SUSTAINABLE REMEDIATION & BROWNFIELD RE-DEVELOPMENT
Former industrial site in St. Laurent, Montreal, Qc

François Dubé, B. A. Sc.
David Harper, M.Sc., P. Geo.
Introduction – Kilmer Brownfield Equity Fund

Sustainable Development & Brownfield Remediation

Former Industrial Site – Site Description

Former Industrial Site – Site Remediation

Conclusion

Acknowledgments
Kilmer Brownfield Equity Fund

Canadian private equity fund with committed capital > $90 million

First dedicated Canadian brownfield fund and an experienced management team

Fund investment sweet spot of $5 to $15 million in land, planning and remediation costs

Fund’s Mandate: “Do Good and Do Well”
Sustainable Development (SD)

A pattern of economic growth in which resource use aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for generations to come.
Greater Energy, Water and Material Efficiencies in the Built Environment

Public Transit Networks

Alternative and District Energy Systems

Restoration of Natural Systems

Greater Density and Intensifications
Brownfield Sites

Abandoned or underuse industrial or commercial sites in established locations with existing infrastructures

Various past site usages with unclear site management practices

Environmental liabilities impacting value of site

Site restoration both technically challenging and costly

Estimated 30,000 to 50,000 Brownfield Sites in Canada
Common Barriers to Brownfield Development

Potential Environmental Liabilities

- Civil and regulatory liabilities affecting both former owners and developers

Process Uncertainties

- Timing and outcomes unclear for environmental and planning matters

Remediation Funding Gap

- Conventional financing is not readily available during site restoration
Brownfield Financing Gap

- Higher Order Use
- Site Closure

Financing Gap

Value = ??

The Problem: Brownfields Cannot be Valued on a Cost Basis
Sustainable Development & Brownfield Remediation

- Former Industrial Site
- Site (5 Ha)
- School
- Railway
- Marcel-Laurin Boulevard
- Vacant
- Residential Condominiums
- Residential Single Family Homes
Planned redevelopment includes:

- 9 residential buildings (900-1,000 residential units)
- 1,000 underground parking spaces
- New green space with linkages to the subway station and a vegetal visual and sound barrier along the rail corridor
Sustainable Development & Brownfield Remediation

LVM

- Environment
- Drinking Water / Waste Water
- Site Remediation
- Sediment Management
- Environmental impact assessments / Institutional support
- Site characterisation and Hydrogeology
- Waste Management
- Air / Acoustic / Asbestos
## Sustainable Development & Brownfield Remediation

<table>
<thead>
<tr>
<th>Traditional Remediation</th>
<th>Sustainable Remediation</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Off-site disposal of demolition material</td>
<td>✓ Environmental Risk Assessment Approach (ERA)</td>
</tr>
<tr>
<td>✓ Excavation and off site disposal of impacted soil exceeding government guidelines</td>
<td>✓ Reuse of demolition material</td>
</tr>
<tr>
<td>✓ Fill material importation on the site</td>
<td>✓ Use of Green Remediation Techniques</td>
</tr>
<tr>
<td>✓ No site restriction</td>
<td>✓ Reuse of on site treated soil</td>
</tr>
<tr>
<td>✓ Short remedial timeline (&lt; 6 months)</td>
<td>✓ Risk Mitigation Plan</td>
</tr>
<tr>
<td>✓ Costly $$$</td>
<td>✓ Innovative construction design</td>
</tr>
<tr>
<td>✓ Production of gas emissions (GHG and others)</td>
<td>✓ Possible site restrictions (no basement, minimum layer of clean soil</td>
</tr>
<tr>
<td></td>
<td>under structures, etc.)</td>
</tr>
<tr>
<td></td>
<td>✓ Negotiation with environmental agencies and municipalities</td>
</tr>
<tr>
<td></td>
<td>✓ Possible site monitoring after remediation</td>
</tr>
<tr>
<td></td>
<td>✓ Longer remedial timeline (6 months – 2 years)</td>
</tr>
<tr>
<td></td>
<td>✓ Low gas emissions</td>
</tr>
<tr>
<td></td>
<td>✓ On site management of the contamination – no liabilities transferred</td>
</tr>
<tr>
<td></td>
<td>to another site</td>
</tr>
<tr>
<td></td>
<td>✓ More cost effective than traditional remedial work (“dig and haul”)</td>
</tr>
</tbody>
</table>
Former Industrial Site – Site Description

