with an associated plant list including scientific plant names. On the plant list, highlight the native vegetation. Calculate and provide the total vegetated area and the total area covered by native plants.

Technologies and strategies
For greenfield sites, design the site to minimize effects on existing healthy native vegetation. Contact local and regional governmental agencies, consultants, educational facilities, and native plant societies as resources for the selection of native plants appropriate for the site.

Resources
For more information about landscaping with native plants, see U.S. EPA's green landscaping resources page at *http://www.epa.gov/greenacres/index.html*, including the Native Plants Factsheet at *http://www.epa.gov/greenacres/nativeplants/factsht.html*.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Native plants can be used to establish a strong sense of place, foster stewardship, and educate people about their natural heritage.[25] Once established, native plants can save time and money by reducing maintenance and resource requirements.[26]

3.10 Credit Preserve and restore native wildlife habitat

Intent
Maintain or restore the plant species, composition, and structure of native ecosystems to provide habitat and promote biodiversity.

Requirements
Low point value:
- **Option 1:** Protect or restore native plants to provide habitat for species of concern within your region as identified by state Wildlife Action Plans, state wildlife agencies, or federal wildlife agencies.
  OR
- **Option 2:** Protect or restore native plants to provide habitat corridors connecting to off-site natural areas, buffers adjacent to off-site natural areas, or refugia for migrating wildlife. This option applies to habitat for species of concern within your region as identified by state Wildlife Action Plans, state wildlife agencies, or federal wildlife agencies.

- **Mid-point value:** Achieve both Option 1 AND Option 2 above.
- **High point value:** Achieve both Option 1 AND Option 2 above AND conduct monitoring surveys to document the presence of wildlife species of concern on-site.
- **Note:** *Protected and restored vegetation must be native and associated with habitat for the selected species of concern. Refer to adjacent or nearby habitats and peer-reviewed references to determine whether plant species on-site are known to provide habitat for the selected species of concern.*
- **Note:** *Protected and restored habitat areas must be fenced off and protected from parked construction vehicles and material storage. Do not develop new buildings or new impervious surfaces in designated habitat areas.*
- **Note:** *Monitoring surveys for the high point value may be conducted in the future for additional credit after project completion.*

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Habitat supports important wildlife such as pollinator species (e.g., insects, birds, and bats) that are necessary for plant reproduction, including cultivation of crops. Up to 80 percent of the world's food plant species are dependent on pollination by animals.[27] Wildlife habitat also supports recreational and ecotourism activities, such as fishing and birdwatching, and opportunities for environmental education.[28]

Suggested submittal documentation
- **Option 1:** Provide a list of maintained and restored vegetation species, including scientific names, and the wildlife species of concern for which habitat on-site exists. Provide peer-reviewed references or vegetation surveys from known habitats to demonstrate that plant species on-site are known to provide habitat for the selected species of concern.
- **Option 2:** Provide maps to show connections to off-site habitats and a list of wildlife species expected to utilize the connection. Provide peer-reviewed references or vegetation surveys from known habitats to demonstrate that plant species on-site are known to provide habitat for the selected species of concern.
- For monitoring surveys, provide documentation to describe when surveys were conducted and how presence of the species of concern on-site was verified.

Technologies and strategies

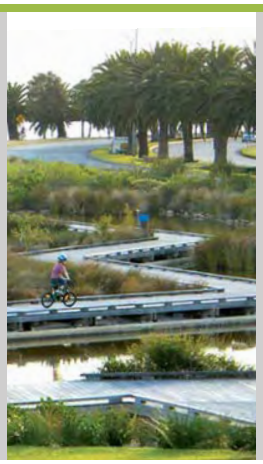
For greenfield sites, design the site to minimize damage to habitat for species of concern, especially those habitat areas that provide opportunities for connectivity. For previously developed sites, contact local and regional governmental agencies, consultants, educational facilities, and native plant societies as resources for the selection of native plants that are associated with habitat for the selected species of concern.

Resources

For more information on state Wildlife Action Plans, see *http://www.wildlifeactionplans.org/about/index.html*.

POINT FRASER:
A Cost-Effective Wetland Renewal

Point Fraser is an important landmark on the banks of the Swan River that flows through the City of Perth in Western Australia. In 2003, the city began a major rehabilitation of the site to treat stormwater runoff, re-create a natural habitat, stabilize the shoreline, and encourage public access. Phase I of the project—re-establishing a viable wetland—was completed in 2005.



Public access through restored habitats

Habitat restoration of a former brownfield

Treating stormwater with parking lot vegetation

Syrinx Environmental PL: Point Fraser Development (Western Australia)

SIZE/TYPE OF PROJECT
15.14 acres/brownfield redevelopment

SITE CONTEXT
Perth is in Australia's Southwest Botanical Province ecoregion. The climate is Mediterranean, with hot dry summers and cool wet winters. The site is situated on a previously reclaimed tidal river flat that had been used as a parking lot and helicopter pad. Prior to redevelopment, the brownfield site, separated from the water by a hard wall, had minimal habitat value and effectively blocked access to the river from the downtown area.

ISSUES/CONSTRAINTS OF THE SITE
- Earlier reclamation projects had filled in the wetland and replaced native species with turf and non-indigenous plantings.
- The soil suffered from acid sulphate contamination that produced sulfuric acid when exposed to oxygen, releasing toxic quantities of heavy metals.
- Stormwater from the adjacent business district carried contaminants and nutrients directly into the river, contributing to algal problems.
- The site's high visibility and social importance required that the project design be subtle yet also encourage visitors' maximum experiential engagement with the surroundings.

FEATURED SUSTAINABLE PRACTICES
Riparian and habitat restoration: The redevelopment included riparian restoration and the re-establishment of resilient and diverse native habitats. Areas subject to high wave impacts were re-graded and planted with indigenous vegetation. Areas with lower wave impacts and existing riparian vegetation were stabilized with jute matting and infill planting.

Soil protection and remediation: Acid sulfate contamination was treated and removed through the construction of temporary limestone storage pads and dewatering ponds. Soil was protected from disturbance using low impact construction methods to sink potential acid material below the water table.

Stormwater management: Off-site and on-site stormwater that previously flowed directly into the Swan River is now processed passively via a series of innovative wetlands, vegetated swales, and pervious walling.

CONSTRUCTION COSTS
- The wetland habitat uses soft engineering techniques instead of conventional hard-walling practices. Brush mattressing and jute matting controlled erosion until vegetation could stabilize the area. These techniques reduced costs for shoreline stabilization by 84 percent.
- Raised and tilted planes were used to address areas with poor drainage, acid sulfate contamination, and high water tables. These features were created reusing existing fill, significantly reducing disposal costs.
- The completed cost of the wetland was AUD $450,000 (USD $433,617), just 5 percent of the project's overall cost.

MONITORING
Water quality improvement: Monitoring since 2004 shows progressive improvement in the wetland water quality; no events of elevated heavy metals have been recorded, nitrogen levels are consistently below algal trigger levels for the Swan River, and total phosphorus results leaving the wetland are below target levels.

Habitat performance monitoring: Prolific flowering and seeding of the installed plants suggests that natural recruitment is likely to be high in future years. A total of 14 different macro-invertebrate groups were identified during monitoring. Five of these are considered sensitive to disturbance and their presence indicates a healthy environment with good habitat development.

LESSONS LEARNED
- Riverbank restoration should have been scheduled to take advantage of seasonal lower water levels.
- A two-year maintenance period on sensitive sites is optimal to ensure the best establishment of re-introduced native species.

3.11 Credit Protect and restore riparian and wetland buffers

Intent
Preserve and enhance riparian and wetland buffers to improve flood control and water-quality services, stabilize soils to control erosion, and provide habitat function.

Requirements
First, determine the average existing buffer width (Class A through E) for streams and wetlands using Table 5-2 below. Preserve and restore buffer protection zones according to the following requirements.

For sites with existing buffer classes A, B, OR C:
- **Low point value:** Preserve and restore to improve buffer width by one class *(see Table 5-2 below)* OR to 100 feet.
- **Mid-point value:** Preserve and restore to improve buffer width by two classes *(see Table 5-2 below)* OR to 200 feet.
- **High point value:** Preserve and restore to improve buffer width by three classes *(see Table 5-2 below)* OR to 300 feet.

For sites with existing buffer classes D OR E:
- **Mid-point value:** Preserve (and restore, if necessary) a buffer width of 200 feet.
- **High point value:** Preserve (and restore, if necessary) a buffer width of 300 feet.
- **Note:** *The average width of the buffer protection zone will meet the requirements specified above. Average buffer width can be calculated using perpendicular transects every 50 feet along a water body. For sites with existing development or paved areas, determine average buffer width to edge of impervious surface.*
- **Note:** *Buffer widths for rivers, streams, and tributaries are measured on each side of the stream from the top of each stream bank for third-order or higher streams, or from the stream centerline for second-order or lower streams.*[29]

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Improved water quality as a result of riparian buffers can increase property values of waterside properties by up to 15 percent,[31] provide increased recreational opportunities (such as fishing and swimming), and improve fisheries.

TABLE 5-2 SITE BUFFER WIDTH CLASSES
As buffer width increases, improved riparian functions are gained.[30]

Class	Total buffer width	Additional functions gained at specified buffer width
A	< 50 feet	Minimal protection of streams and wetlands
B	50-99 feet	Protection from human disturbance, protection of aquatic habitat
C	100-199 feet	Protection of water quality
D	200-300 feet	Protection of wildlife habitat
E	> 300 feet	Protection of wildlife migration corridors and habitat for threatened, endangered, and sensitive species

- **Note:** *Buffer widths for wetlands are measured from the edge of the delineated wetland (as defined by the U.S. Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands).*
- **Note:** *For sites that require restoration, use the Riparian and Wetland Buffer Function Assessment Worksheet in Appendix A for the existing site buffer to identify restoration opportunities and help develop a restoration plan. A restoration plan should outline ways to restore the ability of buffers to: 1) minimize property damage from flooding and provide water quality services, 2) stabilize soils to control erosion, and 3) provide habitat function.*

Suggested submittal documentation

- Provide contour maps showing boundaries of the existing buffer and buffer areas that will be preserved or restored. On the contour map, show locations of new and existing development and impervious surfaces. Describe how buffer protection zones will be protected during construction (e.g., high visibility construction fencing or silt fencing if buffer protection zone is downslope of construction).
- Provide a description of the restoration plan and of how the restoration opportunities identified in the Riparian and Wetland Buffer Function Assessment Worksheet *(see Appendix A)* will be addressed.
- Provide a narrative description of any special circumstances or non-standard compliance paths taken by the project.

Technologies and strategies

Design the site to avoid disturbance and development near streams and wetlands. Contact local and regional governmental agencies, consultants, and educational facilities as resources for the most appropriate and effective restoration techniques and vegetation for the site. Plant appropriate native vegetation, re-grade soils where necessary, and use soft engineering techniques to restore the functions of riparian and wetland buffers.

Resources

- For guidance on protecting riparian and/or wetland buffers during construction, see local sediment and erosion control regulations. If no local guidance is available, refer to the resources at Delaware's Sediment and Stormwater Management Program at *http://www.swc.dnrec.delaware.gov/Pages/SedimentStormwater.aspx* or Stormwater Management Manual for Western Washington (2005) at *http://www.ecy.wa.gov/biblio/0510030.html*.
- For guidance on restoring riparian and/or wetland buffers, see Federal Interagency Stream Restoration Working Group, "Stream Corridor Restoration: Principles, Processes, and Practices (1998)," *http://www.nrcs.usda.gov/Technical/stream_restoration* and Center for Watershed Protection resources (including T Schueler, "The architecture of urban stream buffers," *Watershed Protection Techniques* 1 (1995): pp. 159-163) at *http://www.cwp.org*.
- For guidance on delineating wetlands, see U.S. Army Corps of Engineers resources at *www.usace.army.mil/cw/cecwo/reg/rw-bro.htm*.

3.12 Credit Repair or restore damaged or lost streams, wetlands, and coastal habitats

Intent
Restore streams, wetlands, or coastal habitats that have been buried, piped, drained, channelized, or otherwise degraded to improve water quality, provide habitat, and enhance recreational and educational opportunities.

Requirements
- **Low point value:**
  - **Option 1:** Restore 30 percent of the full length of a stream channel within the property boundary to a stable channel meander.
    OR
  - **Option 2:** Restore 30 percent of the full area of an existing degraded or lost wetland or coastal habitat.
- **Mid-point value:**
  - **Option 1:** Restore 60 percent of the full length of a stream channel within the property boundary to a stable channel meander.
    OR
  - **Option 2:** Restore the 60 percent of the full area of an existing degraded or lost wetland or coastal habitat.
- **High point value:**
  - **Option 1:** Restore the full length of a stream channel within the property boundary to a stable channel meander.
    OR
  - **Option 2:** Restore the full area of an existing degraded or lost wetland or coastal habitat.
- **Note:** *Restored stream, wetland, or coastal area should provide habitat for wildlife with appropriate riparian vegetation and facilitate infiltration and interflow.*
- **Note:** *Restoration of riparian function associated with this credit may help achieve additional credits such as the "Protect and restore riparian and wetland buffers" credit.*

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Restoring streams, wetlands, and coastal habitats can improve water quality, provide educational and recreational opportunities, and revitalize neighborhoods.[32] The water quality benefits of restored habitats can provide recreational opportunities and improved fisheries.

Suggested submittal documentation
Provide documentation to show the historic width, alignment, or extent of the stream, wetland, or coastal habitat (e.g., aerial photographs or maps of the historic location). Provide documentation to show the existing conditions and dimensions of the habitat to be restored. Provide a description of the restoration plan, including dimensions of the area to be restored and the species of maintained and restored vegetation on-site, and describe how the functions of the stream, wetland, or coastal habitat will be restored.

Technologies or strategies

Identify degraded or historic streams, wetlands, or coastal habitats on-site that could be restored and incorporated into site design. Contact local and regional governmental agencies, consultants, and educational facilities as resources for the most appropriate and effective restoration techniques and vegetation for the site. Restoration may include planting appropriate native vegetation, re-grading, and soft engineering techniques to restore habitat functions.

Resources

- For guidance on wetland repair and restoration, see Federal Interagency Workgroup on Wetland Restoration, "An Introduction to Wetland Restoration, Creation, and Enhancement (2003)" at *http://www.epa.gov/owow/wetlands/restore/finalinfo.html*.
- For guidance on restoring stream corridors, see USDA NRCS *Stream Restoration Design Handbook* (2007) at *http://directives.sc. egov.usda.gov/viewerFS.aspx?id=3491*.
- For guidance on restoring coastal habitats, see NOAA Restoration Center resources at *http://www.nmfs.noaa.gov/ habitat/restoration/*.

3.13 Credit Preserve existing healthy soils

Intent
Protect healthy soils from disturbance to support healthy plants, biological communities, and water storage and infiltration.

Requirements
- **Low point value:** Preserve intact and undisturbed 30 percent of existing healthy soils.
- **Mid-point value:** Preserve intact and undisturbed 60 percent of existing healthy soils.
- **High point value:**
  - **Option 1:** Preserve intact and undisturbed 90 percent of existing healthy soils.
    OR
  - **Option 2:** Limit soil displacement and disturbance solely to areas that were already previously disturbed.
- **Note:** *Preserved percentages are measured by surface area.*
- **Note:** *Preserved soils areas must be designated as soil protection zones.*

Suggested submittal documentation
Provide information from the soils management plan *(see 6.1 Prerequisite)* showing the total area of existing healthy soils on-site. Provide calculations to demonstrate the percent surface area of healthy soils preserved intact and undisturbed. Provide plans or photographs to illustrate that the preserved soils are designated as a soil protection zone and protected from disturbance.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Waste decomposition and treatment
- Food and renewable non-food products

Economic and social benefits:
Healthy soils effectively cycle nutrients; store carbon; minimize runoff and maximize water holding capacity; absorb excess nutrients, sediments, and pollutants; provide a healthy rooting environment and habitat to a wide range of organisms; and maintain structure and aggregation. Healthy soils reduce site maintenance costs by providing improved ecosystem services and reduced use of resources.

Technologies and strategies
Limit areas of new development and soil disturbance to zones of previously disturbed soil to maximize the area of healthy soils on-site that can be preserved.

Resources
For more information on strategies to protect healthy soils, see Soils for Salmon resources at *http://www.soilsforsalmon.org/*.

3.14 Credit Preserve existing topography

Intent
Minimize grading and balance cut and fill to limit disturbance to soil horizons.

Requirements
- **Low point value:** Limit grading to 12 inches above or below existing contour and balance cut and fill in 30 percent of soils zoned for disturbance.
- **Mid-point value:** Limit grading to 12 inches above or below existing contour and balance cut and fill in 60 percent of soils zoned for disturbance.
- **High point value**: Limit grading to 12 inches above or below existing contour and balance cut and fill in 90 percent of soils zoned for disturbance.
- **Note:** *This credit is available for sites that do not require any grading.*
- **Note:** *Percentages are measured by surface area.*

Suggested submittal documentation
Provide information from the soils management plan *(see 6.1 Prerequisite)* showing the total area of all soils zoned for disturbance on-site. Provide contour maps for the existing and post-development site to show that elevation increases or decreases do not exceed 12 inches, or provide a grading plan showing that areas of cut or fill do not exceed 12 inches within the specified area (i.e., 30, 60, or 90 percent) of soils zoned for disturbance.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Waste decomposition and treatment
- Food and renewable non-food products

Economic and social benefits:
Soil horizons support the soil biological community, improve vegetative health, and play a role in the hydrologic process. Preserving soil horizons saves money by reducing the need for soil restoration and surface drainage improvements. By limiting grading, sites can also reduce costs for construction machinery and transport of imported soils.

Technologies and strategies
Design the site to preserve the existing topography. Limit the use of planting mounds or other topological forms to areas of previously disturbed soils.

3.15 Credit Restore soils disturbed by previous development

Intent
Restore soil function in areas of previously disturbed soils to rebuild soils' ability to support healthy plants, biological communities, and water storage and infiltration.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Waste decomposition and treatment
- Food and renewable non-food products

Economic and social benefits:
Addressing aspects of soil health such as compaction, organic matter, and soil biology can restore the ability of soils to provide healthy rooting environments for plants and store and infiltrate water. Soil restoration can save costs in the long run because healthy soils support healthy plant growth with less need for pesticides, fertilizers, and irrigation.[34] [35]

Requirements
Restore soils to meet the Soils Restoration Criteria *(see Appendix E)* for two of the three following categories: 1) dry bulk density or cone penetrometer reading, 2) organic matter content, and 3) soil biology.

- **Low point value:** Restore 30 percent of previously disturbed soils in all areas without buildings and paved areas.
- **Mid-point value:** Restore 60 percent of previously disturbed soils in all areas without buildings and paved areas.
- **High point value:** Restore 90 percent of previously disturbed soils in all areas without buildings and paved areas.
- **Note:** *Percentages are measured by surface area.*
- **Note:** *This credit is not intended for structural soils. For structural soils, follow manufacturer guidelines and provide adequate soil volume for plant growth. For trees, provide at least 2 cubic feet of plant-usable rooting soil for each square foot of mature tree canopy,*[33] *with a minimum depth of 2 feet and a maximum depth of 4 feet. Mature tree canopy is defined as at least 60 percent of the optimal tree canopy predicted by plant references. Structural soils can be used to achieve soil volume requirements.*
- **Note:** *Sites with highly damaged soils, such as brownfields, can achieve more points for this credit than greenfield sites.*
- **Note:** *For sites that don't have enough soil volume on-site to restore for the intended uses, sustainable options include reusing mineral/subsoil material and organic matter to create soils or purchasing soil from another site that may otherwise have gone to a landfill.**

Suggested submittal documentation
Provide information from the soils management plan *(see 6.1 Prerequisite)* to show the total area of previously disturbed soils without buildings and paved areas. Provide documentation (such as receipts from soil/compost supplier) to demonstrate that techniques to restore soil occurred. Provide soil tests** to demonstrate that the selected techniques achieved the criteria for two of the three categories above.

Technologies and strategies
Limit new disturbance, buildings, and paved areas to zones of previously disturbed soils. In zones of previously disturbed soils that will be re-vegetated, restore soil characteristics necessary to support the selected vegetation types.

NOTES TO READERS:
* Future drafts of this report will address sustainable strategies for imported soils, manufactured soils, and soil amendments.
** What testing frequency (number of tests per unit area) is reasonable? We want to demonstrate achievement of criteria without incurring excessive costs for the site.

Resources

- For more information on improving soil quality, see USDA Natural Resources Conservation Service resources *(http://soils.usda.gov/sqi/)*.
- For additional information on planning and managing soils in urban areas, see USDA Natural Resources Conservation Service resources *(http://soils.usda.gov/use/urban/)*, including the Urban Soil Primer *(http://soils.usda.gov/use/urban/primer.html)*. Also refer to the resources available at Building Soil *(http://www.buildingsoil.org/)*.

3.16 Credit Manage water on-site

Intent

Replicate the hydrology of the site (infiltration, runoff, and evapotranspiration) based on historic, natural, undeveloped ecosystems in the region to the extent practicable. The USDA NRCS (SCS) Technical Release 55 manual "Urban Hydrology for Small Watersheds" (1986) describes the process for determining a curve number (TR-55 curve number), which can be used to characterize the site's response to long-term precipitation patterns. The TR-55 curve number is based primarily on the hydrologic soils group and the land-use type.

Requirements

Determine the initial curve number and final TR-55 curve number for the site, using the TR-55 Curve Number Determination Worksheet *(see Appendix F)*.

For sites that have not been previously developed or graded:

- **High point value:** Site performs at the level of its target TR-55 curve number. The target curve number is determined for each site based on natural, historic, predevelopment hydrologic soils groups and vegetation cover types (refer to the TR-55 manual to determine the site's target curve number).
- **Note:** *Determine and document that any increased infiltration occurring on-site will not exacerbate regional ecological problems (e.g., increased infiltration in arid climates may alter historic stream types, converting ephemeral to perennial streams).*
- **Note:** *Exemplary performance points are available to sites that were previously subject to row-crop tillage.**

For sites that have been previously developed or graded (i.e., greyfields):

Target TR-55 curve numbers and point values vary by climatic zone. Determine the climatic zone** of the site (i.e., humid East Coast, humid West Coast., semiarid West, or arid Southwest.), and refer to the lookup table specific to the climatic zone in Appendix G to determine the applicable target TR-55 curve number and point values for the site.

Ecosystem services addressed:

- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Human health and well-being benefits
- Cultural benefits

Economic and social benefits:

Municipal water- and wastewater-treatment facilities account for up to 50 percent of the electricity consumed by municipal entities in the United States.[36] Capturing, treating, and reusing runoff on-site can help a site reduce its potable water consumption, leading to reduced public and private utility costs and energy expenditures for pumping, cleaning, and processing water.

Retaining water on-site also decreases discharges to storm-water management systems, which can reduce combined sewer overflow, thus minimizing effects on aquatic habitat and enhancing recreational opportunities such as fishing and birdwatching. This effort can also lead to reduced infrastructure requirements for storm-water collection and treatment.

NOTES TO READERS:

* Should exemplary performance points also be available to sites that were previously used for grazing?

** Target curve numbers may be loosely based on climatic zones.

- humid East Coast (e.g., Raleigh) – 70
- humid West Coast (e.g., Portland) – 70
- semiarid West (e.g., Denver) – 60
- arid Southwest (e.g., Los Angeles) – 85

At this time, the Initiative has data for four U.S. locations but cannot yet make generalizations across climatic zones. For future drafts of this report, data and modeling results for additional U.S. cities will be compiled to verify that generalizations can be made across climatic zones.

- **Low point value:** Achieve a 30 percent reduction in runoff flow volume from the initial curve number.
- **Mid-point value:** Achieve a 60 percent reduction in runoff flow volume from the initial curve number.
- **High point value:** Achieve a 90 percent reduction in runoff flow volume from the initial curve number.
- **Note:** *Exemplary performance points are available to sites that achieve a 100 percent reduction in runoff flow volume from the initial curve number.*
- **Note:** *The TR-55 curve numbers that correspond to these levels of reduction are summarized in the table specific to climatic zones in Appendix G.*
- **Note:** *Determine and document that any increased infiltration occurring on-site will not exacerbate regional ecological problems.*

For sites with environmental contamination (i.e., brownfield sites):
If infiltration on-site is beneficial, refer to the point values for sites that have been previously developed or graded above. Where infiltration is not desirable because of pollutant loadings, use other techniques (e.g., rainwater harvesting, green roofs, or bioretention) to reduce runoff from the site.

