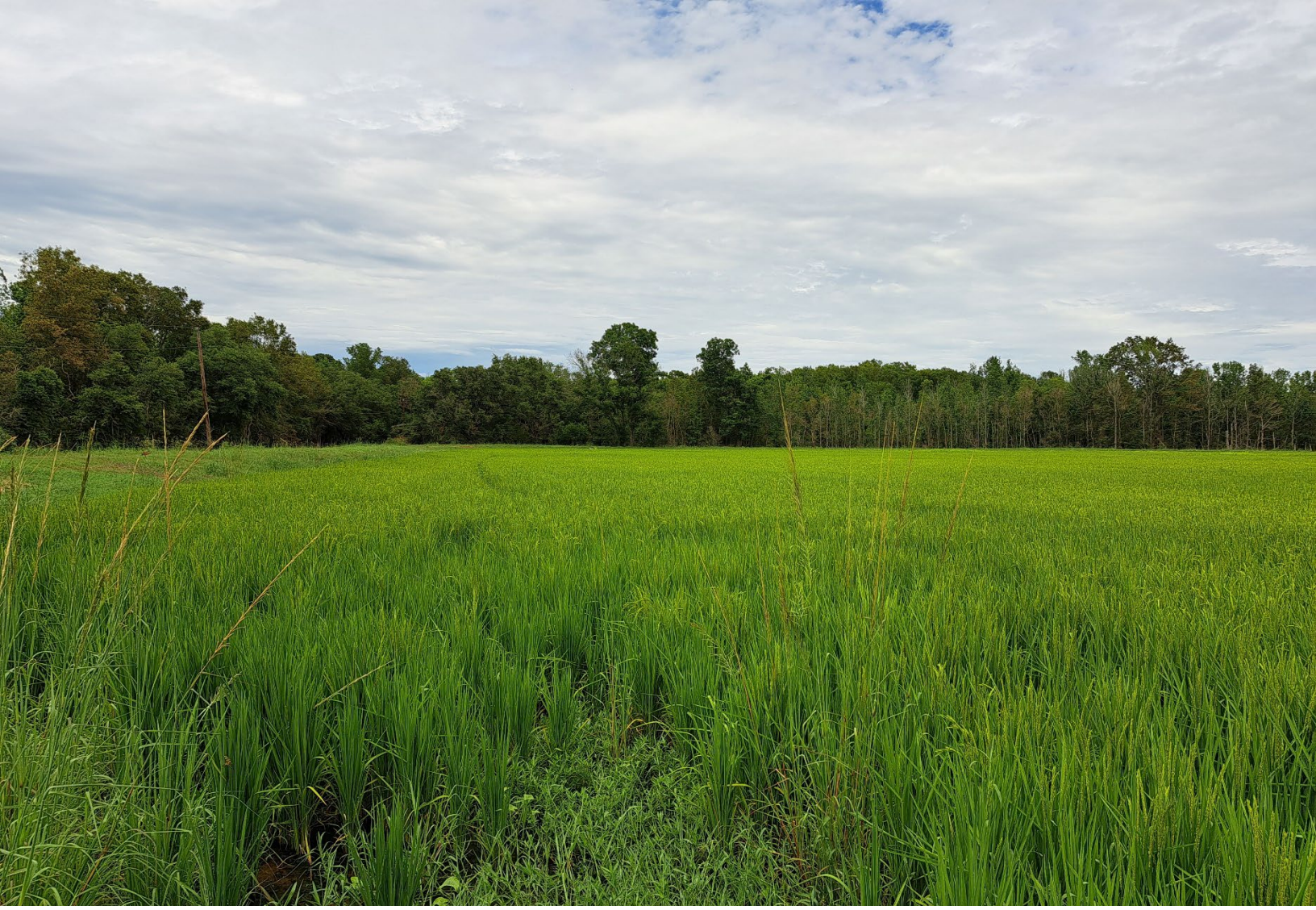

Chevron Proposed Most Feasible Plan for Site Evaluation and Remediation Under R.S. 30:29

Henning Management, LLC vs Chevron USA, Inc, et al.
Docket No 73318: 31st JDC: Division C
Hayes Oil and Gas Field
Calcasieu and Jefferson Davis Parish, Louisiana

5 August 2022

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1. INTRODUCTION

Environmental Resources Management (ERM) has prepared this Chevron Proposed Most Feasible Plan for Site Evaluation and Remediation Under R.S. 30:29 (Plan) pertaining to the Henning Management, LLC vs Chevron USA, Inc., et al. matter. This Plan is submitted to the Louisiana Department of Natural Resources (LDNR) Office of Conservation in support of Chevron's May 27, 2022 limited admission to the court under La. R.S. 30:29.

The focus of this Plan is the former Chevron operations within the areas identified in Chevron's limited admission on the property at issue in the lawsuit (Property), located in the Hayes oil and gas field in Calcasieu and Jefferson Davis Parishes, Louisiana. The Property is the subject of a lawsuit which alleges that Shell Oil Company (Shell), Chevron USA, Inc. (Chevron), H.L. Hawkins & H.L. Hawkins, Jr., Inc (Hawkins), United World Energy Corporation (UWEC), Valero Energy Corporation (Valero), and Graham Exploration, LTD. (Graham) caused soil and groundwater contamination that the plaintiff asserts has been caused by historical oil and gas exploration and production (E&P) operations. The lawsuit was filed in November 2018.

The data collected by ERM, other defense experts, and plaintiff's experts [ICON Environmental Services, Inc. (ICON)] as well as the split sample data collected by ICON are provided and considered as part of this Plan.

1.1 Objective

The objective of this Plan is to present the results of the site investigation activities conducted to date in the vicinity of the former Chevron operations and provide a Most Feasible Plan for further evaluation and remediation under La. R.S. 30:29.

1.2 Overview of Findings

An extensive soil and groundwater investigation of the Property has been conducted that has included the collection and analysis of the following:

- Soil Borings
- Electrical Conductivity probes
- Monitoring Wells
- Soil samples
- Groundwater samples
- Slug tests
- NORM surveys
- Site inspections, field notes, and photographs

ERM has applied both LDNR's Statewide Order 29-B (29-B) and Louisiana Department of Environmental Quality (LDEQ) Risk Evaluation/Corrective Action Program (RECAP) regulatory framework and standards to the investigation and delineation of soil and groundwater underlying the Property and to determine if any remediation is necessary. Through the course of the investigation, ERM installed soil borings for both lateral and vertical delineation of 29-B parameters in soil. Additionally, as further described herein, ERM applied RECAP standards to evaluate the ICON reported non-29-B parameters total petroleum

hydrocarbons (TPH) and barium, and to evaluate the soil-to-groundwater pathway for E&P-related constituents in the former Chevron operational areas including salt below the effective root zone.

As part of its horizontal and vertical delineation, ERM conducted assessment of the shallow water-bearing zone underlying the Property. The groundwater assessment included an extensive investigation into the hydrogeology, usability and yield of the shallow water bearing zone, groundwater classification, and delineation of the lateral and vertical extent of ICON-reported regulatory "exceedances". Through the groundwater investigation, as further described herein, ERM has demonstrated:

- Groundwater is reasonably delineated vertically and horizontally
- Shallow water bearing zone groundwater concentrations are protective of the underlying Chicot aquifer
- The groundwater in the shallow water bearing zone is GW3 in accordance with LDEQ RECAP based upon the yield (slug) testing and total dissolved solids (TDS) concentrations. Additionally, it is naturally non-potable due to the presence of naturally elevated concentrations of chloride, sulfate, iron, and manganese above their respective United States Environmental Protection Agency (EPA) Secondary Maximum Contaminant Level (SMCL) concentrations.

Based on the evaluation of sampling results to date, including the RECAP evaluation, Human Health Risk Assessment, Ecological Risk Assessment (ERA), Effective Root Zone (ERZ) study, NORM evaluation, and evaluation of former E&P operations herein, no active remediation of soil or groundwater is required at the Property to comply with La. R.S. 30:29. However, additional work to remove oilfield NORM/debris, collect additional SPLP chloride data, further delineate barium in soil, and further evaluate delineation and long-term stability of shallow groundwater quality is included in this plan at an estimated cost of approximately $210,000

2. SITE SETTING

The Property consists of multiple tracts located on both sides of Louisiana Highway 14 within the Hayes Oil and Gas Field in Calcasieu and Jefferson Davis Parishes, Louisiana (Figures 1 and 2). The Property encompasses approximately 1,262 acres (~2 square miles) in Sections 16, 17, 18, 19, 20, and 21 of Township 11 South, Range 05W, and Section 24 of Township 11 South, Range 06W.