Assessment Data from 1990 to 2009

Soil
- 345 sampling points
- > 400 samples analysed

Groundwater
- 116 observation wells
- >100 samples analysed

Soil vapors
- 3 sampling events
- 8 samples analysed
Groundwater Contamination and Flow Direction

Depth of groundwater: 2.5 to 3.5m bgs

Variable groundwater flow (W, N-E and E)

Groundwater contaminants: TCE, PAH, TPH C_{10}^{\text{-}} C_{50}^{\text{,}} Sulphide, Chloride
Former Industrial Site – Site Description

Site Geology

Bedrock (between 1.4 and 6.5m bgs)
Silty-sand (1-1.5m)
Fill (0-3.9m)

Figures adapted from Golder, 2009

Residential area
Soil Contamination

Former Industrial Site – Site Description
**Transportation Mechanisms**
A : Evaporation, volatilisation  
B : Upward movement of soil particles  
C : Atmospheric dispersal  
D : Precipitation/deposition  
E : Outdoor air infiltration (gases and particles)  
F : Infiltration to groundwater  
G : Groundwater table fluctuation  
H : Off-site migration by groundwater  
I : Infiltration to sewers

**Exposure Pathways**
1 : Soil ingestion  
2 : Outdoor air inhalation (gases and particles)  
3 : Soil dermal contact  
4 : Indoor dust inhalation  
5 : Indoor air inhalation (gases and particles)  
6 : Ecological receptors direct contact with soil  
7 : Ingestion (plants, surface water, soil)

**Stratigraphic units**
1 : Backfill  
2 : Natural soil  
3 : Bedrock
Former Industrial Site – Site Remediation

Approved Rehabilitation Plan and Risk Assessment

Impacted soil from former site operations (generic residential standards)

- Organic solvents (TCE) and petroleum hydrocarbons: excavation, on site bio-pile treatment and soil reuse as backfill material following treatment

Historical fills from area industries (risk based standards)

- Various metals and PAHs: remained in-place with a capping risk management measure
Former Industrial Site – Site Remediation

Approved Rehabilitation Plan and Risk Assessment

Impacted groundwater (generic sewer use guidelines)

- Free phase recovery and on-site treatment of petroleum hydrocarbons from accumulated water in excavations
- Attenuation of solvent impacts using Zero-Valent Iron (ZVI) as a soil amendment during backfilling and supplemental risk management measures
- Mitigation at the property boundary using of a permeable reactive barrier (ZVI)
Approved Rehabilitation Plan and Risk Assessment

Demolition
- Reuse of crushed concrete as backfill material (residential criteria)

Re-Development
- Restrictions on metals and PAH’s contaminated soil (>residential) left in place

At least 0.4 m of clean fill under roads, parking, bike and pedestrian paths
At least 1 m of clean top soil cover in landscape area
At least 1 m of clean fill under new buildings and along foundations
Demolition

Recycling: 89 % of materials, such as 27,000 metric tons of crushed concrete used as backfill material or final cover and metal recycling
Soil

14,500 m³ of hydrocarbon and VOC’s bio-treated soil reused on site

11,700 m³ of PAH’s and metals impacted soil reused on site based on risk assessment

2,400 m³ of heavily impacted soil treated off site at an authorized facility
Former Industrial Site – Site Remediation

