Technical Assistance Services for Communities
Contract No.: EP-W-07-059
TASC WA No.: TASC-01-R5
Technical Directive No.: TASC-1

Executive Summary of the Removal Action Investigation/Remedial Investigation Report (Revision 1.0) for the West, Seep 2 and Seep 1 Cement Kiln Dust Areas and Alternatives Evaluation (Revision 0.0) for the West, Seep 2 and Seep 1 Cement Kiln Dust Areas

Site Name: Bay Harbor Cement Kiln Dust Site
Location: Bay Harbor, Michigan

Purpose

This document was prepared for the Bay Harbor Regional Stakeholders Group and represents an executive summary of the following two documents relating to activities at the West, Seep 2 and Seep 1 Cement Kiln Dust (CKD) Areas of the Little Traverse Bay (LTB) CKD Release Site near Petoskey, Michigan:

1. July 31, 2009 Removal Action Investigation/Remedial Investigation Report, West, Seep 2 and Seep 1 CKD Areas - Revision 1.0
2. July 31, 2005 Alternatives Evaluation, West, Seep 2 and Seep 1 CKD Areas - Revision 0.0

The Removal Action Investigation/Remedial Investigation Report (RI Report) and the Alternatives Evaluation (AE Report) were prepared on behalf of CMS Land Company and CMS Capital, LLC (referred to collectively as CMS). Findings for the West, Seep 2 and Seep 1 CKD Areas that are significantly different compared to the East CKD Area are described in Sections 2.2, 2.4, 2.5, 3.1, and 3.3-3.4, and Tables 1, 2 and 3.

Section 1. Introduction

- The LTB CKD Release Site is located along five miles of shoreline on Little Traverse Bay of Lake Michigan. The LTB Site is approximately five miles west of the City of Petoskey, and located in Resort Township, Emmet County. The locations of the West CKD Area, Seep 2 CKD Area (including Pine Court and Guard Rail Seep Areas) and Seep 1 CKD Area (collectively referred to as the Development Area) are shown in Figure 1.
- The source of contamination at the Development Area is CKD. Potential contaminants of concern (COCs) (e.g., mercury, arsenic, ammonia, etc., which are discussed in Section 2.7) may be released from the CKD through leaching (dissolving the CKD in water) by infiltrated water or ground water, or from a breach of cover soils.

Section 2. The RI Report

2.1 RI Report Background

- The RI Report describes the investigation activities conducted at the Development Area between August and May 2009. A summary was included that describes results of the expedited removal actions, interim response and augmentation activities conducted prior to May 31, 2009.
- The objective of the RI activities was to generate the data necessary to complete the Development Area characterization and evaluate final remedy alternatives for addressing current and potential threats to public health, welfare and the environment from CKD waste material.