- **Low point value:** Achieve a 20 percent reduction in runoff flow volume.
- **Mid-point value:** Achieve a 40 percent reduction in runoff flow volume.
- **High point value:** Achieve a 60 percent reduction in runoff flow volume.
- **Note:** *The TR-55 curve numbers that correspond to these levels of reduction are summarized in the table specific to climatic zones in Appendix G.*

Notes about methodology

- Increases in impervious surfaces and development within a stream's watershed creates higher runoff volumes and flow rates. Higher flow volumes and velocities lead to erosion along the banks of the stream ("advanced streambank erosion"), thereby introducing large amounts of sediment into the water. Increases in sediment concentrations and turbidity degrade stream habitat and can be detrimental to the health of in-stream biota. Higher flow rates also can exacerbate flooding downstream and cause property damage.
- Four locations were chosen for analysis (using the U.S. EPA's Storm Water Management Model, or SWMM): Raleigh, Denver, Portland, and Los Angeles.*** For various curve number conditions, the accumulated flow volume**** was calculated for multiple intervals of stream flow rate. The results were displayed as a percentage of the peak flow rate. Peak flow rate was determined based on 1-year 24-hour storm, calculated using TR-55.
- A flow rate of 50 percent of the peak flow rate is estimated to be the threshold at which advanced streambank erosion occurs. The total volume of flow that passes a single point in a stream was calculated for conditions at or above 50 percent of the peak flow rate.
- Target curve numbers for greyfields and brownfields in the cities selected for modeling were based on natural, undeveloped soils and vegetation conditions. The target curve numbers for greyfields and brownfields were assumed to be: Raleigh—70, Denver—60, Portland—70, Los Angeles—85. The hydrologic soils group was assumed to be C for each location.
- For a given transition from an initial curve number to a final (lower) curve number, the percent difference in flow volumes was calculated using the difference between the initial curve number and the target curve number as a reference.
- For each location and each transition from initial to final curve number, the percent decrease in flow volumes was plotted. Points are awarded based on the percent decrease in flow volumes.*****

NOTES TO READERS:
*** To readers in these cities: Do the methodology and assumptions work for your region? Is this approach useful, and can it be practically applied?
**** In addition to flow volume, the number of minutes that stream flow rate fell within each interval was also calculated. However, the results were very similar for volume and stream minutes.
***** Is this approach useful, and can it be practically applied?

Suggested submittal documentation

Provide calculations of the composite initial and final curve numbers, using the guidelines in the TR-55 Curve Number Determination Worksheet *(see Appendix F)*, and provide a site map or aerial photograph to demonstrate initial and final site conditions. Describe the strategies used to improve performance toward the target curve number. Some practices may not correlate with a land-use type in the reference tables. If this is the case, make an argument for a different method of choosing the curve number.

Technologies and strategies

Consider all components of the hydrologic cycle (evapotranspiration, runoff, and infiltration) in design. Minimize impervious cover, and maximize cover of pervious or semipervious surfaces that allow water to infiltrate soil. Use soil- and vegetation-based methods, such as multilayered plantings, green roofs, or bioretention facilities, to capture, slow, and treat runoff.

Resources

- Refer to the USDA NRCS (SCS) Technical Release 55 manual "Urban Hydrology for Small Watersheds" (1986) for procedures to determine curve numbers.
- For green stormwater BMPs, refer to existing references (for example, *http://staging.greenvalues.cnt.org/citycalc/calculator.php)* to estimate the curve number for those practices.

3.17 Credit Cleanse water on-site

Intent
Treat water runoff on-site to improve downstream water quality.

Requirements
- **Low point value** Treat 70 percent of average annual runoff volume for the entire site for pollutants of concern *(see below)*.
- **Mid-point value:** Treat 80 percent of the average annual runoff volume for the entire site for pollutants of concern.
- **High point value:** Treat 90 percent or more of average annual runoff volume for the entire site for the pollutants of concern OR site performs at the level of the site's natural ecosystem curve number.
- **Additional point(s):** Site meets credit requirements using soil- and vegetation-based systems to the maximum extent practicable.
- **Note:** *Pollutants of concern may include sources of impairment for waters listed on Clean Water Act Section 303(d) lists, pollutants for which total maximum daily loads (TMDLs) have been developed, or typical urban runoff pollutants (including total suspended solids, cadmium, copper, chromium, lead, zinc, phosphorus, total nitrogen, nitrate-nitrogen, and total Kjeldahl nitrogen).*
- **Note:** *Water must pass through proven technologies to treat pollutants of concern.*
- **Note:** *Regular maintenance is required throughout the life of the project for all selected best management practices (BMPs) to ensure ongoing pollutant removal.*
- **Note:** *Meeting the requirements of the high point value for this credit can help a site achieve other credits such as the "Manage water on-site" credit.*
- **Note:** *Soil- and vegetation-based systems may help achieve this credit while simultaneously achieving credits such as "Preserve and restore plant biomass on-site," "Preserve existing healthy soils," and "Preserve existing topography."*

Ecosystem services addressed:
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Improved water quality supports recreational opportunities and fisheries resources. Water treated on-site can also lead to reduced expenditures for infrastructure and energy associated with public and private stormwater treatment. When a receiving water body does not meet water quality standards (e.g., total maximum daily loads), municipalities incur an additional cost and liability.

Suggested submittal documentation
Provide a list of site-specific pollutants of concern. Describe the treatment principles or mechanisms expected to address the pollutants of concerns (e.g., if dissolved copper is a pollutant of concern, the selected BMP is proven to treat dissolved copper). Demonstrate through peer-reviewed data that the selected BMPs are expected to reduce pollutant loadings to TMDL or other acceptable level. For new practices without proven effectiveness, provide plans for ongoing monitoring (minimum of three years) to show that the new practice is effective in removing pollutants of concern. Provide the applicable section(s) of the site maintenance plan that describe the appropriate maintenance procedures and schedules for all BMPs.

Technologies and strategies

To filter pollutants of concern, reduce impervious surfaces and direct rainwater runoff from all surfaces to soil- and vegetation-based water-treatment methods, such as vegetated swales, filter strips, bioretention facilities, wetlands, and green roofs.

Resources

For information on BMP performance, see International Stormwater BMP Database resources at *http://www.bmpdatabase.org/BMPPerformance.htm* and U.S. EPA's National Menu of Stormwater Best Management Practices at *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm*.

3.18 Credit Eliminate potable water use in ornamental or stormwater features

Intent
To conserve potable water, use only non-potable water in ornamental or stormwater features (i.e., features not intended for primary or secondary contact recreation).

Requirements
Use no potable water in water features that are designed for amenity purposes only (i.e., features not intended for primary or secondary contact recreation).

- **Note:** *Account for mosquito control in design of landscape and water features so that the feature does not provide mosquito habitat.*

Suggested submittal documentation
Provide specific information regarding the source and available supplies of non-potable water. Include calculations demonstrating that on-site water features can meet their water requirements with non-potable supplies.

Technologies and strategies
Collect and reuse non-potable water from sources such as rainwater from rooftops, air-conditioner condensate, or stormwater basins. Estimate volumes of rainwater or graywater available on-site for use in water features, and design water features that do not require additional water from potable water sources.

Ecosystem services addressed:
- Global climate regulation
- Water supply and regulation

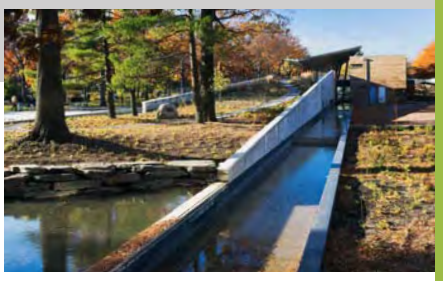
Economic and social benefits:
Using non-potable water sources, such as graywater and rainwater in water features reduces water waste and conserves potable water for higher-priority uses, such as drinking water.

This practice simultaneously decreases the volume of water directed to stormwater management systems and reduces the infrastructure, energy expenditure, and costs associated with pumping, cleaning, and processing municipal water.

QUEENS BOTANICAL GARDEN:
Treating Rainwater as a Resource, Not "Waste"

The Queens Botanical Garden in New York City wanted its Visitor and Administration Center to be a highly visible model of sustainable solutions that are effective, practical, and attractive. The completed project harvests graywater and rainfall to virtually eliminate stormwater outflow and to minimize the demand for potable water throughout the facility.

Captured stormwater in ornamental feature



Accessible, visually pleasing stormwater management areas

© Jeff Goldberg/Esto

SIZE/TYPE OF PROJECT
Approximately 4 acres of a 35-acre public botanical garden

SITE CONTEXT
Queens Botanical Garden is located in downtown Flushing in Queens, the second most densely populated borough in New York City. Saltwater marshes, freshwater wetlands, prairie, and upland pine woodlands once thrived within a very short distance of the site. Temperatures are generally mild, and average rainfall of about 46 inches is well distributed throughout the year. Contaminated portions of the site were remediated, qualifying the area as a brownfield site.

ISSUES/CONSTRAINTS OF THE SITE
- Public access and facility operations had to be maintained throughout the entire period of construction.
- Because of the site's importance to the neighborhood, close communications with the community—in multiple languages—were required to promote neighborhood participation.

FEATURED SUSTAINABLE PRACTICES
Rainwater (stormwater) treatment and reuse:
- Half of the roof is covered by a lightweight green roof.
- All other roof surfaces feed the site's rainwater harvest system.
- Harvested rainwater is cooled and cleansed with vegetation and a gravel substrate that is part of the landscape.
- Processed rainwater is stored in a cistern as the water source for the many ornamental water features.
- Overflow water is directed to a large raingarden.

Graywater reuse: Water from sinks, dishwashers, and shower is processed through a constructed wetland, where bacterial activity by selected plants treats the water naturally. It is then used for toilet flushing.

Native and adapted vegetation: Species native to New York or closely related cultivars make up the majority of plants; mature trees were preserved and integrated into the design.

Soil restoration: Nothing remains of the site's original soil structure; it is now comprised entirely of fill material (construction debris, fly ash, and other materials brought to the site over a period of about 80 years) covered with about 6 feet of imported soil. Specific soil mixes were prepared for all planted areas, and porous substrates were installed to support the efficiency of the raingarden and rain-filtering elements.

Social and educational benefits: The water creates a path that draws visitors through the building and landscape to the various garden spaces. Water conservation and reuse strategies are fully explained on multilingual touch screens in the building's lobby.

CONSTRUCTION COSTS
Because the project was managed by the City of New York and was implemented by multiple contractors working on a variety of projects, cost details are not readily available for the project.

MONITORING
Equipment has been installed on the green roof to monitor soil moisture, ambient air temperature, plant surface temperature, and growing medium temperature. A piezometer on the downstream edge of the roof captures water before it leaves the green roof. Other equipment will help to quantify the practical energy, longevity, climatic, and ecological attributes of the green roof, which can then be translated to other applications in New York.

LESSONS LEARNED
- The procurement and management process required multiple and independent contracts issued to each trade specialty. Substantial project team effort was required to outline the responsibility of each trade and to ensure cooperation among the different disciplines involved.
- Because many techniques were new to the area, some costs escalated; the permit process required long lead times and regular dialogue with authorities.

3.19 Credit Minimize use of potable water in water features designed for full human contact

Intent
To conserve potable water, use non-potable water in water features designed for primary or secondary contact recreation.

Requirements
- **Low point value:** Use non-potable water for at least 50 percent of water consumption in water features designed for full human contact.
- **High point value:** Use no potable water in water features designed for full human contact.*
- **Additional point:** Use no treatment chemicals to clean the water within water features designed for full human contact.
- **Note:** *Account for mosquito control in design of landscape and water features so that the feature does not provide mosquito habitat.*

Suggested submittal documentation
Provide specific information regarding the source, treatment method, and available supplies of non-potable water. Include calculations demonstrating that on-site water features can meet the specified water requirements (i.e., 50 percent or 100 percent of water consumption) with non-potable supplies.

Ecosystem services addressed:
- Global climate regulation
- Water supply and regulation

Economic and social benefits:
Using non-potable water, such as graywater and rainwater, in water features reduces water waste and conserves potable water for higher-priority uses, such as drinking water.

This practice simultaneously decreases the volume of water directed to stormwater management systems and reduces the infrastructure, energy expenditure, and costs associated with pumping, cleaning, and processing municipal water.

Technologies and strategies
Collect and reuse non-potable water from sources such as rainwater from rooftops, air-conditioner condensate, or stormwater basins. Estimate volumes of rainwater or graywater available on-site for use in water features, and design water features that do not require additional water from potable water sources.

NOTES TO READERS:
* Any design that reduces potable water use will still need to address public health concerns. How can one meet the intent of this credit and still follow various state and local regulations for non-potable water use?

3.20 Credit Mitigate potential wildfire risks

Intent
For sites in areas of high fire risk, as defined by local authorities, manage fuels through site design and during maintenance to minimize threats from catastrophic fires occurring both on-site and in the adjacent landscape.

Ecosystem services addressed:
- Global climate regulation
- Hazard mitigation
- Waste decomposition and treatment

Economic and social benefits:
Designing defensible space around structures protects property from wildfire damage by reducing flame heights and making fires easier to extinguish.[37] When fuel loads exceed historical conditions, high intensity fires are more likely to occur, causing significant ecological damage.[38] Management of fuels on-site reduces risks to local ecosystems, property, and lives.

Requirements
For sites with significant areas of undeveloped land:
As part of the site maintenance plan, develop a plan to manage fuels on-site. Use prescribed fires or other fuel management techniques in frequencies and intensities similar to the natural fire regime for the ecosystem. Develop agreements with local fire departments to allow appropriate fires to burn through the site.

For sites with structures:
- **Low point value:** Design the landscape within at least 30 feet of all sides of structures to: 1) include irrigated (using non-potable water) or low stature plantings limited to carefully spaced, low-flammability species, 2) avoid "ladder fuels" that transmit fire from ground level to tree canopy AND in the site maintenance plan, describe plans for maintaining plants to reduce accumulation of dead plant material.
- **High point value:** Meet the low point value AND in the site maintenance plan, describe plans to maintain the full extent of area for defensible space around structures (e.g., Zones 1-4 in Firewise Communities) according to local fire department recommendations. Meet zone-specific fire department recommendations for: 1) species with specific levels of fire resistance, 2) species height, 3) vegetation spacing, and 4) maintenance practices.

- **Note:** *Sites with both significant areas of undeveloped land and structures can receive multiple points for mitigating wildfire risks in both portions of the site.*

Suggested submittal documentation
Provide text from site maintenance plan that describes the plan to manage site fuel and reduce fire risk according to specifications. For sites with structures, provide photographs, plant list including scientific names, and a brief narrative to describe how landscape design surrounding the structure reduces fire risk. If applicable, provide a signed agreement with the local fire department to show that the site meets local recommendations for reducing fire risk.

Technologies and strategies
Contact local fire departments for recommendations on plant spacing, fire-resistant plant species, and fuel management practices appropriate to the local area.

Resources
- For more information on designing for defensible spaces, see Firewise Communities resources at *http://www.firewise.org/* or Fire Safe Council resources at *http://www.firesafecouncil.org/*.
- For information on fire regimes and fire regime condition classes throughout the United States, see *http://www.landfire.gov/viewer/*.

4 SITE DESIGN—HUMAN HEALTH COMPONENTS: Build strong communities and a sense of stewardship

4.1 Credit Promote equitable site design, construction, and use

Intent
To ensure that surrounding communities share in the benefits of site development, provide equitable access and amenities to stakeholder groups of diverse socioeconomic and cultural backgrounds, across all ages and genders.

Ecosystem services addressed:
- Human health and well-being benefits
- Cultural benefits

Economic and social benefits:
Site development that equitably addresses the effects on local residents can promote the long-term stability of local families and businesses. By capturing economic opportunities that result from site development and providing these opportunities to local residents, a site helps support resilient neighborhoods.[39]

Requirements
- **Low point value:** Achieve two of the options below.
- **Mid-point value:** Achieve three of the options below.
- **High point value:** Achieve four of the options below OR develop a community benefits agreement or other similar agreement that outlines how the development will be shaped to provide a range of community benefits.
- **Note:** *Engaging local groups during the design phase of the project may help identify and respond to needs on-site. See the "Engage users and other stakeholders in meaningful participation in site design" credit for more information.*
- **Equitable site design, construction, and use options:**
  - **Option 1:** Commit to a living wage requirement for 75 percent of workers employed during site construction or site maintenance. All employees must receive at least minimum wage.
  - **Option 2:** Provide a service, facility, or activity identified as a community need during meetings with stakeholder groups.
  - **Option 3:** Provide access opportunities or events (minimum of three annually) to underserved community groups or populations who do not typically use the site.
  - **Option 4:** Develop a project labor agreement that targets job opportunities during site construction, operations (e.g., service contracts, job skills development, youth employment), and maintenance to local residents or low-income individuals.

Suggested submittal documentation
- **Option 1:** As part of the project contract, require all contractors to provide a living wage to 75 percent of employees working during site construction, operations, and maintenance.
- **Option 2:** Outline and summarize the feedback and needs of stakeholder groups. Provide site plans and a narrative to describe site elements that meet a specific need of the community.*
- **Option 3:** Provide a narrative and annual plan, signed by the owner of the property, that describes the access opportunities or events to be provided to underserved community groups or populations who do not typically visit the site. Also include unique options to address the access needs of specific user groups (e.g., additional access hours, transportation to and from the site, reduced entry fees, and interpretation in multiple languages.) The plan should include a timeline and multiple strategies for advertising events and encouraging participation.

NOTES TO READERS:
* What effective methods can be used to verify that the site is meeting a specific need of the community? For example, could the mayor or appropriate community leaders sign off on the design to verify the site is meeting a need of the community?

- **Option 4:** Provide a signed copy of the agreement that describes the methods used to advertise job opportunities to targeted individuals and the associated hiring timeline.
- **Community benefits agreement option:** Provide a copy of the agreement signed by contract holders (i.e., developer, community leaders, and contractors).

Technologies and strategies

Communicate with the local community to identify options to reduce negative effects of site development on stakeholders. Select options that allow site development to benefit a wide range of local residents, beyond the primary user groups.

Resources

- For more information on developing community benefits agreements or examples of living wage or "first source" hiring systems, see *http://www.communitybenefits.org*.
- For example language for "first source" hiring systems, see Partnership for Working Families policies and tools at *http://www.communitybenefits.org/article.php?list=type&type=40*.
- To estimate the living wage for the site's location, see the Living Wage Calculator at *http://www.livingwage.geog.psu.edu/*.

4.2 Credit Promote sustainability awareness and education

Intent
Reveal processes that show the sustainable aspects of the site. Promote understanding of sustainability in ways that affect user behavior on-site and beyond.

Requirements
- **Low point value:** Provide educational or interpretive elements that draw attention to and explain sustainable elements of site design, construction, operations, and maintenance, including sustainable features and processes.
- **Mid-point value:** Provide educational or interpretive elements that achieve the low point value above AND:
  - Help users and visitors understand how on-site sustainability features can be applied to off-site situations (such as homes, schools, and workplaces).
    AND
  - Demonstrate and promote the connection to environmentally responsible behavior.
- **High point value:** Provide educational or interpretive elements that achieve the mid-point value above AND provide one of the following options:
  - **Option 1:** Provide interactive interpretive elements that allow site users and visitors to integrate understanding of on-site examples of sustainability with experiences that extend beyond the site.
    OR
  - **Option 2:** Provide programming that welcomes, encourages, and expands sustainability learning and understanding on the site. Activities and programs should welcome diverse participants, recognize cultural context, and support local organizations.
- **Note:** *Exemplary performance credit is available for sites that achieve both Option 1 AND Option 2 above.*

Ecosystem services addressed:
Through increased sustainable behavior both on- and off-site, sustainability awareness and education may expand ecosystem benefits beyond the site, including improved air and water quality, provision of wildlife habitat, and reduced use of harmful materials.

Economic and social benefits:
Sustainable sites give site users and visitors opportunities to observe first-hand the physical design elements that contribute to sustainability. Educating users and visitors can help spread sustainability practices from a single site to other sites and from a given land use to other land uses. Studies of environmentally responsible behaviors at the individual level demonstrate that education and awareness-building is an essential step in changing behavior.[40]

Suggested submittal documentation
Provide a site plan indicating design and locations of sustainability education messages and informational elements. Provide a narrative to describe the content of these elements and how they achieve the point values, based on user needs, research literature, and/or site conditions.
- **Option 1 additional documentation:** Provide a narrative and drawings or photographs to illustrate interactive elements.
- **Option 2 additional documentation:** Provide a narrative to describe the programming intentions, outcome goals, staffing plan, expected audience and participants, and how the site's physical elements will facilitate the programming. Document that the intended programming reflects the feedback collected during the community involvement process.

Technologies and strategies

Design interpretation features with potential audiences in mind. Information might be provided in a number of formats (e.g., signs or placards, maps, models, brochures, electronic kiosks or other displays, or iPod-based tours). Any natural element provided to improve environmental conditions could also include opportunity for user education and understanding. For instance, raingardens for stormwater management can be designed to provide a restorative setting, or a roof garden can serve as a break room. Explore opportunities to educate users so that on-site sustainability lessons can be incorporated into off-site actions and behaviors.

Resources

- For more information on interpretation features and materials, see National Association for Interpretation resources and publications *(http://www.interpnet.com/)* and the Interpreter's Handbook Series (*http://www.uwsp.edu/cnr/Schmeeckle/ Handbooks/*).
- For more information on design features that provide in-context understanding of site ecology and sustainable features, see literature on eco-revelatory design, including: *Eco-Revelatory Design: Nature Constructed Nature Revealed (Landscape Journal,* Special Issue: 1998).
- For more information about the link between a strong sense of place and individuals adopting environmentally responsible behaviors, see D Sobel, *Place-based Education: Connecting Classrooms and communities* (Great Barrington, MA: Orion, 2003); RL Thayer, Jr., *LifePlace: Bioregional Thought and Practice* (Berkeley: University of California Press, 2003); and M Thomashow, *Bringing the Biosphere Home: Learning to Perceive Global Environmental Change* (Cambridge, MA: MIT Press, 2002).
- For more information on educational approaches and programs that foster environmentally responsible behavior, see D McKenzie-Mohr and W Smith, *Fostering Sustainable Behavior* (Gabriola Island, BC: New Society Publishers, 1999).

4.3 Credit Provide for optimum site accessibility, safety, and wayfinding

Intent
Increase site use by addressing both the actual and perceived components of accessibility, safety, and wayfinding.

Requirements
Develop and implement a plan for enabling site use. The plan shall list the techniques employed and how the techniques accomplish the following objectives:

- **Improve site access and usability beyond required accessibility standards.** Use techniques that meet appropriate guidelines based on-site type *(see Table 5-3 on page 95)*.
- **Improve perceived and actual safety of site users.** Use techniques that address the following principles: 1) visibility, 2) choice and control, and 3) maintenance. Techniques shall be based on references that have been demonstrated to improve actual or perceived safety *(see Table 5-3 on page 95)*.
- **Create an environment that makes it easy for users to orient themselves—to distinguish one area from another, to grasp what is where, and to find their way from one place to another.** Techniques shall be based on references that have been demonstrated to improve environmental awareness, understanding, and legibility *(see Table 5-3 on page 95)*.

Ecosystem services addressed:
Human health and well-being benefits

Economic and social benefits:
Safe, accessible, and legible sites encourage both use and enjoyment. Sites that are easy to navigate enhance users' sense of safety, minimize their anxiety, and improve their environmental awareness.[41 42] The easier it is to use the site, the more likely it is that users will take advantage of opportunities for physical activity, mental restoration, and social interaction, as well as opportunities for recreation and nature education.

Suggested submittal documentation*
Provide copies of the project drawings, photos, and a narrative to describe and document the techniques used to improve site accessibility, safety, and understanding. Provide references to show that the techniques selected have been demonstrated to accomplish the intended objectives.

Technologies and strategies
During site design, identify techniques appropriate to the site type and user groups to address safety and accessibility concerns. Identify techniques to improve legibility and understanding of the site's layout and intended uses.

