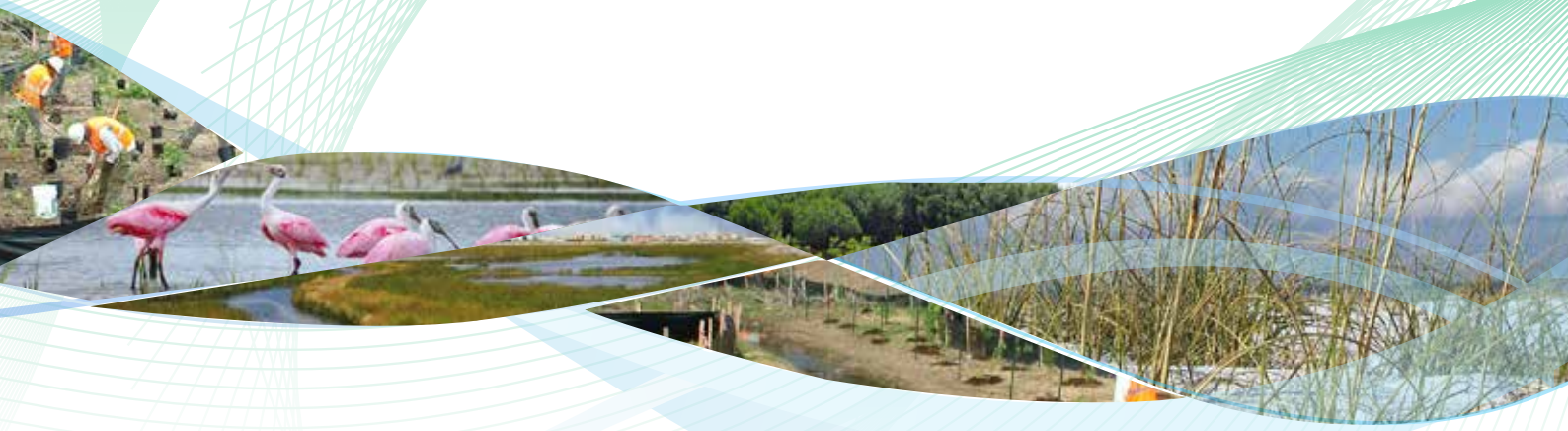
business solutions for a sustainable world



The business case for natural infrastructure

wbcsd

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The World Business Council for Sustainable Development (WBCSD), a CEO-led organization of some 200 forward-thinking global companies, is committed to galvanizing the global business community to create a sustainable future for business, society and the environment. Together with its members, the Council applies its respected thought leadership and effective advocacy to generate constructive solutions and take shared action. Leveraging its strong relationships with stakeholders as the leading advocate for business, the Council helps drive debate and policy change in favor of sustainable development solutions.

The WBCSD provides a forum for its member companies—who represent all business sectors, all continents and a combined revenue of more than $8.5 trillion and 19 million employees—to share best practices on sustainable development issues and to develop innovative tools that change the status quo. The Council also benefits from a network of 70 national and regional business councils and partner organizations, the majority of which are based in developing countries.

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ISBN: 978-2-940521-60-9

Contents

Definitions

- **Business Drivers** are factors (resources, processes, or conditions) required to create the conditions necessary for a business to grow or succeed.
- **Co-benefits** are secondary, or ancillary, benefits (for example, environmental or social) provided by natural infrastructure solutions above and beyond those sought by a particular natural infrastructure solution (for example, wastewater treatment or erosion prevention).
- **Ecosystem Services** are the flows of benefits to people from ecosystems, commonly divided into the following categories:

  Provisioning: goods obtained directly from nature (e.g. crops, water, fiber, genetic material).

  Regulating: Indirect benefits from nature (e.g. mitigation of climate change as carbon is sequestered in vegetation, water filtration by wetlands, erosion control and protection from storm surges by vegetation, crop pollination by insects).

  Cultural: Intangible benefits from nature (e.g. outdoor recreation, spiritual inspiration, mental health, education).
- **Gray Infrastructure** is a human-engineered solution using non-living, non-self-maintaining systems (typically of concrete and steel construction) designed to provide a required function.
- **Natural Capital** is the stock of renewable and non-renewable natural resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people.
- **Natural Infrastructure (NI)** (also **Green Infrastructure**) is a planned or managed (often engineered), natural or semi-natural system designed to fill a specific need. In addition to providing the required function, NI can provide more categories of co-benefits when compared to traditional gray infrastructure.
- **NI Solutions** harness the power of natural ecosystems by leveraging ecosystem services to address a business driver (perform a function), and create or enhance natural capital, often resulting in a range of business benefits and co-benefits.
- **Phytoremediation** is a remediation process that uses plants to contain, degrade, or eliminate pollutant concentrations in contaminated environmental media (soils, water, and air).

Sources: Bradford et al., 2015; Natural Capital Coalition, 2015; The Nature Conservancy et al., 2013; World Resources Institute, 2012.

Acronyms

dioxane	1,4-dioxane
EDF	Electricité de France
EU	European Union
FTE/yr	full-time equivalent per year
GHG	greenhouse gas
ha	hectare
Izta-Popo	Iztaccíhuatl-Popocatépetl
mg/L	milligram per liter
NI	natural infrastructure
NRDC	Natural Resources Defense Council
O&M	operations and maintenance
PUB	Public Utilities Board
RTE	Réseau de Transport d'Électricité
SBR	sequencing batch reactor
UK	United Kingdom
USA	United States of America
USEPA	U.S. Environmental Protection Agency
WBCSD	World Business Council for Sustainable Development

