CLEAN-UP OF TAR PONDS AND COKE OVENS SITES IN SYDNEY, NOVA SCOTIA

1. ABSTRACT

Earth Tech Canada has been retained by the Sydney Tar Ponds Agency (STPA), a special operating agency of the Province of Nova Scotia, to execute the Detailed Design and Construction Oversight of the Sydney Tar Ponds and Coke Ovens Sites in Nova Scotia – the largest remediation project in Canada. The Sydney Tar Ponds clean-up is the result of nearly 100 years of steel production in Sydney, Nova Scotia. At one time, Nova Scotia produced almost 50% of Canada’s steel. When production ceased in 2001, a legacy of contaminated soils, sediments and groundwater remained, bearing such contaminants as PAHs, VOCs, PHCs, PCBs, and heavy metals. What remains today is one million tonnes, an area spanning 68 hectares, of contaminated soil and sediment spread over two major sites – the North and South Tar Ponds, and the former Coke Ovens sites. The site has been studied over the past 15 years. There have been several initial attempts at cleanup; however, it wasn’t until the government announced in 2004, $400 M funding ($280 M Federal, $120 M Provincial), and the largest sum to date for the clean-up, that hopes of a successful clean-up began to take shape. In 2005, Earth Tech participated in the Preliminary Design, Environmental Assessment and Cost Estimate of the clean-up. In August 2006, the Earth Tech team was awarded the Detailed Design and Construction Oversight project. Commencing in October 2006, the project is expected to take 8-10 years with an anticipated completion date of 2014. Earth Tech is conducting the detailed design engineering for the remediation project and overseeing the work including inspection and contract management. Local companies have opportunities to compete for components of the work. Remediation technologies being employed include:

- Channel creation.
- Brook remediation, reconstruction, and enhancement.
- Solidification and stabilization of impacted sediments and soils.
- Capping of solidified and stabilized materials.
- Diversion and collection of contaminated groundwater through walls, trenches and related collection systems.
- Treatment of contaminated groundwater.
- Capping of impacted soils.
- Creation of landfills.
- Creation of materials processing infrastructure.

All remediation technologies and designs were thoroughly reviewed during a Federal Environmental Assessment and are subject to rigorous Federal and Provincial requirements. This paper will review the remedial approach to Canada’s largest
remediation project and provide a status update of current design engineering and construction.

2. **INTRODUCTION**

The Coke Ovens site is a 68 hectare former industrial property which operated from 1901 to 1988. The former Coke Ovens provided coke for the local steel manufacturing industry, while the by-products, such as tar and ammonia, were used to manufacture various other commercial products. An estimated 560,000 tonnes (280,000 m³) of soil at the Coke Ovens site has been contaminated with petroleum hydrocarbons, PAHs, and metals. An additional 1,300 tonnes (1,000 m³) of PAH-contaminated sediment has been identified in Coke Oven Brook and 25,000 tonnes (12,500 m³) of contaminated soil is located in the in-ground Tar Cell at the Coke Ovens site (AMEC 2004).

The Muggah Creek tidal estuary, otherwise known as the North and South Tar Ponds, has been impacted by past practices at the former industrial site. Historic by-product and waste management practices have resulted in significant impacts to soil, surface and groundwater at the site. The North and South Tar Ponds, cover an area of approximately 31 hectares. This area contains over 700,000 tonnes (550,000 m³) of PAH and metals-contaminated sediments. Approximately 5% of the sediments encountered in the Tar Ponds also contain PCBs at concentrations exceeding 50 ppm. Historically, raw sewage has been discharged into both the North and South Tar Ponds (AMEC 2004).

3. **SITE BACKGROUND**

The Sydney Tar Ponds remediation project has an extensive history that dates back to the 1980s. It is easily the most prominent remediation project in Canada today. The tar ponds and coke ovens site is located in the centre of an urban community and is the result of nearly a century of steelmaking. The community considers the site to be a blight on the island’s world renowned reputation as a natural masterpiece that has received many enviable accolades in prominent publications. The community has endured many risk assessments, environmental studies, human health studies, site assessments, more than 1,000 public meetings, a three-week Joint Review Panel Environmental Assessment that provided more than 50 recommendations, and extensive media coverage. The project continues to be closely scrutinized by the public and a lengthy list of stakeholders that includes five aboriginal communities and an involved medical community. Two decades of consultation and stakeholder involvement has provided the Sydney Tar Ponds Agency with a broad insight into successful community engagement techniques. The project is now in the phase of project design and implementation.

