STATE OF LOUISIANA
DEPARTMENT OF NATURAL RESOURCES
OFFICE OF CONSERVATION

IN RE:
STATE OF LOUISIANA AND THE VERMILION PARISH SCHOOL BOARD

DOCKET NO: ENV-L-2016-01

VERSUS

LOUISIANA LAND AND EXPLORATION COMPANY, ET AL

DOCKET NO. 82,162, DIV. "D"
15TH JUDICIAL COURT,
PARISH OF VERMILION
(JUDGE JEROME M. WINSBERG)

LOUISIANA DEPARTMENT OF NATURAL RESOURCES, OFFICE OF CONSERVATION'S MOST FEASIBLE PLAN AND WRITTEN REASONS IN SUPPORT AS REQUIRED BY LA. R.S. 30:29

Respectfully submitted on behalf of:
Louisiana Department of Natural Resources, Office of Conservation
Richard P. Ieyoub, Sr.
Commissioner of Conservation
July 7, 2016

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I. INTRODUCTION

In 2004, the State of Louisiana and the Vermilion Parish School Board (hereinafter "**VPSB**") filed suit in the 15th Judicial District Court against various oil companies and oil interests seeking damages and remediation of property owned by the State and managed by VPSB. A jury trial was held from April 15 to May 4, 2015. Prior to trial, Union Oil Company of California ("**UNOCAL**") admitted that environmental damage existed on the property and that it was responsible for the damage under Act 312. The jury returned a monetary verdict against UNOCAL.

On August 6, 2015, Judge Jerome M. Winsberg, the presiding judge, signed an order referring the matter to the Louisiana Department of Natural Resources, Office of Conservation (hereinafter "**LDNR**") for a public hearing in accordance with La. R.S. 30:29.[1] The order required UNOCAL to develop and submit a plan for evaluation or remediation to LDNR, and permitted VPSB to submit its own plan. UNOCAL timely submitted its plan on October 1, 2015.[2] VPSB, with two authorized extensions, timely submitted its plan on January 5, 2016.[3] In

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[1] La. R.S. 30:29 was enacted by Act 312 of the 2006 Louisiana Legislature, effective June 8, 2006. For reasons already noted earlier in this proceeding in the "Post-Hearing Ruling as to Jurisdiction," In Re: State Of Louisiana and the Vermilion Parish School Board, State of Louisiana, Department of Natural Resources, Office of Conservation, Docket No: ENV-L-2016-01 (April 4, 2016), at pp. 3-4 of that Ruling, La. R.S. 30:29 as enacted in 2006 is the version of the statute that governs this case even though there have been several amendments to the statute since then.

[2] "Most Feasible Plan for Evaluation/Remediation," dated October 1, 2015, prepared by Michael Pisani & Associates ("**UNOCAL Plan**"), in evidence as UNOCAL Exhibit 1, bates nos. U_LDNR 00001-00001-06146. Also submitted by UNOCAL with its plan were a "Site Investigation Report and RECAP Evaluation," dated October 1, 2015, prepared by Environmental Resources Management Southwest, Inc. ("**RECAP Report**"), in evidence as UNOCAL Exhibit 2, bates nos. U_LDNR 00002-00001 **John Rodgers ERA Report** - 02856; and an "Ecological Risk Assessment" report, dated September 30, 2015, by John H. Rodgers, Jr., Ph.D. (""), in evidence as UNOCAL Exhibit 3, bates nos. U_LDNR 00003-00001-00272.

[3] Plaintiff's Feasible Plan, dated January 2016 (received at LDNR on January 5, 2016), prepared by ICON Environmental Services, Inc. ("**Plaintiff's Plan**"), in evidence as Plaintiff Exhibit 2, bates nos. P-DNR-002.0001-2816. Plaintiff's "Ecological Risk Assessment and Toxicological Evaluation Associated with Oil Exploration and

accordance with the LDNR scheduling order, the parties timely supplemented their plans on February 15, 2016.[4]

The public hearing was held on March 2-4 and 7-10, 2016. LDNR employees with relevant technical backgrounds sat as a panel,[5] and heard the testimony of eight experts, five offered by UNOCAL and three by VPSB.[6] Numerous exhibits were shown to the panel during the hearing, and admitted into the record.[7]

After consideration of the evidence, LDNR has decided not to approve either of the plans proposed by the parties, but instead decided to structure a plan which it finds to be the most reasonable plan ("LDNR Most Feasible Plan"). This LDNR Most Feasible Plan ("Plan") is a "feasible plan" within the meaning of La. R.S. 30:29 (I)(3) and LAC 43:XIX.603, and the "most feasible plan" within the meaning of La. R.S. 30:29 (C)(2)&(3) and LAC 43:XIX.627, and is being filed with the Court in accordance with La. R.S. 30:29(C)(2)&(4). The written reasons are

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Production Activities," dated March 2014, prepared by Dr. William J. Rogers ("**Jim Rogers ERA Report**"), is part of Plaintiff's Plan, at Appendix C, and is located at bates nos. P-DNR-002.0259-0353, and is also Plaintiff's Exhibit 303, located at bates nos. P-DNR-303.01-94.

[4] "UNOCAL's Supplement to the Most Feasible Plan for Evaluation/Remediation," dated February 15, 2016, supplementing the plan and reports referred to in n. 2 *supra* ("**UNOCAL's Supplement to Plan**"), in evidence as UNOCAL Exhibit 6, bates nos. U_LDNR 00006-00001-01285, also with "**Supplement to RECAP Report**", supplementing the RECAP Report referred to in n. 2 *supra*, in evidence as UNOCAL Exhibit 7, bates nos. U_LDNR 00007-00001-00103, and with "**Supplemental John Rodgers ERA Report**", supplementing John Rodgers ERA Report referred to in n. 2 *supra*, in evidence as UNOCAL Exhibit 8, bates nos. U_LDNR 00008-00002-00082; and "Supplement to the Plaintiff's Feasible Plan," dated February 15, 2016, supplementing the plan referred to in n. 3 *supra* ("**Plaintiff's Supplement to Plan**"), in evidence as Plaintiff Exhibit 3, bates no. P-DNR-003.001-135.

[5] *See* **Exhibit 1-Panelists and Their Backgrounds** attached at p. 53.

[6] *See* **Exhibit 2-Expert Witnesses Who Testified** attached at p. 55. (The exhibit summarizes academic training, experience, and area tendered and accepted.).

[7] "Defendant's (UNOCAL's) List of Exhibits Admitted at LDNR Hearing," and "VPSB's Exhibits Introduced March 2-10, 2016," are both available in the record. The vast majority of exhibits on the parties' lists, both final lists being received by Hearing Officer on March 15, 2016, were admitted without objection.

incorporated in the Plan, and issued in compliance with La. R.S. 30:29(C)(2) and LAC 43:XIX.627.A.

II. OVERVIEW

The VPSB property at issue, approximately 1200 acres, is located in Vermilion Parish, Louisiana, and consists of Section 16 of Township 15 South, Range 01 East. It is approximately 12 miles north of the Gulf of Mexico, and approximately 0.5 miles east of White Lake.

It is bisected east to west by a man-made canal known as Schooner Bayou Canal (approximate depth 17 feet) which was constructed in the early 1900s as a water transportation channel to permit access from interior areas to Vermilion Bay and into the Gulf of Mexico. Schooner Bayou Canal begins on its west end at White Lake, passes east through the VPSB property, and is then hydrologically connected to the Gulf of Mexico through Vermilion Bay. East of the VPSB property, Schooner Bayou Canal has a lock control structure system in place to mitigate saltwater intrusion.

The VPSB property is situated in what is known as the East White Lake Oil and Gas Field, is below to slightly above mean sea level, is within a marsh environment, and has an extensive man-made canal system (primarily north-south and east-west canals, approximately 8 feet deep), with the main north-south canal connecting into the south side of Schooner Bayou Canal. The canal system has been used, and expanded, through the years to access oil and gas wells which were developed and operated since UNOCAL first began exploration and production ("E&P") activities on the property in approximately 1940. A total of 85 wells have been drilled on the property since UNOCAL first began E&P activities.

UNOCAL produced oil and gas from Section 16 of the East White Lake Field from 1940 to 1995. Peak Operating Company of Lafayette, Louisiana currently produces oil and gas from the property. There is no road access to the property. Access to the property is achieved by boat via the Schooner Bayou Canal and/or oilfield canals.

The "A" Battery (sometimes referred to as "Tank Battery A") is where UNOCAL's, and then Peak's, central operations facility was/is located. It can be seen as early as 1951 in one of the historical aerial photographs in evidence.[8] It is the active central facility today. The "B" Battery (sometimes referred to as "Tank Battery B") can also be seen in the 1951 aerial photograph. The "B" Battery was removed in 1985. Both tank batteries have had nearby waste pits and salt water disposal injection wells associated with them, and E&P oilfield wastes were discharged into them through the years. The salt water injection disposal wells ("SWDs") were operated through the years for the purpose of disposing of waste water produced from the oil and gas wells (the waste water is commonly referred to as "produced water", which is brine/salt water, high in chloride content), which is a form of E&P waste. Testimony and exhibits were introduced at the hearing indicating that there have been historical breaches in some of the SWDs.[9] The proposed remediation/evaluation plans of the parties presented to the LDNR panel during the hearing focus primarily around the "A" and "B" Batteries, and nearby operating areas,

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[8] *See* Plaintiff's Plan, Figure 1-3, "1951 Historical Aerial Image", bates no. P-DNR-002.0076; and *compare with* Figure 1-10 (1998 Aerial), "Location of Pits, Tank Batteries, Flowlines and SWD Breaches", dated Dec. 2015, bates no. P-DNR-002.0083.

[9] *See* Figure 1-10, n. 8 *supra*, and Miller testimony, Tr., Vol. 6, 3/9/16, p. 1563 ("A. ...I have included all of the reported breach locations associated with the saltwater disposal wells because they all represent potential sources as fluids migrated from deeper depths at 12 to 14 or 1700 feet up through this zone, emanating at ground surface.").

including the soil and/or sediment adjacent to and in the canals near the batteries, and including the groundwater underlying the property.

The groundwater zones beneath the property are described here prior to setting forth the parties' proposed plans.[10] Immediately beneath the sediment is the shallow-most groundwater zone referred to by the parties in their plans as the peat zone.[11] This zone is 2 to 4 feet thick, and goes down to an approximate depth of 8 to 20 feet. The parties agree that the groundwater in this peat zone would be classified as a Groundwater Classification 3 (GW3) under LDEQ's RECAP classification.[12] The groundwater in the peat zone is in hydraulic communication with surface water.[13] This peat zone is high in chlorides.[14]

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[10] *See generally* UNOCAL Plan, Section 4.3, "Existing Groundwater Conditions and Quality", bates nos. U_LDNR 00001-00027-00029; Figure 16, "Regional Geologic Cross Sections", bates no. U_LDNR 00001-00062; Figure 39, "Cross Section Locations", bates no. U_LDNR 00001-00085; Figure 40, "MP&A Geologic Cross Section W-E", bates no. U_LDNR 00001-00085; and Figure 41, "MP&A Geologic Cross Section S-N", U_LDNR 00001-00087. *See also* Plaintiff's Plan, Section 2.1.2, "Subsurface Geology", bates nos. P-DNR-002.0018-0019.

[11] This is similar-type material to "peat moss" that you buy at Home Depot, "very organic rich…It's like a sponge." Angle testimony, Tr., Vol. 2, 3/3/16, pp. 504-05. *See* Pisani testimony, Tr., Vol. 1, 3/2/16, p. 316. *See also* Figures 40 and 41, n. 10 *supra*. *See also* Plaintiff's Plan, Section 2.1.2, "Subsurface Geology", bates no. P-DNR-002.0018.

[12] Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1555-56; Plaintiff's Plan, Section 2.2.1, "Peat Zone", bates no. P-DNR-002.0023; UNOCAL Plan, Section 4.3, "Existing Groundwater Conditions and Quality", bates no. U_LDNR 00001-00027. *See* LAC 33:I.Chapter 13 ("RECAP"), §2.1 (RECAP definition of "Groundwater Classification 3").

[13] Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1555-56.

[14] Mr. Miller testified that the chlorides in the peat zone are high. He testified to the following levels: "Southwest of the A battery, 14,000 milligrams per liter; 7,000 behind the A battery; down to the B battery, 16,000 milligrams per liter." *Id.*, p. 1556-57. For the data in the Tables, *see* Plaintiff's Plan, Table 4-2, "Peat Zone Groundwater Data Summary", bates no. P-DNR-002.0169; UNOCAL Plan, Table 6, "Groundwater Analytical Data-All Zones" (with "Peat Zone" at top), bates no. U-LDNR 00001-00177; and Figure 37, "Groundwater Sample Locations", bates no. U_LDNR 00001-00083:

southwest of Tank Battery A, Sample ID AB5, Screened Interval—12-22' (ft bgs), date 11/13/06, 14,400 mg/l chlorides & 17,200 mg/l TDS;

south of Tank Battery A, Sample ID AB15, Screened Interval—8-18' (ft bgs), date 11/13/06, 7,630 mg/l chlorides & 10,300 mg/l TDS; and

at pit area near former Tank Battery B, Sample ID WL 6, Screened Interval—8.5-13.5' (ft bgs), date 1/7/15, 16,600 and 16,500 mg/l chlorides (MPA result for chlorides at this location, 18,100 mg/l); and 32,800 and 31,600 mg/l TDS (Mr. Miller noted that in the footprint of former Tank Battery B chlorides were just under 1,000

A clay layer follows the peat zone to a depth of about 35 to 40 feet.[15] The Chicot Shallow Sand Aquifer ("CHCTS") follows the clay layer.[16]

The CHCTS is a shallow, intermittent sand that goes down to a depth of about 290 to 300 feet.[17] The groundwater within this aquifer would be classified as Groundwater Classification 2 (GW2) based on yield, naturally occurring Total Dissolved Solids (TDS) above 1,000 mg/l, and the absence of public supply water wells within one mile of the property.[18] There are two water wells on the property completed within this shallow zone, both on the north side of Schooner Bayou—the Crouch water well (at a depth of 34 feet), which is abandoned, and the Purvis Hebert water well (at a depth of 41 feet).[19] The parties agree that the water in this aquifer is naturally salty, but they disagree as to the background chloride level, and to what extent oil and gas operations contributed to the elevated chloride levels in this aquifer.[20]

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mg/l [*see* result in Table 4-2 at TBB3S, which is 969 mg/l], but in the pit area which is close by, chlorides are much higher, 16,000 mg/l. Miller testimony, Tr., Vol. 6, 3/9/16, p. 1557).

[15] Angle testimony, Tr., Vol. 2, 3/3/16, p. 505; Pisani testimony, Tr., Vol. 1, p. 316. Figures 40 and 41, n. 10 *supra*. *See also* Plaintiff's Plan, Section 2.1.2, "Subsurface Geology", bates no. P-DNR-002.0018.

[16] Plaintiff's Plan, Section 2.1.2, "Subsurface Geology", bates no. P-DNR-002.0018. UNOCAL Plan, Section 4.3, "Existing Groundwater Conditions and Quality", bates nos. U_LDNR 00001-00027-00028.

[17] Angle testimony, Tr., Vol. 2, 3/3/16, p. 509; Pisani testimony, Tr., Vol. 1, 3/2/16, p. 317.

[18] UNOCAL Plan, Section 4.3, "Existing Groundwater Conditions and Quality", bates no. U_LDNR 00001-00028. *See* RECAP, §2.1 (RECAP definition of "Groundwater Classification 2").

See Plaintiff's Plan, Section 2.2.2, "Chicot Shallow Sand Aquifer (CHCTS)", bates nos. P-DNR-002.0023-0024, noting that seven public water supply wells are screened in CHCTS approximately 7 miles from the property. *See also* Miller testimony, Tr., Vol. 6, 3/9/16, p. 1533 ("Q. [I]t's your testimony...there's no disagreement that...the shallow Chicot Aquifer is a Groundwater 2 USDW? A. Correct.").

[19] UNOCAL Plan, Section 4.3, "Existing Groundwater Conditions and Quality", bates no. U_LDNR 00001-00028; and Figure 19, "USGS Chloride Data, Shallow Water Wells", bates no. U_LDNR 00001-00065. The Crouch well has 1,570 mg/l chlorides and 1,630 mg/l TDS; the Purvis Hebert well has 851 mg/l chlorides and 824 mg/l TDS.

[20] UNOCAL Plan, Section 2.2, "Site Geology" and Section 2.3, "Groundwater Use and Quality", bates no. U-LDNR 00001-00019. Section 2.3 states that "The natural movement of surface water into the uppermost shallow sand aquifer in the area has caused chloride concentrations in the uppermost aquifer to increase and to exceed the US

A 100-foot clay layer follows.[21] The second groundwater aquifer beneath the property is the Chicot Upper Sand Aquifer ("CHCTU"). The groundwater in this aquifer would be classified as Groundwater Classification 1 (GW1) from where it begins approximately 400 feet below the surface of the property to approximately 600 feet below surface.[22] There are currently two wells on the property completed in the CHCTU—the James Guidry camp well located north of Schooner Bayou Canal (at a depth of 519 feet), and the central facility water well (WW-1)

EPA Secondary Drinking Water Standards for chlorides [250 mg/L] and TDS [500 mg/L]. The increase in chlorides and other dissolved solids in the uppermost shallow sand aquifer has occurred, and would have occurred, regardless of oil and gas production in the region." UNOCAL suggests background chlorides are 600-800 mg/l. *See* Angle testimony, Tr., Vol. 2, 3/3/16, p. 521 (referring to the Purvis Hebert water well chloride level). *But see* Plaintiff's Plan, Section 2.2.2, "Chicot Shallow Sand Aquifer (CHCTS)", bates no. P-DNR-002.0023, stating "it is more probable than not that natural groundwater quality in the CHCTS at the VPSB property likely exhibited TDS less than 1000 mg/L before oil and gas operations began." *See also* Section 2.3.4.1, "Chicot Shallow Sand Aquifer", bates no. P-DNR-002.0035 stating: "Salt constituents slightly exceed the US EPA Secondary MCLs of 250 mg/l for chlorides and 500 mg/l for TDS. The calculated background chloride concentration of 487 mg/L is supported by site-specific data. Because the future intended use of the Chicot Shallow Aquifer includes potable use as a possible public supply, a variance from the Statewide Order 29-B background groundwater standards was not employed for these aquifers." Plaintiff's Plan, Figure 2-17, "Groundwater Chlorides in the Chicot Aquifer Shallow Sand Unit in Recent Samples", bates no. P-DNR-002.0100, depicts chlorides levels in the vicinity of Tank Batteries A and B in the 800-900 mg/l range, but also higher levels, with highest levels at MW-3, to the south of Tank Battery A, chlorides of 10,700 mg/l chlorides and TDS of 16,300 mg/l, screened at the 37.5-47.5' interval, and at MW-1, to the southeast of Tank Battery A, with chlorides of 9,580 mg/l and TDS of 18,100 mg/l TDS, screened at the 44-54' interval. *See also* Plaintiff's Plan, Figure 5-4, "Groundwater Contamination Above Background in CHCTS at 30 to 60 Feet", bates no. P-DNR-002.0150 (depicting plume for chlorides above 750 ppm level, and the Purvis Hebert water well is inside the plume); *but see also* Figure 5-5, "Groundwater Contamination Above Background in CHCTS at 60 to 95 Feet", bates no. P-DNR-002.0151 (depicting plume for chlorides above 487 ppm background level at this 60-95 foot level, and the Purvis Hebert water well is outside plume).

[21] Angle testimony, Tr., Vol. 2, 3/3/16, pp. 566-67.

[22] Angle testimony, Tr., Vol. 2, 3/3/16, pp. 452-53 and 456-57. *See* UNOCAL Plan, Section 2.2, "Site Geology", Section 2.3, "Groundwater Use and Quality", bates nos. U_LDNR 00001-00019-00020; and Plaintiff's Plan, Section 2.2.3, "Chicot Upper Sand Aquifer", bates no. P-DNR-002.0024. *See* RECAP, §2.1 (RECAP definition of "Groundwater Classification 1"). The groundwater is fresh water in this aquifer from 400-600 feet. Fresh water means that the chloride content is less than 250 mg/L, the EPA Secondary Drinking Water MCL. Plaintiff's Plan, Section 2.1.2, "Subsurface Geology", bates no. P-DNR-002.0019.

located south of Schooner Bayou Canal (at a depth of 460-70 feet).[23] There is no direct evidence that the fresh water in this zone has been affected by the oil and gas operations at the site.[24]

In broad terms, the parties agree that contamination from E&P waste exists in the soil and/or sediment around the areas of Tank Battery A and Tank Battery B, and also agree that there is contamination from E&P waste in the groundwater. The parties disagree as to the degree of the contamination, and also disagree as to the remedy and/or further evaluation which may be needed.

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[23] *See* Plaintiff's Plan, Section 2.2.3, "Chicot Upper Sand Aquifer (CHCTU)", bates no. P-DNR-002.0024; Figure 2-12, "Site Specific North-South Cross Section Diagram Depicting Lithology", bates no. P-DNR-002.0095; and Figure 4-22, "Groundwater Chlorides on North-South Cross Section Diagram", bates no. P-DNR-002.0133, with chlorides at the Guidry water at 139 ppm, and at the facility water well, WW-1 at 195 ppm (value shown increasing through the years 1983-2010). *See also* UNOCAL Plan, Section 2.3, "Groundwater Use and Quality", bates no. U_LDNR 00001-00020; and Section 4.3, "Existing Groundwater Conditions and Quality", bates no. U_LDNR 00001-00028; and Figure 20, "USGS Chloride Data-Chicot Aquifer", bates no. U_LDNR 00001-00066, with the James Guidry well at 139 mg/l chlorides and 163 mg/l TDS, and the facility well, WW-1, at 195 mg/l chlorides and 192 mg/l TDS.