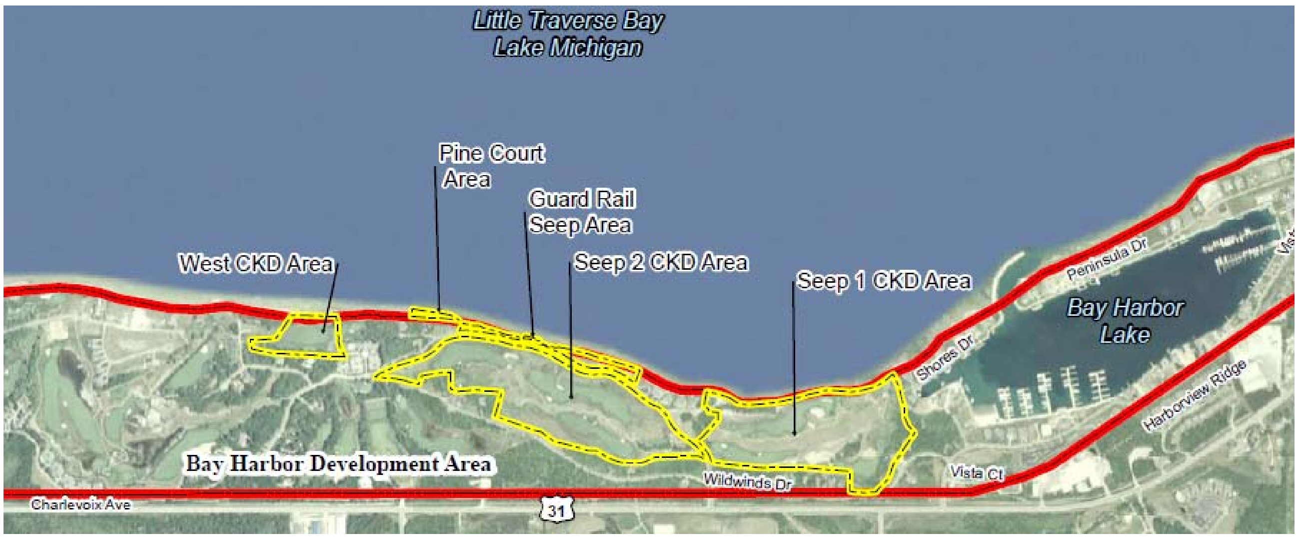

Figure 1. Location of the Development Area: West CKD Area, the Seep 2 CKD Area (including the Pine Court and Guard Rail Seep Areas) and Seep 1 CKD Area (excerpted from Figure 1-1 of the RI Report).

2.2 Expedited Removal Actions and Interim Response

- CMS conducted a series of removal actions prior to formal approval of the entire Work Plan dated July 28, 2005, which included: implementation of a Site Control and Access Management Plan, targeted shoreline survey, overflights, removal action notification and leachate (soluble CKD matter dissolved in water) vacuum recovery.
- An Interim Leachate Recovery System (ILRS) was designed and constructed, and is in operation at the Development Area as required by the Administrative Order on Consent (AOC). Collection trenches have been installed in the West CKD, Pine Court, Guard Rail, Seep 2 CKD and Seep 1 CKD Areas. The Development Area ILRS system has been monitored since installation.
- A series of activities known as augmentation have been undertaken to improve Development Area ILRS performance.
- Most of the data collected show the continued effectiveness of the Development Area ILRS. The occasional and low-level exceedances do not pose any threat to public health and safety or the environment. CMS expects to see a continued decline in the number of pH exceedances since Development Area ILRS augmentation.

2.3 Study Area Investigation

- Investigations and methods used were described in detail in the RI Report and included examination of land surface features; contaminant source investigations, including unconsolidated material sampling (CKD and non-CKD) and leachate; meteorological investigations; surface water investigations; geological investigations; ground water investigations; and ecological investigations.

2.4 Physical Characteristics of the Study Area

- Tee boxes, fairways and greens at the Development Area are maintained with a sprinkler irrigation system. Runoff generally drains to plastic grated inlets located in surface depressions from maintained golf course features (tee boxes, fairways, and greens), native vegetation, and adjacent residential dwellings. Collected runoff is directed through a series of plastic pipes (less than 12 inch diameter) to trunk lines that discharge to drainage swales/creeks, which ultimately discharge to Lake Michigan.
- The native geology at the Development Area consists of limestone or shaley limestone bedrock overlain by a relatively thin cover of unconsolidated deposits. Investigations revealed that the limestone bedrock was highly fractured.
- The regional horizontal ground water flow direction in the vicinity of the Development Area is from south to north, toward Lake Michigan.
- Many of the deep and intermediate depth wells in the well nests at the Development Area show the effects of cycling of the municipal well pumps in the City of Petoskey.
- It is unlikely that static ground water elevations and flow directions are significantly affected by Lake Michigan's tidal fluctuations.

2.5 Nature and Extent of Contamination

- Contaminants of concern (COCs) were identified by evaluating samples from the Development Area against applicable criteria (see Section 2.7).
- The West CKD Area covers approximately 5.4 acres and contains 100,000 cubic yards of CKD. Seep 2 CKD Area covers approximately 34.8 acres and contains 1.1 million cubic yards of CKD. Seep 1 CKD Area covers approximately 15.5 acres and contains 550,000 cubic yards of CKD.
- Surface water analytical samples for the three areas were collected between August 2005 and April 2007. Surface water sampling requirements were eliminated with EPA approval in May 2007.

2.6 CKD Characteristics and Leachate Chemistry

- Cement kiln dust is a by-product of Portland cement production. In general, CKDs are particulate mixtures of partially calcined (heated to drive off carbon dioxide) and unreacted raw limestone feed, clinker dust, and fuel ash, enriched with alkali sulfates, halides, and other volatile inorganic materials. These particulates and combustion gas precipitates are collectively referred to as CKD.
- Upon contact of CKD with water, various chemical reactions take place, resulting in physical and chemical changes in the CKD.
- When water comes in contact with CKD, it reacts with solid-phase minerals in the CKD and is converted to leachate.

