APPENDIX R

Evaluation of Human Health Risk from the Confined Disposal Facility

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IHNC Lock Replacement Project

Evaluation of Human Health Risk from the Confined Disposal Facility (CDF)

19 March 2009

Lance W. Fontenot, Ph.D.
Principal Scientist/Toxicologist

Dana A. Lawton, P.E.
Principal Engineer/Civil

Rudy J. Guichard
Senior Vice President/Principal in Charge

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Prepared for:
U.S. Army Corps of Engineers

Prepared by:
Bioengineering ARCADIS, LLC
3850 North Causeway Boulevard
Suite 1600
Metairie
Louisiana 70002
Tel 504 832 4174
Fax 504 832 2145

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1. Introduction

The Inner Harbor Navigation Canal (IHNC) Lock Replacement Project has been proposed to relieve navigation traffic congestion associated with the existing IHNC (i.e., Industrial Canal) Lock, located between the St. Claude Avenue and Claiborne Avenue Bridges in New Orleans, Louisiana (Figure 1). The IHNC Lock allows for navigation between the higher water surface elevations of the Mississippi River and the lower water surface elevations of the IHNC, the eastern portion of the Gulf Intracoastal Waterway (GIWW), and the Mississippi River Gulf Outlet (MRGO).

Installation of the new lock will require dredging of approximately 2.22 million to 3.44 million cubic yards of sediment and soil from the IHNC. Material found to be suitable for freshwater disposal would be discharged into the Mississippi River, used as backfill around the new lock, and used to create wetlands. An upland confined disposal facility (CDF) has been proposed to accommodate dredged material that has either been determined to be unsuitable for discharge into open water or would be temporarily stockpiled and later utilized as backfill around the lock construction site.

The purpose of this document is to evaluate the potential risks to human health associated with the proposed CDF. While the completed CDF is designed to eliminate exposure to both humans and the environment, there is public concern over a potential failure of the facility both during and after construction. To address these concerns, the following report includes a review of the conceptual design of the CDF and evaluation of potential human health risks based on the following scenarios:

- Risks during filling of the CDF:
  - Non-catastrophic scenarios
  - Catastrophic failure scenarios
- Risks after closure of the CDF:
  - Non-catastrophic scenarios
  - Catastrophic failure scenarios

Results of the engineering risk review and the human health evaluation show that the number of exposure pathways that could result in impacts to human health is limited, especially after closure of the facility. While a potential catastrophic failure of the facility was evaluated, given the current improvements underway in the storm protection system surrounding the location of the proposed facility, it is unlikely that a failure of this magnitude would occur. Human health risks from contact to dredged material placed in the facility even under an extreme failure are minimal based on comparison to conservative risk standards assuming no dilution of the dredged materials after release from the CDF. Risks after construction are considered to be even lower.

2. Background

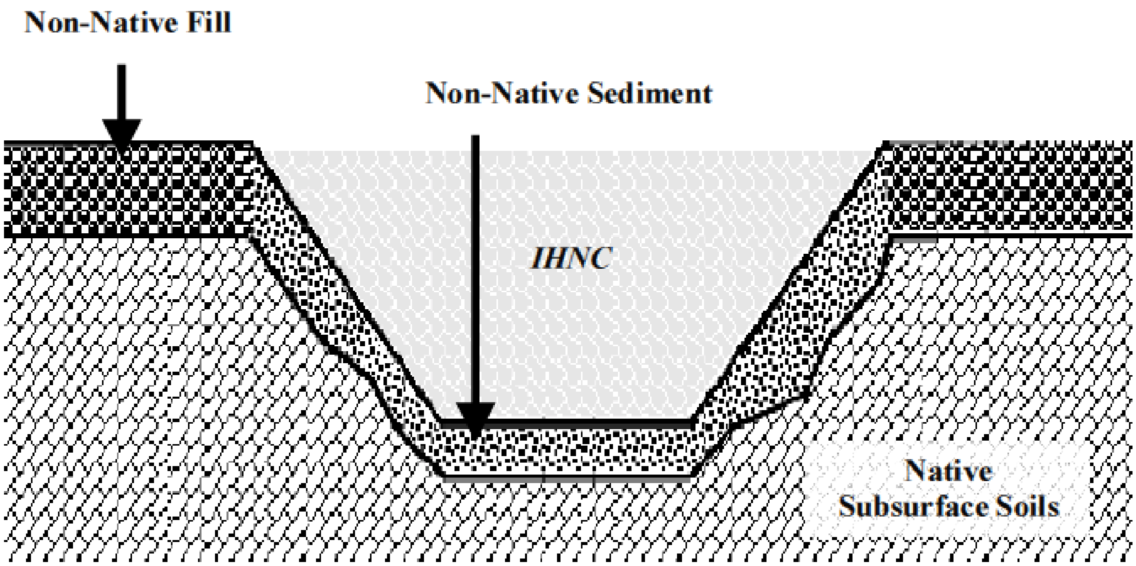
2.1 Purpose of Dredging

The U. S. Army Corps of Engineers (USACE), New Orleans District has been authorized by Congress to replace the existing Industrial Canal Lock. A larger lock would replace the existing lock, which has been in operation since 1921, to accommodate a heavier traffic load and modern deep draft vessels. As part of the construction project, sediment and soil from the area would be dredged to accommodate the new lock, allow ship traffic to bypass the construction site, and deepen the current channel through the IHNC. Installation of the new lock will require dredging of approximately 2.22 million to 3.44 million cubic yards of soil and sediment from the IHNC. The exact amount of material that will need to be dredged depends on the installation technique that will be selected to construct the new lock. Large portions of the material to be dredged are assumed to be suitable for open water disposal; however, approximately 316,800 to 439,300 cubic yards of the material was considered unsuitable for open water disposal due to concentrations of chemicals of potential concern (COPCs) present and will require permanent placement in an upland facility. Dredged material needed for future fill at the lock construction site would also be placed in a CDF. The fill materials are materials that were found to be suitable for open water placement in both freshwater and marine environments. The CDF cells used for stockpiling of fill would be temporary. The fill material would be removed after dewatering and the dikes taken down after the facility was emptied.

2.2 Summary of Available Data

Dredged material was evaluated by the USACE to determine the appropriate placement site alternatives (USACE, 2008b). Material to be discharged into the Mississippi River must meet criteria for open water placement in accordance with 404(b)(1) guidelines. Placement as backfill around the new lock or for creation of new wetlands might be considered open water placement, upland placement, or beneficial use, depending upon whether this occurs as part of the dredging disposal operation or after dewatering in a CDF, the degree of containment employed, and the resulting discharges to the receiving water body. The governing regulations will be dictated by these conditions. Dredged material was first evaluated for suitability for open water disposal, in accordance with the protocols specified in the national guidance, Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Inland Testing Manual (U.S. Environmental Protection Agency [USEPA/USACE, 1998]). This evaluation resulted in the determination that non-native materials in Dredged Material Management Units (DMMUs) 1, 2, 5, and 7 were unsuitable for open water disposal. Dredged material found unsuitable for open water disposal, as well as suitable materials planned to be stockpiled for lock backfill, was evaluated for upland placement in accordance with the relevant protocols specified in the Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Upland Testing Manual (USACE, 2003).

For the purpose of sampling and analysis activities, the IHNC construction project was divided into DMMUs (Figure 2) based on sediment characteristics (i.e., non-native sediment or fill versus native subsurface soil), depth of dredging, and known or suspected areas of contamination. Non-native sediment is unconsolidated material that has deposited naturally within the canal since the IHNC was constructed in the 1920s, while non-native fill is material that was placed adjacent to the canal for industrial development since construction of the IHNC. Native subsurface soil is the material at or below the depth of the original canal cut and consists of clays and alluvial formations (Weston, 2008). Samples were also taken from within the disposal areas and from adjacent reference areas previously not directly impacted by dredged material placement (Mississippi River upstream of the IHNC and Saint Bernard central wetlands).



Taken from Appendix C, Supplemental Environmental Impact Statement (SEIS; USACE, 2008b)

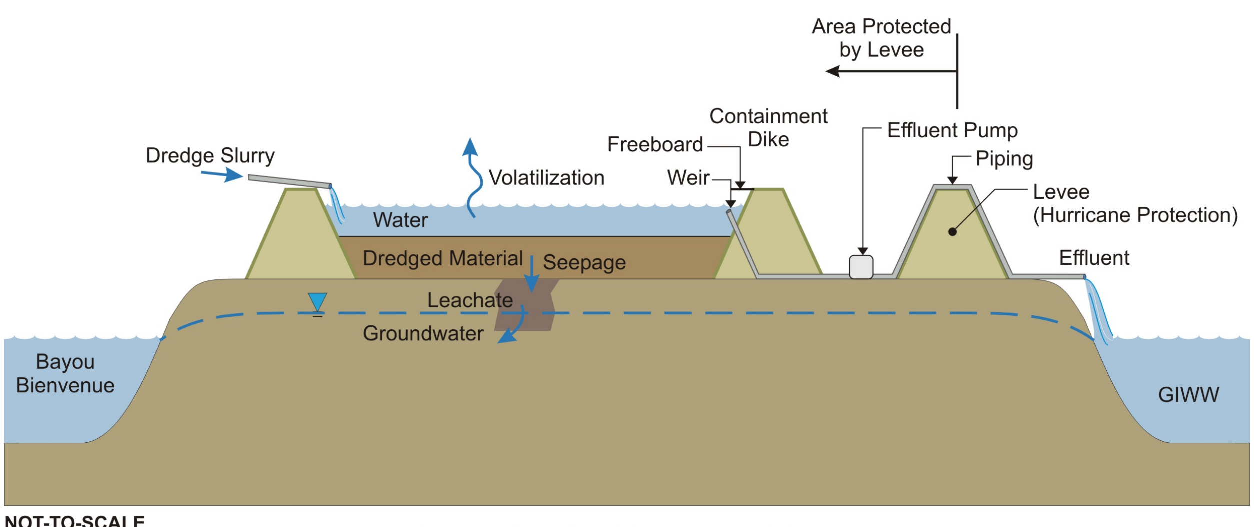
Multiple sediment cores (representative of dredged material) were collected at sampling stations within each DMMU down to the target depth of dredging. Physical and chemical measurements were performed on the samples collected from each individual station and their elutriates. Solid phase and elutriate biological tests were performed on single composites of all stations from within each DMMU. Results from the dredged material evaluation were used to characterize each DMMU and determine acceptable disposal options for each dredging unit, as described in detail in the SEIS, Appendix C (USACE, 2008b).

The majority of the material to be dredged was found to be suitable for open water placement. However, material from four DMMUs was found to be unsuitable for open water placement: DMMUs 1, 2, 5, and 7. These sediments represent the material proposed for permanent placement in the CDF, and chemical results from the samples from these DMMUs are further evaluated within this document for potential risk to human health.

Further evaluation was conducted to assess potential impacts to nearby receiving waters from the effluent and runoff from the CDF based on comparison to appropriate water quality criteria. Results from these tests were used to prepare a conceptual design for the CDF (as discussed below) to predict and eliminate unacceptable impacts.

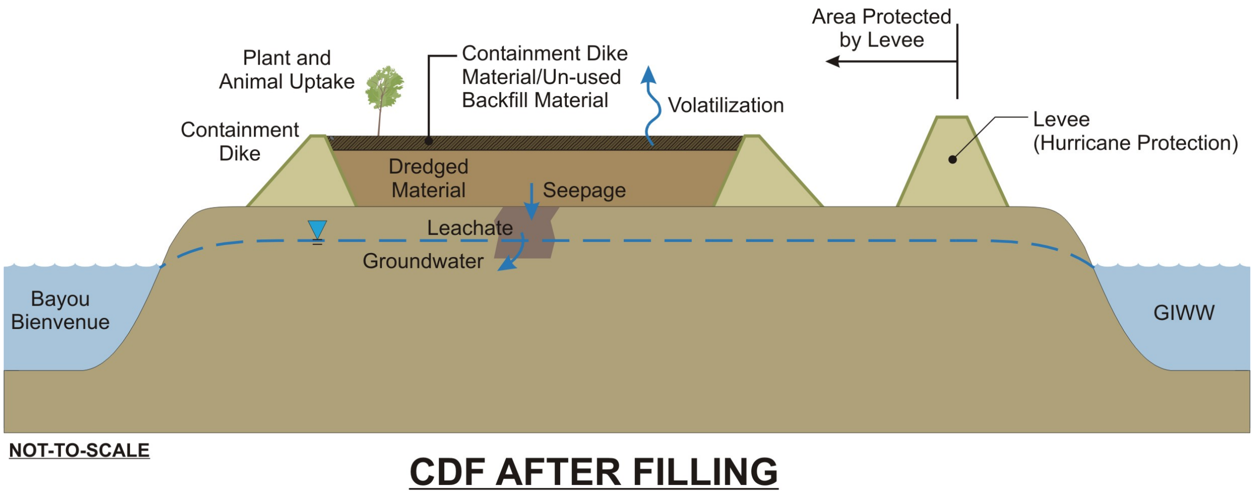
2.3 Description of Planned CDF

The USACE prepared a conceptual design for the proposed CDF in 2008 (USACE, 2008a; SEIS, Appendix E [USACE, 2008b]). The design report describes the planned CDF location and features of the CDF. It describes the results of analyses that were performed as part of the conceptual design. The two figures below show the conceptual models of the proposed CDF during active filling events (which will take place in approximately years 1, 2 or 3, and 7) and after closure. Not depicted are interim year conditions, when water will be fully decanted and the surface of the sediment exposed. During those periods, active dewatering, vegetation control, and runoff management are planned. Assessment of the potential engineering risks under the scenarios discussed above is provided in an appendix to this document. Each risk is described and the level of assessment provided in the CDF conceptual design report is noted (USACE, 2008a). A qualitative assessment of the level of risk and mitigation measures that can be employed to reduce the risk is provided.



CDF DURING FILLING

Note: Interim year conditions are not depicted; during these temporary periods there will be no influent or effluent and the materials will consolidate and the sediment surface potentially exposed.



2.3.1 CDF Location and Surrounding Land Use

The site for the planned CDF is located in Orleans Parish and is approximately 1.5 to 2 miles to the northeast from the location of the new lock. Figure 1 shows the location of the planned CDF. The CDF site is bounded by the GIWW to the north and Bayou Bienvenue to the south.

The site is currently undeveloped. Disposal of dredged materials from dredging operations occurred on this site in the 1950s and the surface soils within the CDF footprint consist of dry, hard, organic silty clays. Wooded lands are present in the footprint of the CDF. Dominant vegetative species within these woodlands consist of a mix of hardwood trees and herbaceous (non-woody) plants. Due to Hurricane Katrina, very little mature vegetation remains in this area. These woodlands are periodically flooded, primarily from rainfall, and are subject to tidal influence. Other than rain events and high tides, this area is not hydraulically connected to nearby water bodies (i.e., GIWW, Bayou Bienvenue). Following consolidation, the CDF will be revegetated. Therefore, the proposed use of the site as a dredged material disposal area is not considered to be incompatible with present land uses in the immediate area.

Surrounding land use within a 1-mile radius includes a salvage yard to the west and undeveloped land to the east, which extends to Paris Road. Bayou Bienvenue borders the site to the south, and the GIWW borders the site to the north. To the south of Bayou Bienvenue and its associated wetlands is the residential neighborhood of the Lower Ninth Ward, which is located approximately 1 mile from the proposed CDF location. The Lower Ninth Ward, heavily impacted by flooding during Hurricane Katrina, is primarily residential with an industrial area located along the IHNC. Jackson Barracks (a U.S. Army National Guard facility) is located along the eastern boundary of this neighborhood. Land use to the north of the GIWW is a mix of undeveloped parcels and industrial facilities (e.g., railroad). There is likely some recreational use of the GIWW and Bayou Bienvenue in the area of the site for activities such as fishing, crabbing, and boating.

The groundwater table typically occurs in the shallow natural levee deposits (silty clays) within 10 feet of the ground surface. Underlying the 15- to 40-foot thick levee deposits is a fairly continuous, fine sand to silty fine sand unit, which is known as the “100-Foot Sand”. The “100-Foot Sand” may extend to depths of 150 feet or more. Individual sand deposits are discontinuous and have relatively low permeability and yield rates (Rollo, 1966). Groundwater is not used for drinking water purposes in the New Orleans area. Water is taken exclusively from the Mississippi River and treated in municipal water works before consumption. All public water supplies in the lower Mississippi River area of Louisiana are drawn from the river. The higher salinity values in aquifers of this area render the water too difficult to treat for general use (Hossman, 1972). The potential future use of groundwater in this area is therefore severely limited. Based on a search of registered water well listings, no drinking water wells exist within a 1-mile radius of the proposed CDF.

Using the criteria defined in the Risk Evaluation/Corrective Action Program (RECAP) (Louisiana Department of Environmental Quality [LDEQ], 2003), groundwater is classified based on the current use of the aquifer, the total dissolved solids (TDS) present, and the specific yield. The shallow groundwater zone likely to occur beneath the site is not likely to produce adequate quality or quantity of groundwater which is supported by the results of a 1-mile radius water well survey which found no demonstrated use and regional information for the New Orleans area. Based on these considerations, the shallow zone groundwater at the site has a presumptive designation of Groundwater Classification 3A (non-drinking water). This groundwater classification is similar to other sites in the New Orleans area that have been examined by LDEQ.

2.3.2 Operation of the CDF

The CDF would consist of two large cells. The east area cell would be used for disposal of material requiring permanent upland disposal, while the west area cell would be used for temporary disposal and dewatering of reusable dredged material. The site was previously used for disposal of dredged material and there still are visible remnants of the old containment dikes. The new containment structures along the outer perimeter of the east and west area cells will also consist of containment dikes. The dikes will be constructed using locally available fill soils. Weirs and pumps will be installed as necessary to remove clarified water from the CDF.