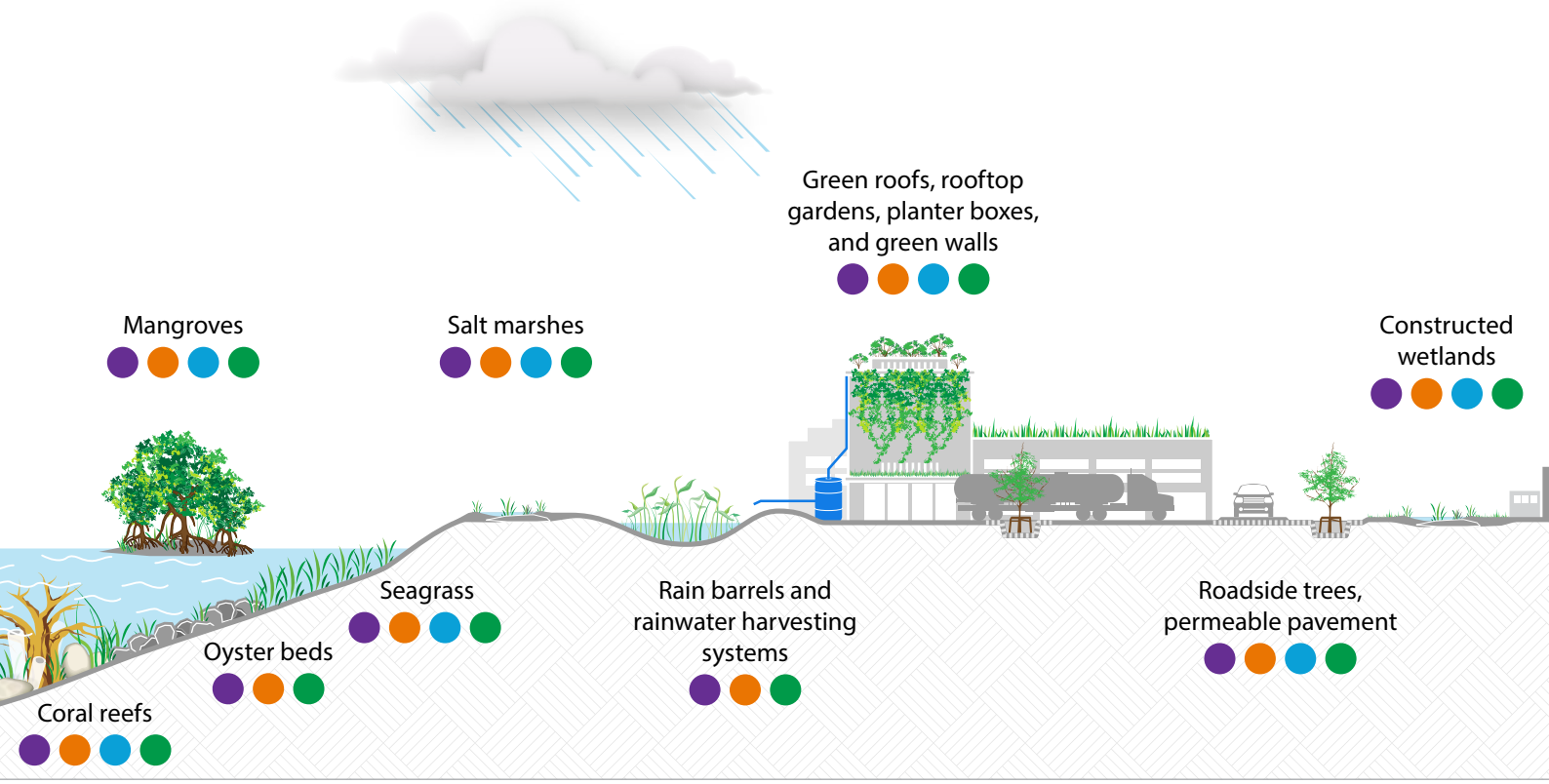
1 Introduction

Natural infrastructure is a planned or managed (often engineered) natural or semi-natural system designed to fill a specific need.

NI can help companies harness the services that nature offers (***ecosystem services***) as a substitute to so-called ***gray infrastructure*** (such as dams and water treatment plants). In some cases, NI may provide more benefits than gray infrastructure, while fulfilling the same function, being equally efficient, and providing the same level of performance. Businesses increasingly realize that they depend directly or indirectly on environmental resources (or ***natural capital***) in many ways, and are trying to preserve natural capital to reduce their exposure to risk. By investing in NI, they can reduce costs, improve operations, generate financial gains, or enhance their reputation.

As a result, businesses across all sectors are increasingly considering ***NI solutions*** as a means to harness the power of existing natural ecosystems or create or enhance natural capital. In this way, companies can capitalize on ***business drivers*** (the business case for NI solutions), while at the same time provide benefits to society and the natural environment (***co-benefits*** of NI). For example, creating or restoring wetlands on the banks of rivers and

Figure 1. Examples of natural infrastructure solutions.



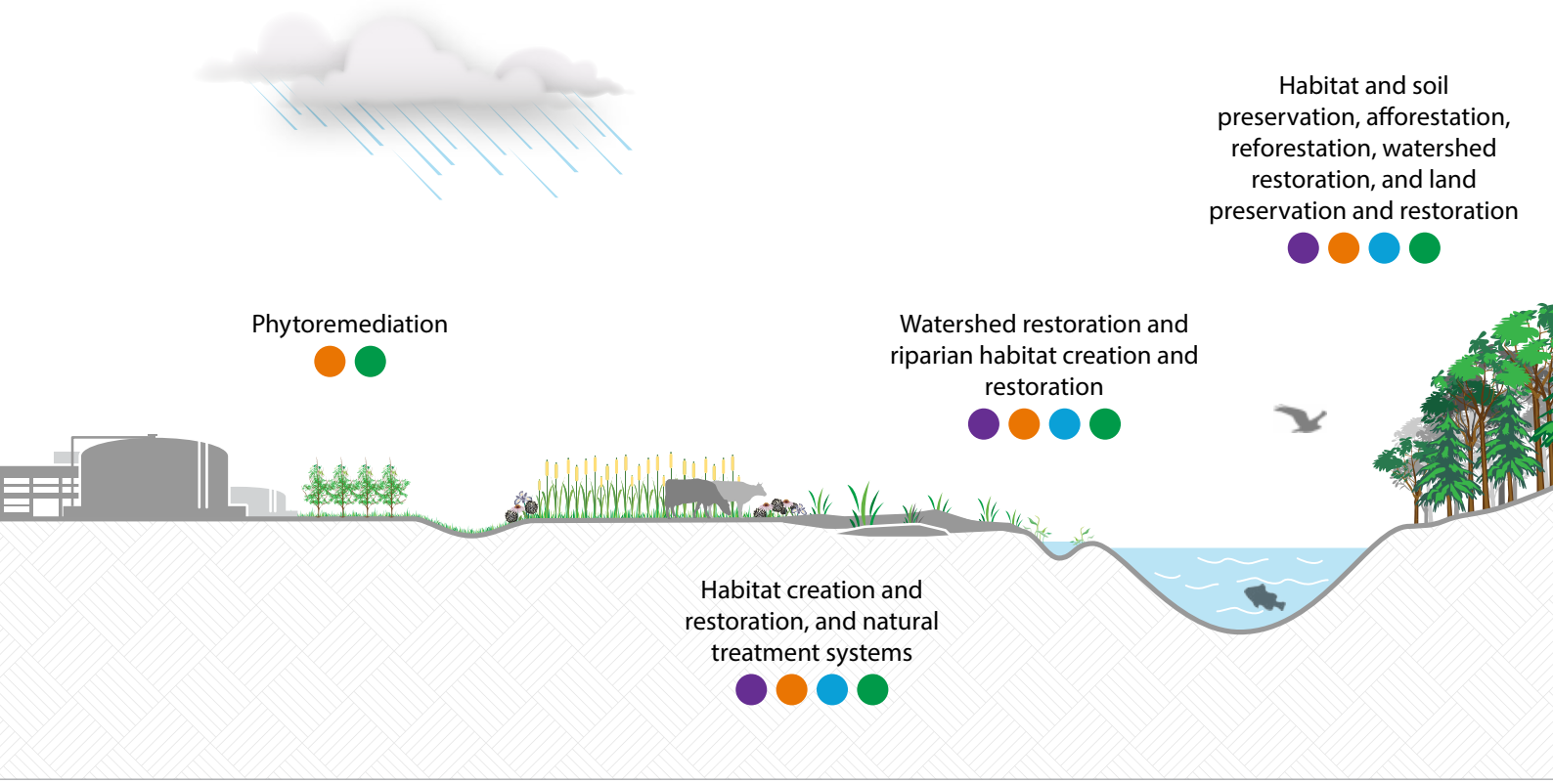
Ecosystem services can be organized into four major categories (Millennium Ecosystem Assessment, 2005).