2.1 Land Use and Ground Surface Topography

The majority of the Property has only been used for agriculture, oil and gas E&P operations, high pressure gas pipeline right-of-ways (ROWs), hunting leases, and undeveloped wetlands along Bayou Lacassine since the 1940s. The portion of the Property west of Highway 14 is not currently in agricultural use and is overgrown with heavy vegetation. The portion of the Property east of Highway 14 is currently used primarily for rice farming. A small portion of the Property (less than 5 acres) appears to have been used for residential purposes from at least 1940 through the late 1950s, and small portions have also been used for hunting leases. The Property is generally flat and slopes very gently towards the southeast with ground surface elevations ranging from approximately six feet above mean sea level (MSL) to the north and zero feet above MSL to the southeast near Bayou Lacassine based upon the United States Geological Survey (USGS) topographic and Light Detection and Ranging (LiDAR) maps provided as Figures 2 and 3, respectively.

A natural gas pipeline transects the Property as shown on Figure 4. Portions of the Property to the north and east are designated as freshwater emergent wetland or freshwater Forested/Shrub wetland by the US Fish and Wildlife Service (USFWS) as shown on Figure 5. The entirety of the Property is located within the Federal Emergency Management Agency (FEMA) 100-year flood zone (Figure 6) indicating that the Property is subject to flooding.

Adjacent properties are primarily utilized for agriculture, oil and gas E&P operations, private residences, or remain undeveloped. Portions of adjacent properties to the north and east are designated as wetlands by USFWS (Figure 5)

2.2 Surface Water

The surface water bodies located in the vicinity of the Property are shown on Figure 7, which include shallow, man-made irrigation and ditches that transect the Property, Bayou Lacassine on the easternmost portion of the Property, and portions of the Property to the north and east designated as swamp/marsh. The Property is located within the Lacassine Bayou – From headwaters to Grand Lake LDEQ Subsegment #LA050601 (Figure 8). The designated uses of the surface water in this subsegment are primary and secondary contact recreation, fish and wildlife propagation, and agriculture. The subsegment is not designated for use as a drinking water supply. The chloride, sulfate, and total dissolved solids (TDS) numerical criteria for this subsegment are 90 mg/L, 10 mg/L, and 400 mg/L, respectively.

Subsegment 050601 is impaired by low dissolved oxygen due to agriculture and livestock (grazing and feeding) operations and natural sources, mercury due to atmospheric deposition, and fecal coliform due to unknown sources (LDEQ, 2021).

A roughly circular pond with a diameter of approximately 150 feet and a maximum depth of approximately 15 feet near the center is located on the Property. This pond was formed after a blowout occurred in 1941 at SN25340, and is further discussed in subsequent sections of this report.

2.3 Surface Soils

The composition of surface soils underlying the Property ranges from clay to silt based upon the United States Department of Agriculture (USDA) soils map provided as Figure 9. Descriptions of the different soil types are provided below (USDA, 1988, 2003, & 2022 USDA Web Soil Survey):

- AEA – The Allemands muck consists of very poorly drained, organic soils in freshwater coastal marshes that are ponded and flooded most of the time. The Allemands Muck typically exhibit 0 to 0.2 percent slopes, soils are generally clayey, and are nonsaline to slightly saline (0.0 to 4.0 mmhos/cm).
- ARA,AR – Arat Mucky Silt. The Arat Mucky Silt consists of very poorly drained, slowly permeable soils in low, broad, backswamp areas. Slopes in the Arat Series are less than 0.5 percent. These areas are ponded and flooded most of the time.
- CrA, Cr – Crowley-Vidrine Complex, 0 to 1 percent slopes. The Crowley Vidrine complex consists of somewhat poorly drained, very slowly permeable soils on broad convex ridges on the Gulf Coast Prairies.
- GDA – The Ged Clay consists of very poorly drained, very slowly permeable soils in freshwater marshes that are adjacent to Gulf Coast Prairies. The Ged Clay soils formed in clayey alluvium and are flooded most of the time.
- JdA, Ju – The Judice silty clay consists of poorly drained, very slowly permeable soils in broad, slightly concave areas on the Gulf Coast prairies. The Judice Series generally has 0 to 1 percent slopes, rarely flooded
- MdA, Mn – Midland Series is a silty clay loam with 0 to 1 percent slopes. These soils are poorly drained and very slowly permeable. The soils are rarely flooded.
- MoA, Mr – Edgerly loam is a poorly drained, slowly permeable soil with 0 to 1 percent slopes. The soils are rarely flooded. These soils are generally fine silt on broad flats on the Gulf Coast prairies and are nonsaline to slightly saline (0.0 to 4.0 mmhos/cm).
- Mt, MwA – Mowata-Vidrine complex are poorly drained, very slowly permeable soils with 0 to 1 percent slopes. The soils are predominately fine grained silts and clays and are rarely flooded.
- W – Water

2.4 Geology

The shallow geology underlying the Property consists primarily of coastal-plain deposits of late-to-middle Pleistocene streams, with modern undifferentiated alluvial deposits near Bayou Lacassine as shown on Figure 10. Geologic cross-sections A through D were prepared based on numerous boring logs completed at the Property. The locations of these cross-sections are provided on Figure 11, and the cross-sections are provided on Figures 12 through 15. The soil boring logs and monitor well construction details prepared by an ERM scientist for locations provided on the cross sections are included in Appendix A. An additional geologic cross section (E) was prepared using water well drillers logs obtained from LDNR on and in the vicinity of the Property. This cross-section location is shown on Figure 16, and the cross section is presented on Figure 17. The cross sections document that the subsurface soils down to a depth of approximately 120 feet below the ground surface (bgs) consist primarily of clays and intermittent silts. Shallow groundwater is present in the laterally variable and discontinuous silt zones.

2.5 Hydrogeology and Groundwater

The area is underlain by the Chicot Aquifer, which occurs at depths greater than approximately 120 feet below the ground surface. The clay-confining unit overlying the Chicot Aquifer is reported by Sargent (2004) to range in thickness from approximately 120 to 200 feet as shown on Figure 18. The clay-confining unit restricts infiltration of precipitation into the groundwater system. The Property is located over an area that has low to no potential to recharge the Chicot Aquifer based on the Louisiana Geological Survey (LGS) map (LGS, 2000) as shown on Figure 19.

Based upon a search of LDNR's Strategic Online Natural Resources Information System (SONRIS) database, there are 15 reportedly active water wells located within a one-mile radius of the Property, including two registered water wells located on the Property (Figure 20). Water well drillers logs obtained from the LDNR are provided in Appendix B.

The two onsite reportedly active water wells are described below. Although these wells are listed as active in the SONRIS database, they were not observed to be present during field activities and are believed to be plugged and abandoned.

- 019-7308Z: Rig supply well drilled in 1990 to a depth of 307 feet below ground surface (bgs). This well is screened from 287 to 307 feet bgs. Based on the well registration, clay was recorded to a depth of 240 feet bgs underlain by sand.
- 053-5827Z: Rig Supply well drilled in 1988 to a depth of 180 feet bgs. This well is screened from 160 to 180 feet bgs. Based on the well registration, clay was recorded to a depth of 120 feet bgs underlain by sand.

Based on deposition testimony provided by Mr. Paul Roussel, a representative of the former landowner (Walker Louisiana Properties), an additional water well is located on the Property north of the well pad associated with UWEC oil well SN 206344. This well location is not consistent with the LDNR registered water wells in the SONRIS database or their corresponding well records and is believed to be unregistered. Based on Mr. Roussel's testimony, this well is 10 inches in diameter, is believed to be approximately 200 feet deep, and produced 3,500 gallons per minute when tested in 2017. At the time of this test, the well was in good working order, but the associated motor was not.

The remaining 15 active wells located within one mile of the Property boundary include:

- One irrigation well drilled to a depth of 250 feet bgs
- Eleven domestic wells. The shallowest of these wells are screened from 120 to 125 feet bgs (019-7437Z), 140 to 145 feet bgs (019-11914Z and 053-6439Z), and 150 to 160 feet bgs (019-12344Z). Remaining domestic wells within one mile of the Property boundary are screened at greater depths.
- Three rig supply wells drilled to depths of 280 feet bgs and deeper.

The Chicot Aquifer water quality is variable, and in places naturally poor, based on the available USGS chloride concentration data shown on Figure 21. The Property and adjacent properties are served by the Jefferson Davis Water and Sewer Commission #1 public water supply (PWS1053014), with service lines through the Property along Highway 14, and along Navarre Road to residences immediately north of the Property boundary. The cost to tap a ¾" water line and install a meter (a typical residential connection) would be $640 on the east side of Highway 14. Making this connection on the west side of Highway 14 would require boring under the highway for a total cost of $1,790. Records of communication, which document ERM's conversations with the Jefferson Davis Water and Sewer Commission #1, are included in Appendix C. The approximate location of water supply lines in and around the Property are shown on Figure 20.

