Case Study: Matthiessen and Hegeler Zinc Smelting Site, near Hegler, Illinois

Site Overview	The Matthiessen and Hegeler Zinc smelting site in Illinois was designated as a Superfund site in 2005 for its high concentration of heavy metals. Through multiple comprehensive field investigations, the Illinois EPA (IEPA) collected soil and sediment samples from the site and the adjacent residential community. Among other contaminants, zinc was found to be present at elevated levels in all samples, and cadmium and lead were elevated in all but one sample. The large surface area of the contaminated site, over 40 hectares (100 acres), poses a challenge for treatment. Two alternative treatment methods were evaluated for long-term sustainability – the traditional method of excavation, hauling, and disposal in a hazardous waste landfill, and an in-situ remediation approach via solidification/stabilization. The life cycle assessment for each alternative was performed using SimaPro for energy inputs and environmental releases through all stages of manufacturing of materials needed for remedial operations, transportation, and remedial implementation. It was found that due to the large quantity of contaminated soil that is required to be excavated and hauled to the nearest landfill, the in-situ method of solidification/stabilization was the more sustainable option in the long-term. Other aspects associated with sustainability include social and economic impacts; both are considered in the remedy selection.
GSR Project Outcome	Considering the environmental, economic, and social aspects (triple bottom line framework), select the sustainable remedial option. This project was performed as a part of environmental remediation engineering course taught at the University of Illinois at Chicago.
Background & Drivers	The IEPA and Weston Solutions collected on-site soil, slag, sediment, and groundwater samples during investigations conducted between 2000 and 2006. Samples were collected on-site as well as the neighboring residential neighborhood. Residential soil sample tests found that lead, arsenic, and copper concentrations were greater than levels established within IEPA Tiered Approach to Corrective Action Objectives (TACO) regulations for protection of residential exposure. Residential soils were above regulatory limits; however, the concentrations were not as high as the on-site soils. Soil and waste samples collected on-site were compared to TACO regulatory limits for industrial/commercial properties. This analysis strictly focused on remediating the site soils. The majority of screening level exceedances were due to elevated arsenic, cadmium, lead, and zinc concentrations, with the highest metal concentrations in the north-central portions of the site as well as within the slag pile. The general extent of metals contamination in site soils extends to the site's boundaries. Polylcyclic aromatic hydrocarbons (PAHs) were detected in site soils above screening levels. The areas of PAH contamination appear to coincide

Background & Drivers (cont.)	with areas of elevated metals, which are the main contaminants and are associated with the slag. The underlying clay soil exhibited significantly lower concentrations of metals, indicating that the majority of the elevated metals concentrations are concentrated within the fill material. To prevent trespassers from coming in contact with the contaminated soil and waste material, the IEPA installed a six-foot chain link fence around the site. In 2005, the site was officially added to the National Priorities List (NPL) due to the risk potential with human contact with the site contamination levels.
Regulatory Program	Superfund Program, USEPA Region V
Site End Use	Unknown
Contaminants of Concern and Impacted Media	Heavy metals in surficial soils/fill materials
Key Stakeholders in Project	Unknown
Cleanup Objectives	For the class project purpose, Illinois TACO Tier 1 screening levels were used as cleanup objectives
Remediation Strategy	Various methods are available for treating soils contaminated with heavy metals, including landfilling (excavating and hauling), containing pollutants via capping/subsurface barriers, solidification/stabilization, vitrification, soil washing/flushing, electrokinetic treatment, and bioremediation. Deciding to use a particular method is a based on several variables, including the size of the project, cost of treatment, effectiveness, time frame, required monitoring, environmental impact, and processing steps, among other considerations. A significant challenge with remediating the Matthiessen and Hegeler Zinc smelting site is its large contaminated surface area.
GSR Strategy/Best Management Practices (BMPs)	Identify the most sustainable remedial option based on environmental, economic and social aspects (triple bottom line dimensions of sustainability)

GSR Metrics and/or Footprinting Tool(s)	The sustainability assessment approach consisted of: • Environmental impacts: life-cycle assessment using SimaPro • Economic impacts: only direct costs of remediation were compared • Social impacts: using Social Sustainability Evaluation Matrix
GSR Project Contact	Krishna R. Reddy University of Illinois at Chicago Ph: 312-996-4755 kreddy@uic.edu
References	Goldenberg, M., and Reddy, K.R. (2014). Sustainability assessment of excavation and disposal versus in-situ stabilization of heavy metal contaminated soil at a Superfund site in Illinois. Geotechnical Special Publication 234, *Proc. of the Geo-Congress 2014*, Editors: Abu-Farsakh, M., Yu, X., and Hoyos, L.R., American Society of Civil Engineers, Reston, VA, pp. 2245-2254. Reddy, K.R., and Adams, J.A. (2015). Sustainable Remediation of Contaminated Sites. Momentum Press: New York, NY.