- **PROVISIONING SERVICES** - any type of benefit to people that can be extracted from nature.
  - Food
  - Water
  - Timber
  - Fiber
- **REGULATING SERVICES -** the benefit provided by ecosystem processes that moderate natural phenomena.
  - Clean air
  - Water purification
  - Human health
  - Pollination
  - Decomposition and waste
  - Erosion and flood control
  - Carbon storage and climate regulation

streams can both increase biodiversity and be more cost-effective than stormwater control measures created with gray infrastructure. Oyster reefs, another NI solution, can reduce coastal erosion and protect businesses from storm surges, while also filtering contaminated seawater and supporting local fisheries.

Businesses can apply NI solutions at different scales—from green roofs on individual buildings, to green belts through industrial complexes, to large-scale watershed restoration and reforestation. Additionally, there is a wide range of NI solutions in use or in development (see **Figure 1** for some examples) that businesses can implement either as standalone or as hybrid solutions that combine NI and gray infrastructure, as needed, to address business needs. For example, NI investments can help:

- Meet government, regulatory, or permitting requirements
- Reduce company risk, and increase company resiliency and adaptation to a changing climate and natural environment
- Address stakeholder and community concerns, such as resource availability, public health, safety, environmental health, aesthetics, recreational opportunities, and biodiversity conservation



- **CULTURAL SERVICES** - a non-material benefit that contributes to the development and cultural advancement of people.
  - Recreational
  - Spiritual
  - Aesthetic

- **SUPPORTING SERVICES -** underlying natural processes that sustain ecosystems.
  - Photosynthesis
  - Soil formation
  - Nutrient cycling
  - Water cycle

What is the difference between natural infrastructure and green infrastructure? The terms natural infrastructure and green infrastructure are commonly used interchangeably, and might have different meanings for different organizations. In this context, we consider both green and natural infrastructure as the use of both natural and semi-natural systems to perform a function, and will use the term natural infrastructure consistently to avoid confusion.

Table 1. Examples of ecosystem services provided by natural infrastructure solutions shown in Figure 1.
Organized alphabetically.

	Afforestation & reforestation	Constructed wetlands	Coral reefs	Green roofs	Green walls	Habitat & soil preservation	Habitat creation & restoration	Land preservation & restoration	Mangroves	Natural treatment systems	Oyster beds	Permeable pavement	Phytoremediation	Planter boxes	Rain barrels	Rainwater harvesting systems	Riparian habitat creation & restoration	Roadside trees	Rooftop gardens	Salt marshes	Seagrass	Watershed restoration
PROVISIONING SERVICES																						
Food	●	●	●			●	●	●	●		●						●		●	●	●	●
Water	●	●		●		●	●	●		●		●		●	●	●	●		●	●		●
Timber	●					●	●	●	●								●	●				●
Fiber	●	●				●	●	●									●			●		●
REGULATING SERVICES																						
Clean air	●	●		●	●	●	●	●	●	●			●	●			●	●	●	●		●
Water purification	●	●		●		●	●	●	●	●	●	●	●				●			●		●
Human health	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●		●
Pollination	●	●				●	●	●	●	●				●			●	●	●			●
Decomposition & waste	●	●				●	●	●	●	●	●		●				●			●		●
Erosion & flood control	●	●	●			●	●	●	●		●	●			●	●	●	●		●		●
Carbon storage	●	●	●	●	●	●	●	●	●	●	●			●			●	●	●	●	●	●
CULTURAL SERVICES																						
Recreational	●	●	●			●	●	●	●								●		●	●	●	●
Aesthetic	●	●	●	●	●	●	●	●	●	●				●			●	●	●	●		●
Spiritual	●	●	●			●	●	●	●					●			●			●		●
SUPPORTING SERVICES																						
Photosynthesis	●	●	●	●	●	●	●	●	●	●			●	●			●	●	●	●	●	●
Nutrient cycling	●	●	●			●	●	●	●	●	●		●				●	●		●	●	●
Soil formation	●	●				●	●	●	●								●			●		●
Water cycle	●	●		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●		●

NI may be an attractive option for businesses because NI solutions can be cost-competitive with or enhance the performance of gray infrastructure, and are applicable to a variety of business contexts, such as:

- Treating industrial process water and wastewater
- Rehabilitating degraded land
- Remediating contaminated or polluted areas (such as ***phytoremediation***)
- Reducing risk and building more resilient infrastructure
- Managing stormwater
- Securing access to water in quantity and quality

This is not an exhaustive list – other applications include sequestration of carbon and air pollutants to reduce a company's greenhouse gas (GHG) emissions, and community or neighborhood beautification.