Dredging of the IHNC will be accomplished using hydraulic dredges. The dredged material will be pumped as a slurry, via pipeline, to the CDF. The CDF will serve as a settling pond for the dredged material. The dredge slurry will enter the CDF at one end, dredged material will settle out, and the clarified water will leave the CDF via a weir at the opposite end of the CDF. From the weir the clarified effluent (water produced during dredging) will be routed to the GIWW. This decanting process is designed such that water quality criteria are met within a specified mixing zone in the receiving water body. The mixing zone takes into consideration the relative flow of the discharge and the receiving water body, dissolved contaminant concentrations in each, and magnitude of dilution required to meet applicable water quality criteria and toxicity-based dilution requirements. Additional information on this process is provided as part as the engineering risk evaluation in the appendix.

After completion of dredging, the dredged material will be dewatered through active management to promote drainage. As the material dries and consolidates, trenches will be dug around the perimeter of the dikes and in the dredged material. Water will be removed from the facility through evapotranspiration and pumping to the receiving water, as necessary. Material remaining in the temporary disposal cell (materials stockpiled for construction fill) will be available for use as final clean cover of the permanent CDF cell. After final placement of dredged material and cover layer, plants and soil organisms are expected to colonize the site ultimately leading to a habitat similar to that at the site prior to its use as a CDF.

3. Human Health Risk Evaluation

The human health risk evaluation describes the potential contact between people and chemicals of potential concern (COPCs) in environmental media. The environmental medium being considered in this risk evaluation is the dredged material proposed for placement in the CDF. The COPCs in the sediment were identified by comparing the concentrations of various chemical constituents found in the sediments to LDEQ RECAP Screening Standards. These COPCs were then further evaluated for potential risk to humans based on general exposure pathways identified in the engineering risk review in the appendix and further defined in conceptual site models (CSMs) developed for each disposal scenario described previously. The evaluation of these exposure pathways and the associated risk are described below.

3.1 Exposure Assessment

The exposure assessment includes the following:

- The Identification of current and potential future land uses at and in the vicinity of the site (described above);
- The identification of potentially exposed populations;
- The identification of potential current and future exposure pathways; and
- The quantification of representative concentrations of COPCs that someone might be exposed to over time (exposure point concentrations), which are then compared to acceptable RECAP Screening Standards.

Based on available site-specific information, the receptors, exposure media, and exposure routes considered to be potentially complete and to warrant potential quantification are summarized below. In general these exposure pathways were evaluated by the USACE during the conceptual design of the CDF (SEIS, Appendix E [USACE, 2008b]) and discussed in the appendix to this document. Pathways and associated risks not completely addressed by the USACE are also considered below.

Risk Scenario	Exposure Pathway and Receptor	Assumptions
Non-catastrophic risk during filling	Trespassers (e.g., off-site recreational receptors) to COPCs in dredged materials and surface water via incidental ingestion and dermal contact	Access to the site by recreational users is limited by fencing; unsuitable fish habitat
Catastrophic failure during filling	Recreational receptors to COPCs in transported dredged materials via incidental ingestion, dermal contact, and/or fish consumption; trespassers via incidental ingestion and dermal contact; workers via incidental ingestion and dermal contact	Worst-case scenario; transported dredged materials conservatively assumed to reach receptors with no dilution; although not expected, residential RECAP soil standards are utilized that take into account any remote possibility of residential exposures
Non-catastrophic risk after closure	No exposure pathways identified	With no exposure, no risk to human health or the environment would be expected
Catastrophic failure after closure	Recreational receptors to COPCs in transported dredged materials via incidental ingestion, dermal contact, and/or fish consumption; trespassers via incidental ingestion and dermal contact; workers via incidental ingestion and dermal contact	Unlikely exposure with potential risks lower than worst-case scenario of failure during filling

COPCs Chemicals of potential concern.

RECAP Risk Evaluation/Corrective Action Program.

For an exposure pathway to be complete, the following elements must be present: (1) a source or chemical release from a source (includes primary and secondary sources); (2) fate and transport mechanisms in release media; (3) an exposure point where contact can occur (i.e., potential areas of exposure within a 1-mile radius of the site); (4) a receptor population at the exposure point; and (5) an exposure route (e.g., ingestion, dermal contact, inhalation) by which contact can occur. An exposure pathway that lacks one or more of these elements is considered to be incomplete. The above information is used to estimate potential exposures under current and reasonably foreseeable land uses at the site and surrounding areas.

3.1.1 Identification of COPCs

COPCs were identified based on comparison of chemical concentrations found in the sediments and soils proposed for dredging to established screening criteria described below. Data were compared to LDEQ RECAP non-industrial soil standards ($Soil_{SSni}$), which represent risk-based constituent concentrations in surface soil that are protective of human health for non-industrial (residential) land use. The use of residential RECAP Screening Standards is very conservative because the exposure potential for the IHNC dredged material placed in a properly designed CDF is much less than that assumed for residential soil.

To evaluate the soil-to-groundwater migration pathway, data were compared to soil screening standards for protection of groundwater ($Soil_{SSGW}$). These standards represent constituent concentrations in soil that are not expected to result in COPCs leaching from soil to groundwater at unacceptable levels.

The following chemical concentrations exceeded the $Soil_{SSni}$ direct contact soil standards:

- Barium in DMMU 1
- PCBs in DMMUs 1, 5, and 7
- Benzo(a)pyrene in DMMU 7
- Total petroleum hydrocarbons (diesel) (TPH-D) in DMMUs 2, 5, and 7

The following chemical concentrations exceeded the $Soil_{SSGW}$ groundwater protection standards:

- Lead in DMMUs 2, 5, and 7
- TPH-D in DMMUs 2, 5, and 7
- Benzene in DMMU 2
- Chlorobenzene in DMMU 2
- Beta-BHC in DMMU 7

Although lead, benzene, chlorobenzene, and beta-BHC exceeded the $Soil_{SSGW}$, it should be noted that these chemical concentrations are higher than concentrations protective of groundwater if used as a drinking water source, not for human health direct contact exposures. Table 1 presents the comparison of sediment data to $Soil_{SSni}$ soil direct contact screening standards. Table 2 presents the comparison of sediment data to $Soil_{SSGW}$ groundwater protection screening standards.

3.2 Exposure Pathways

The exposure pathways identified for the site are based on current and potential future land uses as described above and are evaluated under the following scenarios:

- During filling of the CDF: A CDF containing unconsolidated dredged material within fenced containment berms (interim year conditions may result in some level of sediment consolidation and exposure of surface sediments);

- After closure of the CDF: A CDF containing consolidated dredged material within fenced containment berms;

- A catastrophic failure of the CDF during filling (e.g., overtopping of the dike or breach of dike) that may result in the release of dredged material into surrounding areas; and

- A catastrophic failure of the CDF after closure (e.g., breach of a dike).

The potential release mechanisms, the exposure pathways, the exposure routes, and the affected receptors are described below for each of the above scenarios. Separate figures representing the conceptual site models (CSMs) illustrating each of these categories are also provided.

3.2.1 Exposure during Filling of the CDF

It is expected within the first 7 years of construction that the CDF would contain materials in varying levels of consolidation. Interim year conditions, when water will be fully decanted, may result in increased consolidation and exposure of surface sediments. Consolidation testing and modeling is being conducted in order to obtain more information about the consolidation behavior of the materials to be placed in the CDF and the length of time required for the materials to fully consolidate. The CDF would be designed to fully contain the dredged material from the IHNC and would receive the same level of flood protection as businesses and residences east of the IHNC by virtue of being situated inside the flood control levee. The perimeter of the CDF is expected to be fenced and, as such, would have limited accessibility to the general public. Therefore, under normal circumstances, potential human exposures to material stored in the CDF would only occur within the perimeter of the CDF.

People that may be exposed to the dredged material within the CDF would likely be limited to authorized personnel working in the disposal operation or site maintenance (i.e., workers) and perhaps an occasional unauthorized visitor (e.g., trespassing recreational user). Workers and trespassers may be exposed to COPCs in dredged materials and surface water primarily through incidental ingestion and dermal contact. However, workers would be expected to mitigate potential exposures by using appropriate personal protective equipment and following appropriate health and safety procedures. Inhalation of vapors and/or particulates would not likely be a significant exposure pathway for workers and recreational users due to surface water overlying the dredged materials during disposal and generally moist conditions in the interim periods. In addition, the vast majority of volatile organic compounds (VOCs) were below detection limits in dredged material (i.e., there are a limited number of chemicals present that are capable of volatilizing). Off-site receptors such as fishermen, crabbers, boaters, and hunters are recreational users of the GIWW and Bayou Bienvenue that would not be expected to be exposed to COPCs in CDF dredged materials and surface water unless they were to trespass onto the site itself. In the event of intrusive work (e.g., construction, excavation), appropriate exposure precautions (e.g., use of personal protective equipment) would be taken to mitigate potential exposures of construction workers.

Based on the engineering design of the CDF, surface water runoff from the site will discharge to nearby surface waters, either the GIWW or Bayou Bienvenue. However, this is not expected to result in significant human exposures because applicable water quality criteria are expected to be met within an LDEQ-approved mixing zone within the receiving water body. Leaching of COPCs from dredged material into site groundwater is not expected to be an exposure pathway because site groundwater is not used as a potable drinking water source.

Based on the above information, the potentially complete exposure pathways identified for the CDF during filling are: potential future exposure of trespassers (e.g., recreational receptors) to COPCs in dredged materials; and surface water via incidental ingestion and dermal contact. The magnitude of actual exposure would likely be small given its infrequent nature.

Figure 3 presents the conceptual site model (CSM) for the CDF during filling and identifies potentially complete exposure pathways under that scenario.

3.2.2 Exposure after Closure of the CDF

The CDF would be designed to fully contain the dredged material from the IHNC and would receive the same level of flood protection as businesses and residences east of the IHNC, by virtue of being situated within the flood control levee. One alternative to effectively reduce potential contact with the materials in the IHNC is to sequence the dredged material placement such that DMMUs with COPCs are placed under cleaner layers of dredged material. Material from the cell used for temporary disposal of reusable dredged material will be available for use as final clean cover of the permanent CDF cell. The perimeter of the CDF is expected to be fenced and, as such, would have limited accessibility to the general public. Therefore, potential human exposures to material stored in the CDF are only expected to occur within the perimeter of the CDF, to workers on site during normal CDF operations, and to incidental site visitors or intruders and only during the period prior to closure, at which time additional measures will be employed as necessary to ensure that there is no unacceptable human exposure over the long term.

People that may be exposed to the dredged material within the CDF would likely be limited to authorized personnel working in the disposal operation or site maintenance (i.e., workers) and the occasional visitor (e.g., trespasser). Workers would be expected to use personal protective equipment and appropriate health and safety precautions to mitigate exposures to COPCs. Although trespassers may be exposed to site surface soils, exposure is expected to be infrequent. Furthermore, the CDF will be covered with clean fill upon consolidation, which will mitigate direct contact exposures.

Based on the proposed sequence of dredging, dredged material with the highest overall concentrations of COPCs (DMMU 7) will be deposited in the CDF first, covered by several feet of dredged material, and ultimately covered with nonimpacted material (below RECAP Screening Standards). Inhalation of vapors and/or particulates would not likely be a significant exposure pathway for workers and trespassers because the vast majority of volatile organic compounds (VOCs) were below detection limits in the sediment proposed for dredging and disposal (i.e., limited number of chemicals present that are capable of volatilizing) and the fact that the CDF will be revegetated, which would mitigate fugitive dust emissions (i.e., inhalation of dust). Likewise, off-site receptors such as nearby residents would not be expected to be exposed to COPCs through wind dispersal. Assuming that site materials are consolidated, off-site receptors such as fishermen, crabbers, boaters, and hunters are recreational users of the GIWW and Bayou Bienvenue that would not be expected to be exposed to COPCs in site media. In the event of intrusive activities at the site, appropriate exposure precautions (e.g., use of personal protective equipment) would be taken to mitigate potential exposures of construction workers.

The current conceptual design directs surface water runoff from the site to nearby surface waters, likely the GIWW. This is not expected to result in significant human exposures because the dilution required to meet applicable water quality criteria and toxicity-based dilution requirements are expected to be attainable within an LDEQ permitted mixing zone with proper management of discharge flows. Leaching of COPCs from dredged material into site groundwater is not expected to be a significant exposure pathway because site groundwater is not used as a potable drinking water source.

Based on the above information, no potentially complete exposure pathways are identified for the CDF after closure, assuming the consolidation of dredged material within the CDF. Figure 4 presents the CSM for the CDF after closure.

3.2.3 Exposure from a Catastrophic Release of CDF Materials during Filling of the CDF

In the event of a catastrophic release of the dredged material within the CDF due to a storm event or other natural disaster (i.e., breach of containment berms), unconsolidated materials may mix with floodwaters and enter the surrounding areas of the site. However, even under this scenario, the floodwaters containing suspended dredged material would be primarily contained within the area between the GIWW/MRGO flood protection levee and the Florida Avenue protection levee and would not likely leave the marsh areas along Bayou Bienvenue based on probable deposition in lower elevation areas. Additionally, as material is transported away from the CDF, more mixing would be expected to occur resulting in decreases in potential exposure and COPC concentrations. Receptors that may be exposed to the released dredged material would be recreational users of the GIWW and Bayou Bienvenue such as fishermen, crabbers, boaters, and hunters. Trespassers and workers may also be exposed in such an event. Exposures may include direct contact with COPCs in transported dredged materials (e.g., suspended fine-grained material within the water column or depositional sediments following the release). Fishermen and crabbers may also be exposed to COPCs in fish/crab tissue (primarily bioaccumulative compounds such as polychlorinated biphenyls [PCBs]). Based on the distance between the CDF and the Lower Ninth Ward (approximately 1 mile), the closest populated area, potential exposures of residents to COPCs in transported sediments are not expected. However, it should be noted that residential RECAP soil standards are utilized for this evaluation which takes into account any remote possibility of residential exposures.

Based on the above information, the following potentially complete exposure pathways are identified, assuming a catastrophic release of dredged material within the CDF during filling:

- Potential future exposure of recreational receptors (e.g., fishermen, crabbers, boaters, hunters) to COPCs in transported sediments via incidental ingestion, dermal contact, and/or fish consumption; and

- Potential exposure of workers to COPCs in transported sediments via incidental ingestion and dermal contact.

Figure 5 presents the CSM for the catastrophic release of materials from the CDF during filling in the event that dredged materials were to breach the containment berms.

3.2.4 Exposure from a Catastrophic Release of CDF Materials after Closure of the CDF

The potential exposure of dredged material after closure of the CDF even after a catastrophic release would be considered to be very low. The resulting potential risks would be lower than the worst-case scenario of failure during filling of the CDF. The closed CDF would be effectively covered with nonimpacted material (below RECAP Screening Standards) and vegetated and, based on the proposed sequence of dredging, dredged material would be buried at a depth of more than 5 feet.

Figure 6 presents the CSM for the catastrophic release of materials from the CDF after closure in the event that dredged materials were to breach the containment berms.

3.3 Exposure Point Concentrations

An exposure point concentration (EPC) is a representative chemical concentration that people could be exposed to over time. This value is generally represented by a 95% Upper Confidence Limit (UCL) on the arithmetic mean that is intended to equal or exceed the true average 95 percent of the time and ensure that the true average is not underestimated (LDEQ 2003). EPCs were calculated for each identified COPC. All sediment data were included in the calculation of EPCs (i.e., it was assumed that dredged materials from all DMMUs present an equally probable potential exposure medium). Due to small sample sizes (*n* • 8), UCLs could not be calculated for individual DMMUs. However, arithmetic means were used in lieu of UCLs for individual DMMUs and provide a representative concentration of the COPC during hydraulic dredging.

3.4 Risk Characterization

Risk characterization summarizes and combines the potential exposure analysis and potential toxicity analysis into qualitative and/or quantitative expressions of risk.

To evaluate the risk from the CDF both during filling and after the catastrophic release of dredged material, a comparison of EPCs (and arithmetic averages in the absence of UCLs) to RECAP soil standards for direct contact exposure and soil-to-groundwater migration pathways was conducted. These comparisons are conservative and likely overestimate potential risks to human health and the environment for the following reasons:

- During the process of dredging and filling of the CDF it is likely that the mixing that occurs during dredging and disposal will result in lower concentrations overall than that observed in the in-situ sediments.

- If a catastrophic failure of the CDF were to occur, there would also be orders of magnitude of dilution of the dredge material with surrounding materials and water and limited transport of dredged materials to potential human exposure points.

The results of the risk characterization are summarized below and risk comparisons discussed for the direct contact, groundwater protection, and recreational receptor evaluations.

3.5 Risk Characterization Summary

Risk Scenario	Direct Contact Screening Results	Groundwater Protection Screening Results*	Recreational Receptor Screening Results
Non-catastrophic risk during filling	Protective of direct human exposures	Soil concentrations protective of groundwater	Protective of recreational receptors
Catastrophic failure during filling	Protective of direct human exposures	Soil concentrations protective of groundwater	Protective of recreational receptors

Risk Scenario	Direct Contact Screening Results	Groundwater Protection Screening Results*	Recreational Receptor Screening Results
Non-catastrophic risk after closure	No exposure pathways identified	Soil concentrations protective of groundwater	No exposure pathways identified
Catastrophic failure after closure	Protective of direct human exposures	Soil concentrations protective of groundwater	Protective of recreational receptors

* Groundwater Protection based on LDEQ RECAP soil-to-groundwater leaching analysis assuming Groundwater Classification 3 (non-drinking water).

