Gary Sanitary District

Ralston Street Lagoon Technical and Cost Assessment

August 2007

CDM

Report

August 22, 2007

Mr. Mark J. Koller
Assistant Regional Counsel
Office of Regional Counsel
77 West Jackson Boulevard, (C-14J)
Chicago, IL 60604-3590

Beth Admire
Program Counsel Section Chief
Indiana Department of Environmental Management
100 North Senate Avenue
IGC North Room 1307
Indianapolis, IN 46204-2251

Thomas A. Mariani, Jr.
Chief, Environmental Enforcement Section
US Department of Justice
(DOJ No. 90-5-1-1-2601B)
P.O. Box 7611
Washington, D.C. 20044

Subject: Technical and Cost Assessment (TCA)
Pertaining to the Modified Consent Decree, May 2003
Ralston Street, Gary Sanitary District/City of Gary, Indiana

Dear Mr. Koller/Mr. Mariani/Ms. Admire:

Enclosed is a hard copy of the subject document which is being submitted by the mandatory deadline of August 22, 2007, which is in compliance with the requirements of paragraph 17 of the subject Consent Decree and a subsequent 30-day deadline extension granted by USEPA upon request by the Gary Sanitary District.

We look forward to meeting with you in the near future to discuss the findings of this TCA. In the meantime, should you have any questions pertaining to this matter, please feel free to contact me at (219) 944-0595.

Respectfully,

Luci Horton
Director

cc: Hamilton Carmouche (Attorney for GSD)
Daniel Vicari (CDM)

Executive Summary

The Gary Sanitary District (GSD) respectfully submits this Technical and Cost Assessment (TCA) to the United States Environmental Protection Agency (EPA) in order to select a disposal/clean-up remedy for the polychlorinated biphenyls (PCBs) contained at the Ralston Street Lagoon (RSL) consistent with the requirements of the Toxic Substances Control Act (TSCA). The submitted TCA fulfills the requirements of the Modified Consent Decree and Judgment (Consent Decree) entered in May 2003 (Civil Action H 78-29; H 86-540).

The ranking and justification of the ranking of the alternatives in the TCA was performed by GSD in consultation with Environmental Forensic Investigations, Inc. (Enviroforensics). Camp Dresser & McKee Inc. (CDM) provided discussion on the technical merits and anticipated costs of the technologies and alternatives presented in the TCA.

The RSL is a 19.2-acre lagoon containing approximately 533,000 cubic yards of treated municipal sludge with PCB levels above the TSCA regulatory level of 50 ppm (or mg/kg). Since 1962, when sludge pumping into RSL began, there has been no evidence of spills or uncontrolled releases of PCB into the environment. A Risk Analysis conducted in 1996 showed that PCB contamination in the surface water downstream of the lagoon would be minimal and would not contribute to human health risks. This TCA provides updates to the historical data and uses both current and historical data to evaluate alternatives for remediation.

The alternatives evaluated in the TCA are as follows:

1. **Alternative 1: No Action.** Routine monitoring will be performed to determine if PCBs are migrating off-site.

2. **Alternative 2: Containment on-site.** This alternative is presented in Article 13 of the Decree as alternative d. The alternative generally involves decanting and treating enough of the supernatant to properly install engineering controls to limit the elevation of the lagoon surface water; raising the perimeter berm to prevent surface water discharge to the Grand Calumet River in the event of a 100-year flood and temporarily stabilizing the northern berm during construction with temporary sheeting; purchasing six acres of the residential area east of the RSL to use as a staging area for construction; installing a soil-bentonite barrier wall around the berm that keys into the clay layer; improving fencing along perimeter of site to restrict access; providing deed restrictions and signage; routine monitoring; and preparing a contingency plan. Additionally, innovative technology demonstrations on site could be performed as appropriate.

3. **Alternative 3: Disposal at an off-site location or locations.** This alternative is presented in the Decree as alternative a. It would include the following

components: Purchasing six acres at the adjacent residential area and using it for the contractor's staging area and for a dewatering area; temporary stabilizing the northern berm during construction with temporary sheeting; dredging the sludge and materials containing PCB concentrations greater than 50 ppm and supernatant water; pumping the dredged material into a dewatering system consisting primarily of geotubes; treating the dewatered sludge and supernatant water at the wastewater treatment plant; dewatering to maintain a dry working area inside the lagoon; excavating one foot below the dredge line to remove any possible residual sludge; solidifying the dewatered sludge to pass a paint filter test; disposing the excavated materials in a TSCA-permitted chemical waste landfill; and then regrading the former lagoon to promote surface water runoff.

4. **Alternative 4: Disposal on-site (on property at or near the wastewater treatment plant).** This alternative is presented in the Decree as alternative b. This alternative would include the following components: Purchasing the adjacent residential area and trucking company property and using the property for the contractor's staging area, dewatering area, and a CDDF area; temporarily stabilizing the northern side of the berm during construction with temporary sheeting; dredging the sludge and materials containing PCB concentrations greater than 50 ppm and supernatant water; pumping the dredged material into a dewatering system consisting primarily of geotubes; treating the dewatered sludge and supernatant water at the wastewater treatment plant; dewatering to maintain a dry working area inside the lagoon; excavating one foot below the dredge line to remove any possible residual sludge; solidifying the dewatered sludge to pass a paint filter test; regrading the former lagoon to promote surface water runoff, constructing a CDDF, consolidating the stabilized sludge into the CDDF, and finally capping the CDDF. The CDDF will be constructed above the water table, take up approximately 6 acres, consist of an impermeable compacted clay liner, and covering the sludge with an impermeable cap and cover. A perimeter berm will be constructed around the CDDF above the 100-year flood level. Routine groundwater monitoring and cap maintenance will be performed. Deed restrictions, site fencing, and signage will be included.

5. **Alternative 5: In-situ solidification/stabilization with in-place vegetative/soil cover.** This alternative is presented in the Decree as a combination of alternative (c)(i) and (c)(iii). Article 13, part c of the Decree states that any one or combination of the following alternatives may be used:

   (i) In-situ solidification/stabilization

   (ii) In-situ bioremediation

   (iii) In-place vegetative/soil cover

   The in-situ bioremediation technology was not retained (Section 6.3.5) and the in-place vegetative/soil cover alone may require the removal of all material

containing PCBs in concentrations greater than 500 ppm. Removing only the sludge with PCBs in concentrations greater than 500 ppm (or 10.4% of the sludge volume) at RSL could be technically impractical since the samples with PCBs greater than 500 ppm are located in scattered spots (Fluor Daniel, 1997.) Removal of only the sludge greater than 500 ppm would result in requiring complex excavations, testing, tracking, materials handling, bulking, and off-site disposal. Therefore, the in-place vegetative/soil cover alternative was combined with the in-situ solidification/stabilization alternative. This alternative would include the following components: Purchasing six acres at the adjacent residential area and using it for the contractor's staging area; decanting the supernatant and treating it at the wastewater treatment plant; raising the perimeter berm to provide 100-year flood protection and stabilizing the northern berm with permanent sheeting; installing a soil-bentonite barrier wall to fully encapsulate the RSL sludge; dewatering to maintain a dry working area inside the lagoon; bulking the sludge with fill material, solidifying/stabilizing the bulked sludge in-situ to reduce the mobility of the PCBs; filling the treated material; and covering the lagoon area with an impermeable cap. Routine groundwater monitoring and cap maintenance will be performed. Deed restrictions, site fencing, and signage will be included.

6. **Alternative 6: On-site Dry Cell Containment.** In this alternative the sludge is to be contained and capped in a dry cell within the RSL boundaries. This alternative includes purchasing six acres at the adjacent residential area and using it for the contractor's staging area and for a dewatering area; raising the perimeter berm above the 100-yr flood elevation; installing a cement-bentonite wall to fully encapsulate the RSL sludge and stabilize the perimeter berm; dredging the sludge and materials containing PCB concentrations greater than 50 ppm and supernatant water; pumping the dredged material into a dewatering system consisting primarily of geotubes; treating the dewatered sludge and supernatant water at the wastewater treatment plant; solidifying the dewatered sludge; creating berms across the lagoon to provide equipment access and control of construction operations; dewatering to maintain a dry working area inside the lagoon; creating an underdrain network below the dry cell to facilitate a permanent reduction in the water table, consolidating the treated sludge into the dry cell footprint and installing an impermeable cap over the footprint, and grading the area of the former lagoon that is outside of the dry cell. Routine groundwater monitoring and cap maintenance will be performed. Deed restrictions, site fencing, and signage will be included.

7. **Alternative 7: Compression Cap.** In this alternative the sludge is to be consolidated in place using a ”compression cap” approach to increase the solids content of the sludge by creating a uniform cap that can be placed on top of the sludge and incrementally loading the cap. This alternative involves purchasing six acres of the residential area to use as a contractor staging area; raising the perimeter berm to provide 100-yr flood protection; installing a cement-bentonite wall to fully encapsulate the RSL sludge and stabilize the perimeter berm; decanting and treating the lagoon surface water; constructing a “compression

cap" system on top of the exposed sludge with an internal water collection system to collect water pressed from sludge; using a filling material, including either construction and disposal debris (C&D) or dry Grand Calumet sediments, as cap weighting material; collecting and treating the displaced water at the wastewater treatment plant; placing an impermeable cap once consolidation of the sludge has been reached; providing fencing, consumption advisories, signage, and deed restrictions; and performing routine groundwater monitoring and cap maintenance.

8. **Alternative 8: Filling the Lagoon**. In this alternative the RSL would be filled using a fill material as a bulking agent to increase the solids content of the sludge. The sludge would be bulked from 15% solids to 50% solids and subsequently be mixed with approximately 15% pozzalonic to achieve a material that can be spread, compacted, and load bearing. This alternative would involve purchasing six acres of the residential area to use as a contractor staging area; raising the perimeter berm with fill to provide 100-yr flood protection; stabilizing the northern berm with permanent sheeting; installing a soil-bentonite wall to fully encapsulate the RSL sludge; decanting the lagoon surface water and treating the water at the wastewater treatment plant; importing and dumping dry fill directly into the lagoon; installing sheeting and/or berms to provide equipment access; mixing bulking material with the sludge using soil mixing equipment; performing in-situ stabilization/solidification with approximately 15% pozzalonic; placing and capping the fill with an impermeable cap; providing institutional controls such as fencing, deed restrictions, and signage; and continuous RSL and ground water monitoring. The Grand Calumet Sediment may be utilized in the alternative as a filling material provided they meet the bulking and WAC criteria.

Table 7-1 presents an evaluation of the presented alternatives. The seven (7) criteria that each alternative was evaluated and ranked against were assigned the following values for a total of 200 points, with a 200 being the best possible score:

1. Effectiveness (10 points)
2. Overall protection of public health and environment (20 points)
3. Long-term effectiveness and permanence (20 points)
4. Technical feasibility (90 points)
5. Administrative feasibility (30 points)
6. Availability of services and materials (20 points)
7. Cost (10 points)

GSD ranked the alternatives as follows:

Alternative 8: Filling the Lagoon 152 points

Alternative 5: In-situ S/S with impermeable cover 134 points

Alternative 2: Containment on-site 120 points

Alternative 6: Disposal on-site: Dry Cell 117 points

Alternative 7: Disposal on-site: CDDF 114 points

Alternative 4: Compression Cap 112 points

Alternative 3: Disposal off-site 97 points

Alternative 1: No-Action 96 points

The alternatives comparison process showed that Alternative 8: Filling the Lagoon, ranks highest based on the above criteria with a total score of 152 points because it potentially provides GSD with a flexible remedial alternative. GSD was not comfortable moving forward with Alternative 7 as the stand alone recommended alternative because of the potential risk viewed by GSD. In addition, Alternative 8, potentially can include the Grand Calumet River sediments either as bulking material (meeting the bulking and WAC) or as fill material (meeting the WAC). This solution would assist the GSD, the State of Indiana Department of Environmental Management, the United States Army Corp of Engineers, the USEPA, and the community at large. The combined economic effect and cost savings to the GSD, the State of Indiana, and the federal government through the Great Lakes Legacy Act would be significant. This is particularly important considering that the State may have to pay a considerable amount in siting, constructing, and monitoring another confined disposal facility or transporting Grand Calumet River sediment to other remote disposal facilities and the GSD may have to pay for importing filling or bulking material.

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Section 1
Introduction

1.1 Purpose and Scope

The purpose of the Technical and Cost Assessment (TCA) is to provide a detailed evaluation of possible alternatives and to provide recommendations for feasible alternatives to remediate polychlorinated biphenyls (PCBs) contained in the Ralston Street Lagoon (RSL) consistent with the requirements of the Toxic Substances Control Act (TSCA) to fulfill the requirements of the Modified Consent Decree and Judgment (Consent Decree) entered in May 2003 (Civil Action H 78-29; H 86-540). The TCA has been prepared by Camp Dresser & McKee (CDM) on behalf of the Gary Sanitary District (GSD) and will be utilized by the United States Environmental Protection Agency (EPA) to select a disposal/clean-up remedy for the RSL.

As described in the Consent Decree, the TCA presents the following disposal or clean-up alternatives for the RSL:

a. Disposal at an off-site location or locations of all sludge, sediment, and any other material that contains concentrations of PCBs > 50 parts per million (ppm) as measured by dry weight.

b. Disposal on-site of all sludge, sediment, and any other material that contains concentrations of PCBs > 50 ppm – as measured by dry weight – in an upland, confined de-watering and disposal facility (CDDF). The CDDF would need to:

    1. Be built at or above the RSL water table

    2. Be built in or adjacent to the RSL, or if needed be built nearby and connected hydraulically to the RSL

    3. Receive all materials with concentrations of PCBs > 50 ppm – as measured by dry weight – from the RSL

    4. Be situated so that the return water with PCB contamination from the CDDF to the RSL does not spill into the groundwater or the Grand Calumet River

    5. Employ wastewater recirculation pumping, dewatering, and filtration until all materials with concentrations of PCBs > 50 ppm – as measured by dry weight – are transferred to the CDDF

    6. Be capped and closed

c. Any one or combination of the following:

i. In-situ Solidification/Stabilization (S/S), which may include:

1. Construction of cross dikes and treatment cells
2. Introduction of binder to reduce mobility of sludge, soil and vegetative cover
3. Institutional controls
4. Appropriate long-term maintenance

ii. In-situ Bioremediation, which may include:

1. Aerobic and/or anaerobic biologic degradation of PCBs
2. Construction of diked treatment cells in the RSL
3. Removal of all PCB material found in concentrations > 500 ppm as measured by dry weight

iii. In-place Vegetative/Soil Cover, which may include:

1. Construction of a berm along RSL perimeter
2. Removal of all material containing PCBs > 500 ppm as measured by dry weight
3. Removal and treatment of supernatant
4. Construction of cross dikes to isolate remaining PCB-contaminated material
5. Geotextile and soil covers for dike-created cells containing PCB contaminated material
6. Institutional controls
7. Monitoring for PCB migration and berm integrity

d. Any one other option that GSD may choose.

On behalf of GSD, CDM submitted the draft TCA to the EPA on November 15, 2005, and then performed a formal presentation of the draft TCA to the EPA on December 2, 2002, in Chicago, IL. All parties agreed that additional physical characterization and treatability studies were needed prior to selecting an alternative. After submitting a Supplemental Alternatives Evaluation Study (SAES) Work Plan and Quality Assurance Plan for EPA review and approval, CDM performed the (SAES) on behalf of GSD. The SAES involved performing physical characterization and laboratory

treatability studies with RSL sludge samples. The SAES collected additional information to aid in the evaluation of remediation alternatives, including innovative technologies previously not included in the draft TCA. CDM submitted the SAES to the EPA on October 10, 2006 and then performed a formal presentation of the SAES Report to the EPA on November 3, 2006 in Chicago, IL.

Recently discussions have been held with GSD, CDM, EPA, the Indiana Department of Environmental Management (IDEM), and the United States Army Corps of Engineers (COE) regarding the possibility of using sediments that will be dredged from the Grand Calumet River (GCR) potentially as bulking material for the RSL during remedial action. Of note, this dredging project is currently at the feasibility study level, and that the project involves dredging approximately 300,000 CY of Grand Calumet River sediment over the course of approximately three years.

EPA issued a letter to GSD on March 26, 2007 with response comments to the Draft TCA and the SAES. As part of the re-submittal of the TCA, EPA required the following:

a. Two new alternatives must be considered

    1. Fill in the entire RSL, treat the displaced water, and cap the RSL

    2. Create a dry cell within the boundaries, impound the sludge in the dry cell,

b. Any alternative that leaves PCBs in the RSL will require a slurry wall and, as appropriate, a sheet pile wall

c. The top five to nine feet of clean surface water is to be drawn off and treated on any alternative that proposes to fill the RSL

d. For the Final TCA, more detail must be provided on costs and more information about how values were determined

The scope of the TCA includes the following:

a. A detailed analysis of the alternatives identified above

b. A detailed description of each alternative

c. An evaluation of the alternatives against the following criteria:

    1. Effectiveness

    2. Overall protection of public health and the environment

    3. Long-term effectiveness and permanence

4. Technical feasibility
5. Administrative feasibility
6. Availability of services and materials
7. Cost

d. A comparative analysis of the RSL alternatives

e. A detailed work schedule for each alternative

1.2 Report Organization

The TCA is divided into seven sections:

1. Introduction
2. Site Background
3. Previous Investigations and Interim Measures
4. Screening-Level Risk Analysis to Protect Human Health and the Environment
5. Goals and Requirements
6. Development and Screening of Alternatives
7. Detailed Analysis of Alternatives

Section 2
Site Background

2.1 Site Location and Description

The Ralston Street Lagoon (RSL) is located in the City of Gary, Indiana, approximately one mile west of the Gary Wastewater Treatment and a half mile south of the Gary Municipal Airport. The 22-acre site is bounded on the north and west by the Grand Calumet River and its associated wetlands, on the south by the Indiana Toll Road, and on the east by Ralston Street, a six-acre residential area, and a 4.5-acre commercial area. Farther to the north is the Gary/Chicago International Airport (See **Figure 2-1**). A perimeter fence and earthen berm serving as a service road bound the lagoon. The lagoon has a surface area of approximately 19.2 acres (CDM and HWC, 2005).

2.2 Site History and Use

The RSL was originally developed as a borrow pit by the State of Indiana Toll Road Commission to provide fill material during construction of a nearby toll road with a maximum excavation depth of approximately 27 feet below the water table (Fluor Daniel, 1997). The City of Gary acquired the RSL in 1962 and used the lagoon for storage of sewage sludge generated from the wastewater treatment plant.

Between 1962 and 1988, the Gary Sanitary District made modifications to the RSL, including building an earthen berm along the lagoon perimeter, installing an influent sludge force main between GSD's wastewater treatment plant (WWTP) and the RSL, installing an overflow pipe from the RSL to the Grand Calumet River, constructing a decanting structure at the southeast of the RSL to return supernatant back to the WWTP, and constructing three piers on the south side of the lagoon for access to the sludge distribution pipes. Later, the north effluent pipe (to the Grand Calumet River) was sealed with concrete and the southeast decanting structure (to the WWTP) was sealed with bricks and mortar at a manhole adjacent to the RSL in the southeast corner. The manhole was subsequently bolted. The sludge influent force main was isolated from the RSL at the WWTP via installation of a blind tee flange (Fluor Daniel, 1997). In April 2005, CDM conducted further investigations to verify that the influent and effluent pipes were sealed. CDM inspected the wastewater treatment plant decant line in the southeast corner of the RSL and determined that the line was sealed off with bricks and mortar at a manhole near the RSL main gate. In addition, CDM determined that the overflow pipe along the north side of the lagoon was sealed off with concrete, thus isolating the RSL from the wetland to the north. The sludge influent force main was isolated from the RSL at the WWTP via installation of a blind tee flange.

PCBs in the RSL sludge were first discovered in the early 1980s at concentrations in excess of 50 ppm.

2.3 Regulatory Background

A Consent Decree was entered on June 15, 1983, which was followed by a Modified Consent Decree on September 8, 1987. In 1989 the GSD proposed managing the sewage-containing PCBs in place as an alternative disposal method regulated by TSCA. The EPA responded by outlining the technical requirements that would need to be met in order to permit the RSL as an alternate disposal facility under TSCA in a letter to GSD (EPA letter, August 1990).

A Second Modified Consent Decree and Judgment was entered on October 23, 1992, and subsequently redrafted in 2000.

The Third Modified Consent Decree and Judgment was entered in May 2003. This Consent Decree requires that GSD submit a TCA to the EPA that provides an analysis and recommendation of potential disposal/clean-up alternatives to remedy the sludges containing PCBs at the RSL in accordance with TSCA. GSD submitted the TCA Work Plan to the EPA on May 12, 2004 and the Draft TCA to the EPA on November 15, 2005.

Prior to performing the re-submittal of the TCA, CDM, on behalf of GSD, performed a Supplemental Alternatives Evaluation Study (SAES) which collected information to aid in the evaluation of remediation alternatives, including innovative technologies previously not included in the Draft TCA. The SAES Work Plan and Quality Assurance Plan was reviewed and approved by the EPA prior to beginning the SAES. The SAES report was submitted to EPA on October 10, 2006.

EPA issued a letter to GSD on March 26, 2007 with response comments to the Draft TCA and the SAES submittals. In the letter, EPA noted that no further studies were needed in order to begin preparing the Final TCA, that no alternative from the Draft TCA was being rejected at the time, and that GSD may use what was learned in the SAES to amend the Draft TCA and create any new alternatives as long as the alternatives remain within the parameters set out in the Consent Decree. Additionally, two new alternatives needed to be considered;

> *"The first alternative would be to fill in the entire Ralston Street Lagoon, treat the displaced water, and cap the RSL. The second alternative would be to create a dry cell within the RSL boundaries, impound the sludge in the dry cell, and cap the dry cell."*

2.4 Environmental Setting

2.4.1 Site Geology

As described in the "Ralston Street Lagoon Remediation/Present Recommendations for GSD Action" (Alleman, 1989) and the "Sludge and Surface Water PCB Sampling/Ralston Street Lagoon" (Fluor Daniel, 1997) reports, the RSL is low-lying and adjacent to wetland areas connected to the Grand Calumet River. The Grand Calumet River is a slow-moving river flowing east to west at the RSL that is created

almost entirely by industrial and municipal effluents. Data provided by US Steel and GSD at the time of the investigation conducted by Alleman indicated average total effluent flows of 365 and 40 MGD, respectively (Alleman, 1989). Flow upstream of these discharges averages less than 0.06 MGD. **Figure 2-2** is a graphical representation of the USGS-recorded flow rates and stage in the Grand Calumet River at Industrial Highway in Gary and the NOAA-recorded stage in Lake Michigan at Calumet Harbor from 1994 through 2007. US Steel's production is generally lower during winter and higher during summer; therefore, the flow in the Grand Calumet River is generally lower during winter and higher during summer. This can be seen in **Figure 2-2.**

The RSL is situated within the Calumet Lacustrine Plain. Shallow subsurface soils consist of silts, clays, peats, and beach sands. Most of the sand and clay were deposited late during the Wisconsinan age as lake-bottom and near-shore deposits of glacial Lake Chicago. Generally the RSL contains up to three feet of fill along the berms, and approximately 33 feet of brown to gray fine sand with varying amounts of silt. This formation is underlain by the Wadsworth Till of the Wedron Formation, an impervious gray clay till unit approximately 70 to 80 feet thick. Below the clay till unit lies the Silurian age dolomite bedrock.

The subsurface sand unit is referred to as the Calumet Aquifer, which extends from the Grand Calumet River to Lake Michigan. The Calumet Aquifer is generally saturated to within 5 to 10 feet of the ground surface, with the groundwater flowing generally toward the north with discharge zones at the Grand Calumet River and Lake Michigan. The Calumet Aquifer is not generally used for water supply purposes. Residents in the vicinity of the RSL are supplied by potable drinking water from Lake Michigan (Fluor Daniel, 1997).

A subsurface investigation in November 2004 was performed by K&S Engineers and consisted of drilling twelve (12) soil borings and seven (7) soil probes along the lagoon perimeter berm. The investigation provided data consistent with past subsurface investigations. Borings were drilled to depths between 40 and 45 feet below ground surface (bgs). Of the twelve soil borings, one was located on the southern side of the site (RS-1), one was located on the southwestern side of the site (RS-2), two were located on the western side of the site (RS-3 and RS-4), six were located on the northwestern side of the site (RS-5 through RS-10), and two were located on the eastern side of the site (RS-11 and RS-12). Berm elevations were found to be between 585.5 and 593, with an average berm elevation on the north and western side of the site of approximately elevation 586.2. A subsequent interim berm improvement in February 2005 raised the top of the north and western sides of the berm to elevations of between 586.03 and 587.52 (CDM, 2005).