- Chemical reactions between CKD and water impart some specific properties to leachate, including: high levels of sodium and potassium and low levels of calcium and magnesium (as compared with natural waters); high pH; high concentrations of sulfate, mercury and total dissolved solids (TDS); varying concentrations of aluminum and iron; and fatty acid surfactants (molecules similar in structure to detergent) from the organic matter in CKD.

2.7 Contaminant Fate and Transport

- Table 1 presents the criteria exceeded by potential Development Area COCs in ground water, surface water and/or unconsolidated materials (including non-CKD and CKD).

Groundwater (monitoring well samples):

Residential Drinking Water Criteria	chloride, sum of potential nitrogen sources, ammonia nitrogen as N, TDS, sulfate, pH, aluminum, arsenic, barium, beryllium, chromium, iron, lead, magnesium, manganese, mercury, nickel, selenium, sodium, thallium, vanadium, bis(2-ethylhexyl)phthalate
Groundwater Surface Water Interface Criteria	chloride, % ammonia that will become NH_3 in surface water, TDS, pH, antimony, arsenic, chromium, copper, lead, mercury, nickel, selenium, silver, vanadium, zinc

Unconsolidated Materials (non-CKD and CKD):

Drinking Water Protection Criteria	sum of potential nitrogen sources, total phosphorus, sulfate, aluminum, arsenic, chromium, iron, lead, magnesium, manganese, sodium, thallium
Groundwater Surface Water Interface Protection Criteria	chromium, selenium, manganese
Direct Contact Criteria	chloride, arsenic

Surface Water:

Surface Water Human Non-Cancer Drinking and Non-Drinking Water Criteria	antimony, mercury, lead, arsenic
Final Chronic and Acute, Aquatic Maximum and Wildlife Values	copper, mercury, lead, nickel, selenium, silver, vanadium, zinc
MI Part 4 Water Quality Standards – Rules 50, 51, 53, and 60	chloride, pH, TDS

Table 1. Criteria exceeded by potential Site COCs in ground water, surface water and/or unconsolidated materials (including non-CKD and CKD) (from RI Report, p. 163).

- Potential COCs may be released from the CKD piles through leaching by infiltration of ground water or from a breach of cover soils. Once released from the source area, COCs can move along potential exposure pathways as leachate in ground water; leachate; particulates transported as a solid; suspended sediment in runoff; or as an airborne particle. Of these five potential migration routes, only leachate in ground water and leachate are likely.
- Due to variations in geology, ground water and CKD location, the West CKD Area, Seep 2 CKD Area and Seep 1 CKD Area each exhibit distinctly different ground water/leachate migration routes.
- All of the potential Development Area COCs identified are inorganic and are not subject to biodegradation, with the possible exception of ammonia. Many of the COCs are subject to changes in oxidation states (they are able to react with other atoms), or may react in precipitation (when a chemical comes out of solution as a solid) or adsorption reactions (when a chemical adheres or sticks onto the surface of a particle).

- The migration of the potential Development Area COCs is controlled by a number of factors. Movement (advection) of leachate/ground water is likely the predominant migration mechanism, but will only be significant in areas of downward or lateral gradients (i.e., when the gradient is "flat," the flux of contaminants to Little Traverse Bay will be minimal). Lake Michigan is the regional ground water discharge area for the aquifer beneath the Development Area.
- Site COCs for source material by Development Area are presented in Table 2.

Parameter	COC?	West CKD Area	Seep 2 CKD Area	Seep 1 CKD Area
Soil				
Chloride	Y	√	√	√
Arsenic	Y	√		√
Ground water				
General				
Chloride	Y	√	√	√
Nitrogen-Nitrate	N			
Sum of Potential Nitrogen Sources	N			
Nitrogen-Ammonia	Y		√	√
% Ammonia that will become NH_3 in Surface Water	Y	√	√	√
pH (standard units)	Y	√	√	√
Total Phosphorus	N			
Total Dissolved Solids (TDS)	Y	√	√	√
Sulfate	Y	√	√	√
Metals				
Aluminum	Y	√	√	√
Antimony	N			
Arsenic	Y	√		√
Barium	N			
Beryllium	N			
Cadmium	N			
Chromium	N			
Copper	Y	√	√	√
Iron	Y	√	√	√
Lead	Y	√		
Magnesium	N			
Manganese	N			
Mercury	Y	√	√	√
Nickel	Y	√	√	√
Selenium	Y	√	√	√
Silver	Y	√	√	√
Sodium	N			
Thallium	N			
Vanadium	Y	√	√	√
Zinc	N			
Volatile Organic Compounds (VOCs)	N			
Semivolatile Organic Compounds (SVOCs)	N			

Table 2. Identification of Development Area COCs for Source Material by Site Area (based on Tables 7-1a, 7-1b and 7-1c from the RI Report).