[24] Angle testimony, Tr., Vol. 2, 3/3/16, pp. 566-67 ("The aquifer down there is a confined aquifer....It's a miniscule chance of something getting down through the [100-foot clay] aquitard to affect that zone...And there's a dramatic difference between a water quality above that hundred-foot clay and below it.").

But see, Plaintiff's Plan, Figure 4-22, bates no. P-DNR-002.0133, referred to in n. 23 *supra*, which indicates an increase in chloride level over the period of 1983-2010, from 12 ppm (1983) to 195 ppm (2010), but remains below the US EPA Secondary MCL of 250 mg/l (ppm) as of 2010. Mr. Miller addressed this reported increase in chlorides is his testimony in discussing Figure 4-22, and speculated that one of the possible causes is communication up from a breach of a salt water disposal well. *See* Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1545-47. Mr. Miller stated:

> A....It's [WW1 chloride level] right under 200 milligrams per liter. If you look at historical data, ...the facility water well was sampled in connection with a SWD permit application. So, in the early '80s, chlorides were 12 milligrams per liter. Today there almost 200. So they bumped up progressively and pretty quickly in the '90s, early 2000s. And as to the reason for the increase in chlorides,--it's—in my opinion,...either the result of impacts from—there's been reported breaches that have traveled through this zone on the way up to emanating at ground surface, or you've got the presence of a small lens of fresh groundwater floating on top of brackish water.

III. PROPOSED PLANS

The UNOCAL Plan proposes excavation and removal of soil and/or sediment[25] at former Tank Battery B, and proposes evaluation/monitoring of groundwater for benzene. It relies on the RECAP Report which assesses risk to human health from the oilfield-related constituents of concern ("COCs") on the property, and also relies on the John Rodgers ERA Report which assesses risk to the ecology.[26] The human health risk and/or ecological risk assessments address the COCs in five environmental media—soil, sediment, surface water, groundwater, and biota (crabs and fish). The RECAP Report uses RECAP Management Option 3 (MO-3).[27] The

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[25] Because of the marshy, inundated/submerged wetland nature of the property, both parties' plans often speak of "soil" and "sediment" together for evaluation/remediation purposes. But, "soil" and "sediment" are not the same environmental media. LDNR's Statewide Order 29-B sets forth criteria for "soil" in the Chapter 3 pit closure standards, but does not use the term "sediment". *See* LAC 43:XIX.313.C&D. The Louisiana Department of Environmental Quality's ("LDEQ's") Risk Evaluation/Corrective Action Program ("RECAP"), however, does use both terms, and defines "sediment." *See* sediment definition in RECAP, LAC 33:I.Chapter 13, §2.1. But the RECAP definition is a general definition, and is not helpful to the site-specific sediment conditions in the oilfield canal system in this case. Pursuant to RECAP Appendix B, Site Investigation Requirements, Section B2.5.9, "Surface Water Sampling" guidelines, clarification of sediment is permitted, and can be made applicable to the site-specific conditions. Solely for purposes of this Plan, LDNR is clarifying and making applicable to this case "sediment" defined as "soil particles, sand, clay or other substances that settle to the bottom of a body of water." *See* Stevenson, L. H. & Wyman, B., Facts on File Dictionary of Environmental Science (1991), p. 221. "Body of water" for this definition shall include White Lake, Schooner Bayou Canal and the VPSB Section 16 oilfield canal system. Material below the base of sediment is reported to be [mineral] "soil" by Mr. Miller, who stated:

> A. ...I mapped both sediment and soil on the same map...[but] in...borings at the site, the upper portions represent sediment and the lower portions represent soil...there were many feet of sediment deposited at the base of the canal, such that when we did our boring, the upper three or four feet was unconsolidated mucky sludgy, and then the bottom two feet or so was more consolidated soil.

Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1766-68. Based on this testimony, and other evidence during the hearing, VPSB's Section 16 canal system "sediment" thickness below the surface water column is approximately 3 feet from top to bottom. The applicable standard to address any contamination of "mineral soil" below sediment (as defined here) located within VPSB's Section 16 canal system has been determined to be RECAP soil criteria.

[26] *See* n. 2 *supra* for the hearing record citations to the RECAP Report and the John Rodgers ERA Report.

[27] *See* RECAP, §6.0. Section 6.0, entitled "Management Option 3", describes this management option: "Management Option 3 (MO-3) is a risk-based assessment which provides for: (1) the development of site-specific RS using site-specific exposure and environmental fate and transport data; and (2) the evaluation of all environmental media (i.e., soil, groundwater, air, surface water, sediment and biota), fate and transport pathways, and exposure pathways. The MO-3 RS shall address the protection of human health, the prevention of cross-media transfer, and the protection of resource aesthetics."

UNOCAL Plan is, in essence, an MO-3 site specific plan.

Plaintiff's Plan proposes excavation and removal of sediment from the base of the canals to remove metals and hydrocarbon COCs with exceedances of Statewide Order 29-B standards, RECAP standards, and/or NOAA SQuiRT guidelines, relying on the Jim Rogers ERA Report.[28] It also proposes physical containment of salt-contaminated soil and salt-contaminated groundwater in the peat-zone through use of a grout floor and walls to prevent further leaching of chlorides to the CHCTS aquifer. Finally, it proposes a pump and treat/extraction program for the CHCTS aquifer to remove chloride contamination above background levels.

A. Proposed Plans as to Soil and/or Sediment

1. UNOCAL Soil and/or Sediment Plan

UNOCAL agrees that there are soil exceedances above the Statewide Order 29-B standards for oil & grease near the former south pit area at Tank Battery B, and also near the current production facility (Tank Battery A area), and also agrees that there are Statewide Order 29-B exceedances for metals, arsenic (four locations), mercury (one location), and zinc (one location), in general proximity to one or the other of the tank batteries. The oil & grease and metals exceedances are identified on Figure 42 of the UNOCAL Plan.[29] Statewide Order 29-B soil exceedances are reported in UNOCAL's Table 3,[30] as well as on Figure 42.

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[28] *See* n. 3 *supra*, for the hearing record citation to the Jim Rogers ERA Report. SQuiRT refers to the National Oceanic and Atmospheric Administration ("NOAA") Screening Quick Reference Table.

[29] *See* UNOCAL Plan, Section 4.2, "Existing Soil and Sediment Quality", bates nos. U_LDNR 00001-00026-00027. Section 4.2 refers to Figure 39, but it should have referred to Figure 42, which is entitled "Statewide 29-B Standard Exceedances, Soil/Sediment", bates no. U_LDNR-00088.

[30] UNOCAL Plan, Table 3, "Soil/Sediment Analytical Data", bates nos. U_LDNR 00001-00125-00166.

The soil and/or sediment portion of the UNOCAL Plan proposes reclosing the former Tank Battery B south pit area by removing/excavating residual hydrocarbons exceeding Statewide Order 29-B and RECAP standards to meet site specific RECAP MO-3 standards, and backfilling and grading the excavated area. UNOCAL estimates this reclosure work will cost $600,000.[31]

UNOCAL does not propose any remediation in the Tank Battery A area because of Peak's current production operations centered there, but says that residual hydrocarbons in this area will need to be addressed at the end of oil and gas operations on the property.[32]

While both parties have sampled for salt (EC, ESP, and SAR), and the results are reported in Table 3 of the UNOCAL Plan and Table 4-1 of the Plaintiff's Plan,[33] UNOCAL does not propose remediation of salt (chloride) exceedances because it states that Statewide Order 29-

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[31] *Id.*, Section 4.2, "Existing Soil and Sediment Quality", bates nos. U_LDNR 00001-00027-00028; Section 6.0, "Most Feasible Plan", bates no. U_LDNR 00001-00032; and Figure 66, "Proposed Tank Battery B Pit Re-closure Area", bates no. U_LDNR 00001-00112. UNOCAL did perform pit closure work at former Tank Battery B in 2014, which included excavation of soils and sediments, at an approximate cost of $700,000. *See* UNOCAL Plan, Section 5.0, "Remediation Performed to Date", bates no. U_LDNR 00001-00030-00031. Mr. Michael Pisani testified that the exact cost of the earlier pit closure was $682,700. Pisani testimony, Tr., Vol. 2, 3/3/16, pp. 367-68. The proposed reclosure work, with contingency, comes to $618,591. *Id.*, p. 371-72; and UNOCAL Plan, Table 7, "Tank Battery B (South Pit) Closure Cost Estimate", bates no. U_LDNR 00001-00179.

[32] *See* UNOCAL Plan, Section 4.2, "Existing Soil and Sediment Quality", bates nos. U_LDNR 00001-00028.

[33] As noted earlier, produced water (a/k/a brine or saltwater) is an exploration and production (E&P) waste byproduct. The Statewide Order 29-B pit closure regulations require evaluation of salt parameters, i.e., electrical conductivity **EC** in mmhos/cm (millimhos), exchange sodium percentage **ESP** (percent), and sodium absorption ratio **SAR**. LAC 43:XIX.311.C. Results for EC, ESP, and SAR are reported in the UNOCAL Plan, Table 3, "Soil Sediment Analytical Data", bates nos: U_LDNR 00001-00126, 00132, 00137, 00142, 00147, 00153, 00158, and 00163 (first 3 data columns). Results for same parameters are reported in Plaintiff's Plan, Table 4-1, "Subaqueous Sediment and Soil Data Summary Table", bates nos. P-DNR-002.0158-0168 (data columns 19, 22, and 23). *See also* Plaintiff's Plan, for depictions of EC in Soils/Sediments: Figure 4-1, "Soil EC on North-South Cross Section Diagram", bates no. P-DNR-002.0112; Figure 4-2, "Soil EC on East-West Cross Section Diagram", bates no. P-DNR-002.0113; Figure 4-3, "Soil EC at the 0 to 3 Foot Depth Increment", bates no. P-DNR-002.0114; Figure 4-4, "Soil EC at the 3 to 6 Foot Depth Increment", bates no. P-DNR-002.0115; Figure 4-5, "Soil EC at the 6 to 10 Foot Depth Increment", bates no. P-DNR-002.0116; Figure 4-6, "Soil EC at the 10 to 16 Foot Depth Increment", bates no. P-DNR-002.0117; and Figure 4-7, "Soil EC at the 16 to 24 Foot Depth Increment", bates no. P-DNR-002.0118.

B salt standards (EC, ESP, and SAR) do not apply to an inundated or submerged wetland, which it states this property is with the possible exception of man-made elevated spoil banks.[34]

2. **Plaintiff's Soil and/or Sediment Plan**

Plaintiff's Plan states that there are extensive salt "exceedances" in soil based on Statewide Order 29-B regulatory standards, and depicts those salt "exceedances" in Figures 4-1 through 4-7.[35] Plaintiff's expert, Greg Miller, did, however, agree that there is "considerable uncertainty as to the applicability of the [Statewide Order 29-B] salt standards to submerged wetlands."[36] He does not propose remediating any chlorides in the soil (or sediment) to any standard, but instead proposes addressing salt-contaminated soil by isolating the chlorides from the shallow aquifer below through use of a grout floor and walls.[37]

Plaintiff's Plan proposes physical containment of the salt-contaminated soil and salt-contaminated peat-zone soil and groundwater through use of a combination of slurry walls and a 2-foot thick cement/gel grout floor to a depth of 15 feet below land surface ("bls"). The walls

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[34] *See* UNOCAL Plan, Section 3.1, "Soil" under Section 3.0, "Applicable Remediation Standards", bates no. U_LDNR 00001-00021-22. *See* Pisani testimony, Tr., Vol. 2, 3/3/16, pp. 427-28 (Mr. Pisani stated that there is no remediation for EC or for leachate chlorides in soil because salt standards do not apply to submerged wetlands).

[35] *See* Plaintiff's Plan, Section 4.1.1, "Salt Contamination", bates nos. P-DNR-002.0046-0047; and Figures 4-1 through 4-7, bates nos. P-DNR-002.0112-0118, described in more detail at the end of n. 33 *supra*.

[36] Miller testimony, Tr., Vol. 6, 3/9/16, p. 1691. *See* LAC 43:XIX.313.D.1. Mr. Miller agreed that the Plaintiff's Plan (the plan which he proposes be approved) does not remediate the soil to any chloride standard, and testified: "If the Panel feels that salt standards are applicable in a submerged wetland, then it may require an exception. If they are of the opinion that salt standards don't apply, I am in strict compliance." Miller testimony, this n. *supra*, p. 1692.

[37] Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1690-92.

and floor are to prevent further leaching of chlorides from soil and the peat zone to the CHCTS.[38] The estimated cost of this physical containment plan is $41,821,858.[39]

In its Table 4-1, and in Figures 4-8 through 4-10, Plaintiff's Plan identifies petroleum contamination in the soil and/or sediment (as TPH-D and TPH-O, and as 29-B oil & grease), primarily in areas around Tank Battery A and Tank Battery B, but also more widely distributed in the base of the adjacent canals.[40] Also in Table 4-1, and in Figures 4-11 through 4-14, the Plan identifies soil and/or sediment contamination with metals, arsenic, barium, and mercury, in the two tank battery areas, and also more widely distributed.[41] Plaintiff attributes the barium less to production operations, and more to discharge of drilling fluids.[42] Plaintiff attributes the mercury to a meter which had been located on the north side of the canal at Tank Battery A.[43] Also, plaintiff identifies a single sample with elevated PCBs behind Tank Battery A.[44]

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[38] *See* Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1587-89, 1596-97. *See also* Plaintiff's Plan, Figures 5-2, "Grout Isolation Walls and Floor on North-South Cross Section", bates no. P-DNR-002.0148; and Figure 5-3, "Grout Isolation Walls and Floor on East West Cross Section Diagram", bates no. P-DNR-002.0149.

[39] *See* Plaintiff's Plan, Section 5.3, "Physical Containment of Salt-Contaminated Soils", bates nos. P-DNR-002.0063-0064; and chart entitled "Costs for Isolation Grouting of Salt-Saturated Soil Overlying Aquifer", bates no. P-DNR-002.2774. *See* Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1604-06.

[40] Plaintiff's Plan, Section 4.1.2, "Petroleum Hydrocarbon Contamination in Sediments and Soils", bates nos. P-DNR-002.0047-0049; Table 4-1, "Subaqueous Sediment and Soil Data Summary Table", bates nos. P-DNR-002.0158-0168; and Figures 4-8 through 4-10, and Figure 4-16, bates nos. P-DNR-002.0119-0121 and 0127.

[41] Plaintiff's Plan, Section 4.1.3, "Heavy Metals Contamination in Sediment and Soils", bates no. P-DNR-002.0049; Table 4-1, n. 33 *supra*; and Figures 4-11 through 4-14, bates nos. P-DNR-002.0122-0125.

[42] *See* discussion in Section 4.1.3 referred to immediately above, n. 41 *supra*.

[43] *Id.* The evidence at the hearing regarding the mercury meter has been discussed in the Post-Hearing Ruling as to Jurisdiction referred to in n. 1 *supra*. *See* discussion of evidence at pp. 4-6 of that Ruling.

[44] *See* Plaintiff's Plan, Section 4.1.4, "PCB Contamination in Sediment and Soils", bates no. P-DNR-002.0050 (Sed7 at a depth of 4-6', collected in canal slip behind the compressor building, which plaintiff states exceeded the RECAP $Soil_{ni}$ screening standard).

Plaintiff's Plan proposes excavation of shallow soils in marsh between the canals that are contaminated with arsenic, mercury, TPH-D, and TPH-O, and also high levels of salts and oil & grease that exceed 29-B standards. Plaintiff's Plan also proposes excavation of subaqueous sediment at the base of the canals to remove 29-B exceedances of oil & grease, arsenic, and mercury; to remove LDEQ RECAP $Soil_{ni}$ limiting standards exceedances for arsenic, barium, lead, mercury, TPH-D, TPH-O and/or PCBs; and to remove NOAA SQuiRT TEL exceedances for arsenic, barium, cadmium, chromium, lead, and mercury.[45] Plaintiff estimates the cost to remediate soil to 29-B standards with offsite disposal of discharge water to be $5,612,171; and estimates the cost to remediate the soil to ecological risk standards to be $32,228,191.[46]

B. Proposed Plans as to Groundwater

1. UNOCAL Groundwater Plan

The UNOCAL Groundwater Plan, submitted to LDNR on October 1, 2015, is an evaluation/monitoring plan. In 2010, benzene was detected in monitoring well MW-1 (southeast of Tank Battery A) in the shallow zone of the CHCTS.[47] UNOCAL's 10/1/15 Plan proposed

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[45] *See* Plaintiff's Plan, Section 5.2, "Contaminated Sediment and Soil Excavation and Offsite Disposal", bates no. P-DNR-002.0059.

[46] *See* Plaintiff's Plan, chart entitled "Costs for Excavation/Disposal of Contaminated Soil and Sediment-29-B Exceedances", bates no. P-DNR-002.2761; and chart entitled "Costs for Excavation/Disposal of Contaminated Soil and Sediment-Ecological Exceedances", bates no. P-DNR-002.2767. *See also* Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1585-86. *See also* Plaintiff's Plan, Section 5.2, "Contaminated Sediment and Soil Excavation and Offsite Disposal" and Section 5.2.1, "General Plan for Excavation of Canal Sediment and Soil", bates nos. P-DNR-002.0060-62, where the estimated cost if discharge water is disposed offsite is projected as slightly more than the two charts referred to above, and if injected in a disposal well onsite is projected about the same as the figures in the charts, $5,696,508 to remediate to Statewide Order 29-B limits, and $32,716,131 to remediate to ecological risk standards.

[47] UNOCAL Plan, Table 6, "Groundwater Analytical Data-All Zones", bates no. U-LDNR 00001-00177, Sample ID—MW-1, Screened Interval—44-54' (ft bgs), date 3/5/10 (30 and 29 ppb by ICON, and 28 ppb by MPA). *See also* Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012, Boring ID—MW-1, Screened Interval—44-54' (ft bgs), date 3/5/10 (30 and 29 ppb by ICON, and 28 ppb by MPA). The RECAP MO-1 standard is 5 ppb.

installing three additional monitoring wells—MW-4, MW-5, and MW-6, just east of Tank Battery A, to approximate depths of 60 feet, to complete delineation of the MW-1 area for assessment of benzene, and proposed three years of quarterly groundwater monitoring and reporting.[48] Since the 10/1/15 Plan was submitted to LDNR, benzene was also detected by ICON in the shallow zone at TBB-1S (near Tank Battery B) in December 2015, and at the base of the CHCTS zone, at BC-2 (near Tank Battery A) in February 2016.[49] The estimated cost of installing the monitoring wells proposed in the 10/1/15 Plan, with monitoring and reporting, is $300,000.[50]

UNOCAL's supplement, submitted in February 2016, also has now proposed re-sampling TBB-1S and BC-2 for confirmation of benzene at those locations, and along with other proposed resampling, the total estimated cost for resampling activities is $100,000 to $350,000.[51] UNOCAL has also proposed, as a contingent plan, a pump and disposal system to address

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[48] *See* UNOCAL Plan, Section 6.0, "Most Feasible Plan", bates no. U_LDNR 00001-00032; and Figure 67, "Proposed Groundwater Monitoring Locations", bates no. U_LDNR 00001-00113. *See also* Angle testimony, Tr., Vol. 2, 3/3/16, pp. 570-71.

[49] Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012, Boring ID—TBB1S, Screened Interval—33-43' (ft bgs), date 12/15/15 (7 ppb by ICON); and Boring ID—BC-2, Screened Interval—289.5-309.5' (ft bgs), date 2/3/16 (136 ppb by ICON and 200 ppb by MPA). *See also* UNOCAL's Supplement to Plan, Section 4.2, "Updated Groundwater Summary", bates nos. U_LDNR 00006-00016-00017, and Table 2, "Groundwater Analytical Data—Supplemental ICON Wells (Nov. 2015-Feb. 2016)", bates no. U_LDNR 00006-00069 (same result reported). *See also* UNOCAL's Supplement to Plan, Figure 8, "Supplemental Groundwater Sampling Locations (12/2015-02/2016)", bates no. U_LDNR 00006-00032.

[50] *See* UNOCAL Plan, Section 6.0, "Most Feasible Plan", bates no. U_LDNR 00001-00032.

[51] *See* UNOCAL's Supplement to Plan, Section 4.2, "Updated Groundwater Summary", bates nos. U_LDNR 00006-00016-00017 and 00021. *See also* Angle testimony, Tr., Vol. 2, 3/3/16, p. 571 and 576.

benzene in the shallow groundwater, if deemed necessary by LDNR.[52] This would first include a pilot test. The estimated cost for this contingent plan is $1,700,000 to $2,200,000.[53]

2. **Plaintiff's Groundwater Plan**

Plaintiff's Groundwater Plan proposes three different scenarios for an extraction, treatment, and disposal program for groundwater from the CHCTS, with the objective being to remove chloride contamination above the background level, which it says is 487 mg/L, or to remove enough chlorides to bring the level down to 1000 mg/L. Disposal scenarios are either into an onsite Salt Water Disposal Well (SWD), or alternatively to an offsite commercial SWD.[54] The estimated cost to remediate to background concentrations for all COCs (CHCTS zone for 33-95 feet bls) using onsite disposal is $57,033,254.[55] Remediation to background, but with offsite disposal is estimated at $153,464,089.[56]

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[52] *Id.*, pp. 571-75.

[53] *See* UNOCAL Plan, Section 6.0, "Most Feasible Plan", bates no. U_LDNR 00001-00032.