The shallow soils underlying the Property down to a depth of at least approximately 78 feet below the ground surface consist primarily of clay and silty clay with a highly variable and discontinuous shallow water-bearing zone that consists primarily of clayey silt and silt, with varying amounts of sand in some locations (Figures 11 through 17). The shallow water-bearing zone is composed of laterally variable and discontinuous silt stringers which are encountered at variable depths between approximately 20 and 62 feet bgs. The various silt stringers appear to be poorly interconnected, but generally behave as a single water-bearing unit. The water-bearing silt stringers, where present, range in thickness from zero to approximately 12 feet, with a thickness typically less than 5 feet. A thicker silt zone was encountered in ICON's boring H-32, which appears to be related to nearby Bayou Lacassine. This location is approximately 3,500 feet from the nearest former oilfield operational area and is not representative of subsurface soils beneath the vast majority of the Property. The shallow water-bearing zone is present within shallow soils underlying the Property, which are part of the thick clay confining unit overlying the Chicot Aquifer. The confining unit is reported to range in thickness from approximately 120 to 200 feet beneath the Property. The confining unit restricts infiltration of precipitation into the Chicot Aquifer groundwater system.

It is undisputed that the shallow water-bearing zone has never been used as a water source on the Property. The zone does not provide a viable future source of potable or irrigation water due to its low yield, discontinuous nature and naturally poor water quality [i.e., concentrations of chloride, sulfate, iron, and manganese naturally exceed EPA drinking water standards]. There are no registered water wells within a one-mile radius of the Property that are reported to be screened in the shallow water-bearing zone (Figure 20).

Use of the shallow-water bearing zone groundwater for a permanent, potable water supply is economically impractical, technically unsound, and neither feasible nor practicable. The cost of the installation of a domestic water well and associated equipment (submersible pump and pressure tank) to a typical depth of 150 feet below the ground surface is approximately $5,000 per ERM's investigation of drilling costs with a Louisiana-licensed water well drilling company. The cost to install a domestic water well in the shallow water-bearing zone and the special equipment (including extensive water treatment equipment) needed to provide a reliable yield and potable quality water would exceed the cost of the installation of a typical 150-foot deep water well. A record of communication, which documents ERM's conversation with a local water well driller, is included in Appendix C.

2.5.1 Groundwater Classification

The discontinuous shallow water-bearing zone underlying the Property is RECAP Class 3A groundwater based upon the results of ERM's analysis of slug tests performed by both ERM and ICON, and based upon the measured TDS concentrations. These results document that the shallow water-bearing zone is not able to sustain a yield of greater than 800 gallons per day, as identified in state regulation. The slug test results are summarized on Table 1, and the individual slug test evaluation reports are provided in Appendix D. Slug testing is an approved and most relied upon method of direct measurement of aquifer properties for groundwater classification under RECAP (see RECAP Appendix F). The use of slug testing has been standard practice in aquifer evaluation for many decades and has been routinely used to determine groundwater classification throughout the state of Louisiana since the inception of RECAP regulations. Because slug tests can be performed in multiple locations across a broad area with relative ease, they are especially valuable for evaluating highly variable water-bearing zones, such as the shallow zone present beneath the Property. The slug test analyses are likely an overestimate of the yield in the shallow water-bearing zone, as it does not take into account the poorly connected and discontinuous nature of the zone (i.e., water-bearing silt stringers were not encountered at the anticipated depth in multiple locations, and the shallow water-bearing zone was not encountered at all in some locations [e.g.,

H-11]). In addition, several monitoring wells installed by both ICON and ERM in the shallow water-bearing zone (MW-7, MW-9, MW-9D, MW-11, H-25, H-26, and H-27) went dry during the well purging and sampling process (i.e., the sample bottles had to be filled over numerous attempts to get adequate sample volume using a peristaltic pump flowing at very low flow rates). The monitoring wells that purged dry or exhibited low yields are shown on Figure 22.

2.5.2 Groundwater Flow

Groundwater level data were collected on November 22, 2019, May 24, 2021, and December 21, 2021 from the monitoring wells present on the Property during each event. The well survey data and water elevations are provided on Table 2. The potentiometric surface maps for the shallow water-bearing zone are provided as Figures 23 through 29. Potentiometric maps were prepared for each event for water elevations as measured and as density corrected (equivalent fresh water head [EFWH]). An actual representation of groundwater flow is likely somewhere between these two methodologies. The shallow groundwater flow direction is variable, but on the portion of the Property west of Highway 14, flow is generally to the north. Groundwater flow east of Highway 14 appears to be generally to the northeast; however, groundwater flow direction is to the southwest near Bayou Lacassine (i.e., away from the bayou).

A potential connection between groundwater and surface water was not identified on or near the Property. Shallow groundwater occurs below approximately 20 feet bgs (and often considerably deeper), while surface water bodies do not extend that deep (e.g., field irrigation and drainage canals on the Property are typically only a few feet deep, the pond was measured to be 15 feet at its deepest point, and Bayou Lacassine is less than 10 feet deep). The nearest significant, named surface water body, Bayou Lacassine, was conservatively assumed to be the potential receiving surface water in a downgradient direction (i.e., north/northeast) for demonstrative purposes. This hypothetical assumption does not imply an actual connection of shallow groundwater and surface water, as the assumed connection is not supported by the following facts: Bayou Lacassine is not deep enough to intersect the shallow water-bearing zone, is located approximately 1.25 miles from the nearest area of investigation (AOI) with groundwater containing constituents of concern on the Property, and groundwater flow is away from the Bayou.

Potentiometric groundwater surface elevations in the Chicot Aquifer are approximately 30 to 40 feet lower than potentiometric groundwater surface elevations in the shallow water-bearing zone, as shown on Figures 17 and 29. The large difference in groundwater elevations between the two zones demonstrates that the shallow water-bearing zone is not hydrologically connected to the underlying Chicot Aquifer.

3. HISTORICAL E&P OPERATIONS

Based on available data from LDNR's SONRIS database, nineteen oil and gas wells have been drilled on the Property (Figure 30). Drilling on the Property began in 1938, with the first productive well drilled in 1941. Numerous companies operated on the Property since 1938. Chevron's predecessors (Gulf Oil Corporation and Gulf Refining Company [Gulf]) operated on the Property between approximately 1941 and 1984 before the amendment of Statewide Order 29-B in 1986. Gulf drilled eight wells (three producers, two SWDs, and three dry holes) on the Property. An oil and gas well history for wells on the Property is provided in Table 3 and LDNR oil and gas well files are provided in Appendix E. Mr. Richard Kennedy with Northstar Exploration Company conducted an evaluation of the E&P operations conducted on the Property, including the blowout, and this evaluation is presented in a separate report (see Section 9.5).

The Chevron limited admission areas (Areas 2, 4, 5, 6, and 8) are shown on Figure 30. For informational purposes, other sampling areas on the Property that are not part of the Chevron limited admission are also shown on Figure 30 (Areas 1, 3, 7, and 9).

Historical aerial photographs from 1940 through 2021 that show the historical development of oil and gas operations on the Property and use of the former E&P operational areas are provided on Figures 31 through 51. Figures 52 through 91 provide zoomed-in views of select aerial photos at the Chevron limited admission areas. An overview of the history of former operations areas on the Property is provided below. There are no open pits remaining on the Property.

3.1 Limited Admission Areas

3.1.1 Limited Admission Area 2 (SN 25340 Area)

SN 25340 was drilled by Gulf Refining Company in 1941. While drilling the well, a blowout occurred on July 22, 1941, creating a fire that burned until August 13, 1941. The blowout created a depression that is now filled with water (referred to as the pond in this report). The pond is first visible in the 1951 aerial and is still present today (Figures 53 through 68). The well was P&A'd in 1941. Except for the pond, no other E&P features associated with this former operations area are visible in the aerial photography. The 2004 and 2008 aerial photos (Figures 66 and 67) show agricultural use of the field surrounding the pond. At the time of ERM's investigation, this area was overgrown with thick vegetation.

3.1.2 Limited Admission Area 4 (SN 26358, SN 207055, SN 210306, SN 213760, SN 970424, and SN 970427)

Gulf's E&P operations in Area 4 included producing well SN 26358 (drilled in 1941 by Gulf Refining Company and plugged and abandoned in 1984 by Great Southern Oil and Gas Company), and saltwater disposal wells (SWDs) SN 970424 (drilled in 1957 and P&A'd in 1983 by Gulf Oil Corporation) and SN 970427 (drilled in 1977 and P&A'd in 1984 by Gulf Oil Corporation). Operations associated with these wells are visible beginning in the 1951 aerial and include a pit-like feature on the north side of an east-west oriented road, and a tank battery to the south. By 1962, the pit-like feature to the north is no longer visible and a smaller pit-like feature is present, which is visible through 1981. Two additional pit-like features are first visible in 1961 and remain visible through 1971 (one north of the tank battery and the other south of the tank battery). Various tanks and other indistinct features are visible north of the road through 1984, by which time the Gulf wells were P&A'd.