- **Direct Contact Screening Results** – EPCs and arithmetic averages were compared to RECAP Management Option 1 (MO-1) non-industrial soil standards, which represent risk-based constituent concentrations in surface soil that are protective of human health for non-industrial (residential) use. The exposure pathways addressed by the non-industrial soil standards include the ingestion of soil, inhalation of volatile emissions from soil, and dermal contact with soil. As shown in Table 3, none of the EPCs exceeded the non-industrial (residential) MO-1 soil standards. Based on these results, risks due to human exposures are well within or below benchmarks for risk indicating negligible potential for adverse human health effects. Additionally, the average concentrations of barium reported in IHNC sediment samples proposed for dredging are within the background levels that naturally occur in soil of the New Orleans area. Similarly, the levels of polycyclic aromatic hydrocarbons (PAHs) in these sediments are not elevated when compared to other urban waterways elsewhere in the United States or in waterways such as Bayou St. John in the New Orleans area.

- **Groundwater Protection Screening Results** – EPCs and arithmetic averages were compared to RECAP MO-1 soil standards for the soil protective of a downgradient surface water that is classified as a non-drinking water source ($SoilGW_{3NDW}$). The $SoilGW_{3NDW}$ standard serves to protect groundwater meeting the definition of Groundwater Classification 3. The $SoilGW_{3NDW}$ standard also provides an evaluation of any discharge to the adjacent surface water body that might occur by leaching or seepage through the containment berms. As shown in Table 4, none of the EPCs exceeded the MO-1 $SoilGW_{3NDW}$. The arithmetic averages of benzene and chlorobenzene (which lacked EPCs) were below their associated standards for all DMMUs. Additionally, groundwater is not used for drinking water purposes in the New Orleans area and the shallow zone groundwater at the site has a presumptive LDEQ groundwater designation of Groundwater Classification 3A (non-drinking water).

- **Recreational Receptor Screening Results** – As shown in Table 5, none of the EPCs exceeded the risk-based sediment standards for recreational exposure (SDr) and fish ingestion (SDf). Based on these results, risks due to recreational human exposures are well within or below benchmarks for risk indicating negligible potential for adverse human health effects. Barium, TPH-D, and PAHs are not known to significantly bioaccumulate in fish. Although PCBs may bioaccumulate, the concentrations reported in IHNC sediments are lower than conservative risk-based concentrations that are based on fish ingestion.

4. Summary and Conclusions

Based on the engineering risk review and the human health risk evaluation of dredged materials anticipated to be placed in the CDF, overall risk is found to be low and isolated to a limited number of potential exposure pathways.

Most of the catastrophic scenarios are associated with the effects of hurricanes. Risks associated with forces of nature such as hurricanes and earthquakes are typically dealt with using statistical methods. For example, the 100-year flood protection is defined as the flood elevation that has a 1 percent chance of flooding in any given year (or a recurrence interval of 100 years). For purposes of designing the Hurricane and Storm Damage Risk Reduction System (HSDRRS) protection levels, the USACE has established a protection system designed with elevations sufficient to provide protection from a Standard Project Hurricane (1% chance of occurrence). Additionally, other circumstances have to be considered. For the CDF, even if a levee were to be breached, the CDF dike itself would serve as a backup system and it would be unlikely for both the primary and the secondary system to fail. Therefore, the selection of the 100-year protection level appears appropriate and the overall risk associated with hurricanes is estimated to be small. It will be necessary, however, to confirm that the levee upgrades will be in place at the time the CDF starts to operate and the required level of protection is maintained.

4.1 Risk Management through Proper Design

Risks are often managed by properly designing structures or facilities. Design is typically based on a standard of practice approach. Factors of safety are typically used to provide a margin for uncertainty. These factors are often based on years of experience. Managing risk through proper design is considered a legitimate way of minimizing risk as long as the design is performed by experienced professionals. The design of earthen structures such as containment dikes is an example of this type of risk management. The conceptual design of the CDF addresses factors that can be designed to reduce risk such as specification of sufficient dike height, design of stable dikes, and proper effluent and stormwater runoff management systems.

4.2 Risk Management through Monitoring

Some risks can be managed by performing monitoring in addition to design. Monitoring provides the opportunity to measure parameters such as water quality and adjust the operation within a short time frame if the parameters get out of compliance. For example, the USACE has addressed the potential for water quality exceedances in receiving waters. While the design of appropriate systems to manage effluent reduces risk, monitoring during effluent discharge will further reduce the risk of impacts.

4.3 Risks that have not been Evaluated

The conceptual level design (USACE, 2008a) is naturally still at a relatively early stage and not all of the potential risks have been addressed. It appears that some of the risks identified herein have not been considered in part or to any degree. Risks that appear to require evaluation or additional evaluation are identified in the engineering risk review presented in the appendix. Some examples of risks that may require further evaluation include erosion of the dikes during filling, stability of site for dike placement, and air quality during dredging. These issues are usually evaluated and handled during final design and are incorporated as appropriate in the project plans and specifications before the contract to construct is awarded.

4.4 Potential Human Health Risks

Results of the human health risk evaluation indicate that, even during catastrophic failure of the CDF during filling (worst-case scenario), direct contact (ingestion, skin contact, and inhalation) risks to people and recreational risks (e.g., boating and ingestion of fish/crabs caught in Bayou Bienvenue, IHNC, or GIWW) would not be expected to cause adverse health effects. Conservative assumptions were employed for the health evaluation including the use of residential risk standards and assuming no dilution of the dredged material after release from the CDF.

Results of the groundwater protection evaluation indicate that any leaching from the dredged material to shallow groundwater beneath the CDF (for all scenarios evaluated) would not result in chemical concentrations that could cause adverse health effects. Additionally, groundwater is not used for drinking water purposes in the New Orleans area and within a 1-mile radius of the CDF which further supports the lack of potential health risks from groundwater.

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Tables

Table 1
Comparison of Sediment Data to Soil Direct Contact Screening Standards

Compounds	$Soil_{SSni}$	Units	DMMU 1						DMMU 2						DMMU 5								DMMU 7			
			1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	7	8	1	2	3	4
			07/18/07	07/18/07	07/18/07	07/18/07	07/18/07	07/18/07	07/16/07	07/16/07	07/16/07	07/14/07	07/14/07	07/14/07	08/20/07	08/21/07	08/29/07	08/25/07	08/24/07	08/24/07	08/23/07	08/23/07	08/15/07	08/07/07	08/11/07	08/16/07
Metals																										
Antimony	3.1	mg/kg	0.0464 J	0.0703 J	0.0342 J	0.06 J	0.0817 J	0.0591 J	0.0726 J	0.0961 J	0.0375 J	0.0468 J	0.0446 J	0.0618 J	0.054 J	0.0473 J	0.022 J	0.0343 J	0.0391 J	0.0794 J	0.0701 J	0.114 J	0.0987 J	0.324	0.265 J	0.0543 J
Arsenic	12	mg/kg	3.48 J	2.44 J	3.1 J	3.04 J	3.35 J	2.95 J	3.31 J	3.18 J	3.62 J	3.37 J	3.26 J	3.47 J	3.2 J	3.4 J	3.22	4.06	3.54	3.22	3.97 J	2.05	3.88 J	3.29	3.05 J	2.64 J
Barium	550	mg/kg	130	411	270	556	778	836	276	372	347	178	380	365	486	320	400	196	164	445	118	94	236	462	372	407
Beryllium	16	mg/kg	0.342 J	0.244	0.356	0.344	0.335	0.338	0.418	0.372	0.407	0.412	0.388	0.361	0.365	0.396	0.343	0.366	0.672	0.35	0.456	0.114	0.276	0.425	0.288	0.361
Cadmium	3.9	mg/kg	0.226	0.518	0.291	0.34	0.428	0.354	0.363	0.38	0.335	0.304	0.343	0.318	0.34	0.318	0.28	0.366	0.318	0.514	0.321	0.114	0.25	0.708	0.733	0.248
Chromium +3	12,000	mg/kg	8.55	8.88	9.52	9.76	11.4	8.61	17.5	11.9	11.4	10.2	10	10.5	11.9	9.89	10.3	11.9	12.3	16.6	11.9	8.72	9.87	17.3	10.3	10.9
Chromium +6	23	mg/kg	0.391 U	0.407 U	0.408 U	0.396 U	0.389 U	0.397 U	0.413 U	0.405 U	0.389 U	0.417 U	0.388 U	R	0.386 U	0.391 U	0.39 U	0.395 U	0.403 UJ	0.392 U	0.391 U	0.402 U	0.401 U	R	R	0.388 U
Copper	310	mg/kg	11.5 J	21.2 J	13.8 J	15.6 J	20.6 J	15.8 J	15	17.6	13.9	15	15.9	14	16.3	14.6	15.6	56.4	88	31.9	17.5	16.4	13.7	27.4	17.9 J	17.3
Lead	400	mg/kg	16.6	44.4	24.2	28.9	46.7	28.9	125	62.3	29.6	52.4	31.9	43.8	38.5	27.8	27.9	69.8	61	275	15.7	26.5	28.8 J	135	141	102 J
Mercury	2.3	mg/kg	0.036 J	0.111 J	0.0704 J	0.076 J	0.121 J	0.0844 J	0.0953	0.125	0.0715	0.0936	0.0847	0.0808	0.0872 J	0.0731 J	0.0806	0.206	0.141	0.271	0.0584 J	0.0326	0.0329	0.111	0.107	0.0582
Nickel	160	mg/kg	8.62	7.4	9.19	8.88	10.2	8.86	10.4	9.66	10.4	10.4	9.77	9.93	9.3	9.63	10.4	13.2	19.8	11.4	14.2	8.72	13.1	12.4	10 J	9.08
Selenium	39	mg/kg	1.04 J	0.851 J	0.938 J	0.96 J	1.01 J	1.06 J	1.04 J	1.05 J	1.03 J	1.08 J	1.03 J	1.05 J	0.913 J	0.946 J	0.636 J	0.744 J	0.733 J	0.514 J	1.05 J	0.364 J	0.579 J	0.374	0.564 J	0.365 J
Silver	39	mg/kg	0.0587 J	0.152	0.122	0.128	0.156	0.131	0.109	0.105	0.103	0.0889	0.103	0.0903	0.104	0.0946	0.0933	0.0744	0.0733 J	0.0981	0.111	0.0243 J	0.0237 J	0.116	0.0902 J	0.0854
Thallium	0.55	mg/kg	0.134	0.0925	0.122	0.116	0.113	0.11	0.123	0.109	0.125	0.126	0.116	0.124	0.116	0.12	0.114	0.132	0.134 J	0.117	0.158	0.0614 J	0.0921	0.106	0.102	0.097
Zinc	2,300	mg/kg	34.6 J	71 J	54.4 J	60 J	74.7 J	56.5 J	68.1 J	80.3 J	52.7 J	46.4 J	56.2 J	56.1 J	69.7 J	52.5 J	71.7 J	107 J	353	139 J	47.5 J	55 J	155 J	215	293 J	81.1 J
Pesticides																										
Aldrin	28	µg/kg	0.978 UJ	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	4.46	0.855 UJ	2.86	0.081 U	0.084 U	0.082 U	4.83 NJ	0.85 U	0.086 U	4.93	0.082 U	6.07 NJ	2.43 NJ	0.084 U
Chlordane	1,600	µg/kg	9.78 U	12	3.5	0.83 U	0.83 U	0.83 U	8.17 U	8.36 U	8.49 U	8.42 U	8.47 U	8.55 U	8.3 U	0.81 U	0.84 U	0.82 U	20.2 U	8.5 U	0.86 U	12.1 U	0.82 U	8.1 U	18 U	0.84 U
4,4'-DDD	2,400	µg/kg	3.24 NJ	0.53 PGN	0.63 PGN	0.62 PGN	1.9 PGN	0.63 PGN	9.99	11.3	4.92	3.84 J	7.14	6.65 NJ	2.78	1.9 PG	1.4 PG	3.1	6.72 J	11 PGN	0.49 PG	2.43	1.2 PGN	8.6 NJ	4.68 NJ	2.4 PGN
4,4'-DDE	1,700	µg/kg	0.978 J	1.3	0.37	0.36 PG	0.93 PG	0.31 PG	2.63	2.97	1.07 J	1.08	2.19	1.71 NJ	1.2	0.81	0.43 PG	1.1 PG	2.51 NJ	0.85 U	0.086 U	1.21 U	0.082 U	3.9 NJ	2.2 NJ	0.084 U
4,4'-DDT	1,700	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.83 U	0.081 U	0.084 U	0.082 U	2.02 U	0.85 U	0.47	1.21 U	0.082 U	0.81 UJ	1.8 U	0.084 U
Dieldrin	30	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.83 U	0.081 U	0.084 U	0.082 U	2.02 U	13 PGN	0.086 U	1.21 U	0.082 U	6.07 NJ	2.48 NJ	1.4 PGN
Endosulfan I	34,000	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.562 J	0.847 U	0.855 U	0.83 U	0.18 PG	0.084 U	0.082 U	2.02 U	1.5	0.086 U	1.21 U	0.082 U	0.81 U	1.8 U	0.084 U
Endrin	1,800	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.83 U	0.081 U	0.084 U	0.082 U	2.02 UJ	0.85 U	0.063 J	1.21 U	0.082 U	0.81 UJ	1.8 UJ	0.084 U
Heptachlor	16	µg/kg	0.978 U	0.69 PG	0.23 PGN	0.22 PGN	0.63 PG	0.19 PGN	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.404 J	0.83 U	0.25 PG	0.16 PG	1.6 PG	2.02 U	2.9 PG	0.093 PG	1.21 U	0.15	0.81 U	1.8 U	0.37
Heptachlor Epoxide	53	µg/kg	0.978 U	0.9 PGN	0.28 PGN	0.29 PGN	0.93 PGN	0.3 PGN	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	1.16	0.53 PGN	0.43 PGN	1.5 PG	0.794 J	13 PG	0.15 PGN	1.21 U	0.082 U	3.64 NJ	1.18 J	0.84 PGN
Aroclors (Total)	110	µg/kg	29.9	111	26.7	64	175	71.7	81.7	96.1	41.6	42.6	84.7	80.8	1.66 U	1.68 U	1.65 U	74.4	104	332	25.7	37.9	61.2	250	1.8 U	1.67 U
Methoxychlor	30,000	µg/kg	4.22 J	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	7.26	8.36	4.47	4.68	8.03	7.13 NJ	1.66 U	0.17 U	0.17 U	0.16 U	2.75 NJ	1.7 U	0.17 U	2.5 U	0.17 U	1.67 U	3.67 U	0.16 U
Toxaphene	440	µg/kg	39.7 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	33.1 U	33.4 U	33.5 U	33.2 U	33.5 U	33.3 U	33.2 U	3.4 U	3.3 U	3.3 U	79.4 U	33 U	3.3 U	50 U	3.3 U	33.4 U	73.3 U	3.3 U
Alpha-BHC	82	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	1.91 J	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.274 J	0.081 U	0.084 U	0.082 U	2.02 U	0.85 U	0.086 U	1.21 U	0.082 U	0.81 U	1.8 U	0.084 U
Beta-BHC	290	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	10.4 J	9.61 J	9.39 J	0.889	0.847 U	3.61 NJ	0.83 U	0.081 U	0.084 U	0.082 U	2.02 U	0.85 U	0.086 U	1.21 U	0.082 U	91.1 NJ	1.8 U	0.084 U
Gamma-BHC (Lindane)	390	µg/kg	0.36 J	0.57 B	0.19 B	0.17 B	0.34 BPGN	0.15 B	0.772 J	1	0.849 U	1.17 J	0.937 J	0.855 NJ	1.12	0.54 PG	0.52 PG	0.82 PG	2.69	1.7	0.52 PG	1.21 U	1.6 PG	2.28 J	1.07 J	0.55 B
PAHs																										
Acenaphthene	370,000	µg/kg	48	70	25	28	33	27	42	67	14 J	330	170	76	25	43	310	200	130	44	6.4 J	11	61	76	R	58
Acenaphthylene	350,000	µg/kg	13 J	56	47	18	31	17	20	26	13 J	84	32	34	16 J	22	29	30	25	26	3.3 J	8.3 J	40	46	68	97
Anthracene	2,200,000	µg/kg	25	110	56	39	70	24	50	160	23	360	130	100	110	60	310	140	120	430	11	16	110	210	190	160
Benzo(a)anthracene	620	µg/kg	54	290	140	88	160	68	91	150	54	300	180	290	100	130	200	220	230	190	29	110	210	220 J	R	270
Benzo(a)pyrene	330	µg/kg	59	290	160	96	180	72	95	130	63	290	180	230	100	130	160	180	210	190	32	140	240	190	490	470
Benzo(b)fluoranthene	620	µg/kg	79	410	170	130	230	97	120	180	76	270	210	270	140	160	220	250	290	260	43	180	330	290 J	R	620
Benzo(k)fluoranthene	6,200	µg/kg	32	170	61	52	86	31	45	59	31	100	85	100	46	56	85	97	110	93	16	68	110	6.6 U	230 J	260
Chrysene	62,000	µg/kg	73	410	160	100	200	76	100	170	63	300	190	290	120	160	220	250	280	220	32	140	240	250 J	540 J	390
Dibenzo(a,h)anthracene	330	µg/kg	9.8 J	56	26	20	31	14 J	15 J	21	8.9 J	33	27	32	20	24	28	33	36	36	7.6 U	30	49	37 J	R	82
Fluoranthene	220,000	µg/kg	160	810	340	240	430	180	230	420	120	610	410	860	360	420	810	800	730	560	56	260	570	960	2,000	890
Fluorene	280,000	µg/kg	29	41	22	18	21	15 J	23	50	11 J	230	120	52	32	34	420	150	92	61	4.0 J	11	38	76	120	37
Indeno(1,2,3-cd)pyrene	620	µg/kg	43	250	100	80	130	55	68	88	42	150	110	120	75	95	110	130	150 J	140	26	110	180	91 J	R	310
2-Methylnaphthalene	22,000	µg/kg	6.7 J	20	22	5.2 J	10 J	5.5 J	5.0 J	10 J	17 U	61	16 J	9.5 J	5.8 J	9.0 J	42	24	26	15 J	7.6 U	5.7 J	9.9	19	R	10
Naphthalene	6,200	µg/kg	20 U	19	15 J	5.6 J	8.2 J	4.6 J	6.8 J	8.4 J	17 U	11 J	18	9.5 J	17 U	9.5 J	16	17 J	31	12 J	7.6 U	5.2 J	11	11	R	16
Phenanthrene	2,100,000	µg/kg	67	190	66	56	110	59	82	200	54	890	370	310	120	160	1,100	270	280	240	18	140	150	320 J	410	270
Pyrene	230,000	µg/kg	170	700 J	390 J	230 J	390 J	180 J	200 J	400 J	160 J	800 J	440 J	670	270 J	310 J	680	630	610	510	70	360	860	460 J	R	890
Semivolatile Organics																										
1,2,4-Trichlorobenzene	66,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 UJ	84 U	36 U	49 U	43 U	33 U	36 U	33 U
1,2-Dichlorobenzene	99,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
1,3-Dichlorobenzene	2,100	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
1,4-Dichlorobenzene	6,700	µg/kg	4.8 J	9.6 J	17 U	17 U	17 UJ	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 UJ	2.7 J	18 UJ	20 U	17 UJ	7.6 UJ	2.8 J	8.6 UJ	7.1	7.9	5.8 J
2,4,6-Trichlorophenol	40,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 UJ	36 U	33 U
2,4-Dichlorophenol	16,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
2,4-Dimethylphenol	93,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	7.5 J	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	6.2 J
2,4-Dinitrophenol	7,100	µg/kg	500 UJ	410 U	420 U	400 U	430 U	420 U	420 U	420 U	420 U	420 U	420 U	420 UJ	420 U	420 U	170 U	460 U	500 UJ	420 U	180 U	250 U	220 U	170 UJ	190 UJ	170 U
2,4-Dinitrotoluene	8,900	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
2,6-Dinitrotoluene	4,300	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
2-Chloronaphthalene	500,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	29	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
2-Chlorophenol	15,000	µg/kg	98 U	85 U	84 U	84 U	82 U	84 U	82 U	84 U	85 U	84 U	36 J	86 U	83 U	82 U	34 U	92 U	98 U	84 U	36 U	50 U	43 U	33 U	37 U	33 U
3,3'-Dichlorobenzidine	970	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 UJ	33 U
4-Nitrophenol	32,000	µg/kg	500 U	410 U	420 U	400 U	430 U	420 U	420 U	420 U	420 U	420 U	420 U	420 U	420 U	420 U	170 U	460 U	500 UJ	420 U	180 U	250 U	220 U	170 UJ	190 U	170 U
bis(2-Chloroethyl)ether	330	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
bis(2-Chloroisopropyl)ether	4,900	µg/kg	20 UJ	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 UJ	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
bis(2-Ethylhexyl)phthalate	35,000	µg/kg	130	1,000	250	200	290	100	50 J	120	67 J	75 J	71 J	81	130	90	120	250	2,100	160	190	99	58	320 J	R	89
Butylbenzylphthalate	220,000	µg/kg	20 J	35 J	84 U	10 J	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	15 J	92 U	98 U	84 U	36 U	9.1 J	43 U	20 J	36 U	8.5 J
Dibenzofuran	29,000	µg/kg	5.7 J	17 J	5.2 J	5.6 J	8.2 J	84 U	6.4 J	13 J	81 U	8.4 J	25 J	8.1 J	10 J	18 J	200	18 J	56 J	16 J	2.8 J	9.9 J	11 J	31 J	45	18 J
Diethylphthalate	670,000	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
Dimethylphthalate	1,500,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Di-n-Octylphthalate	240,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 UJ	36 U	33 U
Hexachlorobenzene	340	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Hexachlorobutadiene	820	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Hexachlorocyclopentadiene	1,400	µg/kg	R	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 UJ	R	33 U
Hexachloroethane	5,200	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 UJ	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Isophorone	340,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
Nitrobenzene	2,200	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
N-Nitroso-di-n-propylamine	330	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
N-Nitrosodiphenylamine	90,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	210
Pentachlorophenol	2,800	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 UJ	84 U	36 U	49 U	43 U	33 U	36 UJ	33 U
Phenol	1,300,000	µg/kg	20 U	9.3 J	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	11 J	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	4.0 J	4.5 J	2.9 J
1,1,1-Trichloroethane	82,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	810	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloroethane	1,900	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1-Dichloroethane	66,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1-Dichloroethene	13,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