Case Study: Indian Ridge Marsh Site, Chicago, Illinois

Site Overview	The remediation and restoration of heavily industrialized former wetlands and mesic prairies in the Great Lakes region pose several special challenges due to: (1) widespread and heterogeneous distribution of contaminants; (2) the variety of contaminant classes present; (3) complex hydrogeologic regimes due to extensive and variable industrial filling and dredging; and (4) the presence of sensitive ecological receptors and habitats, including nesting areas for several threatened bird species. Indian Ridge Marsh (IRM) is one of several degraded wetlands in the Calumet region that are slated for remediation and redevelopment as part of the Calumet Open Space Reserve (COSR). The goals of this project were to: (1) assess historically documented contamination based on previous Phase I & II ESAs; (2) identify Areas Of Concern (AOCs) that present the greatest risks to human and ecological receptors to determine the extent/intensity of remedial treatments required to meet established cleanup requirements; (3) evaluate the remedial options available based on applicability, cleanup efficiency, and sustainability metrics; and (4) recommend an appropriate remedial strategy.
GSR Project Outcome	Considering the environmental, economic, and social aspects (triple bottom line framework), select the sustainable remedial option. This project was performed as a part of environmental remediation engineering course taught at the University of Illinois at Chicago.
Background & Drivers	Recent efforts by the City of Chicago and the Illinois Department of Natural Resources to restore historically industrialized wetlands and prairies in the Calumet region (southeast Chicago) have prompted the evaluation of potential remedial options for several tracts of land slated for redevelopment as part of the Great Lakes Restoration Initiative (GLRI), a multi-agency effort to increase funding for remediation and protection of Great Lakes ecosystems. This work sought to evaluate appropriate remedial actions to reduce contaminant concentrations in impacted media to acceptable levels and recommend a feasible remedial strategy for one of these sites – IRM.
Regulatory Program	Not Applicable
Site End Use	Open Recreational Space
Contaminants of Concern and Impacted Media	Heavy metals and polycyclic aromatic hydrocarbons (PAHs) in surficial soils/fill materials
Key Stakeholders in Project	Unknown

Cleanup Objectives	Risk based screening levels (RBSLs) established in the State of Illinois Administrative Code, Tiered Approach to Corrective Action Objectives (TACO) and the Calumet Area Ecotoxicological Protocol (CAEP).
Remediation Strategy	IRM has significant and widespread historic contamination, including documented impacts to soil, sediments, surface water, and groundwater. Restoration of wetland and prairie habitats at IRM holds significant ecological value, especially for several endangered birds (e.g., black crowned night heron) that nest seasonally in these areas. Multiple contaminant classes are present on-site including: heavy metals and PAHs. The contaminated areas that posed the greatest risk to human and ecological health were identified through comparison of measured sample concentrations to RBSLs. AOCs were established based on the geographic distribution of samples with contaminant levels exceeding established RBSLs. The AOCs were targeted for remediation.
GSR Strategy/Best Management Practices (BMPs)	Qualitative and quantitative analyses were conducted to evaluate potential environmental impacts associated with each potential remedial option.
GSR Metrics and/or Footprinting Tool(s)	SiteWise™ and SRT™ were employed to estimate the environmental impacts of potential remedial options and determine the most sustainable and cost-effective remedy. Social Sustainability Evaluation Matrix was applied to assess social aspects of the proposed remediation.
GSR Project Contact	Krishna R. Reddy, Ph.D. University of Illinois at Chicago Ph: 312-996-4755 kreddy@uic.edu
References	Yargicoglu, E.N., and Reddy, K.R. (2013). Green and sustainable remediation of contaminated Indian Ridge marsh site in Chicago, USA. Proceeding of Coupled Phenomena in Environmental Geotechnics (CPEG), Politecnico Di Torino, Torino, Italy, pp. 675-682. Reddy, K.R., and Adams, J.A. (2015). Sustainable Remediation of Contaminated Sites. Momentum Press: New York, NY.

Case Study: Sustainable Return on Investment Analysis of Recycling Materials from a Closed Landfill

Site Overview

A former manufacturing site for electrical components and x-ray film disposed of waste and off-spec plastic film material in two on-site, closed landfills. To repurpose the land for parks and public space, the recyclable film materials were removed. Overall, approximately 40 million pounds of polyethylene terephthalate (PET) were recycled creating additional unrestricted-use areas at the site.