Subsequent operators continued E&P activities in Area 4 after Gulf's operations. SN 207055, a dry hole, was drilled and subsequently P&A'd by Flynn Energy Corporation in 1987. SN 210306 was permitted in

1989 by Richmond Petroleum, Inc., but the permit expired. SN 213760 was permitted in the same location as SN 210306. SN 213760 was drilled in 1990 by Richmond Petroleum Inc. The 1990 aerial imagery shows a large rectangular feature, and some tankage previously associated with Gulf operations is still present, but is gone by 1995. The current well status for SN 213760 is Shut In for Future Utility, and it is the only well on the Property that has not been P&A'd. The well is currently operated by UWEC.

Evidence of agricultural use is visible in the southern portion of Area 4 (primarily south of E&P operational areas), including apparent rice farming from 1971 through 1981, and farming in 2004 and 2008. At the time of ERM's investigation, the east-west oriented road and SN 213760 were present, but Area 4 was otherwise overgrown with thick vegetation. Aerial photos showing this area over time are presented on Figures 52 through 68.

3.1.3 Limited Admission Area 5 (SN 105169 and SN 103174 Area)

SN 103174 and SN 105169 were dually completed wells within the same well bore drilled in 1964 by Gulf Refining Company. Associated operations are visible in the 1968 through 1985 aerial photos. Two pit-like features are visible in the aerial imagery (one north of the well location from 1968 through 1971, and the other to the west of the well location from 1968 through 1998). Both wells were plugged and abandoned in 1980.

Subsequent operators continued E&P activities outside of Chevron's Limited Admission Area 5 after Gulf's operations ceased in 1984. SN 206344 was drilled in 1987 by Flynn Energy Corporation to the east of the former Gulf operational area. Operations are visible in the location beginning in the 1988 aerial photo. A tank battery is visible to the north of the well beginning in the 1988 aerial photo, and a second tank battery is visible immediately to the west beginning in the 1998 aerial photo. By 2019, the tanks were no longer present. The well was plugged and abandoned by UWEC in 2020. The gravel pad associated with this well and the berms associated with the former tank batteries are still present immediately east of Area 5.

Portions of Area 5 appear to go in and out of agricultural use throughout time. During ERM's investigation, Area 5 was overgrown with thick vegetation, but the gravel pad and berms were still present to the east (outside of Area 5). Aerial photos showing this area over time are presented on Figures 69-81.

3.1.4 Limited Admission Area 6 (SN 128241 Area)

SN 128241 was drilled in 1969 by Gulf Oil Corporation. Associated operations are visible in the 1970 through 1981 aerial photos. A pit-like feature is observed in the aerial photographs to the west of the well location during this timeframe (Figures 70 through 73). The well was P&A'd in 1983.

SN 195098 was drilled in 1984 by Graham Exploration Limited to the east of the former Gulf operational area and outside of Area 6. Associated operations are visible beginning in the 1985 aerial photo. A tank battery is observed immediately west of the well in the aerial photographs through 2004. The well was plugged and abandoned in 2012 by UWEC. The gravel pad associated with this well is still present (Figures 74 through 81).

During ERM's investigation, it was observed that the Gulf and subsequent operational areas are contained within a leveed area, separating them from the surrounding drainage ditches and farmland. This area holds water and was fully or partially inundated during all field activities. The former Gulf operational area is heavily vegetated. The area operated by subsequent operators (east of Area 6) is not vegetated, apparently due to the gravel pad.

3.1.5 Limited Admission Area 8 (SN 31298 Area)

SN 31298 was drilled in 1946 by Gulf Refining Company. The well was a dry hole and was plugged and abandoned in 1947. A pit-like feature is observed to the south of SN 31298 in the 1951 aerial photograph, after the well was plugged and abandoned. By 1978 and through at least 2017, the pit-like feature was heavily vegetated. Sometime between 2017 and 2019, the former operational area was converted to agricultural use (rice farming). Aerial photos showing this area over time are presented on Figures 82 through 91.

3.2 Other Sampling Areas

3.2.1 Sampling Area 1 (SN 153121 Area)

SN 153121 was drilled by Gulf Oil Corporation in 1976. The well was a dry hole and temporarily abandoned in 1976. The well was plugged and abandoned (P&A'd) in 1979. Evidence of the well drilling activities for SN 153121 are visible in the 1978 aerial photo (Figure 39). At the time of ERM's investigation, this area was overgrown with thick vegetation.

3.2.2 Sampling Area 3 (SN 20853 Area)

SN 20853 was a dry hole drilled and subsequently P&A'd by Shell Petroleum Corporation in 1938. Operations associated with this well are visible in the 1940 aerial photo, including several pit-like features that are visible through 1962 (Figures 52 through 55). Subsequent aerial photos show agricultural use in 1981 (Figure 60), 2004 (Figure 66), and 2008 [Figure 67]. At the time of ERM's investigation, this area was overgrown with thick vegetation.

Chevron and its predecessors did not operate in Area 3. Sampling results for this area are presented on the tables and figures, but a detailed evaluation is not included as part of this report.

3.2.3 Sampling Area 7 (SN 44135)

SN 44135 was drilled in 1951 by H.L. Hawkins. In 1963, the operator changed to Coastal States Gas Production Company. The well remained in place until being plugged and abandoned in 1971.

Chevron and its predecessors did not operate in Area 7. Sampling results for this area are presented on the tables and figures, but a detailed evaluation is not included as part of this report.

3.2.4 Sampling Area 9

ICON collected background samples in Area 9, which is distant (approximately 3,500 to 5,000 feet) from the nearest former E&P operations in Area 8. ICON's September 30, 2021 *Expert Report and Restoration Plan for the Landowners* alleges the presence of flowlines in the area and an off-site production pit located outside the property boundary to the east. LDNR's SONRIS database does not indicate that E&P operations have taken place in this area, and aerial photos from 1951 through 2019 do not show evidence of flowlines, offsite pits, or other E&P features.

3.3 Other Oil and Gas Wells on the Property

Two other oil and gas well locations are listed in the SONRIS database, but not described in the above sections. SN 97351, located immediately southeast of Area 5, was permitted by Gulf Oil Corporation in 1963, but the permit expired and the well was not drilled. SN 142076 and SN 142399 were dually completed by Ranger Oil Company in February 1973 and P&A'd in October 1973. Evidence of oilfield

operations at this location is not visible in the available aerial imagery, and no sampling was conducted by ICON or ERM at this location.

4. REVIEW OF AGENCY RECORDS

The following sections summarize ERM's review of the available LDNR and LDEQ records related to E&P activities conducted on the Property.

4.1 LDNR Records

A summary of LDNR's regulatory involvement, as documented in its Pit Records and Inspection Reports, Lease Facility Inspection Reports (LFIR), and Compliance Orders (CO) and Notices is presented below.

4.1.1 Pit Records

LDNR has conducted numerous inspections of former pits on the Property since 1987. There are four LDNR-registered reserve pits in the SONRIS database, which are associated with wells that were drilled after Gulf ceased operations in 1984 on the Property (Figure 30). There is one former pit associated with Gulf well SN 105169, based on a review of LDNR's electronic records in SONRIS, LDNR's paper records, and plaintiff-produced documents. This pit was identified in a 1989 inspection (approximately five years after Gulf ceased operations) and was not identified in the SONRIS database. The inspection record noted that the pit was inactive and needed additional freeboard. The location of this former pit has since been used for agriculture and is currently overgrown with thick vegetation.

A review of historical aerial photography identified a number of small, unregistered pits that were used in E&P operations from the 1940s until the 1980s. With the exception of the pit associated with SN 105169 and an apparent reserve pit associated with SN 31298 (this area currently used for farming), aerial photographs show that visible pits were closed prior to the amendment of Statewide Order 29-B in January 1986.

4.1.2 Lease Facility Inspection Reports

At least 49 lease facility inspections of four producing well locations and associated production equipment have been conducted by LDNR from 1988 through 2016 (Table 4). Two of the lease facility inspection reports pertained to a well for which Chevron or its predecessor was the operator of record (SN 105169). The January 1989 lease inspection reported the lease in good condition with the exception of missing well or tank battery identification signs. The February 1989 lease inspection reported multiple deficiencies. This well was P&A'd by Gulf Corporation on May 12, 1980, almost a decade before either of these inspections. Copies of LDNR documents reviewed, including those which contain LDNR lease facility inspection reports, are provided in Appendix F.

4.1.3 Compliance Orders

Seven Compliance Orders have been issued by the LDNR to various operators over the last approximately 23 years (Table 5). Only one Compliance Order pertaining to wells operated by Chevron or Gulf has been issued. Compliance Order #0066 was issued to Gulf Oil Corporation along with Flynn Energy Corporation and Tryvest, Inc. on August 15, 1988 and February 14, 1989. Well SN 105169 received an operational complaint from EPA for noncompliant pits in the field, and noted the Tryvest, Inc. pit. This well was P&A'd by Gulf Corporation on May 12, 1980, almost a decade before the issuance of the Compliance Order. Copies of the LDNR documents reviewed, including those which contain Compliance Orders, are provided in Appendix F.