4. **THE CLEANUP**

The Dominion Iron and Steel Company Ltd. (DISCO) started constructing the steel plant on the eastern shore of Wintering Cove, Sydney Harbour, in 1899. Nearly 70 years later, the Province of Nova Scotia bought the plant and formed Sydney Steel Corp (Sysco). That same year, 1968, the Government of Canada purchased the Coke Ovens under the umbrella of its Crown Corporation Cape Breton Development Corporation (DEVCO). It was a short-lived venture. Sysco took ownership of the Coke Ovens in 1973.
Nearly a decade later, the Department of Fisheries and Oceans found PAHs from the tar ponds in Sydney Harbour lobsters. The alarming find forced the closure of the south arm of the harbour – indefinitely.

The current cleanup effort dates back to 1996. At that time, governments agreed to form the Joint Action Group (JAG) to conduct broad-based community consultation. More than 1,000 community meetings were held. In 2004, JAG forwarded its recommendations for acceptable cleanup technologies to government. That same year, the provincial and federal governments signed a $400 million cost-share agreement to remediate the properties.

The Sydney Tar Ponds Agency, a special operating agency of the province, was formed. The agency prepared a comprehensive environmental impact statement, which was heavily assessed during three weeks of joint panel hearings held in the community. The independent panel submitted its report in July, 2006, completing the project’s legal requirements under the Canadian Environmental Assessment Act. Among the panel’s recommendations was a consideration for governments to eliminate the plan to destroy PCBs from the tar ponds at an incinerator. Landfarming soil at the Coke Ovens site was also omitted after government accepted the recommendations.

The panel’s report was accepted by both provincial and federal governments and the project received formal approval in January, 2007.

5. **TAR PONDS**

The Tar Ponds are 33 hectares (81 acres). The property contains 700,000 tonnes of sediments contaminated with PAHs. About 45,000 tonnes of sediments are contaminated with more than 50ppm of PCBs. The ponds were once the final destination for more than 30 sewer outfalls; an average of 13 million litres per day of sanitary sewage flowed into the tar ponds.

The budget for remediating the tar ponds is $256 million, and is scheduled to take seven years to complete. The technology selected is treating materials in place with stabilization and solidification, then encapsulating with a multi-layered, engineered cap.

6. **COKE OVENS**

The Coke Ovens are 72 hectares (178 acres). The property contains 300,000 tonnes of soil contaminated with PAHs, and VOCs (no PCBs). There is a tar call at the northwest corner of the site that contains 25,000 tonnes of coal tar.

The budget for remediating the Coke Ovens is $144 million and is scheduled to take six years to complete. The technology selected is treating the contents of the tar cell with solidification and stabilization, than encapsulating the rest of the site with a multi-layered, engineered cap.

7. **COST-SHARE**

The province of Nova Scotia has agreed to pay up to $120 million to clean up the site, and the Government of Canada has agreed to fund up to $280 million to complete the work.
8. COMMUNITY
The project is open and transparent. It has a Community Liaison Committee designed to be a sounding board for governments. It has representation from project stakeholders who meet monthly with project managers.

The project has a successful Local Economics Benefits program that is evident in each tender with a 15 percent weighting in each contract evaluation.

The project has many firsts for the community, the province and the country. Currently, the province has its first aboriginal set-aside project (the cooling pond). An aboriginal procurement strategy for the entire project is also being developed.

9. DESIGN/CONSTRUCTION
In January, 2007, the Sydney Tar Ponds Agency hired Earth Tech/CBCL to begin project design.

10. REMEDIATION STRATEGY
The governments of Canada and Nova Scotia proposed to remediate the Sydney Tar Ponds and the Coke Ovens sites. Environment Canada and the Sydney Tar Ponds Agency developed the proposed cleanup plan, drawing on hundreds of engineering and scientific studies, and on public consultations carried out since 1996.

The Preliminary Design Report (Earth Tech 2006) subdivided the areas of the sites into ‘elements.’ The elements are divided by area of the site (Coke Ovens and Tar Ponds site) and based on technical approach (see Figure 1). These design elements are listed in the following table:

<table>
<thead>
<tr>
<th>Element Identifier</th>
<th>Element Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Coke Ovens Brook and Brook Connector Sediment Removal, Conditioning and Transportation</td>
</tr>
<tr>
<td>CO2</td>
<td>Tar Cell Removal, Conditioning and Transportation</td>
</tr>
<tr>
<td>CO5</td>
<td>Vertical Cutoff Walls</td>
</tr>
<tr>
<td>CO6</td>
<td>Coke Ovens Surface Cap</td>
</tr>
<tr>
<td>CO7</td>
<td>Purge Wells</td>
</tr>
<tr>
<td>CO8</td>
<td>Water Treatment Plant</td>
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Protection of the environment was paramount in designing and executing the work and this was reflected in the permit issued by the Nova Scotia Department of Environment and Labour. As a result, the design has prepared and incorporated a project-wide Environmental Management Plan and detailed Environmental Protection Plans for each element. Within these plans were details relating to construction monitoring, compliance monitoring, environmental effects monitoring, and long term monitoring. The plans also included:

- Waste, water, air and noise management.
- Mitigative measures, if required as a result of monitoring.
- Contingency and emergency response plans.
- Environmental awareness training protocols.
- Communication and reporting requirements.