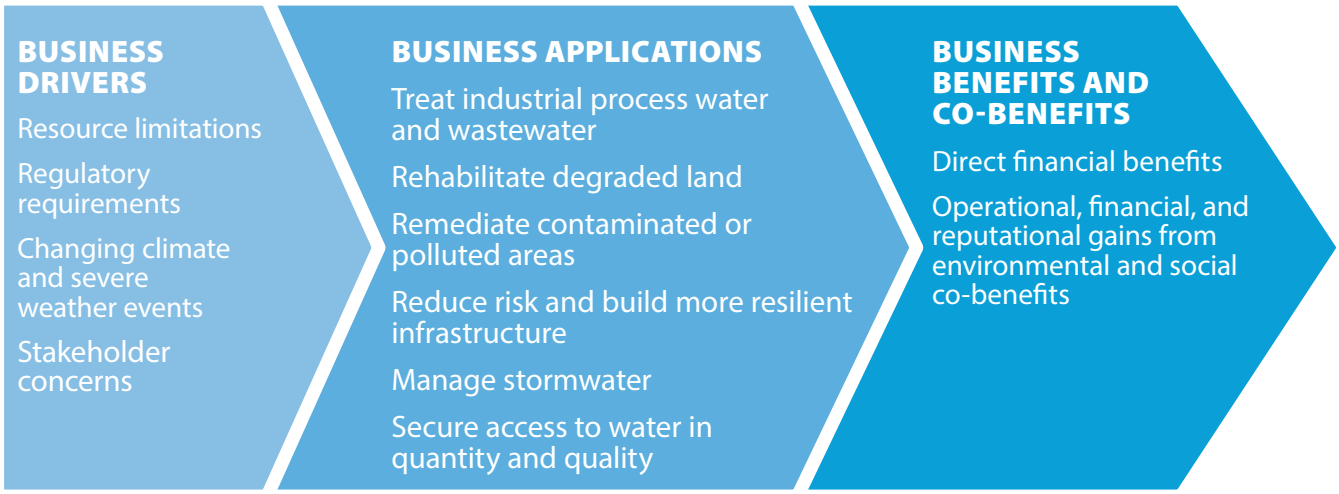
NI solutions can also be engineered to enhance one ecosystem service that serves a single business function, while simultaneously providing a range of additional ecosystem services (**Figure 1** and corresponding **Table 1**). As a result, in addition to direct financial benefits for the business (for example, capital cost savings), NI solutions may also generate additional operational, financial, and reputational gains from environmental and social co-benefits that gray infrastructure alone cannot provide; such as more aesthetically pleasing streetscapes and office complexes, improved air quality, or reduced adverse health effects. These co-benefits enhance or positively contribute to the relationships between the business and community it operates in and serves, as they increase the quality of life in local communities.

Ecosystem services can provide co-benefits to communities locally (such as aesthetically pleasing streetscapes and office complexes), regionally (through improved air and water quality), or globally (for example, climate change mitigation through carbon sequestration).

This document supports companies and individuals considering investments in NI alternatives for their business or project by establishing the business case for NI. There is a broad range of business drivers, applications, benefits, and co-benefits that are constantly expanding to keep pace with the needs of the sustainable infrastructure movement. As a result, this document is not intended to comprehensively capture all the possibilities. Instead, it is intended to highlight the range of available business case studies that illustrate a variety of business drivers for investing in NI and how various business applications created NI benefits, as well as co-benefits for the business, environment, and society. See **Figure 2** for drivers, applications, and benefits covered in this document.

The selection of an appropriate NI solution is based on project-specific drivers and desired applications. As such, the benefits and co-benefits are also sector-, project-, and location-specific. To address some of these nuances, this document outlines some of the challenges of implementing NI solutions, while highlighting the business opportunities. To increase the likelihood of successfully applying NI solutions, the document includes recommendations for corporate capacity-building activities, as well as best practices for project design and implementation.

Figure 2. Example categories of drivers, applications, benefits and co-benefits of NI solutions for business covered in this text.



2 Business drivers for use of natural infrastructure solutions

Infrastructure is fundamental to economic growth, and businesses are continually looking for more cost-effective and better-performing infrastructure solutions. New and emerging business drivers, such as resource limitations, regulatory requirements, climate change, severe weather events, and stakeholder expectations, are causing businesses to seek out NI solutions.

2.1. Resource limitations

Businesses operate under financial, natural, and human resource limitations, and securing these resources is critical for business continuity and growth. NI solutions can often address all three resource limitations, as follows:

- **Financial Resources:** One of the business drivers of NI investments is cost. Some cost comparisons with gray infrastructure alternatives have demonstrated that NI solutions require less of a financial investment. This may be because NI solutions frequently require less human-built equipment and less-intensive operations and maintenance (O&M). Also, NI solutions often require less labor and fewer resources overall, and generate less pollution to be managed. As a result, companies can shorten the life-cycle cost management of infrastructure investments. Interestingly, there may be cases where the upfront costs (for example, construction, design, and permitting) are higher, but the overall financial investment in an NI solution is lower over the project life cycle due to lower long-term O&M costs.

Shell Canada Limited constructs pipeline corridors in ecologically diverse areas. Following construction, disturbed land is restored to an equivalent land capability with minimal impact on the environment. Shell Canada Limited collaborated with the University of Northern British Columbia to research soil bioengineering (the use of living plant material to create structures that perform some soil-related functions) in order to shorten their land reclamation phase, thereby lowering the O&M costs.

Case Study: ***Natural Reclamation and Erosion Control for Onshore Pipelines***

- **Natural Resources:** NI solutions often require less energy and fewer natural resource inputs, as requirements for equipment, additives, oxygen systems, and water (among other things) are reduced. NI solutions also reduce quantities of residuals and associated transportation and disposal costs, while conserving water and expanding or creating wildlife habitats. In addition, land dedicated to NI solutions can simultaneously be managed to support other services (for example, community parks and wildlife habitat). NI solutions can also serve to secure valuable natural resources, like water or soil.

Syngenta is leveraging multifunctional field margins, which can create a number of benefits for biodiversity conservation, including managing soil and water, to achieve higher yields on farms. This can reduce the need for agriculture expansion into the remaining natural habitats that are vital for biodiversity and other ecosystem services. By achieving more crops per acre of land, per drop of water, and per measure of other farm inputs, farmers can resist pressures on land occupancy; therefore, providing more space for biodiversity and ecosystem conservation.

Case Study: ***Multifunctional Field Margins—Enhancing Biodiversity in Agricultural Landscapes***

- **Human Resources:** In comparison to traditional gray infrastructure, NI solutions often require fewer human resources for operation and oversight during long-term O&M.

Knowing that constructed wetlands require fewer human resources and less energy to operate than traditional treatment plants, Philip Morris USA, a wholly owned subsidiary of Altria Group Inc., constructed a treatment wetland as a voluntary effort to provide a low-maintenance alternative to reducing nitrogen and phosphorus in the process wastewater.

Case Study: ***Park 500 Natural Treatment System***

2.2. Regulatory requirements

NI solutions can offer cost-effective ways for addressing regulatory requirements. Increasingly, regulators are recognizing the role of NI in delivering a wide range of co-benefits to society and are promoting the use of NI solutions by businesses. For example:

- The European Commission adopted its Green Infrastructure Strategy (2013) "to promote the deployment of green infrastructure in the European Union (EU) in urban and rural areas," which is a key step in implementing the EU 2020 Biodiversity Strategy.
- The French Parliament passed a law in 2015 that requires new buildings in commercial zones to be partially covered in either vegetation or solar panels (The Guardian, 2015). Green roofs have an insulating effect that helps reduce the amount of energy needed to heat a building in winter and cool it in summer, and are an effective NI solution to address urban heat island effect (USEPA, 2015). They also retain rainwater; thus, helping reduce problems with runoff, while favoring biodiversity, and providing habitat for nesting birds.
- In the United Kingdom (UK), NI is part of the National Planning Policy Framework, and is related to the emerging policy on Sustainable Drainage Systems and climate change adaptation (UK Green Building Council, 2015).
- The U.S. Environmental Protection Agency (USEPA) Green Infrastructure Strategic Agenda 2013 seeks to expand the use of NI through community partnerships and information exchange to meet stormwater management obligations in the Clean Water Act.
- In response to Hurricane Sandy, the U.S. Army Corp of Engineers' North Atlantic Coast Comprehensive Study Report (2015) recommends the use of natural and nature-based solutions as part of an integrated set of solutions for coastal resilience.
- Singapore's Inter-Ministerial Committee on Sustainable Development has set a goal that by 2030, 80 percent of buildings in Singapore will be certified green—which includes energy and water efficiency, green spaces, and eco-friendly materials (Singapore Building and Construction Authority, 2013). The Public Utilities Board (PUB) has published guidelines that include green infrastructure design considerations (PUB, 2014).