Generally, fill was encountered to a depth of three feet, with the exceptions of RS-8, at which nine feet of fill was encountered, and RS-12, where no fill was encountered. Fill generally consisted of sand with various amounts of slag, silt, cobbles, and organics. Under the fill was a layer of loose to medium dense sand 24 to 40 feet thick between elevation 593.0 and 551.5, with an average thickness of 31 feet. Ten (10) soil

samples tested for visual classification showed that the sand ranged from silty to poorly graded sand. Within the sand unit, peat was encountered in four of the six borings on the northwest side of the site (RS-7 through RS-10). The peat formations were consistently two feet thick and were encountered between elevation 579.0 and 571.5. The sand unit also contained dark colored seams with a petrochemical odor in a western boring (RS-4) and five of the six borings (RS-5 through RS-9) on the northwestern side of the berm. The seams ranged from three to seven feet thick and were encountered between elevations 581.0 and 573.5 (CDM, 2005).

A very soft to medium stiff clay was encountered in each boring. The consistency of the clay was based on Standard Penetration Tests in the field and unconfined compression tests in the laboratory. The top of clay ranged from 33 to 40 feet bgs at elevations 555.5 to 551.5. Nine shelby tubes were tested for visual soil classification, Atterberg limits, unconfined compressive strength, specific gravity, and hydraulic conductivity. The clay was classified as either lean clay or lean clay with sand, with unconfined compressive strengths ranging from 0.2 to 0.7 tons per square feet (TSF) and an average unconfined compressive strength of 0.5 TSF. Specific gravities ranged from 2.80 to 2.85 with an average specific gravity of 2.82. Hydraulic conductivities of five samples tested ranged from 1.6×10^{-8} cm/sec to 3.0×10^{-8} cm/sec with an average hydraulic conductivity of 2.2×10^{-8} cm/sec (CDM, 2005).

2.4.2 Surface Water

Surface water level at the RSL and at the adjacent stretch of the Grand Calumet River is generally at elevation 584 (NGVD29). Monthly staff gauge readings at the RSL have shown an increase in the water levels at the lagoon to between elevation 584.8 and 585.3 from January to February 2005 (CDM, 2005) with a subsequent drop between elevation 585.3 and 583.7 from February to December 2005. There was an increase in surface water elevation, 583.7 and 585.4 from December 2005 to April 2007, and a decrease of 585.4 to 584.6 from April to August 2007 (**Figure 2-3**). This fluctuation is attributed to seasonally variable groundwater levels. It has been observed that when the lagoon surface water level is high, the Grand Calumet River is low, and when the RSL surface water level is low, the Grand Calumet River is high. This is due to the seasonally variable groundwater levels' inverse relationship with production at US Steel, which is lower during winter and higher during summer. The 100-year flood elevation at the RSL was determined to be elevation 587.35 (Fluor Daniel, 1992). **Figure 2-3** is a graphical representation of the recorded water level readings at the RSL from January to August 2007.

2.4.3 Human Populations and Land Uses

The RSL is bordered to the east by a six-acre residential area and, farther east, a 4.5-acre property operated by a trucking company. The residential area consists of approximately 15 houses spread out over 59 parcels. Located to the north of the residential area and trucking company and inland of the Grand Calumet River are 5.5 acres of wetlands. **Figure 2-4** shows a parcel map of the residential area, trucking company, and wetlands located east of the RSL. A drainage ditch south of the RSL

and a marsh located north of the RSL are designated as wetlands. Residents obtain their drinking water from the Indiana American Water System (IAWC) system that draws from Lake Michigan.

2.5 Sources of Contamination and Impacted Media

Between 1962 and 1988, approximately 600,000 cubic yards of sewage sludge was pumped to the RSL from the wastewater treatment plant (Fluor Daniel, 1997).

2.5.1 Sludge

A bathymetric survey and 3D modeling software showed that approximately 107,686,020 gallons, or 533,169 cubic yards (CY), of sludge are located at the RSL, of which 96.6% contains PCB concentrations greater than 50 milligrams per kilogram or parts per million (ppm) and 10.4% contains PCB concentrations greater than 500 ppm. The concentration of PCBs in the sludge on a dry-weight basis ranged from 19 to 1,300 ppm with an average value of 182.2 ppm. Solids contents of the sludge samples ranged between 2.0 to 73.0% with an average solids content of 14.7% (Fluor Daniel, 1997).

In a limited treatability study using two sludge samples collected from the middle pier of the lagoon, the solids content of the sludge samples ranged from 14.32% to 15.69% and the organics content ranged from 25.44% to 45.11%. The unit weight of the sludge samples ranged from 67.4 to 67.9 pounds per cubic foot (pcf). Additionally, a conclusion based on the results of the dewatering testing in the treatability study was that the sludge "is not readily free-draining and is basically a suspension of organic and inorganic material with a strong affinity to the water" (Earth Tech, 2004).

CDM collected additional data on the RSL sludge for the Supplemental Alternatives Evaluation Study (SAES) during 2006. In-situ field shear vane tests conducted on sludge samples in six random locations at the lagoon showed that the sludge had peak shear strengths ranging form 8.2 to 227.5 psf occurring between 1% and 6% strain. The average remolded shear strength occurring at an average strain of the sludge is 8.9 psf and 1.5% strain, respectively.

The sludge samples collected had solids contents ranging from 3.7% and 44.3% with a median value of 18.4%. Expressed as moisture content, the sludge samples had a moisture content ranging between 125.5% and 2602.7%. The specific gravity ranged from 1.96 to 3.13 with a median value of 2.71. The organic content ranged from 10.2% to 50.3% with a median value of 26.7%. For the Atterberg Limits, the liquid limits (LL) ranged from 51 to 107 with the median value of 64; the plastic limit (PL) ranged from 40 to 74 with the median value of 47.5; and the plasticity index (PI) ranged from 3 to 33 with the median value of 20.5 (CDM, 2006).

The maximum sludge thickness ranges from 20 to 25 feet (Fluor Daniel, 1997). Using the 533,169 CY of sludge and assuming an 18.5 acre surface area, the average thickness of the sludge at the RSL is approximately 18 feet.

2.5.2 Surface Water

2.5.2.1 Ralston Street Lagoon Water

Historically the highest concentration of PCB in the surface water was measured as 0.001 milligrams per liter (mg/l) (Fluor Daniel, 1997). Recent surface water testing shows that all PCB concentrations were below the testing detection limits (CDM, 2005).

The volume of surface water is estimated as 42 million gallons. This estimation assumes an average water depth of approximately seven feet in the lagoon and is based on historical information and readings recorded by CDM on February 10, 2005 while collecting surface water quality samples.

2.5.2.2 Grand Calumet River

The Grand Calumet River borders the site to the north, directs surface water flow away from the site, and discharges to Lake Michigan. Previous studies (Alleman, 1989, and Fluor Daniel, 1997) reported that the Grand Calumet River was impacted by historic releases of PCBs upstream of the RSL. Furthermore, Fluor Daniel concluded that the release of PCBs from the lagoon to groundwater to the river will not occur unless the lagoon contents are "chemically or physically disturbed" (Fluor Daniel, 1997), and Alleman stated that "the apparent potential for contamination of the Grand Calumet River by groundwater flow from the Ralston Street Lagoon is low" (Alleman, 1989).

2.5.3 Soil

Recent testing of the soils taken from the 9D monitoring well installation indicated that PCB concentrations ranged from undetectable to 17 ppm at depths of 14 to 36 ft below grade. It is important to note that the soils that exceeded the 1.8 ppm residential closure level (based on Indiana's Risk Integrated System Closure guidance) were all 26 to 30 feet below grade (CDM, 2005).

Twelve soil samples from four monitoring well installations were analyzed for PCBs and metals in 1986. Of the twelve soil samples, three were found to have PCBs above the detection level of 0.02 ppm, with the concentrations ranging from 0.021 to 0.31 ppm (Alleman, 1989).

2.5.4 Groundwater

Recent groundwater piezometric measurements (CDM, 2005) indicate an apparent groundwater flow from the south/southeast towards the north/northeast. This is in agreement with previous studies (Alleman, 1989) and indicates that the recently expanded monitoring well network (CDM, 2005) will adequately characterize potential impacts from the RSL to groundwater.

2.5.5 Air

Air monitoring has not been performed at the RSL to date. The release of PCBs to the atmosphere requires that the molecules desorb from the solid phase or volatilize from the liquid phase. All data collected to date indicate that PCBs are located in subsurface soil or sludge in saturated or near saturated conditions. Under these circumstances, PCB transport and release from the Ralston Street Lagoon is much lower than the ambient atmospheric deposition of PCB in this highly industrialized area. Air could be impacted from PCBs through chemical or physical disruptions considered under the alternatives analysis. Any alternative implemented that involves such potential disruptions will consider background monitoring to establish the ambient air quality.

Figure 2-1. Ralston Street Lagoon

Figure 2-2

USGS Flows and Stages from the Grand Calumet River and NOAA Stage of Lake Michigan

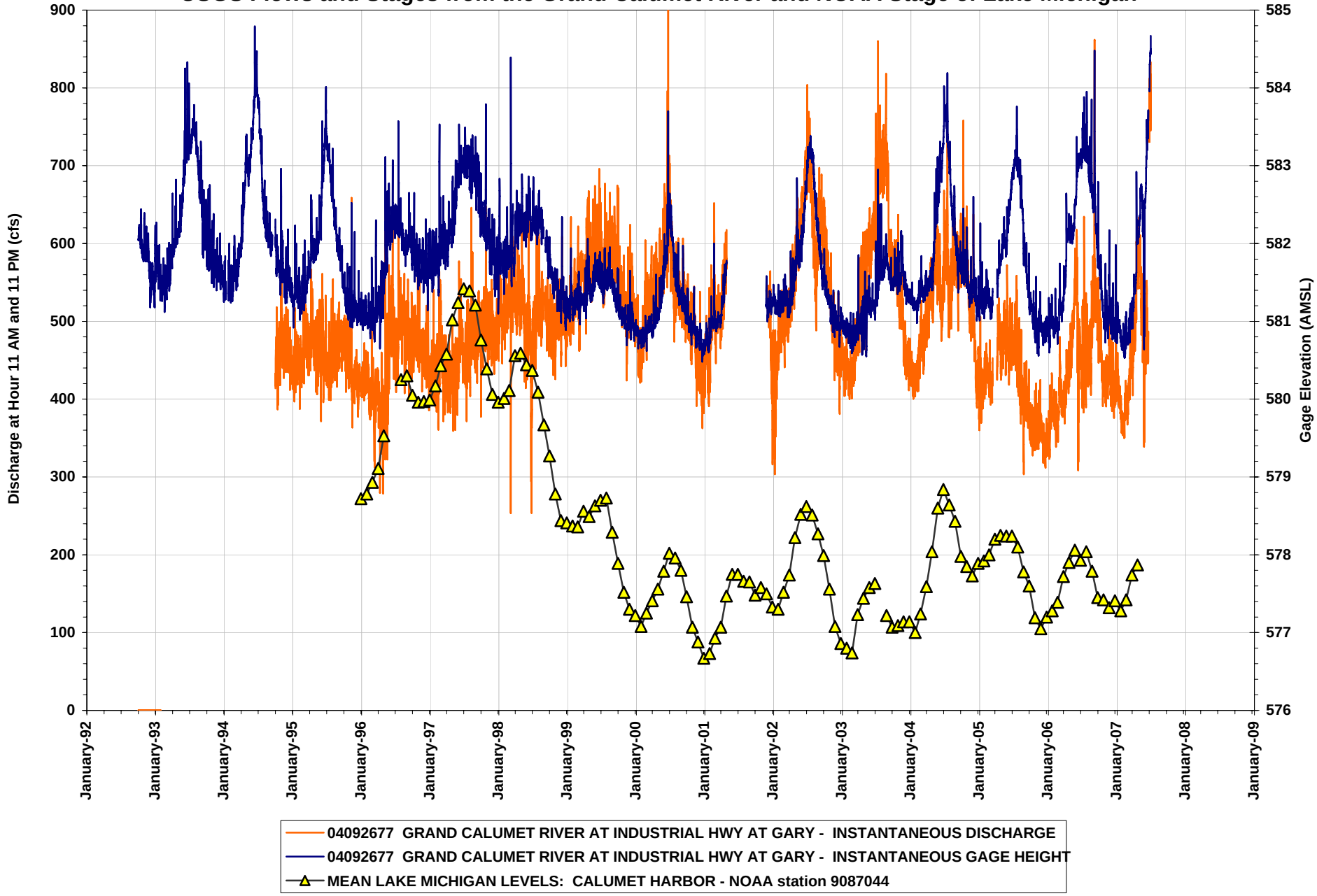

Figure 2-3
Staff Gage Readings at the Ralston Street Lagoon

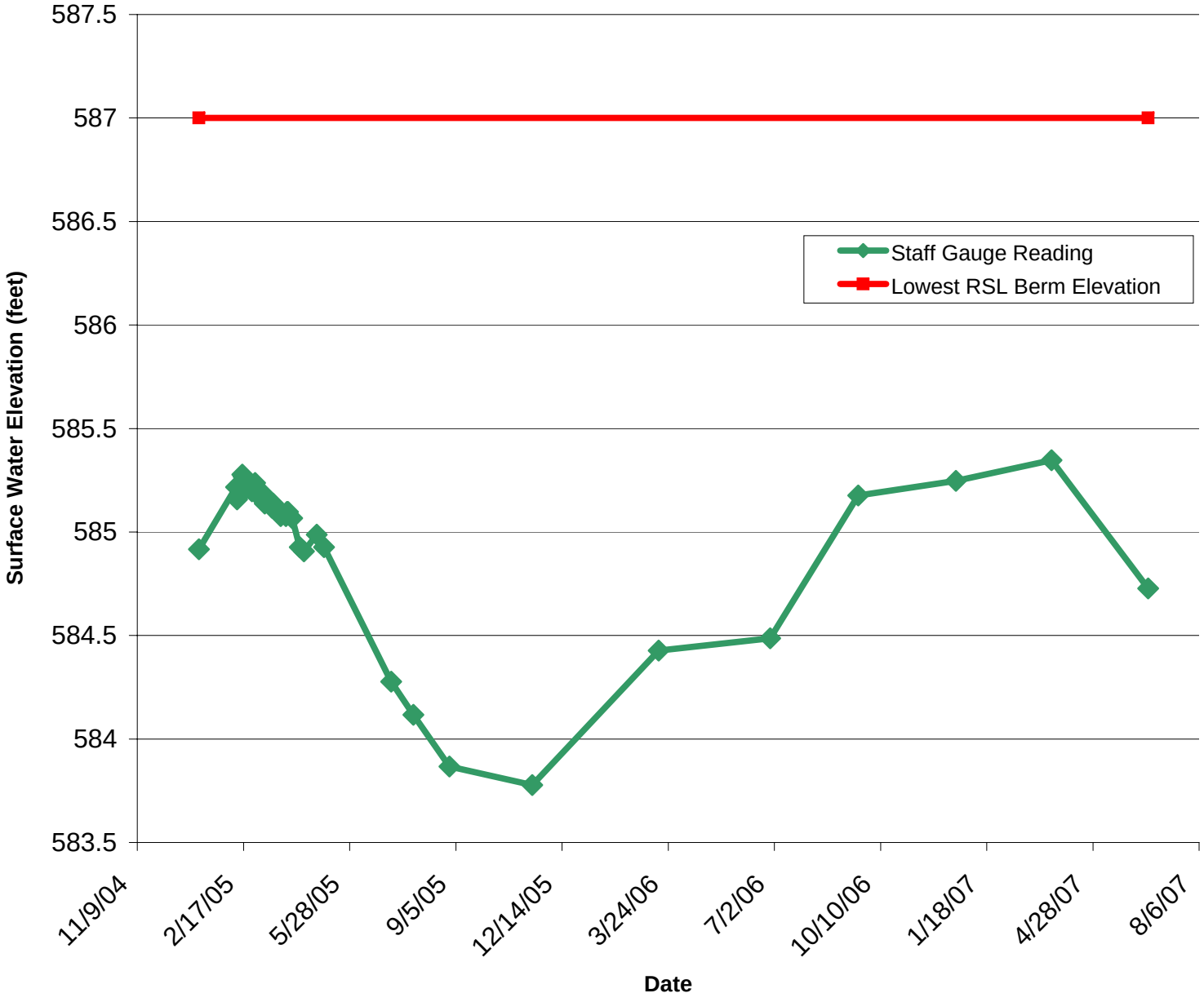

Figure 2-4. Parcels East of the Ralston Street Lagoon

Section 3
Previous Investigations and Interim Measures

3.1 Previous Investigations

Several previous investigations and studies have been undertaken at RSL. A summary of each investigation is presented below.

In May 1983, Canonie, Inc. sampled and analyzed sludge for PCBs from six locations along the three lagoon piers. Samples were taken at five-foot intervals to a maximum depth of 25 feet. Reported dry-weight PCB concentrations of these samples ranged from less than 10 to greater than 1,000 ppm, with an average PCB concentration of 220 ppm. Elevated PCB levels were found in samples below 10 feet in the central and western portions of the lagoon.

In June 1986, Canonie, Inc. collected and analyzed sludge for PCBs at 25 randomly selected locations within the lagoon. Samples were collected in five-foot intervals and composited. PCB concentrations ranged from 70 to 790 ppm with an average PCB concentration of approximately 200 ppm. Aroclors 1242 and 1248 were identified as the primary PCB constituents. Additionally, the samples were tested for ignitability, corrosivity, reactivity, or EP toxicity. Results showed that the sludge samples did not exceed the regulatory thresholds for the tested parameters.

As part of the 1986 investigation, four monitoring wells were installed, with twelve soil samples obtained and analyzed for PCBs during the installations. Three soil samples obtained had PCB levels above the 0.02 ppm detection limit. Two samples from depths of 5.5 to 6.0 feet bgs had PCB levels of 0.31 and 0.10 ppm (on a dry-weight basis) and the third sample, from a depth of 20.5 to 21 feet bgs, had a PCB level of 0.21 ppm. At a depth of 30 feet, the PCB level in the soil samples from each of the four wells was approximately four to five ppm.

Twenty sludge samples at RSL and two sediment samples from the Grand Calumet River were collected and analyzed for PCBs in January 1992. Aroclor 1248 was reported as the predominant PCB present in the RSL sludge. Concentrations ranged from less than 10 to over 300 ppm with an average of less than 50 ppm. Samples were taken from different depths at locations intended to duplicate earlier findings. Individual comparisons between samples at similar locations did not reveal any distinct patterns, but the 1992 data suggested that PCB concentrations throughout RSL could be significantly lower than previously determined (Fluor Daniel, 1992).

Fluor Daniel completed a study in January 1997 investigating the location and extent of PCBs in the sludge of the active RSL. This investigation is considered to be the

definitive investigation at RSL relative to PCB concentration, volume and mass estimates. Surface water sampling was also performed at 15 locations during the investigation. The total volume of sludge in the RSL was estimated to be 107,686,020 gallons. The volume of sludge exceeding 50 ppm PCB was estimated to be 96.6%, or 104,039,551 gallons. Approximately 10.4% of the sludge, or 11,206,260 gallons, was determined to contain PCB concentrations above the 500 ppm level. Fluor Daniel concluded that the PCB concentrations in the sludge did not appear to be distributed in particular areas, that there were essentially isolated single-sample grid locations that contain sludges with PCBs below 50 or greater than 500 ppm, and that separation of these areas from the rest of the sludge was not technically practical.

The average PCB concentration in the sludge was determined to be 182.2 ppm, with a range of 19 to 1,300 ppm. The PCB concentration appeared to be greatest near the center of the lagoon in the deepest layer. PCB concentrations generally increased with increasing depth within the lagoon.

The PCB concentrations measured in the surface water samples were below the method detection limit.

Beginning in 2003, a series of sampling and analytical events took place to characterize, test, and evaluate the sludge and surrounding soils. All sampling and analytical testing followed the previously approved Quality Assurance Project Plan (1996) used in the definitive Fluor Daniel study, with revisions as needed to bring the procedures up to current sampling and laboratory standards as mandated by the U.S. EPA.

In April and May 2003, Earth Tech collected sludge samples from three locations along the western side of the middle pier for limited treatability testing. Analytical and physical characterizations were performed on the sludge samples. Earth Tech performed limited dewatering and solidification/stabilization (S/S) treatability studies on two of the sludge samples. In the dewatering study, three types of dewatering methods were used on the sludge: gravity drainage, filter press dewatering (to a maximum pressure of 50 psi), and centrifugation. In the three dewatering methods, the best results were an increase in the percent solids of the sludge samples from approximately 15% to approximately 30%. Earth Tech concluded that the RSL sludge is not readily free-draining and is basically a suspension of organic and inorganic material with a strong affinity for water (Earth Tech, 2004).

In the S/S study, Earth Tech prepared 19 different mixtures of S/S reagents at various dosages to evaluate the effectiveness of solidifying the sludge. S/S reagents included Type I Portland Cement, hydrated lime, coke flue ash, site lime kiln dust, and organo clay. The maximum unconfined compressive strength of a treated sludge sample was 8.9 psi after 44 days with a dosage of 25% Portland cement.

In 2004, Howard University (Washington, D.C.) graduate students performed their masters' thesis work on RSL sludge samples obtained from Earth Tech's 2003.

Individual theses explored the remediation of PCBs in RSL sludge via aerobic, anaerobic, or vermicular transformations. Although the experiments demonstrated the ability to reduce PCB molecules or remove them from the sludge via bioaccumulation, the experiments were not successful in completely transforming the PCBs to biphenyl. These theses can be found in Appendix H.

In December 2004, Land Resource Management Group (LRMG) prepared a wetland delineation report of the RSL based on a field analysis and data collection event in November 2004 and a review of available resource maps. LRMG determined that there are three wetland areas at the RSL:

- Wetland 1: A roadside ditch located south and west of the lagoon that appears to divert highway runoff into the river to the west of the lagoon.
- Wetland 2: A marsh to the north of the lagoon and adjacent to the south bank of the Grand Calumet River.
- Wetland 3: The lagoon itself.

LRMG concluded that Wetlands 1 and 2 meet the federal definition of wetland and are jurisdictional since they appear to be adjacent via surface water connection to the Grand Calumet River – a navigable "water of the United States." Any introduction of fill or dredged material into these areas will have regulatory impacts and therefore be subject to the U.S. Army Corps of Engineers regulation and local review requirements (LRMG, December 2004).

Although Wetland 3, the lagoon itself, meets the federal "three criteria" definition of wetland (1987 Corps manual), it is considered non-jurisdictional because it is an active man-made lagoon designed and maintained as a municipal waste treatment system and does not meet the U.S. Army Corps Regulatory Program Regulations definition of "waters of the United States" (LRMG, December 2004). The wetland delineation study is located in Appendix A.

Also in November 2004, Robinson Engineering conducted a site topographic and physical inventory survey of RSL. This site survey is located in Appendix J.

During January/February 2005, CDM conducted analytical soil and surface water sampling in accordance with the previously approved QUAPP during monitoring well improvement activities at RSL and presented its findings to the EPA during a May 12, 2005 meeting.

In February, May and August 2005, CDM conducted analytical groundwater sampling at RSL. Groundwater analytical data and soil and surface water analytical data can be found in Appendix C and D, respectively.

In January 2005, K&S Engineers performed a geotechnical investigation of the RSL berm. The investigation consisted of 12 borings and seven test probes, with geotechnical testing performed on certain soil samples. The findings were consistent with past geotechnical investigations. Six clay samples were tested for hydraulic conductivity, with the results showing the clay had a hydraulic conductivity of 1.6 to 3.0×10^{-8} cm/sec, demonstrating that the clay layer has a hydraulic conductivity low enough to act as a confining layer. Another significant finding was that probing in a northwestern section of RSL suspected to contain buried auto bodies did not reveal a presence of auto bodies.

In July 2005, CDM performed an electroshocking analysis at RSL to determine if there were any aquatic species in the lagoon. Results showed that no fish specimens; however, a western painted turtle was captured along the western shore of RSL. The technical memorandum concluded that it is unlikely that a resident fish population exists in RSL. This memorandum can be found in Appendix I.

In October 2006, CDM completed a Supplemental Alternatives Evaluation Study (SAES) focusing on collecting information important in selecting a remedial alternative for the RSL. These factors included the physical properties of the sludge, the ability to dewater the sludge, the in-place sludge strength, and the consolidation properties of the sludge under applied load. The first phase of the SAES included field investigations, collecting samples and performing in-situ testing. The second phase consisted of performing sludge characterization and treatability studies on the sludge.

Sample collection and in-situ shear strength testing were performed at six locations within the lagoon perimeter for the field investigation phase of the SAES. The findings concluded that the solids content and shear strength of the sludge do not increase appreciably with depth, suggesting that the water is closely bound to the sludge particles. Subtracting potential outliers possibly detecting obstructions or the sludge/sand layer interface, the mean in-situ peak shear strength of the RSL sludges was less than 50 psf and the mean in-situ remolded shear strength of the RSL sludges was less than 20 psf, indicative of a very soft soil consistency.