In addition, management plans were prepared relating to water resources and treatment, transportation, land use, and quality assurance and quality control.

11. REMEDIAL APPROACH

Sequencing the project elements is complex and necessary to facilitate the construction as well as ensure that remediated areas remain clean and isolated from upcoming and ongoing work activities. The sections below provide a description of the intent and approach of each element as well as sequencing information considered in bringing the project to the construction phase. The Coke Ovens (CO) elements are described followed by the Tar Pond (TP) elements.

11.1. CO1 – Coke Oven Brook Connector

Coke Oven Brook Connector discharges into the South Tar Pond and comprises the downstream reach of Coke Oven Brook. This brook was the primary pathway for contaminant migration from the Coke Ovens Site into the Tar Ponds. As a result, the stream sediments have been impacted by organic and inorganic contaminants. The purpose of CO1 is to remove impacted sediments and reconstruct the channel. The
reconstructed channel will be isolated by installing a liner in the channel bed and backfilling with rip rap. Construction of this element is required prior to connecting Coke Oven Brook with the commissioned TP1 channels. In addition, construction of CO7 and CO8 is required prior to CO1 since these are upstream elements and must therefore precede CO1.

11.2. CO2 – Tar Cell S/S

The Tar Cell contains approximately 25,000 tonnes of PAH-impacted soil that will be treated by S/S. Bench scale activities were conducted on soil and tar samples at the same time as TP6 bench scale activities. A pilot test is also planned for spring of 2008 pending approval of bench scale results from the regulatory agency.

The Tar Cell contains a significant amount of debris and subsurface foundations and will present a challenge in conducting S/S work in-situ. As a result, S/S treatment is anticipated to be ex-situ at the Tar Cell site. The S/S treatment will also be conducted under cover as prescribed in the Environmental Assessment conducted for the project.

11.3. CO5 – Cutoff Walls

The vertical cutoff walls on the Coke Ovens site are intended to work in conjunction with other design elements of the overall remedial approach. These other design elements include the CO6 surface cap, the CO7 interceptor line, and the CO8 water treatment plant. Specifically, CO5 will serve to control the movement of clean and contaminated groundwater flow. Two cutoff walls have been designed; one across the north side of the Coke Oven site and one on the south and west side. Construction methodology is a combination of bentonite slurry and low permeability soil for areas of changing topography or shallow excavation.

Groundwater modelling was completed to determine the effects of mounding post-construction and to assess the effect of the walls on the local groundwater flow. Constructability challenges for this element include the significant underground abandoned infrastructure (pipes, tunnels, foundations, etc) that remain from historic coking and coal handling operations.

11.4. CO6 – Coke Ovens Surface Cap

The intent of the CO6 cap is to prevent direct contact by receptors with contaminated soil and allow for revegetation at the Coke Ovens site. Capping at the site can begin in areas where other remedial activities are not planned; however, final capping will only be completed after all other Coke Oven elements have been completed. Long term monitoring of the cap will be conducted to ensure that the barrier integrity is maintained.

11.5. CO7 – Coke Oven Groundwater Collection System

As previously indicated, the interceptor system will aid in controlling groundwater at the Coke Ovens site. Two interceptors will be installed; one along the current alignment of Coke Oven Brook and the second along the west side of the site (also known as the Domtar interceptor). These two interceptors will flow by gravity to a central pump station that will transmit these flows to an on-site water treatment plant (CO8). Field programs
(including a pump test) and groundwater modelling has been conducted to support the design.

The Coke Oven Brook interceptor alignment was selected to avoid interference by the extensive underground infrastructure and since the existing brook acts as a groundwater discharge zone. As a result, the interceptor media will be placed near the same elevation as the current bottom of the brook channel to mimic existing conditions. The Coke Oven Brook will be restored as a surface swale with a liner separating the swale from the interceptor infrastructure below. The surface swale will serve to drain surface water off the CO6 cap for discharge downstream into CO1. The Domtar interceptor will be capped by CO6.

As previously noted, the construction of CO7 will precede CO1.

11.6. CO8 – Water Treatment Plant

The on-site water treatment plant will operate for approximately 25 years and treat the groundwater from the Coke Ovens Site. Groundwater collected by the CO7 interceptor system will be conveyed via a pump station and force main to the treatment plant for treatment of organic and inorganic contaminants. Discharge criteria have been established for the effluent, which will discharge into the re-established Coke Oven Brook (just upstream of CO1).