2.8 Summary and Conclusions

- Collection trenches have been installed in the West CKD, Pine Court, Guard Rail, Seep 2 CKD and Seep 1 CKD Areas. Augmentation has been implemented by CMS at all seep areas.
- Most of the effectiveness monitoring data show the continued effectiveness of the Development Area ILRS. CMS expects to see a continued decline in the number of pH exceedances.
- Surface water investigations at Lake Michigan indicate that surface water is not a source of significant exposure to potential COCs other than pH.
- Preferential ground water pathways were identified and aquifer characteristics were determined, which allows CMS to evaluate the feasibility of alternative final remedial systems and compare their expected performance to support final remedy selection.

Section 3. The AE Report

3.1 AE Report Background

- The AE Report is intended to evaluate the remedial alternatives that have been developed as potential options for long term remediation for the West, Seep 2 and Seep 1 CKD Areas.
- The AE Report describes the remedial action alternatives, the extent of affected media, and criteria used to determine which remedial alternative will be most effective at the Development Area.

Interim Response (IR) Actions

- Leachate Migration Controls have been installed in the West CKD Area, Pine Court Seep Area, Seep 2 CKD/Guard Rail Seep Area and Seep 1 CKD Area.
- Pine Court Seep Area used a Carbon Dioxide (CO_2) Pilot Injection System beginning in 2006. Although the system was somewhat effective in reducing pH, delivery of CO_2 to the trench was unable to completely control the high flow rate of moderately elevated pH in certain areas of the shoreline, and use of the Pilot Injection System was terminated in 2009.
- The Seep 2 CKD Area Targeted Leachate Collection Pilot System (TLC System) was installed and operated beginning on May 30, 2008.
- Installation of a slurry wall vertical barrier downgradient of the Seep 1 CKD Area east beach collection drain was completed on October 11, 2008.
- Leachate Generation Controls used at West CKD Area as part of IR actions included the removal of 12,435 tons of CKD-impacted soil, which was completed on February 5, 2009.

Effectiveness of IR Actions

The effectiveness of the IR actions at protecting human health and the environment is evaluated through the following three lines of evidence: (1) effectiveness monitoring – lakeshore pH control; (2) mercury flux analysis; and (3) surface water quality data.

- There has been significant improvement of lakeshore conditions relative to the initial targeted shoreline survey. This demonstrates that the IR is generally effective at controlling pH in the Lake.
- There have been no pH exceedances in the West CKD Area during the April and May 2009 effectiveness monitoring events.

- The Pine Court Seep Area has only had one exceedance noted during effectiveness monitoring that occurred after leachate collection was resumed in May 2009. For all other lakeshore and pool measurements, the only low-level exceedences of pH in the lakeshore were at Seep 2 CKD Area on October 5, 2006. The pH readings ranged from 9 to 9.19, with specific conductance values at or below that expected for the Lake. As such, these lakeshore pH low-level exceedences were potentially due to localized algal influence, since specific conductivities were low. Conductivity is a measure of how well a solution conducts electricity. Since pure water is a poor conductor, conductance gives an estimate of the degree of impurity of the water sample.
- During the most recent effectiveness monitoring in May 2009, no exceedances were recorded at the Seep 1 CKD Area.
- An analysis of mercury flux in ground water was performed to estimate the amount of mercury flux towards Lake Michigan before the implementation of the IR actions (pre-IR) as compared to conditions after the implementation of the IR actions (post-IR or existing). The estimated mercury flux removed by IR actions (excluding any contribution from temporary beach collection at Pine Court Seep Area) is 40.7 milligrams/day.

In summary, the IR actions appear to be effectively mitigating all parameters evaluated.