Table 1
Comparison of Sediment Data to Soil Direct Contact Screening Standards

Compounds	$Soil_{SSni}$	Units	DMMU 1						DMMU 2						DMMU 5								DMMU 7			
			1 07/18/07	2 07/18/07	3 07/18/07	4 07/18/07	5 07/18/07	6 07/18/07	1 07/16/07	2 07/16/07	3 07/16/07	4 07/14/07	5 07/14/07	6 07/14/07	1 08/20/07	2 08/21/07	3 08/29/07	4 08/25/07	5 08/24/07	6 08/24/07	7 08/23/07	8 08/23/07	1 08/15/07	2 08/07/07	3 08/11/07	4 08/16/07
Volatile Organics																										
1,2-Dichloroethane	820	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloropropane	690	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Butanone	590,000	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 UJ	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-pentanone	450,000	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	170,000	µg/kg	20 UJ	20 U	20 U	20 U	7.4 J	8.4 J	20 U	20 U	20 U	8.0 J	980 U	13 J	20 U	20 U	20 U	11 J	23	20 U	20 U	20 U	20 U	20 UJ	20 U	20 U
Benzene	1,500	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 J	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromodichloromethane	1,800	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromoform	48,000	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromomethane	430	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Disulfide	36,000	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Tetrachloride	180	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chlorobenzene	17,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	12,000	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroethane	4,100	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 UJ	5.0 U
Chloroform	44	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloromethane	3,500	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Dibromochloromethane	2,200	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Ethylbenzene	160,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene Chloride	19,000	µg/kg	5.0 U	5.2 UJ	5.2 UJ	5.2 UJ	5.1 UJ	5.1 UJ	5.0 UJ	2.1 J	4.9 U	5.2 UJ	250 U	5.2 U	5.0 UJ	5.2 UJ	5.1 UJ	5.0 UJ	5.0 U	2.5 JB	5.0 UJ	3.0 JB	5.0 UJ	5.0 U	5.0 U	1.4 J
Styrene	500,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	8,300	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Toluene	68,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 UJ	5.0 U
trans-1,2-Dichloroethene	6,900	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Trichloroethene	100	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Vinyl Chloride	240	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Xylenes (total)	18,000	µg/kg	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	760 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U
Inorganics																										
Cyanide	150	mg/kg	R	0.181	0.103	0.156	0.171	0.160	1.32 J	1.50 J	0.317 J	0.515 U	0.491 U	0.523 U	0.158	0.516 U	0.182 U	1.14	0.336 U	0.168	0.502 U	0.500 U	0.500 UJ	5.16	0.502 U	0.698 J
Dinoseb	4,700	µg/kg	12.2 UJ	11.8 U	12.2 U	12 U	12.1 U	11.8 U	11.8 U	12.1 U	12.1 U	12.2 UJ	12 UJ	11.9 UJ	12 U	R	R	R	R	R	R	R	11.8 U	R	1.35 UJ	12 U
Percent Solids	- -	%	61.1	40.7	57.3	41.3	48.7	48.8	45.4	41.8	44.7	46.8	44.6	47.5	54.1	54.1	56.0	74.6	61.1	60.5	66.5	75.8	54.6	65.2	56.4	36.6
TPH																										
TPH-D	65	mg/kg	25.7 J	31.5	10.3	15.2	34.2	11.8	9.99 UJ	66.9 J	32.6 J	36 J	49.1 J	128 J	108	176	187	275	306 J	467	134	371	197	658	95.9 J	105
TPH-G	65	mg/kg	0.033 J	0.0555 J	0.0516 J	0.044 J	0.0389 J	0.0371 J	0.123	0.117	0.0398 J	0.136	26.3	0.0451 J	0.054 J	0.0344 J	0.0509 J	0.223 J	0.177	0.56	0.0993 J	0.0985 UJ	0.054 J	0.506	0.102 U	0.0931 J

Notes:
Shaded values exeed screening standards.
DMMU = Dredge Material Management Unit
PAHs = Polycyclic Aromatic Hydrocarbons.
$Soil_{SSni}$ = Risk-based soil screening standard based on the protection of human health for non-industrial land use.
TPH-D = Total Petroleum Hydrocarbons (Diesel).
TPH-G = Total Petroleum Hydrocarbons (Gasoline).
mg/kg = Milligrams per kilogram.
µg/kg = Micrograms per kilogram.

Table 2
Comparison of Sediment Data to Groundwater Protection Screening Standards

			DMMU 1						DMMU 2						DMMU 5								DMMU 7			
			1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	7	8	1	2	3	4
Compound	$Soil_{SSGW}$	Units	07/18/07	07/18/07	07/18/07	07/18/07	07/18/07	07/18/07	07/16/07	07/16/07	07/16/07	07/14/07	07/14/07	07/14/07	08/20/07	08/21/07	08/29/07	08/25/07	08/24/07	08/24/07	08/23/07	08/23/07	08/15/07	08/07/07	08/11/07	08/16/07
Metals																										
Antimony	12	mg/kg	0.0464 J	0.0703 J	0.0342 J	0.06 J	0.0817 J	0.0591 J	0.0726 J	0.0961 J	0.0375 J	0.0468 J	0.0446 J	0.0618 J	0.054 J	0.0473 J	0.022 J	0.0343 J	0.0391 J	0.0794 J	0.0701 J	0.114 J	0.0987 J	0.324	0.265 J	0.0543 J
Arsenic	100	mg/kg	3.48 J	2.44 J	3.1 J	3.04 J	3.35 J	2.95 J	3.31 J	3.18 J	3.62 J	3.37 J	3.26 J	3.47 J	3.2 J	3.4 J	3.22	4.06	3.54	3.22	3.97 J	2.05	3.88 J	3.29	3.05 J	2.64 J
Barium	2,000	mg/kg	130	411	270	556	778	836	276	372	347	178	380	365	486	320	400	196	164	445	118	94	236	462	372	407
Beryllium	8	mg/kg	0.342 J	0.244	0.356	0.344	0.335	0.338	0.418	0.372	0.407	0.412	0.388	0.361	0.365	0.396	0.343	0.366	0.672	0.35	0.456	0.114	0.276	0.425	0.288	0.361
Cadmium	20	mg/kg	0.226	0.518	0.291	0.34	0.428	0.354	0.363	0.38	0.335	0.304	0.343	0.318	0.34	0.318	0.28	0.366	0.318	0.514	0.321	0.114	0.25	0.708	0.733	0.248
Chromium +3	100	mg/kg	8.55	8.88	9.52	9.76	11.4	8.61	17.5	11.9	11.4	10.2	10	10.5	11.9	9.89	10.3	11.9	12.3	16.6	11.9	8.72	9.87	17.3	10.3	10.9
Chromium +6	100	mg/kg	0.391 U	0.407 U	0.408 U	0.396 U	0.389 U	0.397 U	0.413 U	0.405 U	0.389 U	0.417 U	0.388 U	R	0.386 U	0.391 U	0.39 U	0.395 U	0.403 UJ	0.392 U	0.391 U	0.402 U	0.401 U	R	R	0.388 U
Copper	1,500	mg/kg	11.5 J	21.2 J	13.8 J	15.6 J	20.6 J	15.8 J	15	17.6	13.9	15	15.9	14	16.3	14.6	15.6	56.4	88	31.9	17.5	16.4	13.7	27.4	17.9 J	17.3
Lead	100	mg/kg	16.6	44.4	24.2	28.9	46.7	28.9	125	62.3	29.6	52.4	31.9	43.8	38.5	27.8	27.9	69.8	61	275	15.7	26.5	28.8 J	135	141	102 J
Mercury	4	mg/kg	0.036 J	0.111 J	0.0704 J	0.076 J	0.121 J	0.0844 J	0.0953	0.125	0.0715	0.0936	0.0847	0.0808	0.0872 J	0.0731 J	0.0806	0.206	0.141	0.271	0.0584 J	0.0326	0.0329	0.111	0.107	0.0582
Nickel	1,500	mg/kg	8.62	7.4	9.19	8.88	10.2	8.86	10.4	9.66	10.4	10.4	9.77	9.93	9.3	9.63	10.4	13.2	19.8	11.4	14.2	8.72	13.1	12.4	10 J	9.08
Selenium	20	mg/kg	1.04 J	0.851 J	0.938 J	0.96 J	1.01 J	1.06 J	1.04 J	1.05 J	1.03 J	1.08 J	1.03 J	1.05 J	0.913 J	0.946 J	0.636 J	0.744 J	0.733 J	0.514 J	1.05 J	0.364 J	0.579 J	0.374	0.564 J	0.365 J
Silver	100	mg/kg	0.0587 J	0.152	0.122	0.128	0.156	0.131	0.109	0.105	0.103	0.0889	0.103	0.0903	0.104	0.0946	0.0933	0.0744	0.0733 J	0.0981	0.111	0.0243 J	0.0237 J	0.116	0.0902 J	0.0854
Thallium	4	mg/kg	0.134	0.0925	0.122	0.116	0.113	0.11	0.123	0.109	0.125	0.126	0.116	0.124	0.116	0.12	0.114	0.132	0.134 J	0.117	0.158	0.0614 J	0.0921	0.106	0.102	0.097
Zinc	2,800	mg/kg	34.6 J	71 J	54.4 J	60 J	74.7 J	56.5 J	68.1 J	80.3 J	52.7 J	46.4 J	56.2 J	56.1 J	69.7 J	52.5 J	71.7 J	107 J	353	139 J	47.5 J	55 J	155 J	215	293 J	81.1 J
Pesticides																										
Aldrin	11,000	µg/kg	0.978 UJ	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	4.46	0.855 UJ	2.86	0.081 U	0.084 U	0.082 U	4.83 NJ	0.85 U	0.086 U	4.93	0.082 U	6.07 NJ	2.43 NJ	0.084 U
Chlordane	12,000	µg/kg	9.78 U	12	3.5	0.83 U	0.83 U	0.83 U	8.17 U	8.36 U	8.49 U	8.42 U	8.47 U	8.55 U	8.3 U	0.81 U	0.84 U	0.82 U	20.2 U	8.5 U	0.86 U	12.1 U	0.82 U	8.1 U	18 U	0.84 U
4,4'-DDD	1,500	µg/kg	3.24 NJ	0.53 PGN	0.63 PGN	0.62 PGN	1.9 PGN	0.63 PGN	9.99	11.3	4.92	3.84 J	7.14	6.65 NJ	2.78	1.9 PG	1.4 PG	3.1	6.72 J	11 PGN	0.49 PG	2.43	1.2 PGN	8.6 NJ	4.68 NJ	2.4 PGN
4,4'-DDE	2,000	µg/kg	0.978 J	1.3	0.37	0.36 PG	0.93 PG	0.31 PG	2.63	2.97	1.07 J	1.08	2.19	1.71 NJ	1.2	0.81	0.43 PG	1.1 PG	2.51 NJ	0.85 U	0.086 U	1.21 U	0.082 U	3.9 NJ	2.2 NJ	0.084 U
4,4'-DDT	24,000	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.83 U	0.081 U	0.084 U	0.082 U	2.02 U	0.85 U	0.47	1.21 U	0.082 U	0.81 UJ	1.8 U	0.084 U
Dieldrin	7,600	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.83 U	0.081 U	0.084 U	0.082 U	2.02 U	13 PGN	0.086 U	1.21 U	0.082 U	6.07 NJ	2.48 NJ	1.4 PGN
Endosulfan I	54,000	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.562 J	0.847 U	0.855 U	0.83 U	0.18 PG	0.084 U	0.082 U	2.02 U	1.5	0.086 U	1.21 U	0.082 U	0.81 U	1.8 U	0.084 U
Endrin	2,600	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.83 U	0.081 U	0.084 U	0.082 U	2.02 UJ	0.85 U	0.063 J	1.21 U	0.082 U	0.81 UJ	1.8 UJ	0.084 U
Heptachlor	500	µg/kg	0.978 U	0.69 PG	0.23 PGN	0.22 PGN	0.63 PG	0.19 PGN	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.404 J	0.83 U	0.25 PG	0.16 PG	1.6 PG	2.02 U	2.9 PG	0.093 PG	1.21 U	0.15	0.81 U	1.8 U	0.37
Heptachlor Epoxide	2,000	µg/kg	0.978 U	0.9 PGN	0.28 PGN	0.29 PGN	0.93 PGN	0.3 PGN	0.817 U	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	1.16	0.53 PGN	0.43 PGN	1.5 PG	0.794 J	13 PG	0.15 PGN	1.21 U	0.082 U	3.64 NJ	1.18 J	0.84 PGN
Aroclors (Total)	19,000	µg/kg	29.9	111	26.7	64	175	71.7	81.7	96.1	41.6	42.6	84.7	80.8	1.66 U	1.68 U	1.65 U	74.4	104	332	25.7	37.9	61.2	250	1.8 U	1.67 U
Methoxychlor	380,000	µg/kg	4.22 J	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	7.26	8.36	4.47	4.68	8.03	7.13 NJ	1.66 U	0.17 U	0.17 U	0.16 U	2.75 NJ	1.7 U	0.17 U	2.5 U	0.17 U	1.67 U	3.67 U	0.16 U
Toxaphene	34,000	µg/kg	39.7 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	33.1 U	33.4 U	33.5 U	33.2 U	33.5 U	33.3 U	33.2 U	3.4 U	3.3 U	3.3 U	79.4 U	33 U	3.3 U	50 U	3.3 U	33.4 U	73.3 U	3.3 U
Alpha-BHC	6.4	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	1.91 J	0.836 U	0.849 U	0.842 U	0.847 U	0.855 U	0.274 J	0.081 U	0.084 U	0.082 U	2.02 U	0.85 U	0.086 U	1.21 U	0.082 U	0.81 U	1.8 U	0.084 U
Beta-BHC	16	µg/kg	0.978 U	0.081 U	0.086 U	0.083 U	0.083 U	0.083 U	10.4 J	9.61 J	9.39 J	0.889	0.847 U	3.61 NJ	0.83 U	0.081 U	0.084 U	0.082 U	2.02 U	0.85 U	0.086 U	1.21 U	0.082 U	91.1 NJ	1.8 U	0.084 U
Gamma-BHC (Lindane)	33	µg/kg	0.36 J	0.57 B	0.19 B	0.17 B	0.34 BPGN	0.15 B	0.772 J	1	0.849 U	1.17 J	0.937 J	0.855 NJ	1.12	0.54 PG	0.52 PG	0.82 PG	2.69	1.7	0.52 PG	1.21 U	1.6 PG	2.28 J	1.07 J	0.55 B
PAHs																										
Acenaphthene	220,000	µg/kg	48	70	25	28	33	27	42	67	14 J	330	170	76	25	43	310	200	130	44	6.4 J	11	61	76	R	58
Acenaphthylene	88,000	µg/kg	13 J	56	47	18	31	17	20	26	13 J	84	32	34	16 J	22	29	30	25	26	3.3 J	8.3 J	40	46	68	97
Anthracene	120,000	µg/kg	25	110	56	39	70	24	50	160	23	360	130	100	110	60	310	140	120	430	11	16	110	210	190	160
Benzo(a)anthracene	330,000	µg/kg	54	290	140	88	160	68	91	150	54	300	180	290	100	130	200	220	230	190	29	110	210	220 J	R	270
Benzo(a)pyrene	23,000	µg/kg	59	290	160	96	180	72	95	130	63	290	180	230	100	130	160	180	210	190	32	140	240	190	490	470
Benzo(b)fluoranthene	220,000	µg/kg	79	410	170	130	230	97	120	180	76	270	210	270	140	160	220	250	290	260	43	180	330	290 J	R	620
Benzo(k)fluoranthene	120,000	µg/kg	32	170	61	52	86	31	45	59	31	100	85	100	46	56	85	97	110	93	16	68	110	6.6 U	230 J	260
Chrysene	76,000	µg/kg	73	410	160	100	200	76	100	170	63	300	190	290	120	160	220	250	280	220	32	140	240	250 J	540 J	390
Dibenzo(a,h)anthracene	540,000	µg/kg	9.8 J	56	26	20	31	14 J	15 J	21	8.9 J	33	27	32	20	24	28	33	36	36	7.6 U	30	49	37 J	R	82
Fluoranthene	1,200,000	µg/kg	160	810	340	240	430	180	230	420	120	610	410	860	360	420	810	800	730	560	56	260	570	960	2,000	890
Fluorene	230,000	µg/kg	29	41	22	18	21	15 J	23	50	11 J	230	120	52	32	34	420	150	92	61	4.0 J	11	38	76	120	37
Indeno(1,2,3-cd)pyrene	9,200	µg/kg	43	250	100	80	130	55	68	88	42	150	110	120	75	95	110	130	150 J	140	26	110	180	91 J	R	310
2-Methylnaphthalene	1,700	µg/kg	6.7 J	20	22	5.2 J	10 J	5.5 J	5.0 J	10 J	17 U	61	16 J	9.5 J	5.8 J	9.0 J	42	24	26	15 J	7.6 U	5.7 J	9.9	19	R	10
Naphthalene	1,500	µg/kg	20 U	19	15 J	5.6 J	8.2 J	4.6 J	6.8 J	8.4 J	17 U	11 J	18	9.5 J	17 U	9.5 J	16	17 J	31	12 J	7.6 U	5.2 J	11	11	R	16
Phenanthrene	660,000	µg/kg	67	190	66	56	110	59	82	200	54	890	370	310	120	160	1,100	270	280	240	18	140	150	320 J	410	270
Pyrene	1,100,000	µg/kg	170	700 J	390 J	230 J	390 J	180 J	200 J	400 J	160 J	800 J	440 J	670	270 J	310 J	680	630	610	510	70	360	860	460 J	R	890
Semivolatile Organics																										
1,2,4-Trichlorobenzene	14,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 UJ	84 U	36 U	49 U	43 U	33 U	36 U	33 U
1,2-Dichlorobenzene	29,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
1,3-Dichlorobenzene	2,100	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
1,4-Dichlorobenzene	5,700	µg/kg	4.8 J	9.6 J	17 U	17 U	17 UJ	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 UJ	2.7 J	18 UJ	20 U	17 UJ	7.6 UJ	2.8 J	8.6 UJ	7.1	7.9	5.8 J
2,4,6-Trichlorophenol	1,300	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 UJ	36 U	33 U
2,4-Dichlorophenol	12,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
2,4-Dimethylphenol	20,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	7.5 J	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	6.2 J
2,4-Dinitrophenol	1,700	µg/kg	500 UJ	410 U	420 U	400 U	430 U	420 U	420 U	420 U	420 U	420 U	420 U	420 UJ	420 U	420 U	170 U	460 U	500 UJ	420 U	180 U	250 U	220 U	170 UJ	190 UJ	170 U
2,4-Dinitrotoluene	1,000	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
2,6-Dinitrotoluene	390	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
2-Chloronaphthalene	500,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	29	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
2-Chlorophenol	1,400	µg/kg	98 U	85 U	84 U	84 U	82 U	84 U	82 U	84 U	85 U	84 U	36 J	86 U	83 U	82 U	34 U	92 U	98 U	84 U	36 U	50 U	43 U	33 U	37 U	33 U
3,3'-Dichlorobenzidine	1,800	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 UJ	33 U
4-Nitrophenol	2,600	µg/kg	500 U	410 U	420 U	400 U	430 U	420 U	420 U	420 U	420 U	420 U	420 U	420 U	420 U	420 U	170 U	460 U	500 UJ	420 U	180 U	250 U	220 U	170 UJ	190 U	170 U
bis(2-Chloroethyl)ether	330	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U