In 2009, the River Ic drinking water production plant (in Brittany, France), operated by Veolia Water, was provisionally closed because nitrate concentrations in raw water were up to 120 milligrams per liter (mg/L) of nitrate. This was in excess of the statutory threshold of 50 mg/L, which should not be exceeded for drinking water provision in France. Veolia teamed with Syndicat Mixte Environnemental du Goëlo et de l'Argoat to better understand the functioning of buffer zones in rural areas and optimize their functioning and assess at a catchment area to scale their potential contribution to maintaining and preserving water quality, in particular, in the River Ic catchment area.

Case Study: ***Aquisafe Project: Mitigation of Contaminants to Protect Water Resources in Rural and Semi-rural Areas Using Buffer Zones***

2.3. Changing climate and severe weather events

Businesses are increasingly facing risks from climate change. This may result in regional temperature shifts, variable precipitation and water supply, and more frequent and extreme weather events. Under these conditions, hazards, such as inland floods, drought, heat waves, fires, high winds, and coastal waves and storm surges, may increase the risk of damage to business assets, interrupt the supply chain and impact consumers and employees.

NI solutions can offer increased resilience to these hazards or a means to adapt to future hazards as follows:

- Restoring floodplains can alleviate floods by storing water and releasing it back slowly into streams and rivers.
- Restoring forests and other plant communities in watersheds can mitigate droughts by increasing surface water supplies and replenishing groundwater reserves.
- Maintaining or planting trees and green spaces in cities can help combat the urban heat island effect and manage stormwater.
- Protecting or restoring coastal habitats can help absorb the energy and flood waters associated with coastal waves and storm surges.

In addition to being part of a strategy for climate adaptation, NI solutions can also help with climate mitigation. Plants and soils used in NI solutions may help absorb GHGs and sequester carbon. And while individual projects would have minor influence, cumulatively, businesses have an opportunity to make a difference.

In the Louisiana Coastal Zone, Louisiana, United States of America (USA), Shell Pipeline Company LP is using "living shorelines"—typically comprising marshes or oyster reefs—to protect pipelines from erosion caused by waves from marine traffic, tidal currents, and acute weather events, like hurricanes.

Case Study: ***Coastal Pipeline Erosion Control Using Living Shorelines and Oyster Reefs***

2.4. Stakeholder concerns

NI solutions can effectively address stakeholder needs, such as local communities' or local authorities' concerns about environmental protection and enhancement, scarcity of natural resources, or climate change impacts that can increase exposure to natural disaster. At the same time, they can provide engagement opportunities for education, volunteering, and recreational activities.

The Electricité de France (EDF) Group launched a project to restore the Old Rhine River, with the goal of recovering more typical alluvial habitats, biodiversity, and functions. This project was carried out to address stakeholder concerns and meet licensing requirements to maintain water levels in the Grand Canal d'Alsace and the old Rhine River, and support the relicensing of their hydropower plant. EDF wished to move away from the strict environmental legislation and emphasize a holistic approach to riparian ecosystem restoration. The primary challenge was reaching a fair and balanced agreement among three countries with different expectations and needs. Therefore, project success was the result of stakeholder engagement and their willingness, and consensus, to include NI alternatives in the project design.

Case Study: ***Restoration of the Old Rhine River***

3 Business applications of natural infrastructure solutions

NI solutions have numerous business applications to address various business drivers, often resulting in business benefits (Section 4). **Figure 3** highlights the key categories of business applications outlined in the case studies featured in this document.

Figure 3. Examples of business applications of NI solutions.

Treat Industrial Process Water and Wastewater

Constructed wetlands have been used for industrial process water and wastewater treatment, substituting for traditional wastewater treatment infrastructure.

Photo from case study: Produced Water Treatment Using Reed Beds (Petroleum Development Oman LLC)

Rehabilitate Degraded Land

After disturbance (recent or historical), land is returned to its native state to restore habitat, improve biodiversity, restore natural functions (for example, groundwater replenishment), or secure land productivity.

Photo from case study: Multifunctional Field Margins in Agriculture Landscapes—Enhancing Biodiversity for Sustainable Intensive Agriculture (Syngenta)

Remediate Contaminated or Polluted Areas

Phytoremediation with green plants and their microorganisms is often used to reduce contamination in water or soils.

Photo from case study: Phytoremediation as a Sustainable Approach for Groundwater Contaminated with 1,4-dioxane (dioxane) (The Dow Chemical Company)

Reduce Risk and Build More Resilient Infrastructure

Wetland habitats and living shorelines can be used to augment and strengthen gray infrastructure, reduce flood risk, protect shorelines from erosion caused by waves, and create habitat.

Photo from Coastal Pipeline Erosion Control Using Living Shorelines and Oyster Reefs case study (Shell Pipeline Company LP)

Manage Stormwater

Green roofs, rain gardens, and bioswales have been used in cities and industrial parks to complement stormwater conveyance systems.

Photo from Green Roof and Water Management in Philippines Government Office Building case study (LafargeHolcim Philippines)

Secure Access to Water in Quantity and Quality

Natural treatment systems have been installed to protect drinking water sources from impacts of agriculture.

Photo from Aquisafe Project: Mitigation of Contaminants to Protect Water Resources in Rural and Semi-rural Areas Using Buffer Zone case study (Veolia)

4 Business benefits and co-benefits derived from natural infrastructure solutions

NI solutions may be primarily designed to reduce cost while addressing a particular business driver important for the operation of the business (such as resource limitations or regulatory requirements). However, at the same time, the natural or semi-natural areas restored, protected, or created may also generate environmental and social co-benefits inherent to NI solutions. NI may, therefore, generate a variety of additional financial and reputational gains. As a result, when businesses' financial benefits from NI and gray infrastructure are similar, quantifying co-benefits often reveals that the NI solutions provide greater overall benefits than gray infrastructure. Additionally, these co-benefits may help businesses achieve sustainability goals or reporting requirements. Communicating co-benefits to the public may also help businesses identify novel financing structures that match public and private funds.