CDM performed strength testing on non-dewatered and dewatered sludge samples solidified and/or bulked with Portland Cement Type I/II, Class C Fly Ash, Lime Kiln Dust, Waste Lime, and uniform fine sand. After 28 days, non-dewatered sludge samples reached maximum compressive strengths of up to 7,320 psf (with 20% Portland Cement) and 7,875 psf (with 10% Portland Cement and 60% Lime Kiln Dust). For the dewatered sludge, samples achieved maximum 28-day compressive strengths of up to 8,080 psf (with 10% Portland Cement and 40% Lime Kiln Dust) and 6,841 psf (with 10% Portland Cement and 40% Waste Lime).

CDM performed, as part of the SAES, several studies on dewatering, polymer addition, solidification and bulking. WaterSolve LLC performed a chemical conditioning program on samples of sludge and lagoon surface water and determined

that out of thirteen cationic polymers, Solve127 and Solve 216C were found to dewater the sludge most effectively. These polymers were mixed separately with the sludge and site water at the dosages prescribed by WaterSolve to perform two hanging bag tests. The hanging bag tests are used to simulate dewatering with geotubes. After 39 days in the geotube hanging bag, the solids content of the sludge was increased to 55-60% solids.

CDM sent Environmental Process Dynamics, Inc. composite samples of sludge and site surface water for belt filter press testing. The polymer WaterSolve 216C was selected to mix with the sludge for the belt filer press tests. The maximum solids content achieved from the belt filter press was 59.3%.

Included in the SAES were additive and bulking studies used to determine what additives and dosages were needed to blend/bulk with the sludges in order to pass a paint filter test required for transport and landfill disposal. The additives and bulking materials tested were Portland Cement Type I/II, Class C Fly Ash, Lime Kiln Dust, Waste Lime, and uniform fine sand. The testing showed that in order to pass a paint filter test, approximately 35% LKD was needed to bulk the sludge. For other additives, approximately 15% waste lime was needed, 65% Class C Fly Ash, 90% uniform fine sand, and 30% Portland Cement Type I/II. The studies showed that the sludge can be dewatered sufficiently for transportation using additives required to pass the paint filter test.

Cap and cover studies were performed analyzing several potential options, including sand covers, compost caps, wood chip caps, and geofoam caps. These studies found that it is possible to dewater the sludge in-place by confining it and applying a uniform load on top, however it does not dewater readily, suggesting that consolidation would take a relatively long time and would need to be performed in stages. The geofoam had the best ability to cover and compress the sludge. The sludge failed in bearing capacity under the various other caps, even under small applications of load.

3.2 Published Technical Reports

The following technical reports have been prepared to assist in the characterization and understanding of RSL:

a) December 1984: "Feasibility Study for PCB Disposal at the Ralston Street Lagoon" (IAE). Recommended onsite containment.

b) July 1985: "Lagoon Stabilization Alternatives and Preliminary Conceptual Design" (IAE). Recommended hydraulic containment and maintaining the lagoon level for stability, and presented a preliminary alternative evaluation.

c) August 1986: "Content Sampling & Geologic Structural Sampling Report" (IAE). Summarized lagoon stability issues and recommended interim stability measures and additional sampling.

d) July 1989: "Ralston Street Lagoon Remediation Project Final Report" (Alleman et al.). Presented alternatives for the interim and long-term stabilization of RSL sludge, and recommended raising the lagoon berm, dewatering and treatment of the lagoon surface water, hydraulic containment, backfilling of the lagoon, and a vegetative cover.

e) October 1992: "100-Year Floodplain, Sludge Characterization, and Electromagnetic Survey Report" (Fluor Daniel). Recommended that the lagoon berm be raised to 588.00 feet NGVD, additional sludge sampling to confirm potential biodegradation between 1983 and 1992, and a subsurface investigation to confirm the existence of metallic objects in the berm.

f) December 1992: "Ralston Street Lagoon" (Fluor Daniel). Summarized prior reports and field work, and proposed additional sampling and studies to investigate remedial technologies that would allow for the ultimate disposal and treatment of PCBs onsite.

g) May 1996: "Preliminary Risk Analysis" (Fluor Daniel). A risk analysis was conducted by reviewing the characteristics and toxicology of PCBs, identifying potential pathways of exposure to RSL PCBs, and analyzing a plausible exposure scenario that might increase the risk of exposure. Approximate calculations were performed that showed both the concentration of PCBs in the floodwater flowing over the lagoon and the total quantity of PCB that would be released outside the lagoon during a 100-year flood were extremely small. A review of the floodplain area showed a lack of critical receptors (residential areas and farms) downstream of the RSL within the 100-year floodplain. Fluor Daniel concluded that "the 100-year flooding scenario appears to pose a negligible risk over a period of 1-2 years with regard to human exposure to the PCB from the Lagoon" (Fluor Daniel, 1996).

h) January 1997: "Sludge and Surface Water PCB Sampling Report" (Fluor Daniel). Considered the definitive sampling event and report at RSL. Presented sampling results and characterized the concentrations of PCBs in the sludge. PCB concentrations were presented in 3D profiles. Concluded that 96.6% of the lagoon sludge contains Aroclor 1248 at concentrations above 50 ppm.

i) July 2004: "Final Waste Characterization Report" (Earth Tech). Presented analytical and physical results on two sludge samples obtained from the middle pier. This report can be found in Appendix F.

j) July 2004: "Final Report on Limited Waste Treatability Study" (Earth Tech). Presented findings on limited dewatering and solidification/stabilization (S/S) treatability studies performed on two sludge samples and provided

recommendations on remediation alternatives. Concluded that dewatering is not recommended without the addition of a water treatment chemical, and that additional S/S testing with binders and different additive doses would help to determine optimal treatment mixes. This report can be found in Appendix G

k) May 2005: "Wetland Delineation Report" (Land Resource Management Group). Delineated adjacent wetland areas to the north and south of RSL. This report can be found in Appendix A.

l) April 2005: "Berm Assessment and Recommendations" (CDM/Hannum, Wagle & Cline). Described subsurface soil explorations along the RSL berm at 19 locations. Surveyed and measured berm width at 50 foot increments on the north berm and provided recommendations to raise, widen, and stabilize the northern berm and to add a flood wall. Other recommendations included cleaning and detailing the existing manhole southeast of RSL for future use, performing unconfined compressive strength testing on the subsurface peat layer before significantly loading the berm, and replacing the security fencing. This report can be found in Appendix E.

m) September 2005: "PCB Bioremediation: The State of the Technology" (CDM). Technical memorandum discussing potential anaerobic and aerobic bioremediation technologies. The memorandum concluded that "both anaerobic and aerobic bioremediation processes show promise for PCB remediation. However, technologies for complete biodegradation of a whole PCB Aroclor mixture do not yet exist. Research utilizing state-of-the-art methods of genetic engineering is ongoing, but development of a fully field-implementable technology is probably several years away" (CDM, 2005). This memorandum can be found in Appendix K.

n) October 2005: "Monitoring Well Network Improvements Technical Memorandum" (CDM). Technical memorandum that describes the abandonment of the previous monitoring well network and the installation of the new and existing monitoring well network. This document also contains an assessment of the soil and groundwater analytical data collected from December 2004 to August 2005.

o) November 2005: "Technical and Cost Assessment, Draft Report" (CDM/Quality Environmental LLC). This document summarizes available data from previous reports on the RSL, screens applicable technologies, selects potential remediation alternatives as per the guidelines of the Consent Decree, evaluates each alternative based on the criteria stated in the Consent Decree, and discusses the recommended alternative based on the rankings.

p) October 2006: "Ralston Street Lagoon Supplemental Alternatives Evaluation Study" (CDM). This study involved performing physical characterization and tractability studies with samples of the RSL sludge with the goal of collecting additional information useful to evaluating remediation alternatives, including a number of

innovative technologies previously not included in the Draft TCA. The objectives of the study included further characterization of the physical properties of the RSL sludge as applicable to the technologies to be considered, evaluating the effectiveness of using geotubes and/or other applicable dewatering technologies to dewater, stabilize, or contain the RSL sludges, and to evaluate the effectiveness of various capping technologies at RSL.

3.3 Interim Measures

Interim measures conducted during the preparation of the TCA at RSL include the following:

In April 2005, the north berm was raised under CDM supervision to increase freeboard. Berm improvements included increasing the minimum berm width to 13 feet and raising the top of the northern and western berms to between elevations of 586.03 and 587.52 feet. Berm improvement photographs are located in Appendix L.

In January 2005, CDM expanded the RSL monitoring well network. Expansions included abandoning seven monitoring wells, installing three staff gauges in the Grand Calumet River and one staff gauge in RSL, installing seven new monitoring wells, rehabilitating the remaining wells, and conducting elevation and location surveys for all existing and newly installed wells.

In February, May and August 2005, CDM conducted groundwater and surface water sampling and analysis at RSL. Whole Effluent Toxicity (WET) testing was also performed on RSL surface waters. The results of the WET testing determined that the surface waters of the Ralston Street Lagoon are not toxic to either fathead minnows or Daphnia. Complete analytical results are located in Appendix D, and a discussion of the results is located in Appendix B.

Section 4
Screening-Level Risk Analysis to Protect Human Health and the Environment

4.1 Introduction

GSD commissioned a preliminary risk analysis for RSL in 1996 (Fluor Daniel, 1996) to determine the potential risks to human health and the environment from exposure to the sludge in the lagoon. Primarily, the study focused on the impact of flood waters from the Grand Calumet overtopping the existing berm and flushing PCB-contaminated surface water into the river. The Fluor Daniel study concluded that in the event of berm failure, PCB contamination in the surface water downstream of the lagoon would be minimal. Additionally, the study concluded that the concentrations of PCBs in the floodwater would not contribute to human health risks. Exposure pathways considered in their risk analysis included ingestion, dermal contact and inhalation. However, these pathways were considered incomplete and eliminated from further risk consideration.

The risk analysis in the TCA evaluated the potential short- and long-term risks associated with the implementation of each alternative remedy at the site. Potential exposure pathways for each remedial alternative were evaluated for the overall protection of human health and the environment.

The goal of the risk analysis is to define potential remedial action objectives that can facilitate the development of alternatives that would achieve the overall protection of human health and the environment based upon the anticipated use of the area. Currently the site is being managed as a sludge holding lagoon, and it is not anticipated that the future land use of the lagoon will include municipal use. The future use of the site will depend on the final remedial action, but is anticipated to be a closed lagoon that will be monitored and maintained by GSD. The site is currently fenced and "No Trespassing" signs are posted. This fencing adequately deters public access.

A wetland delineation conducted by Land Resources Management Group (Appendix A) concluded that RSL was a non-jurisdictional wetland, and a man-made lagoon designed and maintained as a municipal sludge holding lagoon. Additionally, in July 2005, GSD commissioned a survey to determine if there were fish and other aquatic life residing in the lagoon. No fish species were observed during the 2.5 hours electroshocking effort. Only one western painted turtle (*Chrysemys picta*) was collected during the survey (Appendix I).

4.2 Evaluating Potential Human Health and Environmental Risks

The spatial boundaries of the screening-level human health and environmental risk evaluation were confined to the Ralston Street Lagoon property. Data used to perform the risk analysis included recently collected data (groundwater, soils, sludge and surface water), supplemented as needed by older historical data, the wetlands delineation, and the fish sampling effort conducted this summer.

Media of concern included surface soil, surface water, groundwater, and impoundment sludges. Groundwater was considered as a medium of concern for the purpose of identifying potential contaminants that might migrate to the impoundment or to the Grand Calumet River. The contaminant of concern (COC) for this risk analysis was restricted to polychlorinated biphenyls (PCBs) in the municipal sludge in the lagoon. PCB-contaminated sludge is regulated under TSCA (40 CFR 761.61).

This risk evaluation was based on comparing site media concentrations with health-based screening levels calculated according to protocol contained in *Risk Assessment Guidance for Superfund* (RAGS) *Volume I: Human Health Evaluation Manual (Part A)* (EPA/540/1-89/002) and utilizing U.S. EPA exposure assumptions (EPA 1991, 2004).

4.2 Media Quantities

The calculated value of 533,169 cubic yards of lagoon sludge (Fluor Daniel, 1997) was confirmed by a recent GIS analysis. It is understood that approximately 96.6% of the sludge contains PCBs at concentrations above 50 mg/kg, which includes approximately 10.4% of the total sludge with PCBs at concentrations above 500 mg/kg (Fluor Daniel, 1997). PCB concentrations in the sludge generally trend higher with depth. They range from 19 mg/kg to 1300 mg/kg, with an average concentration of 182 mg/kg.

The volume of surface water at the lagoon is estimated to be 42 million gallons. This estimate assumes an average water depth of approximately seven feet in the lagoon.

4.3 Potential Exposure Pathways

To determine whether trespassers and/or workers would be exposed to PCBs during remedial activities, the environmental components that lead to human and ecological exposure were evaluated. The pathway analysis consisted of five elements:

(1) A source of contamination

(2) Transport through an environmental medium

(3) A point of exposure

(4) A route of exposure

(5) A receptor population

Completed pathways require that the five above elements have occurred in the past, are currently occurring, or will occur in the future. Potential exposure pathways, however, require that at least one of the five elements is missing but could exist. Potential exposure pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will not be present.

Potential exposure pathways of concern during remediation include inhalation of fugitive dust and/or particulate matter, ingestion of contaminated soil and soil dusts, and skin contact with soil contaminants by on-site workers, construction workers, and on-site trespassers.

The exposure pathways are applicable to the following general response actions:

1. Inhalation: Exposure to volatized PCBs is possible during any action in which sludges are either extracted from the lagoon or disturbed in situ. The potential for inhalation exposure is considered to be more severe for actions that extract the PCBs than those that leave such media in place. Applicable actions include off-site disposal, on-site disposal, and treatment actions. Other response actions are not expected to create a significant potential for inhalation.

2. Particulate Transport: Exposure to PCBs absorbed by sludge in the lagoon is possible either by an individual entering the site, or the failure of the lagoon berm to contain the sludge. Although security measures are in place, a small potential for particulate transport via a 100-year flood event currently exists. Engineered improvements to the lagoon berm and other on-site containment actions are expected to reduce the potential for exposure via particulate transport.

3. Aqueous Transport: Exposure to PCBs from the lagoon is possible via contaminated sludge coming in contact with lagoon surface water that could flow into the Grand Calumet River. Containment, treatment, and on- or off-site disposal actions are expected to reduce the potential for exposure via aqueous transport. The removal of PCBs from the lagoon is expected to reduce the potential for aqueous transport exposure to a greater degree.

4. Direct Contact and Ingestion: Exposure to PCBs through dermal contact or ingestion is limited to authorized personnel or trespassers on the secured RSL property. PCBs are located beneath the lagoon surface water in sludge at concentrations greater than 50 mg/kg and are present in subsurface soils below the surrounding berm in concentrations less than 50 mg/kg. Applicable actions include off-site disposal, on-site disposal, and treatment actions. Other response actions are not expected to create a significant potential for inhalation risks for humans. Ingestion through the consumption of fish could be a potential pathway for human receptors. Ecological receptors could be exposed through ingestion of contaminated biota and surface water.

4.4 Complete Exposure Pathways/Site Conceptual Model

For the purposes of evaluating each alternative, each complete potential exposure pathway will be evaluated relative to PCB short- and long-term risks to human and ecological receptors qualitatively in Section 7. Pathways present during construction versus after completion of an alternative will also be addressed.

Descriptions of exposure pathways for human and ecological receptors are presented in the Site Conceptual Exposure Model (SCEM) (Table 4-1), which includes contaminant sources, fate and transport processes, and exposure routes. The exposure pathways shown in Table 4-1 were considered the most significant and were evaluated in this risk analysis. Specifically, this risk analysis focused on the risks associated with the ingestion of and direct contact with site PCBs that may have migrated from the sewage sludge in the lagoon to overlying surface waters and groundwater. Risks from exposure to the sludge material were evaluated as well.

Table 4-1
Site Conceptual Exposure Model for RLS

Contaminant Source	Exposure Medium	Release Mechanism	Exposure Pathway	Potential Receptor			
				GSD Employee	Trespasser	Construction Worker	Terrestrial and Aquatic Animals
PCBs released from historical municipal practices	Groundwater	Leaching from contaminated sewage sludge	There is no evidence of ecological exposure to undiluted groundwater. Surface water and sewage sludge samples are assumed to include any groundwater that may be discharged to surface water.				
	Surface water in lagoon	Direct input via aqueous transport	Direct contact/ ingestion	●	●	●	●
	Contaminated biota	Consumption of contaminated biota	Ingestion	No fish species were captured in the sludge lagoon. Therefore, piscivorous species such as belted kingfisher, osprey and fish-eating ducks would not be at risk. Fish consumption by humans would not take place.			
	Exposed sewage sludge	Particulate transport	Direct contact/ inhalation/ingestion	●	●	●	

4.5 Risk Analysis

Completed pathways require that the five pathway elements identified in Section 4.3 exist and show that exposure to a contaminant is occurring or will occur in the future. Pathways are considered potential when one of the five elements is missing, but could exist. Potential pathways show that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. The future land use of the Ralston Street Lagoon is expected to be a closed sludge holding lagoon for the Gary Sanitary District. Based upon the groundwater data in Appendix C, no PCBs were detected in the groundwater. The data do not show any effect from PCBs in the sludge lagoon or the groundwater surrounding the lagoon. Surface water data (Appendix D)

for the lagoon also demonstrated no detection of PCBs in the water column. Exposure pathways to human and ecological receptors for these two media are incomplete due to the non-detect of PCBs.

Soil data in Appendix D showed that PCBs in soils associated with MW-9 had detects of PCBs. However, these detects were at depths greater than 14 feet. PCB concentrations from the well borings at this location ranged from 0 to 17 mg/kg. The PCB-contaminated soils associated with MW-9 are unique only to that well, as no other well surrounding the lagoon showed evidence of PCB in the soils. The exposure pathways, as defined in the site conceptual model for human receptors, are incomplete as there is no direct contact or ingestion of contaminated soils associated with MW-9.

Ingestion pathways for contaminated biota to human and ecological receptors are limited due to the non-existence of any fish species in the lagoon. Exposure to the contaminated sewage sludge would be restricted to macroinvertebrate species (and turtles), but the population of these species would most likely be limited if the pore water in the sewage sludge was deficient in dissolved oxygen. Waterfowl have been observed on the lagoon. However, exposure to PCBs would be limited as the forage base would be restricted to planktonic and filamentous algae. Based upon non-detects of PCBs in the lagoon water and the limited potential for PCBs to bioaccumulate in algae, waterfowl feeding on zooplankton and plankton in the lagoon are unlikely to be adversely affected (i.e., reduced survival, growth, and/or reproduction) from exposure to PCBs. Therefore, the potential risks to ecological receptors exposed to PCBs at the lagoon are insignificant.

Under the SCEM, ingestion, dermal contact and inhalation (fugitive dust) of PCB contaminated sludge are viable exposure pathways. A GSD employee is one who will access RSL to monitor and maintain the lagoon area. GSD employees spend approximately one-day week at the RSL for maintenance and monitoring. Trespasser exposure scenario represents an adolescent youth (12 – 18 years old), weighing 56 kg, and being exposed for 143 days per year for a 6-year period. The exposure frequency of 143 days per year is based on a conservative assumption that a trespasser would visit the lagoon two days a week during the spring and fall months (13 weeks per season) and seven days a week in the summer. Construction worker represents those individuals who will spend a three-year period remediating the site. Cancer and non-cancer risks to GSD employees, trespassers and construction workers were evaluated and are discussed in the following section.

4.5.1 Risk Characterization

The human health risks to GSD employees, construction workers and trespassers were evaluated to determine the potential for risks from ingestion of sludge and dermal contact of the sludge material residing in the lagoon.

Tables 4-2 and 4-3 show the potential cancer risks and non-cancer hazards associated with various exposure scenarios for the PCB contaminated sludge at RSL. The results of this risk analysis indicate that:

- The maximum level of PCBs is found more than 20 feet below the sludge surface layer. Thus, exposure to the maximum PCB concentration in the sludge is unlikely.
- Non-cancer hazards for all receptors exposed to the maximum (1,300 mg/kg) and mean (182 mg/kg) concentrations of PCBs are below the EPA threshold for non-cancer hazard of unity (1), indicating the non-cancer hazards for all receptors are insignificant.
- Cancer risks via inhalation pathway for all receptors, under both concentrations, are within EPA's acceptable range of 10^{-4} to 10^{-6}.
- Cancer risks via ingestion and dermal contact cancer risks (3.3×10^{-4}) for trespasser using average concentrations of PCBs in sludge is slightly above the EPA's cancer acceptable range of 10^{-4} to 10^{-6} for cancer. On-site worker (GSD employee) and construction worker cancer risks (5.1×10^{-5} and 7.2×10^{-5}, respectively) are within EPA's acceptable cancer range.
- Cancer risks via ingestion and dermal contact for trespasser, GSD employee and construction worker for the maximum concentration scenario (1,300 mg/kg) are above EPA's cancer acceptable range of 10^{-4} to 10^{-6}.

Currently the PCB contaminated sludge contained within the lagoon does not pose an unacceptable risk unless trespassers gain access to the site, or if GSD employees do not use personal protective equipment and do not follow health and safety protocols. The RSL is fenced and trespassing is prohibited on the property.

Overtopping of the berm, as outlined in the Fluor Daniel (1996) report, could cause the existing berm to be compromised as a result of erosive flows from a 100-year flood event and/or a stormwater event could cause the release of surface water contaminated with PCBs from the sludge layer to the Grand Calumet River and associated wetlands.

The concentration and distribution of PCBs downstream of the lagoon after the 100-year flood event are dependent on the nature and size of the flood event (Fluor Daniel 1996).

TABLE 4-2
SUMMARY OF RISK FOR MEAN PCB CONCENTRATION (182 mg/kg) IN RSL SLUDGE

Parameter Definition	Parameter Code	Units	Trespasser Adolescent Youth	GSD Worker Adult	Construction Worker Adult
INGESTION					
Chemical Concentration in Soil	CS	mg/kg	182	182	182
Conversion Factor	CF1	kg/mg	1.00E-06	1.00E-06	1.00E-06
Ingestion Rate of Soil	IR-S	mg/day	200	100	330
Exposure Frequency	EF	days/year	143	52	250
Exposure Duration	ED	years	6	25	3
Body Weight	BW	kg	56	70	70
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550
Averaging Time (Noncancer)	AT-N	days	2,190	9,125	365
Oral CSF[1]		mg/kg/day	2.0E+00	2.0E+00	2.0E+00
Oral RfD[2]		mg/kg/day	2.0E-05	2.0E-05	2.0E-05
Cancer Risk			4.4E-05	2.6E-05	5.0E-05
Hazard Quotient			7.9E-02	5.4E-01	1.1E-02
DERMAL CONTACT					
Chemical Concentration in Soil	CS	mg/kg	182	182	182
Conversion Factor	CF1	kg/mg	1.00E-06	1.00E-06	1.00E-06
Skin Surface Area Available for Contact	SA	cm^2	2,800	3,300	3,300
Adherence Factor *	AF	mg/cm^2	3.3	0.2	0.3
Absorption Factor *	ABS	unitless	0.14	0.14	0.14
Exposure Frequency	EF	days/year	143	52	250
Exposure Duration	ED	years	6	25	3
Body Weight	BW	kg	56	70	70
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550
Averaging Time (Noncancer)	AT-N	days	2,190	9,125	365
Dermal CSF		mg/kg/day	2.0E+00	2.0E+00	2.0E+00
Dermal RfD[4]		mg/kg/day	2.0E-05	2.0E-05	2.0E-05
Cancer Risk			2.8E-04	2.4E-05	2.1E-05
Hazard Quotient			1.2E-02	5.8E-01	2.7E-02
INHALATION					
Chemical Concentration in Soil	CS	mg/kg	182	182	182
Inhalation Rate of Air	IR-A	m^3/day	13	20	20
Exposure Frequency	EF	days/year	143	52	250
Exposure Duration	ED	years	6	25	3
Particulate Emission Factor	PEF	m^3/kg	1.36E+09	1.36E+09	1.36E+09
Body Weight	BW	kg	56	70	70
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550
Averaging Time (Noncancer)	AT-N	days	2,190	9,125	365
Inhalation CSF[3]		mg/kg/day	3.5E-01	3.5E-01	3.5E-01
Inhalation RfC		mg/kg/day	NA	NA	NA
Cancer Risk			3.5E-10	6.8E-10	3.9E-10
Hazard Quotient			NA	NA	NA
Total Cancer Risk			3.3E-04	5.1E-05	7.2E-05
Total Hazard Index			9.1E-02	1.1E+00	3.8E-02

Notes:

[1] EPA's Integrated Risk Information System (IRIS) online 11/7/2005

[2] The RfD for Aroclor-1254 has been applied to PCB.