GSR and/or Triple Bottom Line Project Outcome

A sustainable Return on Investment (sROI) assessment was prepared to evaluate the net benefit costs of the recycling initiative. Considering the triple bottom line aspects (social, environmental, and economic), the sROI analysis estimated a net benefit of nearly $0.5 million dollars.

The net economic benefit of over $2.2 million and the carbon dioxide equivalent emissions reductions compensated for the social and environmental costs, most notably the high cost of a minor increase in particulate matter (over $2.6 million).

The economic impacts included construction costs, disposal costs, and PET recycling revenue. The social and environmental impacts included carbon dioxide equivalent emissions, particulate matter, sulfur oxides, and volatile organic compounds.

Recycling the PET materials decreased carbon dioxide equivalent emissions over 14,000 metric tons, valued at over $900,000. Shipping the PET material to China for recycling caused an increase in particulate matter, sulfur oxides, and volatile organic compounds above the baseline resulting in a total cost of about $2.65 million.

Sustainable Aspect	Benefit ($million)	Basis
Economic	$2.23	Recycling income less cost of recycle
Environmental	$0.90	Carbon dioxide equivalents
Social	($2.65)	Health impacts (particulates) and acidification (sulfur emissions)
Net	$0.48	

Background & Drivers

The facility was located in a remote and scenic area. Undisturbed buffer areas were designated for transfer to the state as parkland. The non-hazardous nature and recycling opportunity provided an opportunity to further reduce the historical footprint and open additional public access areas for unrestricted future use. A ball field was built over the remaining landfill remnant.

Regulatory Program

This was a voluntary action under state jurisdiction.

Site End Use	The plan was to repurpose the site for parks and public space.
Contaminants of Concern and Impacted Media	PET in a landfill
Key Stakeholders in Project	• State parks department • State solid waste agency • Recycle broker • Confidential client
Cleanup Objectives	• Return, to the extent practicable, closed landfill areas to unrestricted use
Remediation Strategy	• Excavation, washing, and transport for recycle • Backfill and grade recovered areas
GSR Strategy/Best Management Practices (BMPs)	• Recycle PET for non-food use • Reduce landfill physical footprint • Create additional public access and use
GSR Metrics and/or Footprinting Tool(s)	A sROI analysis was used to determine whether recycling the PET materials would be beneficial economically, socially, and/or create a more environmentally sound project compared to the traditional remedy of disposing the materials in an off-site landfill. The sROI methodology is a quantitative approach that captures the economic, environmental, and social impacts of a remediation project in monetary terms. sROI includes an uncertainty analysis to demonstrate the likelihood of realizing costs and benefits. This approach results in a more comprehensive picture of remediation projects and results that are defensible and transparent. The sROI analysis was based on the lifecycle assessment conducted using SimiPro.
GSR Project Contact	Brandt Butler Director of Global Green and Sustainable Remediation Practice AECOM Conshohocken, PA Ph: 610-832-3575 brandt.butler@aecom.com Andrea Bohmholdt, Senior Economist AECOM Germantown, MD Ph: 240-459-2094 Andrea.bohmholdt@aecom.com
Relevant Links	http://onlinelibrary.wiley.com/doi/10.1002/rem.21404/abstract

References	Bohmholdt, A. (2014). Evaluating the Triple Bottom Line Using Sustainable Return on Investment. Remediation Journal, Volume 24, Issue 4, pp. 53-64, Autumn.

Case Study: Targeted Brownfield Assessment of Former Augsbury Tank Farm Site, Ogdensburg, New York

Site Overview	The Brownfields site is a former petroleum tank farm occupying approximately 23 acres. A phased-focused approach was implemented to evaluate the nature and extent of on-site light non-aqueous phase liquid (LNAPL) contamination. This type of investigative approach can improve efficiency and reduce negative impacts to the triple bottom line (TBL) of a remediation project by identifying areas of greatest concern and using minimally invasive site surveys and direct imaging tools. In order to quantify the reduction of impacts to the TBL by implementing a phase-focused approach, a sustainability assessment was conducted for both the implemented approach and a conventional investigation for comparison.
GSR Project Outcome	By implementing a phased-focused approach during site characterization (instead of a conventional approach), the sustainability assessment comparison showed the following reductions: **Environmental impact:** - 35% reduction in greenhouse gas emissions - 38% reduction in total energy used - 42% reduction in nitrous oxide emissions (NO_x) - 41% reduction in sulfur oxide emissions (SO_x) - 8% reduction in particulate matter emissions (PM_{10}) **Economic impact**: 38% reduction in project implementation costs **Societal impact**: 36% reduction in cost borne by society
Background & Drivers	Several environmental sampling events were conducted before the site characterization presented above. Therefore, the driver was to delineate the nature and extent of on-site LNAPL within the allotted Brownfields funding. This was achieved by focusing characterization efforts in one mobilization event, limiting the number of samples for laboratory analysis, and minimizing the amount of waste generated. In addition, the site investigation incorporated EPA Region 2's "Clean & Green" policy, which provides guidelines to enhance the environmental benefits of all Superfund cleanups by promoting technologies and practices that are sustainable.
Regulatory Program	USEPA Region 2 Targeted Brownfields Assessment Program