4.1. Direct financial benefits

NI solutions can maintain or enhance the value of land, property, and infrastructure assets. They also often have fewer initial capital expenditures, reduced long-term O&M costs, or both, when compared to gray infrastructure alternatives. As a result, there can be significant returns on investment, and NI solutions can provide new sources of revenue, as follows:

- **Capital Cost Savings:** NI is often selected because the NI solution requires a lesser initial capital investment than the gray infrastructure alternative. While traditional engineering solutions require capital investment in equipment (such as tanks, pumps, complex piping, and chemicals), NI solutions often leverage existing natural resources, thus resulting in significant cost savings.

Union Carbide Corporation, a wholly owned subsidiary of The Dow Chemical Company, leveraged NI solutions to ensure long-term compliance with USEPA effluent guidelines while reducing O&M costs. However, the project also saw lower capital costs—the initial capital investment for the wastewater treatment wetland constructed at its industrial complex in North Seadrift, Texas, USA, was calculated to be US$1.2 to 1.4 million, as opposed to US$40 million for the gray alternative (1995).

Case Study: ***Constructed Wetlands for Wastewater Treatment***

- **O&M Savings:** O&M costs for natural treatment systems are typically lower than for gray alternatives. While gray infrastructure often requires chemical additions and can produce treatment byproducts (such as sludge or concentrate) that would require management and associated costs, NI solutions often leverage natural processes. Additionally, NI solutions typically require less-intensive O&M than gray alternatives, which can require support 24 hours per day, 7 days per week. NI solutions can also shorten the duration of long-term maintenance of restored lands following land disturbance activities.

LafargeHolcim sought to develop a better approach to their land reclamation and reforestation methods. They found that the NI solution – better management of topsoil and use of biomass created during the felling of the trees – more quickly and effectively restored the landscape following mining activities. This shortened the land lease by 1 to 1.5 years, and reduced long-term land management costs by approximately €100,000 per year.

Case Study: ***Restoration of the Sępólno Gravel Pit***

- **Return on Investment:** NI solutions often demonstrate a significant return on investment as a result of the low capital investment cost and long-term O&M savings, and the appreciation of NI function over time. For instance, studies have shown that though the initial investment may be high, over time, green roofs can reduce the energy needed for cooling on the floor below the roof by more than 50 percent (NRDC, 2012).

1,4-Dioxane (dioxane) is an emerging contaminant of concern receiving much attention. At a large chemical production plant in Terneuzen, The Netherlands, historical site activities led to dioxane-contaminated groundwater. More than 20 years after the dioxane production has stopped, groundwater in the source zone still contains high concentrations of dioxane, and migration with groundwater is threatening nearby surface water. The Dow Chemical Company (Dow Benelux BV) saw two key benefits in applying phytoremediation to manage groundwater contamination:

1. A cost evaluation showed the 10-year cost to contain the plume was significantly less using phytoremediation (€900,000) than for the gray infrastructure alternative (pump and treat with advanced oxidation), estimated at €1.8 million.

2. Dow Benelux BV is leveraging the results as a pilot study and continues the intensive monitoring program to demonstrate the feasibility of this phytoremediation approach as an effective and sustainable method for containing dioxane plumes.

Case Study: ***Phytoremediation as a Sustainable Approach for Groundwater Contaminated with 1,4 Dioxane***

- **Innovation and Revenue Creation:** Businesses have started to explore NI not only from a risk management perspective, but as an opportunity for innovation and resulting revenue creation, such as innovative technologies, new service offerings, or carbon or wetland credits.

LafargeHolcim partnered with SIKA Ag, a manufacturer of specialty chemicals for construction and industry, to develop their green roof technology. The aim was to address rapidly growing urbanization challenges in the Philippines, including reduction of open spaces and increased energy consumption. The technology has been developed initially for the Laguna Lake Development Authority and will be applied in other buildings in the Philippines and across the world. Building on the success of the green roof projects, LafargeHolcim is also offering solutions for stormwater management for driveways and pathways with the pervious concrete Hydromedia.

Case Study: ***Green Roof and Water Management in Philippines Government Office Building***

4.2. Operational, financial, and reputational gains from environmental co-benefits

Typically, NI solutions not only have a smaller environmental footprint but also enhance the environment as compared to gray infrastructure because they are nature-based and self-regenerating. Many NI projects require limited inputs for construction and maintenance, and produce little or no waste. In addition, NI generally provides operational, financial, and reputational gains from the environmental co-benefits, beyond the principal function of the solution.

NI solutions can help maintain clean air and water, reduce natural resource use, and protect or restore habitat for biodiversity, as follows:

- **Improvements in Water, Soil and Air Quality:** Green roofs that are designed to absorb stormwater can also contribute to improved air quality, and neutralize the pH of the rainwater run-off. Constructed wetlands for wastewater treatment improve water quality, and can recreate vital ecosystem functions historically lost as a result of industrial development or urbanization (air purification).

Philip Morris USA constructed a 42-acre (17-hectare [ha]) treatment wetland to manage their industrial process water, working with nature to further reduce nutrient levels in its wastewater. The facility participates in the Virginia Nutrient Credit Exchange, which is designed to coordinate and facilitate nutrient credit trading among its members, with the goal of improving water quality in the Chesapeake Bay watershed, a local community priority.

Case Study: ***Park 500 Natural Treatment System***

- **Resources Conservation:** NI typically uses less energy and fewer natural resources than gray alternatives. It can also contribute to resources conservation; for example, through rainwater harvesting and energy conservation. Additionally, multiple offset methodologies demonstrate that NI, such as wetlands, can be used as net carbon sinks, effectively reducing GHG emissions (American Carbon Registry, 2012; Restore America's Estuaries and Silvestrum, 2015; Louisiana Coastal Protection and Restoration Authority, 2014).

To reduce the high costs of treating and reinjecting produced water, Petroleum Development Oman LLC—a joint venture with Shell Petroleum Company Ltd and the Government of Oman (majority)—proposed the use of reed beds for produced water treatment in Nimr, Oman. In addition to cost savings, the gravity-based wetland design requires close to zero energy for water treatment; thus, reducing power consumption—and carbon dioxide emissions—by approximately 98 percent because of the elimination of electric-powered water treatment and injection equipment.

Case Study: ***Produced Water Treatment Using Reed Beds***

- **Habitat Creation, Restoration, and Connectivity:** Some NI solutions can contribute to and maintain the agricultural productivity of the land, while also providing native habitat; hence, helping maintain or increase biodiversity. For example, small-scale NI projects—green roofs, for example—can support urban-adapted wildlife, such as insects and birds, by helping build a patchwork of habitats in urban and semi-urban environments. Large-scale NI, such as afforestation, reforestation, parks, and urban forests, help to facilitate wildlife movement and connect wildlife populations.