[54] *See* Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1606-38. *See* Plaintiff's Plan, Section 5.4, "Groundwater Extraction, Treatment, and Disposal", bates nos. P-DNR-002.0065-0072. *See also* Figure 5.4, "Groundwater Contamination above Background in CHCTS at 33 to 60 Feet", bates no. P-DNR-002.0150; Figure 5.5, "Groundwater Contamination above Background in CHCTS at 60 to 95 Feet", bates no. P-DNR-002.0151; and Figure 5.6, "Groundwater Contamination 33-60 Feet of CHCTS above Drinking Water Standards and Cl to 1000 ppm", bates no. P-DNR-002.0152. *See also* Figures 5-7 through 5-9, bates nos. P-DNR-002.0153-0155, depicting recovery wells and modeled drawdown for these varying depths to 1000 ppm or background chloride levels.

[55] The $57,033,254 is set forth in a chart in Plaintiff's Plan, Section 5.4, "Groundwater Extraction, Treatment, and Disposal", bates no. P-DNR-002.0072, in two components—$38,208,395 for the 33-60 foot zone and $18,824,859 for the 60-95 foot zone. *See generally*, Appendix G, "Groundwater Remediation Supporting Documents", bates nos. P-DNR-002.2776-2816; and, *see specifically*, Table 3-2, "Costs for Groundwater Recovery with Onsite Injection of Wastewater-CHCTS 33-60' to Background", bates no. P-DNR-002.2784 ($38,208,395), and Table 3-2, "Costs for Groundwater Recovery with Onsite Injection of Wastewater-CHCTS 60-90' to Background", bates no. P-DNR-002.2811 ($18,824,859).

[56] The $153,464,089 is set forth in the chart in Section 5.4 and also in Appendix G, referred to in n. 55 *supra*, and, *see specifically*, Table 3-3, "Costs for Groundwater Recovery with Offsite Disposal of Wastewater-CHCTS 33-60' to Background", bates no. P-DNR-002.2780 ($90,162,634), and Table 3-3, "Costs for Groundwater Recovery with Offsite Disposal of Wastewater-CHCTS 60-90' to Background", bates no. P-DNR-002.2807 ($64,301,455). Also, alternatively, there are estimated costs for remediating chlorides to 1000 mg/l in Section 5.4 and Appendix G.

IV. LDNR MOST FEASIBLE PLAN

A. Most Feasible Plan as to Soil and/or Sediment

High chloride levels in soil and/or sediment are reflected in the EC, ESP, and SAR data in Plaintiff's Table 4-1, and in Plaintiff's Figures 4-1 to 4-7.[57] Mr. Miller testified that there are high EC levels in soil and/or sediment in the 0-3 foot zone south of Tank Battery A; in the 3 to 6 foot zone behind and to the east of Tank Battery A, and at Tank Battery B; in the 6 to 10 foot zone (peat zone) in soil in the vicinity of Tank Battery A and Tank Battery B; and in the 10-16 foot zone at the base of the peat zone, again with highest EC levels near Tank Battery A and Tank Battery B.[58] Mr. Miller testified these hot pockets of chlorides are a result of "historical produced water".[59] Produced water was disposed of in unlined waste pits prior to the oilfield pit regulations in 1986. There was evidence of SWD well breaches in the 1980s and 1990s.[60]

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[57] *See* n. 33 & n. 35, and accompanying text, *supra.*

[58] *See* Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1536-46.

[59] *See* Miller testimony, Tr., Vol. 6, 3/9/16, p. 1539 (says "hot pockets of historical produced water and discharges"; but, also says the soil or sediment around currently active oil and gas operations generally have EC's less than 8.).
See also UNOCAL's RECAP Report, Figure 5-6, "Peat Zone-Chloride Concentrations", bates no. U_LDNR 00002-02844 (which shows that the peat zone chlorides exceedances near Tank Battery A area, at AB 19; south of Tank Battery A, at AB 5, AB 6, AB 7, and AB 15; at Tank Battery B area at WL-6; and to the extreme south of the property, at AB 2 and AB 3.).

[60] Plaintiff's Plan, Section 4.1.1, "Salt Contamination", bates no. P-DNR-002.0047, stating that south of the A-Battery, the salt is likely associated with a former pit by the flare; also south of A-Battery from SWD #A39 where a breach occurred in 1994; and east of A-Battery from SWD #A16 where a leak in surface casing occurred in 1980. *See also* Figure 1-10, "Locations of Pits, Tank Batteries, Flowlines and SWD Breaches", bates no. P-DNR-002.0083, which shows the A-Battery pits to the south; the SWD breaches at #A39 SWD (1994) to the south, and #16A SWD (1980) to the east of A-Battery; and several pits in the area of B-Battery.

Both sides' experts testified that the VPSB property is either entirely, or largely, a submerged wetland.[61] As a submerged wetland, UNOCAL's position is that no salt standards apply and the chlorides in soil do not require remediation.[62]

A primary concern addressed by Statewide Order 29-B Section 313.D.2&3 elevated wetland and upland soil chloride (salt) standards is potential damage from the high chlorides (salt) to vegetation in those environments, which is generally not an issue with vegetation in a submerged wetland in a coastal environment, and based on the evidence, is not an issue here. UNOCAL's expert, Dr. John Rodgers, visited the property and prepared a Wetlands Functions and Services Report.[63] The various types of vegetation observed at the property were documented in the Report.[64] Dr. Rodgers testified the property is a mix of fresh to intermediate marsh, and has salt-tolerant vegetation.[65] He testified that he saw no evidence of potential

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[61] In LAC 43:XIX.Chapter 3.301, the definition of "Submerged Wetland Area" is "a wetland area which is normally inundated with water and where only levee material is available for mixing with waste fluids during the closure of the pit." Dr. John Rodgers, who was tendered as an expert by UNOCAL, and accepted as an expert in ecotoxicology, wetland sciences, and biogeochemistry, testified on direct examination that the property is roughly 1200 acres (which equates to about two square miles), and in his opinion it is a submerged wetland based on lines of evidence, including elevation (0-2'), type of vegetation and biota, and type of soil and hydrology. Rodgers testimony, Tr., Vol. 1, 3/2/16, pp. 82-83 and 96-103. Mr. Greg Miller, who was tendered as an expert by plaintiff, and accepted as an expert in geology, hydrogeology, site assessment and remediation and implementation of regulations, testified on direct examination that most of the property is a submerged wetland, although he stated that some areas are not mapped as wetland, and referred to a UNOCAL exhibit as having anticipated putting spoil material on 40 acres of the property. Miller testimony, Tr., Vol. 6, 3/9/16, p. 1692-93.

[62] *See* UNOCAL Plan, Section 3.0, "Applicable Remediation Standards", and Subsection 3.1, "Soil", bates nos. U_LDNR 00001-00021-00022.

[63] *See* Rodgers testimony, Tr., Vol. 1, 3/2/16, pp. 141-42. *See also* UNOCAL Plan, "Ecosystem Functions and Services Report", dated June 5, 2014, bates nos. U_LDNR 00001-05752-05783. Plaintiff's expert, Dr. Jim Rogers, did not prepare a similar report, and took issue with whether it was a true systems service analysis, but agreed it is a checklist of observations. *See* Rogers testimony, Tr., Vol. 5, 3/8/16, pp. 1314-15.

[64] *Id.*, bates nos. U_ LDNR 00001-05778-05779 (Table 1: Vegetation Observed: May 12, 2014 through May 14, 2014).

[65] *See* Rodgers testimony, Tr., Vol. 1, 3/2/16, pp. 104-05. *See also* UNOCAL Plan, Figure 13, "Vegetative Map", bates no. U_LDNR 00001-00059.

vegetative uptake of oil and gas constituents, and he concluded that the property was in good ecological health.[66] This testimony was not contradicted by plaintiff's expert, Dr. Jim Rogers.[67] Excavation of soil or subsurface soil, based on chlorides, is not required in view of the current state of the evidence.

Plaintiff's position is that whether the property is classified as a submerged wetland is irrelevant because the soil and subsurface soil needs to be protective of groundwater.[68] Mr. Miller, relying on the Statewide Order 29-B leachate chloride test, testified that the high chlorides from the soil and contaminated subsurface soils are leaching into and contaminating the groundwater aquifer(s) below.[69] While Plaintiff's Plan proposes removing Statewide 29-B

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[66] *See* Rodgers testimony, Tr., Vol. 1, 3/2/16, pp. 107-08.

[67] Dr. Rogers was not asked specifically about his observations of the appearance of the health of plants either in direct or cross examination, but during cross examination he was asked about his observations of animals during his visit to the site: "Q. Now, just so the Panel's not confused, you're not saying that there's widespread death and destruction of animals out there, are you? A. Oh, no. There's some—nice habitat on site. I don't deny that." Rogers testimony, Tr., Vol. 5, 3/8/16, pp. 1193-94.

[68] *See* Miller testimony, Tr., Vol. 6, 3/9/16, p. 1536. *See also* Plaintiff's Plan, Section 5.1.2.3, "Source Removal", bates no. P-DNR-002.0057 ("Excavation of contaminated subsurface soils in Peat Zone...that represent leaching threat to underlying aquifers is not deemed feasible.").

[69] *See* Miller testimony, Tr., Vol. 6, 3/9/16, p. 1530-40, describing reliance on the 29-B leachate testing procedure, and his use of plots to correlate EC, 29-B leachate chlorides, and soil soluble chlorides, where he had EC and soil soluble chlorides results, but not leachate chloride results. *See* correlation plots in Figure 2-24, bates no. P-DNR-002.0107; Figure 2-25, bates no. P-DNR-002.0108; and Figure 2-26, bates no. P-DNR-002.0109. LAC 43:XIX.313.F.2 deals with a pit closure option known as "solidification", and the leachate testing method ("SPLP") for chlorides is applicable to the solidification option, with a limit of 500 mg/l chlorides. The Leachate Test Procedure (a 7-day procedure) is set forth in LDNR's Laboratory Procedures for Analysis of Exploration & Production Waste (August 1988), at pp. 30-31.

But see UNOCAL's RECAP expert, Ms. Levert, who testified she did not perform SPLP, but did agree that groundwater protection standards (referring to RECAP) call for the protection of the receiving water body from the peat zone, which she said is the non-drinking surface water. Levert testimony, Tr., Vol. 4, 3/7/16, pp. 936-41. This surface water body is Schooner Bayou Canal, and the man-made canals, which Ms. Levert testified are all hydraulically connected to each other and the peat zone, and there is "a dynamic process going on" between the peat zone and Schooner Bayou and the canals. Ms. Levert stated the canals have chlorides ranging from 1200 to 2000 ppm, and a little bit higher in Schooner Bayou. *Id.*, pp. 1010-14. *See also* Angle testimony, Tr., Vol. 2, 3/3/16, pp. 493-96. The US Army Corps of Engineers monitoring of Schooner Bayou shows it is naturally salty, with natural

exceedances in sediment, including some chlorides, at the base of canals,[70] the Plan states that excavation of contaminated soils and subsurface soils to prevent the leaching threat is not feasible.[71] Mr. Angle (UNOCAL's groundwater expert) agrees that excavation of the peat zone is technically impracticable, stating a "dig-out remedy" would cause further damage.[72] Mr. Pisani (UNOCAL's soil/sediment expert) stated that the soil-groundwater components cannot be separated. Ms. Levert agreed that UNOCAL recognizes that chlorides are migrating and will continue to migrate from the peat zone to the shallow groundwater (the GW2), and are impacting that groundwater,[73] but UNOCAL's position is that since the shallow groundwater (the GW2) has excess chlorides naturally, and no remedy can get it to fresh water status, it is impracticable to undertake an intrusive extensive remedy as to either the peat zone sediment or the shallow groundwater (GW2).[74]

Plaintiff's proposed solution to prevent chloride migration from groundwater in the peat zone is to physically isolate and contain the chlorides in place by using a grout floor and walls beneath the peat zone to prevent downward migration to the groundwater aquifer(s) below.[75] Mr.

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chloride levels at times ranging up to between 3000 and 4000 mg/l near East White Lake. *See* RECAP Report, Section 2.5, "Surface Water Characteristics", bates no. U_LDNR 00002-00022.

[70] *See* Plaintiff's Plan, Figure 4-16, "Soil/Sediment Statewide Order 29-B Exceedances", bates no. P-DNR-002.0127; and Figure 4-17, "Soil/Sediment Exceeding Ecological Standards", bates no. P-DNR-002.0128.

[71] *See* Plaintiff's Plan, Section 5.1.2.3, "Source Removal", bates no. P-DNR-002.0057 (stating excavation in peat zone would risk potential hydraulic basal heave, and would also potentially compromise the underlying aquifer by creating hydraulic communication to surface water.).

[72] *See* Angle testimony, Tr., Vol. 2, 3/3/16, p. 551.

[73] *See* Levert testimony, Tr., Vol. 4, 3/7/16, pp. 996-97.

[74] *See* Pisani testimony, Tr., Vol. 2, 3/3/16, p. 395; and Angle testimony, Tr. Vol. 2, 3/3/16, pp. 553-55.

[75] *See* Plaintiff's Plan, Section 5.3, "Physical Containment of Salt-Contaminated Soils", bates nos. P-DNR-002.0063-0064; and Figure 5-1, "Grout Isolation Areas for Soil Leaching Salts to CHCTS", bates no. P-DNR-

Miller, whose proposal this is, has never seen anything like this attempted in Louisiana,[76] and in fact, there was no evidence that anything comparable has been tried anywhere in a marsh setting. The testimony lacked definitive proof that the untested process of pumping vast amounts of slurried concrete under significant pressure into the marsh will not irreparably harm the marsh environment during the installation process, and will also not irreparably harm the ecologically sensitive marsh afterwards by preventing the marsh area that is confined by the grout floor and walls from performing its natural wetland functions. Because the testimony lacked definitive proof, LDNR finds that a project of this magnitude in this environment is unchartered, with complex logistics, unvetted potential adverse impacts and/or unintended consequences, and unknown expectations for obtaining US Army Corps of Engineers wetlands and/or LNDR coastal use permits. For these reasons, and considering that further sediment, mineral soil and groundwater characterization and evaluation is necessary and a part of the Plan, as discussed later, LDNR has determined this proposed remediation plan to be unreasonable, thus not feasible, at this time.

The CHCTS aquifer (a GW2) underlying the peat zone at the VPSB property is naturally salty, according to plaintiff with a background chlorides level of 487 mg/l and according to UNOCAL with background chlorides ranging from 600 to 800 mg/l.[77] LDNR does not believe, based on the current state of the evidence, that it can be presumed that leaching of unacceptable

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002.0147; Figure 5-2, "Grout Isolation Walls and Floor on North-South Cross Section", bates no. P-DNR-002.0148; and Figure 5-3, "Grout Isolation Walls and Floor on East West Cross Section", bates no. P-DNR-002.0149.

[76] Miller Tr., Vol. 6, 3/9/16, pp. 1713-21.

[77] *See* Plaintiff's Plan, Section 2.3.4.1, "Chicot Shallow Sand Aquifer", bates nos. P-DNR-002.0034-0035 (background for chlorides—487 mg/l); and Angle testimony, Tr., Vol. 2, 3/3/16, p. 521 (600-800 mg/l, referring to the Hebert well chloride levels.).

chloride concentrations from the peat zone into surface water or the CHCTS aquifer is occurring. The high chlorides in the samples in evidence come from discrete locations near historical pits and SWD breaches,[78] and it is likely that chlorides are stabilized and/or declining, and not migrating at an appreciable rate, since the produced water was disposed of many years ago. Given the size of the CHCTS zone relative to the peat zone, chlorides migrating downward into the CHCTS zone may be diluting/attenuating and not appreciably increasing chloride levels that already exist naturally in the CHCTS. The peat zone itself is in direct hydraulic communication with Schooner Bayou Canal (which itself, at times, is naturally salty),[79] and chlorides may be migrating from the peat zone to Schooner Bayou Canal and diluting/attenuating in that direction as well. But none of this is really understood at this time based on the current state of the evidence.

LDNR finds that it is most reasonably protective of the environment at this time not to further excavate soil and subsurface soil. Instead, the most logical and reasonable way to find out what is occurring with chloride levels is to evaluate and delineate chloride levels by developing a site specific background chlorides concentration in accordance with accepted methodology, and then to monitor what is occurring in the CHCTS zone in relation to the developed background concentration. LDNR is requiring this in the groundwater section of this Plan. Monitoring after

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[78] *Compare* Plaintiff's Plan, Figure 5-1, "Grout Isolation Areas for Soil Leaching Salts to CHCTS", bates no. P-DNR-002.0147, *with* Figure 1-10 (1998 Aerial), "Location of Pits, Tank Batteries, Flowlines and SWD Breaches", dated Dec. 2015, bates no. P-DNR-002.0083. Figure 5-1 depicts hot spots of soil contaminated with leachable salts, and these roughly coincide with the areas in Figure 1-10 near Tank Battery A and Tank Battery B where historical pits were located and SWD breaches occurred.

[79] *See* UNOCAL Plan, Figure 7, "US Army Corps of Engineers Surface Water Monitoring Locations", bates no. U_LDNR 00001-00053; and Figures 8-11, Canal Chloride Trend Charts, bates nos. U_LDNR 00001-00054-00057.

specific excavations being required by the Plan should allow an assessment of whether the excavations are having a positive effect on reducing chloride levels.

1. **Tank Battery B - Former Pit Canal (SED 15) Area**

In 2010, TPH-DRO and TPH-ORO exceedances were detected at sample location SED 15 near former Tank Battery B.[80] In late 2014, according to Mr. Pisani, UNOCAL remediated the entirety of the SED 15 area, but at the hearing plaintiff's expert, Mr. Miller, questioned whether SED 15 had completely been remediated, particularly into the canal.[81] During his rebuttal testimony, using a figure that delineated the confirmatory sample locations, and the pit excavation limits, Mr. Pisani again testified that SED 15 had been completely delineated and remediated.[82] In addition to SED 15, other areas in the same general vicinity around former Tank

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[80] Total petroleum hydrocarbons (TPH) is defined as "an estimate of the total amount of petroleum hydrocarbons in a sample that may represent sums of concentrations of a limited number of compounds, groups of compounds, or the entire range of petroleum hydrocarbons. It may contain compounds that are not derived from hydrocarbons." TPH-DRO (Diesel Range Organics) is defined as "the range of extractable total petroleum hydrocarbon constituents used to represent the presence of diesel (C_{10}-C_{28})." TPH-ORO (Oil Range Organics) is defined as "the range of extractable total petroleum hydrocarbon constituents used to represent the presence of oil (C_{28}-C_{35})". *See* RECAP, §2.1 (RECAP definitions of "Total petroleum hydrocarbons (TPH)", "TPH-DRO" and "TPH-ORO").

For SED 15 exceedances, *see* Plaintiff's Plan, Table 4-1, "Subaqueous Sediment and Soil Data Summary Table", bates no. P-DNR-002.0163 (RECAP $Soil_{ni}$ standard—65 mg/kg and 180 respectively for TPH-DRO and TPH-ORO; the results were high both at depths of 0-2' and 2-4', with the highest values at a depth of 2-4', where the TPH-DRO was 152,432 mg/kg and the TPH-ORO was 23,500 mg/kg.).

For SED 15 location, and related sample locations, *see* various figures:

(a) RECAP Report, Figure 3-4, "Sediment Sample Locations (Quadrant 3)", bates no. U_LDNR 00002-02832 (Sed 15; MPA Sed 15-N; MPA Sed 15-W; and MPA Sed 15-W-2); and Supplement to RECAP Report, Figure 3-2, bates no. U_00007-00044 (same).

(b) RECAP Report, Figure 1-2, "Site Features", bates no. U-LDNR 00002-02818 (overview depicting Sed-15 Pit Remediation Area);

(c) RECAP Report, Figure 1-3, "Sed-15 Pit Remediation Area", bates no. U_LDNR 00002-02819 (SED-15; MPA Sed 15-N; MPA Sed 15-W; MPA Sed 15-W-2; MPA Sed 15-E; and MPA Sed 15-E-2); and

(d) UNOCAL Plan, Figure 35, "Former Pit Sampling Locations", bates no. U_LDNR 00001-00084 (Sed 15; MPA Sed 15-N; MPA Sed 15-W; MPA Sed 15-W-2; MPA Sed 15-E; and MPA Sed 15-E-2).

[81] *See* n. 31 *supra*. *See also* Pisani testimony, Tr., Vol. 2, 3/3/16, pp. 357-68; and *see also* Miller testimony, Tr., Vol. 6, 3/9/16, pp. 1526-30.

[82] Pisani rebuttal testimony, Tr., Vol. 7, 3/10/16, pp. 1921-24. *See also* UNOCAL Plan, Figure 4, "Confirmation Sample Locations-SED-15 Areas", bates no. U_LDNR 00001-00917. *Id.*, Figure 2 (Delineation Samples-SED-15 Area) & Figure 3 (Pit Excavation Limits-SED-15 Area), bates nos. U_LDNR 00001-00915-00916.

Battery B are still high in oil and grease, TPH, and/or hydrocarbon fractions. Plaintiff's Figures 4-8 and 4-9 depict TPH-Diesel Range and TPH-Oil Range exceedances, with the highest levels depicted in the Tank Battery B area.[83] Other figures from both parties introduced as part of their plans show Statewide Order 29-B exceedances of oil and grease, and TPH-D, TPH-O, and/or hydrocarbon fractions exceedances of RECAP screening standards and/or ecological standards in the Tank Battery B area.[84]

Testimony and video evidence indicated significant surface oil sheening in the SED 15 area which was visually observable when the sediment was/is disturbed and/or stirred up.[85] The oil sheening clearly violates LDEQ's general surface water quality criteria as to aesthetics, color,

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[83] *See* Plaintiff's Plan, Figure 4-8, "Soil/Sediment TPH-Diesel Range Hydrocarbons", bates no. P-DNR-002.0119; and Figure 4-9, "Soil/Sediment TPH-Oil Range Hydrocarbons", bates no. P-DNR-002.0120.