Site End Use	The redevelopment plan for the property includes constructing recreation space and potentially a community center using existing property structures.
Contaminants of Concern and Impacted Media	Petroleum LNAPL
Key Stakeholders in Project	EPA Region II, NYSDEC, City of Ogdensburg
Cleanup Objectives	The goal for characterization and remediation at the property is to allow the city to return the site to productive use under "Restricted-Residential Use" regulatory goals: - Determine the extent of the on-site petroleum plume - Investigate an area which previously showed an isolated arsenic exceedance - Integrate sustainable remediation principles and practices into site characterization activities - Support future remedial and construction activities
Remediation Strategy	Not applicable to this case study
GSR Strategy/Best Management Practices (BMPs)	TRIAD approach (i.e., phased-focused site characterization), *in situ* screening using the ultra-violet optical screening tool (UVOST), direct imaging survey, direct push technology (DPT) drilling, generated waste minimization, stakeholder engagement meetings
GSR Metrics and/or Footprinting Tool(s)	A sustainability assessment was conducted for each site characterization approach using: **Environmental Impacts**: Naval Facilities Engineering Command SiteWise^{TM} environmental footprint analysis tool **Economic Impacts:** Cost-benefit analysis of project implementation **Social Impacts:** Cost borne by society due to environmental, economic, and social impacts were calculated by identifying the social monetary values associated with environmental footprint analysis metrics

GSR Project Contact	Melissa Harclerode Environmental Scientist, CDM Smith Ph.: 732-590-4616 harclerodema@cdmsmith.com
References	**Harclerode M**, Lal P, and Miller M. 2013. Estimating Social Impacts of a Remediation Project Life Cycle With Environmental Footprint Evaluation Tools. Remediation Journal, Volume 24, Issue 1, 5-20.

Case Study: Vega Science and Technology Park, Venice, Italy	
Site Overview	VEGA is the first Science and Technology Park (PST) in Italy, with 200 companies and 2,000 employees. It represents a model of environmental conversion in Italy, recognized by international certifications for the quality of management with respect to the environment (ISO 14001) and services (ISO 9001). VEGA is located in a strategic geographical position in the heart of the economy of the North East of Italy, near the historic center of Venice, and well connected to the international airport "Marco Polo", to the commercial port, the main infrastructure, water, and roads. VEGA has been operating for over ten years with a mission to upgrade the first industrial zone of Porto Marghera, an area of over 2,000 hectares (one of the largest in Europe), transforming it into a new concept of industrial development and services. The project of the Vega PST of Venice aims at the urban and environmental regeneration of brownfield sites, for the realization of innovative infrastructure designed to accommodate companies with high scientific and technological content, laboratories associated with universities and research centers and related services. The development of the park is divided into four contiguous areas (Areas 1, 2, 3, and 4) comprising an area of approximately 35 hectares. Area 1 covers about 9.4 hectares, and from the redevelopment of this area, the VEGA commenced. In continuity with Area 1, and connected to it, Area 2 is the former Agip Coastal Depots. It overlooks an important waterway that leads into the lagoon. Land reclamation, carried out with the innovative technology of biopiling, or fertilizing the earth in order to remove hydrocarbons, returned a highly attractive piece of land in the proximity of the city of Venice. This intervention represents the most important project carried out in Italy using the biopile technique. Area 3 is situated on the continuation of the road axis that unites the first two areas. It also served as a waterway and has a building capacity of 30,000 square meters. Area 4 covers about 5.9 hectares and the project involves the redevelopment of an area called "the Ex Cargo System" originally used as a coal deposit, with interventions of new buildings (34,300 m), the recovery of an existing research center, the creation of green areas, and construction of parking lots.
GSR Project Outcome	• Environmental outcomes: the regeneration of contaminated soil, environmental requalification through the use of plants and grass, groundwater monitoring, building demolition, securing wastes, etc. • Social and economic outcomes: the site has been redeveloped to house more than 200 companies with 2,000 staff in innovative and eco-sustainable buildings. • Implementation of an energetic upgrading of the area.