Soil
Former Industrial Site – Site Remediation

Soil - “Dig and Haul” and Carbon Dioxide Emissions (Site Specific)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total volume of soil requiring off-site disposal</td>
<td>28,600 m³</td>
</tr>
<tr>
<td>Volume of TPH and VOC’s contaminated soil</td>
<td>16,900 m³</td>
</tr>
<tr>
<td>Volume of PAH’s and metals contaminated soil</td>
<td>11,700 m³</td>
</tr>
<tr>
<td>Volume carried by each dump truck</td>
<td>16 m³ of soil</td>
</tr>
<tr>
<td>Total round trips required</td>
<td>1,788 trips</td>
</tr>
<tr>
<td>Average distance from site to disposal facilities</td>
<td>45 km</td>
</tr>
<tr>
<td>Total traveling distance for disposal (round trip)</td>
<td>160,920 km</td>
</tr>
<tr>
<td>Distance from site to clean fill location</td>
<td>35 km</td>
</tr>
<tr>
<td>Total traveling distance for backfill (round trip)</td>
<td>125,160 km</td>
</tr>
<tr>
<td>Total distance</td>
<td>286,080 km</td>
</tr>
<tr>
<td>Fuel consumption of dump truck (Source 1)</td>
<td>35 L/100 km</td>
</tr>
<tr>
<td>Emission coefficient (Source 2)</td>
<td>2.7 kg CO²/L</td>
</tr>
<tr>
<td>Total CO² Emissions</td>
<td>270,346 kg</td>
</tr>
<tr>
<td>Total CO² Emissions</td>
<td>270 tons</td>
</tr>
</tbody>
</table>

On-site remediation can lead to 75% reduction in CO² emissions compared to dig and haul

SOURCES:
1 Reid, Lesley, Sustainability in Remediation - Calculating CO2 Emissions Associated with Varied Remediation Activities Presented at GeoEdmonton 2008
Former Industrial Site – Site Remediation

Groundwater

Water treatment and management of 360,000 liters of excavation water

Amendment with ZVI to attenuate remaining cVOCs impacts to shallow groundwater after source removal and treatment
Groundwater

Installation of permeable reactive barrier to mitigate any cVOCs impacted groundwater at the site boundary after source removal and treatment.

Installation of monitoring wells for groundwater monitoring.

Groundwater monitoring during and after remediation at the property limits.
Former Industrial Site – Site Remediation

Groundwater
On Site Monitoring and Mitigation Measures During Remedial Work

Ambient air sampling at the site boundaries

Dust control (water spray)

Visual Barrier

Excavation water and process water pumped and treated prior to disposal to sewer system

Process air (Biopile) vacuumed and treated through carbon filters
Schedule

**September 2008** – Former owner put property on market

**April 2009** – Following ESAs (Ph I, II & III), contamination notice for site was registered to environmental agency (MDDEP)

**October to December 2009** – Kilmer negotiation with former owner to purchase brownfield site

**November 2009** – Kilmer & LVM introductory meeting with environmental agency prior to purchase of site
Schedule

**Summer 2010** – Demolition of plant

**June 2010 to June 2011** – Negotiations with local authorities and environmental agency

**April 2011** – Public meeting presenting remediation project

**June to December 2011** – Remediation Plan approved and Completion of site remediation

**May to July 2012** – Attested report and notice of restriction
Introduction – Kilmer Brownfield Equity Fund

Sustainable Development & Brownfield Remediation

Former Industrial Site – Site Description

Former Industrial Site – Site Remediation

Conclusion

Acknowledgments
Conclusion

Environment

Brownfield remediation that will allow greater urban intensification
Reduced off-site disposal and increased waste recycling on site through
the remediation process.
Use of green remediation technologies that reduced greenhouse gas
emissions by 75%
Conclusion

Society

Involvement of the population through public presentation
Reappropriation of land for community use
Economy

The rehabilitation of a brownfield was made possible through a sustainable approach that lowered the remediation costs and made the project viable.

The remediation was completed on time and on budget.
Introduction – Kilmer Brownfield Equity Fund

Sustainable Development & Brownfield Remediation

Former Industrial Site – Site Description

Former Industrial Site – Site Remediation

Conclusion

Acknowledgments
Acknowledgements

MESIQ (ERA, Dr. Sylvain Loranger)

Panzini (Demolition contractor)

Biogénie (Remedial contractor)

WESA (Zero-valent barrier design)

Sustainable Development Technology Canada (SDTC)
Thank you

lvm.ca