[84] *See* Plaintiff's Plan, Figure 4-10, "Soil/Sediment HEM Oil & Grease", bates no. P-DNR-002.0121; Figure 4-16, "Soil/Sediment Statewide Order 29-B Exceedances", bates no. P-DNR-002.0127 (oil & grease exceedances in area of Tank Battery B); Figure 4-17, "Soil/Sediment Exceeding Ecological Standards", bates no. P-DNR-002.0128 (TPH-D and TPH-O in area of Tank Battery B).

See also UNOCAL Plan, Figure 42, "Statewide Order 29-B Standard Exceedances- Soil/Sediment", bates no. U_LDNR 00001-00088 (oil & grease exceedances in area of Tank Battery B—SP-MPA-5, Sed 28, Sed 29, Sed 30, WL-4, and WL 5); Figure 43, "RECAP Direct Contact Standard Screening Standard Exceedances- Soil/Sediment", bates no. U_LDNR 00001-00089 (hydrocarbon fraction exceedances in area of Tank Battery B—Sed 28, Sed 29, and Sed 30); and Figure 44, "RECAP Groundwater Protection Screening Standard Exceedances- Soil Sediment", bates no. U_LDNR 00001-00090 (hydrocarbon fraction exceedances in area of Tank Battery B—Sed 28, WL-4, and WL-5). *See also* RECAP Report, Figure 5-1, "Sediment Constituent Concentrations Above Non-Industrial Direct Contact Screening Standards", bates no. U_LDNR 00002-02839 (hydrocarbon fractions above standards at Sed 28, Sed 29, and Sed 30); and Figure 5-2, "Sediment Constituent Concentrations Above Groundwater Protection Screening Standards", bates no. U_LDNR 00002-02840 (hydrocarbon fractions above standards at Sed 28, WL-4, and WL-5).

[85] Mr. Pisani agreed that oil sheening could be observed in the former Tank Battery B area. He testified to sheening close by SED 15, and to the east and southwest of SED 15, and also close to TBB-2 (in the Tank Battery B area also). *See* Pisani testimony, Tr., Vol. 2, 3/3/16, pp. 351-56 (direct exam), and pp. 376-79 and 416-19 (cross exam), and p. 436 (Snellgrove question). *See also* UNOCAL Exhibit 325, bates no. U_LDNR 00325-00001 (video of sheening while Mr. Pisani in boat); and Plaintiff's Exhibit 10, bates no. P-DNR-10.1 through 10.16 (video of sheening while Mr. Miller in boat).

floating, suspended, and settleable solids, and oil and grease.[86] The surface water criteria also prohibits substances in waters or underlying sediments that alone or in combination will be toxic to human, plant, or animal life.[87] LDNR has consulted with LDEQ concerning surface water and sediment issues, and LDEQ, in connection with its review, has determined that the hydrocarbons detected in the canal sediment in the SED 15 area need to be remediated to address applicable water quality criteria and to be protective of ecological receptors and natural resources as set forth in the RECAP Section 7.0, Ecological Risk Assessment ("ERA") requirements.[88]

The parties did provide ERAs, and the ERAs relied upon a quantitative risk assessment, which is allowed by RECAP, for evaluating ecological risks from COCs in soil and/or sediment.[89] Dr. John Rodgers for UNOCAL and Dr. Jim Rogers for VPSB both have PhDs in the field of ecotoxicology and ecological risk assessment; both are on the faculty of highly respected universities; and both have been consulted extensively by federal agencies through the years. They both were good witnesses, and the panel and reviewing LDEQ agency staff (collectively referred to as "Agency staffs") respects their opinions. But their respective hazard assessments

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[86] *See* LAC 33:IX.1113.B as to aesthetics; color; floating, suspended and settleable solids; taste and odor; and oil and grease. Ms. Levert testified that "to achieve the esthetic standard for hydrocarbons identified in RECAP [10,000 ppm], remediation is warranted at the Tank Battery B south area. That's the area we've been referring to as the WL-4 area, the former pit area." Levert testimony, Tr., Vol. 4, 3/7/16, pp. 869, 932. She also testified that hydrocarbons exceed the direct contact standard at depth at WL-4. *Id.*, p. 931.

[87] LAC 33:IX.1113.B.5 states: "No substance shall be present in the waters of the state or in the sediments underlying said waters in quantities that alone or in combination will be toxic to human, plant, or animal life...."

[88] *See* RECAP, §7.0 ("Ecological Risk Assessment"). As to toxicity to humans, UNOCAL's human health expert, Ms. Angela Levert, has performed a human health risk assessment with a site specific RS for surface water and included an analysis of TPH-DRO and TPH-ORO. *See* RECAP Report, Section 6.4, "MO-3 Surface Water Evaluation", bates nos. U_LDNR 00002-00060-00062; and Table 6-9, "Surface Water Comparison to MO-3 Standards", bates no. U_LDNR 00002-02800. But, there was no ecological risk analysis as to surface water issue.

[89] *See* RECAP, §2.14.5 ("Ecological Risks"): "if the hazard quotient method is used for the assessment of ecological risks, acceptable risk shall be defined as a hazard index of less than or equal to 1.0."

are so far apart that it is difficult for the Agency staffs to rely upon one or the other without much more time, and much more independent analysis of the source information used by each expert, to determine which assessment is more reliable.

Both assessments used similar multi-factor equations to calculate hazard quotients for exposure of indicator species (avian and mammal)[90] to the COCs involved. But, the equations rely upon inputted data that depend on interpretative judgment calls for the data to be inputted into the equations, and the interpretative judgment calls made by each expert varied widely enough that their final hazard quotients are several orders of magnitude apart. Dr. John Rodgers finds no ecological risk at all for any of the COCs; but Dr. Jim Rogers finds ecological risk from every COC.[91]

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[90] The same indicator species were used as surrogates for animals that may be at the property. Those were: six avian species—American Robin, Spotted Sandpiper, Snowy Egret, American Woodcock, Mallard Duck, Great Blue Heron; and four mammal species—Least Shrew, Swamp Rabbit, Red Fox, and American Mink.

[91] Three of the key metals COCs at issue are mercury, barium, and arsenic. Dr. Jim Rogers' (Plaintiff's expert) calculated hazard quotient for mercury is 174 (well above 1.0) (using his low PCL for a Snowy Egret), *see* Rogers' chart entitled "Pollution in Marsh Soil and Canal Sediments", Plaintiff's Exhibit 209, bates no. P-DNR-209.14; while Dr. John Rodgers' (UNOCAL's expert) highest calculated hazard quotient for any of the indicator species (Least Shrew) is 0.06189 (well below 1.0). *See* John Rodgers ERA Report, Table for Least Shrew, bates no. U_LDNR 00003-00098. Thus, Dr. Jim Rogers' HQ for mercury is 2,811 times higher than Dr. John Rodger's HQ. Dr. Jim Rogers' HQ for barium (221) and arsenic (7.1) is 349 times and 186 times higher, than Dr. John Rodgers' highest HQ for barium (0.6320) and arsenic (0.03831). The formulas have inputs that are multiplicative (numerator or denominator), and changing any two inputs by a factor of 10 can change the output (answer) by 100 times. Some of the source materials for the inputs were reviewed, including some peer reviewed literature used, and it is apparent how judgment calls will affect this analysis. Several examples should suffice to make the point. The bioavailability factor for barium used by Dr. Jim Rogers was 1.0, assuming completely bioavailable; that same factor used by Dr. John Rodgers was 0.01, assuming not very bioavailable. These differed by a factor of 100. From the evidence it did not appear there had been any speciation on the barium in the soil and/or sediment to allow a determination if the barium was from barium sulfate (not generally very bioavailable) versus barium chloride or barium hydroxide (very bioavailable). *See* Rogers testimony, Tr., Vol. 5, 3/8/16, p. 1393 (question asked by Ms. Jamie Love to Dr. Rogers). There is a submission from UNOCAL on the barium bioavailability issue, *see* UNOCAL Plan, bates no. U_LDNR 00001-05442-05505, but it does not appear to have speciation data specific to this property. Dr. Jim Rogers used a toxicity reference value ("TRV") for mercury of 0.032 (Least Shrew, the species that drove his low PCL for mercury), *see* Jim Rogers ERA Report, Least Shrew Calculations, bates no. P-DNR-303.81, while Dr. John Rodgers used 1.01. *See* John Rodgers ERA Report, Least Shrew Calculations, bates no. U-00003-00098. These differed by a factor of 32. In addition, as was apparent in testimony, the time (temporal) factor used varied by a factor of more than 3; the home range factor used varied significantly; and one expert used maximum concentrations and the other used 95% UCL concentrations. There were other opportunities for judgment calls which are not mentioned here, and

LDEQ, in connection with its review of these ERAs, has concluded that neither party has provided an acceptable ERA for evaluating the remaining hydrocarbons in the canal sediment, and for determining that these hydrocarbons will not pose an unacceptable ecological risk to plant or animal life.[92] Accordingly, the Plan is requiring that the sediment in the SED 15 area where oil sheening was reported be excavated to the extent that surface water oil sheening is no longer observed. Confirmatory samples are to be collected from surrounding (unexcavated) canal sediment. The confirmatory sediment samples are to be collected and analyzed with a technique acceptable under RECAP. Analytical results for sediment COCs should meet applicable COC background levels. The excavated sediment is to be transported off-site for proper disposal.

2. **Tank Battery B – Triangle Pit Area**

As part of its plan, UNOCAL recommends reclosing the Tank Battery B south pit area.[93] This is a triangular former pit area in the vicinity of former Tank Battery B, to the southeast of SED 15. It is depicted in UNOCAL's Figure 66.[94] UNOCAL's expert, Mr. Pisani, testified this

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the judgment calls can, and did, make significant differences in outcomes possible. Because of the disparity in these ERAs, the panel has not relied on them, and has looked to LDEQ for guidance with the criteria for COCs to protect against ecological risk.

[92] Not only for the reasons already stated in n. 91 *supra*, but these ERAs were not helpful in evaluating the ecological risk and protection of aquatic life from TPH/hydrocarbon toxicity because they did not really address TPH. UNOCAL's expert, Dr. John Rodgers, stated he did not consider TPH a problem, has no TPH concentration data reported in his tables, and while performing a hazard quotient analysis for other COCs, he did not do one for TPH since he says it was not indicated. Rodgers testimony, Tr., Vol. 1, 3/2/16, pp. 191-92. Plaintiff expert, Dr. Jim Rogers, did do a hazard quotient work-up which included calculating a Protective Cleanup Level ("PCL") for TPH, *see* Plaintiff's Exhibit 209, entitled "Pollution in Marsh Soil and Canal Sediments", bates no. P-DNR-209.14, but the calculation was based on one data point, 152,432 mg/kg, which he agreed was an exceedance that had been removed in the Sed 15 remediation work in 2014. He also testified that he did not have really good dose data for TPH. Rogers Tr., Vol. 5, 3/8/16, p. 1201.

[93] *See* UNOCAL Plan, Section 6.0, "Most Feasible Plan", bates no. U_LDNR 00001-00032.

[94] *Id.*, Figure 66, "Proposed Tank Battery B Pit Re-closure Area", bates no. U_LDNR 00001-00112.

area has the same conditions as SED 15.[95] Plaintiff's Figure 4-16 depicts the soil and/or sediment in this triangular area as having 13 feet of Statewide Order 29-B oil & grease exceedances.[96] Mr. Pisani testified that UNOCAL has filed an LDNR Coastal Use Permit application and is prepared to do this reclosure work.[97] The Plan is requiring that UNOCAL create/furnish an AOI Figure which establishes the area to be excavated, and close this pit in accordance with LDNR's Chapter 3 pit closure procedures.[98]

3. **Tank Battery A – WL-3 Mercury Sample Location Area**

As noted in the earlier jurisdiction ruling,[99] at one time prior to the mid-1990s, a mercury manometer was located in a meter building on the main dock of the central gas processing plant at Tank Battery A. That manometer appears to have been the source of mercury that has been detected by the parties in the soil and/or sediment in and around the east-west canal near the main dock at Tank Battery A.[100] Mercury in soil and/or sediment in this area is depicted on

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[95] *See* Pisani testimony, Tr., Vol. 2, 3/3/16, p. 370.

[96] *See* Plaintiff's Plan, Figure 4-16, "Soil/Sediment Statewide Order 29-B Exceedances", bates no. P-DNR-002.0127 (oil & grease at this location is 13 feet thick, 7,284 ft^2 (0.17 acres)). *See also* Figure 4-17, "Soil/Sediment Exceeding Ecological Standards", bates no. P-DNR-002.0128 (TPH-D, TPH-O, mercury, and buried creosote pilings at this triangular pit location).

[97] Pisani testimony, Tr., Vol. 2, 3/3/16, p. 370.

[98] LAC 43:XIX.Subpart 1.Chapter 3.

[99] *See* Post-Hearing Ruling as to Jurisdiction, referred to in n. 1 *supra*, pp. 4-5 (of Ruling).

[100] *See* tables referred to in n. 33 *supra*. Specifically, Table 3, "Soil Sediment Analytical Data", in the UNOCAL Plan; and Table 4-1, "Subaqueous Sediment and Soil Data Summary Table", in the Plaintiff's Plan. *See also* RECAP Report, Table E-1, "Sediment Data", bates no. U_LDNR 00002-00382. Since the hearing, at the request of the panel on 3/31/16, a Revised Table 4-1 has been submitted by plaintiff to reflect wet versus dry weights. All of these tables reflect results for samples for mercury in the soil and/or sediment in and around the main dock. *See also* location of soil and/or sediment samples, Supplement to RECAP Report, Figure 3-2 SUPPL, "Sediment Sample Locations (Quadrant 1)", bates no. U_LDNR 00007-00044.

Plaintiff's Figure 4-14.[101] Most of the mercury detected is in sediment in the canal, as opposed to soil, and is on the north side of the canal right below the main dock, and is addressed in the canal sediment section of this Plan.

There is also mercury exceeding the RECAP Soil SS_{ni} in soil in an isolated location on the south side of the canal in sample WL-3 at a depth of 0-2 feet, as depicted in green (2.3-10 mg/kg) on Plaintiff's Figure 4-14.[102] But, this mercury is below the MO-1 $Soil_{ni}$ standard for the soil.[103] Because of this, it has been determined by LDNR (in consultation with LDEQ) that no further action is necessary for this mercury at this location.

4. **Tank Battery A – South Pit (Pipeline) Area**

Throughout the area generally just south of Tank Battery A, including the same general area as WL-3 discussed above, significant hydrocarbon fractions, hydrocarbon mixtures (TPH-D or TPH-O), and/or oil & grease exceedances, have been identified by the parties, and are shown in the figures presented by both sides during the hearing.[104] In her testimony, Ms. Levert

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[101] Plaintiff's Feasible Plan, Figure 4-14, "Soil/Sediment Mercury", Exhibit P-DNR-002.0125.

[102] *Id. See also* Plaintiff's Revised Table 4-1, submitted 4/8/16, Mercury at WL-3 (at 0-2'), sample date 1/6/15, results of 4.29 mg/kg Wet Wt (ICON) and 5.73 mg/kg Wet Wt (MPA). The Revised Table also reflected a result at WL-3 (4-6') of 3.12 mg/kg Wet Wt (MPA), but on 4/19/16, UNOCAL's counsel notified plaintiff and the panel that the 4-6 foot result on the plaintiff's Revised Table 4-1 was in error since it had not been converted from dry weight to wet weight, and there is no exceedance at 4-6 feet. *See also* RECAP Report, Table E-1, "Sediment Data", U_LDNR 00002-00382, Mercury at WL-3 (at 0-2'), sample date 1/6/15, results of 4.29 mg/kg (dry), 2.73 mg/kg (wet) (ICON); and 7.59 mg/kg (dry), 5.73 mg/kg (wet) (MPA). *See also* Supplement to RECAP Report, Figure 5-1 SUPPL, "Sediment Constituent Concentrations Above Non-Industrial Direct Contact Screening Standards", bates no. U_LDNR 00007-00049 (WL-3 at 0-2' results reflected with a concentration of 4.23 mg/kg (avg wet wt)).

[103] *See* RECAP, Table 2, MO-1, "Standards for Soil", p. T2-3, Mercury $Soil_{ni}$—23 mg/kg.

[104] *See* RECAP Report, Figure 5-1, "Sediment Constituent Concentrations Above Non-Industrial Direct Contact Screening Standards", bates no. U_LDNR 00002-02839 (depicting exceedance of hydrocarbon fractions at WL-3); Plaintiff's Plan, Section 4.1.2, "Petroleum Hydrocarbon Contamination in Sediment and Soils", bates no. P-DNR-002.0047 (high concentrations of TPH-D detected in soils/sediment in areas between canals located southeast of A Battery); Figure 4-8, "Soil/Sediment TPH-Diesel Range Hydrocarbons", bates no. P-DNR-002.0119 (area around WL-3); Figure 4-9, "Soil/Sediment TPH-Oil Range Hydrocarbons", bates no. P-DNR-002.0120 (same area); Figure

identified SS-26 (shown to be slightly southwest of WL-3 on her supplemental maps), as a former pit area where PAHs were detected, and which she testified needs further evaluation and delineation.[105]

The Plan is requiring further evaluation and delineation of soil in this area, and particularly the area around SS-26, to ensure that this area is adequately characterized, and to determine if the current soil conditions are protective of soil to groundwater and soil to surface water pathways for all LAC 43:XIX.Subpart 1.Chapter 3, and RECAP, Appendix D, Table D-1 Indicator Compounds and Hydrocarbon Fractions COCs. The Plan is requiring that UNOCAL submit a work plan, including creating/furnishing an AOI Figure, for the area to be evaluated and delineated.

5. **Area North of Tank Battery A – PCB/TPH Sample Location Area**

PCBs exceeding the RECAP Soil SS_{ni} were detected in SED7 (4-6 foot depth) just north of Tank Battery A.[106] The Plan is requiring that the resampling of this area occur to determine if

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4-10, "Soil/Sediment HEM Oil & Grease", bates no. P-DNR-002.0121 (same area); and Figure 4-16, "Soil Sediment Statewide Order 29-B Exceedances", bates no. P-DNR-002.0127 (same area).

[105] *See* SS-26, just slightly to the southwest of Tank Battery A and also southwest of WL-3 in Figure 3-2 SUPPL, "Sediment Sample Locations (Quadrant 1)", bates no. U_LDNR 00007-00044; and Figure 5-1 SUPPL, "Sediment Constituent Concentrations Above Non-Industrial Direct Contact Screening Standards", bates no. U_LDNR 00007-00049 (SS-26 at 0-2', hydrocarbon fraction exceedances designated in pink). *See* Levert testimony, Tr., Vol. 4, 3/7/16, p. 936 (stating: "I recommend that confirmation sampling for PAHs be performed, because TPH was detected there and we don't have PAH data at that location. So I recommend that we go back and collect PAH data and that we also delineate around that point for PAHs if needed and for TPHs...because it is the location of potentially, a former pit.").

[106] *See* Plaintiff's Plan, Section 4.1.4, "PCB Contamination in Sediment and Soils", bates no. P-DNR-002.0050 (RECAP $Soil_{ni}$ screening standard—0.11 mg/kg; PCB concentration in sample at SED7—0.204 mg/kg); and Table 4-1, "Subaqueous Sediment and Soil Data Summary Table", bates nos. P-DNR-002.0163, Boring ID—SED7, depth of 4-6' (ft bls), date 2/25/10, Total PCBs—0.204 mg/kg (RECAP $Soil_{ni}$ screening standard—0.11mg/kg); but Revised Table 4-1 shows PCBs at this depth of 0.062 mg/kg. Location of SED7 can be seen in sediment sample locations in Supplement to RECAP Report, Figure 3-2 SUPPL, "Sediment Sample Locations (Quadrant 1)", bates no. U_LDNR 00007-00044.

there are PCBs and/or other COCs, notably TPH,[107] or PAHs which have not been sampled for pursuant to RECAP Table D-1, and there needs to be an evaluation of those COCs in the soil above applicable RECAP screening standards. If there are exceedances, there should be a complete delineation, and remediation of the PCBs, TPH, and/or PAHs, to applicable RECAP standards, or demonstrate that the area does not pose a risk in accordance with the appropriate RECAP procedure. The Plan is requiring that UNOCAL submit a work plan, including creating/furnishing an AOI Figure, for the area of resampling, delineation, and/or remediation.