Background & Drivers	The idea of building a science and technology park in the Venice area located in the industrial area of Porto Marghera goes back to the early 1990s, a period of profound change linked to impacts of heavy industry and the need to convert the area to a different production model. This is based on a new and modern concept of industrial development and services in close contact with universities and research centers. The Vega PST of Venice Scarl is a non-profit organization and consortium, founded in 1993, consisting of 34 members including the Venice municipality, the two Venetian universities, important public and private institutions (e.g., the Venice Port Authority), two banking institutions, and small and medium companies. The realization of this science and technology park in an area of production and employment decline that affects Porto Marghera, has set as its goal to boost the local wealth and, as a result, the region, collaborating with the main Venetian public authorities. In recognition of the production of chemical fertilizers in the first zone of Porto Marghera in the 1920s, Vega was born without obliterating its history, the modern buildings of Vega fit and blend in a context of old factories and artifacts, as a symbol of industrial archaeology. The development of this PST was identified as a European Union "Objective 2". This area is officially recognized as undergoing industrial decline and, therefore, eligible for government grants. Vega has thus been able to manage and use more than 30 million Euro from European Structural Funds, provided and managed by the Veneto Region, for activities of urbanization, construction, technological infrastructure, as well as the acquisition of highly sophisticated scientific equipment. The loans have been the driving force for private investment. In the summer of 2000, the so-called "private phase" of development started on Vega, with the intervention of the co-developer Nova Marghera. This was the first company that has endorsed the continuing urban development project Vega (a further 35,000 square meters of new buildings) and marketing activities for the completion of Vega. All investments were essential for attracting companies and to carry out, in parallel, the activity of the PST. The development of Areas 2, 3, and 4 will be continued by private operators: Venice Expo 2015 (Area 2), Real Estate Complex (Area 3), and Docks Venice (Area 4).
Regulatory Program	No information available

Site End Use	Ten years after the start of the regeneration, Vega is the first PST in Italy with 200 companies and 2,000 employees. Over the next decade it is planned to open a new stage of development: the transformation within all four areas for a total of 35 hectares, in the City of Knowledge, Science and Technology which will operate 1,000 companies with 10,000 employees and will be built over 200,000 square meters of buildings and innovative buildings. The Vega PST is a multi-sector park and deals with eight sectors: Nanotechnology, ICT and Digital Media, Environment and Sustainable Development, Restoration and Conservation of Cultural Heritage, Aerospace, Biotechnology, Formation, and Advanced Services. It is a city within a city with spaces for culture and leisure, meeting, movie studios and music, congress and events center, and a science museum. VEGA continues to take new initiatives in favor of starting enterprises, implementing systems of finance who believe in innovative research and marketing policies, and targeted communication to attract innovative and specialized companies. 34% of the companies located in the Park are start-up or spin-offs of companies or universities. Since 2012, the development of Area 2 aims to enhance the real-estate and commercial value of the area by developing a new multifunctional urban district for exhibitions, hospitality, congress, commercial uses, offices, and parking lots. The first step of this process was completed in 2015, with the inauguration of an exhibition pavilion for the Venice Expo 2015.
Contaminants of Concern and Impacted Media	• Heavy metals (Cu, As, Pb, Zn) in soil • Hydrocarbons (benzene, ethylbenzene, toluene, etc.) in soil • Metals, hydrocarbons, and fluorides in groundwater
Key Stakeholders in Project	The public-private company VEGA (the Venice City of Science and Technology) Scarl has as members the Venice Municipality, the two Venetian universities (Ca' Foscari and the University of Architecture IUAV), the most important institutions of public and private local, two banks, large industry (Syndial/ENI) and small and medium-sized companies. The development of Areas 2, 3 & 4 will be continued by private operators: Condotte Immobiliare (Area 2), Immobiliare Complessi (Area 3), Docks Venezia (Area 4).

Key Stakeholders in Project (cont.)	Partners in the VEGA System are: Nanofab company that manages the Nanofabrication Facility, one of the first Italian technology platforms dedicated to the transfer of nanotechnology to the production sector - Hydrogen Park www.hydrogenpark.com, for the coordination and development of projects and initiatives on the use of hydrogen with a very broad spectrum of applications, from prototypes of boats with zero emissions at new power plants operated with this gas and co-generation plants for communities. Venice Technologies supports companies in the development of technology of metals, ceramics, plastics and semiconductors and their applications, mainly addressing the oil and energy sectors, including those related to hydrogen. The regeneration of Area 2 includes a very broad array of stakeholders, including: • The Venice municipality • Ca' Foscari and IUAV universities • Architecture studios • Venice Port Authority • Political actors • NGOs and civic associations.
Cleanup Objectives	The cleanup objectives are defined by two regulations, according to the period when the regeneration process was conducted: • Limit values defined in the Decree of the MoE n. 471/99, which requires the application of "limit values" for contaminant concentrations in soil and groundwater to be compared with the effective values detected at the suspected site in order to define the contamination level and the goal for the remedial action. The limit values are not risk-based. • Framework Environmental Legislation issued on April 14, 2006 which, under Title V, Section 4, deals with contaminated sites cleanup activities. Application of a risk-based tiered approach (similar to the RBCA ASTM procedure): Tier 1 = screening values (CSC) equal to the "limit values" set by DMoE n.471/99; Tier 2 = site specific target levels (CSR) calculated by the application of site-specific risk assessment (backward application) for both soil and groundwater.