Resources
Table 5-3 contains example techniques and suggested references.

NOTES TO READERS:
* What effective methods can be used to verify that the site is achieving accessibility, safety, and wayfinding requirements as outlined in this credit?

TABLE 5-3 TECHNIQUES AND REFERENCES FOR SITE ACCESSIBILITY, SAFETY, AND WAYFINDING

Principles	Potential techniques	Suggested references
Accessibility	• Provide path surfaces and stability appropriate for site users that are mobility impaired. • Remove tread obstacles that are hazardous to site users.	• Missouri Accessibility Guidelines • Proposed Guidelines for Federal Outdoor Developed Areas *(http://www.access-board.gov/outdoor/nprm/)* • American Association of State Highway and Transportation Officials' Guide for the Development of Bicycle Facilities *(http://www.communitymobility.org/pdf/aashto.pdf)* • Principles of universal design *(http://www.universaldesign.org/)*
Safety—Visibility	• On walking trails, improve sight lines between knee height and eye level. • Provide even, consistent lighting that illuminates faces and doesn't cast shadows. • Cluster activities to increase the likelihood of observation by others. • Provide natural surveillance with views from adjacent buildings, streets, and other activity areas. • Provide an overview of the layout and intended uses of the site.	• R Kaplan, S Kaplan, and RL Ryan, *With People in Mind: Design and Management of Everyday Nature* (Washington, DC: Island Press, 1998). • O Newman, *Creating defensible space* (Washington, DC: U.S. Department of Housing and Urban Development, Office of Policy Development and Research, 1996). • Crime Prevention Through Environmental Design. CPTED crime prevention. National Community Development & Crime Prevention Institute. *http://www.cpted-watch.com/*.
Safety—Choice and control	• At entrances, provide open sight lines and view corridors to allow users to assess the usability and safety of the site. • Provide a variety of entrances and exits to prevent feelings of isolation or entrapment. • Provide several path options for free movement to allow the user to control his or her experience.	• DT Luymes and D Tamminga, "Integrating public safety and use into planning urban greenways," *Landscape and Urban Planning* 33 (1995): pp. 391-400. • SE Michael and RB Hull IV, *Effects of vegetation on crime in urban parks* (Blacksburg, VA: Virginia Polytechnic Institute & State University, Department of Forestry, 1994).
Safety—Maintenance and cues to care	• Create a design that the client is capable of maintaining. • Maintain the site so that it looks cared for and attended to (e.g., mowed edges or edging for walkways). • Discourage or repair site vandalism.	• JI Nassauer, "Messy ecosystems, orderly frames," *Landscape Journal* 14 (1995): pp. 161-170. • TN Westover, "Perceptions of crime and safety in three midwestern parks," *The Professional Geographer* 37 (1985): pp. 410-420. • HW Schroeder and LM Anderson, "Perception of personal safety in urban recreation-sites," *Journal of Leisure Research* 16 (1984): pp. 178-194.
Wayfinding—Environmental awareness, understanding, and legibility	• Place clear gateways and entrances to the site. • Provide maps that are oriented in the direction of the view rather than compass point north. • Provide distinctive, memorable, and clearly visible landmarks. • Create a hierarchy of paths. • Develop creative orientation devices such as models, art, and interactive kiosks. • Organize and distinguish coherent areas using similar vegetation, paving, or spatial enclosures.	• K Lynch, *The Image of the City* (Cambridge: MIT Press, 1960). • RS Kaplan, S Kaplan, and RL Ryan, *With People in Mind: Design and Management of Everyday Nature* (Washington, DC: Island Press, 1998). • P Arthur and R Passini, *Wayfinding: People, Signs and Architecture* (New York: McGraw-Hill Ryerson, 1992). • Center for Health Design resources and research *(http://healthdesign.org/)* • Design for Health safety resources *(http://www.designforhealth.net/index.html)*

4.4 Credit Provide views of the natural environment to building occupants

Intent
Provide views of nature from buildings to improve the health and productivity of occupants.

Requirements
Conduct a viewshed analysis oriented from the building(s) into the site and provide views to meet the following requirements:

- **Low point value:**
  - **Option 1:** Provide appropriate vegetation to create or frame views* for 75 percent of the windows of rooms designated as common spaces (e.g., stair-wells, conference rooms, lunch or break rooms, or waiting rooms).
    OR
  - **Option 2:** Provide appropriate vegetation to create or frame views for 60 percent of all building windows.
- **High point value:**
  Provide appropriate vegetation to create and/or frame views for 100 percent of common spaces building windows AND 85 percent of all building windows.
- **Note:** *Large trees add to the quality of the view.*[43 44 45]
- **Note:** *Use vegetation to screen unsightly views from building windows.*
- **Note:** *Achieving this credit may also help a site achieve credits such as "Minimize building heating and cooling requirements with vegetation," "Reduce urban heat island effects," and "Preserve and restore plant biomass on-site."*

Suggested submittal documentation
Provide a copy of the viewshed analysis. Provide a building plan showing the locations of all windows, denoting which windows are expected to benefit from views of the natural environment. Provide photographs and/or site plan to demonstrate the anticipated views from specified building windows (and refer to submittal documentation for "*Preserve and restore plant biomass on-site*" credit, if applicable).

Ecosystem services addressed:
- Human health and well-being benefits
- Cultural benefits

Economic and social benefits:
Outdoor vegetated sites contribute to human well-being in numerous ways, including:

Physical: Physiological functions, the core processes of the human body, are positively affected by experiences with nature. For example, hospital patients who have a view of natural landscapes recover faster from surgery and require less pain medication than do patients with views of built structures.[46] In addition, heart rate, blood pressure, and other measures return to normal levels more quickly when people view natural rather than urban landscapes after a stressful experience.[47 48]

Mental: Research has shown that interaction with or views of nearby nature can improve cognitive functioning.[49] In the workplace, desk workers who have a view of nature report greater job productivity and satisfaction and fewer absences from work.[50] These effects have obvious economic implications.

NOTES TO READERS:
* To meet the requirements of this credit, a view is defined as:
- On-site vegetation that meets the requirements for the low point value of the "Preserve and restore plant biomass on-site" credit.
  OR
- Borrowed (off-site) scenery or distant views of natural resources with some level of public ownership or protection.

Technologies and strategies
Place vegetated areas so they are easily visible from building windows, and use green roofs and green walls to provide views in high-density built environments. Design indoor spaces to maximize view opportunities.

Resources
For more information on preferred views, see R Kaplan, S Kaplan, and RL Ryan, *With People in Mind: Design and Management of Everyday Nature* (Washington, DC: Island Press, 1998).

4.5 Credit Provide opportunities for outdoor physical activity

Intent
Provide on-site opportunities for outdoor physical activity to improve human health.

Requirements
- **Low point value:** Provide two or three unique site amenities that allow site users to meet Centers for Disease Control and Prevention (CDC) guidelines* for physical activity.
- **High point value:** Provide two or three unique site amenities that allow site users to meet CDC guidelines for physical activity AND provide one of the following options:
  - **Option 1:** Provide site amenities that allow users of various age groups and mobility ranges to meet CDC guidelines for physical activity (e.g., children's playground, soccer goals, and senior or wheelchair-appropriate exercise options, or opportunities for gardening).
    OR
  - **Option 2:** Provide physical activity programming on-site to encourage continuing routine physical activity by site users (e.g., opportunities for landscape stewardship).
- **Note:** *Exemplary performance credit is available for sites that achieve both Option 1 AND Option 2 above.*
- **Note:** *For a trail or pathway to qualify as an amenity in this credit, it must be of sufficient length to provide the opportunity to meet CDC requirements for physical activity. A path that supports 30 minutes of brisk walking or 20 minutes of running or jogging (i.e., 2 miles total) could meet this credit. This amount of activity could be accomplished with trails of varying length. For instance, a 0.25-mile pathway with no automobile crossings (or a 0.5-mile pathway with no more than one automobile crossing) could meet this requirement if designed to be an engaging experience over repeated use for 2 miles of brisk walking, running, or jogging.*
- **Note:** *Sidewalks directly adjacent to urban roads or located in a public right-of-way (or its equivalent) do not meet the requirements for this credit.*

Ecosystem services addressed:
- Human health and well-being benefits

Economic and social benefits:
Physical activity is fundamental to human health. Daily moderate activity decreases the incidence of chronic diseases such as diabetes and heart disease. Improved health is correlated with reduced health-care costs.[51 52 53] Physical activity and exercise can also improve mental health by reducing feelings of depression and anxiety, reducing stress, and promoting psychological well-being.[54] The presence of trees and vegetation in children's play areas can support development of children's skills and cognitive abilities[55] and reduce symptoms of attention deficit and hyperactivity disorder (ADHD).[56] Community gardens, which provide opportunity for physical activity, have also been demonstrated to increase property values.[57]

NOTES TO READERS:
* The CDC recommends moderate-intensity physical activity (such as brisk walking) 150 minutes (2.5 hours) each week, or vigorous-intensity physical activity (such as jogging or running) for 75 minutes (1.25 hours) each week. *(http://www.cdc.gov/nccdphp/dnpa/physical/everyone/recommendations/index.htm)*

Suggested submittal documentation

Provide site plans and a narrative to describe the intended options for physical activity, documenting that these are of interest to intended site users. For a pathway to count as an amenity for this credit, describe how it allows users to meet CDC guidelines for physical activity.

- **Option 1 additional documentation:** Indicate on-site plans—and provide a narrative to describe—the amenities intended to accommodate a range of user groups.
- **Option 2 additional documentation:** Provide a narrative to describe the programming intentions, outcome goals, staffing plan, expected audience or participants, and how the site's physical elements will facilitate the programming. Document that the intended programming reflects the feedback collected during the community involvement process.

Technologies and strategies

Identify physical activities preferred by intended user groups, and provide spaces on-site to enable and encourage physical activity. For small sites, creatively design meandering pathways to maximize on-site opportunities.

Resources

- For more information on outdoor physical activity, see Centers for Disease Control and Prevention, Physical Activity Resources *(http://www.cdc.gov/nccdphp/dnpa/physical/index.htm)*, including information on active environments *(http://www.cdc.gov/nccdphp/dnpa/physical/health_professionals/active_environments/index.htm)*.
- For more information on creatively designed trails, see R Kaplan, S Kaplan, and RL Ryan, *With People in Mind: Design and Management of Everyday Nature* (Washington, DC: Island Press, 1998).

4.6 Credit Connect site to surrounding resources, amenities, and services

Intent
Provide convenient access and off-site links for pedestrians, bicyclists, and transit riders to reduce fossil fuel consumption, broaden transit options, and increase opportunities for active living.

Requirements
- **Low point value:** Provide convenient connection to at least two adjacent or nearby resources.*
- **Mid-point value:** Provide convenient connection to at least two adjacent or nearby resources and an existing local trail route or walkway.
- **High point value:** Provide convenient connection to at least two adjacent or nearby resources and a regional trail network.
- **Additional point:** Design supports public access to site that is privately owned.
- **Note:** *To meet the requirements of this credit, a convenient connection must include more than sidewalks directly adjacent to urban roads or located in public right-of-way (or its equivalent).*

Suggested submittal documentation
Provide site plans and photographs to indicate locations of access points that connect the site to off-site resources. If applicable, provide maps of the site within the context of the surrounding off-site trail systems to demonstrate increased connectivity within a larger network due to site access points and trails. Indicate the specifications and materials of the connection route(s) and/or access structures (e.g., bridges or tunnels).

Technologies and strategies
Select sites that could be used to enhance existing or planned trail networks. Design the site to provide multiple access points that allow users to connect to multiple resources. Design and construct site features that enable and encourage connectivity, such as appropriate paving for bike trails versus walking trails, covered parking areas for bicycles, and routing signs that indicate location and distance of nearby features or resources.

Ecosystem services addressed:
- Global climate regulation
- Human health and well-being benefits

Economic benefits:
Increased foot traffic as a result of connectivity can increase economic benefits to local businesses and services.[58] Property values and other economic benefits frequently result from recreational trail networks and greenways.[59 60]

Social and health benefits:
Site connectivity increases the number of accessible resources and services to users, especially for disadvantaged socioeconomic groups who may have difficulty accessing community resources. Pathway site connectivity also reduces fossil fuel-based transportation and promotes mental health and the prevention of chronic disease through increased physical activity. Residents from communities with higher density, greater connectivity, and more diverse land use report higher rates of walking/cycling for utilitarian purposes than low-density, poorly connected, and single land use neighborhoods.[61 62]

Resources
For more information on guidelines for greenways, see A Lusk, *Twenty-three Design Guidelines for Greenways* (Taubman College of Architecture and Urban Planning, University of Michigan, 2002).

NOTES TO READERS:
* Resources include diverse uses such as: bank, child-care facility, community/civic center, convenience store, hair care, hardware store, health club or outdoor recreation facility, laundry/dry cleaner, library, medical/dental office, pharmacy (stand-alone), place of worship, police/fire station, post office, restaurant, school, senior-care facility, supermarket, theater. This list is based on the LEED-ND list of diverse uses.

4.7 Credit Provide outdoor spaces for mental restoration

Intent
Provide outdoor spaces to optimize the cognitive and mental health benefits for site users, including psychological restoration, reflection, and functioning.

Requirements
- Provide outdoor space on-site that is dedicated to quiet use and contains at least four of the five following components:
  - Comfortable seating
  - Comfortable settings that respond to the microclimate (e.g., shade, windbreaks)
  - An amenity or view that encourages site users to utilize the space (e.g., water feature, art, beautiful view, pathways, and opportunities for gardening)
  - Vegetation cover that meets the requirements of the "*Preserve and restore plant biomass on-site*" credit
  - Mitigation of existing stressful factors, such as noise.
- **Additional point:** Site supports public access of a site that is privately owned.
- **Note:** *Sites may replace the components outlined above with other design elements if the selected design elements have been demonstrated to provide restorative settings (four elements are still required). Use peer-reviewed research to justify selection of design elements.*
- **Note:** *Achieving this credit may also help a site achieve credits such as "Minimize building heating and cooling requirements with vegetation," "Prevent and abate sensory stress," and "Preserve and restore plant biomass on-site."*

Ecosystem services addressed:
- Human health and well-being
- Cultural benefits

Economic and social benefits:
Vegetation and other natural elements have the potential to provide for restorative experiences in a number of ways.[63] People are inspired by and gain pleasure from the aesthetic experiences provided by nature.[64] Work that demands focused attention (such as desk work or studying) for a lengthy period can result in mental fatigue, which can be expressed as irritability, physical tiredness, and inability to concentrate; brief interludes in natural settings are mentally restorative, helping us to get back on track with work.[65] Research shows that small areas of nearby nature provide effective restorative settings and experiences.[66]

Suggested submittal documentation
Provide site plans to demonstrate the site area(s) dedicated to providing a restorative setting. Provide a narrative to describe the amenities, views, or other design specifications that support quiet use within the dedicated space. Demonstrate that stressful factors have been mitigated within the dedicated space by providing noise data or other calculations, if applicable. Refer to submittal documentation for "*Preserve and restore plant biomass on-site*" credit, if applicable.

Technologies and strategies
Incorporate small spaces within vegetated areas to create a sense of enclosure and separation from distraction.

Resources
For more information on design elements that provide restorative benefits, see R Kaplan, S Kaplan, and RL Ryan, *With People in Mind: Design and Management of Everyday Nature* (Washington, DC: Island Press, 1998).

4.8 Credit Provide outdoor spaces for social interaction

Intent

Provide outdoor gathering spaces of various sizes and orientations to accommodate small to large groups, for the purpose of building community and improving social ties.

Requirements

- Provide outdoor spaces of varying sizes that accommodate small or large groups, meet the needs of site users and contain at least five of the nine following components:
  - Comfortable, moveable furniture appropriate for user groups
  - Features that make the space(s) comfortable and encourage use under a broad range of conditions, (e.g., lighting, wind breaks, awnings, and other sources of shade)
  - Articulated spaces that provide scale appropriate to a group (rather than a large undifferentiated space)
  - Amenities or views that enhance the aesthetic experience of the social space (e.g., exceptional views, water feature, art)
  - Features and materials that enable social interaction through work or play (e.g., games tables, communications technology, wireless Internet connection)
  - Small-scale food concession and dining area
  - Activity spaces for activities that draw people to the site (e.g., spaces for farmer's market, celebrations, or performances)
  - Easy entry and access from the building(s), and/or major pedestrian corridors
  - Vegetation cover that meets the requirements of the "*Preserve and restore plant biomass on-site*" credit.
- **Additional point:** Provide programming that welcomes, encourages, and expands social interactions on the site. Activities and programs should welcome diverse participants, recognize cultural context, and support local organizations.
- **Note:** *Achieving this credit may also help a site achieve credits such as "Minimize building heating and cooling requirements, with vegetation," "Reduce urban heat island effects," and "Preserve and restore plant biomass on-site."*

Suggested submittal documentation

Provide site plans to demonstrate the dimension and character of site area(s) dedicated to supporting social interaction, the number of individuals for whom seating is available, strategies for creating a comfortable microclimate, and descriptive photographs of furniture and amenities. Describe the views, amenities available, and activity spaces that encourage site use. Refer to submittal documentation for "*Preserve and restore plant biomass on-site*" credit, if applicable.

Ecosystem services addressed:

- Human health and well-being
- Cultural benefits

Economic and social benefits:

Social ties, and the social interaction that creates and nourishes those ties, play an important role in human health.[67] A great deal of evidence links social connectedness to health and well-being, including such diverse outcomes as hormonal responses to stress,[68] resistance to colds,[69] resistance to dementia,[70] survival in cancer patients,[71] and healthy aging.[72]

Mortality rates are higher among persons who lack social and community ties, even when they start out with the same health status, income, and health risk factors.[73] According to an article in *Science*, social isolation "is as significant to mortality rates as smoking, high blood pressure, high cholesterol, obesity and lack of physical exercise".[74]

Not only are social ties important for individual health, but they are important for the healthy functioning of communities as well. There is evidence indicating that landscape design can have significant effects on social interaction, social ties, and indicators of neighborhood health. In neighborhoods, social ties can turn initially unconnected residents into a source of social support and

- **Additional programming documentation:** Provide a narrative to describe the programming intentions, outcome goals, staffing plan, expected audience/participants, and how the physical site elements will be used to facilitate the programming. Document that the intended programming reflects the feedback collected during the community involvement process.

Technologies and strategies: Provide comfortable spaces in vegetated areas with seating arrangements and amenities to draw people and encourage outdoor social gatherings.

Resources

- For information on seating that meets the needs of site users, see:
  - S Carr, M Francis, LG Rivlin, and AM Stone, *Public Space* (New York: Cambridge University Press, 1992).
- For information on designing spaces for social interaction, see:
  - CC Marcus and C Francis, *People Places: Design Guidelines for Urban Space* (New York: John Wiley & Sons, 1997).
  - WH Whyte, *The Social Life of Small Urban Spaces* (Washington, DC: Conservation Foundation, 1980).

sense of community[75 76], and a social unit more capable of forming local organizations,[77] defending against crime,[78 79] and mobilizing for political purposes.[80]

Green surroundings in residential areas are associated with greater social cohesion in neighborhoods. Studies indicate that residents of buildings with more trees and grass report that they know their neighbors better, socialize with them more often, and have stronger feelings of community, and feel safer and better adjusted than do residents of more barren, but otherwise identical, buildings.[81]

Stronger ties develop if outdoor spaces are more attractive and more comfortable, drawing people to them. Such settings support frequent, friendly interaction that becomes the foundation for interpersonal support and resource sharing.

Social interactions have implications for personal security. Neighbors and community members who have stronger social ties are more likely to monitor local activity, intervene if problem behaviors occur,[82] and defend their neighborhoods against crime.[83]

4.9 Credit Design stormwater management features to be a landscape amenity

Intent
Integrate multifunctional stormwater management features into site design to improve both water quality and aesthetics, and to provide a landscape amenity that is both physically or visually accessible to users.

Requirements
Integrate stormwater management features into the site to improve both water quality and aesthetics. The features shall be visible, aesthetically pleasing, and accessible to site users.

- **Note:** *Access to the water feature does not need to include full physical contact (i.e., primary or secondary contact recreation). Recognize the risks of stormwater management features, and design the site to minimize drowning hazards.*
- **Note:** *Meeting the requirements of this credit can help achieve other credits such as "Minimize use of potable water in water features designed for full human contact," "Provide outdoor spaces for mental restoration," and others.*

Suggested submittal documentation
Provide documentation (including plans and photographs) to show physical and visual access to features. Provide a brief narrative to describe how the feature addresses both aesthetic concerns and stormwater management needs.

Technologies and strategies
Consider opportunities to integrate stormwater management features in site design in an aesthetically pleasing way.

Ecosystem services addressed:
- Air and water cleansing
- Water supply and regulation
- Habitat functions
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Studies of landscape preference conducted over several decades show consistent patterns of favorable responses to views of water features across culture, landscape types, and viewer age.[84] Stormwater management features can provide calming views, spaces for restoration, and even opportunities for play and interaction with water.

4.10 Credit Prevent and abate sensory stress

Intent

Assess long-term sensory stressors such as excessive light, noxious odors, wind, and noise, both on- and off-site, to minimize negative effects on human health and functioning.

Requirements

Lighting (adapted from LEED-NC SS Credit 8):

- Light only areas as required for safety and comfort. Do not exceed 80 percent of the lighting power densities for exterior areas and 50 percent for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments.
- All sites will be classified under one of the following zones, as defined in IESNA RP-33, and will follow all of the requirements for that specific zone:

  LZ1—Dark (park and rural settings):
  - Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.01 horizontal and vertical foot-candles at the site boundary and beyond. Document that 0 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down).

  LZ 2—Low (residential areas):
  - Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.10 horizontal and vertical foot-candles at the site boundary and no greater than 0.01 horizontal foot-candles 10 feet beyond the site boundary. Document that 0 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries that abut the public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.

  LZ3—Medium (commercial/industrial, high-density residential):
  - Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical foot-candles at the site boundary and no greater than 0.01 horizontal foot-candles 15 feet beyond the site boundary. Document that 0 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries that abut the public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.

Ecosystem services addressed:

- Habitat functions
- Human health and well-being benefits
- Cultural benefits

Economic and social benefits:

Light: Light pollution can disrupt circadian rhythms and melatonin production, which has been linked to serious health concerns.[85] Reasonable use of outdoor lighting restores dark night skies and preserves the ambiance of the night. In addition, whether outdoor light is directly adjacent to a species habitat or located at some distance, as through sky glow, the combined effects of artificial lighting on vast numbers of nocturnal species have the potential to disrupt the functioning of entire ecosystems by disturbing balances in competition and predation.[86] Excessive night lighting of buildings kills thousands of migrating birds annually.[87]

Noise: Loud sounds can impair hearing, after continuous exposure or after a single instance of a particularly loud sound. Everyday environments are becoming ever louder. Down-trends in hearing ability are particularly noted for children and older adults. Noise has been proven to have negative effects on physio-logical and psychological well- being (known as nonauditory effects). Unwanted, uncontrol-lable and unpredictable sounds can be annoying and disturbing, resulting in physiological stress responses, such as a rise in blood pressure, excessive levels of certain hormones, change in heart

LZ4—High (major city centers, entertainment districts):

- Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.60 horizontal and vertical foot-candles at the site boundary and no greater than 0.01 horizontal foot-candles 15 feet beyond the site boundary. Document that 1 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries that abut the public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.
- All non-emergency lighting will use motion sensors to turn off or be automatically controlled to turn off after curfew hours. Provide manual override capability for after-hours use.

Other sensory stressors:* Locate any excessive sensory sources (on-site or adjacent) and develop a design response for abatement or mitigation.

Suggested submittal documentation

- **For lighting requirements:** Provide copies of the exterior lighting drawings to document the location and type of fixtures installed. Complete the Lighting Power Density tables and Site Lumen Calculations as described in LEED-NC SS Credit 8 *(see http://www.usgbc.org/ShowFile.aspx?DocumentID=1095 for LEED NC Rating System v2.2)*. The following data will be required to complete the template: luminaire type/ID, quantity installed, initial lamp lumens per luminaire, initial lamp lumens above 90 degrees from nadir.
- **For other sensory stressor requirements:** Provide a site plan showing the location of excessive sensory sources and the element(s) of site design that mitigate or abate these stressors. Provide a narrative describing how the stressor character was assessed and how the site design responds to the stressors.