6. **Site Canal Sediment**

Ms. Levert testified that under a reasonable maximum exposure analysis in accordance with RECAP guidelines, there is no human health risk and no sediment remediation beyond the excavation and removal which Mr. Pisani is recommending at Tank Battery B is necessary.[108] As noted earlier, two ecological risk experts testified, Dr. John Rodgers, for UNOCAL, and Dr. Jim Rogers, for plaintiff. They assessed the ecological risk to plant and animal life from COCs, including COCs in sediment, relying on a hazard quotients analysis. These analyses factored in bioaccumulation of COCs in plants and animals. In connection with bioaccumulation, Dr. Rogers, on behalf of plaintiff, collected 22 blue crabs from nine locations in and around the canals on the VPSB property, on October 16-17, 2010. He had the tissue of the crabs analyzed

[107] *See* Plaintiff's Plan, Section 4.1.2, "Petroleum Hydrocarbon Contamination in Sediment and Soils", bates no. P-DNR-002.0047 ("Six feet of oily sludge was encountered at Sed7 at the base of the canal near the compressors located east of the office"); and Table 4-1, "Subaqueous Sediment and Soil Data Summary Table", bates nos. P-DNR-002.0163 (RECAP $Soil_{ni}$ standard—65 mg/kg and 180 respectively for TPH-DRO and TPH-ORO; the results were high both at depths of 0-2', 2-4', & 4-6', with the highest values at a depth of 2-4', where the TPH-DRO was 2,050 mg/kg and the TPH-ORO was 1,410 mg/kg). SED7 can be seen with significant TPH or oil & grease in the following plaintiff figures: Figure 4-8, "Soil/Sediment TPH-Diesel Range Hydrocarbons", bates no. P-DNR-002.0119; Figure 4-9, "Soil/Sediment TPH-Oil Range Hydrocarbons", bates no. P-DNR-002.0120; Figure 4-10, "Soil/Sediment HEM Oil & Grease", bates no. P-DNR-002.0121; and Figure 4-16, "Soil Sediment Statewide Order 29-B Exceedances", bates no. P-DNR-002.0127.

[108] Levert testimony, Tr., Vol. 4, 3/7/16, p. 980.

for contaminants to evaluate ecological effects in a food chain model.[109] He concluded that there were contaminants in excess of a Louisiana Department of Health and Hospitals ("LDHH") tissue advisory, and submitted the results to LDHH. LDHH collected eight (8) crabs at the same locations on November 23 and 29, 2010 and performed its own crab risk assessment.[110] Dr. Rodgers, on behalf of UNOCAL, participated in blue crab and forage fish study in December 2010 and January 2011.[111] The study included 23 locations on or near the site, with 307 crabs collected and analyzed; it concluded there was no potential for ecological risk.[112]

In late 2014, LDNR requested LDHH provide an assessment of the crab studies. LDHH issued a report on March 13, 2015. LDHH concluded that the plaintiff's study was not in accordance with the applicable protocol; that the UNOCAL study was in accordance with the protocol; and that no potential human health hazards were identified from consumption of crabs

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[109] The purpose of the study was to evaluate the potential for bioaccumulation of "Contaminants of Ecological Concern" ("COECs") from the canal sediments and surface water into crabs at the VPSB property. Crab traps were baited at nine (9) locations in the canals around Tank Battery A and Tank Battery B primarily. Twenty two (22) crabs were collected between 7:00 pm on 10/16/10 and 9:00 am on the morning of 10/17/10. The crabs were then sent to a lab and whole crabs were homogenized and analyzed for contaminants within the crabs' digestive systems. The results of the analysis were incorporated into a food chain model. *See* Jim Rogers ERA Report, Section 8.5, "Blue Crab Study", bates no. P-DNR-303.44.

[110] *See* RECAP Report, "East White Lake Oil and Gas Field Seafood Sampling Evaluation Vermilion Parish, Louisiana, Department of Health and Hospitals, March 13, 2015" ("LDHH Seafood Report"), bates no. U_LDNR 00002-00583-00602.

[111] Ms. Angela Levert also participated, and before the study was undertaken, she submitted a quality assurance and sampling plan to LDEQ, LDNR, LDHH, and the Louisiana Department of Wildlife and Fisheries. See letter to agencies from Ms. Levert, dated 12/6/10, RECAP Report, bates no. U_LDNR 00002-00098-00099.

[112] *See* Crab and Fish Collection Report, RECAP Report, bates no. U_LDNR 00002-00130-00152; and John Rodgers ERA Report, bates no. U_LDNR 00003-00062.

and fish from the VPSB canals. This conclusion supports Ms. Levert's opinion as to human health risk, but does not address the ecological risk. [113]

In reviewing all of this, LDEQ has determined that the ecological risk from contaminated canal sediment will require more stringent remedial goals than human health risk. For reasons stated earlier, LDEQ has chosen not to rely on the ERA reports submitted by the parties. But it has reviewed both parties' ERA reports, and because it has determined that the ecological exposure risks to ecological receptors for COCs identified in canal sediment are the controlling risks, and because ecological exposure risks do have more stringent regulatory criteria than the human health exposure risks here, LDEQ is recommending that ecological risk criteria be used in addressing the sediment at the VPSB site. LDEQ has identified the NOAA Apparent Effects Threshold ("AET") values as appropriate ecological risk criteria to use for the metals COCs in sediment in this case.[114]

Michael Pisani & Associates ("MPA"), in the Plan it submitted on behalf of UNOCAL, provided canal sediment background sample results for metals where ICON (VPSB's consultant and expert) split samples with MPA. Those background sample results included hydrocarbon analysis of TPH-D and TPH-O. Using those results, LDNR, in consultation with LDEQ, has established background concentrations in accordance with RECAP Section 2.13 for all of the metals, and TPH-D and TPH-O, to be used in analyzing the canal sediment for potential

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[113] *See* LDHH Seafood Report, referred to in n. 110 *supra*, bates no. U_LDNR 00002-00596 (listing LDHH conclusions).

[114] The NOAA Screening Quick Reference Table (SQuiRT), *see* n. 28 *supra*, provides screening concentrations for inorganic and organic contaminants in various environmental media. Plaintiff introduced the SQuiRT Table at Plaintiff's Exhibit 148, bates no. P-DNR-148.01 to 34; and UNOCAL introduced it at UNOCAL Exhibit 180, bates no. U-LDNR 00180-00001 to 00034. The AET values for the metals involved can be found in the SQuiRT Table at bates no. P-DNR-148.02, and at bates no. U_LDNR 00180-00002.

remediation.[115] The background concentrations are set forth in Tables 1-10 attached to the Plan.[116] Using the background concentrations, the Plan adopts the following procedures for evaluating the canal sediment, and for determining whether it needs to be remediated.

Where analytical results at sample locations indicated background concentrations were exceeded for one or more COCs, the analytical results have been compared to the AET values.[117] Sample locations B9, B12, B14, B17, SS4, SS6, SS9, SS13, SS14, and SS15, where COC results were below background concentrations and/or applicable AET values, have been eliminated from any further action.[118]

For each canal sediment sample location outside of an area to be excavated[119] where barium results are reported to be above the barium background concentration (SS3, SS7, SS8, SS10, SS11, SS12, SS17, SS20, Sed7, Sed8, Sed10, Sed11, Sed12, Sed13, Sed14, Sed17, Sed18, Sed19, Sed20, Sed25, Sed27, Sed31, B4, and TBB-2D),[120] UNOCAL should submit a work plan

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[115] RECAP, §2.13 ("Identification of Background Concentration").

[116] The background tables are attached to the Plan: Mercury (Table 1 at p. 58); Barium (Table 2 at p. 59); Arsenic (Table 3 at p. 60); Cadmium (Table 4 at p. 61); Chromium (Table 5 at p. 62); Lead (Table 6 at p. 63); Zinc (Table 7 at p. 64); Selenium (Table 8 at p. 65); Strontium (Table 9 at p. 66); and TPH-D and TPH-O (Table 10 at p. 67).

[117] *See* n. 114 *supra*. While there are AET values for the metals involved, TPH-D and TPH-O do not have AET values.

[118] The elimination process from further action looks to the greater of: 1) background concentration; or 2) AET value. For example, the barium AET value is less than calculated background concentration, so the barium background concentration is relied on; while the mercury AET value is above the calculated background concentration, so the mercury AET value is relied. An exception is being applied to mercury detected beneath the main dock at Tank Battery A where the panel has decided to rely on the more stringent background concentration because of evidence directly linking that mercury to spillage from a mercury manometer. There was no such direct evidence linking mercury detected at other locations to mercury spillage or other cause.

[119] Areas where sediment is to be excavated include Tank Battery B, SED 15 area, where oil sheening is occurring, discussed in this Plan, Section IV (A)(1), and Tank Battery A, mercury manometer spill area, discussed next in this section.

[120] *See* Figures 1-4 at pp. 72-75.

detailing how it intends to address the barium results in sediment at the location exceeding barium background criteria.[121]

Canal sediment where mercury results are reported to be above the background concentration at Tank Battery A, which evidence has indicated was caused by a spill from a mercury manometer used in gas metering operations (gauging station),[122] should be excavated to the extent that confirmatory samples collected from surrounding (unexcavated) canal sediment meets mercury background sediment concentrations and/or the mercury AET. Confirmatory sediment samples should be collected in a manner, and analyzed with a technique acceptable to LDNR. The excavated sediment should be transported off-site for proper disposal.

For canal sediment at sample locations SS8, SS19, Sed5, Sed6, Sed15, Sed16, Sed28, HG-MPA-01, HG-MPA-02, HG-MPA-06, and HG-MPA-07,[123] where mercury was reported to be above the background concentration and above the mercury AET, UNOCAL should resample the locations in a manner, and with a technique, acceptable to LDNR, and analyze the samples for mercury to confirm or verify whether or not mercury is present at a concentration exceeding the background concentration and the AET value. UNOCAL should report sample results, findings, and any proposed further evaluation and/or remediation plans to address sample locations exceeding the AET value to LDNR for consideration.

For each canal sediment sample location outside of an area to be excavated where TPH-D and/or TPH-O are reported to be above the respective background concentration, or where a

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[121] Background concentration is being used as criteria since it is greater than AET value. *See* n. 118 *supra.*

[122] *See* Figure 3 at p. 74.

[123] *See* Figures 2-4 at pp. 73-75.

sample location includes a sample result for any hydrocarbon fraction reported above the method detection limit (SS1, SS3, SS8, SS-19, SED9, SED31,SS10, SED11, SED16, SS-25, SED5, SS2, SED8, SS7, B5, SED20, SED10, SED8, SS-20, SED7, SED27, SED12, SS12, SS11, TBB-2D, SED17, SED11, SED6, B4, SED18, TBB-2M, SED25, SED31, TBB-1D, SED19, SED30, SS-26, SED30, SED28, SS16, and Sed-BK-06), UNOCAL should submit a work plan for further evaluation and/or remediation to LDNR for consideration.[124]

For canal sediment at SED BK 07 where TPH-D and TPH-O (SED BK 07 COCs) were reported to be above the background concentration (mercury is below the AET, so it is not considered further as a COC at this location),[125] UNOCAL should resample the location in a manner, and with a technique, acceptable to LDNR and analyze the sample for SED BK 07 COCs to confirm or verify whether or not SED BK 07 COCs are present at concentrations exceeding background concentrations. UNOCAL should report sample results, findings and any proposed further evaluation and/or remediation plans to LDNR for consideration.

UNOCAL should create Figures which depict canal sediment locations where additional evaluation and/or remediation is necessary in accordance with the above procedures. In connection with work plans being submitted by UNOCAL for all of the above, UNOCAL should create/furnish an AOI Figure(s) for the sediment areas to be resampled, delineated, and/or remediated.

UNOCAL should compare all mineral soil sample location analytical results to applicable RECAP MO-1 $Soil_{ni}$ standards and submit its findings to LDNR for No Further

[124] *See* Figures 5-8 at pp. 76-79.

[125] *See* Figure 7 at p. 78.

Interest (NFI) determination consideration. For locations where sample results exceed one or more MO-1 standard(s), UNOCAL should submit a work plan for further evaluation, delineation, and/or remediation. UNOCAL should create/furnish an AOI Figure(s) for the soil areas to be evaluated, delineated, and/or remediated.

Further delineation may be necessary to fully characterize canal sediment and/or mineral soil conditions to establish Areas of Investigation acceptable to LDNR. For areas not requiring excavation, UNOCAL should submit a revised ERA addressing all of the above sample locations for all COCs in accordance with RECAP Section 7.0.

B. **Most Feasible Plan as to Groundwater**

The evidence established that the peat zone groundwater zone (a GW3) and the shallow groundwater zone, the CHCTS (a GW2), have elevated COCs (notably barium, benzene, and/or radium, depending on the zone, and/or depth within zone), and have elevated chloride levels (which for purposes of the Plan is considered a COC). The Plan for these groundwater zones set forth in subsections 2-5 below is an evaluation plan because the data as to the COCs discussed below is considered incomplete. In some cases, resampling is being required for confirmation of the existence of the COCs. This evaluation Plan is also requiring complete delineation and characterization the COCs. The evaluation Plan for the GW2 is covered at three different depths moving down to the base of the GW2 aquifer.

It is unclear that produced water, and an increased chloride level caused by that produced water, has rendered the aquifer and VPSB property unusable for the intended purposes and/or use. The parties have not established the background chlorides level satisfactorily, and have not fully delineated the chlorides level vertically and horizontally in the aquifer, to allow an

informed evaluation on what effect, if any, chlorides from produced water have had on intended use. That is why the Plan, as discussed in subsection 6 below, is requiring background concentrations be developed pursuant to RECAP, Appendix D, and groundwater chlorides and TDS be evaluated and delineated further.[126]

1. **Groundwater North of Schooner Bayou**

There is evidence of elevated chlorides north of Schooner Bayou Canal in the 40-50 foot zone of the CHCTS. That evidence is from samples taken at two water wells on the Section 16 property at issue in this case—the Crouch and Purvis Hebert water wells, and brief testimony from Mr. Miller. Mr. Miller suggested an offsite former scrubber facility owned by UNOCAL was a potential source.[127] He testified that he is in the "very early phases of assessment on that property." The alleged source is on a different property than the Section 16 property at issue in this proceeding, and it is unclear that the Act 312 referral by Judge Winsberg intended to include this scrubber facility issue. LDNR has decided not to address this as part of this Plan. LDNR

[126] LDNR is assuming for purposes of this evaluation plan that produced water which entered the aquifer was/is "contamination".

[127] Mr. Miller testified that there are elevated chlorides on the property on the north side of Schooner Bayou near the Crouch and Purvis Hebert water wells located on the property. He interpreted a 1968 aerial photograph as suggesting salt scarring from a pit just on or near Schooner Bayou just to the east of VPSB's Section 16 property. But, he testified "We just are...in very early phases of assessment on that property", so "quite honestly I think it's too early to tell" if the soil data and groundwater data at the Crouch well and Purvis Hebert well is coming from a shore scrubber to the east of the property. Miller testimony, Tr., Vol. 5, 3/8/16, pp. 1477-90. He testified that the chlorides in those wells were screened at 33-60'. *Id.*, p. 1477. The reported chloride results for the Crouch water well (abandoned) in parts per million (ppm) at an estimated 34 foot level were 1570 ppm (MPA) and 1630 ppm (ICON) and for the Purvis Hebert water well at an estimated 41 foot level were 851 ppm (MPA) and 824 ppm (ICON). *See* UNOCAL Plan, Table 6, "Groundwater Analytical Data-All Zones", bates no. U_LDNR 00001-00177 (40-50' Zone); and Plaintiff's Plan, Table 4-3, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-002.0170.

will, however, investigate this with a different procedure.[128] That procedure is being provided by LDNR separately, but contemporaneously, with this Plan.

2. **Peat Zone (South of Schooner Bayou)**

For the peat zone groundwater, plaintiff says that "constituents of concern considering the Peat Zone to be classified a $GW3_{ndw}$ include chlorides and Radium 226-228."[129] Chlorides and TDS are at elevated levels in the peat zone water/porewater. The highest chloride levels are 14,400 mg/l near Tank Battery A (AB5), and 16,600 mg/l chlorides near Tank Battery B (WL-6).[130] These can be seen on UNOCAL Plan Figure 47 (and Supplement Figure 14)[131] and Plaintiff Figure 4-18.[132] Plaintiff's figure depicts chloride plumes above 1000 mg/l and above 10,000 mg/l, with the highest level at WL-6, the area of the former pit being closed as part of this Plan.[133] The highest chlorides are in spots caused by produced water from former pits and historical SWD breaches.[134] Radium in the peat zone is shown in Plaintiff's Table 4-2 and depicted in UNOCAL's Figure 49 and Supplement Figure 16, with levels of radium in excess of

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[128] *See* reasons set forth in "Post-Hearing Ruling as to Jurisdiction," n. 1, *supra*, at p. 13 of Ruling.

[129] *See* Plaintiff's Plan, Section 4.2.1, "Groundwater Contamination in the Peat Zone", bates no. P-DNR-002.0050.

[130] *Id.*; and UNOCAL Plan, Section 4.3, "Existing Groundwater Conditions and Quality", bates no. U_LDNR 00001-00027. *See also* Plaintiff's Plan, Table 4-2, Peat Zone Groundwater Data Summary, bates no. P-DNR-002.0169; and UNOCAL Plan, Table 6, "Groundwater Analytical Data-All Zones" (with "Peat Zone" at top), bates no. U-LDNR 00001-00177. *See* Figure 37, "Groundwater Sample Locations", bates no. U_LDNR 00001-00083.

[131] UNOCAL Plan, Figure 47, "Groundwater Chloride Concentrations-Peat Zone", bates no. U_LDNR 00001-00093; and UNOCAL's Supplement to Plan, Figure 14, "Groundwater Chloride Concentrations-Peat Zone", bates no. U_LDNR 00006-00039. *See also* RECAP Report, Figure 5-6, "Peat Zone-Chloride Concentrations", bates no. U_LDNR 00002-02844; and Supplement to RECAP Report, Figure 5-6 SUPPL, "Peat Zone-Chloride Concentrations", bates no. U_LDNR 00007-00054.

[132] Plaintiff's Plan, Figure 4-18, "Groundwater Chlorides in the Peat Zone", bates no. P-DNR-002.0129.

[133] *See* this Plan, Section IV (A)(2) ("Tank Battery B-Triangle Pit Area") *supra*. *See also* UNOCAL Plan, Figure 66, "Proposed Tank Battery B Pit Re-closure Area", bates no. U_LDNR 00001-00112.

[134] *Compare* Figure 4-18 *with* Figures 1-10 and 5-1, referred to in n. 78 *supra*.

the EPA standard of 5 picocuries per liter (combined Ra-226 and Ra-228) in roughly the same areas as the highest chloride levels.[135] The combined radium level at WL-6 exceeds 5 pCi/l. MPA's combined radium result is 24.5 pCi/l, and ICON's radium result is 31.5 pCi/l.[136]

Figure 9 to the Plan is an "8-20 Foot Groundwater AOI" at WL-6.[137] The Plan is requiring elevated chlorides, TDS, and radium, be evaluated here. UNOCAL should submit a work plan to address the evaluation to be conducted. As indicated in subsection 6 below, the Plan is requiring that site specific background concentrations for chlorides and TDS be developed. The Plan is also requiring semiannual monitoring for the COCs at WL-6 for two years after pit closure to determine if COC concentrations reduce as a result of removing contamination from the former pit.[138]

3. **40-50 foot Zone of the CHCTS (GW2)**

Elevated barium in excess of the RECAP MO-1 standard of 2 milligrams per liter (2 ppm), and elevated benzene in excess of the RECAP MO-1 standard of 5 micrograms per liter (5 ppb or

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[135] The EPA standard for combined Radium 226/228 is 5 picocuries per liter ("pCi/l"). For radium in peat zone, *see* Plaintiff's Plan, Table 4-2, "Peat Zone Groundwater Data Summary", bates no. P-DNR-002.0169 (results for combined Ra 226/228 in data col. 31). *See also* UNOCAL Plan, Figure 49, "Groundwater Radium Concentrations-Peat Zone", bates no. U_LDNR 00001-00095; and UNOCAL's Supplement to Plan, Figure 16, "Groundwater Radium-226/228 Concentrations-Peat Zone", bates no. U_LDNR 00006-00041. UNOCAL radiation expert, Dr. John R. Frazier, who did not testify, but has a report which is part of the UNOCAL Plan, states that groundwater samples with more than 2-3 grams of Louisiana soil are expected to have greater than 5 pCi/l of naturally occurring Ra-226 and Ra-228 without necessarily being related to the presence of oilfield NORM. *See* UNOCAL Plan, Report of John R. Frazier, bates no. U_LDNR 00001-5132, at p. 5138.

[136] *See* Plaintiff's Plan, Table 4-2, "Peat Zone Groundwater Data Summary", bates no. P-DNR-002.0169 (WL-6, screened interval—8.5-13.5', date 1/7/15, combined radium 226/228 of 31.50 pCi/l (ICON result only)). *See also* UNOCAL's Supplement to Plan, Figure 16, "Groundwater Radium-226/228 Concentrations-Peat Zone", bates no. U_LDNR 00006-00041 (24.5 pCi/l (MPA result) and 31.5 (ICON result) for combined radium 226/228).

[137] After the hearing, the panel requested shape files for groundwater locations in UNOCAL's Figure 9 to help analyze potential AOIs based on the data. The parties agreed upon, and furnished the shape files to the panel on 4/5/16. *See* UNOCAL's Supplement to Plan, Figure 9, "Groundwater Sampling Locations", bates no. U_LDNR 00006-00034. *See* the Plan's Figure 9, at p. 80.

[138] *See* n. 93 to n. 98 *supra*, and accompanying text.

0.005 ppm), were detected in the GW2 at MW-1 southeast of Tank Battery A in a sample taken in March 2010.[139] These COCs were later detected in 2010 in lesser amounts but still in excess of the standard for benzene at two other sample locations (one of those is also in excess of the standard for barium) in the GW2 just south/southeast of Tank Battery A area—SB-1 and HP-MPA-09-T. All three sample locations have elevated chlorides in relation to other nearby sample locations.[140]

Figure 10 attached to the Plan[141] depicts an AOI-1S (in orange) to the southeast of Tank Battery A. The Plan is requiring that the area in AOI-1S, which includes sample locations MW-1, SB-1, and HP-MPA-09-T, be further investigated as to three COCs—barium, benzene, and chlorides.[142] HP-MPA-09-T marginally exceeds the MO-1 standard for a GW2 for benzene; and

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[139] The ICON sample result at MW1 for barium on 3/5/10 was 15.4 ppm; and the MPA sample result was 13.7 ppm). The ICON sample result at MW1 for benzene on 3/5/10 was 0.030/0.029 ppm (30/29 ppb), and the MPA sample result for benzene was 0.028 ppm (28 ppb). *See* Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012.