Table 2

Comparison of Sediment Data to Groundwater Protection Screening Standards

Compound	$Soil_{SSGW}$	Units	DMMU 1						DMMU 2						DMMU 5								DMMU 7			
			1 07/18/07	2 07/18/07	3 07/18/07	4 07/18/07	5 07/18/07	6 07/18/07	1 07/16/07	2 07/16/07	3 07/16/07	4 07/14/07	5 07/14/07	6 07/14/07	1 08/20/07	2 08/21/07	3 08/29/07	4 08/25/07	5 08/24/07	6 08/24/07	7 08/23/07	8 08/23/07	1 08/15/07	2 08/07/07	3 08/11/07	4 08/16/07
Semivolatile Organics (Continued)																										
bis(2-Chloroisopropyl)ether	800	µg/kg	20 UJ	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 UJ	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
bis(2-Ethylhexyl)phthalate	79,000	µg/kg	130	1,000	250	200	290	100	50 J	120	67 J	75 J	71 J	81	130	90	120	250	2,100	160	190	99	58	320 J	R	89
Butylbenzylphthalate	220,000	µg/kg	20 J	35 J	84 U	10 J	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	15 J	92 U	98 U	84 U	36 U	9.1 J	43 U	20 J	36 U	8.5 J
Dibenzofuran	24,000	µg/kg	5.7 J	17 J	5.2 J	5.6 J	8.2 J	84 U	6.4 J	13 J	81 U	8.4 J	25 J	8.1 J	10 J	18 J	200	18 J	56 J	16 J	2.8 J	9.9 J	11 J	31 J	45	18 J
Diethylphthalate	360,000	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
Dimethylphthalate	1,500,000	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Di-n-Octylphthalate	10,000,000	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 UJ	36 U	33 U
Hexachlorobenzene	9,600	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Hexachlorobutadiene	5,500	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Hexachlorocyclopentadiene	1,200,000	µg/kg	R	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 UJ	R	33 U
Hexachloroethane	2,200	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 UJ	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
Isophorone	560	µg/kg	98 U	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 U	83 U	82 U	33 U	92 U	98 U	84 U	36 U	49 U	43 U	33 U	36 U	33 U
Nitrobenzene	330	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
N-Nitroso-di-n-propylamine	330	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	6.6 U
N-Nitrosodiphenylamine	2,100	µg/kg	20 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	6.6 U	7.3 U	210
Pentachlorophenol	1,700	µg/kg	98 UJ	81 U	84 U	84 U	82 U	84 U	82 U	84 U	81 U	84 U	80 U	81 UJ	83 U	82 U	33 U	92 U	98 UJ	84 U	36 U	49 U	43 U	33 U	36 UJ	33 U
Phenol	11,000	µg/kg	20 U	9.3 J	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U	11 J	17 U	17 U	6.8 U	18 U	20 U	17 U	7.6 U	9.9 U	8.6 U	4.0 J	4.5 J	2.9 J
Volatile Organics																										
1,1,1-Trichloroethane	4,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	6	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloroethane	58	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1-Dichloroethane	7,500	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1-Dichloroethene	85	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethane	35	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloropropane	42	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Butanone	5,000	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 UJ	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-pentanone	6,400	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	1,500	µg/kg	20 UJ	20 U	20 U	20 U	7.4 J	8.4 J	20 U	20 U	20 U	8.0 J	980 U	13 J	20 U	20 U	20 U	11 J	23	20 U	20 U	20 U	20 U	20 UJ	20 U	20 U
Benzene	51	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 J	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromodichloromethane	920	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromoform	1,800	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromomethane	40	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Disulfide	11,000	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Tetrachloride	110	µg/kg	5.0 UJ	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 UJ	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chlorobenzene	3,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	12,000	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroethane	35	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 UJ	5.0 U
Chloroform	900	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloromethane	100	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Dibromochloromethane	1,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Ethylbenzene	19,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene Chloride	17	µg/kg	5.0 U	5.2 UJ	5.2 UJ	5.2 UJ	5.1 UJ	5.1 UJ	5.0 UJ	2.1 J	4.9 U	5.2 UJ	250 U	5.2 U	5.0 UJ	5.2 UJ	5.1 UJ	5.0 UJ	5.0 U	2.5 JB	5.0 UJ	3.0 JB	5.0 UJ	5.0 U	5.0 U	1.4 J
Styrene	11,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	180	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Toluene	20,000	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 UJ	5.0 U
trans-1,2-Dichloroethene	770	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Trichloroethene	73	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Vinyl Chloride	13	µg/kg	5.0 U	5.2 U	5.2 U	5.2 U	5.1 U	5.1 U	5.0 U	5.0 U	4.9 U	5.2 U	250 U	5.2 U	5.0 U	5.2 U	5.1 U	5.0 U	5.0 U	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Xylenes (total)	150,000	µg/kg	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	760 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U
Inorganics																										
Cyanide	400	mg/kg	R	0.181	0.103	0.156	0.171	0.160	1.32 J	1.50 J	0.317 J	0.515 U	0.491 U	0.523 U	0.158	0.516 U	0.182 U	1.14	0.336 U	0.168	0.502 U	0.500 U	0.500 UJ	5.16	0.502 U	0.698 J
Dinoseb	140	µg/kg	12.2 UJ	11.8 U	12.2 U	12 U	12.1 U	11.8 U	11.8 U	12.1 U	12.1 U	12.2 UJ	12 UJ	11.9 UJ	12 U	R	R	R	R	R	R	R	11.8 U	R	1.35 UJ	12 U
Percent Solids	- -	%	61.1	40.7	57.3	41.3	48.7	48.8	45.4	41.8	44.7	46.8	44.6	47.5	54.1	54.1	56.0	74.6	61.1	60.5	66.5	75.8	54.6	65.2	56.4	36.6
TPH																										
TPH-D	65	mg/kg	25.7 J	31.5	10.3	15.2	34.2	11.8	9.99 UJ	66.9 J	32.6 J	36 J	49.1 J	128 J	108	176	187	275	306 J	467	134	371	197	658	95.9 J	105
TPH-G	65	mg/kg	0.033 J	0.0555 J	0.0516 J	0.044 J	0.0389 J	0.0371 J	0.123	0.117	0.0398 J	0.136	26.3	0.0451 J	0.054 J	0.0344 J	0.0509 J	0.223 J	0.177	0.56	0.0993 J	0.0985 UJ	0.054 J	0.506	0.102 U	0.0931 J

Notes:

Shaded values exeed screening standards.

DMMU = Dredge Material Management Unit

PAHs = Polycyclic Aromatic Hydrocarbons.

$Soil_{SSGW}$ = Soil screening standards beased on the protection of groundwater meeting the definition of Groundwater Category 1.

TPH-D = Total Petroleum Hydrocarbons (Diesel).

TPH-G = Total Petroleum Hydrocarbons (Gasoline).

mg/kg = Milligrams per kilogram.

µg/kg = Micrograms per kilogram.

Table 3

Comparison of Exposure Point Concentrations and Average Concentrations to Human Health Direct Contact Residential Standards

Compound	Units	DMMU Averages				Maximum Concentration	Maximum Location	EPC Concentration	Direct Contact Soil Standards: Management Option 1 $Soil_{ni}$	Concentration Protective of Human Health Yes/No
		DMMU 1	DMMU 2	DMMU 5	DMMU 7					
Barium	mg/kg	497	320	278	369	836	DMMU 1-6	423	5,500 (2,250) [a]	Yes
Aroclors (Total)	µg/kg	79.7	71.3	72.4	78.7	**332**	DMMU 5-6	108	210	Yes
Benzo(a)pyrene	µg/kg	143	165	143	**348**	**490**	DMMU 7-3	228	330	Yes
TPH-D	mg/kg	21.5	53.8	253	264	**658**	DMMU 7-2	294	650 (325) [a]	Yes

Notes:

Bolded values exceed standards.

[a] Parenthetical value is adjusted for additivity (target organ for barium and TPH-D is kidney).

DMMU = Dredge Material Management Unit.

EPC = Exposure Point Concentration, i.e., 95% Upper Confidence Limit of the mean.

RECAP = Risk Evaluation/Corrective Action Program.

$Soil_{ni}$ = RECAP Standard applicable to surface soil located in an area meeting the definition of non-industrial (residential) land use.

TPH-D = Total Petroleum Hydrocarbons (Diesel).

mg/kg = Milligrams per kilogram.

µg/kg = Micrograms per kilogram.

Table 4

Comparison of Exposure Point Concentrations and Average Concentrations to Soil Protective of Groundwater Standards

Compound	Units	DMMU Averages				Maximum Concentration	Maximum Location	EPC Concentration	Soil-to-Groundwater Protection Standards	Concentration Protective of Human Health Yes/No
		DMMU 1	DMMU 2	DMMU 5	DMMU 7				Management Option 1 $Soil_{GW3NDW}$	
Lead	mg/kg	31.6	57.5	67.8	**102**	**275**	DMMU 5-6	81.8	100	Yes
Beta-BHC	µg/kg	0.232	5.79	0.655	23.3	**91.1**	DMMU 7-2	12.8	49	Yes
TPH-D	mg/kg	21.5	53.8	253	264	658	DMMU 7-2	294	176,900	Yes
Benzene	µg/kg	5.13	45.9	5.05	5.00	250	DMMU 2-5	NA	3,770	Yes
Chlorobenzene	µg/kg	5.13	2004	5.05	5.00	12000	DMMU 2-5	NA	609,000	Yes

Notes:

Bolded values exceed standards.

DMMU = Dredge Material Management Unit.

EPC = Exposure Point Concentration, i.e., 95% Upper Confidence Limit of the mean.

NA = Not available. EPCs were not calculated for benzene and chlorobenzene because these constituents only had one detection each.

$Soil_{GW3NDW}$ = Soil protective of Groundwater Classification 3 (non-drinking water) standards. Thickness of groundwater source (S_d) was assumed to be 5 feet. Distance to surface water body was assumed to be 300 feet. Dilution factor of 29 was used to calculate groundwater standards.

TPH-D = Total Petroleum Hydrocarbons (Diesel).

mg/kg = Milligrams per kilogram.

µg/kg = Micrograms per kilogram.

Table 5

Comparison of Exposure Point Concentrations and Average Concentrations to Risk-Based Human Health Direct Contact Standards for Recreational Exposure

Compound	Units	DMMU Averages				Maximum Concentration	Maximum Location	EPC Concentration	Risk-Based Sediment Standard		Concentration Protective of Human Health Yes/No
		DMMU 1	DMMU 2	DMMU 5	DMMU 7				SD_r	SD_f	
Barium	mg/kg	497	320	278	369	836	DMMU 1-6	423	160,000 (80,000) [a]	8,500 (4,250) [a]	Yes
Aroclors (Total)	µg/kg	79.7	71.3	72.4	78.7	**332**	DMMU 5-6	108	6,900	140	Yes
Benzo(a)pyrene	µg/kg	143	165	143	**348**	**490**	DMMU 7-3	228	2,000	330*	Yes
TPH-D	mg/kg	21.5	53.8	253	264	658	DMMU 7-2	294	68,000 (34,000) [a]	3,700 (1,850) [a]	Yes

Notes:

Bolded values exceed standards.

[a] Parenthetical value is adjusted for additivity (target organ for barium and TPH-D is kidney).

* Based on analytical quantitation limit (LDEQ 2003).

DMMU = Dredge Material Management Unit.

EPC = Exposure Point Concentration, i.e., 95% Upper Confidence Limit of the mean.

SD_r = Risk-based chemical concentration in sediment for the recreational exposure pathway.

SD_f = Risk-based chemical concentration in sediment for fish ingestion exposure pathway.

TPH-D = Total Petroleum Hydrocarbons (Diesel).

mg/kg = Milligrams per kilogram.

µg/kg = Micrograms per kilogram.