Technologies and strategies

Identify and minimize sources of sensory stress. Adopt site lighting criteria and use screens to mask noise to maintain safe levels of sensory stressors.

rhythm, and a slowing down of digestion. Sustained noise-induced stress can result in negative responses of immune, circulatory, cardiovascular, or gastrointestinal systems. Children exposed to noises may be especially vulnerable.[88] Urban traffic is a significant source of annoyance,[89 90] with secondary effects. Urban residents in noisy areas are at higher risk for sleep disturbances, and such disturbances are significantly related to neuroticism and subjective noise sensitivity.[91 92] Sleep is required for physical and mental recuperation. Sleep loss can impair daytime task performance at work or school. Noise can interfere with daily routine activities,[93] and chronic loud transit noise exposure can lead to poorer reading performance by school children.[94]

Odor: Odor can affect psychological and physical health. Noxious odors may irritate nasal passages and induce a cough, throat irritation, and other physical symptoms.[95 96] Odor can also affect mood, with malodorous conditions being linked to increased tension, depression, anger, and fatigue.[97] Other research indicates the importance of mood on worker productivity.

NOTES TO READERS:

* Future drafts of this report will explore opportunities to mitigate other sources of sensory stress, including noise, high winds, and noxious odors. The requirements for achieving this credit will also be strengthened and described more fully. For instance, a requirement for noise stressors may be: "Eliminate or abate all continuous noise sources that are greater than 85 decibels." Please provide references or suggestions to expand and improve this credit, including suggested metrics for detrimental levels of odors, high winds, etc.

4.11 Credit Protect and promote unique cultural and historical site attributes

Intent
Protect, reveal, or respect cultural and historical legacies* to enhance community's sense of place and historic precedents of sustainability.

Requirements**
- **Option 1:** Protect sites listed on National and State Historic Registers.
  OR
- **Option 2:** Protect and reveal places that are important to local culture and local histories, including cultural landscapes and other non-registered places.
- **Note:** *Engaging the local community during the design phase of the project may help identify important local histories or cultures that are not included on National or State Historic Registers. See the "Engage users and other stakeholders in meaningful participation in site design" credit for more information.*

Ecosystem services addressed:
- Human health and well-being benefits
- Cultural benefits

Economic and social benefits:
Economic benefits of including cultural aspects in site design may include opportunities for increased employment, entrepreneurship, and tourism. Enhanced human experiences of, and attachments to, the land can result in a stronger sense of stewardship.

Suggested submittal documentation
Provide photographs and a narrative to describe how site design responds to and protects unique cultural and historical site features.

Technologies and strategies
Communicate with local, state, and federal agencies, educational facilities, and the local community to identify important cultural or historic places, landscapes, or concepts to incorporate into site design.

Resources
See National Park Service Historic Landscape Initiative *(http://www.nps.gov/history/hps/hli/index.htm)*, The Cultural Landscape Foundation *(http://www.tclf.org/)* and National Trust for Historic Preservation *(http://www.preservationnation.org)* for more information on protecting historic and cultural landscapes.

NOTES TO READERS:
* In this context, cultural and historical legacies can include physical locations, attributes, or artifacts, in addition to human uses and the history or perceived relevance of the site. This category also includes historic and cultural landscapes.
** How do cultural and historical sites contribute to sustainability? What additional requirements would help more directly meet the intent of sustainability in this credit?

PEARL BREWERY: Preserving History

The 125-year-old Pearl Brewery, a Texas landmark on the banks of the San Antonio River, produced its signature beverage until 2001. Once considered a candidate for demolition, the 22-acre site is being revitalized in a project that preserves its historical value while creating a lively urban environment. The completed development will include residences, galleries, shops, and educational facilities linked by public gardens and tree-lined streets.

Seating in the shade of salvaged trees

Photos by Rialto Studio

Preserving the site's historic character

Collecting irrigation rainwater in old brewing tanks

SIZE/TYPE OF PROJECT
Approximately 27 acres/greyfield redevelopment

SITE CONTEXT
The brewery is a greyfield site located in a dense urban setting in downtown San Antonio. Historically, the site was a part of the Texas Blackland Prairie, made up of oak savanna woodland and tallgrass prairie. The climate is moderately subtropical and humid.

ISSUES/CONSTRAINTS OF THE SITE
Expansive soils: The nature of the soil, which shrinks and swells depending on water content, required deeper footings, flexible paving systems, and the addition of organic materials to increase the soil's ability to retain water.

Historic preservation: The clients made it a priority that the new project reflect both the history of the site and its inherent industrial character, and that it serve as a magnet for residents and visitors alike.

FEATURED SUSTAINABLE PRACTICES
Protect and promote unique cultural and historic site attributes:
- Initial development has focused on preservation of several of the original buildings, including the stable, shipping warehouse, and garage. All three facilities have been redeveloped for other purposes while reusing major elements of the original construction.
- Existing railroad tracks have been reinstalled in their original locations to define pedestrian walkways and roads.
- Native plantings and local limestone are used throughout the project to enhance the site's sense of place and its cultural heritage.

Material reuse: Two beer brewing tanks (7,500 gallons each) have been refurbished and reused for rainwater collection to date, with additional tanks scheduled for use in future phases of construction. The concrete used in the development is locally produced using river sand and aggregates that are unique to the site, combined with 40 percent fly ash (a waste byproduct generated in the combustion of coal).

Stormwater management:
- 60,000 square feet, or 65 percent, of the roof surface area is used for rainwater collection. A significant percentage of the tanks, valves, and pipes used in the system are salvaged from the brewing operation.
- A bioswale has been implemented at the site perimeter sufficient to ensure percolation of the first 0.5 inch of rain runoff.

CONSTRUCTION COSTS
Overall project costs are not available. Costs of implementing the rainwater harvest and irrigation system were moderated by the reuse of brewing tanks, which were fully retrofitted for their new purpose at a cost of $5,000 each.

MONITORING
Vegetation retained has remained healthy. Visitor use is increasing as new parts of the project come on line.

LESSONS LEARNED
- Because of negative experiences with graywater in a previous project, the team decided not to use harvested rainwater in any setting where it might come into contact with the public. All rainwater used for irrigation is dispersed through drip or tree bubblers.
- The project required the designers to implement a number of new details to meet sustainable site goals. Although the "learning curve" was steep for this project, future implementations should be much easier.

5 SITE DESIGN—MATERIALS SELECTION

Reuse/recycle existing materials and support sustainable production practices

5.1 Prerequisite Eliminate use of lumber from threatened tree species

Intent
To minimize negative effects on other ecosystems, only purchase lumber extracted from non-threatened tree species.

Requirements
Use no wood species listed on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species as endangered in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU), or near threatened (NT).

Suggested submittal documentation
Provide a species list of all lumber purchased. Include the tree species classification by IUCN *(http://www.iucnredlist.org/)*.

Technologies and strategies
Identify suppliers that provide sustainably harvested lumber.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
The interactions and feedback mechanisms of natural ecosystems have developed over time to result in relative stability and resistance to pests and diseases. Reducing populations of already threatened species can disrupt stable natural ecosystems, which control more than 95 percent of the potential crop pests and carriers of human diseases.[98]

5.2 Credit Support sustainable practices in plant production

Intent
Purchase seeds and plants from providers that reduce resource consumption, waste, and risks of invasive species.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Water supply and regulation
- Habitat functions
- Human health and well-being benefits

Economic and social benefits:
Nurseries save costs by reducing resource consumption and minimizing waste generation. By eliminating the use and distribution of invasive species, nurseries also help reduce the costs of controlling and managing the damage done by invasive species in natural ecosystems.

Requirements
- Obtain 100 percent of purchased plants from nurseries that employ at least four of the six sustainable practices below.
- Obtain 100 percent of purchased seeds from nurseries that employ at least three of the six sustainable practices listed below.

Sustainable practices in plant production include:
- **Reduce greenhouse gas emissions.** Purchase or produce renewable energy to meet the minimum requirements in Table 5-4 below.[99] Renewable energy sources must meet the Center for Resource Solutions (CRS) Green-e products certification requirements.
- **Use integrated pest management.** Employ a certified integrated pest management (IPM) practitioner.
  OR The nursery is IPM-certified.
- **Prevent use and distribution of invasive species.** Follow Voluntary Codes of Conduct for Nursery Professionals *(http://www.centerforplantconservation.org/invasives/codesN.html)*.
- **Reduce potable water consumption.** Use non-potable water for 70 percent of total irrigation volume.
- **Use sustainable soil amendments.** Use peat-free planting media or soils obtained from sustainable sources.
- **Reduce plant pot waste.** Use recyclable or compostable plant pots for 50 percent of potting requirements.

Suggested submittal documentation
Provide documentation from plant providers and installers, including utility bills and other calculations, to demonstrate that sustainable practices are employed as specified.

Technologies and strategies
Identify—and select plants from—nurseries that actively implement better business practices to reduce damage to the environment and conserve resources.

TABLE 5-4 MINIMUM PURCHASE OR PRODUCTION REQUIREMENTS FOR GREEN POWER

If your annual electricity use in kilowatt-hours is…	You must, at a minimum, purchase or produce this much green power
≥ 100,000,000 kWh	20 percent of your use
10,000,001 – 100,000,000 kWh	30 percent of your use
1,000,001 – 10,000,000 kWh	60 percent of your use
≤ 1,000,000 kWh	90 percent of your use

5.3 Credit Support sustainable practices in materials manufacturing

Intent
Purchase materials from manufacturers whose practices increase energy efficiency, reduce resource consumption and waste, and minimize negative effects on health and the environment. Plants and soils are excluded from this credit.

Ecosystem services addressed:
- Global climate regulation
- Water supply and regulation

Economic and social benefits:
Manufacturers save money by reducing resource consumption and increasing energy efficiency.

Requirements
Seventy-five percent of products for construction (by cost) come from manufacturers that have developed an environmental management system to reduce negative environmental effects and increase operating efficiency AND employ two of the three sustainable practices below.

Sustainable practices in manufacturing include:
- **Use renewable energy:** Final manufacturing process uses at least 10 percent renewable energy.
- **Reduce greenhouse gas emissions:**
  - **Option 1:** Reduce emissions during the manufacturing process by 25 percent below the plant performance in 2000.
    OR
  - **Option 2:** Offset 25 percent of the emissions generated during the manufacturing process.
- **Reduce potable water consumption:** No net consumption of potable water during the manufacturing process.
- **Note:** *"Manufacturing process" refers to the final manufacturing stage of the product life.*
- **Note:** *Identification of life cycle costs as part of this credit may also help achieve the "Conduct a life cycle assessment" credit.*

Suggested submittal documentation
Provide total costs for materials (excluding plants and soils) and a tabulation of each material used on the project that is being tracked for sustainable manufacturing practices. The tabulation must include a description of the material, the manufacturer of the material, the product cost, and the sustainable practices employed by the manufacturer. Include documentation from manufacturers (e.g., utility bills, copies of sustainability assessment or environmental management system documents, etc.) to demonstrate that sustainable practices are employed as specified.

Technologies and strategies
Identify and select materials from manufacturers that actively implement better business practices to reduce harm to the environment and conserve resources.

Resources
- For more information on environmental management systems, see *http://www.epa.gov/EMS/*.
- For more information on sustainability assessments, refer to ASTM E 2129 Standard Practice for Data Collection for Sustainability Assessment of Building Products at *http://www.astm.org/ Standards/E2129.htm*.

5.4 Credit Reuse on-site structures, hardscape, and landscape amenities

Intent
Reuse existing structures, hardscape, and landscape amenities (e.g., retaining walls and benches) in their existing form to extend the life cycle of existing building stock, conserve resources, and reduce waste.

Requirements
- **Low point value:** If needed for program plan, reuse in their existing form 50 percent of the surface area of existing structures, hardscape, and landscape amenities on-site.
- **Mid-point value:** If needed for program plan, reuse in their existing form 75 percent of the surface area of existing structures, harsdcape, and landscape amenities on-site.
- **High point value:** If needed for program plan, reuse in their existing form 95 percent of the surface area of existing structures, hardscape, and landscape amenities on-site.
- **Note:** *Hazardous materials are excluded from total surface area.*

Suggested submittal documentation
Calculate the total surface area of all existing structures, hardscape, and landscape amenities on-site, and the total surface area of these materials that will be used on-site. Demonstrate the use for these materials in the program plan. Demonstrate that the specified percentages of existing structures, hardscape, and landscape amenities are retained.

Technologies and strategies
Identify opportunities to incorporate existing site materials into site design.

Ecosystem services addressed:
- Global climate regulation
- Cultural benefits

This credit also prevents negative effects on environmental quality that can be associated with new material production and raw material extraction, such as air pollution, water-quality degradation, and habitat destruction.

Economic and social benefits:
Retaining existing structures and amenities avoids the cost of disposing of them at a landfill. Using existing materials as resources for new site development (rather than viewing them as "waste") reduces costs for new purchased materials. Reusing existing landscape structures can also connect site users to historical or cultural legacies, which may result in tourism opportunities and strengthened cultural pride.

5.5 Credit Use salvaged and recycled content materials

Intent
To reduce the use of virgin materials and avoid sending useful materials to the landfill, use salvaged materials from other local projects (e.g., salvaged bricks or salvaged lumber from nearby sites) or materials with recycled content. Plants and soils are excluded from this credit.

Requirements
- **Low point value:** 50 percent of materials (by cost or replacement value) are salvaged or have recycled content.
- **High point value:** 95 percent of materials (by cost or replacement value) are salvaged or have recycled content.
- **Note:** *Materials must meet or exceed Comprehensive Procurement Guidelines for product-specific minimum for post-consumer materials content or total recovered materials content.*

Suggested submittal documentation
Provide the total cost or replacement value of project materials. Provide a tabulation of each material used on the project that is being tracked for recycled content. The tabulation must include a description of the material, the product cost, and the percentage of post-consumer or total recovered-materials content.

Ecosystem services addressed:
• Global climate regulation
This credit also prevents negative effects on environmental quality that can be associated with new material production and raw material extraction, such as air pollution, water quality degradation, and habitat destruction.

Economic and social benefits:
Using materials salvaged from other projects may reduce costs for site development by eliminating or minimizing the need for new purchased materials.

Technologies and strategies
Establish a project goal for recycled content or salvaged materials and identify material suppliers or local projects than can help achieve this goal.

Resources
- For more information on Comprehensive Procurement Guidelines, see *http://www.epa.gov/epaoswer/non-hw/procure/products.htm*.
- For more information on salvaged materials, see resources such as the Green Building Research Guide's searchable database *(www.greenguide.com/exchange/search.html)* or the Reuse Development Organization *(http://www.redo.org)*.

MALOLEPSY/BATTERSHELL RESIDENCE: Creative Recycling

The Malolepsy/Battershell project is a residential garden renovation in Portland, Oregon. The owners wanted to continue to grow most of their own vegetables, while reducing potable water use for irrigation, managing stormwater runoff, reducing heat from the concrete driveway, reusing salvaged materials, and maintaining the garden's bioregional characteristics. They wanted the completed project to be child friendly and to allow for outdoor dining and other family activities. For economic and ecological reasons they also wanted to reuse as much material as possible.

Vegetation appropriate for site microclimate

Patio, pathways, and fencing of salvaged materials

Photos by D. Tolman

SIZE/TYPE OF PROJECT

5,000 square feet/urban residential

SITE CONTEXT

The site is located in the Willamette Valley ecoregion, and has a Mediterranean/marine west coast climate with mild winters and summers. The project is in a residential area with individual lots of approximately 5,000 square feet.

ISSUES/CONSTRAINTS OF THE SITE

- Very limited space available to meet multiple design and food production goals
- The 40 percent slope and concrete driveway directed runoff either into the basement of the home or immediately into the street.
- Because summers are generally dry, the site required irrigation to produce vegetables for the family.
- The soil was highly compacted and areas were contaminated with the toxic pesticide chlordane.

FEATURED SUSTAINABLE PRACTICES

Use salvaged/recycled materials:

No materials were purchased other than concrete for setting three 4 x 4 posts into the existing driveway for mounting an artistic fence that established the upper quarter of the driveway as usable space.

- Existing vegetation was retained and incorporated into the new design.
- During all phases of construction, landscape waste was recovered and reused.
- Bricks from a decommissioned chimney were used to make a permeable patio and pathways.
- Broken concrete was used for stepping stones and to create a drywell under the small backyard lawn.
- Fencing was constructed from salvaged wood.

Protect/restore soils:

- Implementation was staged to reduce additional compaction, and no heavy equipment was used on-site.
- An aspen forest was designed in the backyard to ameliorate chlordane contamination in play areas. Exposed soil was heavily mulched.
- Soil in the play area was amended with 25 cubic yards of compost and replanted with turf for quick establishment.

Reduce potable water use:

- Rainwater barrels were installed to collect water for irrigation.
- Plants were selected according to site microclimates.
- Irrigation was carefully designed to provide only the water needed for each bed.

CONSTRUCTION COSTS

The total cost for the project was $16,500, including design, labor, soil enhancements, and plant material. All other materials were recycled or donated.

MONITORING

- Potable water use for the site has been reduced to less than 10 percent of total domestic water, despite high demand in the summer. In the second year (after establishment) only one watering was required in the front yard during the dry season.
- Field tests of the soil show that the composting has improved the existing soil.
- Weed eradication has been successful; only two to three hours of weeding are required per season.

LESSONS LEARNED

The greatest challenge was education—communicating effectively how and why natural systems work. The designer followed up with regular post-installation visits to tutor the homeowner and encourage maintenance of the new garden.

5.6 Credit Use certified wood

Intent
Purchase certified lumber to encourage exemplary forest management that is both environmentally and socially responsible.

Requirements
- **Low point value:** 50 percent of new wood-based materials and products (based on cost) purchased is certified in accordance with forest certification systems that USGBC recognizes as conforming to its Forest Certification System Benchmark.
- **Mid-point value:** 75 percent of new wood-based materials and products (based on cost) purchased is certified in accordance with forest certification systems that USGBC recognizes as conforming to its Forest Certification System Benchmark.
- **High point value:** 100 percent of new wood-based materials and products (based on cost) is certified in accordance with forest certification systems that USGBC recognizes as conforming to its Forest Certification System Benchmark.

Suggested submittal documentation
Provide receipts documenting total cost of wood-based materials and products used on-site, noting those purchased from providers that meet certification requirements. Provide documentation from provider(s) to demonstrate certification meets USGBC's Forest Certification System Benchmark.

Ecosystem services addressed:
- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Sustainably harvested wood provides a stable source of lumber, minimizes negative effects on ecosystems, and benefits local economies.

Technologies and strategies
Establish a project goal for certified wood products and identify suppliers that can achieve this goal.

Resources
For more information on the USGBC draft Forest Certification System Benchmark, see *https://www.usgbc.org/ ShowFile.aspx?DocumentID=4374*.

5.7 Credit Use products designed for reuse and recycling

Intent
Select products that lend themselves to recycling and reuse to minimize future energy consumption for deconstruction and avoid sending useful materials to the landfill. Plants and soils are excluded from this credit.

Requirements
- **Low point value:** 30 percent of products and/or product components for construction (by cost) are reusable or recyclable at the end of the product life.
- **Mid-point value:** 60 percent of products and/or product components for construction (by cost) are reusable or recyclable at the end of the product life.
- **High point value:** 90 percent of products and/or product components for construction (by cost) are reusable or recyclable at the end of the product life.
- **Note:** *In the case of mixed material assemblies, determine the portion of the total weight that is reusable or recyclable. Multiply the proportion of total weight by the total cost to determine the proportion of product assembly that meets the requirements of this credit.*

Ecosystem services addressed:
• Global climate regulation
This credit also prevents negative effects on environmental quality that can be associated with new material production and raw material extraction, such as air pollution, water quality degradation, and habitat destruction.

Economic and social benefits:
Sites may generate revenue in the future for sale of materials salvaged from reusable or recyclable products on-site.

Suggested submittal documentation
Calculate the total costs of products and/or product components for construction, and provide a list of the products that are reusable or recyclable. Demonstrate that the costs of reusable or recyclable products comprise the specified percentage of total product costs during construction.

Technologies and strategies
Establish a project goal for recyclable or reusable products and identify material suppliers than can help achieve this goal.

Resources
For more information designing for deconstruction, see resources available at Lifecycle Building Challenge *(http://www.lifecyclebuilding.org/resources.php)*.

5.8 Credit Use adhesives, sealants, paints, and coatings with reduced VOC emissions

Intent
To reduce harmful health effects associated with air pollution, select paints, sealants, adhesives, coatings, and other products used in site development that contain reduced amounts of volatile organic compounds (VOCs).

Ecosystem services addressed:
- Global climate regulation
- Human health and well-being benefits

Economic and social benefits:
VOCs contribute to forming ground-level ozone, which is the primary component of smog. Ground-level ozone can cause respiratory infections, lung inflammation, and aggravation of respiratory diseases such as asthma.[100]

Requirements (based on LEED-NC EQ Credits 4.1 and 4.2):
- All adhesives and sealants used on-site shall comply with the requirements of the following reference standards: South Coast Air Quality Management District Rule #1168 and Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.
- All paints and coatings shall comply with the requirements of the following reference standards: Green Seal Standard (GS-11, First edition, May 20, 1993) for architectural paints, coatings, and primers; Green Seal Standard (GC-03, Second Edition, January 7, 1997) for anti-corrosive and anti-rust paints; and South Coast Air Quality Management District Rule #1113 (in effect on January 1, 2004) for architectural coatings.

Suggested submittal documentation
Provide a list of each adhesive, sealant, paint, and coating used on-site. For each product, include the manufacturer's name, product name, specific VOC data (in g/L, less water), and the corresponding allowable VOC from the referenced standard.

Technologies and strategies
Specify low-VOC materials in construction documents. Ensure that VOC limits are clearly stated in each section of specifications where adhesives, sealants, paints, and coatings are addressed.

Resources:
- For more information on South Coast Air Quality Management District rules, see *http://www.aqmd.gov/rules*.
- For more information on Green Seal Standards, see *http://www.greenseal.org/standards/commercialadhesives.htm*.

5.9 Credit Conduct a life cycle assessment

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Habitat functions
- Waste decomposition and treatment
- Human health and well-being benefits

Intent

Conduct a full or partial life cycle assessment (LCA) to reveal the environmental and human health effects throughout the life of a material that has not been previously assessed.

Requirements

- **Low point value:** In lieu of a full LCA, identify a portion of life cycle inventory data for a stage of the product's life (e.g., manufacturing stage or extraction stage) associated with a material and make this data publicly available (including a methodology report according to the ISO 14043 standard on reporting with reference to the ASTM E1991-05 Environmental Life Cycle Assessment (LCA) of Building Materials/Products). Make the data publicly available in references such as a peer-reviewed journal or in the National Renewable Energy Laboratory (NREL) U.S. Life-Cycle Inventory Database.
- **High point value:** Conduct a full product LCA (including cradle-to-gate processes and waste stream treatment) for one material that has not been previously assessed, and share the results in a peer-reviewed journal. Follow the ISO 14040, 14041, 14042, and 14043 methodologies and ASTM E1991-05, and undergo a peer-review process. Provide a qualitative interpretation of LCA information within the ecosystem services framework.
- **Note:** *Peer-review process must be conducted by an experienced and independent reviewer.*
- **Note:** *Identifying life cycle costs may also help achieve the "Support sustainable practices in materials manufacturing" credit.*

Suggested submittal documentation

Publish LCA materials to make them readily available for public use. Provide a brief narrative to describe how the LCA informed decision-making process about materials selected for use on-site.

Technologies and strategies

Use tools such as the Athena Institute's EcoCalculator or Impact Estimator, or the National Institute of Standards and Technology's Building for Environmental and Economic Sustainability (BEES) software to help evaluate the effects of a material throughout its life cycle.

Resources

- For more information on Athena Institute's EcoCalculator, see *http://www.athenasmi.ca/tools/ecoCalculator/index.html*.
- For more information on the National Institute of Standards and Technology Building for Environmental and Economic Sustainability (BEES) software, see *http://www.bfrl.nist.gov/oae/software/bees*.
- For more information on the National Renewable Energy Laboratory (NREL) U.S. Life-Cycle Inventory Database, see *http://www.nrel.gov/lci/database/default.asp*.