[140] *See* Plaintiff's Table 4-3 referred to immediately above in n. 139 *supra*, for chlorides in mg/l at these locations: (1) MPA-09T—2,200 (ICON) and 2,350 (MPA); (2) MW-1—9,580 (ICON) and 9,150 (MPA); and SB1—5,470 (ICON) and 4,160 (MPA).

[141] *See* Figure 10 to the Plan, at p. 81.

[142] UNOCAL has identified this AOI in its figures. *See* UNOCAL's Supplement to Plan, Figure 21, "RECAP GW2 40 to 60 foot Zone", bates no. U_LDNR 00006-00046: AOI including HP-MPA-09-T (COCs-benzene and chlorides), MW-1 (COCs-barium, benzene, and chlorides), and SB-1 (COCs-barium, benzene, and chlorides). *See also* Supplement to RECAP Report, Figure 5-15 SUPPL, "Preliminary AOIs for 40 to 60 Foot Zone, Ground Water-Screening Level", bates no. U_LDNR 00007-00064: same AOI, same three sample locations, same COCS; but also including strontium as a COC at all three sample locations. Plaintiff has essentially identified this same AOI in two of its figures, with its barium plume drawn slightly larger. *See* Plaintiff's Plan, Figure 4-25, "Groundwater Barium in the Chicot Shallow Sand Unit at 33 to 60 Feet BLS", bates no. P-DNR-002.0136 (barium plumes in yellow (above 10 mg/l) and blue (above 2 mg/l), centered around MW-1); and Figure 4-28, "Groundwater Benzene in the Chicot Shallow Sand Unit at 33 to 60 Feet BLS", bates no. P-DNR-002.0139 and Plaintiff's Supplement to Plan, Figure 9, "Groundwater Benzene in the Chicot Shallow Sand Unit at 33 to 60 Feet BLS", bates no. P-DNR-003.022 (benzene plume in red (above 5 ppb) centered around MW-1, but including the MPA-09-T and SB-1 locations).

MW-1 and SB-1 both exceed the MO-1 standard for a GW2 for benzene and barium.[143] The delineation between MW-1 and HP-MPA-09-T is not complete, and the Plan is requiring these wells be resampled to verify the presence of COCs. If resampling shows these wells are contaminated, then the Plan is requiring a minimum of four wells be placed to delineate this area, with one well to the S-SE of MW-1, one to the north, and wells to the west and south of HP-MPA-09-T. Further wells may be necessary to complete the delineation.

Sample location HP-MPA-08-T sits on the eastern edge of the VPSB property. One of the splits of the 10/1/10 sample marginally exceeded the barium standard, and the sample also has elevated chlorides.[144] The Plan is requiring further investigation of these COCs in this area. The source of contamination may be offsite, but a single sample is not sufficient to make that determination. This Plan requires further delineation necessary to establish source of the contamination.

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[143] As noted in the text, RECAP Table 3, "Management Option 1, 2 and 3-Standards for Groundwater", MO-1 standard for GW2 (and GW1) for barium is 2 mg/l (2 ppm); and for benzene is 0.005 mg/l (5 ppb). The results for these COCs reported in Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012, are:

(1) Boring ID—MPA-09T, Screened Interval—42-45' (ft bgs), date 10/1/10 (barium, 0.66 (ICON) and 1.59 (MPA); and **benzene, 0.0051** (ICON) and **0.00508** (MPA));

(2) Boring ID—MW-1, Screened Interval—44-54' (ft bgs), date 3/5/10 (**barium, 15.4** (ICON) and **13.7** (MPA); and **benzene, 0.30** (ICON) and **0.28** (MPA));

(3) Boring ID—SB1, Screened Interval—44-54' (ft bgs), date 5/7/10 (**barium, 4.81** (ICON) and **5.82** (MPA); and **benzene, 0.016** (ICON) and **0.017** (MPA).

See also UNOCAL Plan, Table 6, "Groundwater Analytical Data-All Zones", bates no. U-LDNR 00001-00174 (barium results varies from Plaintiff's Table 4-3) and 00177 (benzene results essentially the same as in Plaintiff's Table 4-3).

[144] *Id.* Barium results in Plaintiff's Table 4-3 for location MPA-08T on 10/1/10 are 1.40 (ICON) and **2.04** (MPA), and chloride results are 1,500 (ICON) and 1,520 (MPA). This location is depicted as a separate AOI in UNOCAL's Supplement to Plan, Figure 21, and Supplement to RECAP Report, Figure 5-15 SUPPL, both referred to in n. 142 *supra*. Plaintiff shows this location at the outer edge of his "above 2 mg/l plume" for barium in Plaintiff Figure 4-25, and shows "nd" for benzene at this location in Plaintiff's Figure 4-28.

Elevated barium and elevated benzene in excess of the RECAP MO-1 standards were detected in the GW2 near former Tank Battery B in a sample, TBB-1S, taken by ICON in December 2015.[145] The benzene result of 7 ppb was only very marginally over the 5 ppb standard. Elevated chlorides were also present.[146] Figure 10 also includes an AOI-2S (in red) around sample location TBB-1S. The Plan is requiring resampling and further delineation to verify that contamination did not occur during well installation.[147] If the COCs are still present after the resampling event, then the Plan is requiring wells to be installed in a triangular pattern (minimum of three) for delineation of the COCs. Further wells may be deemed necessary to complete delineation.

UNOCAL should submit a work plan to address the resampling, evaluation, and delineation activities to be conducted in this groundwater zone.

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[145] For results at TBB-1S, *see* Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012: Boring ID—TBB-1S, Screened Interval—33-43' (ft bgs), date 12/17/15 (**barium, 13.5** (ICON) and NS (MPA); and **benzene, 0.007** (ICON) and NS (MPA)). *See also* UNOCAL's Supplement to Plan, Figure 21, and Supplement to RECAP Report, Figure 5-15 SUPPL, both referred to in n. 142 *supra*, which reflect that MPA (UNOCAL) results at TBB-1S for barium and benzene are elevated and essentially the same as the ICON results. Plaintiff again has essentially identified this same AOI in two figures, with its barium plume drawn slightly larger. *See* Plaintiff Figure 4-25 (barium plumes in yellow (above 10 mg/l) and blue (above 2 mg/l), centered around TBB-1S; and Figure 4-28 (benzene plume in red (above 5 ppb) centered around TBB-1S).

[146] *See* Plaintiff's Table 4-3 Rev 15 Feb 2016, referred to above in n. 143 *supra*, for chlorides in mg/l at TBB-1S—13,400 (ICON). *See also* UNOCAL's Supplement to Plan, Figure 21, and Supplement to RECAP Report, Figure 5-15 SUPPL, both referred to in n. 142 *supra*, which reflect that MPA (UNOCAL) results at TBB-1S for chlorides as 16,900 and 15,200, both somewhat higher than the ICON results.

[147] There was some testimony at the hearing about whether a false positive reading for benzene occurred in the TBB-1S sample. Mr. Angle initially testified that he felt that there may have been carryover of contamination from another well during the ICON installation of the TBB-1 well. But, when questioned about this on cross examination, he had no conclusive evidence to support this. In any event, he testified that the TBB-1S benzene result of 7 ppb is marginally above the standard, and needs to be confirmed. *See* Angle testimony, Tr., Vol. 2, 3/3/16, pp. 545-47, 558, 581.

4. **70-100 foot Zone of the CHCTS (GW2)**

Plaintiff (ICON) detected elevated TPH-D on 12/15/15 in the 66-76 foot interval in sample TBB-3D near Tank Battery B.[148] This result was called into question by Mr. Angle when he testified to his belief that the ICON sample had been contaminated with creosote. He produced a chemical analysis during rebuttal testimony to support his belief.[149]

Figure 11 attached to the Plan[150] depicts an AOI-1M (in red) around sample location TBB-3D. The Plan is requiring that the area in AOI-1M be resampled to verify that the results obtained reflect actual conditions in the groundwater. Purging should be sufficient to ensure that PAHs and hydrocarbons that were potentially introduced during the installation process are removed. The Plan is requiring that this area be analyzed for the full RECAP Table D-1 for crude oil, and any other COCs that exceeded GW-2 MO-1 standards. If COCs are still present, the Plan is requiring that this area be delineated through further sampling to the north, south, and southwest. Further wells may be deemed necessary to complete delineation.

UNOCAL should submit a work plan to address the resampling, evaluation, and delineation activities to be conducted in this groundwater zone.

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[148] The RECAP Table 3, MO-1 standard for GW2 (and GW1) for TPH-D is 0.34 mg/l (0.34 ppm) *See* Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012: Boring ID—TBB-3D, Screened Interval—66-76' (ft bgs), date 12/15/15 (**TPH-D, 2.28** (ICON).

[149] Mr. Angle testified that he felt creosote-containing material ended up in the drilling mud, and had been entrained by ICON when drilling at this location. He testified that in his opinion the sample results for TBB-3D were affected by ICON drilling through creosote piling at this location. During his rebuttal testimony he testified using a chemical finger print analysis, which was received by him after the hearing started, and which was produced during his rebuttal testimony, and which confirmed his opinion. *See* Angle testimony, Tr., Vol. 2, 3/3/16, pp. 548-49, 589; and Angle rebuttal testimony, Tr., Vol. 7, 3/10/16, pp. 1954-55, 1964-66.

[150] *See* Figure 11 to the Plan, at p. 82.

5. **250-300 foot Zone of the CHCTS (GW2)**

Elevated benzene was detected on 2/3/16 at BC-2 near the base of the shallow groundwater zone significantly in excess of the RECAP groundwater screening standard of 5 ppb or 0.005 ppm.[151]

Elevated aromatics greater than C_8-C_{10} were also detected at BC-2 in excess of the RECAP groundwater screening standard of 0.15 ppm.[152]

Figure 12 attached to the Plan[153] depicts an AOI-1D (in red) around BC-2. The Plan is requiring that the elevated benzene and aromatics at this location be verified. If verified, then the Plan is requiring further delineation. The Plan accepts the UNOCAL Plan proposed placement of

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[151] *See* Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012: Boring ID—BC-2, Screened Interval—289.5-309.5' (ft bgs), date 2/3/16 **benzene, 0.136** (ICON) and **0.2** (MPA). *See also* Plaintiff's Supplement to Plan, discussion as to BC-2 in ICON's supplemental report, bates no. P-DNR-003.002; and Figure 8, "Groundwater Benzene on the East-West Cross Section Diagram", bates no. P-DNR-003.021. ICON installed the BC-2 monitoring well in early 2016 in the vicinity of Tank Battery A near VPSB SWD #16A (sn40010) where, according to ICON's supplemental report, documentation has indicated the SWD was leaking through a hole in the surface casing in October 1980 and was channeling outside of the conductor casing into the adjacent canal. *See* Plaintiff's Supplement to Plan, bates no. P-DNR-003.002; and Plaintiff's Supplement to Plan, Figure 9, ""Groundwater Benzene in the Chicot Shallow Sand Aquifer Unit at 33 to 60 Feet BLS", bates no. P-DNR-003.022 (reflecting the 136 ppm at BC-2, with information box showing proximity of SWD#16A breach in 1980). *See* UNOCAL's Supplement to Plan, Table 2, "Groundwater Analytical Data-Supplemental ICON Wells (Nov. 2015-Feb. 2016)", bates no. U_LDNR 00006-00069: Boring ID—BC-2, Screened Interval—279-299', date 2/3/16, **benzene, 0.2 mg/l**. *Id.,* Section 4.2, "Updated Groundwater Summary, Summary of Findings, 250 to 300 Foot Sand Zone", bates no. U_LDNR 00006-00017; and Figure 29, "Groundwater Barium, Benzene, and TPH Concentrations-250 to 300 Foot Zone", bates no. U_LDNR 00006-00054 (benzene at BC-2 reflected as 0.2 mg/l). *See also* Supplement to RECAP Report, Figure 5-17 SUPPL, "Greater than 250 Foot Zone-Benzene Concentrations", bates no. U_LDNR 00007-00066 (benzene at BC-2 reflected as 0.2 mg/l; screening standard 0.005 mg/l).

[152] *See* Section 4.2, "Updated Groundwater Summary, Summary of Findings, 250 to 300 Foot Sand Zone", bates no. U_LDNR 00006-00017; and Figure 29, "Groundwater Barium, Benzene, and TPH Concentrations-250 to 300 Foot Zone", bates no. U_LDNR 00006-00054 ((TPH-Aromatic Greater than C_8-C_{10} at BC-2 reflected as 0.405 mg/l). Supplement to RECAP Report, Figure 5-18 SUPPL, "Greater than 250 Foot Zone-Aromatics Greater than C_8-C_{10} Concentrations", bates no. U_LDNR 00007-00067 (**aromatics** at BC-2 reflected as **0.405 mg/l**; screening standard 0.15 mg/l)). *See also* Plaintiff's Supplement to Plan, Table 4-3 Rev 15 Feb 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary", bates no. P-DNR-003.012: Boring ID—BC-2, Screened Interval—289.5-309.5' (ft bgs), date 2/3/16, (does not report hydrocarbon fractions, but does report elevated TPD-G above 0.34 mg/l, **0.503** (ICON).

[153] *See* Figure 12 to the Plan, at p. 83.

wells for delineation purposes.[154] But, further wells may be necessary to complete delineation. When benzene (and other COCs) at BC-2 have been adequately characterized and delineated, to the extent the source(s) can be determined,[155] UNOCAL must provide a plan to remediate the benzene (and other COCs) to the applicable RECAP standards,[156] or demonstrate to LDNR's satisfaction that the COCs do not pose a risk in accordance with the appropriate RECAP procedure.

Figure 12 also includes AOI-2D (in orange) around BC-2 and BC-4. UNOCAL's Supplemental Wells Groundwater Table 2 indicates the GW_{ss} screening standard for iron is 0.3 mg/l. BC-2 and BC-4 both have iron results above 0.3 mg/l, and they are also elevated in relation to nearby wells.[157] The Plan is requiring that elevated iron in these wells be verified and delineated. Figure 4 also includes AOI-3D (in yellow) around BC-2, BC-3, and BC-4. There is elevated barium in excess of the RECAP MO-1 standard in all three wells; elevated strontium in

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[154] *See* UNOCAL Plan, Figure 67, "Proposed Groundwater Monitoring Locations", bates no. U_LDNR 00001-00113; UNOCAL's Supplement to Plan, Section 4.2, "Updated Groundwater Summary, Summary of Findings, 250 to 300 Foot Sand Zone", bates nos. U_LDNR 00006-00017-00021; and Figure 8, "Supplemental Groundwater Sampling Locations (12/2015-02/2016)", bates no. U_LDNR 00006-00032. *See also* Angle testimony, Tr., Vol. 2, 3/3/16, p. 571 and 576.

[155] Mr. Miller suggested during the hearing that historical breaches of SWDs may represent potential source of fluids migrating from beneath this zone. *See* his excerpted testimony in n. 9 and n. 24 *supra*. Plaintiff's Supplement to Plan, Figure 8, "Groundwater Benzene on the East-West Cross Section Diagram", bates no. P-DNR-003.021, shows SWD #16 essentially right at the BC-2 well location. Figure 8 shows that no benzene was detected at MC-2 (screening interval 148-168') directly above BC-2 (screening interval 289.5-309.5') which suggests the distinct possibility that the benzene at BC-2 is coming from below not from above. (Chlorides and TDS are also significantly elevated at BC-2—18,800 ppm and 28,600 ppm respectively, and are an order of magnitude higher than at MC-2—1,290 ppm and 2,360 ppm, which may suggest the possibility of a leaking SWD.). The SWD(s) should be investigated as a possible source of the benzene.

[156] Depending on confirmation sampling and/or further delineation, remediation could include a pump and disposal system to address/remove benzene, such as the one proposed by UNOCAL. *See* n. 52 and n. 53 *supra*.

[157] *See* UNOCAL's Supplement to Plan, Table 2, "Groundwater Analytical Data-Supplemental ICON Wells (Nov. 2015-Feb. 2016)", bates no. U_LDNR 00006-00068: Boring ID—BC-2, Screened Interval—279-299', date 2/3/16, **iron, 13.5 mg/l**; and Boring ID—BC-4, Screened Interval—269.5-289.5', date 2/4/16, **iron, 8.71 mg/l**.

two wells, based on a US EPA lifetime health advisory level of 4 mg/l referred to by ICON, although there is no MO-1 standard for strontium; and elevated combined radium 226/228 in excess of the EPA standard in all three wells. The Plan is requiring the elevated barium, strontium and radium in these wells be verified and delineated.[158]

UNOCAL should submit a work plan to address the resampling/verification and delineation activities to be conducted in this groundwater zone.

6. **Site Groundwater-Chlorides**

The information as to background levels of chlorides/TDS in the groundwater zones is inconclusive. The Plan is requiring a site specific background for chlorides/TDS concentrations and full delineation of the chlorides/TDS in the groundwater zones be developed and approved in

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[158] MO-1 standard for barium is 2 mg/l (2 ppm); no MO-1 standard for strontium, but plaintiff, in its Table 4-3, uses US EPA lifetime health advisory level of 4 mg/l (Table 4-3 Rev 15 Feb 2016, bates no. P-DNR-003.012); and EPA standard for total radium 226/228 is 5 pCi/l:

See UNOCAL results reported at UNOCAL's Supplement to Plan, Table 2, "Groundwater Analytical Data-Supplemental ICON Wells (Nov. 2015-Feb. 2016)", bates no. U_LDNR 00006-00068 and 00069:

Boring ID—BC-2, Screened Interval—279-299', date 2/3/16, **barium, 21.0 mg/l**, strontium 31.3 mg/l, and total radium (NS);

Boring ID—BC-3, Screened Interval—279-299', date 2/9/16, **barium, 3.32 mg/l**, strontium 3.6 mg/l, and total radium (NS); and

Boring ID—BC-4, Screened Interval—269.5-289.5', date 2/4/16, **barium**, **4.71 mg/l**, strontium 4.59 mg/l, and total radium (NS).

See also UNOCAL's Supplement to Plan, Figure 29, "Groundwater Barium, Benzene, and TPH Concentrations-250 to 300 Foot Zone", bates no. U_LDNR 00006-00054 (**barium**: at BC-2, **22.5/21.0 mg/l** (Diss); at BC-3, **3.53/3.32 mg/l** (Diss); and at BC-4, **4.97/4.71** mg/l (Diss). Because radium results were not available at start of the hearing, they are not reported in UNOCAL's tables or Figures.

See also results reported at Plaintiff's Table 4-3 Rev 22 Mar 2016, "Chicot Aquifer Shallow Sand (CHCTS) Groundwater Data Summary" (NO BATES NUMBER, AS REV 22 MARCH 2016 TABLE WAS SUPPLIED AFTER HEARING TO INCLUDE TOTAL RADIUM RESULTS:

Boring ID—BC-2, Screened Interval—289.5-309.5', date 2/3/16: **barium, 20.8 mg/l** (ICON) and **22.5 mg/l** (MPA); strontium 27.7 mg/l (ICON) and 29.6 (MPA); and total radium, **77.8 pCi/l** (ICON) and NR (MPA);

Boring ID—BC-3, Screened Interval—287-307', date 2/9/16: **barium, 3.3 mg/l** (ICON) and **3.53 mg/l** (MPA); strontium, 3.49 mg/l (ICON) and 4.61 mg/l (MPA); and total radium, **6.4 pCi/l** (ICON) and NR (MPA); and

Boring ID—BC-4, Screened Interval—280-300', date 2/4/16: **barium, 4.47 mg/l** (ICON) and **4.97 mg/l** (MPA); strontium, 4.03 mg/l (ICON) and 4.07 mg/l (ICON); and total radium, **10.8 pCi/l** (ICON) and NR (MPA).

accordance with RECAP, Appendix D,[159] and is also requiring semiannual monitoring and assessment of the chlorides/TDS levels for a minimum of two years after the excavations being required by the Plan. Whether a pump and treat plan is warranted and feasible can be re-evaluated once the monitoring and assessment phase is concluded and data evaluated.

7. **Site Groundwater-Radium**

LDEQ regulates radium in environmental media. Any Radium 226/228 groundwater analytical sample results with exceedances above applicable LDEQ-radium standards/criteria are to be forwarded to LDEQ by UNOCAL as a requirement of this Plan. UNOCAL should meet with the appropriate LDEQ staff for guidance in addressing any groundwater issues remaining as to radium, strontium and/or any related constituents (and should also meet with LDEQ staff as to NORM issues, if any, remaining). If additional work activity to meet radium-related regulatory requirements is required by LDEQ, then as part of this Plan, work plans submitted and approved by LDEQ, and LDEQ's determination that the conditions at the VPSB property meet applicable radium standards/criteria and regulations, are to be provided to LDNR.

C. Cost Estimate to Implement Most Feasible Plan

The cost estimate to implement the Plan as presently known is $1,411,190 (rounded). This includes: 1) UNOCAL's estimate to close Tank Battery B, South Pit, which LDNR accepts;[160] 2) UNOCAL's estimate for groundwater monitoring wells, which LDNR accepts;[161]

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[159] *See* RECAP Appendix D, "Guidelines for Assessing Non-Traditional Parameters", p. D-NTP-1. (Chlorides are considered a non-traditional parameter, and a LDEQ-approved background concentration in accordance with RECAP Section 2.13 may be used as SS or RS for evaluation of chlorides in the groundwater zones.).