Remediation Strategy	Land regeneration has been carried out with the innovative technology of "biopiling". The foundation technologies of land or composting biopile is the ability of numerous microbial strains, both via bacterial and fungal modes, in a controlled environment, to degrade a broad spectrum of chemicals transforming them into energy and nourishment. The principle application refers to the removal and on-site treatment of the fractions of contaminated soil in appropriate functional structures called "piles" in which the physical (temperature, pH, redox potential) and nutritional (macro and micronutrients) parameters are optimized. In particular, the use of fungal strains has proven particularly effective for the treatment of aromatic and halogenated compounds, while the inoculum in stacks of bacterial mesophilic and/or thermophilic strains has a greater catabolic affinity for the open chain hydrocarbons. The main phases for the implementation of the biopile technology are reported below: • Construction of a containment structure (stalls) comprised of impermeable plastic material, having a width of 5 m and a variable length of 20-40 m, generally underlain by a clay layer (30-50 cm) covered with a sheet of HDPE raised at the edges. • Construction of a drainage net positioned at the base of the pit, comprised of PE pipes connected to a suction pump capable of conveying the percolation fluids to a storage container. • Construction of a network of PE pipes, positioned at an intermediate level within the stack to convey air flow (generated by an appropriate blower) through the entire stack, thereby, increasing the flow of oxygen and accelerating exothermic reactions of organic materials. • Installation of a system for sprinkling liquid on the pile surface to supply the microbial biomasses with nutrients necessary for the maintenance of the physiological activities of fungi and bacteria. Utlizing probes positioned at different levels within the stack to verify thermal and redox levels within the material during the treatment.
Strategy/Best Management Practices (BMPs)	*No information available*
GSR Metrics and/or Footprinting Tool(s)	*No information available*

Project Contact	Tommaso Santini, Dott. Vega Science and Technology Park Venice, Italy Tel. +39 041.509.3007 t.santini@vegapark.ve.it

Case Study: Tar Ponds and Coke Ovens, Sydney, Nova Scotia, Canada	
Site Overview	One hundred years of steel and coke production resulted in >1M tonnes of contaminated soil and sediment, as well as groundwater impacts. The selected remedial method included solidification/stabilization, surface capping, active groundwater treatment, and cut-off walls. Remediation resulted in the reclamation of 240 acres (97 hectares-) in Sydney's downtown.
GSR Project Outcome	The long-term social, economic, and environmental impact on the entire community required a community-based process for the project to be successful. Specifically, the success of the project depended on incorporating the 55 Panel recommendations (see below); thus, socio-economic indicators (Outcomes) were established. Example Outcome: Recommendation #34 could be measured as "number of women employed in a non-traditional trade", and this was then used during decision-making throughout the remediation project.
Background & Drivers	Following several "false-starts", in 1996, a Joint Action Group (JAG) was formed. In 1998/99, a Memorandum of Understanding was signed and a cost-sharing agreement created between the federal, provincial, and municipal governments. In 2001, the Sydney Tar Ponds Agency (STPA) was created to manage the clean-up effort. In 2002-2004, the cleanup alternatives were tested and deemed successful, the JAG provided recommendations, and Environment Canada/STPA formulated the cleanup plan. In 2005, a full panel review of the cleanup plan was ordered (highest level of Environmental Impact Assessment). After three weeks of public hearings in 2006, the Panel delivered 55 recommendations that were accepted in January 2007. Of the 55 recommendations, there was heavy focus on the following socio-economic considerations: #32 – Community Involvement #33 – Economic Benefits (local business and labor, market skills, long-lasting) #34 – Women's Employment (non-traditional trades and technologies) #35 – African NS Employment (Cape Breton Black Employment Partnership Committee) #36-38 – Transportation/Rail #39 – 45 – Future use #55 – Community Liaison Committee In addition, given the size and nature of the project, it was required to adhere to federal procurement policy regarding employment equity (e.g., aboriginal procurement).