4.2 LDEQ EDMS Records

ERM conducted a review of LDEQ's Electronic Document Management System (EDMS) records for properties within a one-mile radius of the Property with Agency Interest (AI) Numbers. One AI number (AI No. 166486) was located within the Property boundary. The LDEQ records for the AI located on the Property primarily consist of air-related permit documents for E&P facilities.

Copies of the relevant LDEQ EDMS documents are provided in Appendix F.

5. REGULATORY FRAMEWORK

The oil and gas E&P operations that have been conducted on the Property are regulated by LDNR's Office of Conservation. LDNR rules for environmental protection are presented in Louisiana Administrative Code, Title 43, Part XIX (LAC 43: XIX), Subpart I, commonly referred to as Statewide Order 29-B.

Statewide Order 29-B has evolved over time, with major revisions in the mid-1980s requiring the registration of existing pits and the ultimate upgrading or phase out/closure of existing pits. Prior to the January 20, 1986 amendments to Statewide Order 29-B, there were no specific or numeric LDNR standards for registration or closure of pits. Many of the former wells and associated former pits or other operational features on the Property, including all Gulfs wells, were plugged and abandoned and/or closed well before Statewide Order 29-B was amended.

The LDEQ RECAP risk assessment regulation provides further criteria for assessment of current and historical E&P operations. RECAP was developed by LDEQ based on EPA guidance to provide a framework for evaluating risks to human health and the environment from chemical constituents in impacted media (e.g., soil and groundwater). RECAP has been used as an applicable regulatory standard by the LDNR in the approval and development of most feasible plans to address the Act 312 requirement to protect the environment, public health, safety and welfare in compliance with relevant and applicable standards promulgated by a state agency.[1]

5.1 Soil

The applicable or relevant and appropriate standards for soils are Statewide Order 29-B Chapter 3 pit closure criteria and LDEQ RECAP standards. The Statewide Order 29-B pit closure regulations establish standards for metals, salts and hydrocarbons (oil & grease) in soils at E&P sites. RECAP addresses these and additional constituents in the context of risks to human health and the environment.

The soil data gathered from the Property have been compared to the following Statewide Order 29-B criteria (adopted in 1986) and to RECAP standards (adopted in 2003) where appropriate:

- Range of pH: 6-9
- Total metals (mg/kg wet weight, unless noted):
  - Arsenic: 10
  - Cadmium: 10
  - Chromium: 500
  - Lead: 500
  - Mercury: 10

[1] See MFPs issued by LDNR in the Tensas Poppadoc, Savoie, Moore, Sweet Lake, Vermillion Parish School Board, Hero Lands, LA Wetlands, Jeanerette Lumber, and Neumin Production matters, where RECAP was a component of the LDNR MFP. The MFP in the Neumin Production matter summarizes the use of RECAP in previous cases, stating "LDEQ's RECAP procedures have been recognized as containing groundwater evaluation and/or remediation standards applicable to E&P sites, and RECAP has been used as the principal regulatory standard for groundwater evaluation and/or remediation in every Act 312 [case] where groundwater has been an issue…. Use of LDEQ's RECAP, at least in part, to demonstrate compliance with Section 319.A has been proposed by responsible parties, considered and ultimately accepted by LDNR on a case-by-case basis for over 20 years beginning October 2001 with Guillory Landfarm Facility Closure, Site Code 0103, located in Eunice, Louisiana." (H.C. Drew Estate vs Neumin Production Company et al, Docket No: ENV-L-2022-01, LDNR Office of Conservation's Most Feasible Plan and Written Reasons in Support as Required by LA.R.S. 30:29, June 29, 2022)

- Selenium: 10
- Silver: 200
- Zinc: 500
- True Total Barium: 40,000 (Upland)
  20,000 (Wetland) (dry weight)

- Oil and Grease: <1 percent (dry weight)
- Electrical Conductivity: <4 mmhos/cm (Upland)
  <8 mmhos/cm (Wetland)
- Sodium Adsorption Ratio: <12 (Upland)
  <14 (Wetland)
- Exchangeable Sodium Percentage: <15 percent (Upland)
  <25 percent (Wetland)

Per Statewide Order 29-B Section 313 Part D., "Pits containing E and P Waste may be closed onsite by mixing wastes with soil from pit levees or walls and adjacent areas provided waste/soil mixtures at completion of closure operations do not exceed the following criteria, as applicable, unless the operator can show that higher limits for EC, SAR, and ESP can be justified for future land use or that background analyses indicate that native soil conditions exceed the criteria."

Based on a root study performed by Dr. Luther Holloway and Mr. Patrick Ritchie on the Property, the effective root zone is up to approximately 10 inches. Statewide Order 29-B salt parameters in soil are agronomic standards established to promote the growth of crops and other vegetation; therefore it is appropriate to apply them only to soils within the effective root zone. Soils within the upper one foot were thus compared to Statewide Order 29-B standards for land treatment in uplands and elevated wetlands, as appropriate.

In addition to the promulgated LDNR salt standards, LDEQ established guidelines for salt parameters in a 2012 document entitled, "How should a release of brine (sodium chloride) be addressed under RECAP?" [Commonly referred to as the RECAP Frequently-asked-questions (FAQ) on salt]. The RECAP FAQ on salt adopts the Statewide Order 29-B standards for salt parameters for soils within the effective root zone as a screening tool and utilizes a synthetic precipitation leaching procedure (SPLP) approach for determining salt concentrations in deeper soils that are protective of groundwater. To assess salt parameters in soils below the effective root zone, RECAP utilizes a comparison of soil SPLP leachate results to standards for chloride appropriate to the specific groundwater classification.

RECAP does not address radioactive materials. However, LDEQ regulations for oilfield NORM in soil are contained in LAC 33: Part XV Chapter 14 and the NORM data have been evaluated by Dr. John Frazier in accordance with LDEQ's NORM regulations (see Section 9.4).

5.2 Groundwater

There are no direct comparative groundwater standards provided in Statewide Order 29-B; therefore, the groundwater data have been evaluated in accordance with LDEQ's RECAP regulation. EPA's Maximum Contaminant Levels (MCLs) and Secondary Maximum Contaminant Levels (SMCLs) are used in RECAP as screening levels and to evaluate groundwater zones that are classified as a drinking water resource. MCLs are enforceable standards established by EPA to protect the public against consumption of

drinking water contaminants that present a risk to human health. An MCL is the maximum allowable concentration of a contaminant in drinking water supply, which can be delivered to the consumer. SMCLs are non-enforceable standards that are used as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. MCLs and SMCLs do not apply to RECAP Class 3 groundwater.

A February 25, 2011 Memorandum of Understanding (MOU) between LDNR and LDEQ establishes a mechanism for the use of RECAP procedures for the evaluation or remediation of groundwater at E&P sites. This interagency agreement recognizes that RECAP contains groundwater evaluation and remediation standards and protocols that are applicable and appropriate for E&P sites, as the provisions of 29-B do not contain comparative groundwater standards.

5.2.1 Radionuclides Rule

The Radionuclides Rule (65 FR 76707), promulgated on December 7, 2000, specifies a MCL of 5 pCi/L for combined radium-226/-228 in Community Water Systems (CWS) [See relevant regulations provided in Appendix G]. The Radionuclides Rule applies to all CWSs; however, the regulations do not apply to non-community water systems (US EPA, 2002, page I-4). A CWS is defined as:

> "a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents."

The Radionuclides Rule is not applicable to the following two types of Non-Community Water Systems (NCWS) as defined in 40 CFR Part 141 – National Primary Drinking Water Regulations (Appendix G):

> "Non-transient non-community water system or NTNCWS means a public water system that is not a community water system and that regularly serves at least 25 of the same persons over 6 months per year."
>
> "Transient non-community water system or TWS means a non-community water system that does not regularly serve at least 25 of the same persons over six months per year."

Due to naturally poor water quality and low yield, the shallow water-bearing zone is not a suitable source for a CWS or NCWS. Consequently, the Radionuclides Rule regulations (i.e., 5 pCi/L MCL for Combined radium-226/-228) are not applicable to the reasonably anticipated future use of the groundwater in the shallow water-bearing zone underlying the Property.

5.2.2 Louisiana Title 51 Public Health-Sanitary Code

In addition to the natural limitations on use of the shallow groundwater due to low yield and poor quality, any attempted use of groundwater in the shallow water-bearing zone for potential potable supply use could/would result in non-compliance with the Louisiana Title 51 Public Health-Sanitary Code regulation as outlined below:

> Part XII. Water Supply §347.A of the regulations state: "All inhabited premises and buildings located within 300 feet of an approved public water supply shall be connected with such supply, provided that the property owner is legally entitled to make such a connection."