[160] Estimate is $619,000. *See* n. 31 *supra*, referring to UNOCAL Plan, Table 7, bates no. U_LDNR 00001-00179.

[161] Estimate is $300,000. *See* n. 50 *supra*, and accompanying text.

3) estimate for SED 15 area remediation (Table 11)[162]; 3) estimate for sampling and excavation/disposal of mercury at Tank Battery A (Table 12)[163]; 4) estimate for resampling costs (Table 13)[164]; and 4) estimate for groundwater costs (Table 14).[165] This estimate does not include additional well installations that may be necessary pursuant to this Plan; any additional evaluation costs that may be necessary from additional sampling and/or further delineation required by this Plan (beyond what is specifically covered in cost tables above); and/or any remediation costs that may be necessary based on results of sampling and/or further delineation. Additional costs will depend on what sampling and/or delineation reveals.

V. CONCLUSION

In consideration of, and based on, all the evidence, the LDNR Most Feasible Plan, supported by written reasons incorporated herein, after consultation with the Louisiana Department of Environmental Quality, is the most reasonable plan which addresses the admitted environmental damage to soil, in conformity with the Louisiana Constitution, Article IX, Section 1 to protect the environment, public health, safety and welfare, and is in compliance with the specific relevant and applicable standards and regulations as mandated by La. R.S. 30:29.

Richard P. Ieyoub, Sr.
Commissioner of Conservation
Louisiana Department of Natural Resources,
Office of Conservation
July 7, 2016

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[162] Estimate is $171,436.00. *See* Table 11, "SED 15 Area Remediation Cost", at p. 68.

[163] Estimate is $114,367.50. *See* Table 12, "Sample/Excavate/Disposal Cost Mercury Tank Battery A", at p. 69.

[164] Estimate is $14,940.00. *See* Table 13, "Resampling Costs", at p. 70.

[165] Estimate is $206,386.00. *See* Table 14, "Groundwater Costs", at p. 71.

EXHIBIT 1—PANELISTS AND THEIR BACKGROUNDS

The three panelists who served for the public hearing in the captioned case held on March 2-4 and 7-10, 2016 were:

1. **Mr. Gary W. Snellgrove**. Mr. Snellgrove has a Bachelor of general studies from LSU in 1988, and an M.S. in environmental science from McNeese State University in 1993. His training at McNeese concentrated in environmental technology, environmental remediation, and environmental cleanups, and included courses in solid waste, hazardous waste, and groundwater issues. After working in the petrochemical industry in environmental matters for the next five years, including as a project manager for the Citgo Refinery in industrial hygiene and filtration services, he joined LDNR in 1998. He started as an environmental impact manager working with the injection and mining division in the E & P waste management program. In 2007, he became the Environmental Division Director at LDNR with responsibility for the legacy site remediation program and groundwater resources management. He is currently in that position today. He previously served on the LDNR panels for Public Hearings held pursuant to Act 312 in the Tensas Poppadoc (2009), Savoie (2012), Avahoula Resources (2013), Agri-South, LLC (2013), and Moore v. Denbury Onshore (2015) cases.

2. **Mr. Stephen Pennington**. Mr. Pennington has a B.S. in renewable natural resources from Texas A&M University in 1981. He worked in a variety of jobs that required technical training, including lab technician at Dow Chemical, quality assurance in the analytical chemistry lab at Ciba-Geigy, wetland delineations and endangered species surveys at HNTB Corporation, paralegal work on environmental cases for the Kean Miller law firm, naturalist interpretative work for the Office of State Parks, and then, in 1999, he joined LDNR as a coastal resource scientist in the Coastal Management Group. In 2007, he transferred to LDNR's Office of Conservation to join the legacy group. In 2010/2011, his title became environmental impact manager, and he was involved with above ground issues, mainly soils and vegetation, but his duties also included looking at groundwater data to compare it to screening standards under RECAP. He reported directly to Mr. Gary Snellgrove. He is currently in that position today and continues to report directly to Mr. Snellgrove. He previously served on the LDNR panels for Public Hearings held pursuant to Act 312 in the Tensas Poppadoc (2009), Reese (2012), Savoie (2012), Avahoula Resources (2013), Agri-South, LLC (2013), Moore v. Denbury Onshore (2015), and Sterling Sugars (2015) cases.

3. **Mrs. Jamie C.T. Love**. Mrs. Love has a B.S. in geology from University of Missouri-Kansas City (UMKC) in 2005, and an M.S. in Geosciences from Mississippi State University in 2008. She is a licensed geologist in the State of Louisiana. Her training at UMKC focused in environmental methods, natural hazards and paleo-seismic studies. Her research at Mississippi State concentrated on suspended sediment transport. She worked as a hazardous materials cleanup manager from 2004 to 2006. In 2008 she joined LDEQ as a Geologist focusing on RCRA remediation. While at LDEQ she participated in Hurricane Incident Command and the BP Oil Spill. She joined LDNR in 2015 as a Geologist Supervisor working directly under Gary Snellgrove. She previously served on the LDNR panels for Public Hearings held pursuant to Act 312 in the Moore v. Denbury Onshore (2015) and Sterling Sugars (2015) cases.

EXHIBIT 2—EXPERT WITNESSES WHO TESTIFIED

There were five expert witnesses who testified on behalf of UNOCAL and three expert witnesses who testified on behalf of the Vermilion Parish School Board during the public hearing held in the captioned case on March 2-4 and 7-10, 2016. They were:

Expert witnesses who testified on behalf of UNOCAL:

4. **Dr. John H. Rodgers, Jr**. Dr. Rodgers has a B.S. in Botany from Clemson University in 1972, an M.S. in Botany/Plant Ecology from Clemson in 1974, and a Ph.D. in Botany/Aquatic Ecology from Virginia Polytechnic and State University in 1977. Dr. Rodgers' CV is admitted in evidence as UNOCAL Exhibit U_LDNR 00001-05788 to 05867. It was identified by Dr. Rodgers as UNOCAL Exhibit U_LDNR 00003-00125 to 00209 (which is also admitted in evidence). Hearing Transcript, Vol. 1, 3/2/16, p. 79. Dr. Rodgers directs the Ecotoxicology Program in the Department of Forestry and Natural Resources at Clemson, and is a professor at Clemson of environmental toxicology, ecotoxicology. *Id.*, p. 61. (*See also* CV referenced *supra*). He was tendered and accepted as an expert in the areas of ecotoxicology, wetland sciences, and biogeochemistry. *Id.*, pp. 68, 75-76.

5. **Mr. Michael E. Pisani**. Mr. Pisani has a B.S. in Civil Engineering from Auburn University in 1975, and an M.S. in Environmental Engineering from Georgia Institute of Technology in 1981. He is a Registered Professional Engineer in the States of Louisiana and Texas. Mr. Pisani's CV is admitted in evidence as UNOCAL Exhibit U_LDNR 00001-00191 to 00193. The parties stipulated that he is an expert in the fields of environmental engineering, environmental investigation, remediation, remediation costs, oilfield remediation, and environmental remedial practices. Hearing Transcript, Vol. 1, 3/2/16, p. 294.

6. **Mr. David G. Angle**. Mr. Angle has a B.S. in Geology from the University of Delaware in 1982 and an M.S. in Geology North Carolina State University in 1985. He is a Certified Professional Geologist, a Certified Ground Water Professional, and a Registered Geologist in Louisiana, Mississippi, and Texas. Mr. Angle's CV is admitted in evidence as UNOCAL Exhibit U_LDNR 00001-00187 to 00190. The parties stipulated that he is an expert in the areas of geology, hydrogeology, site assessment, remediation, environmental regulatory standards, and soil and groundwater fate and transport. Hearing Transcript, Vol.2, 3/3/16, pp. 446-47.

7. **Ms. Angela M. Levert**. Ms. Levert has a B.S. in Chemistry from Spring Hill College in 1988 and an M.S. in Environmental Chemistry from the University of North Carolina in 1990. Ms. Levert's CV is admitted in evidence as UNOCAL Exhibit U_00007-00102 to 103. She has been practicing in the area of human health risk assessment for many years. She has worked with the LDEQ RECAP program since it began as a draft in 1996, and estimates that she has prepared over a hundred RECAP plans. Hearing Transcript, Vol. 4, 3/7/16, pp. 867-68. The parties stipulated that she is an expert in the areas of environmental data evaluation, human health risk assessment, and RECAP. *Id.*, p. 867.

8. **Mr. Calvin C. Barnhill**. Mr. Barnhill has worked in the oil and gas industry for 47 years. He has undergraduate and graduate petroleum engineering degrees from LSU. He has taught at LSU's Well Control School, and has also taught at the University of Louisiana at Lafayette and at the University of Texas. He has been a registered professional petroleum engineer in good standing since 1980. He currently is a consulting professional petroleum engineer. Hearing Transcript, Vol. 6, 3/9/16, pp. 1795-96. The parties stipulated to Mr. Barnhill's expertise in the areas of petroleum engineering, oilfield operations, and professional engineering. *Id.*, pp. 1794-95.

Expert witnesses who testified on behalf of Vermilion Parish School Board:

1. **Dr. William J. ("Jim") Rogers**. Dr. Rogers has a B.S. and an M.S. in Biology from West Texas State University (now West Texas A&M) in 1974 and 1976, respectively, and a Ph.D. from Texas A&M University in Wildlife and Fisheries Sciences with a focus on Risk Assessment and Environmental Toxicology in 1999. Hearing Transcript, Vol. 4, 3/7/16, p. 1122. Dr. Rogers' CV is admitted in evidence as P-DNR-303.13 to 303.38. He is currently Regents Professor and the Program Director of the Environmental Science Program at West Texas A&M, and administers the school's environmental toxicology lab. He has been involved in ecotoxicology and environmental risk assessment since inception. Hearing Transcript, Vol. 4, 3/7/16, pp. 1122-23. He was tendered and accepted as an expert in the fields of ecotoxicology and ecological risk assessments. *Id.*, pp. 1129-30.

2. **Mr. Charles R. Norman**. Mr. Norman is a licensed professional engineer in three states. Over a 46 year career, he worked for major oil and gas companies, served as a professor at McNeese State University teaching petroleum, civil and mechanical engineering, and currently is a consulting professional engineer in the field of petroleum engineering.

Hearing Transcript, Vol. 5, 3/8/16, pp. 1402-03. The parties stipulated to Mr. Norman's expertise in the areas of petroleum engineering, operations engineering, and professional engineering. *Id.*, pp. 1398-99.

3. **Mr. Gregory W. Miller**. Mr. Miller has a B.S. in Geology from the University of Southwestern Louisiana in 1982. Mr. Miller's CV is admitted in evidence as P-DNR-002.2713 to 2725. He has worked in oil-field industry related work since the mid-1980s. He is currently the president of and senior geologist/principal hydrogeologist with ICON Environmental Services, Inc. The parties stipulated to Mr. Miller's expertise in the areas of geology, hydrogeology, site assessment and remediation and implementation of regulations. Hearing Transcript, Vol. 5, 3/8/16, p. 1443.

Table 1: Calculated Sediment Background for Mercury[166]

LOCATION	DEPTH	MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	0.104	0.1					
SED-BK-02	0-0.5	0.0952	0.132					
SED-BK-03	0-0.5	0.0799	0.1					
SED-BK-04	0-0.5	0.0962	0.1					
SED-BK-05	0-0.5	0.0769	0.1					
SED-BK-08	0-0.5	0.14	0.1					
SED-BK-09	0-0.5	0.0826	0.1					
SED-BK-10*	0-0.5	0.0398	0.1					
SED-BK-11*	0-0.5	0.0505	--					
				0.024199	0.257579	0.093947	**0.118146**	0.069748

[166] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 2: Calculated Sediment Background for Barium[167]

LOCATION	DEPTH	MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	155	897					
SED-BK-02	0-0.5	288	317					
SED-BK-03	0-0.5	347	319					
SED-BK-04	0-0.5	582	388					
SED-BK-05	0-0.5	388	388					
SED-BK-08		383	313					
SED-BK-09	0-0.5	264	231					
SED-BK-10*	0-0.5	274	205					
SED-BK-11*	0-0.5	319	--					
				168.1487	0.47186	356.3529	**524.5017**	188.2042

[167] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 3: Calculated Sediment Background for Arsenic[168]

		MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	1.04	4.99					
SED-BK-02	0-0.5	4.17	4.26					
SED-BK-03	0-0.5	4.51	2.83					
SED-BK-04	0-0.5	3.87	4.79					
SED-BK-05	0-0.5	2.37	6.32					
SED-BK-08	0-0.5	4.71	5.98					
SED-BK-09	0-0.5	8.47	9.45					
SED-BK-10*	0-0.5	4.86	6.79					
SED-BK-11*	0-0.5	9.95	--					
				2.389343	0.454553	5.256471	**7.645814**	2.867127

[168] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 4: Calculated Sediment Background for Cadmium[169]

		MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	0.631	0.496					
SED-BK-02	0-0.5	0.595	0.495					
SED-BK-03	0-0.5	0.0486	0.5					
SED-BK-04	0-0.5	0.0989	0.497					
SED-BK-05	0-0.5	0.615	0.499					
SED-BK-08	0-0.5	0.826	0.498					
SED-BK-09	0-0.5	0.826	0.497					
SED-BK-10*	0-0.5	0.797	0.499					
SED-BK-11*	0-0.5	1.01	--					
				0.239043	0.431006	0.554618	**0.793661**	0.315574

[169] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 5: Calculated Sediment Background for Chromium[170]

		MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	13.1	11.7					
SED-BK-02	0-0.5	14.7	12.5					
SED-BK-03	0-0.5	18	13.4					
SED-BK-04	0-0.5	13.2	11.5					
SED-BK-05	0-0.5	7.2	8.26					
SED-BK-08	0-0.5	17.7	12.2					
SED-BK-09	0-0.5	11.7	10.2					
SED-BK-10*	0-0.5	23.3	12.9					
SED-BK-11*	0-0.5	18.6	--					
				3.977923	0.293816	13.53882	**17.51675**	9.5609

[170] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 6: Calculated Sediment Background for Lead[171]

		MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	11.546	12.6					
SED-BK-02	0-0.5	18.45	17.9					
SED-BK-03	0-0.5	22.3	17					
SED-BK-04	0-0.5	20.3	17.6					
SED-BK-05	0-0.5	7.85	8.21					
SED-BK-08	0-0.5	24.05	17.3					
SED-BK-09	0-0.5	11.446	11					
SED-BK-10*	0-0.5	27.2	13.8					
SED-BK-11*	0-0.5	21.26	--					
				5.570269	0.338422	16.45953	**22.0298**	10.88926

[171] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 7: Calculated Sediment Background for Zinc[172]

		MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	31	23.4					
SED-BK-02	0-0.5	46.1	46.6					
SED-BK-03	0-0.5	58.3	48.3					
SED-BK-04	0-0.5	42.9	42.9					
SED-BK-05	0-0.5	21.5	19.3					
SED-BK-08	0-0.5	58.3	44.1					
SED-BK-09	0-0.5	16.4	29.3					
SED-BK-10*	0-0.5	205	43.9					
SED-BK-11*	0-0.5	90.9	--					
				43.58853	0.853496	51.07059	**94.65912**	7.482061

[172] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 8: Calculated Sediment Background for Selenium[173]

		MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	5.05	1.98					
SED-BK-02	0-0.5	4.76	1.98					
SED-BK-03	0-0.5	5.56	2					
SED-BK-04	0-0.5	4.4	1.99					
SED-BK-05	0-0.5	4.92	1.99					
SED-BK-08	0-0.5	6.61	1.99					
SED-BK-09	0-0.5	6.61	1.99					
SED-BK-10*	0-0.5	6.37	1.99					
SED-BK-11*	0-0.5	8.08						
				2.141329	0.533215	4.015882	**6.157211**	1.874554

[173] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 9: Calculated Sediment Background for Strontium[174]

		MPA (mg/kg) dry	Icon (mg/kg) dry	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	69.4	80.5					
SED-BK-02	0-0.5	44.6	44.4					
SED-BK-03	0-0.5	45.8	37.4					
SED-BK-04	0-0.5	41.8	38.5					
SED-BK-05	0-0.5	84.3	129					
SED-BK-08	0-0.5	64.5	47.8					
SED-BK-09	0-0.5	84.7	84.6					
SED-BK-10*	0-0.5	103	62.8					
SED-BK-11*	0-0.5	100						
				26.78984	0.391563	68.41765	**95.20748**	41.62781

[174] SED BK 06 and SED BK 07 eliminated from list due to close proximity to current and/or operating well sites. All analytical results for all background locations were included in development of background concentrations.

Table 10: TPH-D and TPH-O Background Calculations[175]

TPH-D							
		Icon (mg/kg) wet	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	20.1					
SED-BK-02	0-0.5	41.5					
SED-BK-03	0-0.5	27.8					
SED-BK-04	0-0.5	25.6					
SED-BK-05	0-0.5	20					
SED-BK-08	0-0.5	20					
SED-BK-09	0-0.5	20					
SED-BK-10*	0-0.5	20					
			7.571894	0.310642	24.375	**31.94689**	16.80311

TPH-O							
		Icon (mg/kg) wet	Standard Deviation	Coeff of variation	Average	**Upper Limit**	Lower Limit
SED-BK-01	0-0.5	57.7					
SED-BK-02	0-0.5	64.4					
SED-BK-03	0-0.5	52.8					
SED-BK-04	0-0.5	50.5					
SED-BK-05	0-0.5	52					
SED-BK-08	0-0.5	50					
SED-BK-09	0-0.5	50					
SED-BK-10*	0-0.5	50					
			5.139414	0.096199	53.425	**58.56441**	48.28559

[175] As applied to the VPSB Section 16 site, sample locations with detectable quantities of TPH-D and TPH-O reported just above the method detection limit were considered acceptable for background determination purposes. *See* Risk-Based Methodologies for Evaluating Petroleum Hydrocarbon Impacts at Oil and Natural Gas E&P Sites (API Publication 4709).

Table 11: SED 15 Area Remediation Cost

Permitting, Planning and Reporting	Unit Cost	Units	Quantity	Cost	Cost Basis
Work Plan Development	$10,000.00	unit	1	$10,000.00	MPA
Permitting	$15,000.00	unit	1	$15,000.00	MPA
Closure Report Prep and Submittal	$10,000.00	unit	1	$10,000.00	MPA

Field Services	Unit Cost	Units	Quantity	Cost	Cost Basis
Mobilization and Barge Charters	$15,000.00	each	1	$15,000.00	MPA
Shale Barge	$337.50	barge day	4	$1,350.00	MPA
Spud Barge (excavator and work platform)	$550.00	barge day	4	$2,200.00	MPA
Large Tugboat and Crew (900hp)	$2,800.00	day	4	$11,200.00	MPA
Small Tugboat and Crew (300hp)	$1,750.00	day	4	$7,000.00	MPA
Tugboat Fuel (lump sum)	$400.00	day	4	$1,600.00	MPA
Crew Boat with Captain	$1,100.00	day	4	$4,400.00	MPA
Crew Boat Fuel	$400.00	each	4	$1,600.00	
Silt and Oil Boom	$500.00	day	4	$2,000.00	MPA
Excavator Long Reach w/Operator	$1,680.00	day	4	$6,720.00	MPA
Excavator Rental/Intercoastal City Dock	$1,000.00	day	4	$4,000.00	MPA
Sheet Piling Purchase	$27,000.00	each	1	$27,000.00	MPA
Sheet Piling Labor and Equipment	$17,300.00	each	1	$17,300.00	MPA
Mud Pumps and Hoses	$6,175.00	each	1	$6,175.00	MPA
Solid Waste Loading and Transport	$7,500.00	each	1	$7,500.00	MPA
Sanitary, Absorbant, Misc Materials	$3,000.00	each	1	$3,000.00	MPA
Disposal of Excavated Material*	$23.50	bbl	86	$2,021.00	MPA
Barge Cleaning	$6,000.00	barge	1	$6,000.00	MPA
Boat Rental	$900.00	day	1	$900.00	MPA
National Forms	$70.00	each	1	$70.00	MPA
Construction Oversight	$1,250.00	day	4	$5,000.00	MPA
Sampling and Analytical	$125.00	sample	8	$1,000.00	ICON
Power Probe Mob/Demob	$1,500.00	unit	1	$1,500.00	ICON
Power Probe with Crew (Direct Push Sampling)	$1,900.00	day	1	$1,900.00	ICON
			TOTAL	$171,436.00	

*Assumes: 50'x50'x3' ex = 278cuyd = 43.4bbl x 2 for water

Table 12: Sample/Excavate/Disposal CostMercury Tank Battery A

	Unit Cost	Unit	Quantity	Cost	Cost Basis
Mobilization/Barge Charges	$15,000.00	each	1	$15,000.00	MPA
Shale Barge	$337.50	barge/day	3	$1,012.50	MPA
Spud Barge	$550.00	barge/day	3	$1,650.00	MPA
Large Tug/Crew	$2,800.00	day	3	$8,400.00	MPA
Small Tug/Crew	$1,750.00	day	3	$5,250.00	MPA
Crew Boat w/Captain	$1,100.00	day	3	$3,300.00	MPA
Tug Boat Fuel	$400.00	day	3	$1,200.00	MPA
Crew Boat Fuel	$400.00	day	3	$1,200.00	MPA
Silt Boom (300')	$250.00	day	3	$750.00	MPA
Oil Boom (300')	$250.00	day	3	$750.00	MPA
Long Reach Excavator w/Operator	$1,680.00	day	3	$5,040.00	MPA
Dock Rental	$1,000.00	day	3	$3,000.00	MPA
Disposal of Excavated Material*	$800.00	bbls	13.8	$11,040.00	WM
PowerProbe Mob/Demob	$1,500.00	unit	1	$1,500.00	ICON
PowerProbe w/Crew	$1,900.00	day	2	$3,800.00	ICON
Lab Analysis	$125.00	sample	8	$1,000.00	ICON
Sheet Piling Purchase	$27,000.00	each	1	$27,000.00	MPA
Sheet Piling Labor and Equipment	$17,300.00	each	1	$17,300.00	MPA
Mud Pumps and Hoses	$6,175.00	each	1	$6,175.00	MPA
			TOTAL	$114,367.50	