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Figures

Figure 1. Project Location Map

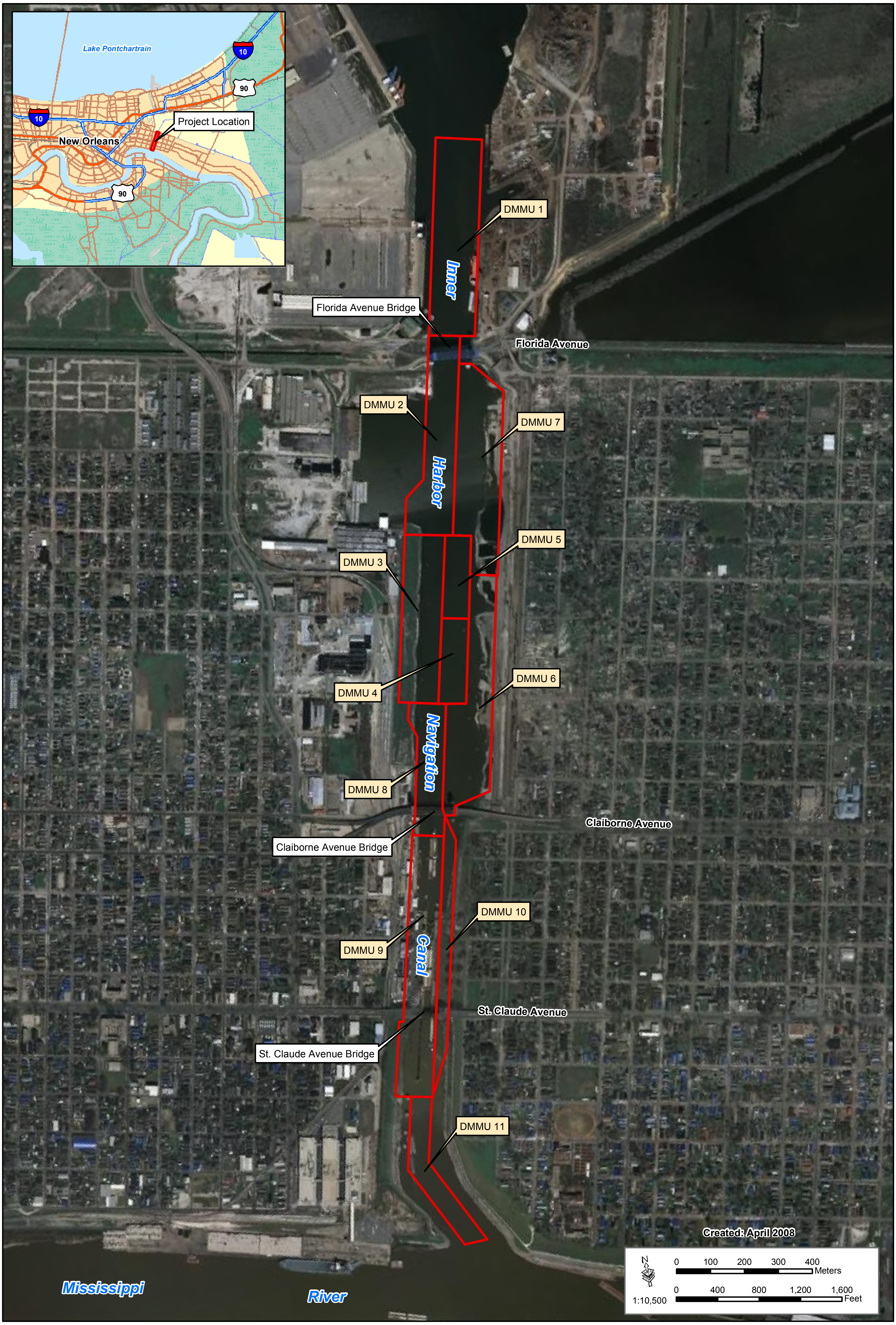
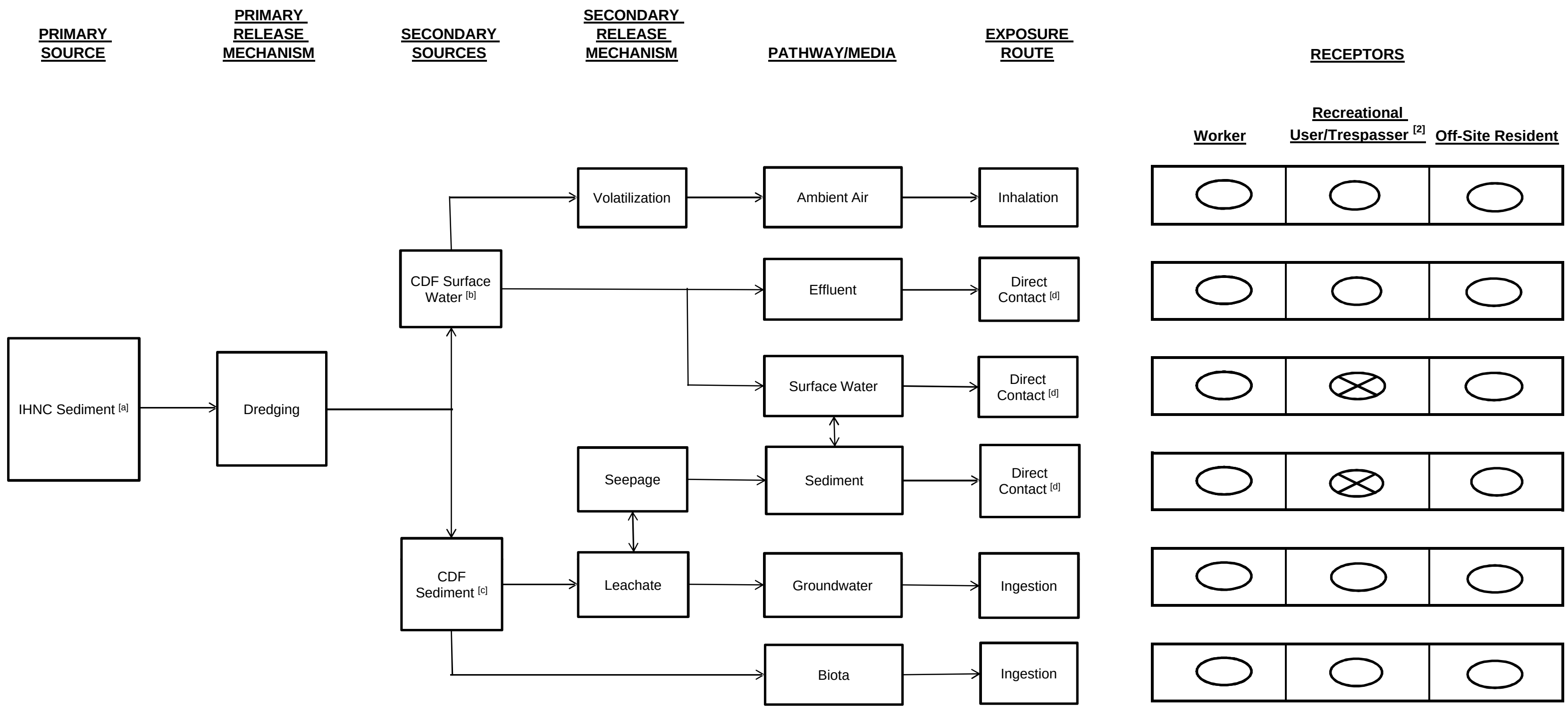


Figure 2. Location of Dredged Material Management Units

Figure 3. Scenario A: Conceptual Site Model During Filling of the Confined Disposal Facility [1]



LEGEND:

(⊗) = Potentially complete exposure pathway

(○) = Exposure pathway is incomplete or insignificant

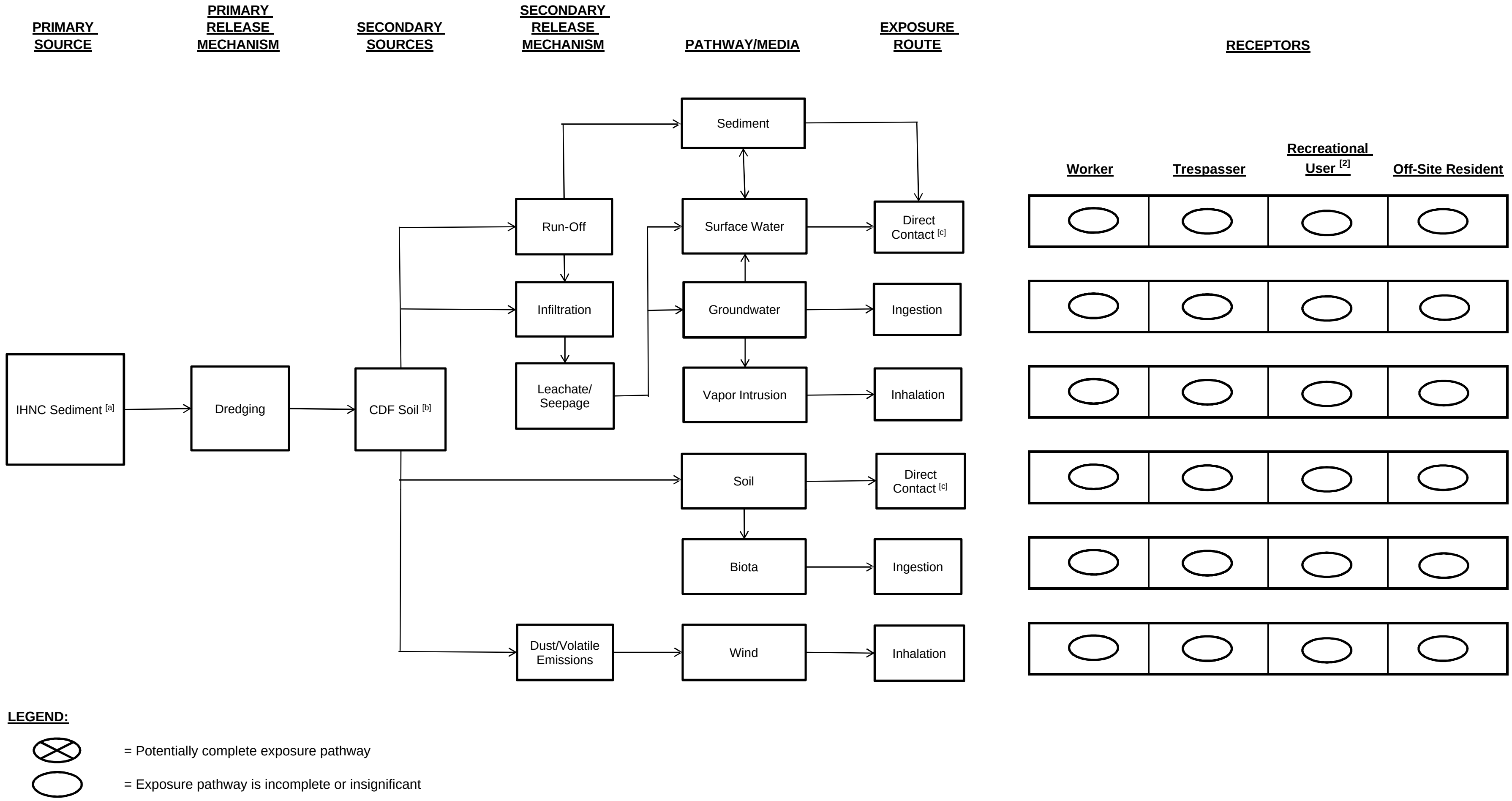
NOTES:

[1] Conceptual site model assumes dredged material within CDF is not consolidated, i.e., exposure may occur within first 7 years of construction when materials in CDF aren't fully dewatered.
[2] Recreational users may include fishermen, crabbers, boaters, and hunters, i.e., users of the nearby GIWW and Bayou Bienvenue, that trespass onto the CDF site.
[a] It is assumed that contaminants in IHNC sediments are a result of industrial releases.
[b] Surface water refers to surface water in CDF associated with hydraulic dredging.
[c] Sediment refers to dredged sediment from IHNC.
[d] Direct contact may include dermal contact and/or incidental ingestion of sediment and/or surface water.
CDF = Confined Disposal Facility
IHNC = Inner Harbor Navigation Canal
GIWW = Gulf Intracoastal Waterway

REFERENCE:

Derived from the Example Conceptual Site Model in USEPA (1988) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* .

Figure 4. Scenario B: Conceptual Site Model After Closure of the Confined Disposal Facility [1]



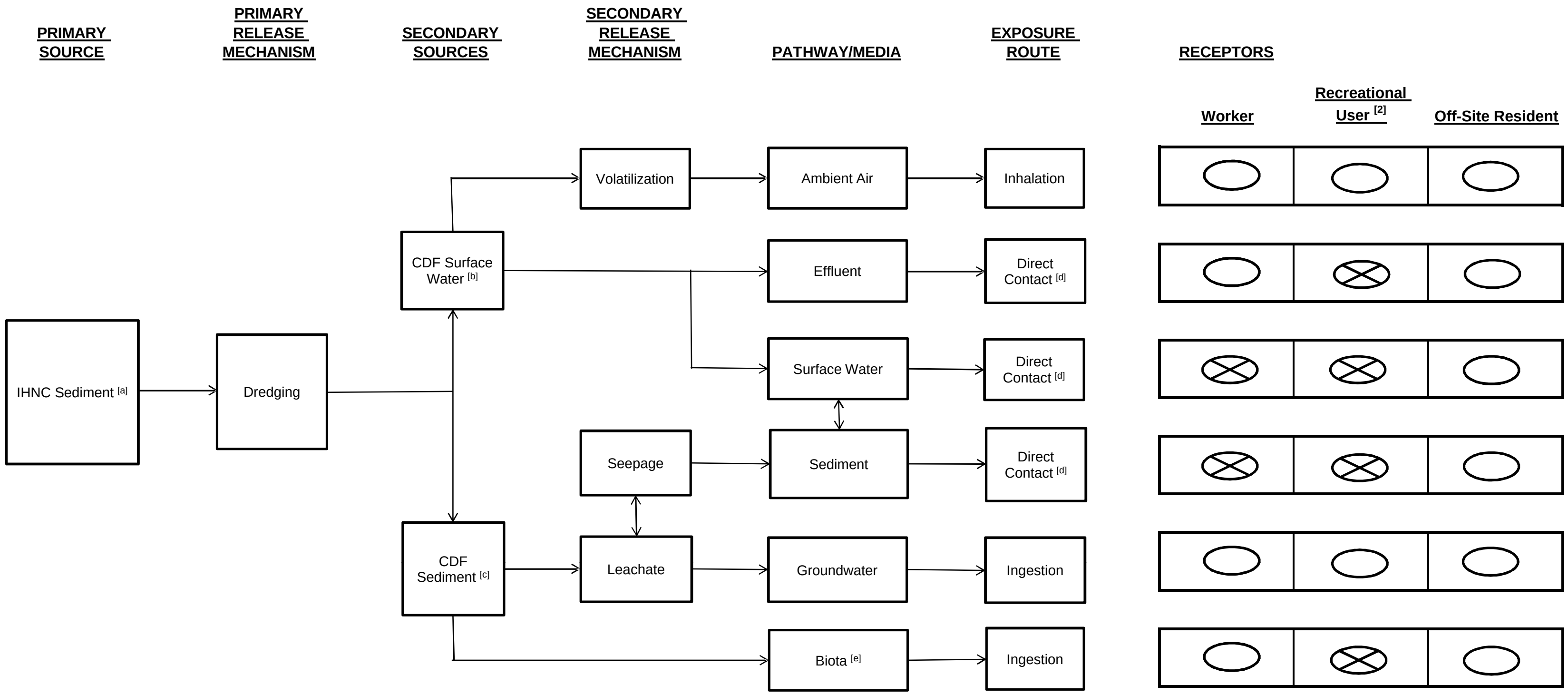
NOTES:

[1] Conceptual site model assumes dredged material within CDF is fully consolidated and dewatered, i.e., primary exposure medium is soils.
[2] Recreational users may include fishermen, crabbers, boaters, and hunters, i.e., users of the nearby GIWW and Bayou Bienvenue.
[a] It is assumed that contaminants in IHNC sediments are a result of industrial releases.
[b] Soil is considered to be covered, consolidated sediments within the CDF.
[c] Direct contact may include dermal contact and/or incidental ingestion of sediment, soil, and/or surface water.
CDF = Confined Disposal Facility
IHNC = Inner Harbor Navigation Canal
GIWW = Gulf Intracoastal Waterway

REFERENCE:

Derived from the Example Conceptual Site Model in USEPA (1988) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* .