6. INVESTIGATION ACTIVITIES AND RESULTS

The following sections discuss the results of the 2019 to 2021 investigations conducted on the Property. The soil, groundwater, and surface water analytical data are summarized on Tables 6, 7, and 8, respectively. The field parameters recorded during the groundwater sampling events are provided on Table 9. Soil geotechnical data are summarized on Table 10. Sample location maps are provided as Figures 92 through 98. Soil boring logs and monitor well construction diagrams are provided in Appendix A. Laboratory reports are provided in Appendix H. Field notes and photographs and photo logs recorded by ERM during site investigation activities on the Property are provided in Appendices I and J. LDNR well registration documents for the monitoring wells installed by ERM are included in Appendix K. The five Chevron limited admission areas, along with the four sampling areas not included in Chevron's limited admission, are shown on Figure 30 and the data from these areas are provided on Tables 6 and 7.

6.1 Soil

ICON conducted soil sampling during multiple field events in October and November 2019, March to April 2021, and August 2021 which included the installation of 34 soil borings. Soil borings were advanced with a Geoprobe® drill rig. Either a track mounted or marsh master mounted rig was used based on access and seasonally wet conditions. ICON collected soil samples from the borings, and split samples were collected by ERM where adequate sample volume was provided. An ERM scientist logged soil cores, and the boring logs are provided in Appendix A.

ICON advanced a conductivity probe and/or hydraulic profiling tool (HPT) at 24 of the soil boring locations. The locations of the ICON conductivity and HPT probe logs advanced on the Property and the probe logs are shown on Figure 99. ICON did not perform dissipation tests during the advancement of HPT probes; therefore, these data cannot be effectively used to estimate hydraulic conductivity.

ERM conducted additional site investigation activities between November 2021 and January 2022, which included advancing soil borings at 73 locations (59 new soil boring locations, 13 soil resample locations, and 12 monitoring wells at 11 locations). Soil borings and monitoring wells were installed with a hydraulic direct push Geoprobe® rig equipped with a dual tube sampling system to collect continuous soil cores in acetate lined core barrels. A hand auger was used to advance shallow soil borings that could not be accessed by the Geoprobe® rig. Walker Hill Environmental (WHE), a Louisiana-licensed water well driller, performed the drilling. Soil borings where monitoring wells were not installed were grouted to the ground surface using a Portland/powdered bentonite grout mixture consistent with LDEQ/LDOTD specifications, except some shallow hand auger borings were backfilled with soil cuttings.

Both ICON and ERM's investigations were hindered by site conditions (e.g., ICON cancelled field events due to wet/flooded conditions on the site; ERM required a marsh master with a brush cutter attachment to clear paths through the thick vegetation to the boring locations). Additionally, drilling was difficult beneath the site (hard, swelling clays resulted in four feet of recovery in as little as one-foot pushes in some locations; WHE was not able to install 1" diameter monitoring wells at some locations due to the inability to drive 3.25" barrels to the target depth).

Soil samples were collected continuously in four-foot long, new, dedicated acetate liners from each boring to the total depth. The soil samples were logged in the field by an ERM scientist, including field screening with a Photo Ionization Detector (PID), and handheld electrical conductivity (EC) pen. Soil samples were collected for laboratory analysis in new laboratory-provided containers and immediately placed on ice. Soil samples were sent to Element Materials Technology in Lafayette, Louisiana, Pace Analytical in Baton Rouge Louisiana, and Waypoint Analytical in Marrero, Louisiana for analysis. These laboratories are

Louisiana Environmental Laboratory Accreditation Program (LELAP) accredited laboratories. ICON was present during ERM's investigation and collected splits of ERM's soil samples.

Soil samples collected from the water-bearing zone and/or underlying clay unit in ERM's borings H-12R, H-16R, and MW-8 were sent to Ardaman & Associates, Inc. in Baton Rouge, Louisiana for geotechnical analyses including laboratory classification, grain size, and vertical permeability. The geotechnical results, presented on Table 10, document the clayey and fine-grained nature of the majority of the soils underlying the Property, and the variability in the composition of the water-bearing zone. The vertical permeability of the clay layer encountered beneath the shallow water-bearing zone ranges from 3.2×10^{-9} to 1.1×10^{-7} cm/sec (Table 10). The permeability of the clay layer is consistent with the Statewide Order 29-B definition of a "Natural liner – having a hydraulic conductivity no greater than 1×10^{-7} cm/sec". The predominantly clayey soils underlying the Property are part of the confining unit that precludes vertical water migration and protects the Chicot Aquifer below the confining unit.

ERM's resamples of H-8 (H-8R 0-2') and H-28 (H-28R 0-2') were sent to Core Mineralogy, Inc. (Core) in Broussard, Louisiana for barium speciation by semi-quantitative x-ray diffraction (XRD) and energy dispersive x-ray spectrometry (EDX). The barium speciation results are included in the Core laboratory report in Appendix H.

HLP Engineering (HLP) conducted a soil sampling event on July 3, 2020, on behalf of UWEC. Ten borings were advanced to a depth of 0.5 to 1.0 ft bgs with the use of a 2-inch diameter stainless steel hand auger. Samples were collected east of Area 5 (B1, B2, and B3) and east of Area 6 (A1, A2, A3, A4, and A5). Samples C1 and C2 were collected off site and are not included in ERM's evaluation. Samples collected were sent to Element Materials Technology in Lafayette, Louisiana for analysis. ERM was not notified of this sampling event and was not present to observe the sampling or collect split samples.

During ICON and ERM's investigations, a total of over 650 soil samples from 102 locations on the Property were submitted for laboratory analysis.

Soil laboratory results are presented on Table 6. Constituent distribution maps for 29-B salt parameters (electrical conductivity [EC], sodium adsorption ratio [SAR], and exchangeable sodium percentage [ESP]), and RECAP parameters barium, and total petroleum hydrocarbon (TPH) fractions in soil, are presented on Figures 100 through 113. A discussion of the soil results in each sampling area is included in Section 7 of this report.

Dr. Luther Holloway and Mr. Patrick Ritchie performed a root study on the Property concurrently with ERM's investigation. Based on their results, effective root zones are shallow across the Property, up to approximately 10 inches in depth (see Section 9.2).

6.2 Hydrogeology

An ERM scientist visually logged soil cores during the soil and groundwater investigation activities and the boring logs are provided in Appendix A. Cross sections depicting the subsurface lithology based on ERM boring logs are shown on Figures 12 through 15. The shallow soils underlying the Property down to a depth of at least approximately 78 feet below the ground surface consist primarily of clay and silty clay with a highly variable and discontinuous shallow water-bearing zone that consists primarily of clayey silt and silt, with varying amounts of sand in some locations. The shallow water-bearing zone is composed of laterally variable and discontinuous silt stringers which are encountered at variable depths between approximately 20 and 62 feet below ground surface. The various silt stringers appear to be poorly interconnected, but generally exist as a single water-bearing unit. The water-bearing silt stringers, where present, range in thickness from zero to approximately 12 feet, with a thickness typically less than 5 feet. A thicker silt zone was encountered in ICON's boring H-32, which appears to be related to nearby Bayou

Lacassine. This location is approximately 3,500 feet from the nearest former oilfield operational area and is not representative of subsurface soils beneath the vast majority of the Property. The shallow water-bearing zone is present within shallow soils underlying the Property, which are part of the confining unit overlying the Chicot Aquifer. The confining unit is reported to range in thickness from approximately 120 to 200 feet beneath the property. The confining unit restricts infiltration of precipitation into the Chicot Aquifer groundwater system. Data collected by both ERM and ICON confirms that the confining unit beneath the shallow water-bearing zone is protective of the Chicot Aquifer across the Property (including the vicinity of the former blowout well) through the following lines of evidence:

- The clay-confining unit overlying the Chicot Aquifer is reported by Sargent (2004) to range in thickness from approximately 120 to 200 feet, which is generally consistent with water well drillers logs on the Property. Boring logs from wells installed by ICON and ERM show that the bottom of the shallow water-bearing zone beneath the Property was encountered at a maximum depth of approximately 62 feet (see boring log H-12R, Appendix A). Approximately 60 feet of clay confining unit (and in some locations considerably more) separates the shallow water bearing zone from the underlying Chicot Aquifer
- Potentiometric groundwater surface elevations in the Chicot Aquifer are approximately 30 to 40 feet lower than potentiometric groundwater surface elevations in the shallow water-bearing zone, as shown on Figures 17 and 29.
- Vertical permeability data collected beneath the shallow water-bearing zone in multiple locations across the Property (including H-12R 74-76', adjacent to the former blowout well) is consistent with the Statewide Order 29-B definition of a "Natural liner – having a hydraulic conductivity no greater than 1 x 10^{-7} cm/sec" and precludes vertical water migration and protects the Chicot Aquifer below the confining unit.
- SPLP chloride data collected beneath the shallow water bearing zone demonstrates protection of groundwater (e.g., H-12 76-78', MW-4 58-60', and H-16R 50-50.5')
- Laboratory results for 29-B salt parameters in soil, along with EC probe logs and field EC readings, demonstrate that salt impacts are vertically delineated in each Chevron limited admission area where 29-B salt parameter exceedances were observed, including the vicinity of the former blowout well (see Section 7), and shows that the clay confining unit is protective of vertical migration beneath the shallow water-bearing zone.