[3] The RfC value was based on unit risk $1x10^{-4}$ $(\mu g/m^3)^{-1}$ from IRIS online 11/7/05

[4] Oak Ridge National Laboratory Risk Assessment Information Services online 11/7/05

[*] EPA 2004. Risk Assessment Guidance for Superfund Vol I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) EPA/540/R-99/005, July

Chronic Daily Intake (CDI) (mg/kg-day) =

Ingestion: CS x CF1 x IR-S x EF x ED x 1/BW x 1/AT

Dermal: CS x CF1 x SA x AF x ABS x EF x ED x 1/BW x 1/AT

Inhalation: CS x IR-A x EF x ED x 1/PEF x 1/BW x 1/AT

TABLE 4-3

SUMMARY OF RISK FOR MAXIMUM PCB CONCENTRATION (1,300 mg/kg) IN RSL SLUDGE

Parameter Definition	Parameter Code	Units	Trespasser Adolescent Youth	Site Worker Adult	Construction Worker Adult
INGESTION					
Chemical Concentration in Soil	CS	mg/kg	1,300	1,300	1,300
Conversion Factor	CF1	kg/mg	1.00E-06	1.00E-06	1.00E-06
Ingestion Rate of Soil	IR-S	mg/day	200	100	330
Exposure Frequency	EF	days/year	143	52	250
Exposure Duration	ED	years	6	25	3
Body Weight	BW	kg	56	70	70
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550
Averaging Time (Noncancer)	AT-N	days	2,190	9,125	365
Oral CSF[1]		mg/kg/day	2.0E+00	2.0E+00	2.0E+00
Oral RfD[2]		mg/kg/day	2.0E-05	2.0E-05	2.0E-05
Cancer Risk			3.1E-04	1.9E-04	3.6E-04
Hazard Quotient			1.1E-02	7.6E-02	1.6E-03
DERMAL CONTACT					
Chemical Concentration in Soil	CS	mg/kg	1,300	1,300	1,300
Conversion Factor	CF1	kg/mg	1.00E-06	1.00E-06	1.00E-06
Skin Surface Area Available for Contact	SA	cm^2	2,800	3,300	3,300
Adherence Factor*	AF	mg/cm^2	3.3	0.2	0.3
Absorption Factor *	ABS	unitless	0.14	0.14	0.14
Exposure Frequency	EF	days/year	143	52	250
Exposure Duration	ED	years	6	25	3
Body Weight	BW	kg	56	70	70
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550
Averaging Time (Noncancer)	AT-N	days	2,190	9,125	365
Dermal CSF		mg/kg/day	2.0E+00	2.0E+00	2.0E+00
Dermal RfD[4]		mg/kg/day	2.0E-05	2.0E-05	2.0E-05
Cancer Risk			2.0E-03	1.7E-04	1.5E-04
Hazard Quotient			1.7E-03	8.2E-02	3.8E-03
INHALATION					
Chemical Concentration in Soil	CS	mg/kg	1,300	1,300	1,300
Inhalation Rate of Air	IR-A	m^3/day	13	20	20
Exposure Frequency	EF	days/year	143	52	250
Exposure Duration	ED	years	6	25	3
Particulate Emission Factor	PEF	m^3/kg	1.36E+09	1.36E+09	1.36E+09
Body Weight	BW	kg	56	70	70
Averaging Time (Cancer)	AT-C	days	25,550	25,550	25,550
Averaging Time (Noncancer)	AT-N	days	2,190	9,125	365
Inhalation CSF[3]		mg/kg/day	3.5E-01	3.5E-01	3.5E-01
Inhalation RfC		mg/kg/day	NA	NA	NA
Cancer Risk			2.5E-09	4.9E-09	2.8E-09
Hazard Quotient			NA	NA	NA
Total Cancer Risk			2.3E-03	3.6E-04	5.1E-04
Total Hazard Index			1.3E-02	1.6E-01	5.4E-03

Notes:

[1] EPA's Integrated Risk Information System (IRIS) online 11/7/2005

[2] The RfD for Aroclor-1254 has been applied to PCB.

[3] The RfC value was based on unit risk $1x10^{-4}$ $(\mu g/m^3)^{-1}$ from IRIS online 11/7/05.

[4] Oak Ridge National Laboratory Risk Assessment Information Services online 11/7/05

[*] EPA 2004. Risk Assessment Guidance for Superfund Vol I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) EPA/540/R-99/005, July

Chronic Daily Intake (CDI) (mg/kg-day) =

Ingestion: CS x CF1 x IR-S x EF x ED x 1/BW x 1/AT

Dermal: CS x CF1 x SA x AF x ABS x EF x ED x 1/BW x 1/AT

Inhalation: CS x IR-A x EF x ED x 1/PEF x 1/BW x 1/AT

It is conservatively calculated that the PCB mass in the lagoon surface water (0.114 kg) mixed with the floodwaters would result in PCB concentrations of 0.000211 kg/acre for the 540 floodplain acres downstream of the lagoon. The Indiana Department of Environmental Management (IDEM) has issued guidance (327 IAC 6.1) for the land application of wastewater sludges and biosolids relative to PCBs. The guidance outlines the maximum application rates for sludges containing PCBs is 2 mg/kg. The concentrations found in the floodplains soils downstream after a berm failure are well below the IDEM land application rates. Additionally, PCB levels in the water would be reduced from 0.001 mg/L to 0.000637 mg/L, which is well below the Indiana (Article 2. 327 IAC 2-1-6) Human Health (30-day average) of 0.790 mg/L.

The historical and recent investigations found that the PCBs are effectively contained in the lagoon and are not migrating to the groundwater or adjacent surface waters. Access to the RSL is prohibited and only limited to GSD employees, who periodically monitor and maintain the lagoon area. Long-term cancer and non-cancer risks to GSD employees and construction workers under the average PCB exposure scenario are within EPA's approved cancer risk range, and for trespassers, the risk is slightly above the acceptable EPA cancer risk range.

There is potential for surface waters in the lagoon to mix with high flows for a 100-year flood event. The resulting downstream concentrations in the floodwaters and soils are well below acceptable risk levels. However, appropriate engineering solutions would be implemented to ensure the lagoon surface water does not reach the Grand Calumet River.

4.5.2 Short-term Risks

Short-term risks are those risks (human and ecological) that are associated with a specific remedial action (e.g., excavation of sludges). Short-term risks can last several years, as it may take that long for the remedial action to be put in place. Workers implementing remedial action would be aware of the pathways of exposure (i.e. inhalation, ingestion, dermal contact), and would take necessary measure to reduce or eliminate the risks according to the mandatory site health and safety procedures.

GSD employees may potentially be at risk during routine monitoring and maintenance of the lagoon and berm if exposed to the maximum PCB level in the sludge material. However, typical health and safety precautions, such as wearing gloves and coveralls, should be implemented to minimize or eliminate contact with the sludge.

The greatest human health risk at RSL, could come from any extensive remedial action that results in excavating and removing the contaminated sludge from the lagoon. Workers and the surrounding residential community could be exposed from unacceptable levels of contaminants during excavation, and residual waste could fall off trucks that are transporting waste off site to an approved disposal area. However these risks could be minimized if the construction workers implemented proper safety measures (e.g., respirators and protective clothing), and ensured decontamination procedures are followed to protect the public from waste falling off disposal trucks.

Fugitive dust from unstable or disturbed dirt surfaces (such as construction areas, vacant lots, dirt roads and dirt tracked out onto paved surfaces) should be controlled to protect the general public.

Short-term impacts associated with a remedial action alternative would include temporary disturbance of some land around the lagoon to construct support facilities for remedial activities. Potential impacts associated with increased fugitive dust emissions during excavation activities and minor impacts to biota and wetlands exist. Short-term impacts include the temporary loss of habitats at the lagoon and possible impacts of accidental spills of construction and operational materials into the adjacent wetlands. Mitigative measures and engineering controls would be employed to minimize these short-term impacts and risks. Waste hauling of PCB contaminated materials to off-site facilities would be in compliance with Indiana Department of Transportation regulations and guidelines. Short-term risks for each remedial alternative will be addressed in greater detail in Section 7.

Section 5
Goals and Requirements

5.1 Introduction

This section describes the goals and requirements used to develop the alternatives to be analyzed against the criteria specified in the Consent Decree. The Remedial Action Objectives (RAOs) combined with federal and state requirements for PCB cleanup and/or disposal provide a basis for developing and evaluating these alternatives.

5.2 Remedial Action Objectives

Based on the requirements of the Consent Decree and the risk assessment outlined in Section 4, the suggested RAOs for the RSL are as follows:

1. Prevent ingestion, inhalation, or direct contact with RSL sludges or surface soils that contain PCBs to the extent practicable

2. Permanently and/or significantly reduce the mobility of RSL sludges that contain PCBs to the extent practicable

3. Prevent RSL surface water potentially containing PCBs from discharging to the Grand Calumet River to the extent practicable

5.3 Applicable, or Relevant and Appropriate Requirements (ARARs)

All recommended alternatives will comply with the legally applicable, or relevant and appropriate Federal and State requirements, standards, criteria and limitations (ARARs). The design criteria for each component of the proposed alternatives are intended to be based on the most stringent of the ARARs. Certain alternatives may require a variance to the ARARs under TSCA 761.61 (c) risk-based disposal, provided that the method will not pose an unreasonable risk of injury to health or the environment

5.3.1 Consent Decree

Article 8 of the Consent Decree states that "the area known as the Ralston Street Lagoon (RSL) along with its contents shall be subject to, and shall be addressed by, Defendants under the requirements of the Toxic Substances Control Act (TSCA) and the regulations and policies issued under TSCA, including but not limited to all of Title 40 C.F.R. Part 761, including in particular Section 761.61" (Consent Decree, 2003).

Specific requirements for each alternative outlined in the Consent Decree are presented in Section 1.1.

5.3.2 Federal Requirements

5.3.2.1 Toxic Substances Control Act (TSCA)

Article 8 of the Consent Decree states that RSL "shall be addressed by Defendants under the requirements of the Toxic Substances Control Act (TSCA) and the regulations and policies issued under TSCA, including but not limited to all of Title 40 C.F.R. Part 761, including in particular Section 761.61." Section 761.61 outlines cleanup and disposal options for PCB remediation waste. 761.61(a) and 761.61(b) describe cleanup and disposal options based on PCB concentrations, while 761.61(c) describes a risk-based disposal approach.

Characterization of RSL sludge

Currently the sludge at RSL can be considered "PCB sewage sludge" as defined in TSCA 761.3 because it contains PCBs in concentrations > 50 ppm. To transport the sludges to a chemical waste landfill or to consider on-site disposal options, the sludges need to be processed such that the material passes the "paint filter test," indicating no free water is present. Processing may include bulking the sludges with soils, dewatering the sludges, and/or chemically treating the sludges. The sludges may then be considered "bulk PCB remediation waste" as defined in 761.61(a)(4)(i) of TSCA:

> Bulk PCB remediation waste includes, but is not limited to, the following **non-liquid** PCB remediation waste: soil, sediments, dredged materials, muds, **PCB sewage sludge**, and industrial sludge.

761.61(a) and 761.61(b) - Cleanup and disposal options based on PCB concentrations

The following on-site cleanup and disposal options are outlined in 761.61(a) and 761.61(b) and are based on PCB concentrations of non-liquid PCB remediation waste.

Site fence and signage (PCB concentrations >25 ppm and <=50 ppm for future low-occupancy areas)

Processed sludge (in a non-liquid state) at RSL can be defined as "bulk PCB remediation waste" as noted in 761.61(a)(4)(i). Part 761.61(a)(4)(i)(B) lists cleanup levels and containment options for future low occupancy areas. Bulk PCB remediation wastes >25 ppm and <= 50 ppm require a fence and signage around the site.

Site cap (PCB concentration >25 ppm and <= 100 ppm for future low-occupancy areas)

Bulk PCB remediation wastes >25 ppm and <= 100ppm require that the site is lined and capped with an impermeable cover system and that deed restrictions are placed on the property. The cover system must be designed and constructed to:

(1) Provide long-term minimization of migration of liquids through the closed landfill

(2) Function with minimum maintenance

(3) Promote drainage and minimize erosion or abrasion of the cover

(4) Accommodate settling and subsidence so that the cover's integrity is maintained

(5) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present

Hazardous waste landfill (PCB concentrations >= 50 ppm and < 500 ppm)

761.61 (a)(5)(iii) states that "bulk PCB remediation wastes with a PCB concentration >= 50 ppm shall be disposed of in a hazardous waste landfill permitted by EPA under section 3004 of RCRA, or by a State authorized under section 3006 of RCRA, or a PCB disposal facility approved under this part." Since the sludge at RSL has a geometric mean concentration of PCBs of 182 ppm (Fluor Daniel, 1997), on-site closure may require meeting the requirements of a hazardous waste landfill rather than a chemical waste landfill.

Chemical waste landfill (PCB concentrations >= 500 ppm)

761.61(b) allows performance-based disposal and states that non-liquid PCB remediation waste may be disposed of in an incinerator or a chemical waste landfill approved under Section 761.75. The technical requirements for a chemical waste landfill include:

(1) Soils: The landfill site will be located in a thick, relatively impermeable formation or have either a three-foot compacted soil liner with a permeability of 1x10-7 cm/sec or synthetic membrane liner be placed under the contamination.

(2) Hydrologic conditions: The bottom of the landfill shall be above the historical high groundwater table, and there shall be no hydraulic connection between the site and standing or flowing surface water. The site shall also have monitoring wells and a leachate collection system.

(3) Flood protection: If the landfill site is below the 100-year flood elevation, surface water diversion dikes around the perimeter of the site will be provided with a minimum height equal to two feet above the 100-year flood elevation.

(4) Topography: The site shall be situated in an area of low to moderate relief.

Additional requirements include sampling surface waters and monitoring wells for PCBs during construction and after closure, installing a leachate collection monitoring system, operating the chemical waste landfill, and building a site fence or wall and maintaining access roads.

Since some sludge at RSL contains PCB concentrations greater than 500 ppm, it can be conservatively assumed that off-site disposal would require a chemical waste landfill rather than a hazardous waste landfill. Generally, the only possible way that RSL sludges would be accepted in a hazardous waste landfill would be if they were segregated, stockpiled, and extensively sampled during excavation to prove that the stockpile did not contain PCB concentrations greater than 500 ppm. This type of record keeping is very difficult, time consuming, and expensive to implement during construction and can be considered technically impractical.

761.61(c) - Risk-based disposal

761.61(c) allows for a risk-based disposal option that requires approval by the EPA upon submitting an application. 761.61(c)(2) states that "EPA will issue a written decision on each application for a risk-based method for PCB remediation wastes. EPA will approve such an application if it finds that the method will not pose an unreasonable risk of injury to health or the environment." GSD's proposed alternative is a risk-based disposal option that meets the Remedial Action Objectives in Section 5.2 and is based on the risk analysis outlined in Section 4.

5.3.2.2 Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) regulations apply to wastes that exhibit ignitability, corrosivity, reactivity, or EP toxicity characteristics. Test results showed that RSL sludge did not exhibit any of these characteristics (letter from Canonie Engineers Inc. to IAE Inc., June 3, 1986), so RCRA regulations for disposal of the sludge do not apply to RSL.

RCRA hazardous waste landfill and solid waste landfill requirements are listed below to guide the evaluation of capping components of the on-site disposal option.

Hazardous waste landfill

As stated in 761.61(a)(5)(iii), bulk PCB remediation wastes with a PCB concentration >= 50 ppm will be disposed of in a hazardous waste landfill permitted by EPA under section 3004 of RCRA.

Hazardous waste landfill closure requirements are outlined in 40 CFR 264.310. The final cover must be designed to:

(1) Provide long-term minimization of migration of liquids through the closed landfill

(2) Function with minimum maintenance

(3) Promote drainage and minimize erosion or abrasion of the cover

(4) Accommodate settling and subsidence so that the cover's integrity is maintained

(5) Have a permeability less than or equal to the permeability of the natural subsoils present acting as the liner system

Solid waste landfill

Solid waste landfill closure requirements are outlined in 40 CFR 264.228. The technical requirements of the final cover are the same as those listed for a hazardous waste landfill closure listed above. Additionally, the final cover must:

(6) Eliminate free liquids by removing liquid wastes or solidifying the remaining wastes and waste residues

(7) Stabilize remaining wastes to a bearing capacity sufficient to support final cover

The last requirement (7) may be applied to the in-situ solidification/stabilization alternative at RSL.

5.3.2.3 Clean Water Act

The selected remedy must comply with the criteria for water quality based on toxicity to aquatic organisms and human health as outlined in 40 CFR Part 131.

5.3.2.4 Clean Air Act

The selected remedy must meet air quality levels that protect public health as described in 40 CFR Part 50.

5.3.2.5 Protection of Wetlands and Floodplains

RSL is located in a floodplain and is surrounded by wetlands to the north and to the south. The selected remedy should, if possible, minimize the destruction, loss or degradation of wetlands, and must avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of the flood plain as described in 40 CFR Part 6, Appendix A. If wetlands are impacted as a result of implementing the selected remedy, the area of impacted wetlands would either be restored or relocated as necessary.

5.3.3 State of Indiana

5.3.3.1 Indiana Department of Environmental Management

Title 329, Article 4.1 of the Indiana Administrative Code (IAC) describes the state regulations for wastes containing PCBs. Below are State requirements for municipal solid waste landfill and chemical waste landfill location restrictions and outlines for a contingency plan to provide guidance in order to evaluate an on-site disposal facility.

Municipal solid waste landfill and chemical waste landfill location restrictions

Significant local restrictions are listed in 329 IAC 4.1-8-3 for chemical waste landfills and 329 IAC 10-16 for municipal solid waste landfills. Section 3(a) states that chemical

waste landfills must comply with local restrictions found in 329 IAC 10-16 that apply to a new municipal solid waste landfill. These offsets state that such landfills must be:

1. 900 feet from a dwelling
2. 6 miles from a public airport
3. 100 feet from a wetland or jurisdictional water
4. 2,640 feet from a school
5. 1,250 feet from a hospital
6. 200 feet from a continuously flowing river or stream
7. 200 feet offset from the real property boundary of the landfill
8. 1,000 feet from a potable water supply or drinking water supply intended to be used for humans
9. 600 feet from a factory or office
10. 3,000 feet from a community water supply well
11. Not to be located in violation of Indiana Code (IC) 14-22-34, *Nongame and Endangered Species Conservation.*

The offsets from a dwelling, public airport, wetlands or jurisdictional water, continuously flowing river, and the offset of the landfill to the RSL property boundary, are all restrictions that potentially affect RSL should an on-site disposal site be proposed adjacent to it.

Another State requirement for chemical waste landfills is the flood plain and floodway sitting restrictions. 329 IAC 10-16-2 (1)(c)(ii) requires that if the landfill falls within a 100-year floodplain, a dike must be constructed that will have a top elevation not less than three (3) feet above the base flood elevation. TSCA requires that a dike be constructed two (2) feet above the base flood elevation. The more stringent State requirement may govern when considering designing an on-site disposal facility.

Contingency plan

A contingency plan must be considered when evaluating the on-site disposal alternative at RSL. 329 IAC 4.1-11 outlines the components of a contingency plan that an owner or operator of an alternative disposal facility is required to prepare and maintain in accordance with 40 CFR 264.51 through 40 CFR 264.54. The contingency plan must:

(1) Be designed to minimize hazards to human health and the environment from fires, explosions, or any unplanned release of PCB waste to the air, soil, surface water, or ground water

(2) Meet the requirements of 40 CFR 264.51 through 40 CFR 264.54

Section 6
Development and Screening of Alternatives

6.1 Introduction

This section describes the rationale used to develop the alternatives to be analyzed against the criteria specified in the Decree.

When discussing the development of alternatives, it is important to note that since 1962, when sludge pumping to RSL began, there has been no evidence of spills or uncontrolled releases of PCB into the environment. Samples of the subsurface soils below the berm have all tested for PCB concentrations below 50 ppm, all groundwater sampled from the improved groundwater monitoring well network at RSL has not detected PCBs, and the maximum PCB concentration in the surface water in the lagoon has been tested to be 0.001 ppm (Fluor Daniel, 1997.) Testing and site history indicate that there has been no evidence that RSL PCBs have migrated offsite.

6.2 General Response Actions

General response actions (GRAs) are broad categories encompassing an array of technology types that may produce a similar result. Response actions are selected on the basis of their applicability to the characteristics and contamination at a given site. Some response actions may be capable of meeting all of the remedial action objectives alone, but combinations of response actions may prove more effective or less expensive. The following response categories have been deemed potentially applicable for RSL and will be discussed for each medium of concern: no action, limited action, on-site containment, off-site disposal, on-site treatment, or on-site disposal. Each action is described in the following text. Each action or combination thereof is a component of the alternatives documented in the Decree.

6.2.1 No Action

As a baseline for comparison, the no-action response will be considered and carried through the detailed analysis. This option considers the possibility of PCB migration via surface water or other pathways, with only natural attenuation processes, such as adsorption and degradation, as avenues for intrinsic remediation. It also allows continuous groundwater monitoring to determine if PCBs have migrated off-site.

The no-action response must be evaluated in terms of the exposure and risk to human health and the environment. This evaluation must include estimating the baseline risk, present and expected, against which other responses can be compared. The no-action response may be deemed appropriate for soil or sediment problems in which natural environmental mechanisms are predicted to degrade or immobilize contaminants of concern and result in concentrations that meet U.S. EPA standards in

a reasonable time period, or in cases where the contaminants of concern appear to be contained and have not shown signs of migrating.

6.2.2 Limited Action

The limited-action response at RSL encompasses a variety of technologies that either restrict site access or use, or make engineering site improvements that enhance the existing controls. These technologies may include fence installation, berm improvement, sheet piling, temporary capping, groundwater extraction, decanting the supernatant in the lagoon, controlling elevation of lagoon surface water, performing innovative technology demonstrations on site, preparing a contingency plan, issuing consumption advisories, limiting/restricting groundwater use, restricting deeds, or posting signage. Limited actions may prevent or minimize the potential for imminent or ongoing releases of PCBs. Long-term effectiveness of natural attenuation processes can be determined through continued environmental monitoring.

6.2.3 On-Site Containment

The containment-action response involves little or no treatment, but focuses on reducing the mobility of contaminants of concern and the associated risk of direct exposure, thereby protecting human health and the environment. Containment actions may include such technologies as covering (capping) or enclosing exposed sludge or sediment deposits with clay or geomembranes. It may also include horizontally containing the groundwater and surface water by berm stabilization, slurry walls, sheet piling, or installing groundwater extraction wells to create an inwards hydraulic gradient around the lagoon.

6.2.4 Off-Site Disposal

Off-site disposal at RSL generally requires removal of the sludge and any material containing PCB concentrations greater than 50 ppm. The removal action response is designed to remove the volume of affected media. If necessary, the excavated material is treated to reduce the contaminant concentration or bioavailability and is then disposed of or managed in an appropriate facility. Removal actions may include hydraulic or mechanical dredging and conventional excavation. Disposal actions may include TSCA or non-TSCA landfills, or incineration. Extracted sludge may be treated or dewatered prior to its ultimate disposal.

6.2.5 On-site Treatment Action

Treatment-action responses are designed to reduce the volume, mobility, and/or toxicity of contaminants of concern via transformation of the constituent. The treatment remedial response for contaminated solids allows for in-situ or ex-situ technologies ranging from physical (solid- and liquid-phase separation), chemical (solidification/stabilization, solvent extraction, oxidation), thermal (low-temperature desorption and incineration), and biological (aerobic or anaerobic degradation). These technologies range from relatively simple, well-understood and widely applied

concepts to state-of-the-art innovative approaches with limited or nonexistent full-scale applications. The range of these potential technologies will be pared down to a manageable number of options later in this section, prior to assembly into potential remedial alternatives.

6.2.6 On-Site Disposal

On-site disposal actions involve permanent removal of contaminated media to a permitted on-site location (such as a landfill.) On-site disposal prevents exposure to and reduces mobility of contaminants, but does not reduce the volume or toxicity of the contaminants. Treatment may be required as part of the disposal alternative. On-site disposal is a major component associated with alternatives involving removal of sludge and soil. It is differentiated from on-site containment by virtue of the relocation of waste rather than containment in place.

6.3 Technology Screening

This section describes the technology screening performed for each general response action at RSL to meet the requirements of the RAOs.

6.3.1 No Action

No action was retained for all media as a baseline in order to compare alternatives.

