Case Studies

for Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas

EPA's Brownfields Program is designed to empower states, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields. A brownfield is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. EPA's Brownfields Program provides financial and technical assistance for brownfield revitalization, including grants for environmental assessment, cleanup, and job training.

What is Green Infrastructure?

Most development and redevelopment practices cover large areas of the ground with impervious surfaces such as roads, driveways, sidewalks and new buildings themselves, which then prevent rainwater from soaking into the ground. These hard surfaces increase the speed and amount of stormwater that runs into nearby waterways, carrying pollutants and sediment each time it rains.

Green infrastructure seeks to reduce or divert stormwater from the sewer system and direct it to areas where it can be infiltrated, reused or evapotranspirated. Soil and vegetation are used instead of, or in conjunction with, traditional drains, gutters, pipes and centralized treatment areas. In many new and redevelopment projects, green infrastructure is implemented to manage and mitigate the polluted runoff created by precipitation that falls on rooftops, streets, sidewalks, parking lots and other impervious surfaces.

How can Green Infrastructure be Applied to Brownfield Sites?

Brownfields redevelopment and sustainable stormwater management both produce economic and environmental benefits by improving urban areas, protecting open space and preventing further pollution of the nation's waters. However, in order to prevent further environmental damage by infiltrating precipitation through contaminated soil, onsite stormwater management must be done carefully, using particular design guidelines. There are projects across the country that have found effective solutions to the challenge of developing a brownfield site with residual contamination, by incorporating appropriate natural systems for stormwater management.

Greening Old Industrial Lands in Emeryville, California

Emeryville, California occupies just 1.2 square miles of dense, formerly industrial land along the San Francisco Bay between Berkeley and Oakland. In the 1990s, Emeryville started a comprehensive brownfields redevelopment project to address serious economic and social costs associated with large tracts of vacant or underutilized non-residential property throughout the city. The redevelopment of several targeted brownfields had many positive outcomes for the city, such as new jobs and residents, and increased income and tax revenue, but also had negative environmental impacts by increasing overall impervious surfaces contributing to runoff and non-point source pollution.

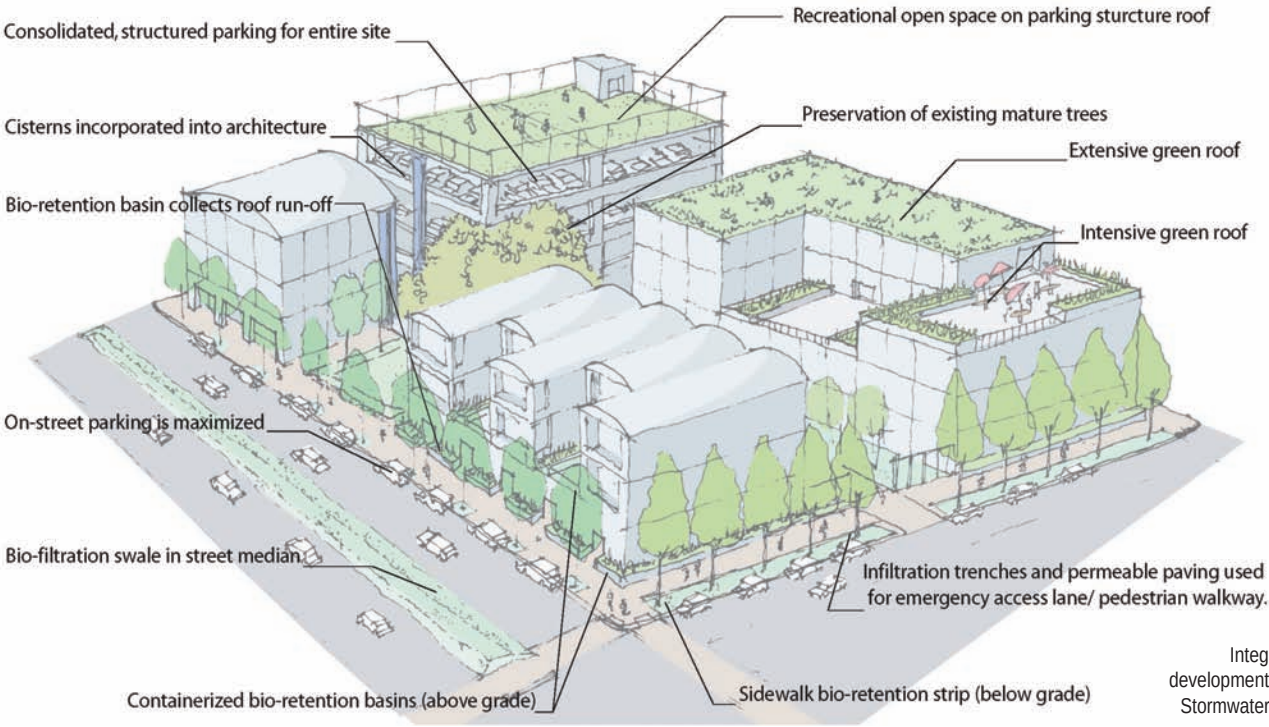
The Green City Lofts in Emeryville, California.