6.3 Groundwater

ICON's November 2019 through August 2021 investigation activities included installation and sampling of 19 groundwater monitoring wells at 18 locations. With the exception of well H-26 (which did not produce sufficient water to fill all of ICON's or any of ERM's sampling containers), ERM collected split samples during ICON's groundwater sampling events. ICON conducted slug tests at wells H-3, H-9, H-18, H-20, and H-27. ICON plugged and abandoned one well (H-34) after groundwater sampling was completed.

S. J. Langlinais & Associates, Inc., a Louisiana-licensed professional land surveyor based in Abbeville, Louisiana surveyed the location, top of casing (TOC), and ground surface elevation of ICON's wells on May 24, 2021. ICON's wells H-32A, H-32B, H-33, and H-34 were not installed at the time of the survey and were not subsequently surveyed. ICON conducted a round of water level measurements in the existing monitoring wells on November 22, 2019, and May 24, 2021.

ERM's November 2021 to January 2022 investigation activities included the installation and sampling of 12 monitoring wells at 11 locations. Monitoring well installation was performed by Walker Hill Environmental (WHE), a Louisiana-licensed environmental driller. The monitoring wells were installed in

or adjacent to the boreholes used to continuously collect soil samples for visual description purposes. Where WHE was able to advance 3.25" barrels to the target depth, a 1-inch diameter Schedule 40 polyvinylchloride (PVC) monitoring well equipped with a prepacked screen (0.01-inch slot) was installed in the borehole. Due to difficult drilling conditions, some boreholes could only be completed to the target depth with 2.25" barrels, necessitating the use of ¾-inch diameter PVC well materials. A 20/40 grain size silica sand pack was placed in the annular space and extended to approximately 2 feet above the top of the screen. An approximate 2 to 3-foot bentonite pellet plug was placed on top of the sand pack. The remainder of each borehole was tremie-grouted to the ground surface using a Portland/powdered bentonite grout mixture consistent with LDEQ/Louisiana Department of Transportation and Development (LDOTD) specifications. A locking cap was installed on each monitoring well.

Each monitoring well was completed with an above-grade, locking, steel protective casing. The protective casing was set in an approximate two-foot by two-foot, approximate 4-inch thick concrete pad. Steel guard posts were installed around monitoring well MW-11, which is located near a gravel road. The monitoring wells were installed in accordance with the LDEQ/LDOTD Construction of Geotechnical Boreholes and Groundwater Monitoring Systems Handbook.

Representative groundwater samples were collected from each ERM well following the procedures outlined below. Dedicated polyethylene tubing was lowered to the approximate middle of the well screen and a peristaltic pump was used to develop, purge, and sample each well. Each monitoring well was developed to remove fine-grained sediment and prepare the well for the collection of water samples representative of the actual groundwater quality at each location. Well development was accomplished by pumping and surging. Groundwater was purged at EPA-recommended rates of 0.1 to 0.5 liters/minute. Field geochemical parameters including pH, temperature, specific conductance (SC), dissolved oxygen (DO), turbidity, and oxidation-reduction potential (ORP) were measured during the well purging process. A graduated bucket was used to measure the volume of water removed. Development and purging was determined to be complete when water quality parameters had stabilized and water clarity showed no further improvement. Wells that purged dry during development were allowed to recover and purged dry multiple times prior to sampling. The field parameters recorded during the groundwater sampling events are provided on Table 9.

Following stabilization of field parameters, the groundwater input tubing was disconnected from the flow-through cell, and laboratory-supplied sample bottles were filled at the purge rate. Each groundwater sample was directly discharged to the laboratory-supplied sample bottles. Each sample bottle was labeled with a unique sample number, the date and time of collection, and the sampler's initials. ICON was present during ERM's groundwater sampling activities and collected split samples.

Samples were placed on ice immediately following collection and submitted under proper chain-of-custody to Waypoint Analytical in Marrero, Louisiana, Pace Analytical in Baton Rouge Louisiana, and Eberline Analytical in Oak Ridge, Tennessee for analysis. These laboratories are LELAP accredited laboratories.

During ICON and ERM's investigations, a total of 61 groundwater samples from 31 monitoring wells on the Property were submitted for laboratory analysis.

M. P. Mayeux Surveying and Boundary Consulting, L.L.C., a Louisiana-licensed professional land surveyor based in Scott, Louisiana surveyed the location, top of casing, and ground surface elevation of ERM's wells and the remaining ICON wells on December 15-16, 2021, and January 11, 2022. The survey data are included in Appendix L. ERM conducted water level measurements in the surveyed monitoring wells, along with the remaining ICON monitoring wells, on December 21, 2021. Water levels were measured in each well using an electronic tape, which was slowly lowered down the center of the casing

and the water level was recorded to the nearest hundredth of a foot. The survey data from ERM's investigation and groundwater elevation measurements from both ICON and ERM's investigations are presented in Table 2. Groundwater elevations were adjusted for density (equivalent fresh water head [EFWH]) and are shown on Table 2. Potentiometric surface maps showing groundwater elevations as measured and adjusted for density are provided on Figures 23 through 28.

Slug tests were performed on each of ERM's twelve monitoring wells. The slug tests were performed with a solid stainless steel or PVC slug. Water levels in the wells were continuously recorded using an In-Situ Level Troll 700 pressure transducer and data logger. ERM analyzed the data from both ICON and ERM's slug tests by uploading the water level data into AQTESOLV Version 4.5, a commercially available and widely used software program. The water level displacement data collected during the tests were plotted electronically on a logarithmic scale vs. elapsed time on a linear scale. As specified in RECAP Appendix F, the Hvorslev (1951) curve-matching method for confined aquifers was used to calculate the hydraulic conductivity. The well yield for each well was calculated based upon LDEQ's RECAP Appendix F equations. The overall yield of the shallow water-bearing zone was calculated as specified by RECAP by taking the geometric mean of wells screened in the shallow water-bearing zone. The overall yield of the discontinuous shallow water-bearing zone is 398 gallons per day (gpd) and falls within the range specified by LDEQ as a Class 3 aquifer (less than 800 gpd). The calculated yield is likely an overestimate, as it does not account for locations where shallow groundwater was not encountered. The slug test results are presented in Table 1. Slug test reports are presented in Appendix D.

The barium, chloride, radium-226/-228, and sulfate results in groundwater are shown on Figures 114 through 117. Benzene and hydrocarbon results in groundwater are shown on Figures 118 and 119. A discussion of the groundwater results in each sampling area is included in Section 7 of this report.

Various monitoring wells on the Property exhibit concentrations of sulfate that exceed the EPA SMCL. If the sulfate present in the shallow groundwater was the result of oilfield activities, a correlation between chloride and sulfate concentrations would be expected. However, as shown on Figure 120, the highest detected sulfate concentrations do not correlate with the highest chloride concentrations. The lack of any correlation is consistent with a natural source of sulfate. Similarly, concentrations of iron and manganese were detected in multiple monitoring wells across the Property above their corresponding SMCLs. Iron and manganese were detected above the SMCLs in monitoring wells in areas consistent with natural conditions (i.e. Areas 1 and 9) demonstrating that iron and manganese are naturally occurring in the shallow water-bearing zone at concentrations above the SMCLs.

To visually depict the natural groundwater quality in the shallow groundwater, ERM has prepared both Piper and Stiff diagrams utilizing concentrations of the naturally occurring cations (sodium, potassium, calcium and magnesium) and anions (chloride, bicarbonate and sulfate) present in the groundwater (Figures 121 and 122). Piper and Stiff diagrams visually depict variations in water chemistry resulting from variable concentrations of cations and anions naturally present in groundwater.

An examination of the grouping of the individual sample results on the Piper diagram assists in the identification of individual water types and evaluating differences between various water types. Water samples that plot in the same general location on a Piper diagram indicate similar water quality. Groundwater and surface water samples collected on the Property and a typical produced water sample collected in the Hayes field are shown on the Piper diagram on Figure 121. Based on the laboratory results, along with the distance from former oilfield operations (i.e., sample locations are from 3,500 to 5,000 feet from the nearest former operational area), groundwater in H-32A, H-32B, H-33, and H-34 is clearly representative of natural conditions. Samples H-20, H-22, H-23, H-24, H-25, H-26, H-27, MW-1, MW-2, MW-3, MW-8, MW-9, MW-9D, and MW-10 plot in the same general area on the Piper diagram, demonstrating similar groundwater quality that is likely representative of natural variation.