*Assumes ex area 20'x20'x3' = 44cuyd = 6.9bbls

13.9bbls = 583gal = 10.6 55gal drums

Table 13: Resampling Costs

	Unit Cost	Units	Quantity	Cost	Cost Basis
Power Probe Mobilization/Demob	$1,500.00	units	1	$1,500.00	ICON
Power Probe w/Crew (direct push sampling)	$1,900.00	day	6	$11,400.00	ICON
Lab Analysis	$125.00	sample	12	$1,500.00	ICON
Geologist	$90.00	hr	6	$540.00	ICON
			TOTAL	$14,940.00	

Table 14: Groundwater Costs

Site access	Unit Cost	Units	Quantity	Cost	Cost Basis
Boat/Barge for access to locations	$ 4,800.00	Unit	5	$ 24,000.00	5/27/14 Walker Hill Estimate & 10%
Crew Boat	$ 1,600.00	Day	15	$ 24,000.00	Icon estimate
Mileage	$ 0.52	mile	200	$ 104.00	Icon estimate
				$48,104.00	

Installation of MWs (40-50ft)	Unit Cost	Units	Quantity	Cost	Cost Basis
Drill Rig Mobilization/Demobilization	$ 1,850.00	Lump	1	$ 2,035.00	5/27/14 Walker Hill Estimate & 10%
Sonic Drill Rig and Crew	$ 5,500.00	Day	5	$ 27,500.00	5/27/14 Walker Hill Estimate & 10%
DPT Rig & Crew	$ 1,850.00	Day	5	$ 10,175.00	5/27/14 Walker Hill Estimate & 10%
Two-Inch PVC Materials	$ 12.00	Unit	60	$ 792.00	5/27/14 Walker Hill Estimate & 10%
Four-Inch PVC Materials	$ 25.00	Foot	60	$ 1,650.00	5/27/14 Walker Hill Estimate & 10%
Five foot by one-inch pre-pack PVC well screens	$ 175.00	Each	18	$ 3,465.00	5/27/14 Walker Hill Estimate & 10%
Drill Crew Per Diem	$ 300.00	Day	5	$ 1,650.00	5/27/14 Walker Hill Estimate & 10%
Above-grade Surface Completions	$ 600.00	Unit	4	$ 2,640.00	5/27/14 Walker Hill Estimate & 10%
Oversight, Development, and Equipment	$ 1,500.00	Day	5	$ 7,500.00	MPA Estimate
				$ 57,407.00	

Resampling	Unit Cost	Units	Quantity	Cost	Cost Basis
Geologist	$ 95.00	Hour	104	$ 9,880.00	Icon Cost Estimate
Technician	$ 55.00	Hour	104	$ 5,720.00	Icon Cost Estimate
Analytical (RCRA Metals, TDS, BTEX, TPH-G, TPH-D/O)	$ 328.00	Sample	8	$ 2,624.00	Icon Cost Estimate
Analytical (Radium 226/228)	$ 70.00	Sample	8	$ 560.00	Icon Cost Estimate
Analytical (Alkalinity, Mercury, Sulfate, Bromide, Chlorides)	$ 180.00	Sample	16	$ 2,880.00	Icon Cost Estimate
Sampling Equipment	$ 350.00	Event	13	$ 4,550.00	MPA Estimate
				$ 26,214.00	

Miscellaneous	Unit Cost	Units	Quantity	Cost	Cost Basis
Frac Tank	$ 45.00	Day	5	$ 225.00	Icon Estimate
100 gallon storage containers	$ 40.00	Day	5	$ 200.00	Icon Estimate
Soil disposal	$ 88.00	Hour	112	$ 9,856.00	Icon Estimate
Groundwater Disposal	$ 0.21	Gallon	500	$ 105.00	Icon Estimate
Groundwater Transport	$ 525.00	Load	1	$ 525.00	
				$10,911.00	

Monitoring Well Surveying	Unit Cost	Units	Quantity	Cost	Cost Basis
Two-man Survey Crew plus Equipment and Office	$ 2,500.00	Day	5	$ 13,750.00	MPA Estimate
				$13,750	

Project Management & Reporting	Unit Cost	Units	Quantity	Years	Cost	Cost Basis
Project Management	$ 5,000.00	Year	1	2	$ 10,000.00	MPA Estimate
Data Evaluation and Quarterly/Annual Reporting	$ 20,000.00	Year	1	2	$ 40,000.00	MPA Estimate
					$50,000	
				Total:	*$206,386.00*	

Note that this is an estimate. This estimate does not include additional well installations or remediation that *MAY* be required after confirmation sampling.

Figure 1: North ½ Hg and Ba

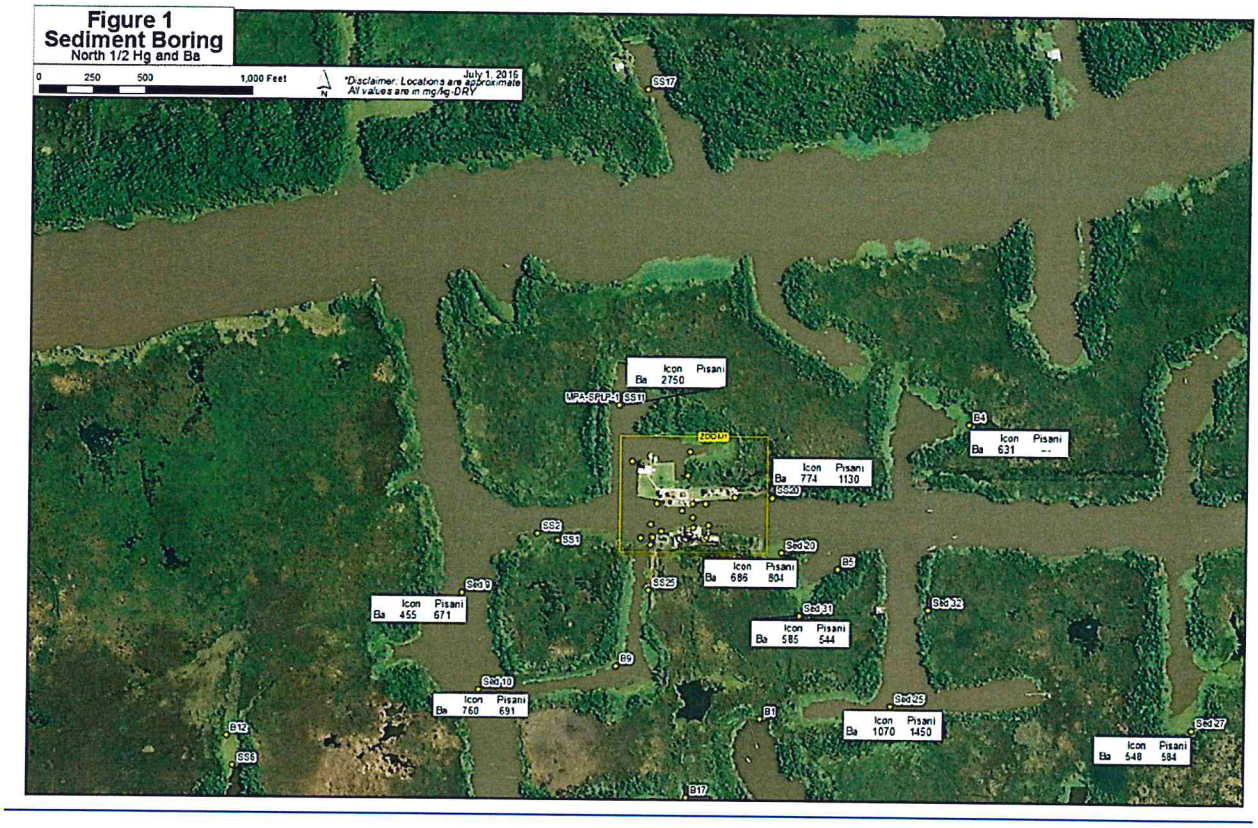

Figure 2: South ½ Hg and Ba

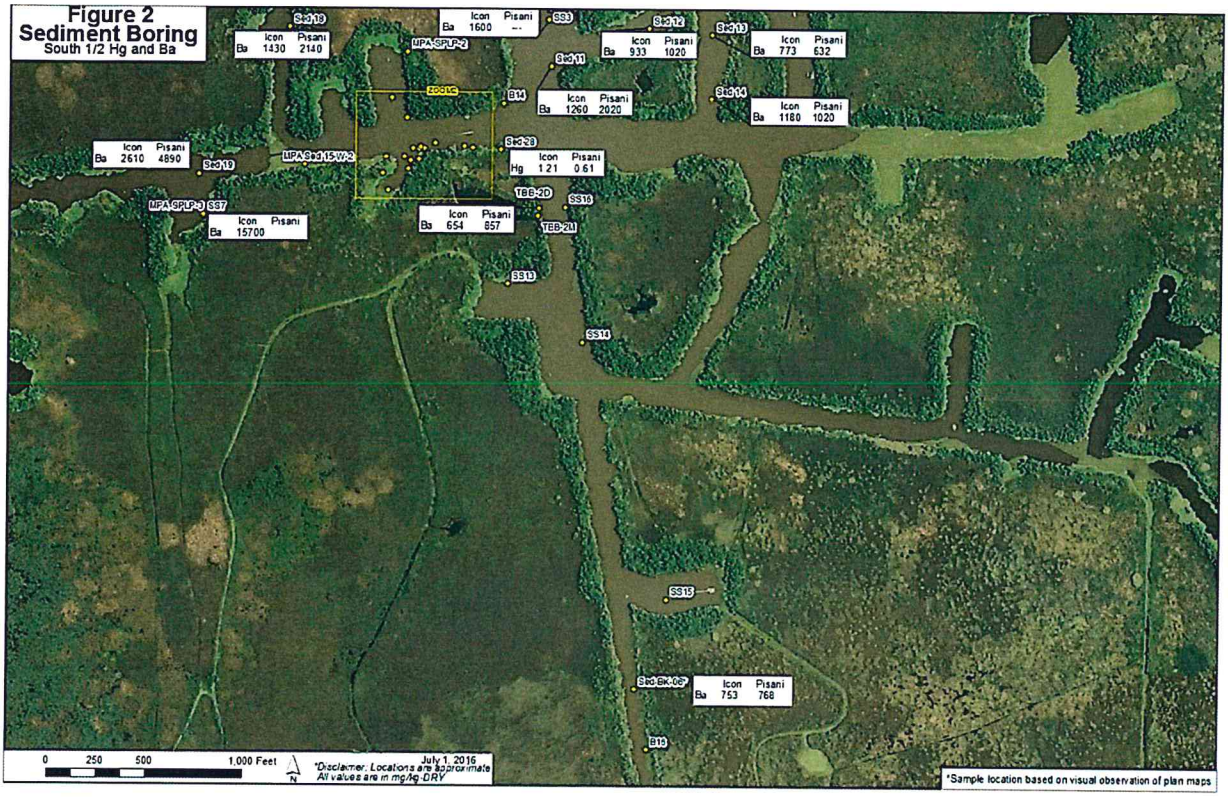

Figure 3: Zoom Fig. 1-Hg and Ba

Figure 4: Zoom Fig. 2-Hg and Ba

Figure 5: North ½ TPH

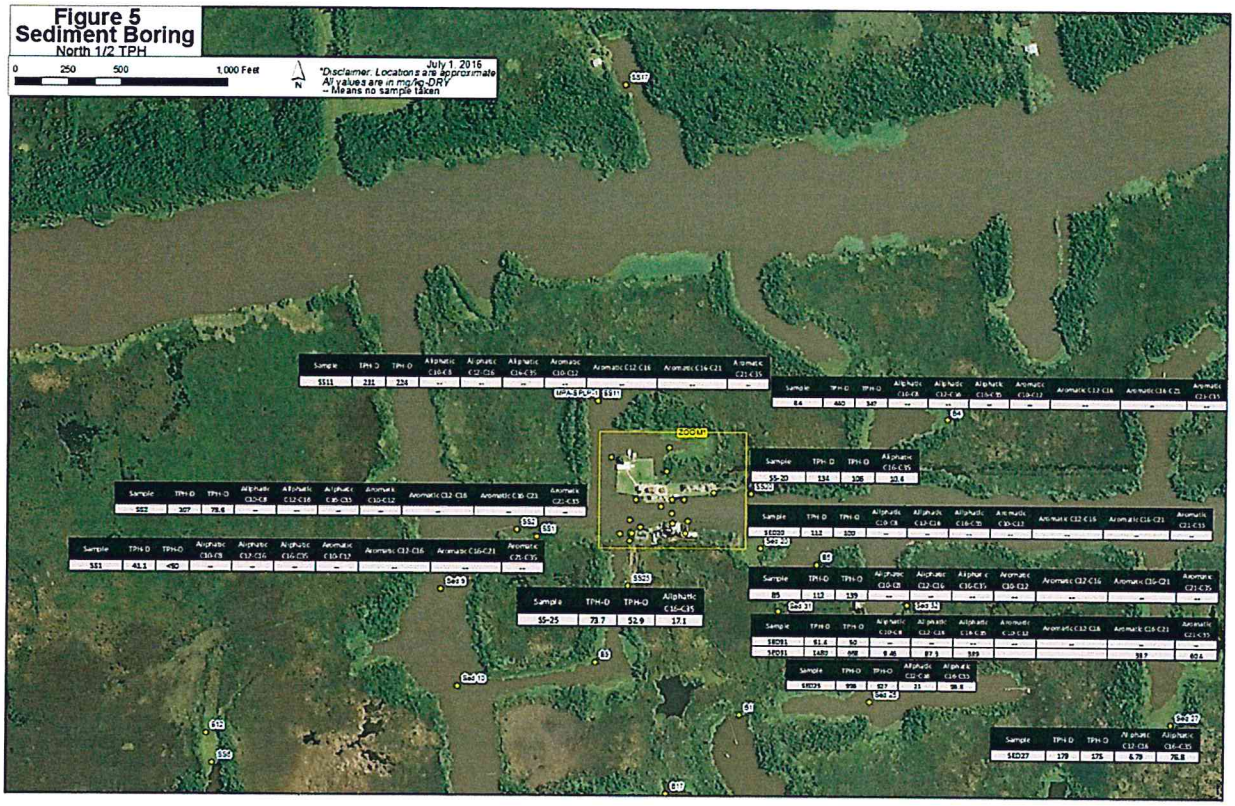

Figure 6: South ½ TPH

Figure 7: Zoom Fig. 5-TPH

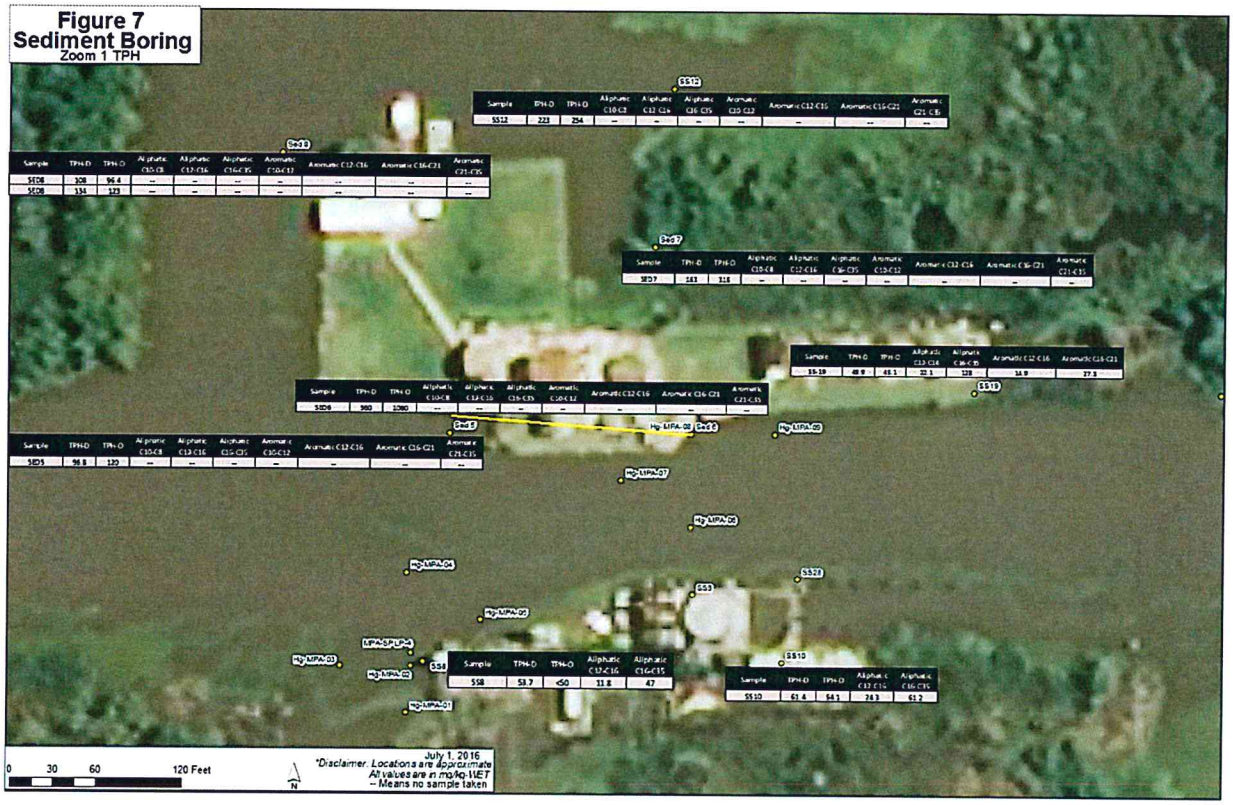

Figure 8: Zoom Fig. 6-TPH

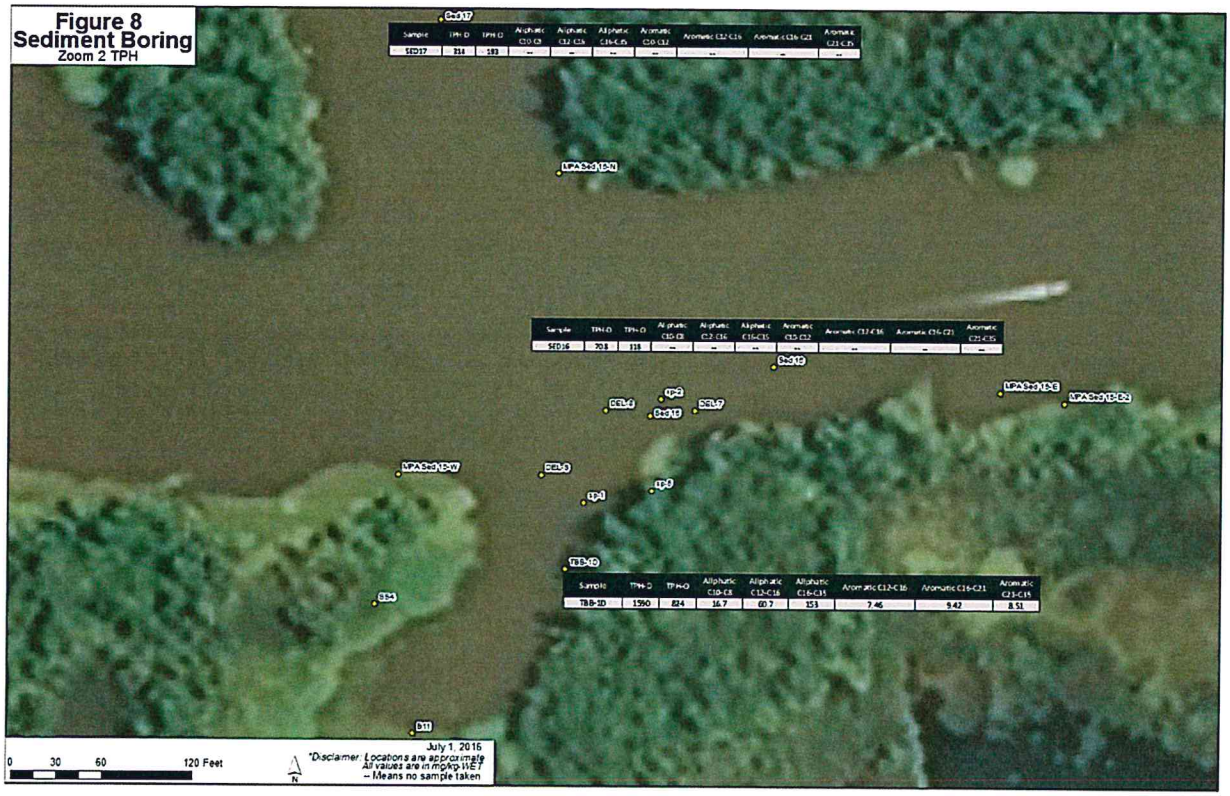

Figure 9: 8-20 Foot Groundwater AOI

Figure 10: 40-50 Groundwater AOI's

Figure 11: 70-100 Foot Groundwater AOI

Figure 12: 250 Foot Groundwater AOI's