Site End Use	The community contributed to the site end use, which is Open Hearth Park, a 96-acre (39-hectare) green area featuring sports fields, walking trails, art installations, a playground, and panels chronicling the history for the Former Sydney Tar Ponds area.
Contaminants of Concern and Impacted Media	The site contained groundwater, soil, and sediment contamination. Primary COCs include: • PAHs • Petroleum hydrocarbons • PCBs • Dioxins • Heavy metals
Key Stakeholders in Project	The stakeholders chosen by the Panel included groups impacted by the industry: women, youth, aboriginal community, African Nova Scotians, local business, and residents. Other key stakeholders in the Project include: • Government of Canada – Public Works and Government Services Canada • The Province of Nova Scotia • Cape Breton Development Corporation • Cape Breton Regional Municipality • The entire community
Cleanup Objectives	Cleanup objectives were risk-based to be protective of human health and the environment. Environmental sensitivities include the marine/estuarine environment, including fish habitat.
Remediation Strategy	• Solidification and stabilization of impacted sediments • Surface capping of impacted soils • Land use controls • Cut-off walls to control groundwater migration • Groundwater collection system and water treatment plant • Long-term monitoring

GSR Strategy/Best Management Practices (BMPs)	There was a heavy focus on socio-economic considerations throughout the project, based on Panel recommendations. For example:
	• Protecting workers and the public through implementation of a comprehensive health and safety plan, report cards on contractors' health and safety performance, and the elimination of unsafe contractors
	• Ensuring social equality and justice was achieved via inclusivity and engagement in the decision process, including:
	  o The Review Panel / Public Hearings
	  o Environmental Committee
	  o Community Liaison Committee
	  o Ongoing reporting (Federal Treasury Board reporting on Panel Recommendations)
	• Promoting transparency through:
	  o Establishment of Sydney Tar Ponds Agency and Community Liason Committee
	  o Public tendering process with review committee
	  o Communication of work plans, sampling/testing program, and results
	  o Timely update of public website
	• Considering impacts/benefits to local areas during the project (e.g., dust, noise, and airborne chemical vapor monitoring throughout the construction phase)
	• Considering the wider effects of changes in site usage:
	  o Enhancement of previously contaminated and unusable land
	  o Community input into final product
	  o Potential continuing economic benefit
	• Supporting job creation through contractual requirements, including:
	  o Employment diversity / employment for minorities
	  o Aboriginal procurement / participation
	  o Local workers
	• Providing education and training opportunities and enhancing innovation and new skills within the community via the support of:
	  o Training in non-traditional careers for women
	  o Creation of Women Unlimited with Nova Scotia Community College
	  o Co-op students, Engineers in Training (EIT) involvement
	  o Career days for female youth
	  o Techsploration program for young women
	  o Bridging technology gaps
	  o Environmental/technical education and training
	  o Establishment of Centre for Sustainable Energy at Cape Breton University

GSR Metrics and/or Footprinting Tool(s)	STPA required contractors and consultants working on the project to submit monthly Local Economic Benefits (LEB) report cards to ensure that contractual requirements and guarantees included in winning proposals were being fulfilled. STPA was required to report on progress in meeting 55 recommendations via Annual Accountability Reports and Annual Tracking Documents. A community survey was conducted each year to measure the success of the project with regards to subjects such as transparency, communication, and perceived local economic benefit and community well-being. These tools allowed for quantitative analysis of qualitative factors. For example, by polling the positive response of the community to the following statement "Once the Tar Ponds and Coke Ovens sites are remediated, Sydney will be a good place to live, work, and play." it was possible to quantitatively measure the impact of the project on how citizens felt about their community.
Lessons Learned	It is possible to quantitatively assess and measure apparently qualitative socio-economic factors. Stakeholder involvement is critical to the success of large-scale, contentious remediation projects. Earlier stakeholder involvement could have diminished controversy around the project and would likely have resulted in decreases in project duration and cost.
GSR Project Contact	Maylia K. Parker, P.Geo. Stantec Consulting Ltd. Dartmouth, NS (902) 468-7777 Maylia.Parker@stantec.com Former STPA Project Director: Donnie Burke, CET, PMP, EP Nova Scotia Lands Inc. Sydney, NS (902) 567-2715 BURKEDF@gov.ns.ca
Relevant Links	Canadian Environmental Assessment Agency http://www.ceaa-acee.gc.ca/052/details-eng.cfm?pid=8989 Sydney Tar Ponds Agency (STPA) website: www.tarpondscleanup.ca
References	Sydney Tar Ponds Agency (STPA) website: www.tarpondscleanup.ca