11.7. CO9 – On-site Engineered Landfill

Debris generated from other project elements and decontaminated at the TP2 materials processing facility will be sent to the CO9 landfill for final deposition. The landfill will be constructed at the start of site activities and remain in operation for the duration of the project. A closure plan has been prepared with final capping, cover, and grading established. Long term monitoring of the cap will also be conducted.

11.8. TP1 – Coke Oven and Wash Brook Channels

In order to control surface water flow entering the Tar Ponds, it is necessary to convey the flows from Wash Brook and Coke Oven Brook to Sydney Harbour. As one of the first remedial activities, this will be accomplished by constructing a channel through the Tar Ponds. The sediments within the channel will be excavated for treatment by S/S (TP6). A liner will be placed at the bottom of the channel and backfilled with rip rap and armour stone. The liner will help mitigate migration of contaminants into the cleaned channel. The Tar Ponds are currently tidal and once commissioned the TP1 channel will separate surface water flows and tidal flows in the Tar Ponds from other remedial work activities.

An important consideration for design of the channel was that the upstream urban catchment area not be exposed to an increased risk of flooding post-construction. Detailed hydraulics modelling was carried out to determine channel depth and profile result to support the design. Fish passage was also incorporated into the design of the channel.

11.9. TP2 – Materials Processing Facility

The materials processing facility is combined with the contractor’s compound and will serve as the central access point to all construction activities at the site. Site control on a
remediation project is a cornerstone to prevent the spread of contamination into clean areas. As a result, operations of the materials processing facility will include the ability to control the flow of traffic onto and off the site as well as personnel and vehicle decontamination.

The materials processing facility will process debris generated from other construction activities. It is expected that almost all elements will generate debris that includes wood timbers, slag, general waste (tires, automobile parts, etc), and construction and demolition debris. Materials received at the facility will either be crushed (concrete or slag) and sent for treatment by S/S, decontaminated and recycled (steel), or decontaminated and sent to the on-site landfill for disposal. Air treatment within the facility was considered due to the nature of the material being processed. In addition, protection of the public and environment was incorporated into the design of this enclosed facility.

11.10. TP6 – Solidification and Stabilization

Treatment of the Tar Ponds sediments by S/S will be completed prior to encapsulation (TP7). The design of TP6 has focussed on the development of a mix recipe and performance criteria.

Development of a mix recipe to determine quantity and type of additives for treatment has been on-going since the preliminary design stage of the project. Additives such as cement, quicklime, and locally available fly ash and slag have been considered. Bench scale testing to determine mix ratios has been undertaken with approximately 35 recipes mixed to-date. Preferred recipes have been identified for pilot testing. Development of performance criteria for strength, permeability, and leachate is another important component of the recipe mix development. These criteria will be the measure for successful treatment during execution of the quality control and quality assurance programs during construction.

Once bench testing results are approved by the regulatory body, as required by the project permit, pilot testing will be conducted. In addition to assessing constructability and scale up from the bench scale, air emissions will be assessed during the pilot scale. The pilot test is anticipated to be conducted in the spring of 2008.

11.11. TP7 – Tar Ponds Cap

The Tar Ponds cap will encapsulate the sediments treated by S/S under element TP6. The cap will likely be constructed using a combination of geotextiles, clay, and granular fill. Another component of element TP7 is the relief of pressure caused by groundwater from under the S/S’d monolith. In order to achieve pressure relief trenches are proposed that would discharge by gravity to the TP1 channel. Water chemistry would be tested prior to release of the water to ensure that treatment was not required.

In areas of the pond with standing water, even at low tide, alternate methods of material placement might be required for the initial lift. These will use placement by crane or even hydraulic sluicing or spraying of the material onto the geotextile. Due to the presence of sediments, the water depths in the Ponds are sufficiently shallow that routine barge work for capping will likely only be feasible in portions of the north end of the North Pond.
A second lift of granular fill will be placed to provide additional protection and ensure confinement of the sediments. Upon completion, the surface of the cap will either be raised so that it is above the high tide mark, or it will be left at an elevation where much of it will be inundated at high tide, similar to many salt marshes.

The cap surface will be protected from erosion by the cofferdam at Battery Point. Rip-rap or other armouring will be used as needed to manage erosion from waves, storm surges, or floods. Armouring will be provided along the waterway channels in Muggah Creek as needed to prevent erosion. It is expected that Vegetation alone will likely prevent erosion over most of the area of the capped Tar Ponds.

12. CURRENT STATUS

Design is progressing to facilitate construction on a number of elements, in particular at the Coke Ovens site, by the spring of 2008. In addition, pilot scale activities will be conducted to enable the S/S portion of the project to proceed.

13. REFERENCES