6 CONSTRUCTION

Minimize effects of construction-related activities

6.1 Prerequisite Create a soils management plan

Intent

Develop a plan prior to construction to optimize soil function, and communicate to grading, construction, and landscape contractors the intended management of soils.

Requirements

- Refer to the mapped locations of healthy and previously disturbed soils developed during the site assessment, and calculate the total surface area of zones of healthy soils and previously disturbed soils.
- On the soils map and grading plan, designate intended treatment for all site soils, including, but not limited to:
  - Healthy soils that will be retained in place and designated as soil protection zones
  - Previously disturbed soils that will be restored in place
  - Soils that will be disturbed during construction, restored, and re-vegetated
  - Soils that will be minimally graded during site development, restored, and re-vegetated.
- For soils that will be restored, describe treatment details for each zone, including the type, source, and expected volume of amendments *(see Appendix E for guidance)*.
- Communicate the soils plan to contractors (including site preparation, grading, construction, and landscape contractors) from the start of the project.

Ecosystem services addressed:

- Global climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Waste decomposition and treatment
- Food and renewable non-food products

Economic and social benefits:

Healthy soils reduce site maintenance costs by providing improved ecosystem services and reduced use of resources. Clearly defining and communicating soils goals to all site contractors will help protect valuable soil functions and minimize expensive restoration requirements.

Suggested submittal documentation

Provide a copy of the soils management plan for the site that includes maps and treatment types for each soil zone on the site, with signatures of all site contractors to demonstrate that the plan was communicated.

Technologies and strategies

Consider existing soils conditions during site design, and communicate clearly with all site contractors to ensure that soils goals are understood and achieved.

Resources

For a guide to developing a soils management plan, see Soils for Salmon resources (*http://www.soilsforsalmon.org/*), including the Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 *(http://www.soilsforsalmon.org/ pdf/SoilBMP_Manual-2007.pdf)*, or the King County form Achieving the Post-construction Soil Standard *(http://www.metrokc.gov/ddes/forms/ls-inf-SoilPost-ConStd.pdf)*.

6.2 Prerequisite Restore soils disturbed during construction

Intent
Restore soils disturbed during construction in all areas that will be re-vegetated, to rebuild soils' ability to support healthy plants, biological communities, and water storage and infiltration.

Requirements
- Restore 100 percent of soils disturbed during construction in all areas to be re-vegetated. Restore soils to meet the Soils Restoration Criteria *(see Appendix E)* for two of the three following categories: 1) dry bulk density or cone penetrometer reading, 2) organic matter content, and 3) soil biology.
  AND
- Achieve appropriate soil volume for plant growth. For trees, provide at least 2 cubic feet of plant-usable rooting soil for each square foot of mature tree canopy,[101] with a minimum depth of 2 feet and a maximum depth of 4 feet. Mature tree canopy is defined as at least 60 percent of the optimal tree canopy predicted by plant references. Structural soils can be used to achieve soil volume requirements.

Suggested submittal documentation
Provide information from the soils management plan to show the total area of soils disturbed during construction. Provide documentation (such as receipts from soil/compost supplier) to demonstrate that techniques to restore soil occurred. Provide soil tests* to show that the selected techniques achieved the criteria for two of the three categories above.

Ecosystem services addressed:
- Global climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Waste decomposition and treatment
- Food and renewable non-food products

Economic and social benefits:
Addressing aspects of soil health such as compaction, organic matter, soil biology, and soil volume can restore the ability of soils to provide healthy rooting environments for plants and store and infiltrate water. Soil restoration can save costs in the long run because healthy soils support healthy plant growth with less need for pesticides, fertilizers, and irrigation.[102 103]

Technologies and strategies
Limit disturbance during construction to zones of previously disturbed soils to minimize the need for additional restoration. In areas that will be re-vegetated, restore soil characteristics necessary to support the selected vegetation types.

Resources
- For more information on improving soil quality, see USDA Natural Resources Conservation Service resources *(http://soils.usda.gov/sqi/)*.
- For additional information on planning and managing soils in urban areas, see USDA Natural Resources Conservation Service resources *(http://soils.usda.gov/use/urban/)*, including the Urban Soil Primer *(http://soils.usda.gov/use/ urban/primer.html)*. Also refer to resources available at Building Soil *(http://www.buildingsoil.org/)*.

NOTES TO READERS:
* What testing frequency (number of tests per unit area) is reasonable? We want to demonstrate achievement of criteria without incurring excessive costs for the site.

6.3 Credit Achieve a carbon-neutral site

Intent

Eliminate net carbon emissions throughout the life of the site, including construction, operations, and maintenance. Reduce emissions through decreased energy consumption and provide carbon sinks to effectively offset the carbon balance of the site.

Ecosystem services addressed:

- Global climate regulation
- Local climate regulation
- Air and water cleansing
- Human health and well-being benefits

Economic and social benefits:

Reducing emissions due to construction, operations, and maintenance activities helps minimize the drivers of global climate change such as CO_2 and NO_X and reduces levels of air pollutants correlated with harmful health effects such as aggravated asthma and heart and lung disease.[104]

Requirements

- Offset all greenhouse gas emissions generated during site construction, operations, and maintenance by:
  - Using on-site restored vegetation and soils to act as sinks for greenhouse gases
    OR
  - Purchasing credits from a legally binding trading system that provides independent third-party verification. For all calculations,* use a time interval that includes 20 years** from the project completion date.
- **Note:** *The Sustainable Sites Initiative encourages readers to request information from manufacturers regarding embodied energy of products. While embodied energy information is not readily available for many landscape materials at this time, future calculators for this credit may expand to include this information as it becomes available.*
- **Note:** *Emissions associated with buildings need not be included in the calculations for this credit.*
- **Note:** *Vegetation and soils can provide greenhouse gas sinks on-site. Credits such as "Preserve and restore native wildlife habitat" and "Preserve and restore plant biomass on-site" may help achieve this credit.*

Suggested submittal documentation

Estimate total carbon emissions occurring during site construction (including transport of materials to the site and emissions from construction equipment), operations, and maintenance (including maintenance equipment emissions). Estimate total carbon sequestered by vegetation and soils of re-vegetated and restored areas on-site. For all calculations, use a time interval that includes 20 years from the project completion date. Use these estimates to calculate the net effect of the site on global greenhouse gas levels. If off-site carbon credits are purchased, provide receipts and documentation to demonstrate that the amount of credits purchased offset the net carbon emissions from the site.

NOTES TO READERS:

* The Sustainable Sites Initiative is currently developing a series of calculators to assess the carbon footprint of a site and the expected carbon sequestration of restored vegetation and soils. The calculators will be reviewed by a panel of experts and released for public comment in 2009. At this time, we would like your feedback on the direction and intent of the credit, as well as information on existing calculators that take site development and sequestration into consideration.

** The time interval can be revised to correspond with congressional actions on greenhouse gas emissions to help achieve U.S. goals for mitigating climate.

Technologies and strategies

Reduce emissions during site construction by salvaging materials available on-site or from nearby projects, selecting locally manufactured products, or selecting transport methods with increased fuel efficiency. Use construction and maintenance equipment that is properly maintained, powered by cleaner fuels, or uses verified technologies to reduce emissions. Increase carbon sequestration by reducing and preventing soil compaction and restoring disturbed sites with deep-rooted grasses and trees.

Resources

- For more information on emissions from diesel engines, see U.S. EPA's National Clean Diesel Campaign at *http://www.epa.gov/cleandiesel/* and *http://www.epa.gov/otaq/diesel/construction/index.htm*.
- For more information on emissions from landscape maintenance equipment, see U.S. EPA's Final Rule for control of emissions of air pollution from new non-road spark-ignition engines, equipment, and vessels at *http://www.epa.gov/otaq/equip-ld.htm*.
- For more information on calculating emissions during construction, see Sacramento Metropolitan Air Quality Management District information at *http://www.airquality.org/ceqa/index.shtml#construction* and HC Frey and P Kuo, *Best Practices Guidebook for Greenhouse Gas Reductions in Freight Transportation* (2007) at *http://www4.ncsu.edu/~frey/Frey_Kuo_071004.pdf*.
- For more information on calculating a site's carbon sequestration, see "Methods for calculating carbon sequestration by trees in urban and suburban settings," U.S. Department of Energy (1998), *ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/ sequester.pdf*. Also, see resources such as STRATUM, available from USDA Forest Service Center for Urban Forest Research at *http://www.fs.fed.us/psw/programs/cufr/*, or Build Carbon Neutral at *http://buildcarbonneutral.org/*.

6.4 Credit Divert construction and demolition materials from disposal

Intent
Divert construction and demolition (C&D) debris from disposal in landfills and incinerators to avoid down-cycling of materials, to redirect resources back to the manufacturing process or to appropriate sites, and to support a net zero-waste site.

Ecosystem services addressed:
• Global climate regulation
This credit also prevents negative effects on environmental quality that can be associated with new material production and raw material extraction, such as air pollution, water quality degradation, and habitat destruction.

Economic and social benefits:
Retaining C&D materials on-site reduces the cost of disposal at a landfill. Using C&D materials as resources for new site development, rather than viewing them as "waste," reduces costs for new purchased material, such as wood, concrete and other types of masonry, and drywall.

Requirements
- **Low point value:** Divert 50 percent of structural materials and 95 percent of roads/infrastructure materials (e.g., asphalt, concrete, metal) from disposal through recycling, reprocessing, or reuse on-site or off-site.
- **High point value:** Achieve the low point value AND one of the following:
  - **Option 1:** 50 percent of C&D materials (both structure and infrastructure) are reused, recycled, or reprocessed on-site
    OR
  - **Option 2:** 25 percent of C&D materials are reclaimed from on-site and reused either on-site or off-site. Off-site uses may include other projects, sale to salvage outlets, or donation to salvage charities.
- **Note:** *Calculations may be based on weight or volume, but must be consistent throughout. Totals exclude plants or soils.*
- **Note:** *If materials are to be reused as soil amendments, soil tests must first be conducted to determine that the material would be appropriate for the site soils. Non-composted and non-organic materials should not be added to soil as an amendment unless these materials can be demonstrated to benefit site soils.*

Suggested submittal documentation
Provide a general description of each type/category of C&D materials generated, location of receiving agent, and quantity of waste diverted (by category) in tons or cubic yards. Provide documentation (such as receipts and photographs) to verify that the weight or volume of C&D materials are reused according to specifications.

Technologies and strategies
Develop a construction waste-management plan to specify and communicate the expectations and requirements of the project.

Resources
For guidance on developing C&D waste-management specifications, see resources such as California Integrated Waste Management Board's Construction and Demolition Debris Recycling Specifications page *(http://www.ciwmb.ca.gov/ ConDemo/Specs/)* or WasteCap Wisconsin's page on Construction and Demolition Specifications *(http://www.wastecapwi.org/)*.

6.5 Credit Control and retain construction pollutants

Intent
Minimize discharge of construction pollutants* (including sediment) to water bodies during construction to protect water quality and aquatic habitats.

Requirements (adapted from LEED-NC SS Prerequisite 1):
Create and implement an erosion and sedimentation control (ESC) plan for all construction activities associated with the project. The ESC plan shall conform to erosion and sedimentation requirements of the 2003 EPA Construction General Permit (regardless of project size) OR local erosion and sedimentation control standards and codes, whichever is more stringent. The plan shall list the BMPs employed and describe how the BMPs accomplish the following objectives:

- Prevent loss of soil during construction by stormwater runoff or wind erosion, including protecting topsoil by stockpiling for reuse
- Prevent sedimentation of storm sewer or receiving streams
- Prevent polluting the air with dust and particulate matter
- Prevent escape of other pollutants from construction site (e.g., thermal pollution, concrete wash, fuels, chemical runoff, and pavement sealants).
- **Note:** *The construction phase of the project is considered complete when the site is stabilized or a notice of termination is filed.*
- **Note:** *The Construction General Permit (CGP) outlines the provisions necessary to comply with Phase I and Phase II of the National Pollutant Discharge Elimination System (NPDES) program. Although the CGP applies only to sites greater than 1 acre, its requirements are applied to all projects for the purposes of this credit.*

Ecosystem services addressed:
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Habitat functions
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

Economic and social benefits:
Retaining pollutants and sediment on-site improves water quality and provides associated benefits such as protection of aquatic habitat and opportunities for recreation such as fishing and swimming.

Suggested submittal documentation
Provide copies of the project drawings and a brief narrative to describe and document the erosion and sedimentation control measures implemented on-site. Provide confirmation regarding the compliance path taken by the project (i.e., NPDES Compliance or Local Erosion Control Standards). If a local standard has been followed, provide specific information to demonstrate that the local standard is equal to or more stringent than the referenced NPDES program.

Technologies and strategies
Develop a plan during the design phase of the project to retain sediment on-site during construction. Consider employing strategies such as temporary and permanent seeding, mulching, earth dikes, silt fencing, sediment traps, and sediment basins.

Resources
For more information on 2003 EPA General Construction Permit, see *http://cfpub.epa.gov/npdes/ stormwater/cgp.cfm*.

NOTES TO READERS:
* Future versions of this report will address sedimentation during site operations and maintenance.

6.6 Credit Use excess vegetation, rocks, and soil generated during construction

Intent
Retain and use on-site vegetation, soils, and mineral/rock waste generated during the land-clearing activities of the design and development process to achieve a net zero-waste site.

Ecosystem services addressed:
- Global climate regulation
- Waste decomposition and treatment

Economic and social benefits:
Retaining land-clearing materials on-site avoids the cost of waste disposal. Using existing site materials as a resource also reduces the need for new purchased materials and soil amendments such as compost and mulch.

Requirements
- **Low point value:** Retain 100 percent land-clearing materials for use within 50 miles of the site.
- **High point value:** Retain 100 percent of land-clearing materials on-site.
- **Note:** *This credit is available for sites that do not require any land clearing.*
- **Note:** *Soils must be reused for functions comparable to their original function—that is, topsoil is used as topsoil, subsoil as subsoil.*
- **Note:** *For the purposes of this credit, land-clearing plant materials include only inert, non-invasive, non-viable propagules and tissue. Diseased and/or invasive plant material need not be included in land-clearing material totals. However, these types of materials should be managed on-site to prevent spread. See the prerequisite for "Control and manage invasive species" for more details.*

Suggested submittal documentation
Provide an estimate of the amount of excess vegetation, soils, and mineral/rock waste generated (in tons or cubic yards), location of receiving agent, and quantity of materials (in tons or cubic yards) received by receiving agent. Provide documentation (such as receipts and photographs) to verify that land-clearing materials are retained according to specifications.

Technologies and strategies
Use existing vegetation, soils, and mineral/rock materials as resources in site design. Use excess vegetation removed during land-clearing to develop compost, mulch, or erosion-protection measures, and reuse existing soils and rocks in site design instead of importing new materials to the site.

Resources
For more information on composting, see U.S. EPA's GreenScapes program at *http://www.epa.gov/greenscapes/index.htm*, including *http://www.epa.gov/epaoswer/non-hw/green/pubs/home-gs.pdf*.

7.1 Prerequisite Plan for sustainable landscape maintenance

Intent
Develop a landscape maintenance plan that outlines the long-term strategic plan for the site and identifies short-term action plans to achieve sustainable maintenance goals.

Requirements
Prepare a landscape maintenance plan with the integrated design team that addresses both the long-term strategic plan and short-term actions to achieve sustainable maintenance goals, using the Landscape Maintenance Plan Guidance *(see Appendix H)* as a guide. The landscape maintenance plan can be organized by activity and time of year to help guide maintenance managers and crews in their work.

Ecosystem services addressed:
Various services can be addressed through sustainable maintenance practices. Sustainable maintenance reduces resource consumption and waste, enhances flora and fauna health and diversity, and provides positive and healthy experiences.

Suggested submittal documentation
Provide a narrative overview of the landscape maintenance plan's long-term strategic plan and short-term action plans to achieve sustainable goals. List the integrated design team members who developed the landscape maintenance plan. Provide documentation showing that site managers have reviewed and agreed to implement the plan. Although the Landscape Maintenance Plan in Appendix H is intended as a guide to identifying the long-term strategic plan and developing short-term action plans, not all topics apply to all sites and each site may contain important unique elements that are not explicitly addressed there.

7.2 Credit Minimize exposure to localized air pollutants

Intent*
Restrict tobacco smoking and landscape maintenance activities that expose site users to localized air pollutants.**

Requirements
Maintenance options:

- **Low point value:** Schedule activities that generate emissions (e.g., landscape maintenance and pesticide application) to occur when site users are not present. In the site maintenance plan, designate appropriate times for emission-generating maintenance.
- **High point value:** Use manual landscape maintenance equipment or equipment that does not release air pollutants during use. In the site maintenance plan, specify the type of equipment used for maintenance and note that no equipment with gasoline- or diesel-powered engines shall be used for maintenance.

Outdoor smoking options:

- **Low point value:** Develop and implement a policy to prohibit smoking outdoors at least 25 feet away from entries, operable windows, air intakes, bus stops, parking for people with disabilities, patios, overlooks, and other outdoor gathering areas where people could inadvertently come in contact with tobacco smoke when occupying, entering, or leaving the site. A site is not required to extend no-smoking zones beyond the boundaries of the site. Clearly designate outdoor smoking areas that meet the above requirements and provide adequate waste disposal (adapted from the LEED-NC EQ Prerequisite 2 and Green Guide for Health Care FM Prerequisite 6 for Environmental Tobacco Smoke Control).***
- **High point value:** Develop and implement a policy to prohibit smoking within the entire site.
- **Note:** *According to the U.S. Department of Health and Human Services, there is no risk-free level of exposure to secondhand smoke. Even low levels of exposure can harm non-smokers' health. Separating smokers from non-smokers,*

Ecosystem services addressed:

- Global climate regulation
- Air and water cleansing
- Human health and well-being benefits

Economic and social benefits:
Cleaner air is linked to reduced health care costs. The estimated annual economic value of avoiding the effects of ozone and particulate matter in air is nearly $10 billion in a four-county area of southern California (the South Coast Air Quality Management District) alone.[105] Volatile organic compound (VOC) emissions from small non-road engines such as lawn mowers, leaf vacuums, and other outdoor power equipment contribute to the formation of ozone, which impairs lung function and is a key ingredient in smog.[106]

Individual cigarettes are point sources of air pollution; smokers in groups become an area source of secondhand smoke pollution. Secondhand smoke contains respirable particles that can cause breathing difficulty for those with chronic respiratory diseases or trigger an asthmatic attack in those with disabling asthma.

Outdoor tobacco-free zones reduce exposure to secondhand smoke, which is responsible for an estimated 3,000 lung cancer deaths and 35,000 heart disease deaths in non-smoking individuals each year in the United States.[107]

NOTES TO READERS:
* Materials selection that affects localized air quality is addressed in the "Use adhesives, sealants, paints, and coatings with reduced VOC emissions" credit.
** Future drafts of this report will explore adequate buffers between sources of pollution and high-use portions of the site. Please provide references on this subject.
*** Is there a less prescriptive option to meet the intent of this credit and limit effects of tobacco smoke to site users?

cleaning the air, and ventilating buildings cannot eliminate secondhand smoke exposure. Conventional air-cleaning systems can remove large particles, but not the smaller particles or the gases found in secondhand smoke. Establishing a smoke-free environment is the only effective way to protect non-smokers from secondhand smoke.[108]

- **Note:** *To implement a tobacco-free policy, post appropriate signs in the specified tobacco-free area. In the site maintenance plan, describe how the site will be monitored for compliance and potential repercussions for violators.*

Suggested submittal documentation

- **Maintenance options:** Provide the applicable section(s) of the site maintenance plan that describe(s) how the selected options to minimize localized air pollution will be implemented and enforced. Document that the plan has been shared with and agreed upon by the maintenance contractor.
- **Outdoor smoking options:** Provide a copy of the smoke-free policy and implementation plan OR prepare a copy of the site plan indicating designated smoking areas and their distances from entries, operable windows, air intakes, outdoor gathering areas and other locations where occupants could inadvertently come in contact with tobacco smoke.

Technologies and strategies

Design the site to minimize maintenance requirements for gasoline-powered equipment. Take into account prevailing winds and microclimate effects in locating exterior smoking areas. Consider innovative techniques, such as filters near air intakes or outdoor smoke rooms, to limit the effects of tobacco smoke on site users.

Resources

- For techniques to minimize emissions during landscape maintenance, see U.S. EPA's guidance at *http://www.epa.gov/otaq/equip-ld.htm* or *http://www.epa.gov/OMS/consumer/19-yard.pdf*.
- For a model voluntary comprehensive non-smoking policy for businesses and organizations, See California's Clean Air Project secondhand smoke resources for outdoor tobacco smoke at *http://www.ccap.etr.org/index.cfm?fuseaction=resources.outdoor*.
- For example ordinances for smoke-free events and outdoor areas, see Public Health Law & Policy Technical Assistance Legal Center (TALC) at *http://talc.phlpnet.org/pubs/ publications.php?choice=new_browse&search=1#events*.
- For ordinance lists, maps, and data, see American Nonsmokers' Rights Foundation at *http://www.no-smoke.org/goingsmokefree.php?id=519*.

7.3 Credit Recycle organic matter generated during site operations and maintenance

Intent
Use vegetation trimmings generated during operations and maintenance as compost and mulch to improve soil health and reduce the need for chemical fertilizers, irrigation, and pesticides.

Ecosystem services addressed:
- Global climate regulation
- Waste decomposition and treatment

Economic and social benefits:
Recovering landscape trimmings for use as compost or mulch saves money by reducing or eliminating the need for purchased fertilizers, pesticides, and irrigation.[109] Reusing landscape "waste" as a resource on-site also reduces costs for waste disposal. When clippings are mulched and left on the lawn, total lawn maintenance time may also be reduced.[110]

Requirements
- **Low point value:** Compost and/or recycle 100 percent of excess plant material off-site within 50 miles.
- **Mid-point value:** Compost and/or recycle at least 50 percent of excess plant material on-site; compost and/or recycle the remaining green waste off-site within 50 miles.
- **High point value:** Compost and/or recycle 100 percent of excess plant material on-site.
- **Additional point:** For sites that provide food options, provide space for on-site collection of compostable organics to prevent them from entering the municipal solid-waste stream. Sites must conduct a waste audit to estimate amount of organic waste generated.
- **Note:** *For the purposes of this credit, excess plant materials include only inert, non-invasive, non-viable propagules and tissue.*
- **Note:** *Recycling can include mulching, grazing, leaving plant materials in situ, and management through prescribed fire. Prescribed fire does not include burning trash or brush piles.*
- **Note:** *Diseased and/or invasive plant material need not be included in green-waste totals. However, these types of materials should be managed on-site to prevent spread. See "Control and manage invasive species" prerequisite for more details.*

Suggested submittal documentation
Provide calculations of the approximate amount of excess plant material and the process for composting and/or recycling. Provide site plans to verify that organic matter collection areas have been provided to meet the needs of the site. If composting and/or recycling takes place off-site, the maintenance plan must document the receiving company and its distance from the site.

Technologies and strategies
Leave landscape trimmings in situ or collect excess vegetation generated during site maintenance to divert to a composting facility on- or off-site.

Resources
For more information on composting, see U.S. EPA's GreenScapes program at *http://www.epa.gov/greenscapes/index.htm*, including *http://www.epa.gov/epaoswer/non-hw/green/pubs/home-gs.pdf*.

7.4 Credit Provide for storage and collection of recyclables

Intent
Provide space for collection of recyclable materials (including paper, glass, plastics, and metals) to facilitate recycling and reduce waste generation and waste disposal in landfills.

Ecosystem services addressed:
- Global climate regulation

Economic and social benefits:
Recycling programs can reduce costs for disposal of waste at landfills and generate revenue through sales of materials collected for recycling.[111]

Requirements
Provide an easily accessible area that serves the entire site and is dedicated to the collection and storage of non-hazardous materials for recycling, including (at a minimum) paper, glass, plastics, and metals.

Suggested submittal documentation
Provide site plans to verify that recycling collection areas have been designed to meet the needs of the site. Provide a brief narrative or calculations to demonstrate that the size and location of recycling collection areas are adequate for expected site program needs. Documentation should include types of materials that are being collected for recycling, the recycling location where materials will be deposited, and frequency of pickup for recyclables.

Technologies and strategies
Coordinate the size and function of the recycling areas with the anticipated collection services for glass, plastics, paper, and metals to maximize the effectiveness of the dedicated areas.