Site Conceptual Model

- *West CKD Area:* Perched ground water (ground water separated from the main body of ground water by an unsaturated zone) saturates the CKD and is the main mechanism of leachate generation. The leachate migrates toward and discharges near the IR drain.
- *Seep 2 CKD Area (Seep 2 Seep, Guard Rail Seep and Pine Court Seep Area*s): Cement kiln dust is saturated by ground water perched above the marker shale. Interim Response drains are effectively controlling leachate in the Seep 2 and Guard Rail Seep Areas. Leachate from Pine Court Seep Area is primarily generated in the vicinity of Seep 2 recovery well 1 (S2RW-1); it then migrates to the Pine Court Beach Area where this mixed and attenuated leachate migrates to the Pine Court IR drains. The existing TLC extraction system and operation of the IR drains in the Pine Court Seep Area are positively affecting discharge in the Pine Court Seep Area.
- *Seep 1 CKD Area*: The leachate generation mechanisms at Seep 1 CKD Area are shallow interflow that contacts CKD near the bedrock surface in the western portions of the pile and regional ground water saturating CKD in the central portion of the pile. While municipal well pumping influences the hydraulic gradient, it does not significantly affect leachate migration. Saturated CKD exists in the western and central portions of the Development Area. Leachate discharged in this area is effectively controlled by existing IR drains and the vertical barrier wall.

3.2 Identification and Screening of Technologies: Remedial Action Objectives, ARARs, General Response Actions, Identification of Screening Technology Types and Process Options, Alternative Assembly and Screening Evaluation, Alternative Screening

A broad range of remedial technologies were screened, combined into alternatives and evaluated. Remedial Action Objectives (RAOs) are the basis for evaluating possible remedial technologies and remedial action alternatives. Further response activities are required to integrate the IR actions as appropriate and ensure adequate financial resources. Remedial Action Objectives for the Development Area consider current and potential future risk and comply with Applicable or Relevant and Appropriate Requirements (ARARs) and are:

- Protection of human health by reducing exposure to soil, ground water, and surface water exceeding water quality standards.
- Protection of the environment by minimizing leachate migration.

Contaminants of Concern

- Remedial Action Objectives were established (either using state or federal standards, whichever is more stringent) for soil/CKD, ground water, surface water and site-specific COCs. The State of Michigan Part 201[1] criteria were identified as the most stringent ARARs for both CKD leachate and surface water impacted by ground water venting.
- Contaminants of concern identified for soil and ground water at the Development Area are shown in Table 2 (Section 2.7).
- The Development Area meets the conditions contained in the laws and rules that govern mixing zones at the ground water/surface water interface (GSI). An application for the Michigan Department of Environmental Quality (MDEQ) to develop final mixing zone-based GSI cleanup criteria will be pursued as appropriate for the Development Area remedy.

Site-specific response actions that were screened, evaluated and retained were as follows:

Soil (CKD)

- No action (retained as control).
- Institutional controls.
- Removal by excavation with off-site disposal.
- Excavation and reuse, and excavation and treatment with off-site disposal or reuse.
- Containment and isolation by containment cell construction, horizontal barriers, vertical barriers and consolidation.
- In-situ treatment.

Ground Water

- No action (retained as control).
- Institutional controls.
- Removal by extraction wells or collection trenches.
- Containment and isolation by upgradient extraction wells, upgradient collection trenches, vertical barriers and horizontal barriers.
- Monitored natural attenuation.

Leachate Management Response Actions

- On-site treatment at a wastewater treatment facility with discharge to surface water via a new National Pollutant Discharge Elimination System (NPDES) permit.

---

[1] For background information on Michigan Part 201 Generic Criteria see http://www.michigan.gov/deq/0,1607,7-135-3311_4109_9846_30022-101581--,00.html

- On-site pretreatment and disposal to an off-site Publicly Owned Treatment Works (POTW) for treatment and discharge to surface water via an existing NPDES permit.
- Off-site disposal using deep well injection. On-site disposal at a deep well was included in the screening of process options as per MDEQ's request.
- Off-site land application of collected leachate.
- Evaporation of leachate using an off-site evaporation pond.

The retained technology types and process options were combined and assembled into alternatives and screened against short and long term aspects of effectiveness, implementability and cost.

3.3-3.4 Development and Screening of Alternatives. Detailed Analysis of Alternatives: Introduction, Individual Analysis of Alternatives, Comparative Analysis

Alternative 1: No Action

- This was considered as a baseline for comparison of other remedial actions.