6.3.2 Limited Action

Unlike the no-action response, the limited-action response attempts to limit the potential of an uncontrolled PCB release to the environment. This response also consists of implementing site security measures, such as fencing, consumption advisories, signage and deed restrictions, to inhibit unauthorized access and direct contact with contaminated solids. Decanting the supernatant to the GSD wastewater treatment plant and installing controls to limit the lagoon surface-water elevation were retained to prevent RSL lagoon surface water potentially containing PCBs from discharging to the Grand Calumet River. Access restrictions, signage and deed restrictions were retained to prevent ingestion, inhalation, or direct contact with RSL sludges and surface soils that contain PCBs. Preparing a contingency plan was retained to minimize hazards to human health and the environment from fires, explosions, or any unplanned sudden or nonsudden release of PCB waste to the air, soil, surface water, or groundwater. Additionally, innovative technology demonstrations on site when appropriate was retained to measure the effectiveness of new technologies at RSL.

6.3.3 On-Site Containment

The two categories for on-site containment consist of capping and the horizontal containment of PCB migration. Caps consist of permeable or low-permeability soils, articulated concrete matting, or synthetic membranes placed over the sludge. A soil and vegetative cover was retained in accordance with alternative (c) listed in the

Decree, and an impermeable cap was retained to fulfill the requirements in accordance with alternative (b) of the Decree.

Capping can prevent ingestion, inhalation, and direct contact with the sludge and can also prevent future stormwater from falling into contact with the sludge and becoming contaminated. Capping would include dewatering and treating the lagoon surface water, filling and compacting the sludge in the lagoon with a suitable material, grading the fill to promote stormwater runoff and proper drainage, and placing a cap and cover system. Capping may include constructing diked treatment cells to aid in constructability. The sludge will require some treatment (dewatering, bulking and/or solidification/stabilization) to achieve a sufficient bearing capacity to support a final cover. Impermeable soil and synthetic caps were both retained.

As part of the Supplemental Alternatives Evaluation Study (SAES), CDM performed several column studies to evaluate potential capping technologies including sand, vegetative covers (one consisting of woodchips and one of compost), and Geofoam. The study found that compost can be used to provide a thin cover on the sludge, though it is unlikely that the small load applied by such a thin cover will cause the underlying sludge to consolidate in any reasonable length of time without additional measures being taken.

The studies found that the sludge will fail in bearing capacity with only small applications of load. When material is placed on the surface of the sludge, the material will break through the sludge if the layer of material placed exceeds 3 or 4 inches. The exception to this is if the sludge is contained, as was the case with using a compression cap and then loading on top of the cap. An important conclusion in the study was that a geofoam cover appears to have the best ability to cover and compress the sludge during a reasonable albeit long period of time. A compression cap design would need pilot study testing to further develop consolidation time estimates and loading schedules but could potentially provide sludge "containment" that would allow the sludge to be loaded and consolidated under that load.

The second type of on-site containment technology is a horizontal barrier. A horizontal barrier will prevent the migration of PCBs from RSL via surface water and/or groundwater. Surface water horizontal barriers include increasing the elevation of the lagoon berm to provide 100-year flood protection for the lagoon and prevent human exposure from a flood event. Berm stabilization by widening the berm and/or sheeting the berm along the northern side will improve the berm stability and significantly reduce the risk of a berm collapse and potential release of PCBs into the Grand Calumet River. Berm stabilization and raising the berm above the 100-year flood elevation were retained to reduce the potential mobility of sludges significantly and to prevent RSL surface water potentially containing PCBs from discharging to the Grand Calumet River.

Groundwater horizontal barriers include sheet piling, slurry walls, and a network of groundwater extraction wells to create an inward hydraulic gradient within the site. Sheet piles are driven to the top along the lagoon boundaries to prevent migration. Sheet piles are technically feasible at RSL because of the subsurface conditions: slag fill, fine sand with occasional silt, and the confining lean clay layer. There is generally an absence of obstructions such as boulders, cobbles, and gravel. The sheet piles would be driven into the clay approximately 55 to 60 feet below grade. Sheet-pile walls are usually more permeable than slurry walls.

The concern about one section of the site being used as an automobile dump was explored by CDM during the berm assessment investigation performed in 2005 (CDM, 2005). Test probes and borings in that area did not find any evidence of buried automobiles.

Soil-bentonite slurry walls, and to a lesser extent cement-bentonite slurry walls, are commonly used technologies in containment applications. Soil-bentonite slurry wall construction typically involves a specialized long-arm excavator trenching a three-foot-wide wall to a key-in depth roughly two to three feet into a confining layer, usually clay or rock. The trench is held open by a bentonite slurry and backfilled by a mixture of trench spoils, bentonite slurry, and usually an offsite clay source to provide the backfill mix with sufficient fines to achieve low in-place permeability, typically on the order of 1x10-7 cm/sec for soil-bentonite slurry walls and 1x10-5 to 1x10-6 cm/sec for cement-bentonite slurry walls.

At RSL, an off-site clay borrow source would need to be located and site/offsite material blends would need to be tested to determine the appropriate amount of offsite clay necessary to achieve a low-permeability backfill mix. An unconventional technique would be required to backfill the soil-bentonite wall for an approximate 700 foot stretch on the northwestern part of the berm. The berm's narrow width, between 13 and 23 feet wide according to the berm investigation (CDM, 2005), leaves little room to place excavated trench spoils along the berm. Nevertheless, a qualified slurry wall contractor would be able to successfully construct the wall at RSL.

Cement-bentonite slurry walls use similar specialized excavating equipment. However, rather than backfilling the trench with trench spoils, the trench is backfilled with cement-bentonite. The cement used is typically slag cement rather than Portland cement. A cement-bentonite slurry wall may also have enough strength to act as a berm stabilization substitute for the sheeting along the northern side of the lagoon.

Soil-bentonite and cement-bentonite slurry walls would be technically feasible at RSL because the clay layer meets the criteria of a continuous low permeability confining layer (the permeability is less than 1x10-7 cm/sec) at a depth of approximately 35 to 40 feet below grade, into which the slurry wall would be keyed.

Hydraulic containment of groundwater can be accomplished using a series of wells installed around the lagoon. Alternatively, a bio-polymer trench drain could be used.

A disadvantage of creating an inward hydraulic gradient along the northern and western portion of RSL is that this would allow potentially contaminated water from the Grand Calumet River to enter the lagoon. All horizontal-barrier actions were retained for all media, but it is understood that between sheet piling, slurry walls, and hydraulic containment, only one technology would be used for each alternative.

In all cases, there may be some type of impact to the adjacent wetlands. However, the wetlands could be restored or relocated as part of the remedy.

6.3.4 Off-Site Disposal

The contaminated solids could be shipped to an off-site TSCA chemical waste landfill, or RCRA solid or hazardous waste landfill, as appropriate for the type of waste. This technology involves dewatering, soil and sludge excavation, materials handling, and transportation to an off-site location using standard equipment (e.g., excavators, rolloffs, and dump trucks). Since a portion of the sludge contains PCBs in concentrations exceeding 500 ppm, and discerning the levels of PCB concentrations in the sludge will be technically challenging during excavation, it can be conservatively assumed that all sludge will be required to be disposed of in a chemical waste landfill in compliance with TSCA. Additionally, the sludge will need to be solidified before sending it off-site in order to pass a paint filter test required for transport and landfill disposal.

CDM performed, as part of the SAES, studies determining what additives and dosages were needed to blend/bulk with the sludges in order to pass a paint filter test required for transport and landfill disposal. The additives and bulking materials tested were Portland Cement Type I/II, Class C Fly Ash, Lime Kiln Dust, Waste Lime, and uniform fine sand. The testing showed that in order to pass a paint filter test, approximately 35% LKD was needed to bulk the sludge. For other additives, approximately 15% waste lime was needed, 65% Class C Fly Ash, 90% uniform fine sand, and 30% Portland Cement Type I/II. The studies showed that the sludge can be dewatered sufficiently for transportation using additives required to pass the paint filter test.

Incineration could also be considered for the excavated sludge, but is cost-prohibitive compared to a TSCA landfill. All surface soils and any excess soils below the sludge that get excavated with PCB concentrations below 50 ppm can be disposed of in a RCRA solid waste landfill.

Since off-site disposal prevents ingestion, inhalation, or direct contact with RSL sludges or surface soils that contain PCBs and permanently reduces the mobility of RSL sludges that contain PCBs, the off-site disposal actions of TSCA and non-TSCA landfills were retained.

6.3.5 On-site Treatment Action

There are four major classes of treatment actions: physical, chemical, thermal, or biological. For physical treatment, solid and liquid phase separation was retained, and would be required prior to any disposal action. Solid and liquid phase separation can be accomplished through a filter press, centrifuge, or clarifier. An additional physical treatment process is bulking or densification. Bulking involves adding a fill material to the sludge, preferably a relatively dry material (high solids content), and mixing the fill material with the sludge in order to attain a bulked sludge with an increased solids content. The goal of bulking is to change the physical properties of the sludge and create a material that is in a solid phase that can be readily spread, placed in lifts, and compacted. Bulking also reduces the mobility of the PCBs because the sludge is no longer in a semi-liquid phase. Bulking does increase the volume of the PCBs with the addition of material but would theoretically reduce the PCB concentrations of the bulked sludge.

At RSL, bulking may be performed in-situ. Truckloads of material would be dumped directly into the lagoon in one spot before there is enough material to begin mixing operations. Mixing in a 20 to 25 foot lagoon with equipment along the edge of the lagoon will require specialized soil mixing equipment. Cross berms and sheeting may need to be constructed to improve equipment access and control of the mixing operations.

For the purposes of generating alternatives, two types of materials are used within the limits of the RSL, bulking material and filling material. A bulking material is a would be physically blended or mixed with the sludge to increase the solids content of the sludge, and the bulked sludge would be able to be placed, spread, compacted, or solidified to achieve a sufficient compressive strength. A bulking material would be required to meet a bulking criteria and a Waste Acceptance Criteria (WAC). Bulking material may include Grand Calumet Sediment meeting the bulking criteria and the WAC.

A filling material would be placed on top of a compression cap (i.e not be mixed with the RSL sludge). Filling material would be utilized solely to load the compression cap; it does not get bulked or mixed with the sludge. A fill material would be required to meet the WAC. Filling material may include Grand Calumet Sediment meeting the WAC.

The proposed bulking criteria would be:

- Having physical and chemical characteristics acceptable to EPA and GSD and capable of mixing with the RSL sludge.
- Capable of densification and/or solidification using in-situ methods such that the final bulked volume is equal to or less than capacity of the RSL.

- Having a minimum solids content of 85 %.

The proposed Waste Acceptance Criteria (WAC) would be:

- Having chemical characteristics acceptable to EPA and GSD for placement into the RSL.
- Shall not contain free liquid as determined by passing the Paint Filter Liquids Test (EPA Method 9095A).
- Shall not contain stones larger than 4-inches in diameter.
- Shall not contain deleterious materials such as, but not limited to, granite blocks, broken concrete, masonry rubble, steel, or similar materials.
- Shall have a minimum solids content of 70%.
- Shall have minimum unconfined compressive strength of at least 500 pounds per square foot (psf).

The chemical treatment actions of solidification/stabilization (S/S), solvent extraction, and oxidation were considered. Solidification improves the strength and handling characteristics of soil, wastes, sediments and sludge. Stabilization immobilizes the chemicals in the treated medium. While inorganic metals are the primary constituent addressed by stabilization, PCBs can be immobilized as well to a large degree. S/S treatment can be performed either in situ using large-diameter augers or ex situ using a pugmill operation, and may include the addition of bulking materials, such as sands or locally available slag, to strengthen the sludge.

At RSL, S/S treatment could be performed in-situ. After pumping off the supernatant and treating it at GSD's wastewater treatment facility, equipment would begin treating the sludge at one end of the lagoon and working around the perimeter until the treated sludge becomes a stable platform. The outer platform allows for construction equipment to be mobilized inside the lagoon and the S/S treatment would continue around the perimeter, working towards the center of the lagoon.

Earth Tech performed a limited S/S treatability study in 2004 to investigate potential additives that may be used to strengthen the RSL sludge. Of the two sludge samples tested, the mixture that yielded the maximum unconfined compression strength of nine psi (or 1,296 psf) was a 25% Type I Portland cement. The reported volume expansion of this treated mixture was 27% (Earth Tech, 2004.)

CDM performed, as part of the SAES, strength testing on non-dewatered and dewatered sludge samples solidified and/or bulked with Portland Cement Type I/II, Class C Fly Ash, Lime Kiln Dust, Waste Lime, and uniform fine sand. After 28 days, non-dewatered sludge samples reached maximum compressive strengths of up to

7,320 psf (with 20% Portland Cement) and 7,875 psf (with 10% Portland Cement and 60% Lime Kiln Dust). For the dewatered sludge, samples achieved maximum 28-day compressive strengths of up to 8,080 psf (with 10% Portland Cement and 40% Lime Kiln Dust) and 6,841 psf (with 10% Portland Cement and 40% Waste Lime).

This study showed that the shear strength of the sludge can be increased dramatically with some of the additives evaluated in this report.

Solvent extraction is a process for removing PCBs from solid material and was not retained due to a lack of a feasible demonstration for PCB-contaminated waste. Oxidation is a chemical process that converts chlorines to chlorides in the PCB molecules and was not retained due to a lack of a feasible demonstration for PCB-contaminated waste.

For thermal treatment actions, thermal desorption was considered. Thermal desorption is a solids drying process whereby heat is applied to contaminated solids at temperatures in the range of 300 to 1,000ºF to drive off water and organic contaminants, resulting in a clean dry solid matrix. Subsequently, treatment of the vaporized gases is accomplished via condensation, thermal oxidation or carbon adsorption. Although thermal desorption is most effective in removing compounds that have a boiling point below 600ºF such as PCBs, it is not expected to treat sludges with high PCB concentrations to below 50 ppm, and was not retained.

Biological treatment processes use contaminant-utilizing microbes to destroy organic hazardous constituents and form less toxic products. For optimal biodegradation, sufficient quantities of nutrients such as nitrogen and phosphorus must be available. Other environmental conditions that affect bacterial growth include soil moisture, temperature, oxidation-reduction potential, pH and salinity. In some cases, modification of one or more of these conditions may be necessary to stimulate microbial growth. This technology can be applied in situ; the bacteria and nutrients are introduced into the waste material by excavation and on-site treatment or by excavation and bioreactor treatment. In each of these cases, biodegradation may be enhanced by optimizing environmental conditions for contaminant degrading microorganisms. Ambient environmental conditions are more easily maintained in a bioreactor unit than in situ.

Howard University (Washington, DC) graduate students performed their masters' thesis work on RSL sludge samples. Individual theses explored the remediation of PCBs in RSL sludge via aerobic, anaerobic, or vermicular transformations. Although the experiments demonstrated the ability to reduce PCB molecules or remove them from the sludge via bioaccumulation, the experiments were not successful in completely transforming the PCBs to biphenyl.

Additionally, CDM researched available bioremediation technologies and concluded that "both anaerobic and aerobic bioremediation processes show promise for PCB remediation. However, technologies for complete biodegradation of a whole PCB

aroclor mixture do not yet exist. Research utilizing state-of-the-art methods of genetic engineering is ongoing, but development of a fully field implementable technology is probably several years away" (CDM, 2005.) Because of the conclusions presented in the memorandum and the inconclusive results of the Howard University studies, aerobic and anaerobic bioremediation technologies were not retained.

6.3.6 On-Site Disposal

The contaminated solid material could be disposed of on-site with a dewatering and disposal facility (CDDF) as described in the Decree. A CDDF would require an impermeable cell to be constructed and the sludge to be excavated and transported to the CDDF. Once in the CDDF, the sludge would be dewatered and consolidated, and the water separated from the sludge would be treated. The CDDF would then be capped and closed. It would prevent ingestion, inhalation, or direct contact with the sludges or surface soils containing PCBs, and significantly reduce the mobility of the sludges. Therefore, this technology was retained.

Potential dewatering technologies include centrifugation, gravity draining, and filter pressing. Earth Tech performed a small-scale dewatering treatability study in 2004 exploring these technologies with limited success. Two sludge samples with initial percent solids concentrations ranging from 14% to 16% were placed in large funnels and allowed to gravity drain over seven days. The resulting dewatered sludges contained between 14% and 29% solids. Filter press dewatering testing was performed on the same sludge samples at pressures of 10, 25 and 50 pounds per square inch (psi.) The maximum percent solids achieved was 30.9%. Centrifugation dewatering was also performed at a speed of 1,000 revolutions per minute (rpm.) The resulting percent solids content of the sludges ranged from approximately 14%to 18% (Earth Tech, 2004.)

CDM performed, as part of the SAES, several studies on dewatering, polymer addition, solidification and bulking. WaterSolve LLC performed a chemical conditioning program on samples of sludge and lagoon surface water and determined that out of thirteen cationic polymers, Solve127 and Solve 216C were found to dewater the sludge most effectively. These polymers were mixed separately with the sludge and site water at the dosages prescribed by WaterSolve to perform two hanging bag tests. The hanging bag tests are used to simulate dewatering with geotubes. After 39 days in the geotube hanging bag, the solids content of the sludge was increased to 55-60% solids.

CDM sent Environmental Process Dynamics, Inc. composite samples of sludge and site surface water for belt filter press testing. The polymer WaterSolve 216C was selected to mix with the sludge for the belt filer press tests. The maximum solids content achieved from the belt filter press was 59.3%.

The SAES study found that the sludge can be dewatered using polymer addition with geotube technology or belt filter pressing, or by confining the sludge in place and

applying a uniform load. The study showed that the solids content of the sludge can be increased up to 50-58%. The sludge does not readily lose water, even under load and therefore consolidation of the sludge would take a relatively long time. It is likely that consolidation of the sludge under any given loading scheme would need to be performed in stages. In a consolidation scenario, either imported fill, construction and debris waste, or dry sediment dredged from the Grand Calumet River (if it is readily available) may be used to load the compression cap.

CDM sized a conceptual dewatering area within the residential area east of the lagoon for planning purposes, assuming that a system of geotubes and polymers would be used for dewatering. Based on input from WaterSolve on geotube sizes and capacities and on polymer feed units, a footprint of approximately 450 ft wide by 385 ft long, or 4 acres, was assumed for the dewatering area. The area included a layout of 18 geotubes, confined within a bermed area and lined so that water that comes out of the geotubes can be collected and treated. The area would include polymer feed units that would inject polymer in with the sludges that would be dredged and pumped into the geotubes. For this conceptual exercise, each geotube was 36 feet wide, 8 feet high, and 200 feet long with a capacity to hold 1,800 CY of solids, for a total capacity for the 18 geotubes of 32,400 CY of solids. Assuming that the sludges dewater from 15% solids to approximately 50% solids (as shown possible in the SAES with hanging bag testing), the total volume of dewatered sludges at the RSL will be approximately 132,500 CY (from 533,200 CY at 15% solids). Therefore, to completely remove the sludges from the lagoon and dewater in this area, four cycles of dredging/dewatering are needed.

To construct the CDDF above the water table and in an area with enough work space, the CDDF would need to be built on property adjacent to RSL. This scenario would require GSD to purchase properties in the residential area and the trucking company located to the east of RSL. As shown on Figure 2-5, the residential area contains approximately 15 homes and is six acres, and the trucking company is 4.5 acres.

Assuming that the sludge could be dewatered to approximately 50% solids and then solidified/stabilized with approximately 30% pozzalonic, an estimated 172,500 CY of processed sludge will get consolidated in the CDDF. Therefore, assuming 3:1 sideslopes and having a maximum width of 300 feet (the estimated minimum width of the residential area, a limiting factor), the CDDF would be approximately 50 feet tall, 300 feet wide, and 620 feet long. This footprint takes up approximately 4.2 acres and along with a dewatering area and contractor staging area, would fit in the 10.5 acre space occupied by the residential area and the trucking company property. There is room for the footprint of the CDDF to be expanded slightly to reduce the CDDF height.

This option would require maintaining a dry working area inside the lagoon either with hydraulic containment or groundwater well pumping. The footprint of the CDDF would be prepared "in the dry" with a suitable subbase and then a three-foot

compacted clay liner. Cells used to process the sludge in various phases would be constructed by either earthen dikes or sheet piling. Earthen dikes could be designed to support construction equipment. Processed sludge would be transferred to the clay liner and eventually covered with an impermeable cap. The sludge may be processed by creating a dewatering area with geotubes and water collection areas on a portion of the residential area. Sludge may be pumped from the lagoon into the geotubes, dewatered, and then bulked or stabilized. The water falling out of the sludge would be collected and pumped to the Wastewater Treatment Plant for treatment.

Another on-site disposal option proposed by the EPA would be to construct a "dry cell" within the RSL footprint and systematically transfer and process the sludge from it's in-state condition to a condition that can be readily placed and compacted, similar to the CDDF option. The dry cell would be constructed at the bottom of the RSL, so the water table would have to be permanently lowered and controlled within the dry cell limits. This can be done by constructing a perimeter cut-off wall and creating a permanent groundwater extraction well system within the RSL.

6.3.7 Site Constraints and Construction Considerations

Many of the technologies, when applied to RSL, involve staging areas for construction equipment. Since the lagoon itself takes up approximately 19.2 of the 22 acres available at the site, leaving only room for an access road, it is necessary to obtain land adjacent to the site large enough for a construction staging area. Based on the property dimensions, it is assumed that, at minimum, approximately all six acres of the residential area east of RSL will be purchased and demolished for the following technologies that require heavy construction:

1. Off-site disposal
2. Containment
3. Treatment

It is also assumed that the entire residential area and trucking company will be purchased and demolished for the on-site disposal option because approximately 10.5 acres would be needed for the CDDF unit.

6.4 Summary of Retained Technologies

The following technologies were retained for further evaluation as remediation alternatives at the Ralston Street Lagoon based on the RAOs:

1. No Action: Groundwater monitoring
2. Limited Action: Decanting supernatant, controlling lagoon surface water elevation, access restriction, deed restriction, signage, contingency plan, innovative technologies demonstrations

3. Containment Action: Soil cap, synthetic cap, berm improvement, soil-bentonite barrier wall, and hydraulic containment

4. Off-Site Disposal: TSCA landfill, non-TSCA landfill

5. Treatment Action: Solid- and liquid-phase separation, solidification/stabilization, in-situ bulking

6. On-Site Disposal: non-TSCA landfill (CDDF)

6.5 Developed Alternatives

The pertinent technologies for RSL include groundwater monitoring, limited action, off-site disposal, on-site disposal, on-site containment, and treatment. These technologies are components of the following eight alternatives developed for RSL:

1. **Alternative 1: No Action.** Routine monitoring will be performed to determine if PCBs are migrating off-site.

2. **Alternative 2: Containment on-site.** This alternative is presented in Article 13 of the Decree as alternative d. The alternative generally involves decanting and treating enough of the supernatant to properly install engineering controls to limit the elevation of the lagoon surface water; raising the perimeter berm to prevent surface water discharge to the Grand Calumet River in the event of a 100-year flood and temporarily stabilizing the northern berm during construction with temporary sheeting; purchasing six acres of the residential area east of the RSL to use as a staging area for construction; installing a soil-bentonite barrier wall around the berm that keys into the clay layer; improving fencing along perimeter of site to restrict access; providing deed restrictions and signage; routine monitoring; and preparing a contingency plan. Additionally, innovative technology demonstrations on site could be performed as appropriate.

3. **Alternative 3: Disposal at an off-site location or locations.** This alternative is presented in the Decree as alternative a. It would include the following components: Purchasing six acres at the adjacent residential area and using it for the contractor's staging area and for a dewatering area; temporarily stabilizing the northern side of the berm during construction with temporary sheeting; dredging the sludge and materials containing PCB concentrations greater than 50 ppm and supernatant water; pumping the dredged material into a dewatering system consisting primarily of geotubes; treating the dewatered sludge and supernatant water at the wastewater treatment plant; dewatering to maintain a dry working area inside the lagoon; excavating one foot below the dredge line to remove any possible residual sludge; solidifying the dewatered sludge to pass a paint filter test; disposing the excavated materials in a TSCA-permitted chemical waste landfill; and then regrading the former lagoon to promote surface water runoff.

4. **Alternative 4: Disposal on-site (on property at or near the wastewater treatment plant).** This alternative is presented in the Decree as alternative b. This alternative would include the following components: Purchasing the adjacent residential area and trucking company property and using the property for the contractor's staging area, dewatering area, and a CDDF area; stabilizing the northern side of the berm during construction with temporary sheeting; dredging the sludge and materials containing PCB concentrations greater than 50 ppm and supernatant water; pumping the dredged material into a dewatering system consisting primarily of geotubes; treating the dewatered sludge and supernatant water at the wastewater treatment plant; dewatering to maintain a dry working area inside the lagoon; excavating one foot below the dredge line to remove any possible residual sludge; solidifying the dewatered sludge to pass a paint filter test; regrading the former lagoon to promote surface water runoff, constructing a CDDF, consolidating the stabilized sludge into the CDDF, and finally capping the CDDF. The CDDF will be constructed above the water table, take up approximately 6 acres, consist of an impermeable compacted clay liner, and covering the sludge with an impermeable cap and cover. A perimeter berm will be constructed around the CDDF above the 100-year flood level. Routine groundwater monitoring and cap maintenance will be performed. Deed restrictions, site fencing, and signage will be included.