Resources
For information on estimating waste generation to set up recycling programs, see California Integrated Waste Management Board's Solid Waste Characterization page *(http://ciwmb.ca.gov/WasteChar/)*.

7.5 Credit Use renewable sources for site outdoor electricity

Intent
Use electricity from renewable sources to reduce the site's carbon footprint and minimize air pollution, habitat destruction, and pollution from mining.

Ecosystem services addressed:
- Global climate regulation

Economic and social benefits:
Renewable energy sources add an economically stable source of energy to the mix of U.S. generation technologies.

Requirements
- **Low point value:** Use on-site renewable sources to generate 50 percent of site outdoor electricity OR engage in at least a two-year contract for the purchase of 100 percent of site electricity from renewable sources.
- **High point value:** Use on-site renewable sources to generate 100 percent of site outdoor electricity OR engage in at least a four-year contract for the purchase of 100 percent of site electricity from renewable sources.*
- **Note:** *Renewable energy sources must meet the Center for Resource Solutions (CRS) Green-e products certification requirements. Other sources of green power are eligible if they satisfy the Green-e program's technical requirements.*
- **Note:** *Site outdoor electricity is defined as all electricity that powers appliances outside of the building.*

Suggested submittal documentation
Provide documentation to demonstrate the renewable energy sources used and the percent of annual energy use generated or purchased from each renewable source.

Technologies and strategies
Assess the project for non-polluting and renewable energy potential, including solar, wind, geothermal, and low-impact hydro. Determine the energy needs of the site and investigate opportunities to engage in a green-power contract.

Resources
For more information about renewable sources and the Green-e program, see *http://www.green-e.org*.

NOTES TO READERS:
* Are these reasonable requirements for length of contract and percent renewable energy?

[1] PR Ehrlich, "The concept of human ecology: A personal view," *IUCN Bulletin* 16, no. 4-6 (1985): pp. 60-61.

[2] RS De Groot, MA Wilson, and RMJ Boumans, "A typology for the classification, description and valuation of ecosystem functions, goods and services," *Ecological Economics* 41, no. 3 (2002): pp. 393-408.

[3] The basic concept is to allow the buffer to become narrower at some points, as long as the average width of the buffer meets the minimum requirements. This approach provides flexibility and fairness for sites with buffers, as discussed in Center for Watershed Protection resources (including T Schueler "The architecture of urban stream buffers," Watershed Protection Techniques 1 (1995): pp.159-163), http://www.cwp.org.

[4] AJ Castelle, C Conolly, M Emers, et al., *Wetland Buffers: Use and Effectiveness* (Olympia, WA: Adolfson Associates, Inc., Shorelands and Coastal Zone Management Program, Washington State Department of Ecology, Publication #92-010, 1992).

[5] Buffer width measurement definition is based on: T Schueler, "The Architecture of Urban Stream Buffers."

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[7] R Putnam, "The Prosperous Community: Social Capital and Public Life," *The American Prospect* 13 (Spring 1993): pp. 35-42.

[8] R Putnam, "Bowling Alone: America's Declining Social Capital," *Journal of Democracy* 6, no. 1 (January 1995), pp. 65-78.

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[11] C Schively, *Enhancing Transportation: The Effects of Public Involvement in Planning and Design Processes* (Minneapolis: Humphrey Institute of Public Affairs, University of Minnesota, 2007).

[12] D Pimentel, R Zuniga, and D Morrison, "Update on the environmental and economic costs associated with alien-invasive species in the United States," *Ecological Economics* 52 (2005): pp. 273-288.

[13] Ibid.

[14] TJ Swiecki and EA Bernhardt, "Guidelines for Developing and Evaluating Tree Ordinances," International Society of Arboriculture, *http://www.isa-arbor.com/publications/ordinance.aspx* (accessed August 20, 2008).

[15] U.S. Environmental Protection Agency, *Outdoor Water Use in the United States*, EPA-832-F-06-005, Department of the Interior (2007).

[16] KL Kopp, T Cerny, and R Heflebower, *Water-Wise Landscaping*, Utah State University Extension, HG-518 (2002).

[17] *Outdoor Water Use in the United States.*

[18] "Wastewater Treatment and Water Reclamation," Lawrence Berkeley National Laboratory Water Energy Technology Team, *http://water-energy.lbl.gov/node/16* (accessed August 20, 2008).

[19] K Vargas, EG McPherson, JR Simpson, et al., *Interior West Community Tree Guide: Benefits, costs, and strategic planning*, U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, General Technical Report, PSW-GTR-205 (2007).

[20] PJ Peper, EG McPherson, JR Simpson, et al., *New York City, New York: Municipal Forest Resource Analysis*, U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station (2007).

[21] "Heat Island Effect," U.S. Environmental Protection Agency, *http://www.epa.gov/hiri/index.html* (accessed August 20, 2008).

[22] "Heat Island Effect: Trees and Vegetation," U.S. Environmental Protection Agency, *http://www.epa.gov/hiri/strategies/vegetation.html* (accessed August 20, 2008).

[23] "Heat Island Effect: Vegetation and Air Quality," U.S. Environmental Protection Agency, *http://www.epa.gov/heatisland/strategies/level3_vegairquality.html* (accessed August 20, 2008).

[24] "Heat Island Effect," U.S. EPA.

[25] I Brook, "Making here like there: Place attachment, displacement and the urge to garden," *Ethics, Place and Environment* 6 (2003): pp. 227-234.

[26] "Landscaping with Native Plants Factsheet," U.S. Environmental Protection Agency, http://www.epa.gov/greenacres/nativeplants/factsht.html#Why Should I (accessed August 20, 2008).

[27] SL Buchman and GP Nabhan, *The Forgotten Pollinators* (Washington, DC: Island Press, 1996), p. 312.

[28] De Groot, Wilson, and Boumans. "A typology for the classification, description and valuation of ecosystem functions, goods and services."

[29] Buffer width measurement definition is based on: T Schueler, "The Architecture of Urban Stream Buffers."

[30] The buffer widths in Table 5-2 are based on a literature review of current sources from local, state, and federal agencies, as well as resources from the Center for Watershed Protection, peer-reviewed research, and university publications.

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APPENDICES

APPENDIX A

Riparian and Wetland Buffer Function Assessment Worksheet

This worksheet is intended to accompany:
1.2 Prerequisite: Protect and restore floodplain functions of riparian and coastal zones
3.11 Credit: Protect and restore riparian and wetland buffers

Intent
This is a guidance document intended for sites with riparian or wetland areas, to help determine the quality of a site's existing riparian or wetland buffers. This worksheet will help site managers identify problem areas (those evaluated as "poor"), as well as areas that could be protected (aspects with a "good" rating) or enhanced (aspects with a "moderate" rating). To achieve the prerequisite and credit listed above, the appropriate area of buffer should be protected and restored, with special focus on the ecosystem functions described in this evaluation worksheet.

Riparian Buffers
The evaluation is based primarily on the "Potential Riparian Buffer Development Site Evaluation Form, Woonasquatucket River" developed by the Rhode Island Department of Environmental Management. The categories of evaluation reflect the ecosystem services potentially provided by riparian areas, including:

- Water cleansing
- Habitat functions
- Water supply and regulation/hazard mitigation
- Cultural benefits.

WATER CLEANSING

A. Buffer Bypass*	
Complete bypass of buffer by surface runoff/stormwater from subject site	poor
Partial bypass of buffer by surface runoff/stormwater from subject site	moderate
No bypass of buffer by surface runoff/stormwater from subject site	good

*A buffer bypass includes: erosion gullies, swales, point discharges from pipes, or other hydro-modifications that divert surface runoff and prevent it from traveling as sheet flow or interflow through the riparian area.

B. Sources of Sediment or Pollutant Loading	
Potential sediment or pollutant loading* in all subdrainage areas flowing to the riparian buffer (or associated water body**) on the subject site	poor
Potential sediment or pollutant sources in some subdrainage areas flowing to the riparian buffer (or associated water body) on the subject site	moderate
No potential sediment or pollutant sources flowing to the riparian buffer (or associated water body) on the subject site	good

*Potential sediment or pollutant loading sources include impervious areas, disturbed or unvegetated lands, stormdrain outfalls, etc.
**Areas of potential sediment or pollutant loading may bypass the buffer due to pipes or gullies, as identified in Category A: Buffer Bypass.

C. Vegetation Condition*	
Poor vegetation coverage throughout riparian buffer	poor
Moderate vegetation quality and coverage, or patches of good and poor quality and coverage	moderate
Good vegetation quality and coverage throughout the riparian buffer	good

*Criteria for vegetation quality and coverage vary by region but generally include the following parameters: presence of native vegetation; number of vegetation layers; canopy cover; ground cover; limited evidence of ongoing human disturbance or management (mowing, clearing, structures, impervious surfaces), etc.

D. Soil Erosion and Stream Bank Stability	
Significant areas of active soil erosion or unstable banks/shoreline*	poor
Occasional areas of active soil erosion or unstable banks/shoreline	moderate
No signs of active erosion or unstable banks/shoreline	good

*erosion or instability beyond natural levels, possibly a result of disturbance

HABITAT FUNCTIONS

E. Exotic and/or Invasive Plant Species	
Significant presence of invasive or exotic plant species causing deterioration of biological functions*	poor
Presence of invasive or exotic plant species; future deterioration of biological functions likely without intervention	moderate
Limited or no invasive or exotic plant species present; future deterioration of biological functions unlikely	good

*Biological functions include plant and wildlife habitat and aquatic/terrestrial wildlife food and shelter.

F. Connection to Adjacent Wildlife Habitat	
The riparian area is isolated and does not connect to other naturally vegetated habitats or priority habitat areas.*	poor
The riparian area is close, but not directly connected to, other naturally vegetated habitat; opportunities may exist to connect.	moderate
The riparian area connects physically and functionally to adjacent priority habitat areas or is part of a habitat corridor connecting two or more such areas.	good

*Naturally vegetated habitats may include forests, wetlands, or abandoned fields that are not under ongoing disturbance or management by humans. Priority habitats will vary by region but may include areas identified as supporting threatened or endangered species, interior forest species, or migratory bird populations.

G. Aquatic Habitat	
The aquatic habitat is highly degraded and not likely to support fish species or water-dependent wildlife.	poor
The aquatic habitat is somewhat degraded, but may support some fish or water-dependent wildlife.	moderate
The aquatic habitat is high quality and likely to support fish or water-dependent wildlife.	good

*Characteristics of high-quality aquatic habitat will vary by region and type of water body. Refer to appropriate regional environmental evaluation guidance.

H. Human Disturbance	
Extensive human disturbance* within the riparian area (i.e., structures, impervious surfaces, cleared/mowed areas, trash piles, etc.)	poor
Moderate, ongoing human disturbance within the riparian area (i.e., limited clearing of vegetation/mowing, livestock access, limited trash dumping, etc.)	moderate
Limited or no evidence of ongoing human disturbance within the riparian area	good

*in a way that negatively impacts wildlife or wildlife habitat

WATER SUPPLY AND REGULATION/HAZARD MITIGATION

I. Watershed Position	
The site occupies a low (downstream) position in the watershed (includes a fourth-order stream or higher).	poor
The site occupies a middle position in the watershed (includes second- or third-order streams).	moderate
The site occupies an upper position in the watershed and includes first-order streams, springs, or seeps.	good

J. Flood Attenuation*	
Significant modifications have reduced or eliminated the ability of the water body to accommodate flooding.	poor
Some modifications have reduced the ability of the water body to accommodate flooding.	moderate
There is no evidence of modifications that have reduced the ability of the water body to accommodate flooding.	good

*Examples of modifications that would reduce the ability of a water body to accommodate flooding include straightened channels, armored banks or shoreline, impervious surfaces, blockage or reduction of floodplain areas, filling or draining of wetlands or topographic depressions, etc.

CULTURAL BENEFITS

K. Visual Accessibility	
The riparian area is not visually or physically accessible to the public.	poor
The riparian area is visually but not physically accessible to the public.	moderate
The riparian area is both visually and physically accessible to the public.	good

L. Proximity of School or Community Center	
The site is not within 1 mile of a school, community center, or densely populated area.	poor
The site is within 1 mile of a school, community center, or densely populated area.	good

M. Opportunities for Education	
The site does not offer opportunities for people to view wildlife, native plant communities, and other characteristics of a naturally functioning stream corridor.	poor
The site offers opportunities for people to view wildlife, native plant communities, and other characteristics of a naturally functioning stream corridor.	good

Wetland Buffers

The evaluation is based primarily on the "Potential Riparian Buffer Development Site Evaluation Form, Woonasquatucket River" developed by the Rhode Island Department of Environmental Management. The categories of evaluation reflect the ecosystem services that can potentially be provided by wetland buffer areas, including:

- Water cleansing
- Habitat functions
- Water supply and regulation/hazard mitigation
- Cultural benefits.

WATER CLEANSING

A. Buffer Bypass*	
Complete bypass of buffer by surface runoff/stormwater from subject site	poor
Partial bypass of buffer by surface runoff/stormwater from subject site	moderate
No bypass of buffer by surface runoff/stormwater from subject site	good

*A buffer bypass includes: erosion gullies, swales, point discharges from pipes, or other hydro-modifications that prevent surface runoff from traveling as sheet flow or interflow to the wetland.

B. Sources of Sediment or Pollutant Loading	
Potential sediment or pollutant loading* in all subdrainage areas flowing to the wetland buffer (or associated water body**) on the subject site	poor
Potential sediment or pollutant sources in some subdrainage areas flowing to the wetland buffer (or associated water body) on the subject site	moderate
No potential sediment or pollutant sources flowing to the wetland buffer (or associated water body) on the subject site	good

*Potential sediment or pollutant loading sources include impervious areas, disturbed or unvegetated lands, stormdrain outfalls, etc.
**Areas of potential sediment or pollutant loading may bypass the buffer due to features identified in Category A: Buffer Bypass.

C. Vegetation Condition*	
Poor vegetation coverage throughout the wetland buffer	poor
Moderate vegetation quality and coverage, or patches of good and poor quality and coverage	moderate
Good vegetation quality and coverage throughout the wetland buffer	good

*Criteria for vegetation quality and coverage vary by region but generally include the following parameters: presence of native vegetation; number of vegetation layers; canopy cover; limited evidence of ongoing human disturbance or management (mowing, clearing, structures, impervious surfaces), etc.

HABITAT FUNCTIONS

D. Exotic and/or Invasive Plant Species	
Significant presence of invasive or exotic plant species causing deterioration of biological functions*	poor
Presence of invasive or exotic plant species; future deterioration of biological functions is likely without intervention.	moderate
Limited or no invasive or exotic plant species present; future deterioration of biological functions is unlikely.	good

*Biological functions include plant and wildlife habitat and aquatic/terrestrial wildlife food and shelter.

E. Connection to Adjacent Wildlife Habitat	
The wetland and wetland buffer area is isolated and does not connect to other water bodies or naturally vegetated habitats or priority habitat areas.*	poor
The wetland and wetland buffer area is close, but not directly connected to, other water bodies or naturally vegetated habitat; opportunities may exist to connect.	moderate
The wetland and wetland buffer area connects physically and functionally to adjacent water bodies or priority habitat areas or is part of a habitat corridor connecting two or more such areas.	good

*Naturally vegetated habitats may include forests, wetlands, or abandoned fields that are not under ongoing disturbance or management by humans. Priority habitats will vary by region but may include areas identified as supporting threatened or endangered species, interior forest species, or migratory bird populations.

F. Aquatic Habitat*	
The wetland habitat is highly degraded and not likely to support water-dependent wildlife.	poor
The wetland habitat is somewhat degraded, but may support some water-dependent wildlife.	moderate
The wetland habitat is high quality and likely to support water-dependent wildlife.	good

*Characteristics of high-quality aquatic habitat will vary by region and type of water body. Refer to appropriate regional environmental evaluation guidance.

G. Human Disturbance	
Extensive human disturbance* within the wetland or wetland buffer area (i.e., structures, impervious surfaces, cleared/mowed areas, trash piles, drainage, etc.)	poor
Moderate, ongoing human disturbance within the wetland or wetland buffer area (i.e., limited clearing of vegetation/mowing, limited trash piles, etc.)	moderate
Limited or no evidence of ongoing human disturbance within the wetland or wetland buffer area.	good

*in a way that negatively affects wildlife or wildlife habitat

WATER SUPPLY AND REGULATION/HAZARD MITIGATION

H. Flood Attenuation*	
Significant modifications have reduced or eliminated the ability of the wetland to accommodate flooding.	poor
Some modifications have reduced the ability of the wetland to accommodate flooding.	moderate
There is no evidence of modifications that have reduced the ability of the wetland to accommodate flooding.	good

*Examples of modifications that would reduce the ability of a wetland to accommodate flooding include impervious surfaces, filling or draining of wetlands or topographic depressions, etc.

CULTURAL BENEFITS

I. Visual Accessibility	
The wetland or wetland buffer area is not visually or physically accessible to the public.	poor
The wetland or wetland buffer area is visually but not physically accessible to the public.	moderate
The wetland or wetland buffer area is both visually and physically accessible to the public.	good

J. Proximity of School or Community Center	
The site is not within 1 mile of a school, community center, or densely populated area.	poor
The site is within 1 mile of a school, community center, or densely populated area.	good

K. Opportunities for Education	
The site does not offer the opportunity for people to view wildlife, native plant communities, and other characteristics of a naturally functioning wetland or wetland buffer.	poor
The site offers the opportunity for people to view wildlife, native plant communities, and other characteristics of a naturally functioning wetland or wetland buffer.	good

APPENDIX B
Site Assessment Guidance and Regional Resource Identification

This guidance document is intended to accompany:
2.1 Prerequisite: Conduct a pre-design site assessment

Intent
The knowledge collected and documented during a site assessment is critical for guiding the design process. This guidance document will help identify opportunities to use sustainable strategies and protect or regenerate ecosystem services on-site.

The following material includes general information to collect during a site assessment to help achieve Sustainable Sites Initiative prerequisites and credits. The column on the left lists topics to address during the site assessment. Columns on the right are left blank for the integrated design team to use to provide details regarding site conditions and how this information will be addressed during site design. The table below does not include all of the information that may need to be collected in every site assessment, and various sites may contain additional important unique elements that are not explicitly addressed here.

I. REGIONAL CONTEXT			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected**	**How can this information influence site design?**
Surrounding context of site and potential considerations for site design, including: • local transportation options and future plans (including mass transit, bicycle, and pedestrian facilities, and roadways) • recreation activities, community resources, and other amenities • views or vistas, including those that look onto another property that could be enhanced • off-site habitat for wildlife, including habitat along migratory routes and wildlife corridors • existing stressful factors, including noise, odor, or excessive light	• Connect site to surrounding resources, amenities, and services • Provide opportunities for outdoor physical activity • Prevent and abate sensory stress • Provide outdoor spaces for mental restoration • Provide views of the natural environment to building occupants		

II. REFERENCE CONDITIONS Identify reference conditions for the site to develop an understanding of local systems and to help define project goals. A site can preserve or restore elements using native reference conditions as a guide.			
Document the following information:	**Applicable prerequisites and/or credits**	**Information collected**	**How can this information influence site design?**
Reference soil	• Restore soils disturbed by previous development • Restore soils disturbed during construction		
EPA Level III ecoregion	• Promote a sense of place with native vegetation. • Use appropriate, non-invasive plants		
Major habitat types of the region	Preserve and restore native wildlife habitat		
Target TR-55 curve number for the site	Manage water on-site		

III. EXISTING SITE CONDITIONS To address the topics in this section, conduct field tests and inventories with the help of qualified professionals. Some questions may require additional research or conditions modeling. Seasonal field visits may be necessary to identify ephemeral, impermanent conditions on-site.			
CLIMATE			
Document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Average annual and average monthly precipitation patterns, and any unique microclimate factors that may affect site design decisions and plant selections	• Manage water on-site • Reduce potable water consumption for irrigation • Minimize or eliminate potable water consumption for irrigation • Eliminate potable water use in ornamental or stormwater features • Minimize use of potable water in water features designed for full human contact • Design stormwater management features to be a landscape amenity • Use appropriate, non-invasive plants • Preserve and restore plant biomass on-site • Provide outdoor spaces for mental restoration • Provide outdoor spaces for social interaction		

SOILS			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Dominant soil profiles (minimum of 3-foot depth), textures, erodability, and subsurface drainage	• Create a soils management plan • Preserve existing healthy soils • Preserve existing topography • Restore soils disturbed during construction • Restore soils disturbed by previous development		
Topography	• Preserve existing topography		
Locations of prime farmland soils, unique soils, and/or soils of statewide importance	• Limit disturbance of prime farmland soils, unique soils, and soils of statewide importance		
Locations of healthy soils and previously disturbed soils (including locations of existing soil that could be used as a source of soil organisms for later re-introduction)	• Create a soils management plan • Preserve existing healthy soils • Preserve existing topography • Restore soils disturbed during construction • Restore soils disturbed by previous development		

HYDROLOGY			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Direction of overland water flow on-site and its effects on the watershed as a whole	• Manage water on-site. • Cleanse water on-site. • Control and retain construction pollutants.		
Locations of water resources (such as lakes, streams, wetlands, and estuaries) or other regulated or protected hydrologic areas (such as recharge zones), and portions of the site that are located within: • 100-year floodplain, as determined by FEMA (or using calculations specific to the site if no 100-year floodplain elevations have been calculated for the site) • 300 feet of a stream • 300 feet of any wetlands • FEMA coastal hazard zones (Zones V and A).	• Protect and restore floodplain functions of riparian and coastal zones • Protect and restore riparian and wetland buffers • Repair or restore damaged or lost streams, wetlands, and coastal habitats		
Shoreline erosion rate in the region	• Protect and restore floodplain functions of riparian and coastal zones		
Potential changes in future floodplains and coastal shorelines due to climate change or other regional trends that may affect the site	• Protect and restore floodplain functions of ripariand coastal zones • Protect and restore riparian and wetland buffers		

HYDROLOGY continued			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Quality of riparian and wetland buffers (using the guidelines in the Riparian and Wetland Buffer Function Assessment Worksheet, see Appendix A)	• Protect and restore floodplain functions of riparian and coastal zones • Protect and restore riparian and wetland buffers		
Lost or damaged surface waters, wetlands, or coastal habitats that could be restored	• Repair or restore damaged or lost streams, wetlands, and coastal habitats		
Watershed conditions, including target pollutants that have been identified and existing local, regional, or state watershed plans for the site's watershed	• Manage water on-site. • Cleanse water on-site • Protect and restore floodplain functions of riparian and coastal zones • Protect and restore riparian and wetland buffers • Repair or restore damaged or lost streams, wetlands, and coastal habitats		
Existing and potential pollution sources (both point and non-point sources) and health hazards on-site and adjacent to the site that may impact the site	• Select brownfields or greyfields for redevelopment • Restore soils disturbed by previous development • Cleanse water on-site		
Seasonal groundwater elevations or problems with over-infiltration that may affect BMP selection	• Manage water on-site • Cleanse water on-site		
Initial TR-55 curve number of the site (using TR-55 Curve Number Determination Worksheet, see Appendix F)	• Manage water on-site		
Potable and non-potable water sources for the site, and opportunities to capture, treat, and reuse rainwater and graywater	• Manage water on-site • Reduce potable water consumption for irrigation • Minimize or eliminate potable water consumption for irrigation • Eliminate potable water use in ornamental or stormwater features • Minimize use of potable water in water features designed for full human contact • Design stormwater management features to be a landscape amenity		
Wastewater and stormwater treatment facilities for the site, and opportunities to alleviate environmental and infrastructure concerns	• Manage water on-site • Reduce potable water consumption for irrigation • Minimize or eliminate potable water consumption for irrigation • Eliminate potable water use in ornamental or stormwater features • Minimize use of potable water in water features designed for full human contact • Design stormwater management features to be a landscape amenity		