Alternative 2: Existing IR Actions

- This alternative consists of ground water migration control, targeted CKD removal, containment and isolation, natural attenuation, institutional controls, and treatment and disposal of ground water combined to form a remedial alternative representative of the existing Development Area conditions.
- Institutional controls consist of ground water use limitations. The Development Area is expected to continue to be used as a golf course with adjacent mixed residential and recreational land uses. Maintenance of the existing vegetated cover would be part of the long term operation and maintenance (O&M) for the Development Area. Ground water use restrictions would prohibit the use of ground water as a drinking water source.

Alternative 3: Existing IR Actions and Targeted Surface Water Improvements

- This alternative includes the existing CKD cover system, which will be modified to provide surface water drainage at locations identified as potential recharge areas (e.g., surface depressions where ponding occurs) in and around the Pine Court Seep Area CKD extent. Storm sewer system improvements along Pine Ridge Court and Coastal Drive to collect surface runoff are also included in this alternative.
- Surface water improvements within the existing CKD extent are expected to reduce infiltration water that migrates downward into and across the top of the CKD. Surface water improvements upgradient of the CKD extent are expected to reduce infiltration water that infiltrates and migrates northward as interflow across the top of rock and seasonally saturates CKD near the bottom of the pile.

Alternative 4: Existing IR Actions, Targeted Surface Water Improvements, and Targeted Upgradient Diversion

- In this alternative, upgradient perched ground water diversion will be provided using ground water extraction wells installed above the marker shale south of Pine Court Seep Area along Coastal Woods Court. Perched ground water diversion will reduce perched ground water flow and elevations on top of the marker shale. Reducing perched ground water elevations will decrease the saturated thickness of CKD in the Pine Court Seep Area, thereby minimizing generation of impacted ground water.

- Reducing impacted perched ground water flow and the mass of mercury in that flow with perched ground water diversion is expected to significantly aid the existing Development Area ILRS at minimizing mercury flux to the Lake.

Alternative 5: Existing IR Actions, Targeted Surface Water Improvements, Targeted Leachate Collection, and Targeted Upgradient Diversion

- This alternative consists of all paired technology types and process options detailed in Remedial Alternative 4 with migration and source generation control of impacted ground water by means of TLC.
- The existing TLC System will be expanded and integrated into the existing Development Area ILRS. Similar to perched ground water diversion, TLC will reduce perched ground water flow and elevations on top of the marker shale.

Alternative 6: IR Actions, Targeted Impermeable Cover System, and Targeted Upgradient Diversion

- This alternative consists of all paired technology types and process options detailed in Remedial Alternative 5 with containment and isolation provided by consolidation of CKD and a targeted impermeable cover system.
- As part of this alternative the smaller disconnected CKD area west of Coastal Woods Court, ‘dogbone area,’ may be removed and consolidated with the main Pine Court Seep Area. Cement kiln dust removal from the dogbone area is expected to, in time, progressively aid the Pine Court Seep Area west collection drain at controlling lakeshore pH and minimizing mercury flux to the Lake.
- Infiltration of precipitation and irrigation water contacting CKD in the approximate Pine Court Seep Area would be substantially eliminated by: contouring the pile to promote positive drainage and prevent ponding; constructing a 4-foot soil cover system over an approximate 16-acrea area that incorporates a flexible membrane liner; constructing a surface water drainage system; and establishing vegetation to minimize erosion and promote evapotranspiration.

Alternative 7: Modified IR Actions, Targeted Removal

- This alternative consists of CKD removal from the entirety of the Pine Court Seep Area and as described in Remedial Alternative 2: active ground water migration control with existing IR actions except collection from the Pine Court Seep Area ILRS, natural attenuation, institutional controls, and treatment and disposal of ground water.
- Approximately 350,000 cubic yards of CKD and impacted overburden will be removed from the entirety of the Pine Court Seep Area.
- Excavation, dewatering, and dust control best management practices are expected to increase the quantity and worsen the quality of leachate during removal activities. Excavation also exposes previously covered non-weathered and unsaturated CKD to precipitation, which will add to the leachate that must be managed. Increased gradients resulting from dewatering will produce increased flow rates toward the excavation area and through surrounding unexcavated CKD.

- Complete CKD removal from the Pine Court Seep Area would, in time, result in substantial elimination of high pH discharge and mercury flux to the Lake from the existing Pine Court Seep Area CKD source.