Figure 5. Scenario C: Conceptual Site Model for Catastrophic Failure During Filling of the Confined Disposal Facility [1]



LEGEND:

= Potentially complete exposure pathway

= Exposure pathway is incomplete or insignificant

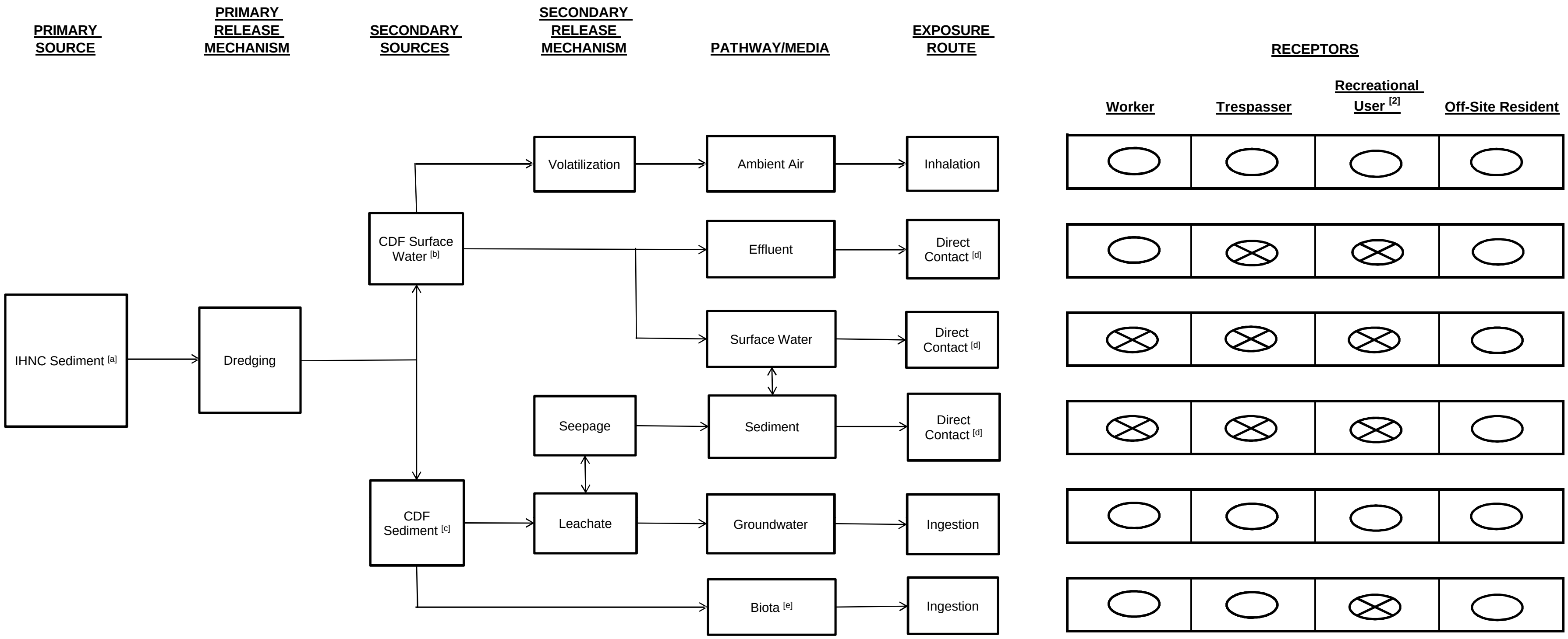
NOTES:

[1] Conceptual site model assumes dredged material within CDF would breach containment berms and enter surrounding areas during filling activities.
[2] Recreational users may include fishermen, crabbers, boaters, and hunters, i.e., users of the nearby GIWW and Bayou Bienvenue.
[a] It is assumed that contaminants in IHNC sediments are a result of industrial releases.
[b] Surface water refers to surface water in CDF associated with hydraulic dredging.
[c] Sediment refers to dredged sediment from IHNC.
[d] Direct contact may include dermal contact and/or incidental ingestion of sediment and/or surface water.
[e] Biota = Fish and/or crabs
CDF = Confined Disposal Facility
IHNC = Inner Harbor Navigation Canal
GIWW = Gulf Intracoastal Waterway

REFERENCE:

Derived from the Example Conceptual Site Model in USEPA (1988) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* .

Figure 6. Scenario D: Conceptual Site Model for Catastrophic Failure After Closure of the Confined Disposal Facility[1]



LEGEND:


= Potentially complete exposure pathway


= Exposure pathway is incomplete or insignificant

NOTES:

[1] Conceptual site model assumes dredged material within CDF would breach containment berms and enter surrounding areas after closure, but prior to consolidation.
[2] Recreational users may include fishermen, crabbers, boaters, and hunters, i.e., users of the nearby GIWW and Bayou Bienvenue.
[a] It is assumed that contaminants in IHNC sediments are a result of industrial releases.
[b] Surface water refers to surface water in CDF associated with hydraulic dredging.
[c] Sediment refers to dredged sediment from IHNC.
[d] Direct contact may include dermal contact and/or incidental ingestion of sediment and/or surface water.
[e] Biota = Fish and/or crabs
CDF = Confined Disposal Facility
IHNC = Inner Harbor Navigation Canal
GIWW = Gulf Intracoastal Waterway

REFERENCE:

Derived from the Example Conceptual Site Model in USEPA (1988) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* .

Appendix A

Engineering Risk Review

ARCADIS
Infrastructure, environment, buildings

Building Sustainable Communities on an Ecological Foundation
Bioengineering GROUP

HNTB

US Army Corps of Engineers®
New Orleans District

Engineering Risk Review

Confined Disposal Facility (CDF)

19 March 2009

Engineering Risk Review

Confined Disposal Facility (CDF)

Prepared for:

U.S. Army Corps of Engineers

Prepared by:

Bioengineering ARCADIS, LLC

3850 North Causeway Boulevard

Suite 1600

Metairie

Louisiana 70002

Tel 504 832 4174

Fax 504 832 2145

Our Ref.:

NL990058.0001.00001

Date:

19 March 2009

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Figures

1. Risks during Filling of the CDF

The following summarizes potential risks that might occur during filling of the Confined Disposal Facility (CDF) (Figure 1). It is important to note that filling of the CDF will occur over a period of approximately seven years. Sediment will be placed hydraulically. The filling and water removal (decanting) process is described in more detail below. The risks identified below were evaluated as part of the conceptual design of the CDF (USACE, 2008a) and have or will be addressed during future design stages of the CDF design. Figure 1 shows a graphic representing the conceptual CDF design during filling and includes a summary table of potential risks described below.

1.1 Catastrophic Failure Scenarios – Risks during Filling of the CDF

1.1.1 Overtopping of Containment Dike due to Flooding Resulting from Levee Breach during Hurricane

Hurricane protection is discussed in the conceptual design report (USACE, 2008a) and is summarized in this paragraph. During Hurricane Katrina, levees in the vicinity of the proposed CDF location did break and flooding throughout the area occurred. Flood risk maps for the pre-Katrina protection level indicated that flood levels of up to 8 feet could occur at the CDF location during a 100-year event. The 100-year flood protection is defined as the flood elevation that has a 1 percent chance of flooding in any given year (or a recurrence interval of 100 years). Flood risk maps for the conditions that exist after levee upgrades appear to indicate that no flooding would occur at the CDF site during the 100-year event.

During the active life of the conceptual CDF, the design provides for the CDF containment dikes to be constructed to an elevation of 15 feet (about 2 feet higher than the pre-Katrina hurricane protection levee's required level). This elevation of 15 feet is equivalent to the new 100-year levee elevations required in this portion of the Hurricane and Storm Damage Risk Reduction System (HSDRRS).

Assuming the HSDRRS levee system is in place and meets the 100-year level of protection elevation of 15 feet, the USACE will construct the containment dike top elevation equal to or greater than the unprotected base flood elevation. Due to the uncertainty of the base flood elevation at the time of the conceptual design, it has been assumed that it may be as high as the current 100-year HSDRRS level. If the CDF containment dikes are constructed to an elevation of 15 feet, the design would result in approximately 7 to 9 feet of additional protection above the, maximum predicted unprotected base flood elevation in the area surrounding the proposed disposal area. The unprotected base flood elevation assumes that the hurricane protection levees along the Gulf Intracoastal Waterway (GIWW) are not in place. However, additional protection from surge associated with a hurricane will be provided by the new gate locations proposed in the GIWW, Mississippi River Gulf Outlet (MRGO), and Seabrook and the earthen levees and floodwalls that provide hurricane protection to this area. The final elevations will be established during the detail design of the CDF.

Assuming the CDF and the top elevation of the containment dike are constructed to a level above the anticipated base flood level for the 100-year event, the risk of overtopping of the CDF containment dike during filling of the CDF is estimated to be low.

Based on the increased level of protection provided by the significant enhancement to the HSDRRS, the risk associated with the CDF overtopping is estimated to be low as long as the required elevations are constructed above the unprotected 100-year base flood elevation.

1.1.2 Erosion of Containment Dike after Breach of Levee during Hurricane

Potential for erosion of the containment dike in the event of a levee breach adjacent to the CDF is mentioned in the conceptual CDF design report (USACE, 2008a), although the risk was not quantitatively analyzed in that report. Flow velocities impacting the dike would need to be high enough to cause significant erosion. Flow velocities will need to be evaluated during the final design.

The proposed CDF containment dike cross section presented in the conceptual CDF design report is substantial. The conceptual design included a base width of the dike slightly larger than 300 feet with an average dike height of 15 to 17 feet and a crest width of 7 feet. It is estimated that flow velocities would need to be very high to erode substantial portions of the dike and cause a release of the dredge slurry. Detailed engineering analysis will be conducted of the final CDF containment dike system to minimize any potential for significant erosion.

Mitigation measures to limit or prevent erosion include designing armoring, if necessary, to resist erosive flows. Additionally, the distance between the levee and the CDF containment berm should be selected such that water overtopping the levee will not cause high-flow velocities along the dike alignment.

If the current required HSDRRS protection levels are maintained during the operational life, the risk of overtopping and/or catastrophic erosion is estimated to be low.

1.1.3 Containment Dike Failure

The containment dike could potentially fail if the underlying foundation soils are not strong enough to support the loading conditions during filling. This scenario is not described in the conceptual CDF design. The conceptual CDF design report (USACE, 2008a) provides some subsurface information, which was collected in 1957, for the general area. This information includes soil boring logs, soil strength data, subsurface cross sections, and the results of slope stability analyses for the bank of the GIWW. The site is underlain by relatively soft soils consisting predominantly of highly plastic clays and a layer of peat at the ground surface. Some of the factors of safety against potential failure calculated to assess the stability of the bank appear to be relatively low, but do not indicate failure. The sizes of the potential failure masses that were analyzed were quite substantial and reach up to about 200 feet behind the face of the bank. Stability analysis should be conducted, adhering to the October 2007 HSDRRS guidance.

The risk associated with containment dike failure is estimated to be low assuming that the dikes will be designed properly during final design of the CDF. If stability of the containment dike was marginal, it would most likely show signs of distress during construction, instead of during filling of the CDF. Careful observations during construction of the dike will therefore provide additional confidence in the performance of the dike during filling. Additionally, failure of the dike would be associated with excessive deformation of the dike, which will not likely be large enough to constitute a release of significant amounts of dredge slurry. Typically, when slope failures occur, the slope deforms until a new stable condition is reached. This might reduce the freeboard (i.e., the distance between the water surface and the top of the dike) somewhat, but would not necessarily constitute a release of dredge slurry. The conceptual dike design also shows a very long, relatively flat slope on the assumed outboard side, which will be unlikely to experience significant deformation and will require a substantial amount of distance between the adjacent levee and the edge of the bank of the GIWW. The stability of the bank of the GIWW is not likely to be affected by construction of the CDF if a proper offset distance between the GIWW and the dike is selected based on geotechnical engineering analyses. The stability of the adjacent levee is generally only at risk if the containment dike is constructed so close to the levee and the river bank that it destabilizes the river bank. This scenario is estimated to be unlikely, but can be addressed during the stability assessment of the containment dike.

Subsurface conditions and soil strength need to be investigated. To obtain this information, a new subsurface investigation, which addresses the stability of the dike, levee, and GIWW bank, may need to be performed. Slope stability analyses need to be performed during final design using an adequate target factor of safety against potential failure. If soil conditions are not adequate to support the dike, improvement of the subsurface conditions by employing ground improvement construction techniques may be an option to provide adequate stability.

1.2 Non-Catastrophic Scenarios – Risks during Filling of the CDF

1.2.1 Overtopping of Containment Dikes due to Adverse Weather

Large rain storm events can result in a substantial rise in water elevation within the CDF within a relatively short time (on the order of 13 to 15 inches in 24 hours during the 100-year storm event). Additionally, waves within the CDF and water masses being pushed by high winds resulting in higher water levels at one end of the CDF can substantially reduce the distance between the water surface and the top of the dike. This distance is known as freeboard. Accordingly, the CDF needs to have sufficient freeboard during normal operating conditions (i.e., no precipitation and no high winds) such that adverse weather conditions do not result in overtopping of the containment dikes. The analyses necessary to determine the required amount of freeboard was not included during conceptual CDF design.

The risk associated with overtopping of the dikes is estimated to be low. The freeboard can be properly selected based on available precipitation design data and wave analyses based on wind design data. Additionally, the large majority of water that might go over the dike during a storm event would be relatively clear and uncontaminated because the upper portion of the water column normally contains relatively little sediment.

Mitigation measures include designing the freeboard based on precipitation and wind design data.

1.2.2 Water Quality Criteria Exceedance in Receiving Water

The dredged slurry will be delivered to the CDF via pipeline. Once the slurry enters the CDF, the slurry slows down and the sediment particles start settling out to the bottom of the CDF. In a properly designed CDF, the water that flows over the weir at the other end of the CDF will contain significantly reduced amounts of suspended sediment particles. The water discharged from the weir during disposal operations (referred to as the effluent) will be discharged to the adjacent water body, the GIWW. Chemical constituents that may be present in portions of the dredged material are primarily attached to sediment particles, which will settle out within the CDF. There remains a potential for small amounts of the chemical constituents to be carried across the weir. Chemical constituents can remain attached to fine-grained particles that are not settled out prior to discharge, or dissolved in the effluent waters flowing over the weir. It is important to note that, even if the effluent generated within the CDF does not meet the published water quality criteria, the effluent will meet the water quality criteria within an allowable distance from the discharge point within the GIWW. Additionally, water quality monitoring can be performed to ensure that the criteria are actually met. If exceedances are expected or reported, dredging operations can be adjusted by either dredging more slowly or by treating the effluent prior to discharge into the receiving water.

Based on the dilution requirement and mixing analyses performed as part of the conceptual CDF design, the potential for water quality exceedances outside a permitted mixing zone is estimated to be low. Water quality criteria are generally expected to be met (SEIS Appendix C [USACE, 2008b]). The discharge process can be managed and monitored. Necessary steps can be taken to meet the water quality criteria. If necessary, carbon will be broadcast near the discharge weir when dredging areas producing higher effluent concentrations than can be accommodated within the mixing zone.

After completion of dredging, the ponded water in the CDF will be discharged from the CDF as described above. After discharge of the ponded water, stormwater will need to be removed from the CDF as it occurs until the dredged material has dried and the CDF can be closed. This interim scenario that exists between the “during filling” and “after filling” scenarios is addressed in the conceptual CDF design (USACE, 2008a). Preliminary analyses were performed to show whether stormwater runoff could potentially cause water quality criteria exceedances in the receiving water.

A simplified laboratory runoff test (SLRP) is being conducted to mimic the conditions of the dredged material after it has dried, which sometimes results in higher metals releases than occur from wet material. The preliminary results of that analysis indicate that dilutions for runoff from dried (oxidized) material can be met within an allowable mixing zone in either the GIWW or Bayou Bienvenue (SEIS Appendix C [USACE, 2008b]).

Stormwater can generally be managed so that water quality impacts are avoided. If stormwater management is designed properly, the risk associated with water quality criteria exceedances due to runoff is low.

Mitigation measures include design of a stormwater management system. The conceptual CDF design report mentions the following options for management of stormwater:

- Collection of stormwater runoff and gradual discharge into Bayou Bienvenue and optional distribution of discharge along the length of the bayou to achieve dilution of chemical concentrations; and

- Discharge of runoff to the wetland area to the west of the CDF, where flows would dissipate and enter the bayou along the perimeter of the wetland. Routing the runoff through the wetland would remove a portion of the soil particles and contaminants.

The report states that additional climate and stream flow information is needed before effluent and stormwater runoff management alternatives can be definitively evaluated.

1.2.3 Ambient Air Quality Criteria Exceedance

Air quality could potentially be affected by chemical constituents that enter the air at the disposal site. This process is referred to as volatilization. Air quality can also be affected by dust. However, the material will be delivered to the CDF as slurry and therefore dust is not a primary concern during active disposal and when the area is ponded. During construction, dust is typically controlled by misting in conjunction with dust monitoring. The conceptual CDF design report (USACE, 2008a) considered volatilization from the CDF during the active disposal period when ponded water exists from the CDF after decanting when the dredged material is exposed to air. The analysis is quite conservative in that it assumes that the volatile constituents in the ponded water remain at their initial concentrations, which are in equilibrium in the influent slurry and does not consider losses and depletion of the contaminants from the dredged material. The analysis assumes that the entire ponded surface is stable although mixing occurs vertically in the pond. It did not explicitly address the turbulence occurring at the point of discharge which would result in higher losses of volatile constituents at the inlet than would occur from a stable surface. The area impacted would be relatively small, however, as compared to the overall surface area of the CDF. The differences in losses would be much smaller than the overestimation of volatile losses resulting from ignoring depletion of the contaminants. Volatile emissions can be reduced using submerged discharge, if necessary, but given the low concentrations of volatile constituents present, volatilization is not expected to present a health risk.

Based on the initial review of the existing data, the risk associated with volatilization during filling does not appear to be significant. If air monitoring during dredging indicates ambient air quality exceedances, dredging may need to be slowed or stopped until controls are implemented.

1.2.4 Groundwater Quality Impacts

Groundwater quality could potentially be affected by chemical constituents migrating from the dredge slurry into the groundwater. This process is referred to as leaching and is typically driven by groundwater flow or seepage. Infiltration of surface water can also result in seepage and subsequent leaching of chemical constituents into the groundwater.

Potential groundwater impacts are estimated based on leaching tests that were conducted on samples of the dredged material. Results of a preliminary risk evaluation of the potential for the dredge material to leach constituents to the groundwater beneath the CDF indicates that existing chemical constituent concentrations would not result in groundwater concentrations that would pose any unacceptable risk to the public and shallow groundwater is not used for drinking water purposes within a 1-mile radius of the CDF and in the New Orleans area.

2. Risks after Filling of the CDF

The following summarizes potential risks that might occur after filling of the CDF is complete and the facility is closed. After completion of dredging and filling of the CDF, the dredged material in the CDF will progressively dewater and, eventually, only relatively dry sediment remains. Figure 2 shows a graphic representing the conceptual

CDF design after filling and includes a summary table of potential risks described below.