VEGETATION			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Initial biomass density index of the site (using Site BDI Calculation Worksheet, see Appendix C)	• Preserve and restore plant biomass on-site • Provide outdoor spaces for mental restoration • Provide outdoor spaces for social interaction		
Locations of significant vegetation patches that can be incorporated into site design, including: • special status trees • threatened or endangered species habitat • blocks of habitat and corridors or connections between habitat patches • native plant communities • distinctive individual plants or communities • vegetation that could provide shade to buildings, parking lots, or spaces used for mental restoration, social interaction, or physical activities. • List scientific names of plants and any state, federal, or regional designations.	• Preserve special status trees. • Preserve threatened or endangered species habitat • Preserve and restore plant biomass on-site • Preserve and restore native wildlife habitat • Promote a sense of place with native vegetation • Minimize building heating and cooling requirements with vegetation • Reduce urban heat island effects • Provide views of the natural environment to building occupants • Provide outdoor spaces for mental restoration • Provide outdoor spaces for social interaction		
Locations of invasive and noxious weed species on-site. List scientific names of plants and indicate whether each species is considered invasive under state, federal, or regional lists.	• Control and manage invasive species		
Wildfire risk on-site and local fire department recommendations for preventing catastrophic fires	• Mitigate potential wildfire risks		

MATERIALS INVENTORY			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Existing rocks, sediment, and soils on-site that could be reused	• Use excess vegetation, rocks, and soil generated during construction		
Existing landscape materials and other site elements (e.g., structures, roads, parking lots, and pathways) and that could be safely retained, reused, or recycled	• Use excess vegetation, rocks, and soil generated during construction • Divert construction and demolition materials from disposal • Reuse on-site structures, hardscape, and landscape amenities		

HUMAN USE OF SITE			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Current and historic land use and management	• Select brownfields or greyfields for redevelopment. • Restore soils disturbed by previous developmen. • Cleanse water on-site • Engage users and other stakeholders in meaningful participation in site design. • Protect unique cultural and historical site attributes		
Existing site users	• Develop a program plan with site performance goals • Engage users and other stakeholders in meaningful participation in site design • Promote equitable site design, construction, and use		
Locations of interesting or unique features that will enhance the user experience and encourage site use such as view corridors, large trees, and water	• Provide views of the natural environment to building occupants • Provide outdoor spaces for mental restoration • Provide outdoor spaces for social interaction		
Site elements with known or perceived cultural and historical significance, including cultural or historic landscapes	• Protect unique cultural and historical site attributes		

REGIONAL RESOURCES			
Identify and map and/or document the following information:	**Applicable prerequisites and/or credits**	**Information collected (include maps if necessary)**	**How can this information influence site design?**
Nearby projects or construction sites that may have materials, soils, or vegetation that could be reclaimed for use on-site	• Use salvaged and recycled content materials • Achieve a carbon-neutral site		
Opportunities to generate renewable energy on-site (wind, solar, geothermal, etc.) or off-site renewable energy sources available to the site	• Use renewable sources for site outdoor electricity		
Sustainable plant nurseries and sustainable manufacturers that could supply vegetation and materials to the site	• Support sustainable practices in plant production • Support sustainable practices in materials manufacturing		
Local recycling or material reuse/resale facilities	• Use salvaged and recycled content materials • Achieve a carbon-neutral site		
Locally manufactured and distributed materials	• Achieve a carbon-neutral site		

APPENDIX C
Site Biomass Density Index (BDI) Calculation Worksheet

This document is intended to accompany:
3.6 Credit: Preserve or restore plant biomass on-site

SITE BDI CALCULATION WORKSHEET (FOR USE IN CALCULATING BOTH INITIAL AND PLANNED BDI)			
Vegetation cover type within zone*	**Percent of total site area**	**BDI**	**Percent of total site area x BDI (column A x column B)**
	A	**B**	**C**
Trees with understory		5	
Trees without understory (less than 10 percent herbaceous/shrub cover)		4	
Shrubs		2	
Herbaceous annuals and perennials and/or succulents		2	
Tall grasslands		2	
Turfgrass		1	
Green roof		0.5	
Impervious cover or bare ground not shaded by vegetation or vegetated structures		0	
TOTAL (sum of all rows above)	100 percent	N/A	Initial/planned BDI

*Do not include invasive species in calculations for initial BDI. These areas will be excluded from total site area. Similarly, if the site is dominated by an undesirable non-native or native species that is commonly considered locally problematic (e.g., a prairie ecosystem invaded by woodland), then these species may be excluded from total site area in calculations for initial BDI. In submittal documentation, demonstrate (with references published through a vetted, transparent process and accepted by the regional stakeholders) that the existing vegetation is considered locally problematic. For green-wall-area calculations, use a BDI of 1. Calculate the total surface area of vegetated wall, multiply by a BDI of 1, and divide by the total site area. Add this value to the site total for your initial/final BDI.

APPENDIX D

Biomass Density Index (BDI) Point Value Lookup Tables

This document is intended to accompany:
3.6 Credit: Preserve or restore plant biomass on-site

WETLANDS						
		Initial BDI				
		0-1.2	1.2-2.4	2.4-3.6	3.6-4.8	4.8-6.0
Planned BDI	0-1.2	0	0	0	0	0
	1.2-2.4	Low	0	0	0	0
	2.4-3.6	Mid	Low	0	0	0
	3.6-4.8	High	Mid	Low	0	0
	4.8-6.0	High	High	High	High	High

TEMPERATE FOREST						
		Initial BDI				
		0-1	1-2	2-3	3-4	4-5
Planned BDI	0-1	0	0	0	0	0
	1-2	Low	0	0	0	0
	2-3	Mid	Low	0	0	0
	3-4	High	Mid	Low	0	0
	4-5	High	High	High	High	High

TROPICAL FOREST						
		Initial BDI				
		0-0.8	0.8-1.6	1.6-2.4	2.4-3.2	3.2-4.0
Planned BDI	0-0.8	0	0	0	0	0
	0.8-1.6	Low	0	0	0	0
	1.6-2.4	Mid	Low	0	0	0
	2.4-3.2	High	Mid	Low	0	0
	3.2-4.0	High	High	High	High	High

GRASSLANDS						
		Initial BDI				
		0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5
Planned BDI	0-0.5	0	0	0	0	0
	0.5-1.0	Low	0	0	0	0
	1.0-1.5	Mid	Low	0	0	0
	1.5-2.0	High	Mid	Low	0	0
	2.0-2.5	High	High	High	High	High

SHRUBLANDS						
		Initial BDI				
		0-0.4	0.4-0.8	0.8-1.2	1.2-1.6	1.6-2.0
Planned BDI	0-0.4	0	0	0	0	0
	0.4-0.8	Low	0	0	0	0
	0.8-1.2	Mid	Low	0	0	0
	1.2-1.6	High	Mid	Low	0	0
	1.6-2.0	High	High	High	High	High

DESERT						
		Initial BDI				
		0-0.20	0-20-0.40	0.40-0.60	0.60-0.80	0.80-1.0
Planned BDI	0-0.2	0	0	0	0	0
	0.2-0.4	Low	0	0	0	0
	0.4-0.6	Mid	Low	0	0	0
	0.6-0.8	High	Mid	Low	0	0
	0.8-1.0	High	High	High	High	High

APPENDIX E
Soils Restoration Criteria

This document is intended to accompany:
3.15 Credit: Restore soils disturbed by previous development
6.2 Prerequisite: Restore soils disturbed during construction

Soils Restoration Criteria*—Meet criteria in the root zone (minimum of 12 inches) in two of the following three categories:

* Underlying subsoil should drain appropriately for site uses. Additional credit can be achieved for restoring subsoils such that they resemble the horizons of a reference soil or show similar drainage patterns.

1. Achieve ideal **dry bulk densities or cone penetrometer readings*** in 100 percent of the root zone (minimum of 12 inches in depth) in all areas without buildings and paved areas. See the tables** below for levels appropriate to soil texture.

   * Bulk density values are adapted from NRCS *Soil Quality Institute 2000* (general relationship of soil bulk density to root growth based on soil texture). Cone penetrometer values are adapted from *Cornell Soil Health Assessment Training Manual*.

TABLE 1. DRY BULK DENSITIES

Soil Texture	Maximum Acceptable Bulk Density (g/cm^3)
Sand, loamy sand	< 1.60
Sandy loam, loam	< 1.40
Sandy clay loam	< 1.40
Loam, silty clay loam	< 1.40
Silt, silt loam	< 1.30
Silt loam, silty clay loam	< 1.10
Sandy clay, silty clay, clay loam (35-45 percent clay)	< 1.10
Clay (>45 percent clay)	< 1.10

For methods, refer to ASTM D 4564 Standard Test Method for Density and Unit Weight of Soil in Place by the Sleeve Method, ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method, or ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

TABLE 2. CONE PENETROMETER READINGS

Cone Penetrometer				
	Surface Resistance (PSI)	Subsurface Resistance (PSI)		
	All Textures	Sand	Salt	Clay
worst	≥ 200	≥ 300	≥ 300	≥ 280
best	≤ 110	≤ 230	≤ 230	≤ 200

Penetration reading must be taken when soil is at field capacity (several days after free drainage).
Along with penetration readings, document the moisture level of soil and spacing interval for conducting the test.

Apply slow, even pressure so penetrometer advances in the soil at a rate of 4 seconds per 6 inches or less.
Record the highest pressure for each of the two depths.

For example test methods, use references such as Methods of Soil Analysis: Part 1 – Physical and mineralogical methods (EA Klute, ed.) or ASTM D3441 Standard Test Method for Mechanical Cone Penetration.

NOTES TO READERS:
** Are the values in both tables appropriate? What references exist with alternate acceptable values?

2. Achieve appropriate **organic matter** for plant growth and for water storage and infiltration. The top 12 inches of soil contains at least 3 percent organic matter (by loss-on-combustion tests*) or achieves organic matter levels comparable to your site's reference soil by amending with a mature compost material.

   * Acceptable test methods for determining soil organic matter include the most current version of ASTM D2974 "Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils" and TMECC 05.07A "Loss-On-Ignition Organic Matter Method."

3. Provide conditions to restore **soil organism** biomass activity and diversity**. The relative levels of bacteria, fungi, nematodes, and protozoa vary for different ecosystems. The balance of these groups of organisms should replicate those in your site's reference soils. In absence of a reference soil, refer to guidance** on relative levels of soil organisms that are appropriate for your ecosystem.

NOTES TO READERS:
** Is there any published guidance for appropriate soil organism ratios in U.S. ecosystems?

APPENDIX F
TR-55 Curve Number Determination Worksheet

This document is intended to accompany:
3.16 Credit: Manage water on-site

Note: This guidance refers to the USDA NRCS (SCS) TR-55 Manual Urban Hydrology for Small Watersheds (1986).

I. Determine the hydrologic soils group

For healthy soils, refer to soils maps and estimated infiltration rates based on soils descriptions (Appendix A of the TR-55 Manual includes estimated infiltration rates for each soils group).

For disturbed soils or imported fill materials, determine the hydrologic soils group based on the soil texture and infiltration rate using the table below.

Soil Description	Infiltration Rate	Hydrologic Soils Group
Deep, well-drained sand or gravel	>0.3 in./hr.	A
Deep, moderately well-drained to well-drained, moderately fine to moderately coarse texture	0.15-0.3 in./hr.	B
Moderately fine to fine-textured soils, usually with a layer that impedes downward movement of water	0.05-0.15 in./hr.	C
Clay soils with permanently high water table, clay pan or clay layer near the surface, or shallow soils over impervious material	0-0.05 in./hr.	D

To determine the equivalent hydrologic soils group for green infrastructure and best management practices:

- **Permeable pavement:** The subsoil is usually the limiting factor for infiltration under permeable pavement. Consider the subsoil and any modifications to the subsoil (such as compaction) and select the lowest infiltration rate of these to determine the appropriate hydrologic soils group. McCuen's Change in Curve Number Method (at the end of this appendix) may also be used if the design allows for a specific storage volume.
- **Green roof:** Use McCuen's Change in Curve Number Method to determine the curve number for the green roof area.
- **Infiltration facilities (rain gardens, bioswales, bioretention facilities, etc.):** Use the expected infiltration rate of the proposed soil mixture. McCuen's Change in Curve Number Method may also be used to account for a design storage volume.
- **Rainwater collection cisterns:**
  - *Option 1: CN = McCuen's Change in Curve Number Method*
    The rainwater is ultimately used in the landscape (e.g., for irrigation, stormwater features, or ornamental water features) or leaves the site via stormdrains.

- *Option 2: CN = 0 or the collection area is removed from the calculations*
  The hydrologic functions are not replaced and the collected rainwater leaves the site via sanitary sewers. Impacts from removing rainwater from the local watershed should be taken into consideration.
- For more detailed guidance on determining the curve number for best management practices, see McCuen's Change in Curve Number Method at the end of this appendix.

II. Determine the cover type

Refer to the cover types listed in Tables 2-2a-d in the TR-55 Manual. The quality of the cover type is determined by the percent ground cover. For final curve number calculations, the percent cover should be based on estimated plant sizes/coverage after 10 years.

To determine the equivalent cover type for common green infrastructure and best management practices:

- **Permeable pavement:** Use the cover type from Table 2-2a "gravel."
- **Green roof**: The cover type should be determined based on the proposed planting plan.
- **Infiltration facilities**: The cover type should be determined based on the proposed planting plan.

- For more detailed guidance on determining the curve number for best management practices, see McCuen's Change in Curve Number Method at the end of this appendix.

III. Determine the composite curve number

Based on the soils and cover types, calculate the composite curve number for the site.

Feature or Soil Name and Hydrologic Group	Cover Description	CN	Area (proportion of total site area)	Product of CN x area
n/a	Pavement	98	0.35	34.3
Infiltration 1, A	Woods, fair	36	0.1	3.6
Green Roof 1, B	Herbaceous, fair	71	0.3	21.3
Memphis, B	Meadow	58	0.1	5.8
Loring, C	Woods, good	70	10.5	10.5
			Total = 75.5 Composite Curve Number = 76.0	

McCuen's Change in Curve Number Method* (*Adapted from MDE 1983)

This document describes a methodology for determining the curve number for best management practices (such as green roofs, permeable pavements, infiltration facilities, etc.) that hold a certain volume of runoff.

The change in curve number method is described below.

Background

The method described below is a volume-based approach to control increases in discharge rates by storing the increased runoff depth caused by changes in land use. This method was developed by Dr. Richard McCuen as part of the development of the Maryland Standards and Specifications for Stormwater Management Infiltration Practices (MDE 1984) and described by MDE in the publication titled, "Modelling Infiltration Practices Using TR-20" (MDE 1983). The materials presented below have been adapted from that reference.

Step 1

The before-development peak discharge (q_b) can be determined using the NRCS (SCS) graphical method:

$$q_b = (q_{ub})(A)(Q_b) \qquad \text{Equation 1}$$

In Equation 1, q_{ub} is the unit peak discharge, in cubic feet per second per square mile per inch of runoff (csm/in.), from Fig. 1 based on the "before-development" time of concentration (t_{cb}) in hours. Q_b is the before-development depth of runoff in inches. A is the drainage area in square miles.

Using a subscript "a" to indicate "after development," the after-development peak discharge (q_a) is given by:

$$q_a = (q_{ua})(A)(Q_a) \qquad \text{Equation 2}$$

While the total drainage area (A) will remain constant, both the unit peak discharge (q_u) and the runoff depth (Q) will typically be greater for the after-development conditions. If development causes a decrease in the time of concentration, then the unit peak discharge will increase. Similarly, an increase in the percent of imperviousness will cause an increase in the volume of runoff. If the stormwater management policy requires q_a to be equal to q_b, then the policy could be met if a difference in depths of runoff ΔQ was controlled. ΔQ is determined as follows:

$$Q_{ua}(A)(Q_a - Q_b) = q_{ub}(A)Q_b \qquad \text{Equation 3}$$

Therefore, solving for ΔQ yields:

$$\Delta Q = Q_a - (q_{ub}/q_{ua})(Q_b) \qquad \text{Equation 4}$$

If there is no significant change in t_c, then (q_{ub}/q_{ua}) equals 1.0, and $\Delta Q = q_a - q_b$. If the development increases the t_c significantly, q_{ub} will usually be less than q_{ua} and ΔQ will be greater than the difference in the runoff depth $(Q_a - Q_b)$.

Method 1—Change in Curve Number Method

The after-development curve number can be reduced to reflect the runoff volume stored by infiltration or other best management practices. The runoff volume stored will be based on the design of the best management practices. The revised after-development curve number (CN*) is determined by the following equation:

$$CN^* = 200/[(P + 2Q + 2) - \sqrt{(5PQ + 4Q^2)}]$$

where P is the design rainfall depth in inches, and Q is the after-development runoff depth minus the runoff depth stored by the best management practices (ΔQ) in inches.

The revised curve number method is most applicable for cases where several best management practices are distributed evenly over the drainage area. For example, the method is best applied for residential land uses where each lot may have an infiltration practice. The level of peak discharge reduction is achieved by distributing the runoff storage volume over the entire watershed area and is reflected by adjusting the curve number.

Case Study

A 25-acre wooded area is to be converted to 0.25-acre residential lots. The change in curve number method will be used to determine the volume of storage required to release the 1-year pre-development discharge rate, and develop the outflow hydrograph below a best management practice facility.

Hydrologic Data

D.A. = 25 acres = 0.0390 sq. mi.
P (1-year storm) = 3.3 in.
CN_b = 66 t_b = 0.75 hrs.
CN_a = 75 t_a = 0.37 hrs.
q_{ub} = 375 csm/in. (From TR-55 Fig. 4-2)
q_{ua} = 590 csm/in. (From TR-55 Fig. 4-2)

Method 1— Change in Curve Number Method

Step 1: Compute the increased upland runoff depth for the 1-year storm.

$$Q = Q_a - (q_{ub}/q_{ua})\, Q_b$$
$$Q = 1.16 - (375/590)\,(0.69) = 0.72 \text{ inches}$$

The infiltration basin is sized to store 0.72 inches (65,340 cu. ft.) of runoff.

Step 2: Compute the adjusted curve number (CN*) associated with the revised after-development runoff depth (Q).

$$Q = 1.16 - 0.72 = 0.44 \text{ inches}$$
$$CN^* = 200/[(P + 2Q + 2) - \sqrt{(5PQ + 4Q^2)}$$
$$CN^* = 200/[(3.3 + 2(0.44) + 2) - \sqrt{(5(3.3)(0.44) + 4(0.44)^2)}]$$
$$CN^* = 59.78$$

APPENDIX G

TR-55 Curve Number Point Value Lookup Tables

HUMID EAST COAST
(REFERENCE SITE: RALEIGH, NC)

GREYFIELD / TARGET CURVE NUMBER = 70

Initial Curve Number	Final Curve Number																												
	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
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Low point value = 30 percent reduction in runoff volume

Mid-point value = 60 percent reduction in runoff volume

High point value = 90 percent reduction in runoff volume

HUMID EAST COAST
(REFERENCE SITE: RALEIGH, NC)

BROWNFIELD / TARGET CURVE NUMBER = 70																												
	Final Curve Number																											
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
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Low point value = 20 percent reduction in runoff volume
Mid-point value = 40 percent reduction in runoff volume
High point value = 60 percent reduction in runoff volume

SEMIARID WEST
(REFERENCE SITE: DENVER, CO)

GRAYFIELD / TARGET CURVE NUMBER = 60

Initial Curve Number	Final Curve Number																																				
	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60
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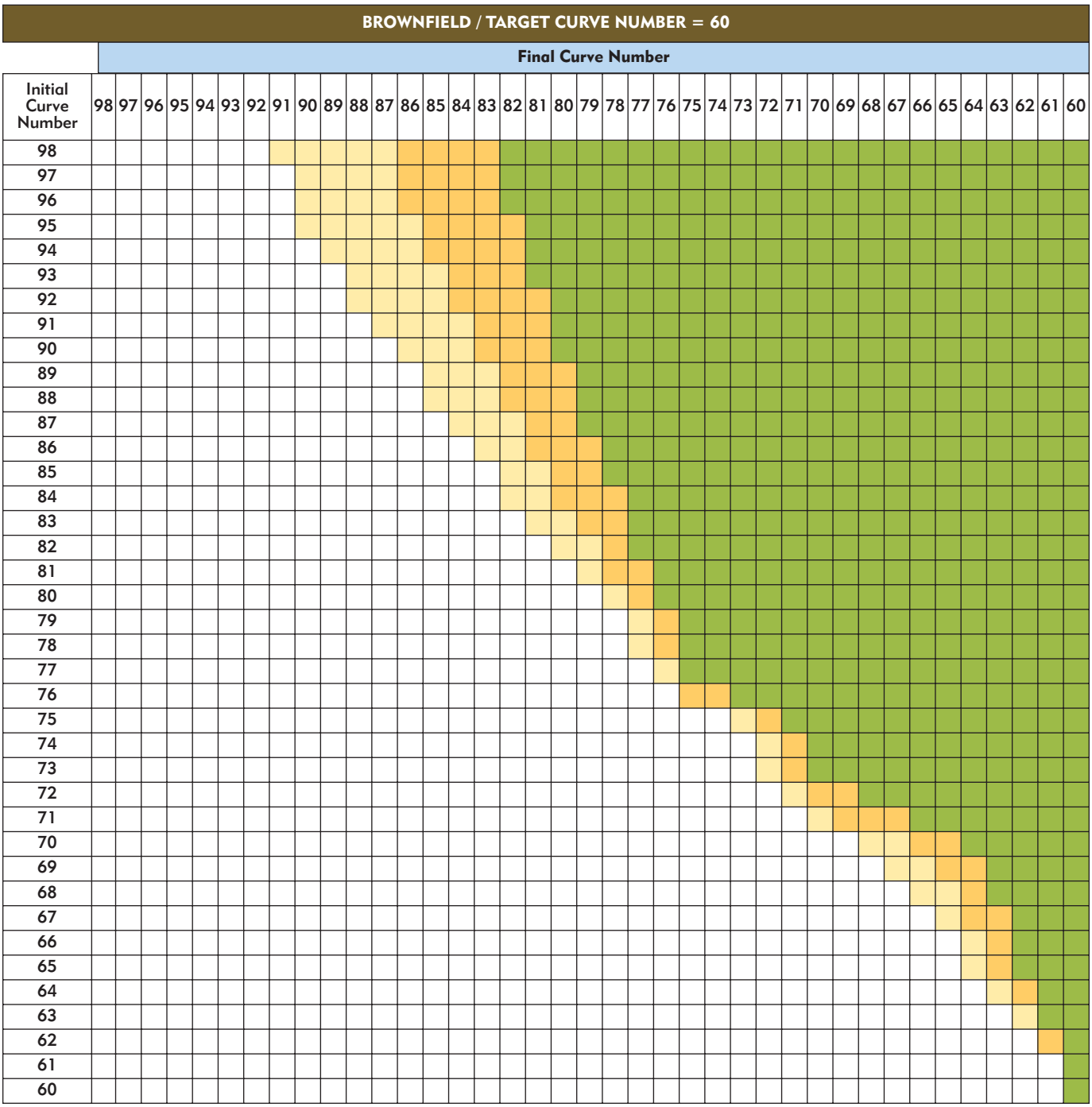
Low point value = 30 percent reduction in runoff volume

Mid-point value = 60 percent reduction in runoff volume

High point value = 90 percent reduction in runoff volume

SEMIARID WEST
(REFERENCE SITE: DENVER, CO)



Low point value = 20 percent reduction in runoff volume
Mid-point value = 40 percent reduction in runoff volume
High point value = 60 percent reduction in runoff volume

HUMID WEST COAST
(REFERENCE SITE: PORTLAND, OR)

GREYFIELD / TARGET CURVE NUMBER = 70																												
	Final Curve Number																											
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
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Low point value = 30 percent reduction in runoff volume
Mid-point value = 60 percent reduction in runoff volume
High point value = 90 percent reduction in runoff volume

HUMID WEST COAST
(REFERENCE SITE: PORTLAND, OR)

BROWNFIELD / TARGET CURVE NUMBER = 70																												
	Final Curve Number																											
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
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Low point value = 20 percent reduction in runoff volume

Mid-point value = 40 percent reduction in runoff volume

High point value = 60 percent reduction in runoff volume

ARID SOUTHWEST
(REFERENCE SITE: LOS ANGELES, CA)

GREYFIELD / TARGET CURVE NUMBER = 85														
	Final Curve Number													
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85
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Low point value = 30 percent reduction in runoff volume

Mid-point value = 60 percent reduction in runoff volume

High point value = 90 percent reduction in runoff volume

ARID SOUTHWEST
(REFERENCE SITE: LOS ANGELES, CA)

BROWNFIELD / TARGET CURVE NUMBER = 85														
	Final Curve Number													
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85
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Low point value = 20 percent reduction in runoff volume
Mid-point value = 40 percent reduction in runoff volume
High point value = 60 percent reduction in runoff volume

APPENDIX H
Landscape Maintenance Plan Guidance

This guidance document is intended to accompany:
7.1 Prerequisite: Plan for sustainable landscape maintenance
To download a Microsoft Excel spread sheet version of Appendix H click here

Intent
This guidance document will help the integrated design team identify issues to consider for the future operations and maintenance of the site. It can be used to help the team develop a landscape maintenance plan that identifies the long-term desired outcomes for the site and short-term plans to achieve sustainable maintenance goals.