5. **Alternative 5: In-situ solidification/stabilization with in-place vegetative/soil cover.** This alternative is presented in the Decree as a combination of alternative (c)(i) and (c)(iii). Article 13, part c of the Decree states that any one or combination of the following alternatives may be used:

   (i) In-situ solidification/stabilization

   (ii) In-situ bioremediation

   (iii) In-place vegetative/soil cover

   The in-situ bioremediation technology was not retained (Section 6.3.5) and the in-place vegetative/soil cover alone may require the removal of all material containing PCBs in concentrations greater than 500 ppm. Removing only the sludge with PCBs in concentrations greater than 500 ppm (or 10.4% of the sludge volume) at RSL could be technically impractical since the samples with PCBs greater than 500 ppm are located in scattered spots (Fluor Daniel, 1997.) Removal of only the sludge greater than 500 ppm would result in requiring complex excavations, testing, tracking, materials handling, bulking, and off-site disposal. Therefore, the in-place vegetative/soil cover alternative was combined with the in-situ solidification/stabilization alternative. This alternative would include the following components: Purchasing six acres at the adjacent residential area and using it for the contractor's staging area; decanting the supernatant and treating it at the wastewater treatment plant; raising the perimeter berm to provide 100-year

flood protection and stabilizing the northern berm with permanent sheeting; installing a soil-bentonite barrier wall to fully encapsulate the RSL sludge; dewatering to maintain a dry working area inside the lagoon; bulking the sludge with fill material, solidifying/stabilizing the bulked sludge in-situ to reduce the mobility of the PCBs; filling the treated material; and covering the lagoon area with an impermeable cap. Routine groundwater monitoring and cap maintenance will be performed. Deed restrictions, site fencing, and signage will be included.

6. **Alternative 6: On-site Dry Cell Containment.** In this alternative the sludge is to be contained and capped in a dry cell within the RSL boundaries. This alternative includes purchasing six acres at the adjacent residential area and using it for the contractor's staging area and for a dewatering area; raising the perimeter berm above the 100-yr flood elevation; installing a cement-bentonite wall to fully encapsulate the RSL sludge and stabilize the perimeter berm; dredging the sludge and materials containing PCB concentrations greater than 50 ppm and supernatant water; pumping the dredged material into a dewatering system consisting primarily of geotubes; treating the dewatered sludge and supernatant water at the wastewater treatment plant; solidifying the dewatered sludge; creating berms across the lagoon to provide equipment access and control of construction operations; dewatering to maintain a dry working area inside the lagoon; creating an underdrain network below the dry cell to facilitate a permanent reduction in the water table, consolidating the treated sludge into the dry cell footprint and installing an impermeable cap over the footprint, and grading the area of the former lagoon that is outside of the dry cell. Routine groundwater monitoring and cap maintenance will be performed. Deed restrictions, site fencing, and signage will be included.

7. **Alternative 7: Compression Cap.** In this alternative the sludge is to be consolidated in place using a "compression cap" approach to increase the solids content of the sludge by creating a uniform cap that can be placed on top of the sludge and incrementally loading the cap. This alternative involves purchasing six acres of the residential area to use as a contractor staging area; raising the perimeter berm to provide 100-yr flood protection; installing a cement-bentonite wall to fully encapsulate the RSL sludge and stabilize the perimeter berm; decanting and treating the lagoon surface water; constructing a "compression cap" system on top of the exposed sludge with an internal water collection system to collect water pressed from sludge; using a filling material, including either construction and disposal debris (C&D) or dry Grand Calumet sediments, as cap weighting material; collecting and treating the displaced water at the wastewater treatment plant; placing an impermeable cap once consolidation of the sludge has been reached; providing fencing, consumption advisories, signage, and deed restrictions; and performing routine groundwater monitoring and cap maintenance.

8. **Alternative 8: Filling the Lagoon.** This alternative will include bulking the lagoon with bulking material and solidifying/stabilizing the material to achieve sufficient bearing capacity, and then capping with an impermeable cap. This alternative would involve purchasing six acres of the residential area to use as a contractor staging area; raising the perimeter berm with fill to provide 100-yr flood protection; stabilizing the northern berm with permanent sheeting; installing a soil-bentonite wall to fully encapsulate the RSL sludge; decanting the lagoon surface water and treating the water at the wastewater treatment plant; importing and dumping dry fill directly into the lagoon; installing sheeting and/or berms to provide equipment access; mixing the bulking material with the sludge using soil mixing equipment; performing in-situ stabilization/solidification with approximately 15% pozzalonic; placing and capping the fill with an impermeable cap; providing institutional controls such as fencing, deed restrictions, and signage; and continuous RSL and ground water monitoring.

Section 7
Detailed Analysis of Alternatives

7.1 Introduction

The TCA is required to include a detailed analysis of alternatives that evaluates the following criteria listed in Article 15 of the Decree: effectiveness, overall protection of public health and the environment, long-term effectiveness and permanence, technical feasibility, administrative feasibility, availability of services and materials, and cost.

The criteria and components of the criteria in the Decree are generally consistent with CERCLA guidance (EPA, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, 1988). However, this alternatives analysis was performed using the criteria provided in the Decree in Article 15, Section c.

As noted in the Executive Summary, the ranking of the alternatives in the TCA was performed by GSD with consultation from Enviroforensics. CDM provided discussion on the technical merits of the technologies and alternatives presented in the TCA.

7.2 Criteria

Table 7-1 presents an evaluation of the presented alternatives. The seven (7) criteria that each alternative was evaluated and ranked against were assigned the following values for a total of 200 points, with a 200 being the best possible score:

1. Effectiveness (10 points)
2. Overall protection of public health and environment (20 points)
3. Long-term effectiveness and permanence (20 points)
4. Technical feasibility (90 points)
5. Administrative feasibility (30 points)
6. Availability of services and materials (20 points)
7. Cost (10 points)

7.2.1 Effectiveness

The Decree defines effectiveness as the ability to bring the RSL into compliance with 40 CFR 761.

Alternative 3 is considered to be more effective than the other alternatives because it includes the removal and disposal of all material with PCB concentrations over 50 ppm at a TSCA-approved landfill, whereas the other alternatives allow the materials

with PCB concentrations over 50 ppm to remain on-site and rely on risk-based alternatives.

Although Alternatives 4, 5, 6, 7, and 8 are risk-based alternatives that require regulatory approval, they are generally effective considering all alternatives have vertical containment and capping. In Alternatives 4, 5, and 6, the sludge is either stabilized and solidified thereby changing its matrix and physical characteristics, or densified and compressed reducing the contaminant mobility. According to 761.61 (c), the EPA will approve such an application provided that the method does not pose an unreasonable risk of injury to human health or the environment. Alternatives 4 and 6 provide visual field confirmation that the sludge has been completely excavated and secured because the sludge is transferred and placed in an impermeable confinement cell. The confinement cells reduce the mobility of the PCBs by removing the hydraulic connection of PCBs to the groundwater and by encompassing the PCBs both vertically and horizontally. Furthermore, the volume of sludge is reduced by dewatering.

For Alternative 4, the CDDF would be constructed above the water table. For Alternative 6, the water table would be permanently lowered with engineering controls to below the base of the dry cell, which will be constructed within the lagoon footprint. The dry cell will be encapsulated by a cement-bentonite cutoff wall keyed into the low permeability clay layer, removing the hydraulic connection of PCBs to the groundwater.

However, due to site constraints, the CDDF in Alternative 4 will need to be constructed to a maximum height of up to approximately 50 feet. Because RSL is located approximately one-half a mile from the Gary Airport, the inherent risks associated with air traffic into the CDDF may pose a difficulty in gaining regulatory acceptance to site the CDDF in this location.

Alternatives 5 and 7 are generally considered to be equally effective. In each of these alternatives, the PCBs are below the water table within the RSL footprint, but there is a limited hydraulic connection to the groundwater because a soil-bentonite cutoff wall encapsulates the material. Additionally, the mobility of the PCBs is further reduced because in each of these alternatives, the sludges are dewatered or bulked and then further solidified via chemical stabilization, except for Alternative 7. The mobility of PCBs is reduced further in each alternative because an impermeable cap will be implemented in each case.

Because the sludge is not completely stabilized but densified and partially stabilized, Alternative 8 is considered slightly less effective than Alternative 5. There is, however, a significant reduction in the mobility of the sludge due to densification and partial stabilization. In Alternatives 5 and 8, there is a noticeable expansion in volume of sludge because bulking material is added to increase the solids content of the sludge rather than dewatering the sludge.

GSD considers Alternative 7 to be less effective than Alternatives 3, 4, 5, 6, and 8 due to the unknown time needed to consolidate the sludge to 50% solids, and the liquid state of the sludge until it is dewatered. While the sludge is in liquid form, the PCBs have a high mobility. The compression cap does reduce the volume of the sludge with consolidation.

The mobility of PCBs is reduced further in each alternative because an impermeable cap will be implemented in each case.

Alternative 2 hydraulically disconnects the PCBs from the groundwater by constructing a slurry wall around the lagoon and keying the wall into a confining layer. The mobility of the PCBs are further reduced by berm stabilization and raising the berm above the 100-year flood level to prevent surface water of the RSL potentially containing PCBs from discharging to the Grand Calumet River to the extend practicable. Additionally, performing innovative technology demonstrations on site allows for potential future active remediation alternatives such as bioremediation, dewatering, and S/S to be explored.

As stated below under the human health protection discussion, the subsurface barrier wall hydraulically disconnects the sludge from the groundwater. The sludge would be isolated vertically at the bottom by the natural clay layer. This confinement alternative relies on the effectiveness of the natural clay layer and the slurry wall. A potential risk scenario, although highly unlikely, could be that the sludge escapes containment at the bottom through fractures or fissures or horizontally due to a potential leak in a slurry wall. Quality control measures during slurry wall installation minimizes this risk.

No action is not considered effective.

7.2.2 Overall Protection of Public Health & Environment

This section addresses whether a selected remedial alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. The selected remedy must meet these criteria.

Alternative 1, the no-action alternative, provides the most long-term risk to public health and the environment. There is potential for the berm to be overtopped during a 100-year flood event, and if no maintenance is conducted on the berm, it could erode or collapse over time, releasing lagoon water and some accompanying sludge into the Grand Calumet River. GSD employees and nearby residents could be at risk if access is not controlled at the site.

Alternative 2 raises the berm, decants the lagoon supernatant, and controls the maximum surface water elevation to protect against lagoon surface water runoff to

the Grand Calumet River, improves the berm stability to prevent a possible berm collapse to reduce the mobility of the sludge significantly, and improves site fencing to prevent ingestion, inhalation, or direct contact with RSL sludge or surface soils that contain PCBs. Ongoing groundwater monitoring has shown that PCBs have not migrated off-site, and the groundwater monitoring will continue under this alternative.

Additionally, the subsurface barrier wall hydraulically disconnects the sludge from the groundwater. The sludge would be isolated vertically at the bottom by the native clay layer. This confinement alternative relies on the effectiveness of the natural clay layer and the slurry wall. A potential risk scenario could be that the sludge escapes containment at the bottom through a clay fissure or horizontally due to a potential leak in a slurry wall. Quality control during slurry wall installation minimizes this risk, and further investigations of the clay layer would increase the confidence that the layer can act as a confining layer.

Because there would be no final cap constructed for this alternative, there is a risk of potential exposure to humans, birds and other wildlife. Note that while no fish species have been observed at this time, there is a potential for species to exist in the lagoon and therefore there could be future exposure to humans or other animals that were to consume those fish species. Potential exposure pathways of concern are discussed in Section 4.

Resident access would be eliminated because the six acres of residential property would be purchased for this alternative. Additionally, implementing appropriate health and safety procedures for GSD employees who will monitor and maintain RSL would reduce or eliminate risks.

In Alternative 3, remediation of on-site sludge will be carried out by dredging, dewatering, stabilizing, and disposing of the PCB-contaminated sludge in a TSCA-permitted chemical waste landfill. Potential exposure pathways of concern during remediation include inhalation of dust and/or particulate matter, ingestion of contaminated soil and soil dusts, and skin contact with soil contaminants by on-site workers, on-site trespassers, and/or nearby residents.

Alternative 3 introduces an additional potential pathway of exposure. Even though the waste will be stabilized prior to hauling to a TSCA-permitted chemical waste landfill, nearby residents, businesses, and roads along the transport route would be at added risk of a potential exposure to contaminated wastes. The closest TSCA-permitted chemical waste landfill to the RSL is in Wayne, Michigan, approximately 235 miles away. On-site workers would ensure that proper health and safety protocols are followed using appropriate personal protective equipment (i.e., respirators and protective clothing) and transport vehicles are properly decontaminated on-site. Except for some potential exposure of waste material during transportation, this alternative provides protection to human health and environment. Since the sludge

will be partially solidified prior to transporting off-site, that will reduce the risk of exposure during transport.

Though Alternative 2 reduces and controls the risk horizontally with a perimeter cutoff wall and vertically by raising and stabilizing the perimeter berm, Alternatives 4, 5, 6, 7, and 8 reduce and control the risk better by employing a perimeter cutoff wall, raising the berm above the 100-yr flood level, by constructing an impermeable cap, and by processing the sludge into a bulked and/or stabilized form that is a less mobile state.

Alternatives 4, 5, 6, 7, and 8 are considered to provide generally equal overall protection to public health and the environment because all alternatives have vertical containment, capping, and the sludge is processed in a solidified and/or bulked form. Alternatives 4 and 6 do create impermeable confinement cells above the water table. A possible drawback with Alternative 4 is the dimensions of the CDDF. As stated in Section 6.3.6, the CDDF would be dimensioned at approximately 50 feet tall, 300 feet wide, and 620 feet long, taking up a footprint of approximately 4.7 acres. The height of the CDDF may pose a danger to aviation associated with the neighboring Gary/Chicago International Airport. However, the footprint of the CDDF may be slightly expanded to reduce the height of the CDDF. On-site workers need to ensure proper health and safety protocols are followed using personal protective equipment, and that transport vehicles are properly decontaminated on-site.

GSD has ranked Alternative 7 lower because, although it has similar containment features as other alternatives, there is insufficient data (at the time of preparing this document) pertaining to the amount of time that would be required for the compression cap to achieve the required consolidation and dewatering of the sludge. While the sludge is still in the liquid state, there is a potential risk involved if the sludge escapes containment due to a possible leak in the wall or fissure in the native clay. Quality control during slurry wall installation minimizes this risk, and further detailed investigations of the clay layer would increase the confidence that the layer can act as a confining layer.

7.2.3 Long-Term Effectiveness and Permanence

The long-term effectiveness of the technology is measured against the ability to minimize the risk posed by all PCB contamination equal to or in excess of 50 ppm that permanently resides in RSL or any site controlled or operated by GSD.

Although technically Alternative 3 is considered to provide more long-term effectiveness and permanence than the other alternatives because all PCB contamination equal to or exceeding 50 ppm will be removed from RSL and disposed of off site at a disposal facility not operated by GSD, Alternatives 2, 4, 5, 6, 7 and 8 are considered to be equally effective in providing long-term effectiveness and permanence because a soil-bentonite or cement-bentonite barrier wall or a CDDF are considered to be long-term containment options. The effectiveness of a soil-bentonite

or cement-bentonite barrier wall can be evaluated by implementing a Quality Assurance/Quality Control plan during construction which involves monitoring the slurry mixing, excavation, backfilling (soil-bentonite), and testing of the backfill mix to check that the barrier wall materials meets the specified criteria. Additionally, the wall can be cored after construction to verify its completeness and competence. For the CDDF option, compacted clay liners or geosynthetic clay liners (GCLs) can be evaluated during construction by performing a combination of in-place density/moisture content testing, laboratory testing on physical properties of incoming materials, or taking samples of installed GCL liner.

Alternatives 4 and 6 allow for the sludge to be visually removed and then consolidated into a dry confinement cell above the water table, reducing the potential mobility of the PCBs. The effectiveness of the confinement cell can be monitored with routine visual inspections and cap maintenance.

The impermeable cap applied to Alternatives 4, 5, 6, 7, and 8 can be easily maintained with routine visual inspections and cap maintenance.

Between Alternatives 2, 5, 7, and 8, Alternative 2 is considered to be less effective than the others because the sludge is still in "liquid" form and is not capped like the other alternatives.

In regards to S/S treatment is applied in-situ, there is an inherent uncertainty of whether or not all of the sludges were uniformly treated and if there are any pockets of untreated sludges. S/S treatment can be verified after construction by drilling and taking core samples through the treated area and performing a visual analysis of the cores.

Alternative 7 involves confining and subsequently loading and consolidating the sludges, therefore both reducing the volume and also minimizing the risk that the sludges will mobilize.

When factoring in magnitude of risk regarding "worst-case scenarios" once the alternative has been implemented, Alternative 3 ranks the highest because the sludge and PCBs are removed from the RSL. Alternative 4, 5, and 6 may rank the next highest because the sludge has been chemically modified and has a different matrix. PCBs would be trapped or chemically bound within the stabilized mass. If the CDDF were breached, a relatively minimal amount of the stabilized sludge may be transported via gravity, but the majority of the material would either not move or be contained within the CDDF berm footprint.

Alternative 8 ranks the next highest in terms of magnitude of risk because the bulked PCB sludge may be stabilized, reducing the mobility of the PCBs.

Additionally, in each of these alternatives, the material with PCBs remains within the RSL footprint and shares a berm with the Grand Calumet River.

GSD considers Alternatives 2 and 7 to be less effective than the others because in both the alternatives sludge remains in "liquid" form (in Alternative 7, this is during the period of consolidation). Alternative 7 does provide capping and gradual loading for sludge consolidation but the consolidation time is unknown. Alternative 2 does not provide capping.

Alternative 2 ranks last in magnitude of risk because the volume of material with PCBs remains the same, the material remains within the RSL footprint, and the properties of sludge remain the same. A breach in the berm separating the Grand Calumet River and the RSL could potentially cause sludges to end up in the Grand Calumet River. However, it is important to note that this Alternative includes raising and widening the berm above 100-yr flood levels and stabilizing the berm with permanent sheeting, thus significantly reducing the risk of a berm failure.

No action is not considered permanent.

7.2.4 Technical Feasibility

Technical feasibility places emphasis on general site characteristics and contaminant types and concentrations. These parameters are used to determine the technical feasibility of implementing a particular alternative. The degree of difficulty in construction and operation, reliability of the technology, capability of the technology being demonstrated, challenges in scheduling, community impacts during construction and operation, environmental impacts of construction, and the feasibility of monitoring should be considered. The analysis should also consider what can be done if the alternative fails to achieve its remediation goal.

No action is always considered to be the most technically feasible alternative.

For degree of difficulty in construction and operation, Alternative 2 ranks the highest, followed closely by Alternative 8. Alternative 2 requires standard construction and operation techniques that don't rely on complex construction techniques or unproven technologies and whose services and materials are readily available. Alternative 2 requires berm raising and stabilizing, installing a pipe to control the elevation of the lagoon surface water, installation of a soil-bentonite slurry wall, site grading, and fencing, but no final cap.

Alternative 8 is similar to Alternative 2, with the added component of decanting the lagoon surface water and treating the water at the wastewater treatment plant; installing sheeting and/or berms to provide equipment access; mixing bulking materials within the lagoon, and placing and capping the fill with an impermeable cap. The Grand Calumet River sediments may be used should they meet the bulking

criteria and WAC, are readily available, and, as stated before, may help remediate two adjacent sites concurrently. Other local materials are also available.

Alternative 5 ranks the next highest in construction and operation, followed closely by Alternative 7 and then Alternative 6. Alternative 5 includes bulking the sludge and then in-situ S/S. S/S treatment is a reliable technology and usually requires Portland cement, a commonly used and understood additive. Bench testing similar to testing performed in the SAES (CDM, 2006) and then full-scale pilot testing on a pre-design level would be conducted prior to construction to determine the most effective S/S treatment.

Alternative 7 is ranked next in construction provided constructability of a compression cap is technically feasible. This is a new technology that hasn't been implemented for a remedy similar to the RSL. Pilot studies will need to be done to aid in final design of compression cap, including loading and consolidation. The concept of the compression cap is fairly straightforward, and the cap materials are readily available and understood. The compression cap consists of an underdrain system consisting of a series of perforated plastic pipes screened to prohibit fines from entering the pipes; the cap itself, designed to rest atop the sludges; and then loading material to be placed atop the compression cap. There is a wide range of acceptable material, including imported fill Grand Calumet River sediment meeting the WAC, or C&D waste. As the cap gets loaded, a dozer will be spreading the material over the cap to evenly distribute the load, and the water that is squeezed out of the sludges during consolidation will be collected in the piping and pumped and treated. Once the cap is assembled, minimal construction and operation is required. At the conclusion of loading, the lagoon gets covered with an impermeable cap similar to Alternatives 4, 5, 6, and 8.

Alternative 6 is similar to Alternative 4 in that a dry cell is constructed to encompass processed sludge, however additional materials handling and maintaining a large dewatered area is required to transport the processed sludge to the bottom of the lagoon for spreading and compacting.

Alternatives 3 and 4 rank the lowest for degree of difficulty in construction and operation. Alternative 3 includes dredging, dewatering, and ex-situ solidification/stabilization to pass a paint filter test, then staging the processed sludge to be systematically transported to a TSCA-permitted chemical waste landfill. Alternative 4 includes dredging, dewatering, ex-situ stabilizing, and then consolidating the processed sludge in a CDDF. These operations are understood. The dredging and dewatering system may require pilot testing to test the dredging, pumping, polymer addition, and dewatering rates on a large scale.

Each of these alternatives draws upon reliable technologies. Soil-bentonite and cement-bentonite slurry wall construction used in Alternatives 2, 5, 6, 7, and 8 are commonly understood and reliable technologies, there are many previous slurry wall

projects that demonstrate the use of this technology, the required services and materials should be readily acceptable at RSL, and the effectiveness of the slurry walls can be monitored during construction with QA/QC practices. Dewatering techniques that may be used in Alternatives 3, 4, and 6 are fairly common, and full-scale dewatering testing prior to construction will aid in determining the most effective way, both technically and financially, to dewater the RSL sludge. The information collected during the SAES, in particular the results of the hanging bag testing, can be drawn upon to plan a pilot scale dewatering program.

GSD ranks the compression cap concept from Alternative 7 lowest among alternatives for reliability of technology because this application hasn't been developed in a similar remediation before. The SAES contains information on laboratory level consolidation of the sludge using a compression cap idea. The rate of consolidation of the sludge under a compression cap may be increased by either installing vertical wick drains through the sludge to create more drainage paths for the water or adding polymer to the sludge to allow the sludge to loose water faster as shown during the hanging bag testing. The compression cap design may require a pilot study on site.

When evaluating construction scheduling aspects, GSD ranks Alternatives 2 and 8 the highest, followed closely by Alternative 5 and then Alternative 7. This is not surprising, because these alternatives do not require the sludge to be transferred outside of the lagoon or handled multiple times. As noted in Section 7.2.6, dredging the sludges out of the RSL may take approximately 2.5 years.

Alternatives 3, 4, and 6 all received low rankings for construction scheduling aspects, again because these alternatives involved multiple large scale construction steps such as dredging, dewatering, ex-situ solidification/stabilization, compacting, and transporting large quantities of materials. Each of these alternatives will take at least 3 to 5 years to implement during construction.

When evaluating potential impacts on the local community during construction, Alternatives 2, 3, 4, 5, 6, 7, and 8 all require the use of six acres of residential area east of the RSL will be purchased by GSD to use as a contractor staging and/or dewatering area, and Alternative 4 further requires that the 4.5 acres of commercial property further east be purchased by GSD to either facilitate the footprint of the CDDF. These land acquisitions pose potential impacts on local community during construction, but Alternative 3 will pose the most impact, as approximately 8,000 trucks would be required to transport processed sludge across state lines to a TSCA-permitted chemical waste landfill. Additionally, this alternative would require a relatively long construction period and subsequently impact the local community for an extended period of time.

The environmental conditions during construction for Alternatives 2, 7, and 8 rank the highest, followed closely by Alternative 5 and then Alternatives 4 and 6. This is because these alternatives do not require the sludge to be transferred away from the

lagoon, therefore minimal sludge handling and potential contact will be required. In Alternative 7, the compression cap minimizes the risk of any contact with the sludge. These alternatives allow more manageable and controlled health and safety practices during construction and therefore presents less short term risk than Alternatives 3, 4, and 6.

The environmental conditions during construction for Alternatives 3, 4, and 6 are ranked the lowest because the sludges are transported and handled multiple times, whether during the dredging operations, solidification/stabilization ex-situ, spreading and compacting the processed sludge, or transporting the material. Each time the sludges get disturbed or handled will result in a potential risk of a PCB release.

7.2.5 Administrative Feasibility

Administrative feasibility is an evaluation tool that places emphasis on permitting issues, applicable non-environmental laws, other known concerns of other regulatory agencies, and the coordination with agencies during the design and implementation of the alternative.