2.1 Catastrophic Failure Scenarios – Risks after Filling of the CDF

2.1.1 Erosion of Containment Dike after Breach of Levee during Hurricane

As mentioned in the previous section, hurricane protection is discussed in the conceptual design report (USACE, 2008a) and the findings of the conceptual design investigation are summarized in an earlier section of this engineering risk assessment (refer to the section entitled Risks after Filling of the CDF / Catastrophic Failures). Potential for erosion of the containment dike in case of a breach of the levee during a hurricane event is mentioned in the conceptual CDF design report (USACE, 2008a).

The risk associated with erosion during filling of the CDF was discussed in an earlier section of this report and was estimated to be low. The risk associated with erosion after filling would be smaller than during filling. The dredged material in the CDF will be much dryer and denser after dewatering and consolidation and therefore the probability of any material to be released in case a containment structure was damaged due to erosion is estimated to be low. Risk of erosion will be further reduced after the site is revegetated.

Mitigation measures in addition to those already listed earlier for the case of filling of the CDF are not necessary.

2.2 Non-Catastrophic Scenarios – Risks after Filling of the CDF

2.2.1 Water Quality Criteria Exceedances due to Stormwater Runoff

Upon completion of dredging activity and after settling and drying of the dredged material within the CDF, a cover consisting of unimpacted “clean” dredge material will be placed over the permanent CDF to avoid contact of stormwater with any potential constituents of concern. Therefore, surface runoff after filling of the CDF is not considered to be a risk.

2.2.2 Ambient Air Quality Criteria Exceedances

As described under the risk assessment for the condition during filling, air quality could potentially be affected by chemical constituents that enter the air at the disposal site.

This process is referred to as volatilization. The conceptual CDF design report (USACE, 2008a) considered volatilization for the condition after dredging.

Based on the evaluation presented in the conceptual design, the risk associated with volatilization after filling is estimated to be low. The preliminary conclusion presented in the USACE report was that only ammonia would produce significant volatile emissions. It was further concluded that ammonia emissions do not pose a health risk.

Mitigation measures include preparation of an operation plan to reduce nuisance odors and the potential release of volatile constituents if the risk assessment indicates a significant threat exists.

2.2.3 Plant and Animal Uptake

Plants and soil organisms are potential vectors for the transfer of chemical constituents from the dredge material to ecological receptors of concern (e.g., birds, mammals) that may forage within the CDF. The CDF design report included in the SEIS states that plant and animal uptake pathways are not considered to be relevant to the CDF due to:

- The expected range of salinity (3 to 16 parts per thousand) of material placed in the CDF (Weston, 2008) may exceed the tolerance range of most soil invertebrates; and
- Vegetation management planned for the purpose of allowing multi-year sediment placement in the CDF and access to the temporarily stored sediment, once dewatered.

After completion of dredging, the dredged material will be dewatered through active management to promote drainage. As the material dries and consolidates, trenches will be dug around the perimeter of the dikes and in the dredged material. Water will be removed from the facility through evapotranspiration and pumping to the receiving water, as necessary. Material from the cell used for temporary disposal (suitable for open water disposal) will likely be used as final cover of the permanent CDF cell. Natural vegetation will establish after final placement of final soil cover. Soil invertebrates will also start to populate the CDF area after vegetation is established. Based on the following considerations, plant and animal uptake from the material stored in the CDF is not anticipated to be significant.

As previously indicated, part of the ongoing maintenance of the CDF during the operation years will include vegetation management. Excess vegetative growth will be removed or minimized, by chemical treatment, mechanical means, or other methods, thereby preventing natural succession during the active life of the CDF prior to closure. While some animals from adjacent areas will have the ability to cross through, or land in, the CDF during their normal search patterns for food, water, and shelter, the CDF would be considered a highly disturbed habitat and unattractive for long-term habitation. Furthermore, the CDF (approximately 450 acres) is likely to be only a small portion of resident (and to a lesser extent migratory) wildlife foraging area, thereby resulting in a *de minimis* area of concern for exposure.

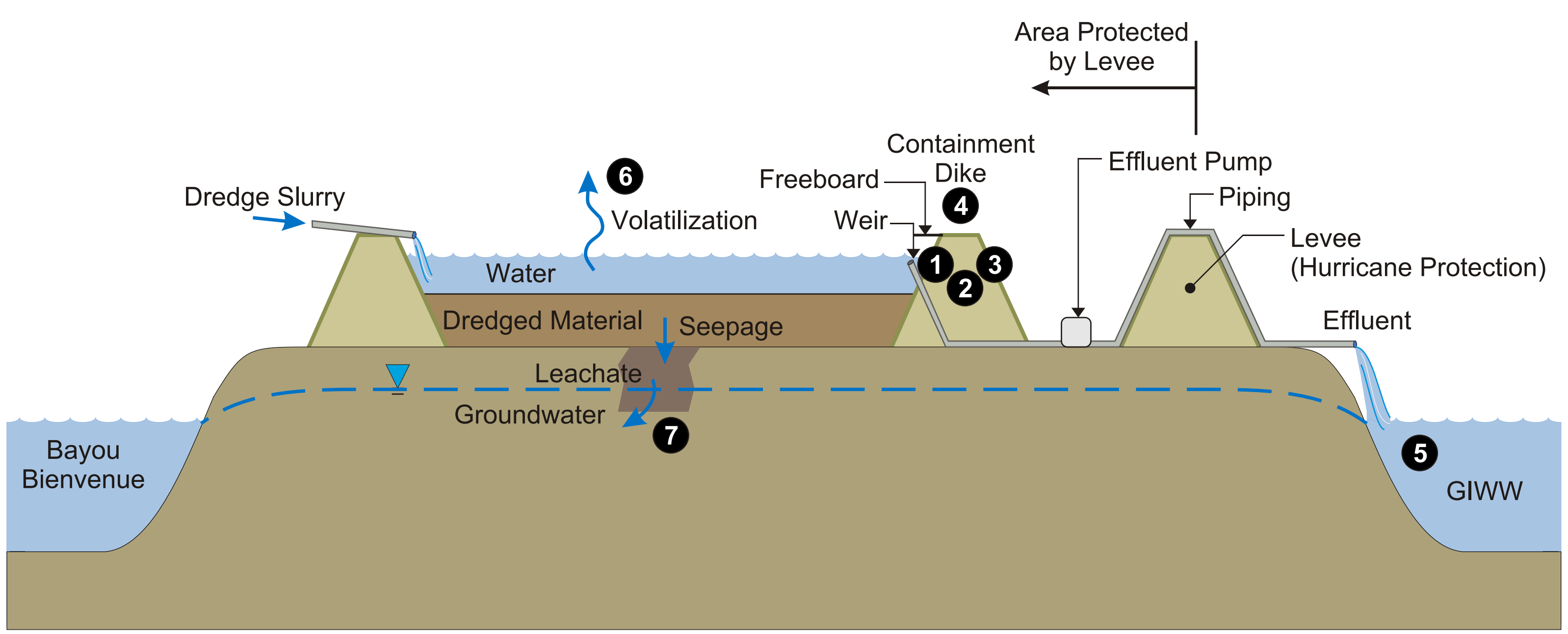
Habitat quality provided by the CDF after filling will be similar to the habitat quality of adjacent upland (forested scrub/shrub) areas. At this time, and largely as a result of Hurricane Katrina, adjacent upland areas are considered highly disturbed and dominated by opportunistic species such as the Chinese tallow tree, Within several thousand feet south and east of the CDF, undisturbed marsh and wetlands are present in the Bayou Bienvenue drainage basin (estimated 25,000 – 30,000 acres in coverage). These habitats in the surrounding area of the CDF are largely undisturbed and in late-successional stages of development. These habitats tend to provide higher quality food and cover for wildlife than the disturbed habitat of the CDF.

The proposed sequence of dredging will result in the sediments having the highest potential for elevated chemical concentrations being deposited in the CDF first, covered by several feet of non-impacted sediment material, and ultimately covered with non-impacted berm material. Plants that become established in the CDF will have roots primarily in non-impacted surface material. Soil organisms will burrow in the non-impacted surface material where suitable oxygen and plant detritus are available. Therefore, adverse ecological exposures to the surface soil of the CDF by these organisms after filling are not likely.

2.2.4 Groundwater Quality Impacts

As described in the preliminary risk evaluation of the potential to adversely impact groundwater quality beneath the CDF during filling, the long-term risks associated with the inactive CDF are minimal. The preliminary conclusion is that during the time when there is the greatest potential to adversely impact groundwater (during filling) the highest concentrations present in the dredge material do not pose a significant threat to the groundwater quality beneath the CDF. This conclusion is supported by the results of the soil-to-groundwater leaching evaluation for potential human exposures and by the lack of shallow groundwater use as drinking water within a 1-mile radius of the site and the general New Orleans area.

Figures



NOT-TO-SCALE

CDF DURING FILLING

Note:
Interim year conditions are not depicted; during these temporary periods there will be no influent or effluent and the materials will consolidate and the sediment surface potentially exposed.

No.	Description of Risk	Background	Evaluation	Mitigation
Catastrophic Scenarios				
1	Overtopping of Dike during Hurricane	Hurricane protection is discussed in USACE report. Dike height will be selected such that the top of the dike is above the unprotected 100-year base flood level.	Estimated risk is low based on design of facility; top of dike will be above 100-year flood level. Additional protection provided by new Gate Structure within the GIWW should minimize potential for surge overtopping of CDF dikes.	- Confirm hurricane protection level. - Maintain required dike elevations to match hurricane protection levels.
2	Erosion of Dike during Hurricane	Hurricane protection is discussed in USACE report. Additional protection provided by new Gate Structure within the GIWW should minimize potential for surge overtopping of CDF dikes. However, erosion scenario has not been analyzed.	Estimated risk is low. Flow velocities probably not high enough to cause substantial erosion. Conceptual dike cross section is substantial and not likely to erode enough to constitute a release.	- Design armoring as necessary. - Offset dike from levee as necessary.
3	Dike Failure	Dike failure is not discussed in USACE report. Subsurface soils may be soft.	Estimated risk is low if dikes are designed properly. Even if dike experiences deformation, a large release is not likely. Failure would likely occur before filling of CDF starts.	- Perform stability analysis. - Ground improvement could be an option to strengthen foundation soils, if necessary.
Non-Catastrophic Scenarios				
4	Overtopping of Dike due to Adverse Weather	Overtopping due to storm event (precipitation, wind, waves) has not been addressed in the USACE report. CDF needs to be designed to have sufficient freeboard to accommodate adverse conditions.	Estimated risk is low if freeboard is selected properly. Overtopping is also not expected to result in a significant release because mainly water would spill over the dike.	- Design CDF to allow for appropriate freeboard.
5	Water Quality Criteria Exceedances in Receiving Water	Sediment settling, expected effluent quality, and water quality in receiving water are addressed in the USACE report.	Estimated risk is low because the discharge process can be managed and monitored. Measures can be taken to improve effluent quality, if necessary (e.g., effluent treatment).	- Perform decant water management analysis and design. - Design water quality monitoring program. - Adjust dredging operations or water management as necessary (can treat effluent, if necessary).
6	Ambient Air Quality Criteria Exceedance	Air quality is addressed in the USACE report only for the condition after filling of the CDF.	Based on preliminary human health risk assessment, volatilization of contaminants is unlikely. Dredging/filling operation can be adjusted if air quality criteria are exceeded.	- Evaluate the potential for air quality impacts during dredging. - Design mitigation measures for nuisance odors. - Adjust dredging/filling operation, as necessary.
7	Groundwater Quality Impacts	Groundwater quality is addressed in the USACE report only for the condition after filling of the CDF.	Risk is low based on preliminary human health risk assessment; groundwater in the shallow aquifer is not a drinking water source within 1 mile of the CDF.	- If required by LDEQ, a groundwater monitoring program can be implemented.

Notes:
1) The reader should refer to the main text of this report for more detailed discussions.
2) The term "dike" refers to the containment dike of the Confined Disposal Facility (CDF).
3) "USACE report" refers to the conceptual CDF design report (USACE, 2008a).

U.S. ARMY CORPS OF ENGINEERS
CONFINED DISPOSAL FACILITY (CDF)
FOR IHNC LOCK REPLACEMENT PROJECT
HUMAN HEALTH RISK ASSESSMENT

ENGINEERING RISK REVIEW
RISKS DURING FILLING OF CDF

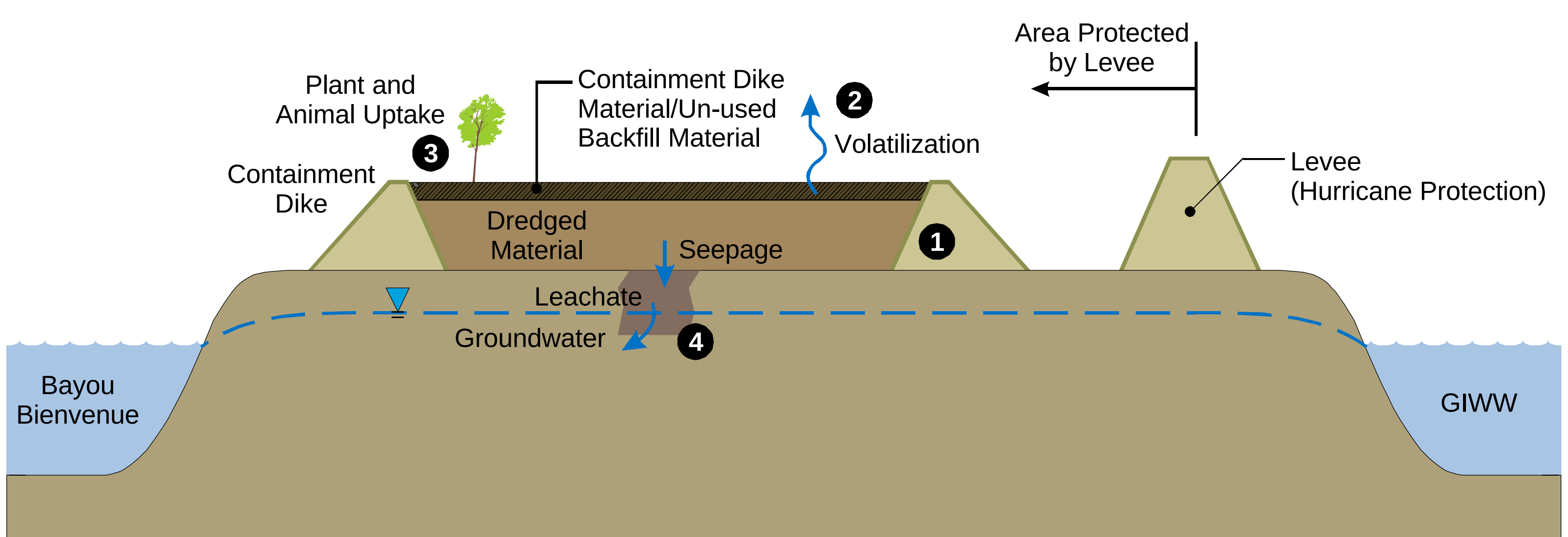
ARCADIS

FIGURE
1

02/18/09 SYRACUSE, NY-ENV/CAD-DJH
NL500014/0000/SY001/CDR/00014G01.CDR

No.	Description of Risk	Background	Evaluation	Mitigation
Catastrophic Scenario				
1	Erosion of Dike during Hurricane	Hurricane protection is discussed in USACE report. Additional protection provided by new Gate Structure within the GIWW should minimize potential for surge overtopping of CDF dikes. Erosion scenario has not been analyzed.	Estimated risk is low based on design of facility; top of dike will be above 100-year flood level. Flow velocities probably not high enough to cause substantial erosion. Conceptual dike cross section is substantial and not likely to erode enough to constitute a release. Risk is less than during filling of CDF because the contained material will be solid instead of liquid.	- Design armoring as necessary. - Offset dike from levee as necessary.
Non-Catastrophic Scenarios				
2	Ambient Air Quality Criteria Exceedance	Air quality is addressed in the USACE report.	The estimated risk associated with volatilization of chemical constituents is low based on the conceptual-level assessment by the USACE. Ammonia could produce volatile emissions, but would not pose health risk.	- Develop operational plan to address nuisance odors.
3	Plant and Animal Uptake	Plant and animal uptake are addressed only briefly in USACE report. They were assumed not to pose a problem for the temporary portion of the CDF. The permanent portion of the CDF was not addressed.	The risk associated with plant and animal uptake has not been addressed for the condition after filling (permanent portion of the CDF).	- Evaluate plant and animal uptake for permanent portion of CDF. - Consider placing a cover over the permanent CDF to isolate the dredged material from plants and animals.
4	Groundwater Quality Impacts	Groundwater quality is addressed in the USACE report.	The estimated risk associated with leaching of chemical constituents is low based on the conceptual-level assessment by the USACE. Preliminary risk assessment demonstrated that soil leaching pathway was protective of human health.	- Design long-term groundwater monitoring program if required by LDEQ. - Consider placing properly graded cover to reduce infiltration.

Notes:
1) The reader should refer to the main text of this report for more detailed discussions.
2) The term "dike" refers to the containment dike of the Confined Disposal Facility (CDF).
3) "USACE report" refers to the conceptual CDF design report (USACE, 2008a).



NOT-TO-SCALE

CDF AFTER FILLING

U.S. ARMY CORPS OF ENGINEERS
CONFINED DISPOSAL FACILITY (CDF)
FOR IHNC LOCK REPLACEMENT PROJECT
HUMAN HEALTH RISK ASSESSMENT

ENGINEERING RISK REVIEW
RISKS AFTER FILLING OF CDF

ARCADIS

FIGURE 2

02/26/09 SYRACUSE, NY-ENV/CAD-DJH
NL500014/0000/SY001/CDR/00014G02.CDR