In the leftmost column below, sustainable maintenance goals are listed that may be part of a site's long-term strategic plan for maintenance. Columns to the right of this column are left blank so that site managers can provide further details on long-term and short-term maintenance for the site, including activities, skill level, timeline/schedule, and other details (such as location, materials provider, etc.).

The topics listed below should be considered when developing a landscape maintenance plan. However, they are not all necessarily applicable to all sites, and certain unique elements or maintenance requirements of a given site may not be explicitly addressed here. The landscape maintenance plan should be reviewed and updated annually.

Maintenance plan topics to be addressed by the integrated design team including the maintenance contractor or staff	10-year desired outcome from maintenance practice	Required actions to achieve 10-year desired outcome (include specific details below)				Notes
		Specific maintenance activities	Skill level required to complete the task	Timeline/ schedule	Other details	
Plant Stewardship						
Plant maintenance: Maintain vegetation including large trees according to long-term plans for the site.						
Plant health: Monitor plant health to detect problems. Determine the proper techniques for dealing with dead, diseased, or pest-infested vegetation.						
Site safety: Maintain vegetation to ensure site safety and meet the needs of the intended uses of the site.						
Plant procurement: Purchase vegetation and seed from sustainable plant production facilities. *NOTE: Sustainable practices in plant production include those that reduce greenhouse gas emissions, use integrated pest management, prevent use and distribution of invasive species, reduce potable water consumption, use sustainable soil amendments, and reduce plant pot waste.*						
Pest management: Control pests or diseases using, at a minimum, integrated pest management (IPM) techniques. ***NOTE**: IPM takes an ecological approach to vegetation and pest management with an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures.*						

Maintenance plan topics to be addressed by the integrated design team including the maintenance contractor or staff	10-year desired outcome from maintenance practice	Required actions to achieve 10-year desired outcome (include specific details below)				Notes
		Specific maintenance activities	Skill level required to complete the task	Timeline/ schedule	Other details	
Invasive Species Management						
Invasive species control and removal: Prescribe treatments for invasive species identified on-site. *NOTE: Include proposed methods to manage the species and control its spread; description of the treatment phases; follow-up treatment timelines and techniques; and a long-term monitoring plan for existing invasive species.*						
Invasive species encroachment: Monitor for early detection and rapid response to invasive species encroachment (on an annual basis, at a minimum), which includes monitoring for newly listed species (review State and Federal Noxious Weeds laws and regional lists to identify any recent species additions).						
Organic Plant Materials Management						
Healthy plant-material management: Compost or recycle (including mulching, grazing, or prescribed fire) excess organic materials generated on-site, including fuels that may contribute to catastrophic wildfires.						
Invasive or diseased plant disposal: Dispose of organic plant materials generated on-site that are not suitable for composting or recycling (e.g., diseased vegetation or invasive seed sources) in a manner that does not increase the likelihood of spread.						
Soil Stewardship						
Soil amendments: Use the least harmful amendments (such as compost) to support soil and plant health and address nutrient deficiencies. ***NOTE:*** *Determine and document the source of compost, such as compost recovered from on-site plant material or compost that meets specifications for high-quality soil amendments, such as Oregon specifications for soil amendments (available at http://www.oregon.gov/ODOT/HWY/SPECS/docs/08book/08_01000.pdf) or Texas Transportation Institute's landscape soil amendment requirements (available in the Synthesis of New Methods for Sustainable Roadside Landscapes at http://tti.tamu.edu/documents/0-5330-1.pdf).*						
Fertilizers: Use fertilizers only when the need has been determined (e.g., with a soil test or plant symptom diagnosis), and ensure that fertilizer application methods are effective and efficient.						
Erosion and compaction: Alleviate soil erosion or soil compaction due to site use or maintenance.						

Maintenance plan topics to be addressed by the integrated design team including the maintenance contractor or staff	10-year desired outcome from maintenance practice	Required actions to achieve 10-year desired outcome (include specific details below)				Notes
		Specific maintenance activities	Skill level required to complete the task	Timeline/ schedule	Other details	
Irrigation and Water Use						
Irrigation allotment and schedule: Adhere to a watering schedule (frequency and duration) that will allow the site to meet annual volume requirements and restrictions. This oversight may include disconnecting or removing temporary irrigation systems after the plant establishment period.						
Irrigation water source: Maintain non-potable water sources used for landscape irrigation (e.g., rainwater harvesting or graywater systems).						
Stormwater Management Features and BMPs						
Stormwater management features and BMPs: Provide proper maintenance to ensure continued effectiveness.						
Water Features						
Non-toxic water treatments: Use the least harmful techniques to maintain water features (including features designed for human contact).						
Snow and Ice						
Removal: Manage snow/ice in ways that do not degrade water quality or negatively influence surrounding plant health. Locate stockpile areas and manage any snowmelt that will be used as a water source on-site.						
Hardscape, Landscape Amenities, or Structures						
Functionality and extended use: Use the least harmful techniques* to maintain the site's hardscape (e.g., pathways, walls, patios), landscape amenities, and structures (e.g., gazebos, arbors, restroom facilities). *For materials that emit volatile organic compounds (VOCs), such as paints, sealers, adhesives, and coatings, refer to:* • *South Coast Air Quality Management District Rule #1168, South Coast Air Quality Management District Rule #1113 (in effect on January 1, 2004)* • *Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000* • *Green Seal Standard (GS-11, First edition, May 20, 1993) for architectural paints, coatings, and primers* • *Green Seal Standard (GC-03, Second Edition, January 7, 1997) for anti-corrosive and anti-rust paints.*						
Site safety: Maintain hardscape, landscape amenities, and structures to ensure site safety and meet the needs of the intended uses of the site.						
Solar reflectivity: Clean the surfaces of architectural devices, structures, or paving materials with a solar reflectance index of at least 29 to ensure effectiveness.						
Historic or cultural structures: Maintain and determine how conflicts between historic and environmental concerns will be addressed.						

Maintenance plan topics to be addressed by the integrated design team including the maintenance contractor or staff	10-year desired outcome from maintenance practice	Required actions to achieve 10-year desired outcome (include specific details below)				Notes
		Specific maintenance activities	Skill level required to complete the task	Timeline/ schedule	Other details	
Recyclable Materials—Paper, Glass, Plastics, and Metals						
Recyclable materials: Manage all paper, glass, plastics, and metals that will be generated on-site for recycling.						
Recyclable Materials—Organic Food Waste						
On-site food waste: Collect and recycle food waste that will be generated on-site.						
Landscape Maintenance Equipment						
Equipment maintenance: Properly maintain equipment to limit air-pollutant emissions.						
Equipment selection: Use equipment and/or fuels that minimize air-pollutant emissions.						
Visitor experience: Adhere to a maintenance schedule that minimizes users' exposure to noise, localized air pollution, and other disturbances.						
Invasive species management: Clean equipment to remove invasive species to prevent transport to other sites.						
Personnel						
Personnel support: Educate personnel about the goals of the maintenance plan.						
Job opportunities: Advertise position openings for site maintenance personnel to provide job opportunities to local and/or low-income residents.						
Other Potential Maintenance Issues						
Undesirable wildlife: Effectively and humanely manage nuisance wildlife species.						
Sensitive areas: Protect portions of the site that may require minimized human use or disturbance (e.g., restored riparian buffers or sensitive wildlife habitat).						
Pollutants and toxins: Plan ahead to manage unintended spills or releases of potential pollutants or toxic materials.						
Monitoring and Adaptive Management						
Monitor the site: Assess the actual performance relative to its expected performance.						
Update plan: Re-evaluate the maintenance plan on an annual basis, and revise as needed to adapt to future conditions and unforeseen changes.						

GLOSSARY

Appropriate plant species plants adapted to site conditions, climate, and design intent

Aquifer in hydrologic terms, permeable layers of underground rock or sand that hold or transmit groundwater below the water table that will yield water to a well in sufficient quantities to produce water for beneficial use

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASTM International originally known as the American Society for Testing and Materials (ASTM), an organization formed in 1898 that develops voluntary consensus standards for a wide range of industries from petroleum, paint, flooring, environmental siting, and more

Biomass the amount of living matter, especially plant matter, in a given area

Brownfield abandoned, idled, or underused industrial and commercial facilities/sites where expansion or redevelopment is complicated by real or perceived environmental contamination; a site documented as contaminated by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local Voluntary Cleanup Program; a site defined as a brownfield by a local, state, or federal government agency

Buffer protection zone for the purposes of this report:
- Buffer protection zones must be fenced off and protected from parked construction vehicles and material storage such that the functionality is not altered.
- Do not develop new buildings or new impervious surfaces in buffer protection zones.
- If the buffer protection zone was previously degraded, it must be restored with appropriate native vegetation to retain sediment and prevent erosion.
- In the maintenance plan, describe how buffer protection zones will be protected and maintained in the future.

Carbon footprint the total amount of carbon dioxide and other greenhouse gases emitted over the life cycle of a product or service, through vehicle emissions, electricity use, and fuel consumption. The bigger the footprint, the greater the contribution to climate change.

Chemical fertilizer any inorganic material of wholly or partially synthetic origin that is added to the soil to sustain plant growth

CITES the Convention on International Trade in Endangered Species of Wild Fauna and Flora, an international agreement between governments to ensure that international trade in specimens of wild animals and plants does not threaten their survival. The trade is diverse, ranging from live animals and plants to a vast array of wildlife products, including food products, exotic leather goods, wooden musical instruments, timber, tourist curios and medicines. Levels of exploitation of some animal and plant species are high and the trade in them, together with other factors such as habitat loss, is capable of heavily depleting their populations and even bringing some species close to extinction.

Compost partially decomposed organic plant and animal matter that can be used as a soil conditioner or fertilizer

Cradle-to-cradle a phrase that refers to a product's environmental footprint from the point of extraction of raw materials (cradle), through processing, manufacturing, and use. Ideally, sustainable products would be designed so that reuse and recycling could take place at each stage, resulting in zero waste going to landfills.

Cradle-to-gate a phrase that refers to a product's environmental footprint from raw material acquisition (the cradle) through final manufacturing (the factory gate)

Deconstruction a process to carefully dismantle or remove useable materials from structures, as an alternative to demolition

Disturbed soils indicators of disturbed soils *may* include one or all of the following:
- soil horizons that differ significantly from the reference soil
- bulk densities that differ significantly from the reference soil
- weedy, opportunistic, or invasive plant species.

Down-cycling reprocessing that breaks down materials so that only their components are suitable for use, rather than their original form. For example, lumber can be reused as lumber or down-cycled to become mulch.

Ecoregion areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources

Ecosystem services natural assets that provide a full suite of goods and services vital to human health and livelihood. Many of these goods and services are traditionally viewed as free benefits to society, or "public goods," such as wildlife habitat and diversity, watershed services, carbon storage, and scenic landscapes. Lacking a formal market, these natural assets are traditionally absent from society's balance sheet; their critical contributions are often overlooked in public, corporate, and individual decision-making.

Embodied energy the total energy that a product may be said to "contain," including all energy used in growing, extracting, and manufacturing the product and the energy used to transport it to the point of use. The embodied energy of a structure or system includes the embodied energy of its components plus the energy used in construction.

Emissions pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts

Environmental management system (ISO 14001) a standard, first published in 1996 by the International Organization for Standardization (see ISO), that specifies requirements for an environmental management system. ISO 14001 applies to those environmental aspects over which an organization has control and over which it can be expected to have an influence. This standard is applicable to any organization that wishes to implement, maintain, and improve an environmental management system; assure itself of its conformance with its own stated environmental policy; demonstrate conformance; ensure compliance with environmental laws and regulations; seek certification of its environmental management system by an external third party organization; and make a self-determination of conformance.

EPA U.S. Environmental Protection Agency

Erosion the wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential, commercial, or industrial development, road building, or logging

Evapotranspiration the process of evaporation by transpiration, in which the water contained in vegetation is converted to water vapor and evaporated through leaves

Fauna animals of a particular region or time

Flora plants of a particular region or time

Foot candles a unit of illuminance or illumination equal to 1 lumen per square foot. This is the illuminance provided by a light source of luminous intensity 1 candela (formerly candle) at a distance of 1 foot, hence the name. Full sunlight with zenith sun produces an illuminance of about 10,000 foot-candles on a horizontal surface. Full moonlight provides an illuminance of about 0.02 foot-candles.

Geothermal energy an alternative energy source that uses the heat of the Earth for direct-use applications, geothermal heat pumps, and electrical power production

Grading altering a land surface by cutting, filling and/or smoothing to meet a designated form and function

Graywater water generated from domestic purposes that may be reused for irrigation and other domestic purposes

Green Seal Standards environmental standards that establish environmental requirements for commercial adhesives (GS-36), architectural paints, coatings, and primers (GS-11), and anti-corrosive and anti-rust paints (GS-03), among others. Green Seal is an independent nonprofit organization that promotes the manufacture and sale of environmentally responsible consumer products *(http://www.greenseal.org)*.

Green-e products products certified under any of three Green-e Programs *(http://www.green-e.org/)*:

- *Green-e Climate*, a voluntary certification program launched in 2007 that sets consumer protection and environmental integrity standards for greenhouse gas (GHG) emission reductions sold in the voluntary market
- *Green-e Energy*, the nation's leading independent certification and verification program for renewable energy
- *Green-e Marketplace*, a program that allows companies to display the logo when they have purchased a qualifying amount of renewable energy and passed Green-e verification standards

Greenfield a site that has not been previously developed or graded

Greenhouse gas any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons (HCFCs), ozone (O_3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

Greyfield a site that has been previously developed or graded

Habitat the place where a population (e.g., human, animal, plant, microorganism) lives and its surroundings, both living and non-living

Habitat function the use and benefits of habitats to associated biological communities

Hardscape any landscape feature that is not a plant, such as retaining walls, sidewalks, decks, benches, and fences

Healthy soils indicators of healthy soils *may* include one or all of the following:

- soil horizons that are similar to the reference soil
- bulk densities that are similar to the reference soil
- vegetation that is representative of native plant communities.

Heat island thermal gradient differences between developed and undeveloped areas. The urban heat island effect results in higher temperatures in cities and suburbs than in the surrounding areas, which contributes to ground level ozone formation, reduced air quality, and higher air conditioning loads in the surrounding buildings.

Hydrology the science dealing with the properties, distribution, and circulation of water **—Hydrologic** *adj.*

IESNA Illuminating Engineering Society of North America, a professional organization considered a technical authority in illumination

Illuminance value the density of the luminous flux incident on a surface, expressed in foot-candles or lux. This term should not be confused with illumination (i.e., the act of illuminating or state of being illuminated).

Impervious cover a surface that prevents water from infiltrating into the ground. For instance, rain does not readily penetrate asphalt or concrete pavement and groundwater cannot readily penetrate clay or bedrock.

Infiltration the penetration of water through the ground surface into subsurface soil

Integrated design process an iterative process that requires various stakeholders and disciplines to interact and coordinate with one another as early as possible and throughout the life cycle of a landscape project, to make the most effective use of resources to benefit the environment and the project (definition adapted from Whole System Integrative Design Process committee, 2006, Market Transformation to Sustainability Guideline Standard)

Invasive species a species listed as invasive under State Noxious Weeds laws, Federal Noxious Weeds laws, or regional lists (when listing occurs through a vetted, transparent process and has been accepted by the regional stakeholders). An invasive species is an exotic plant adapted to growing conditions similar to those found in the region to which it is imported. Because such a species usually has no natural enemies (pests, diseases, or grazers), it flourishes, disrupting the native ecosystem and forcing out native plant species and resulting in habitat loss, water-table modification, and other serious problems.

IPM integrated pest management, an ecological approach to vegetation and pest management with an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures. IPM includes well-timed non-toxic treatments and understanding of the pests' life cycles.

ISO International Organization for Standardization, a network of the national standards institutes of 157 countries, one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system *(http://www.iso.org)*

ISO 14040, 14041, 14042, 14043 methodologies a series of life cycle assessment methodologies consisting of four components: goal and scope definition, inventory analysis, impact assessment, and interpretation

LCA life cycle assessment, a concept and a method to evaluate the environmental effects of a product or activity holistically, by analyzing its entire life cycle. Life cycle assessment is typically described in three complementary phases: inventory analysis, impact assessment, and improvement assessment.

LEED-NC Leadership in Energy and Environmental Design Green Building Rating System for New Construction, a U.S. Green Building Council program designed to guide and distinguish high-performance commercial and institutional projects, including office buildings, high-rise residential buildings, government buildings, recreational facilities, manufacturing plants and laboratories

LEED-ND Leadership in Energy and Environmental Design Rating System for Neighborhood Development, a U.S. Green Building Council program that integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design. LEED certification provides independent, third-party verification that a development's location and design meet accepted high levels of environmentally responsible, sustainable development.

Living wage often defined as the wage that a full-year, full-time worker would need to earn to support a family of four at the poverty line. Cities and counties with a higher cost of living tend to have higher living wage levels.

Low-income individual an individual whose family's taxable income for the preceding year did not exceed 150 percent of the poverty level amount

Lumens the luminous flux emitted (within a unit solid angle or 1 steradian) by a point source having a uniform luminous intensity of 1 candela

Luminaire a complete electric lighting unit, including housing, lamp, and focusing and/or diffusing elements; informally referred to as fixture

Microclimate localized climate conditions within an urban area or neighborhood, or the climate around a tree or shrub or a stand of trees. Microclimates are formed by natural or man-made geography and topography, such as hills, buildings, and the presence or absence of trees and vegetation.

Mitigation measures taken to reduce adverse effects on the environment

Native plants for the purposes of this report: plants native to the EPA Level III ecoregion OR known to naturally occur within 200 miles of the site

Noxious weed any plant designated by a federal, state or county government as injurious to public health, agriculture, recreation, wildlife or property. A noxious weed may be listed under State Noxious Weeds laws, Federal Noxious Weeds laws, or regional lists (when listing occurs through a vetted, transparent process and has been accepted by the regional stakeholders).

NRCS see USDA NRCS

Organic matter carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources

Ozone ground-level ozone, a molecule that occurs naturally in both upper and lower levels of Earth's atmosphere. In the lower atmosphere, or troposphere, extending 7 to 10 miles above the surface, ozone is a chemical oxidant and major component of photochemical smog. It can seriously impair the respira-tory system and is one of the most widespread of all the criteria pollutants for which the Clean Air Act required EPA to set standards. Ozone in the troposphere is produced through complex chemical reactions of nitrogen oxides, which are among the primary pollutants emitted by combustion sources; hydrocarbons, released into the atmosphere through the combustion, handling, and processing of petroleum products; and sunlight.

Particulate matter fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions

Pathogen microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in humans, animals and plants

Penetrometer a diagnostic tool to measure the extent and depth of subsurface compaction, also known as a soil compaction tester

Pesticide substances or mixtures intended to prevent, destroy, repel, or mitigate any pest. A pesticide is also any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

Pollutant load the amount of polluting material that a transporting agent, such as a stream, a glacier, or the wind, carries at a given time

Post-consumer materials a material or finished product that has served its intended use and has been diverted or recovered from waste destined for disposal. Post-consumer materials are part of the broader category of recovered materials.

Potable water municipally treated water or well water that is suitable for drinking

Primary contact recreation any recreational or other water use in which there is prolonged and intimate body contact with the water, involving considerable risk of absorbing waterborne constituents through the skin or of ingesting constituents from water in quantities sufficient to pose a significant health hazard (e.g., swimming, waterskiing).

Recovered materials waste materials and byproducts that have been recovered or diverted from solid waste; does not include materials and byproducts generated from, and commonly reused within, an original manufacturing process

Reference soils
- soils native to a site as described in NRCS Soil Surveys (refer to soils within the region if the site soils are not mapped)
- undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site

Reuse a practice in which reclaimed materials are used again with minor changes to the material structure (i.e., avoids down-cycling)

Riparian areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands

Salvage the utilization of waste materials

Secondary contact recreation any recreational or other water use in which body contact with the water is either incidental or accidental, and in which the probability of ingesting appreciable quantities of water is minimal (e.g., fishing, wading)

Silt fencing methods of controlling sediments around a construction site. Often bare earth must be exposed, and these devices are designed to retain sediments carried by runoff on or near the site.

Soil bulk density the relative density of soil measured by dividing the dry weight of a soil by its volume

Soil compaction the level of compression of a soil. Compaction can impede root growth, or can be used to stabilize soils to support buildings or roads.

Soil horizon a layer of soil or soil material approximately parallel to the land surface and differing from adjacent related materials in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistency, kinds and numbers of organisms present, degree of acidity or alkalinity, etc.

Soil protection zone for the purposes of this report:
- Soil protection zones must be fenced off and protected from all vehicle and equipment traffic, parked construction vehicles, and material storage.
- Soil protection zones may not be covered by new buildings or new impervious surfaces.
- Soil protection zones may be re-vegetated or enhanced as long as the soil quality is not degraded.

Soil texture the relative proportions of the various size groups (sand, silt, and clay) of the individual soil grains in a mass of soil

South Coast Air Quality Management District Rules #1168, 1113
- Rule 1168 refers to adhesive and sealant applications. The purpose of this rule is to reduce emissions of volatile organic compounds (VOCs) and to eliminate emissions of chloroform, ethylene dichloride, methylene chloride, perchloroethylene, and trichloroethylene from the application of adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers, or any other primers. This rule applies to all commercial and industrial sales and applications of adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers, or any other primers, unless otherwise specifically exempted by this rule.
- Rule 1113 refers to architectural coatings. The purpose of this rule is to limit the VOC content of architectural coatings or to allow the averaging of such coatings, as specified, so their actual emissions do not exceed the allowable emissions if all the averaged coatings had complied with the specified limits.

SRI solar reflectance index, a value that incorporates both solar reflectance and emittance in a single value to represent a material's temperature in the sun. SRI quantifies how hot a surface will become relative to standard black and standard white surfaces. It is calculated using equations based on previously measured values of solar reflectance and emittance as laid out in the American Society for Testing and Materials Standard E 1980. It is expressed as a fraction (0.0 to 1.0) or percentage (0 percent to 100 percent).

Special status trees for the purposes of this report: trees defined by federal, state or local entities as heritage, historic or landmark trees or various permutations of these terms

Stormwater management feature a created aquatic landscape element with the intended function of stormwater treatment or flood attenuation

STRATUM Street Tree Management Tool for Urban Forest Managers, a computer application that uses tree inventory data to quantify the structure, function, value, and management needs of any street tree resource

Swale an open drainage channel lined with vegetation and designed to detain or infiltrate stormwater runoff; also *bioswale* or *vegetated swale*

TMDL total maximum daily load, a calculation of the highest amount of a pollutant that a water body can receive and safely meet water quality standards set by the state, territory, or authorized tribe

TR-55 curve number a number used to characterize the site's response to long-term precipitation pattern, based primarily on the hydrologic soils group and the land use type. The USDA NRCS (SCS) Technical Release 55 manual "Urban Hydrology for Small Watersheds" (1986) describes the process for determining a runoff curve number and estimating runoff and peak discharges in small watersheds.

USDA NRCS U.S. Department of Agriculture Natural Resources Conservation Service, an agency that provides leadership in a partnership effort to help America's private land owners and managers conserve their soil, water, and other natural resources

VOCs volatile organic compounds, a variety of organic compounds that vaporize at room temperature, including benzene, chloroform, p-Dichlorobenzene, formaldehyde, and tetrachloroethylene. VOCs are the principal component in atmospheric reactions that form ozone and other photochemical oxidants, causing a variety of negative health effects from dizziness, eye and respiratory tract irritation, nervous system damage, developmental effects, and cancer.

Wastewater the spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter

Wetland for the purposes of this report, defined by the Clean Water Act definition (U.S. Code of Federal Regulations 40 CFR 230.3): those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

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