Alternatives 2 through 8 will all be subject to the U.S. Army Corps of Engineers regulation and local review requirements because any potential temporary roads constructed or build up of the berms will impact the wetlands to the north and south of the RSL.

Alternatives 2 through 8 will all require GSD to purchase the adjacent residential area to accommodate a contractor staging/dewatering area to support the needs of heavy construction, and Alternative 4 is considered less administratively feasible because it will further require GSD to purchase the adjacent commercial property to the east of the RSL to accommodate the CDDF (Alternative 4).

Alternative 3 is considered to be the least administratively feasible. Alternative 3 may encounter administrative challenges because the alternative requires sludges to be transported off-site to a TSCA-compliant chemical waste landfill, located out of state (the nearest TSCA-compliant chemical waste landfill is located in Wayne, Michigan). Alternative 3 will require chain-of-custody manifests and DOT permits.

Alternative 2 does not appear to be administratively feasible as it does not address the EPA's desire to have the PCB contaminated sludge capped from potential human health and ecological receptors. Alternative 4 is the next least desirable alternative as construction of the CDDF will require coordination with the Gary/Chicago International Airport and the Federal Aviation Administration (FAA) because its near proximity and associated height in relation to the flight path of the proposed expanded runway.

Alternatives 5, 6, and 7 rank high with regard to the administrative feasibility as they meet the overall objectives posed by the Consent Decree. Alternatives 7 and 8 may incorporate the resolution of the RSL sludge with the remediation of the Grand Calumet River within the City of Gary.

No action is not considered administratively feasible because this alternative will not be acceptable to the EPA.

7.2.6 Availability of Services and Materials

This section addresses whether a selected remedial alternative the availability of all equipment, service, material, and personnel components need to meet the schedule for implementation as defined in the Decree.

No action does not require any materials or services other than those needed for groundwater monitoring, and therefore ranks highest in the availability criterion.

Alternatives 2, 7, and 8 rank higher than Alternatives 3, 4, 5, and 6. These three alternatives don't require transporting the sludge, stabilization/solidification or dredging and dewatering. As noted in Section 6, the conceptual dredging and dewatering system at RSL would require that the lagoon sludge be dredged in four "cycles" since the 4-acre parcel for dewatering can only accommodate approximately 32,000 CY of dewatered sludge, or approximately one quarter of the dewatered RSL sludge.

The size and dimensions of the lagoon are also a limiting factor to the dredging operations; unlike dredging on the open waters with no size limitations, the RSL site can not accommodate some of the larger dredging units; for a smaller unit CDM estimated that a dredging rate of 500 gallons per minute (gpm) might be achieved, and assuming 8 hour days of continuous dredging at 180 days per year (standard construction year), dredging the RSL sludge would take approximately 2.5 years.

Alternative 2 requires standard dozers, backhoes, and haul-trucks and sheeting to raise and stabilize the berms, and a fencing contractor to re-fence the perimeter. For the soil-bentonite slurry wall installation, a local clay borrow source would need to be identified for mixing with on-site trench spoils and bentonite slurry to create an impermeable backfill. Soil-bentonite barrier wall construction is specialized and usually requires an excavator to dig the wall, and standard dozer and backhoe equipment to assist in mixing and backfilling. Powdered bentonite would be imported and mixed on-site to create slurry, possibly in Baker tanks. The slurry wall contractors and materials should be readily available.

Alternative 7 requires a cement-bentonite slurry wall (similar availability of services, materials, and construction time to that of a soil-bentonite slurry wall), and then construction and loading of the compression cap. Once the cap has been assembled,

little work is required, just incrementally loading the cap and collection of the water that is released from the consolidated sludges.

Alternatives 8 and 5 are the next highest ranked alternative because they do not require the sludge to be transported, dredged, or dewatered. Alternative 5 requires in-situ S/S treatment, which would typically require large-diameter hollow stem auger mixing equipment and a reagent such as Portland cement. Local additives such as slag can also be utilized. Alternative 5 also requires an in-place impermeable cover be constructed, which typically requires standard construction equipment and imported sands, geosynthetic materials, topsoil, and hydroseeding. An impermeable cap is also required for Alternatives 4, 6, 7, and 8.

Alternatives 4, and 6 are ranked next highest. Alternative 4 was ranked the highest of this group because the lagoon was to be regraded after dredging operations, not dewatered and maintained dry for accepting processed sludges to be spread at the bottom of the lagoon. Maintaining a dry lagoon bottom and transferring the processed sludges from the dewatering area at the east of the RSL down to the bottom of the lagoon, then spreading and compacting the processed sludges requires some effort and double handling. In Alternative 4, the processed sludges only have to be transferred a short distance to the CDDF facility, which is above the water table and more accessible for construction equipment. GSD ranks Alternative 7 below Alternatives 4, 6, and 8 because of the connection and assembly details of constructing a compression cap, concerns about uniformly loading the compression cap, and water collection.

Alternative 3 is ranked lowest of the alternatives in availability of services and materials. Alternative 3 ranks lower than the other alternatives for this criterion because Alternative 3 has the same sludge handling requirements as Alternatives 4 and 6, and also requires a large volume of PCB-contaminated sludges to be disposed of at a TSCA-permitted chemical waste landfill. According to the EPA website (http://www.epa.gov/pcb/pubs/stordisp.html), as of June 2007 there are ten (10) TSCA-permitted chemical waste landfills available in the United States, and approximately 172,000 CY of sludges at RSL would need to be transported to these chemical waste landfills. Assuming that one truck can carry 22 CY of sludges off-site for disposal, approximately 8,000 trucks will be needed to implement this alternative. CDM contacted the closest of the landfills, Wayne Disposal Inc. in Wayne, Michigan for cost estimates and to confirm that Wayne Disposal Inc. had the capacity to handle the volume of material. Wayne Disposal, Inc. is approximately 235 miles from Gary, Indiana.

7.2.7 Cost

Alternatives are required to be evaluated relative to each other with respect to capital and operations and maintenance (O&M) costs. Land acquisition, permitting fees, and long-term monitoring costs are also to be considered. Estimated costs used for this phase of the screening process are determined on the basis of engineering judgment

and previous project experience. Quantities used to prepare these cost estimates are approximate and intended to provide an order of magnitude estimate. The detailed analysis level accuracy range of this cost estimate is -30 to +50 percent.

For each alternative, engineering design costs (6%), engineering services during construction (6%), contractor fees (10%), and administrative fees (5%) were estimated as a percentage of the total construction cost. A contingency fee of 30% of the total construction costs was added to encompass any unanticipated costs or quantities. Operation and maintenance costs assume a 30-yearoperation period.

Tables 7-2 to 7-9 contain the detailed cost estimates.

No action is always the lowest cost alternative. The only costs associated with no action are operation and maintenance costs, which include a semi-annual groundwater sampling event. The no-action alternative is estimated to cost approximately **$287,000.**

Alternative 2 is estimated to cost approximately **$17,980,000** to implement and is the second least expensive cost alternative. Construction elements include land acquisition of adjacent residential area, site preparation, installing lagoon surface water controls, raising the perimeter berm with fill, stabilizing the perimeter berm with permanent sheeting, soil-bentonite slurry wall installation, and site grading and fencing. O&M costs include semi-annual water sampling and berm maintenance. Stabilizing the northern part of the berm requires roughly 125,400 square feet of sheet piling. The amount of sheet piling may be significantly reduced if a cement-bentonite slurry wall is installed rather than a soil-bentonite slurry wall. This option may be further evaluated during pre-design. Also note that costs associated with performing innovative technology demonstrations on site were not included.

Alternative 3 is estimated to cost approximately **$107,943,000** to implement. Construction elements include land acquisition of adjacent residential area, site preparation, temporary stabilization of the northern berm with temporary sheeting, dredging the sludge and supernatant, pumping the mixture to an adjacent dewatering system, treating the separated water at the wastewater treatment plant, stabilizing/solidifying the dewatered sludge, offsite removal of stabilized/solidified sludge to a TSCA-approved chemical waste landfill, undercutting 1-ft below bottom of sludge at lagoon, site grading, including grading the lagoon to promote drainage, and fencing. O&M costs include semi-annual water sampling.

Alternative 4 is estimated to cost approximately **$66,856,000**. Construction elements include land acquisition of adjacent residential and commercial areas, site preparation, stabilization of the northern berm with temporary sheeting, dredging the sludge and supernatant, pumping the mixture to an adjacent dewatering system, treating the separated water at the wastewater treatment plant, stabilizing/solidifying the dewatered sludge, constructing the base of the CDDF, consolidation of treated

sludge into CDDF, capping the dry cell with an impermeable cap, and site grading and fencing. O&M costs include semi-annual water sampling and cap maintenance.

Alternative 5 is estimated to cost approximately **$79,275,000**. Construction elements include land acquisition of adjacent residential area, site preparation, raising the perimeter berm with fill, stabilizing the northern berm with sheeting, construction of a soil-bentonite barrier wall around the RSL perimeter, decanting and treating the lagoon surface water, importing fills and bulking with sludges within lagoon, in-situ S/S treatment of the bulked sludges, capping the sludges with an impermeable cap, and site grading and fencing. O&M costs include semi-annual water sampling and cap maintenance.

Alternative 6 is estimated to cost approximately **$66,261,000**. Construction elements include land acquisition of adjacent residential area, site preparation, raising perimeter berm, installation of a cement-bentonite barrier wall (used to stabilize the entire berm including the northern berm) around the RSL footprint, dredging the sludge and supernatant, pumping the mixture to an adjacent dewatering system, treating the separated water at the wastewater treatment plant, stabilizing/solidifying the dewatered sludge, preparing the bottom of the lagoon, including building cross berms, installation of an under drain system, and dewatering to maintain a dry working area, consolidation of treated sludge into dry cell, regrading lagoon footprint outside of the dry cell, capping the dry cell with an impermeable cap, and site grading and fencing. O&M costs include semi-annual water sampling, groundwater dewatering and treating within the dry cell, and cap maintenance.

Alternative 7 is estimated to cost approximately **$43,713,000**. Construction elements include land acquisition of adjacent residential area, site preparation, raising the perimeter berm with fill, installation of a cement-bentonite barrier wall(used to stabilize the entire berm including the northern berm) around the RSL footprint, surface water dewatering and treating, construction and incremental loading of compression cap, water treatment of water separated from sludge, construction of an impermeable cap, and site grading and fencing. O&M costs include semi-annual water sampling and cap maintenance. Additional O&M costs are included for a staff of two people accepting imported fill, possibly construction and disposal (C&D) waste for a period of approximately four years, similar to landfill operations. One of the workers would operate a bulldozer and manage any stockpiled material that will get loaded up on the compression cap.

Alternative 8 is anticipated to cost approximately **$66,454,000**. Construction elements include land acquisition of adjacent residential area, site preparation, raising the perimeter berm, stabilizing the northern berm with sheeting, installation of a soil-bentonite barrier wall around the RSL footprint, decanting the lagoon surface water, importing dry fill material and bulking the material with the sludge, constructing cross berms for equipment access, soil mixing the bulked material continuously,

capping the lagoon with an impermeable cap, and site grading and fencing. O&M costs include semi-annual water sampling and cap maintenance.

7.3 Schedule for Implementation of Alternatives

The Decree requires that the selected alternative be implemented within five years of the date of selection by the U.S. EPA. Alternatives 2, 4, 5, and 8 would be able to be designed and implemented within the required five-year period. This period does not include state or federal review time or time spent negotiating land acquisition from the adjacent residential and/or commercial areas. Alternatives 3 and 6 will most likely need at least 5 years to design and implement due to the time consuming construction components and sequencing of the alternatives, notably dredging, dewatering, ex-situ solidification, spreading and compacting materials, maintaining dry and workable lagoon bottom, multiple handling, and transporting the processed sludge. GSD believes that the time schedule for Alterative 7 can not be determined at this stage due to the lack of time rate data on sludge consolidation. Construction schedules can be adjusted depending on the contractors' sequencing, whether the construction is to be completed in phases, or seasonal conditions.

Design components of the alternatives generally include the following:

- **Pre-design investigation.** The pre-design investigation would help determine design and performance criteria and include pilot and treatability studies to determine the most effective methods of dewatering and/or bulking, S/S treating, or consolidating the RSL sludges. The investigation would also generate additional information to provide to the contractor to help determine appropriate equipment and construction sequences and strategies. The investigation would include a field sampling program during which sludge samples would be collected at various depths and locations within RSL. Physical tests would be run on the sludges to determine the homogeneity of the samples. These tests were performed during the SAES (CDM, 2006).

  For alternatives where dewatering is involved, representative samples would be used in the laboratory to perform additional small-scale dewatering and bulking tests, such as measuring the effects of adding fill to a sludge column and mixing, or adding different polymers to the sludges to determine if a polymer can reduce the sludges affinity to water. Results of the laboratory tests would allow for full-scale dewatering, bulking and/or S/S testing programs to be developed and implemented. For a soil-bentonite slurry wall, additional borings would be taken along the perimeter berm during the pre-design investigation of the clay layer to confirm subsurface conditions, fill data gaps, and obtain materials for a barrier wall treatability study. The purpose of the treatability study is to determine the proportions of on-site soils, off-site soils (with high fines contents) and slurry necessary to create a backfill mix that creates a subsurface barrier wall that is both impermeable (typically has a permeability of 10-7 cm/sec or less for a soil-cement

bentonite slurry wall, or 10-5 to 10-6 cm/sec or less for a cement-bentonite slurry wall) and chemically compatible with the site soils and groundwater. Chemical compatibility testing would include performing hydraulic conductivity testing on the backfill mix with potable water and then switching the permeant to the site groundwater and passing one to three pore volumes of site water through the backfill mix sample and measuring any changes in hydraulic conductivity. Similar types of testing would be performed for a cement-bentonite wall.

For Alternative 7, pre-design investigation and studies will be required to determine rate of consolidation, design of compression cap, and addition, if necessary, of polymer.

If Grand Calumet River sediments are to be incorporated into the RSL remediation as bulking or filling material, dewatering, bulking, and/or solidification testing would be performed on representative samples of Grand Calumet River sediment.

- **30%, 60%, 90%, and 100% Design Stages.** These are typical design stages during a remedial design. Each stage may require a submittal to the EPA for review. The 30% design addresses the remedial design objectives and explores various design options and potential problems. At the 60% design stage, the design objectives and strategies are clear, a significant part of the design has been completed, and initial design drawings have been prepared. At the 90% design stage, the design components have been addressed and the majority of the design has been completed, including design drawings and specifications. The pre-design investigations can be carried out concurrently with the 30% design. It is anticipated that the laboratory investigations can be concluded prior to 60% design submittal, and that full-scale testing can be concluded prior to 90% design submittal.

7.4 Summary and Conclusions

The alternatives comparison process showed that **Alternative 8: Filling the Lagoon**, ranks highest based on the above criteria with a total score of 152 points because it potentially provides GSD with a flexible remedial alternative. GSD was not comfortable moving forward with Alternative 7 as the stand alone recommended alternative because of the potential risk viewed by GSD. In addition, Alternative 8, potentially can include the Grand Calumet River sediments either as bulking material (meeting the bulking and WAC) or as fill material (meeting the WAC). This solution would assist the GSD, the State of Indiana Department of Environmental Management, the United States Army Corp of Engineers, the USEPA, and the community at large. The combined economic effect and cost savings to the GSD, the State of Indiana, and the federal government through the Great Lakes Legacy Act would be significant. This is particularly important considering that the State may have to pay a considerable amount in siting, constructing, and monitoring another confined disposal facility or transporting Grand Calumet River sediment to other

remote disposal facilities and the GSD may have to pay for importing filling or bulking material.

Table 7-1 Ranking Analysis of Alternatives

Criteria	Total Possible Score	Alt 1 No Acion	Alt 2 Containment	Alt 3 Off-site Disposal	Alt 4 On-site Disposal	Alt 5 Solidification	Alt 6 Dry Cell	Alt 7 Compression Cap	Alt 8 Filling
Effectiveness		1	3	10	10	10	10	6	7
Total	**10**	**1**	**3**	**10**	**10**	**10**	**10**	**6**	**7**
Overall Protection									
Protection to Human Health		1	5	10	10	10	10	7	10
Reduces/Controls/Eliminates Risk		1	5	10	10	10	10	7	9
Total	**20**	**2**	**10**	**20**	**20**	**20**	**20**	**14**	**19**
Long term Effectiveness									
Magnitude of Risk		1	2	10	9	8	9	6	7
Adequacy and Releability of Controls		1	5	10	10	10	10	6	9
Total	**20**	**2**	**7**	**20**	**19**	**18**	**19**	**12**	**16**
Technical Feasibility									
Difficulty in Construction//Operation		10	8	1	1	5	3	4	7
Reliability of Technology		1	4	10	10	10	10	3	10
Demonstration of Technology		1	8	1	5	5	5	1	5
Availability of Services and Material		10	8	1	3	5	3	10	10
Scheduling Aspects		10	8	1	2	5	3	5	8
Potential Impact During Construction		10	8	1	3	4	3	6	7
Environmental Conditions During Construction		10	8	1	3	5	3	8	8
Potential Future Cleanup Actions		1	3	5	7	7	7	5	7
Ability to monitor Effectiveness		5	5	10	5	5	5	2	5
Total	**90**	**58**	**60**	**31**	**39**	**51**	**42**	**44**	**67**
Administrative Feasibility									
Need for Permit		1	7	1	3	5	3	7	7
Adherence to Criteria		1	3	5	5	5	5	5	5
Other known concerns of Agencies		1	3	5	5	5	5	5	7
Total	**30**	**3**	**13**	**11**	**13**	**15**	**13**	**17**	**19**
Availability of Services and Material									
Treatment/Storage/Disposal facility		10	9	1	3	8	3	7	8
Equipment/Personnel/Services		10	9	1	5	8	4	5	8
Total	**20**	**20**	**18**	**2**	**8**	**16**	**7**	**12**	**16**
Subtotal (without Cost criteria)	**190**	**86**	**111**	**94**	**109**	**130**	**111**	**105**	**144**
Ranking (without Cost criteria)		**8**	**4**	**7**	**6**	**2**	**3**	**5**	**1**
Total Cost		10	9	3	5	4	6	7	8
Total	**10**	10	9	3	5	4	6	7	8
Total	**200**	**96**	**120**	**97**	**114**	**134**	**117**	**112**	**152**
Final Ranking		**8**	**3**	**7**	**5**	**2**	**4**	**6**	**1**

Total Possible Points = 200

SUMMARY OF TCA ALTERNATIVES

Alternative	Total Cost
ALTERNATIVE 1: NO ACTION	$ 287,000.00
ALTERNATIVE 2: ON-SITE CONTAINMENT	$ 17,980,000.00
ALTERNATIVE 3: OFF-SITE DISPOSAL	$ 107,943,000.00
ALTERNATIVE 4: ON-SITE DISPOSAL (CDDF)	$ 66,856,000.00
ALTERNATIVE 5: IN-SITU SOLIDIFICATION/STABILIZATION	$ 79,275,000.00
ALTERNATIVE 6: DRY CELL	$ 66,261,000.00
ALTERNATIVE 7: COMPRESSION CAP	$ 43,713,000.00
ALTERNATIVE 8: FILLING THE LAGOON	$ 66,454,000.00

TABLE 7-2					
ALTERNATIVE 1: NO ACTION					
Estimated Cost for Remediation					
Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Total Capital Costs**				$ -
2	**Engineering Design (6% of construction cost)**	1	LS	0.00	$ -
3	**Engineering Services During Construction (6% construction costs)**	1	LS	0.00	$ -
4	**Contingency (30%)**	1	LS	0.00	$ -
	Total Remediation Cost Before O&M				$ -
5	**Annual O&M (semi-annual water sampling and reporting)**	1	LS	20,000.00	$ 20,000
6	**Present Worth of O&M**	1	LS	287,000.00	$ 287,000
7	**Total Alternative 1**				**$ 287,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

TABLE 7-3					
ALTERNATIVE 2: ON-SITE CONTAINMENT					
Estimated Cost for Remediation					
Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Site Preparation Costs**				
	Contractor Mob/Demob	1	LS	116,000.00	$ 116,000
	Clearing and Grub	6	Acre	23,000.00	$ 138,000
	Preparation of Contractor working areas and material lay down	6	Acre	25,000.00	$ 150,000
	Health & Safety/Monitoring Stations	1	LS	23,000.00	$ 23,000
	Preparation of access road	1	LS	25,000.00	$ 25,000
	Site survey	1	LS	25,000.00	$ 25,000
	Fill Berm to 3' above 100-yr flood (EL 590.4, assume 4'fill, 28'wide berm around perimeter)	21,570	CY	15.00	$ 323,600
	Erosion control Matting	7,000	SY	3.00	$ 21,000
	Permanent sheet pile wall on northern berm (2200 LF x 57' deep, 2/3 below bot.peat)	125,400	VSF	45.00	$ 5,643,000
	Subtotal Site Preparation Costs				$ 6,464,600
2	**Purchasing Adjacent Land (6 acres of Residential Area)**				
	Acquisition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	412,000.00	$ 412,000
	Relocation Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	270,000.00	$ 270,000
	Demolition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	36,000.00	$ 36,000
	Subtotal Purchasing Adjacent Land				$ 718,000
3	**Decanting, Installation of Surface Water Controls**				
	Minimal supernatant decanting and treatment (assume 1' of water)	6,028,235	gal	0.06	$ 361,700
	Concrete Weir Water Level Control System	1	LS	289,000.00	$ 289,000
	Water Management	1	LS	46,000.00	$ 46,000
	Subtotal Dewatering, Installation of Surface Water Controls				$ 696,700
4	**Soil-Bentonite Barrier Wall**				
	Subcontractor Mob/Demob	1	LS	75,000.00	$ 75,000
	Install Soil-Bentonite slurry wall around berm (assume 40' deep)	208,000	VSF	14.00	$ 2,912,000
	Install augmented clay cover over slurry wall (2' high, 5' wide)	1,926	CY	17.00	$ 32,700
	Installation of monitoring well network	1	LS	100,000.00	$ 100,000
	Subtotal Soil-Bentonite Barrier Wall				$ 3,119,700
5	**Site Grading and Fencing**				
	Seeding, grading outside lagoon	12,000	SY	1.00	$ 12,000
	Repair/Replace Fencing	5,200	LF	23.00	$ 119,600
	Subtotal Site Grading and Fencing				$ 131,600
	Total Capital Costs				$ 11,130,600
6	**Engineering Design (6% of construction cost)**	1	LS	668,000.00	$ 668,000
7	**Engineering Services During Construction (6% construction costs)**	1	LS	668,000.00	$ 668,000
8	**Contractor Fee (10%)**	1	LS	1,113,000.00	$ 1,113,000
9	**Administrative Costs (5%)**	1	LS	557,000.00	$ 557,000
10	**Contingency (30%)**	1	LS	3,340,000.00	$ 3,340,000
	Total Remediation Cost Before O&M				$ 17,476,600
11	**Annual O&M (water sampling, berm maintenance)**	1	LS	35,000.00	$ 35,000
12	**Present Worth of O&M**	1	LS	503,000.00	$ 503,000
13	**Total Alternative 2**				**$ 17,980,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