To secure a reliable water supply critical to support the stability of Volkswagen de México production efforts, The Volkswagen Group, headquartered in Wolfsburg, Germany, supported the Iztaccíhuatl-Popocatépetl (Izta-Popo) project. The aim of this project was to restore groundwater capture functionality diminished by years of deforestation from illegal logging, livestock farming, and fires. The team re-planted the deforested slopes between the two volcanoes in the source region of the Rio Atoyac, and constructed pits and earthen banks to facilitate infiltration. Over 6 years, the Izta-Popo project team planted 490,000 trees, and installed 91,000 pits and 430 earthen banks to preserve water on over 750 ha.

Case Study: ***Izta-Popo—Replenishing Groundwater through Reforestation in Mexico***

4.3. Operational, financial, and reputational gains from social co-benefits

Businesses see operational, financial, and reputational gains from social co-benefits generated when employing NI solutions, such as increased worker safety, increased job opportunities, and skill development, while maintaining their social license to operate. These co-benefits can increase the quality of life in the local and global communities where the business operates by enhancing public health, communities and livability; thereby, building strong company ties with the neighboring communities. Some examples include:

- **Operational Safety:** Although NI solutions require some O&M, safety issues are minimized due to reduced labor hours required to support

and maintain the system. As a result, exposure to workplace hazards, like noise, chemicals, lifting, driving, and mechanical and electrical components, are proportionally reduced.

Union Carbide Corporation completed a financial assessment for the wastewater treatment wetland constructed at their industrial complex in North Seadrift, Texas, USA (DiMuro et al., 2014). The results indicated that the wetland alternative required minimal O&M, while the sequencing batch reactor (SBR) alternative would have required onsite operators at all times—0.75 full-time equivalents per year (FTE/yr) for the constructed wetland versus 12 FTE/yr for the SBR. In addition, there was reduced construction and implementation time for the constructed wetland over the SBR. Reduced labor hours result in reduced operator exposure to injury or fatality.

Case Study: ***Constructed Wetlands for Wastewater Treatment***

- **Job Creation and Skill Development:** As more businesses invest in NI solutions, the demand for related skills will increase, resulting in new training and career opportunities. O&M training will expand to ecosystem processes, project design objectives, and management of the physical attributes of the system. Additionally, NI can contribute to natural resource-based industries, particularly commercial fisheries, by enhancing coastal habitat.

Syngenta began the Operation Pollinator project to mitigate the declining populations of pollinator species potentially caused by changes to intensive agricultural practices. Under this project, Syngenta promotes sustainable use of land and other resources by assisting growers through the delivery of education and training, agronomic research, and advice. Educating growers about good agricultural practices that enhance food production, reduce soil erosion, and improve pollination also produces widespread social benefits – which can bring economic benefits.

Case Study: ***Operation Pollinator—Enhancing Biodiversity in Agricultural Landscapes***

- **Social License to Operate:** NI solutions offer valuable opportunities for businesses to engage stakeholders in selecting infrastructure alternatives that meet their needs, while providing multiple social co-benefits for neighboring communities.

The limited company Réseau de Transport d'Électricité (RTE) manages the French electricity transmission network. As a public utility, its role is to operate, maintain, and develop the high and very high voltage network. As part of the LIFE Elia-RTE project, RTE restores peatlands located under overhead power lines to improve their functionality (that is, regulating services of the peatlands, such as support for low-flow water purification, contribution to water storage and climate regulation). Once restored, these areas encourage the return of plant and animal communities native to these ecosystems and are able to serve as corridors for biodiversity. As the landscape has improved, so has the public perception of the vegetation management in the forest corridor and relations with local stakeholders – strengthening RTE's social license to operate.

Case Study: ***Peatland Restoration***

- **Enhanced Public Health, Communities, and Livability:** More green space, trees, and parks create opportunities for outdoor physical activity, access to recreational amenities, and infrastructure resilience, as well as improved air quality. NI projects offer improved public services, such as educational, research, and recreational opportunities for local residents and visitors. NI investments can even lead to increases in property values due to the enhanced aesthetics of streetscapes, greenways, and parklands. NI solutions, such as parks and permeable pavements, for example, can also reduce noise pollution by dampening traffic, train, or plane noise.

Driven by regulatory requirements and community demand, LafargeHolcim France implemented a quarry rehabilitation and management program in the south of France that created a stormwater catchment and beneficial wetland habitat that provide regulating services (water purification). Reforestation and the creation of shoreline areas and gently sloped riverbanks with varied contours offer diverse natural habitats (for example, woodlands, ponds, resting places, and small islands) favorable to many species. Additionally, the Bellegarde reservoirs provide the community with a range of recreational benefits, such as bird watching, fishing, boating, and jet skiing.

Case Study: Water Management and Flood Prevention in France

5 Business challenges and opportunities for implementation of natural infrastructure solutions

Practical experience in implementing NI solutions shows that challenges exist, but, as demonstrated in **Table 2**, businesses can transform these challenges into opportunities leveraged to enhance their teams, partnerships, operations, and profitability.

Table 2. Examples of business challenges and opportunities for implementation of natural infrastructure solutions.
Information contained in this table is a compilation of that provided in case studies and contributing author experience.

CHALLENGES	OPPORTUNITIES
NI may require more initial human resources if the expertise is not available within the business or if NI requires additional research and development, design, and permitting.	Partner with thought leaders, universities, and nonprofit organizations; potential to create new revenue sources for new commercial products, services, or credits in environmental markets.
The project team will need to go through a technology learning curve.	Provide training and career development opportunities for project team to develop skills, experience, and confidence to apply NI to the business or specific projects.
Regulatory and stakeholder buy-in may be required for innovative approaches.	Collaborate with regulators and stakeholders to drive policy change to enable use of NI solutions.
Design must meet company, industry, and regulatory performance requirements.	Collaborate with regulators, industry, economists, restoration ecologists, and organizational leaders to develop environmentally beneficial solutions.
There may be more land requirements than for gray infrastructure; real estate costs and opportunity costs will need to be taken into account to purchase new land, or divert existing property from a different use.	Engage with landowners to optimize land use or restore land to its original state; or consider offsetting development on other parts of an industrial site.
Natural variability may reduce NI performance; short summers may limit planting season.	Use native species to improve survival rate, while contributing to biodiversity conservation.
Biotic stressors—birds, rodents, and other pests; and natural hazards—fire, flood, and wind—could destroy NI.	Collaborate with academic institutions (wildlife biologists) and subject matter experts to develop solutions that resolve stressors.
NI requires a long time horizon to reach design performance levels because of time needed for biota to grow and ecosystems to establish.	Create co-benefits or co-produced ecosystem services beyond the design function in order to provide co-benefits to both the business and neighboring community.
Long-term liability considerations require long-term monitoring to mitigate risk and satisfy regulatory requirements.	Perform long-term monitoring to generate data and knowledge that serve as proofs or learning tools to draw upon for future projects and pilot studies.