Stormwater solutions for brownfields with residual contamination often require that no surface water infiltrates the soil. This works fine in most settings where there is more space, particularly uncontaminated space available for diversion, retention and treatment. Emeryville was not able to adopt other cities' stormwater strategies because of the compacted, contaminated soils within its dense, high-value urban area. In 2004, Emeryville received a Smart Growth grant from the U.S. EPA to create local sustainable solutions to brownfield redevelopment. In 2005, Emeryville City Council adopted Stormwater Guidelines for Dense, Green Development that apply to development projects of 10,000 square feet or more. These guidelines emphasize site design that uses vegetated stormwater management practices and integrates parking strategies that reduce the total number of parking spaces required in the community by way of shared parking, making the best use of on-street parking, and pricing strategies. Emeryville's Stormwater Guideline's for Dense, Green Development can be found at: www.ci.emeryville.ca.us/planning/pdf/stormwater_guidelines.pdf.

Emeryville's solutions encourage minimizing total impervious area and managing stormwater onsite to prevent surface run-off. The guidelines suggest a range of design options that can stand alone or be combined into an integrated approach. Tree preservation and planting with structured soils work well within the space constraints of parking lots, sidewalks and dense development. Green roofs can either be extensive or intensive to manage rainfall through evapotranspiration and bio-filtration. Stormwater reuse is another creative way to manage stormwater in dense urban areas. Cisterns placed above or below ground are suggested for water storage and reuse of rainwater for irrigation and other non-potable uses. Green City Lofts, a 62-unit multifamily development in Emeryville, reuses stormwater for irrigation on the site of a former paint facility contaminated with petroleum hydrocarbons.

Detention, retention, and biofiltration are suitable for contaminated sites because they prevent exfiltration to underlying soils and allow adequate time for water to be in contact with plants and trees for bioremediation. Infiltration trenches and basins collect stormwater and infiltrate or attenuate runoff and may also use filter devices for pre-treatment. Permeable pavement and rain gardens are not usually suitable for sites with residual contamination, but Emeryville's Stormwater Guidelines suggest that in these circumstances, the area be capped and the stormwater retention vault below the permeable surface lined and fitted with under-drains connected to the storm sewer system.

Almost all of the solutions outlined in Emeryville's Stormwater Guidelines confer a range of additional benefits of green infrastructure beyond improved water quality and ecosystem health, including unique and attractive streetscapes, additional recreation and open space, as well as helping the city to be more competitive in attracting further housing and business development.



Integrated design for dense development. (Source: Emeryville's Stormwater Guidelines for Dense, Green Development.)

From Model A to a Model of Redevelopment in Dearborn, MI

Built by Henry Ford in the 1920s, the Rouge Truck Manufacturing Complex was a marvel of industrial efficiency. Raw materials went into one end of the plant and completed vehicles came out the other. Over time, the area devolved into a brownfield and in 2000, the Ford Motor Company began a project to redevelop the plant as a model of sustainable manufacturing.

The former Rouge Truck Factory in Dearborn, Michigan utilizes landscaped swales and wetlands containing native plants, bushes, and trees to remediate soils.

The centerpiece of stormwater management at this industrial area is a 10-acre green roof that can retain approximately 50% of precipitation falling onto it. Additionally, it decreases the building's energy costs and will likely double the roof's lifespan. Other stormwater features include collection of excess runoff and its reuse throughout the plant. Porous pavement allows water to drain through to a filter system that improves quality before being used elsewhere.