TABLE 7-4					
ALTERNATIVE 3: OFF-SITE DISPOSAL					
Estimated Cost for Remediation					
Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Site Preparation Costs**				
	Contractor Mob/Demob	1	LS	289,000.00	$ 289,000
	Clearing and Grub	6	Acre	23,000.00	$ 138,000
	Preparation of Contractor working areas and material lay down	6	Acre	100,000.00	$ 600,000
	Health & Safety/Monitoring Stations	1	LS	116,000.00	$ 116,000
	Preparation of access road	1	LS	25,000.00	$ 25,000
	Temporary sheet pile wall on northern berm (2200 LF x 57' deep, 2/3 below bot.peat)	125,400	VSF	45.00	$ 5,643,000
	Site survey	1	LS	25,000.00	$ 25,000
	Subtotal Site Preparation Costs				$ 6,836,000
2	**Purchasing Adjacent Land (6 acres of Residential Area)**				
	Acquisition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	412,000.00	$ 412,000
	Relocation Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	270,000.00	$ 270,000
	Demolition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	36,000.00	$ 36,000
	Subtotal Purchasing Adjacent Land				$ 718,000
3	**Dredging and Dewatering**				
	Dredge sludges	533,169	CY	20.00	$ 10,663,400
	Dewater sludge (assume solids content goes from 15% to 50%)	107,686,020	gal	0.06	$ 6,461,200
	Water treatment of separated sludge water including dredged surface water	123,738,747	gal	0.06	$ 7,424,300
	Water Management	1	LS	1,179,000.00	$ 1,179,000
	Subtotal Excavation and Dewatering				$ 25,727,900
4	**Sludge Stabilization and Offsite Removal**				
	Ex-situ Stabilize Sludge with 30% Pozzalonic (to pass paint filter test)	113,649	CY	30.00	$ 3,409,500
	Offsite Removal to TSCA chemical waste landfill (Assume 30% volume increase)	147,744	CY	207.00	$ 30,582,900
	Subtotal Stabilization and Offsite Removal				$ 33,992,400
5	**Regrading of Lagoon**				
	Undercut 1-Ft below bottom of sludge	27,801	CY	8.00	$ 222,400
	Additional Fill Material for Filling Void Area/Promote Drainage	50,000	CY	15.00	$ 750,000
	Installation of monitoring well network	1	LS	100,000.00	$ 100,000
	Subtotal Installation of lagoon regrading				$ 1,072,400
6	**Site Grading and Fencing**				
	Add 1' clean fill over berm	5,393	CY	15.00	$ 80,900
	Seeding, grading outside lagoon	12,000	SY	2.00	$ 24,000
	Repair/Replace Fencing	5,200	LF	23.00	$ 119,600
	Subtotal Site Grading and Fencing				$ 224,500
	Total Capital Costs				$ 68,571,200
7	**Engineering Design (6% of construction cost)**	1	LS	4,114,000.00	$ 4,114,000
8	**Engineering Services During Construction (6% construction costs)**	1	LS	4,114,000.00	$ 4,114,000
9	**Contractor Fee (10%)**	1	LS	6,857,000.00	$ 6,857,000
10	**Administrative Costs (5%)**	1	LS	3,429,000.00	$ 3,429,000
11	**Contingency (30%)**	1	LS	20,571,000.00	$ 20,571,000
	Total Remediation Cost Before O&M				$ 107,656,200
12	**Annual O&M (semi-annual water sampling and reporting)**	1	LS	20,000.00	$ 20,000
13	**Present Worth of O&M**	1	LS	287,000.00	$ 287,000
14	**Total Alternative 3**				**$ 107,943,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

TABLE 7-5					
ALTERNATIVE 4: ON-SITE DISPOSAL (CDDF)					
Estimated Cost for Remediation					
Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Site Preparation Costs**				
	Contractor Mob/Demob	1	LS	289,000.00	$ 289,000
	Clearing and Grub	10.5	Acre	23,000.00	$ 241,500
	Preparation of Contractor working areas and material lay down	10.5	Acre	25,000.00	$ 262,500
	Health & Safety/Monitoring Stations	1	LS	116,000.00	$ 116,000
	Preparation of access road	1	LS	25,000.00	$ 25,000
	Fill Berm to 3' above 100-yr flood (EL 590.4, assume 4'fill, 28'wide berm around perimeter)	21,570	CY	15.00	$ 323,600
	Temporary sheet pile wall on northern berm (2200 LF x 57' deep, 2/3 below bot.peat)	125,400	VSF	45.00	$ 5,643,000
	Site survey	1	LS	25,000.00	$ 25,000
	Subtotal Site Preparation Costs				$ 6,925,600
2	**Purchasing Adjacent Land (Residential Area + Trucking Company Property)**				
	Acquisition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	587,000.00	$ 587,000
	Relocation Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	350,000.00	$ 350,000
	Demolition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	54,000.00	$ 54,000
	Purchase trucking company property	1	LS	1,500,000.00	$ 1,500,000
	Subtotal Purchasing Adjacent Land (Residential Area + Trucking Company Property)				$ 2,491,000
3	**Dredging and Dewatering**				
	Dredging Sludge	533,169	CY	20.00	$ 10,663,400
	Dewater sludge (assume solids content goes from 15% to 50%)	107,686,020	gal	0.06	$ 6,461,200
	Water treatment of sludge water including dredged surface water	123,738,747	gal	0.06	$ 7,424,300
	Ex-situ Stabilize Sludge with 30% Pozzalonic	113,649	CY	30.00	$ 3,409,500
	Prepare confining cell w/ 1' subbase (assume 300' x 620')	6,890	CY	23.00	$ 158,500
	Prepare confining cell w/ 3' thick compacted clay liner (assume 300' x 620')	20,670	CY	29.00	$ 599,400
	Transferring sludges into CDDF	147,744	CY	6.00	$ 886,500
	Water Management	1	LS	1,179,054.00	$ 1,179,100
	Subtotal Excavation and Dewatering, Construct Cells, Transfer Sludge				$ 30,781,900
4	**Regrading lagoon**				
	Undercut 1-Ft below bottom of sludge	27,801	CY	8.00	$ 222,400
	Additional Fill Material for Filling Void Area/Promote Drainage	50,000	CY	15.00	$ 750,000
	Subtotal Regrading Lagoon				$ 972,400
5	**Cap Placement on CDDF**				
	Sand Venting Layer (1')	6,890	CY	23.00	$ 158,500
	Gas Vents (1 per acre)	5	each	5,000.00	$ 25,000
	HDPE liner (60 mil)	4.2	Acre	19,200.00	$ 80,600
	GCL	4.2	Acre	58,000.00	$ 243,600
	Drainage Layer (1')	6,890	CY	23.00	$ 158,500
	Common Fill layer (1')	6,890	CY	15.00	$ 103,400
	Topsoil layer (6")	3,445	CY	23.00	$ 79,200
	Installation of monitoring well network	1	LS	100,000.00	$ 100,000
	Subtotal Cap Placement				$ 948,800
6	**Site Grading and Fencing**				
	Seeding, grading outside lagoon	12,000	SF	2.00	$ 24,000
	Repair/Replace Fencing	5,200	LF	23.00	$ 119,600
	Subtotal Site Grading and Fencing				$ 143,600
	Total Capital Costs				$ 42,263,300
7	**Engineering Design (6% of construction cost)**	1	LS	2,536,000.00	$ 2,536,000
8	**Engineering Services During Construction (6% construction costs)**	1	LS	2,536,000.00	$ 2,536,000
9	**Contractor Fee (10%)**	1	LS	4,226,000.00	$ 4,226,000
10	**Administrative Costs (5%)**	1	LS	2,113,000.00	$ 2,113,000
11	**Contingency (30%)**	1	LS	12,680,000.00	$ 12,680,000
	Total Remediation Cost Before O&M				$ 66,354,300
12	**Annual O&M (water sampling, cap maintenance)**	1	LS	35,000.00	$ 35,000
13	**Present Worth of O&M**	1	LS	502,000.00	$ 502,000
14	**Total Alternative 4**				**$ 66,856,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

TABLE 7-6					
ALTERNATIVE 5: IN-SITU SOLIDIFICATION/STABILIZATION					
Estimated Cost for Remediation					
Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Site Preparation Costs**				
	Contractor Mob/Demob	1	LS	289,000.00	$ 289,000
	Clearing and Grub	6	Acre	23,000.00	$ 138,000
	Preparation of Contractor working areas and material lay down	6	Acre	25,000.00	$ 150,000
	Health & Safety/Monitoring Stations	1	LS	116,000.00	$ 116,000
	Preparation of access road	1	LS	25,000.00	$ 25,000
	Site survey	1	LS	25,000.00	$ 25,000
	Fill Berm to 3' above 100-yr flood (EL 590.4, assume 4'fill, 28'wide berm around perimeter)	21,570	CY	15.00	$ 323,600
	Erosion control Matting	7,000	SY	3.00	$ 21,000
	Permanent sheet pile wall on northern berm (2200 LF x 57' deep, 2/3 below bot.peat)	125,400	VSF	50.00	$ 6,270,000
	Subtotal Site Preparation Costs				$ 7,357,600
2	**Purchasing Adjacent Land (6 acres of Residential Area)**				
	Acquisition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	412,000.00	$ 412,000
	Relocation Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	270,000.00	$ 270,000
	Demolition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	36,000.00	$ 36,000
	Subtotal Purchasing Adjacent Land				$ 718,000
3	**Decanting**				
	Lagoon surface water decanting and treatment (assume 7' deep)	42,197,650	gal	0.06	$ 2,531,900
	Water Management	1	LS	1,179,054.00	$ 1,179,100
	Subtotal Excavation and Dewatering				$ 3,711,000
4	**In-situ S/S Treatment**				
	Imported fill used to bulk sludges (assume solids content goes from 15% to 50%)	309,848	CY	20.00	$ 6,197,000
	In-situ S/S treatment of sludges (assume 30% pozzalonic)	737,603	CY	35.00	$ 25,816,100
	Subtotal In-situ S/S Treatment				$ 32,013,100
5	**Cap Placement**				
	Sand Venting Layer (1')	29,847	CY	23.00	$ 686,500
	Gas Vents (1 per acre)	19	each	5,000.00	$ 95,000
	HDPE liner (60 mil)	18.5	Acre	19,200.00	$ 355,200
	GCL	18.5	Acre	26,100.00	$ 482,900
	Drainage Layer (1')	29,847	CY	23.00	$ 686,500
	Common Fill layer (1')	29,847	CY	15.00	$ 447,700
	Topsoil layer (6'')	14,923	CY	23.00	$ 343,200
	Installation of vegetative cover	18.5	Acre	3,500.00	$ 64,800
	Subtotal Cap Placement				$ 3,161,800
6	**Soil-Bentonite Barrier Wall**				
	Subcontractor Mob/Demob	1	LS	75,000.00	$ 75,000
	Install Soil-Bentonite slurry wall around berm (assume 40' deep)	208,000	VSF	14.00	$ 2,912,000
	Install augmented clay cover over slurry wall (2' high, 5' wide)	1,926	CY	17.00	$ 32,700
	Installation of monitoring well network	1	LS	100,000.00	$ 100,000
	Subtotal Soil-Bentonite Barrier Wall				$ 3,119,700
7	**Site Grading and Fencing**				
	Seeding, grading outside lagoon	12,000	SF	2.00	$ 24,000
	Repair/Replace Fencing	5,200	LF	23.00	$ 119,600
	Subtotal Site Grading and Fencing				$ 143,600
	Total Capital Costs				$ 50,224,800
8	**Engineering Design (6% of construction cost)**	1	LS	3,010,000.00	$ 3,010,000
9	**Engineering Services During Construction (6% construction costs)**	1	LS	3,010,000.00	$ 3,010,000
10	**Contractor Fee (10%)**	1	LS	5,020,000.00	$ 5,020,000
11	**Administrative Costs (5%)**	1	LS	2,510,000.00	$ 2,510,000
12	**Contingency (30%)**	1	LS	15,070,000.00	$ 15,070,000
	Total Remediation Cost Before O&M				$ 78,844,800
13	**Annual O&M (water sampling, cap maintenance)**	1	LS	35,000.00	$ 35,000
14	**Present Worth of O&M**	1	LS	430,000.00	$ 430,000
15	**Total Alternative 5**				**$ 79,275,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

TABLE 7-7					
ALTERNATIVE 6: DRY CELL					
Estimated Cost for Remediation					
Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Site Preparation Costs**				
	Contractor Mob/Demob	1	LS	289,000.00	$ 289,000
	Clearing and Grub	6	Acre	23,000.00	$ 138,000
	Preparation of Contractor working areas and material lay down	6	Acre	25,000.00	$ 150,000
	Health & Safety/Monitoring Stations	1	LS	116,000.00	$ 116,000
	Preparation of access road	1	LS	25,000.00	$ 25,000
	Fill Berm to 3' above 100-yr flood line (EL 590.4, assume 4'fill, 28'wide berm, filling side slopes)	79,378	CY	15.00	$ 1,190,700
	Site survey	1	LS	25,000.00	$ 25,000
	Erosion control Matting	7,000	SY	3.00	$ 21,000
	Subtotal Site Preparation Costs				$ 1,954,700
2	**Purchasing Adjacent Land (6 acres of Residential Area)**				
	Acquisition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	412,000.00	$ 412,000
	Relocation Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	270,000.00	$ 270,000
	Demolition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	36,000.00	$ 36,000
	Subtotal Purchasing Adjacent Land				$ 718,000
3	**Dredging and Dewatering**				
	Dredging Sludge	533,169	CY	20.00	$ 10,663,400
	Dewater sludge (assume solids content goes from 15% to 50%)	107,686,020	gal	0.06	$ 6,461,200
	Water treatment of sludge water including dredged lagoon surface water	123,738,747	gal	0.06	$ 7,424,300
	Water Management	1	LS	1,179,054.00	$ 1,179,100
	Subtotal Dredging				$ 25,728,000
4	**Ex-situ S/S Treatment and Dewatered sludge placement**				
	Ex-situ Stabilize Sludge with 30% Pozzalonic	113,649	CY	30.00	$ 3,409,500
	Building cross berms (3 across) for equip. access (sheet piles)	89,100	VSF	18.00	$ 1,603,800
	Building cross berms (3 across) for equip. access (struc. fill)	15,000	CY	23.00	$ 345,000
	Transferring sludges into dry cell (assume double handling)	147,744	CY	12.00	$ 1,772,900
	Subtotal In-situ S/S Treatment				$ 7,131,200
5	**Under Drain System**				
	Installation of 2ft drainage layer	13,000	CY	23.00	$ 299,000
	Installation of 6"-dia PVC pipe @ 50' O.C	6,760	LF	25.00	$ 169,000
	Subtotal of Under Drain				$ 468,000
6	**Cap Placement**				
	Sand Venting Layer (1')	10,809	CY	23.00	$ 248,600
	Gas Vents (1 per acre)	7	each	5,000.00	$ 35,000
	GCL	6.7	Acre	26,100.00	$ 174,900
	HDPE liner (60 mil)	6.7	Acre	19,200.00	$ 128,600
	Drainage Layer (1')	10,809	CY	23.00	$ 248,600
	Common Fill layer (1')	10,809	CY	15.00	$ 162,100
	Topsoil layer (6")	5,405	CY	23.00	$ 124,300
	Subtotal Cap Placement				$ 1,122,100
7	**Regrading lagoon**				
	Undercut 1-Ft below bottom of sludge	10,068	CY	6.00	$ 60,400
	Additional Fill Material for Filling Void Area/Promote Drainage	18,108	CY	12.00	$ 217,300
	Subtotal Regrading Lagoon				$ 277,700
8	**Cement-Bentonite Barrier Wall**				
	Subcontractor Mob/Demob	1	LS	75,000.00	$ 75,000
	Install Cement-Bentonite slurry wall around berm (assume 40' deep)	208,000	VSF	20.00	$ 4,160,000
	Install augmented clay cover over slurry wall (2' high, 5' wide)	1,926	CY	17.00	$ 32,700
	Installation of monitoring well network	1	LS	100,000.00	$ 100,000
	Subtotal Cement-Bentonite Barrier Wall				$ 4,367,700
9	**Site Grading and Fencing**				
	Seeding, grading outside lagoon	12,000	SF	2.00	$ 24,000
	Repair/Replace Fencing	5,200	LF	23.00	$ 119,600
	Subtotal Site Grading and Fencing				$ 143,600
	Total Capital Costs				$ 41,911,000
10	**Engineering Design (6% of construction cost)**	1	LS	2,510,000.00	$ 2,510,000
11	**Engineering Services During Construction (6% construction costs)**	1	LS	2,510,000.00	$ 2,510,000
12	**Contractor Fee (10%)**	1	LS	4,190,000.00	$ 4,190,000
13	**Administrative Costs (5%)**	1	LS	2,100,000.00	$ 2,100,000
14	**Contingency (30%)**	1	LS	12,570,000.00	$ 12,570,000
	Total Remediation Cost Before O&M				$ 65,791,000
15	**Annual O&M (water sampling, cap maintenance)**	1	LS	35,000.00	$ 35,000
16	**Present Worth of O&M**	1	LS	470,000.00	$ 470,000
17	**Total Alternative 6**				**$ 66,261,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

TABLE 7-8
ALTERNATIVE 7: COMPRESSION CAP
Estimated Cost for Remediation

Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Site Preparation Costs**				
	Contractor Mob/Demob	1	LS	58,000.00	$ 58,000
	Clearing and Grub	6	Acre	4,000.00	$ 24,000
	Preparation of Contractor working areas and material lay down	6	Acre	12,000.00	$ 72,000
	Health & Safety/Monitoring Stations	1	LS	116,000.00	$ 116,000
	Preparation of access road	1	LS	12,000.00	$ 12,000
	Site survey	1	LS	12,000.00	$ 12,000
	Fill Berm to 3' above 100-yr flood line (EL 590.4, assume 4'fill, 28'wide berm, filling side slopes)	79,378	CY	15.00	$ 1,190,700
	Subtotal Site Preparation Costs				$ 1,484,700
2	**Purchasing Adjacent Land (6 acres of Residential Area)**				
	Acquisition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	412,000.00	$ 412,000
	Relocation Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	270,000.00	$ 270,000
	Demolition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	36,000.00	$ 36,000
	Subtotal Purchasing Adjacent Land				$ 718,000
3	**Compression Cap**				
	Material Cost				
	Compression Cap	29,847	CY	80.00	$ 2,387,800
	Connections (10% of compression cap cost)	1	LS	246,000.00	$ 246,000
	Underdrain HDPE pipe 6" diameter, 50' o/c spacing	32,500	LF	25.00	$ 812,500
	Fill Material added on top of Cap (12'), assume free fill	358,160	CY	15.00	$ 5,372,400
	Sheeting for 2 work platforms (assume each platform is 20' x 40') depth 57'	13,680	VSF	45.00	$ 615,600
	Labor + Equipment Cost				
	Placing and initial loading of compression cap	1	LS	347,000.00	$ 347,000
	Subtotal Compression Cap				$ 9,781,300
4	**Dewatering**				
	Lagoon surface water decanting and treatment (assume 7' deep)	42,197,650	gal	0.06	$ 2,531,900
	Water treatment of separated sludge water (50% solids)	81,541,097	gal	0.06	$ 4,892,500
	Water Management	1	LS	393,018.00	$ 393,000
	Subtotal Dewatering				$ 7,817,400
5	**Site Grading and Fencing**				
	Grading outside lagoon	3.5	acre	3,500.00	$ 12,300
	Repair/Replace Fencing	5,200.0	FL	14.00	$ 72,800
	Subtotal Site Grading and Fencing				$ 85,100
6	**Cement Bentonite Barrier Wall**				
	Subcontractor Mob/Demob	1	LS	75,000.00	$ 75,000
	Cement bentonite slurry wall around berm (Assume 40' deep)	208,000	VSF	20.00	$ 4,160,000
	Augmented clay cover over slurry wall (2' high, 5' wide)	1,926.0	CY	17.00	$ 32,700
	Installation of monitoring well network	1	LS	100,000.00	$ 100,000
	Subtotal Cement Bentonite Barrier Wall				$ 4,367,700
7	**Cap Placement**				
	Sand Venting Layer (1')	29,847	CY	23.00	$ 686,500
	Gas Vents (1 per acre)	19	each	5,000.00	$ 95,000
	HDPE liner (60 mil)	18.5	Acre	19,200.00	$ 355,200
	GCL	18.5	Acre	26,100.00	$ 482,900
	Drainage Layer (1')	29,847	CY	23.00	$ 686,500
	Common Fill layer (1')	29,847	CY	15.00	$ 447,700
	Topsoil layer (6")	14,923	CY	23.00	$ 343,200
	Installation of vegetative cover	18.5	Acre	3,500.00	$ 64,800
	Subtotal Cap Placement				$ 3,161,800
	Total Capital Costs				$ 27,416,000
8	**Engineering Design (6% of construction cost)**	1	LS	1,644,960.00	$ 1,644,960
9	**Engineering Services During Construction (6% construction costs)**	1	LS	1,644,960.00	$ 1,644,960
10	**Contractor Fee (10%)**	1	LS	2,741,600.00	$ 2,741,600
11	**Administrative Costs (5%)**	1	LS	1,370,800.00	$ 1,370,800
12	**Contingency (30%)**	1	LS	8,224,800.00	$ 8,224,800
	Total Remediation Cost Before O&M				$ 43,043,120
13	**Annual O&M (water sampling, cap maintenance)**	1	LS	35,000.00	$ 35,000
	O&M for material acceptance (4 yrs, 1 laborer, 1 operator, 1 dozer, 270 days/yr)	4	YR	50,000.00	$ 200,000
14	**Present Worth of O&M**	1	LS	470,000.00	$ 470,000
15	**Total Alternative 7**				**$ 43,713,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

TABLE 7-9					
ALTERNATIVE 8: FILLING THE LAGOON					
Estimated Cost for Remediation					
Item No	Item	Quantity	Unit	Unit Cost (2007)	Cost
1	**Site Preparation Costs**				
	Contractor Mob/Demob	1	LS	289,000.00	$ 289,000
	Clearing and Grub	6	Acre	23,000.00	$ 138,000
	Preparation of Contractor working areas and material lay down	6	Acre	25,000.00	$ 150,000
	Health & Safety/Monitoring Stations	1	LS	116,000.00	$ 116,000
	Preparation of access road	1	LS	25,000.00	$ 25,000
	Site survey	1	LS	25,000.00	$ 25,000
	Fill Berm to 3' above 100-yr flood line (EL 590.4, assume 4'fill, 28'wide berm)	9,748	CY	15.00	$ 146,200
	Permanent sheet pile wall on northern berm (2200 LF x 57' deep, 2/3 below bot.peat)	125,400	VSF	50.00	$ 6,270,000
	Erosion control Matting	7,000	SY	3.00	$ 21,000
	Subtotal Site Preparation Costs				$ 7,180,200
2	**Purchasing Adjacent Land (6 acres of Residential Area)**				
	Acquisition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	412,000.00	$ 412,000
	Relocation Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	270,000.00	$ 270,000
	Demolition Cost (source: Gary Department of Redevelopment, July 2007)	1	LS	36,000.00	$ 36,000
	Subtotal Purchasing Adjacent Land				$ 718,000
3	**Decanting**				
	Lagoon surface water decanting and treatment (assume 7' deep)	42,197,650	gal	0.06	$ 2,531,900
	Water Management	1	LS	1,179,054.00	$ 1,179,100
	Subtotal Decanting				$ 3,711,000
4	**Bulking and Filling**				
	Bulk material, (assume solids content of 85% for bulk material)	309,848	CY	20.00	$ 6,197,000
	Mixing of Bulked material w/ RSL sludges assume solids content goes from 15% to 50%	533,000	CY	25.00	$ 13,325,000
	Added 15% cement for strength	126,427	CY	20.00	$ 2,528,500
	Building cross berms (3 across) for equip. access (sheet piles)	89,100	VSF	18.00	$ 1,603,800
	Building cross berms (3 across) for equip. access (struc. fill)	15,000	CY	23.00	$ 345,000
	Subtotal Bulking and Filling				$ 23,999,300
5	**Cap Placement**				
	Sand Venting Layer (1')	29,847	CY	23.00	$ 686,500
	Gas Vents (1 per acre)	19	each	5,000.00	$ 95,000
	HDPE liner (60 mil)	18.5	Acre	19,200.00	$ 355,200
	GCL	18.5	Acre	26,100.00	$ 482,900
	Drainage Layer (1')	29,847	CY	23.00	$ 686,500
	Common Fill layer (1')	29,847	CY	15.00	$ 447,700
	Topsoil layer (6")	14,923	CY	23.00	$ 343,200
	Installation of vegetative cover	18.5	Acre	3,500.00	$ 64,800
	Subtotal Cap Placement				$ 3,161,800
6	**Soil Bentonite Barrier Wall**				
	Subcontractor Mob/Demob	1	LS	75,000.00	$ 75,000
	Soil bentonite slurry wall around berm (Assume 40' deep)	208,000	VSF	14.00	$ 2,912,000
	Augmented clay cover over slurry wall (2' high, 5' wide)	1,926.0	CY	17.00	$ 32,700
	Installation of monitoring well network	1	LS	100,000.00	$ 100,000
	Subtotal Soil Bentonite Barrier Wall				$ 3,119,700
7	**Site Grading and Fencing**				
	Seeding, grading outside lagoon	12,000	VSF	2.00	$ 24,000
	Repair/Replace Fencing	5,200	LF	23.00	$ 119,600
	Subtotal Site Grading and Fencing				$ 143,600
	Total Capital Costs				$ 42,033,600
8	**Engineering Design (6% of construction cost)**	1	LS	2,520,000.00	$ 2,520,000
9	**Engineering Services During Construction (6% construction costs)**	1	LS	2,520,000.00	$ 2,520,000
10	**Contractor Fee (10%)**	1	LS	4,200,000.00	$ 4,200,000
11	**Administrative Costs (5%)**	1	LS	2,100,000.00	$ 2,100,000
12	**Contingency (30%)**	1	LS	12,610,000.00	$ 12,610,000
	Total Remediation Cost Before O&M				$ 65,983,600
13	**Annual O&M (water sampling, cap maintenance)**	1	LS	35,000.00	$ 35,000
14	**Present Worth of O&M**	1	LS	470,000.00	$ 470,000
15	**Total Alternative 8**				**$ 66,454,000**

O&M assumes a 30 year period
Present worth calculations assume a 7% interest rate

CDM

SANITARY DISTRICT
GARY
STORM WATER MANAGEMENT DISTRICT