6 Critical success factors for implementation of natural infrastructure solutions

BEST PRACTICES FOR PROJECT DESIGN AND IMPLEMENTATION
Use the WBCSD NI Decision Tree to determine whether your project is right for considering NI.
Tour similar facilities to learn from their experiences.
Research related ecosystems to determine a fit-for-purpose design that will thrive over the long term.
Engage regulators to garner their support for NI solutions to address business needs.
Engage stakeholders to understand and address their needs and concerns, to the extent possible, to establish and maintain community support.
Engage staff with NI project knowledge and experience.
Leverage cross-disciplinary and cross-functional design teams.
Partner with academia, neighboring communities, engineering consulting firms, and nonprofit organizations to develop innovative NI business solutions.
Train staff to meet project-specific NI solution needs.
Use the WBCSD NI Checklist so that the design considers life-cycle costs and other co-benefits in the decision-making process.
Leverage built-in triggers (for example, design specifications) to prompt engineers to consider NI solutions during the project concept phase.
Consider hybrid solutions when NI alone cannot meet business needs or regulatory requirements.
Consider pilot studies that can be scaled up.
Specify NI requirements in the standard engineering specifications so that NI solutions are considered by the project team.
Use the WBCSD NI ProjectSelect™ Tool to evaluate the cost benefit of design alternatives.
Monitor the NI systems for a period of time to ensure successful growth of vegetation and restoration of the ecosystem.
Make adjustments as needed.
Leverage lessons learned, and share them with the business community.
BEST PRACTICES FOR CORPORATE OPERATIONS CAPACITY-BUILDING ACTIVITIES
Develop an organizational framework for NI that supports different business functions to identify how they can contribute to NI within the organization (for example, Risk Management, Investor Relations, Corporate Reporting, Operations, Finance, and Asset Management).
Partner with academia, neighboring communities, engineering consulting firms, and nonprofit organizations to develop innovative NI business solutions.
Hire staff with NI project knowledge and experience.

Table 3 contains elements that may increase the likelihood of applying NI solutions successfully, including best practices for project design and implementation. Once a business has implemented NI solutions successfully, some corporate operations' capacity-building activities may be called for to fully integrate NI solutions into the strategic organizational planning and investment decision-making processes.

Table 3. Some critical success factors for implementation of NI solutions.
Information contained in this table is a compilation of that provided in case studies and contributing author experience.

Feasibility Study and Conceptual Design	Design	Construction	Post-Construction	
✓				
✓				
✓				
✓	✓	✓	✓	
✓	✓	✓	✓	
✓				
✓	✓	✓	✓	
✓	✓	✓	✓	
✓				
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✓				
✓	✓			
			✓	
			✓	
			✓	
Train existing staff to build organizational capacity and expertise in natural and hybrid infrastructure engineering.				
Form cross-disciplinary and cross-functional design teams with strong ecology and biology expertise, including landscape architects, civil and water resources engineers, economists, and public relations specialists.				
Develop built-in triggers to inject innovative NI solutions into the corporate project decision-making process.				

7 Summary

Companies are increasingly designing a variety of cost-competitive NI solutions to produce ecosystem services that address key business drivers. Based on the required business application, environment, and project-specific design parameters, the NI solution can also produce a broad range of direct financial benefits; and indirect operational, financial, and reputational gains from environmental and social co-benefits, which gray infrastructure alone cannot provide. These co-benefits, in turn, enhance the relationships between the business and community they operate in and serve. To better understand how your business can benefit from the use of NI solutions, refer to the **Natural Infrastructure for Business Platform.**

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Acknowledgements

Written by Elizabeth Bradford, CH2M

Support and key technical input that shaped the document was also provided by:

- Violaine Berger, Joppe Cramwinckel, Tatiana Fedotova, and Sara Traubel of WBCSD
- Jeffrey North and Sheila M.W. Reddy of The Nature Conservancy
- James Bays, Velislava Ivanova, Mary Jo Kealy, Jonathon Weier, and Jessica Wollmuth of CH2M

CH2M and The Nature Conservancy are engaged in a 5-year collaboration to catalyze a market-level shift in how infrastructure solutions are designed and implemented, proving the business case for combining conventional engineered solutions with natural habitat restoration and environmental conservation. Our collective goal is to create lasting, tangible, and sustainable improvements to the natural and built environment. Together with WBCSD, we produced a business platform that will serve as a tool businesses can implement on their natural infrastructure projects – thereby driving the WBCSD's Natural Infrastructure Business Solution objective of making natural infrastructure investments a common practice by 2020.

Case studies that formed the foundation for this document were provided by:

The Dow Chemical Company (France Guertin, Paul Van Riet, Wim Staal, Mike Uhl, and Mark Weick); EDF (Agnès Barillier, Laurent Bellet, Geraldine Duvochel, Alain Garnier, and Claire Varret); LafargeHolcim (Jim Rushworth, Morgaine Warau, Krzysztof Bambynek, Maciej Czapski, Łukasz Ludwisiak, Sylwester Sroka, Philippe Lussou, and Emma Topacio); Philip Morris USA & Altria (Tony Nobinger and Robert Bethea); RTE (Aurore Bailly, Cecile Leclere, and Jean-François Lesigne); Shell (Duska Disselhoff, Christian Van Maaren and Alfio Mianzan); Syngenta (Varun Vats and Romano de Vivo); Veolia (Coline Jacobs and Christelle Pagotto); and The Volkswagen Group (Michael Kühn and Raul Rodriguez Sanchez)

We are grateful for the helpful input from key contributors to the document:

Suncor Energy (Prit Kotecha and Kathleen Gardiner-Manning); Mondi (Peter Gardiner and Tanya Patterson); EDF (Claire Varret), The Dow Chemical Company (Elizabeth Uhlhorn and Mark Weick); Shell (Alfio Mianzan); Vale (Helio Laubenheimer, Gabriel Ribeiro Silva, and Sofia Shellard)

Sincere gratitude and thanks to the members of the WBCSD Investing in Natural Infrastructure working group, WBCSD member companies, and external experts who provided input and guidance throughout the process; in particular, member companies that have provided case studies.

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World Business Council for Sustainable Development www.wbcsd.org
4, chemin de Conches, CH-1231 Conches-Geneva, Switzerland, Tel: +41 (0)22 839 31 00, E-mail: info@wbcsd.org
1500 K Street NW, Suite 850, Washington, DC 20005, US, Tel: +1 202 383 9505, E-mail: washington@wbcsd.org

 ISBN 978-2-940521-60-9