Case Study: Sustainability Appraisal of Soil Amendments for the Revegetation of the Gunnar Mine and Mill Tailings Cover – A Pilot Project. Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada.	
Site Overview	The Gunnar Mine and Mill (the Site) Remediation Project involves the remediation of a legacy cold war-era uranium mine and mill located on the shore of Lake Athabasca, northern Saskatchewan, Canada. The Site consists of tailings areas, waste rock piles, a flooded pit and underground workings, and infrastructure related to uranium mining. The remediation of the Site is now being addressed by a joint governmental program.
GSR and/or Triple Bottom Line Project Outcome	The Saskatchewan Research Council (SRC) wanted to evaluate the use of a sustainability appraisal (SA) as a pilot project to illustrate the benefits of the approach to maximize the sustainability outcomes of a remediation project; one that involves stakeholders' participation, and maximizes economic and social benefits while delivering environmental benefits.
Background & Drivers	The Site is located in the Lake Athabasca region, which is home to small aboriginal and non-aboriginal northern communities. These communities have been engaged in the project since its onset in early 2000s. This area was home to a boom of uranium mining in the 1950s. By mid 1960s, most of the mines had closed. The Site was one of the largest mines in this area. The selection of an organic soil amendment for the vegetative soil cover was used as a case-study for this pilot study. Important drivers for this pilot project were: identifying the appropriate soil amendment that would support indigenous plant growth, providing community benefits, and incorporating economic and social objectives in the assessment.
Regulatory Program	The Canadian Nuclear Safety Commission (CNSC) and Saskatchewan Ministry of Environment regulate aspects of the project to ensure people and the environment are protected.
Site End Use	The Site is being remediated to facilitate passage for traditional land use purposes by local aboriginal and non-aboriginal community members. That said, the Site is expected to be forever considered an industrial site.
Contaminants of Concern and Impacted Media	Given the nature of site (i.e., a legacy uranium mine and mill), the chemicals of concerns are: arsenic, copper, lead, radium-226, uranium, and gamma radiation in all affected media.

Key Stakeholders in Project	As the sustainability appraisal was a pilot project, the team did not consult with the actual Gunnar Project stakeholders. The following SRC employees acted as representative stakeholder groups for the SA: a forestry expert, a chemical engineer, a local community member and field staff, a business unit manager, and a financial analyst.
Cleanup Objectives	The objective of the pilot project was to select an organic soil amendment for the vegetative soil cover for the Gunnar tailings areas.
Remediation Strategy	Four soil amendment options were compared: • No soil amendment • Peat soil amendment (a common organic amendment) • Commercial bio-char amendment • Locally produced bio-char amendment using local timber
GSR Strategy/Best Management Practices (BMPs)	SRC adopted the three-tier SURF-UK sustainability appraisal approach to the pilot project: • Tier 1 consisted of a qualitative comparison of the options by the project team. • Tier 2 consisted of a semi-quantitative multi-criteria analysis (MCA) comparing the four options • Tier 3 consisted of quantitative environmental and cost life cycle assessments (LCA) comparing three of the four options
GSR Metrics and/or Footprint Tool(s)	Specialized tools were used: the web-based MCA tool ExpertChoice and the LCA software Simapro. Options were compared against several metrics such as: biodiversity, greenhouse gases, occupational risks, public safety, project cost, and economic opportunities.
Lessons Learned	Some key lessons from the pilot project were: Tier I should involve stakeholders to ensure mutual understanding of the sustainability appraisal. The MCA tool was very useful to collect diverging views from stakeholders, some located in remote areas. Early engagement of stakeholders is essential to the success of the SA. Trade-offs among metrics are inevitable.
GSR Project Contact	This project was carried out by a team from the Environmental Remediation business unit at the SRC, Saskatoon, Sasksatchewan, Canada. Project lead: Elizaveta Petelina (SRC, Elizaveta.Petelina@src.sk.ca) Team members: David Sanscartier (SRC, david.sanscartier@src.sk.ca), D. Reanne Ridsdale (University of Saskatchewan intern, Drridsdale@gmail.com), and Susan MacWilliam (SRC).
Relevant Links	Petelina et al. (2014) Environmental, social, and economic benefits of biochar application for land reclamation purposes, in van Zyl (Ed), Proceedings 38th BC TRCR Symposium http://emrlibrary.gov.yk.ca/ebooks/proceedings_38th_annual_british_columbia_mine_reclamation_symposium.pdf Saskatchewan Research Council. Gunnar Uranium Mine and Mill Site website at: http://www.src.sk.ca/about/featured-projects/pages/project-cleans.aspx