Landscaped swales and wetlands containing native plants, bushes, and trees remediate the soils surrounding the building by taking up, sequestering, and even treating pollutants that accumulated during more than 80 years of manufacturing. This vegetation also provides valuable habitat for wildlife and helps to cleanse water before it enters the nearby Rouge River. Water quality monitoring data show increased levels of dissolved oxygen necessary for fish and other species to thrive. Bacteria levels are also declining, which is beneficial not only to fish but to the increasing numbers of people who enjoy spending time on the river.

Toxic Steel Residue Gives Way to New Residences for Pittsburgh, PA

Four miles from downtown Pittsburgh, on a 238-acre parcel adjacent to Nine Mile Run, a brownfield has been redeveloped into the residential area known as Summerset at Frick Park. Over $300,000 in EPA Brownfields Assessment funds were used to survey the area, which once held piles of slag—a by-product of combusting coal to create steel.

Summerset at Frick Park features 713 housing units with 336 single-family homes, 121 townhouses, and 256 apartment units. In the process, Nine Mile Run, the last free-flowing stream in the City of Pittsburgh, was transformed as well.

Summerset at Frick Park in Pittsburgh, Pennsylvania, built on a former brownfield.

Degraded by sewage and high-alkaline seeps from the accumulated slag, this urban stream has undergone a renaissance. On-site soils were blended with granular slag, wood chips and fertilizers and used to plant steep slopes with grasses and legumes. Trees tolerant of high pH and compaction were also used to populate the stream banks

The project increased the city's green space, and created new trails connecting Frick Park to the Monongahela River. It provided new housing without sacrificing natural space or resources. The community also enjoys improved river access, enhanced tax revenues, a beautified landscape, and new recreational opportunities.

Definitions

Bioswales are open channels with a dense cover of vegetation where runoff is directed or retained to evapotranspirate and filter.

Evapotranspiration is the return of water to the atmosphere either through evaporation or by plants.

Green Infrastructure and ***Low Impact Development (LID)*** both refer to systems and practices that use or mimic natural processes to infiltrate, evapotranspirate or reuse stormwater or runoff on the site where it is generated.

Green roofs can be used to effectively reduce or eliminate runoff from small and medium sized storms. A soil mixture is placed over a waterproof membrane and drainage system and then planted with water absorbent and drought tolerant plants. Most systems also have root barriers. These roofs soak up stormwater and release it back into the atmosphere through evaporation and plant respiration, while draining excess runoff.

Rain gardens serve the same purpose as stormwater planters and are appropriate where there is more area to plant vegetation. Sizing is dependent on the area of impervious surfaces draining to the rain garden, but they can be designed to only treat a portion of the runoff so they can be placed in most situations.

Stormwater harvest and reuse. Rainwater harvested in cisterns, rain barrels, or other devices may be used to reduce potable water used for landscape irrigation, fire suppression, toilet and urinal flushing, and custodial uses. Storage and reuse techniques range from small-scale systems (e.g., rain barrels) to underground cisterns that may hold large volumes of water.

Stormwater planters. Downspouts can be directed into stormwater planters. These planters are used to temporarily detain, filter and evapotranspirate stormwater using plant uptake.

Additional Resources

The Emeryville, California *Stormwater Guidelines for Green, Dense Redevelopment* provides guidance on using vegetative stormwater treatment measures for this dense, brownfield-laden city: www.ci.emeryville.ca.us/planning/stormwater.html.

EPA's *Green Infrastructure Web site* (www.epa.gov/npdes/greeninfrastructure) provides definitions, case studies and performance data for various practices that might be applicable to brownfield sites.

The Low Impact Development Center is dedicated to research, development, and training for water resource and natural resource protection issues. The Center focuses specifically on furthering the advancement of Low Impact Development technology: www.lowimpactdevelopment.org.

Green Roofs for Healthy Cities collects and publishes technical information on green roof products and services: www.greenroofs.org.

The Center for Watershed Protection's Better Site Design Tools provide links to various better site design resources and publications: www.cwp.org/PublicationStore/bsd.htm.

American Rivers' ***Catching the Rain: A Great Lakes Resource Guide for Natural Stormwater Management*** describes a variety of low impact development strategies that can be implemented in a wide range of built environments. Available at: www.americanrivers.org/site/DocServer/CatchingTheRain.pdf?docID=163

EPA's *Brownfields Program Website* (www.epa.gov/brownfields) provides information on and resources for assessing, cleaning up and redeveloping brownfields, including grant funding opportunities.