Alternative 8: Removal

- This alternative consists of removal of CKD from the entirety of the Development Area and is expected to take five construction seasons to complete. It is anticipated that dewatering of ground water will be required during the removal. The dewatering flow will be treated to neutralize high pH CKD-impacted ground water and discharged to the Lake.
- Cement kiln dust would be removed from the entirety of the Development Area, loaded into trucks, and transported to a Resource Conservation and Recovery Act (RCRA) Subtitle D landfill for disposal as nonhazardous waste.
- None of the IR actions installed at the Development Area are used in this alternative; therefore this alternative is inconsistent with the AOC.

Detailed Analysis of Alternatives

The National Contingency Plan (NCP)[2] criteria were used as a basis to compare the relative advantages and disadvantages of each alternative. The criteria include:

1. Protection of human health and the environment.
2. Compliance with ARARs (chemical-, action- and location-specific ARARs and other advisories).
3. Long term effectiveness (remaining risk, effectiveness of controls).
4. Reduction of toxicity, mobility, and volume (through treatment, remaining contaminants after treatment).
5. Short term effectiveness (protection of community and workers during remedial action, environmental impacts, time to complete remedial actions).
6. Implementability (reliability, availability of off-site treatment, equipment, technologies).
7. Cost (capital, operating and maintenance).
8. Community acceptance.
9. State acceptance

Criteria included under numbers 1 through 7 were used in this detailed analysis of alternatives. The overall score is used to rank the alternatives and is developed from individual scores that are based on the ability of the alternative to meet each of the seven criteria. Each of the seven criteria is weighted evenly and a score between 1 and 5 is assigned. A score of 1 is assigned when low achievement of the criterion is expected, 3 when moderate achievement is expected, and 5 when high achievement is expected. Intermediate scores of 2 and 4 are assigned when low to moderate and moderate to high achievement is expected. The highest achievable overall score is 35. Table 3 includes the score of each alternative.

---

[2] U.S. EPA, 2003. *Subchapter J – Superfund Emergency Planning, and Community Right-to-Know Programs, Part 300 – Nationwide Oil and Hazardous Substances Pollution Contingency Plan,*[40 CFR Ch. I (7-1-03 Edition)].

Alternative Analyzed	Total Score	Comments
1 – No Action	15	This alternative is not expected to meet the objectives for protection of human health and the environment; compliance with ARARs; short or long term effectiveness; or reduction in toxicity, mobility, or volume (TMV) through treatment.
2 – Existing IR Actions	25	This alternative is expected to meet the RAOs for soil and ground water.
3 – Existing IR and Targeted Surface Water Improvements	25	This alternative is more favorable than Alternative 2 because of increased long term effectiveness expected from surface water improvements at a small cost relative to other alternatives; however the improved effectiveness was not substantial enough to warrant higher scoring for long term effectiveness.
4 – Existing IR, Targeted SW Improvements, and Targeted Upgradient Diversion	26	This alternative achieved a higher score for long and short term effectiveness because both impacts to ground water and the flow of impacted ground water will be reduced, thereby reducing the overall mercury flux to the Lake relatively soon after implementation. However, perched ground water diversion may require an extensive design investigation and increased levels of long term O&M, adding to the costs. This alternative achieved a lower score for cost criterion.
5 – Existing IR, Targeted Surface Water Improvements, Targeted Upgradient Diversion, and Targeted Leachate Collection	27	This alternative achieved higher achievement of TMV criterion because TLC increases the volume of impacted ground water collected and treated to reduce pH. This alternative also has higher long term effectiveness because TLC and targeted diversion together result in a greater overall mercury flux reduction. However, the improved effectiveness was not substantial enough to warrant higher scoring.
6 – IR, Targeted Upgradient Diversion, and Targeted Impermeable Cover System	23	This alternative had lower achievement of TMV, implementability, and cost criterion when compared to Alternative 5. This alternative does not include long term TLC and has a higher overall cost than Alternative 5.
7 – Modified IR and Targeted Removal	21	This remedy is expected to meet the soil and water RAOs in the long term, but direct discharge of excavation water to the Lake might not meet water ARARs in the short term.
8 – Removal	17	This remedy is expected to meet the soil and water RAOs in the long term, but direct discharge of excavation water to the Lake might not meet water ARARs in the short term.

Table 3. Comparative Analysis of Alternatives Evaluated against NCP Criteria.