The Stiff diagrams shown on Figure 122 demonstrate the presence of groundwater samples consistent with natural conditions on the Property. In areas which show indications of a produced water signature (e.g., H-9, H-12, H-16, and H-18), water quality improves rapidly with distance from the former operational areas. This demonstrates that groundwater migration has been limited, and that E&P activities have not affected the shallow groundwater underlying the majority of the Property.

The horizontal groundwater gradient beneath the Property is low at approximately 0.0003 to 0.003 in the shallow water-bearing zone. The low hydraulic conductivity and slow groundwater movement in the shallow water-bearing zone limits the potential for migration of residual salt impacts in soil or groundwater.

6.4 Surface Water

On December 16, 2021, ERM conducted a field investigation of the pond on the Property. Depth measurements were collected using a stainless steel plumb bob attached to a fiberglass tape measure. The maximum water depth measured was approximately 15 feet near the center of the pond. Two surface water samples were collected from the pond at depths of 2 feet and 13 feet. Samples were collected by attaching tubing to the tape measure and plumb bob to pump water from the desired depth. The same sampling equipment and procedure used for groundwater sampling (described in Section 6.3) was also used for surface water sampling. Samples were placed on ice immediately following collection and submitted under proper chain-of-custody to Waypoint Analytical in Marrero, Louisiana, and Eberline Analytical in Oak Ridge, Tennessee for analysis. These laboratories are LELAP accredited laboratories. The surface water sample location, SW-BO, is shown on Figure 98, and surface-water sample results are presented on Table 8.

M. P. Mayeux Surveying and Boundary Consulting, L.L.C., a Louisiana-licensed professional land surveyor based in Scott, Louisiana surveyed the surface water elevation of the pond on December 16, 2021. The survey data are included in Appendix L.

7. EVALUATION OF SAMPLING RESULTS

An evaluation of the soil, groundwater, and surface water sampling results on the Property is provided in this section. A RECAP evaluation of the data is presented in Section 8 of this report.

7.1 Limited Admission Areas

7.1.1 Limited Admission Area 2

7.1.1.1 Soil

ICON advanced three borings around the pond in Area 2 (H-9, H-11, and H-12). Elevated 29-B salt parameters were observed in H-9 and H-12. However, ICON's EC probe logs show a rapid decrease in EC at these locations below the maximum sampled depth (see Figure 99). Elevated 29-B salt parameters were primarily encountered below the root zone, with only one slight exceedance in the root zone (SAR of 14.4 at H-12 0-2'). Exceedances of 29-B salt standards were not identified at any depth in the H-11 location. Barium was detected above the RECAP screening standard in the 0-2' interval at H-11.

ERM's investigation included further evaluation of soil in Area 2. A boring was advanced at the H-12 location (H-12R) to a depth of 78 feet. Soil samples were collected in the 0-1', 1-2', and 2-3' intervals and demonstrate that elevated SAR is not encountered in the effective root zone (i.e., upper one foot of soil). A sample collected in the 76-78' interval did not exhibit exceedances of 29-B salt parameters and provides vertical delineation in Area 2. Geotechnical analysis was performed on the 74-76' interval and the sample had a vertical permeability of 3.2×10^{-8} cm/sec, demonstrating that clayey soils underlying the shallow water-bearing zone in Area 2 preclude vertical water migration and protect the Chicot Aquifer below the confining unit. Five additional soil borings (MW-1 through MW-5) were advanced by ERM for horizontal delineation purposes. Each of these borings was advanced to a minimum of 60 feet. Laboratory samples collected at MW-1 through MW-4 did not exhibit exceedances of 29-B salt parameters and the locations horizontally delineate 29-B salt parameters in soil to the north, west, and south. Horizontal delineation was previously achieved to the east by ICON's H-11 boring; therefore, soil samples from MW-5 were not submitted for laboratory analysis. Field EC measurements from the MW-5 boring further demonstrate delineation of salt parameters to the east (see boring log in Appendix A).

ERM's investigation also included further evaluation of barium in soil, including stepout borings to the north, east, and south of H-11, and laboratory analysis of barium at MW-1 through MW-4. Barium concentrations were reported above the RECAP screening standard in the 0-2' interval at some boring locations, though often not confirmed in the split sample results (see Figure 107). H-11 was resampled (H-11R) for SPLP barium in the 0-2' interval, and the leachate results demonstrate that the barium detected at the H-11 location is protective of groundwater. Barium is further evaluated under RECAP in Section 8.

Based on the RECAP evaluation, additional delineation is proposed for barium, and the concentrations are screened in Figure 107 relative to the default limiting screening standard (550 mg/kg) and an updated RECAP screening value of 1,600 mg/kg. The updated screening value and proposed sampling program to further delineate barium in soil is presented in detail in Section 10.

7.1.1.2 Groundwater

ICON installed and sampled monitoring wells at the H-9 and H-12 locations adjacent to the pond. Groundwater at H-9 and H-12 exhibited elevated concentrations of chloride (up to 23,900 mg/L and 45,800 mg/L, respectively). Concentrations were detected above the RECAP groundwater screening

standard (GW_{ss}) and/or RECAP Class 3 Non-Drinking Water standard (GW_{3NDW}) for strontium (up to 22.3 mg/L and 49.2 mg/L) and benzene (up to 0.014 mg/L and 0.089 mg/L). Combined radium-226 and -228 was reported above the EPA MCL in ICON's samples of H-9 (17.0 pCi/L) and H-12 (50.0 pCi/L) but the values were not confirmed in ERM's split samples (0.787 pCi/L and 2.079 pCi/L, respectively); regardless, the radium-226/-228 standards are not applicable to the shallow water bearing zone due to its low yield. H-12 also included barium (up to 2.27 mg/L) and TPH-G (0.209 mg/L) reported above the RECAP GW_{SS}; however, ERM's split sample was analyzed for TPH fractions (the LDEQ recommended methodology for hydrocarbon risk assessment), which were not detected above the RECAP screening standards. ICON did not install a monitoring well at the H-11 location, presumably because the shallow water-bearing zone was not encountered.

ERM installed and sampled monitoring wells at five stepout locations around the former blowout well location (MW-1 through MW-5). The soil boring at each of these locations was advanced to a minimum of 60 feet bgs in order to target the water-bearing zone at the same depth interval encountered at H-9 and H-12 (approximately 50 to 60 feet bgs). However, the shallow water-bearing zone was encountered somewhat shallower at MW-3, MW-4, and MW-5, demonstrating the highly variable and discontinuous nature of the shallow water-bearing zone. One of these samples, ICON's split of MW-5, contained a concentration above the RECAP GW_{SS} for strontium, which was not confirmed in ERM's split sample. Monitoring wells MW-1 through MW-5 provide horizontal delineation to below screening levels in Area 2 for barium, benzene, and radium. The chloride of up to 1,320 mg/L detected at MW-5 is further delineated to the east in Area 4 (see Section 7.1.2.2). The chloride concentration detected at MW-4 to the north (up to 1,090 mg/L) is over 40 times lower than the maximum detected chloride concentration in Area 2 (45,800 mg/L at H-12), demonstrating rapidly declining chloride concentrations over a short distance (approximately 360 feet in the down-gradient direction). Chloride is delineated to below GWss to the west and south by MW-1 through MW-3. A proposed sampling plan to further delineate chloride in groundwater north of MW-4 is presented in Section 10.

Water quality at MW-1, MW-2, and MW-3 is similar to natural conditions and within expected natural variability, as shown on the Piper and Stiff diagrams (Figures 121 and 122). Elevated concentrations of chloride, sulfate, iron, and manganese demonstrate the naturally poor quality of the shallow water-bearing zone.

7.1.1.3 Surface Water

Surface water samples collected from the pond are consistent with fresh water conditions. ICON detected low concentrations of TPH-D and TPH-O at 13 feet deep, and these detections were not confirmed in ERM's TPH fraction analysis and appear to be related to natural organic material in the pond. The unimpacted conditions and shallow depth of the pond indicate a lack of connection with the shallow water-bearing zone and the Chicot Aquifer.

7.1.2 Limited Admission Area 4

7.1.2.1 Soil

ICON's investigation in and around Area 4 included the collection of soil samples from ten borings in and around the former operational areas (H-2, H-7, H-8, H-10, H-15, H-16, H-20, H-21, H-22, and H-23). Elevated 29-B salt parameters were observed in H-15, H-16, and H-21, including EC at the maximum depth sampled by ICON in H-16. However, ICON's EC probe log shows a rapid decrease in EC at this location below the maximum sampled depth (see Figure 99). Samples collected at H-15 and H-21 decline with depth to levels below the 29-B salt parameter standards. Elevated 29-B salt parameters were

primarily encountered below the root zone, with only one sample exhibiting exceedances of standards in the root zone (ESP of 23.8% and SAR of 12.9 at H-21 0-2' [neither exceedance confirmed in ICON split sample]). TPH-D was reported by ICON above the RECAP screening standard at H-15 in the 4-6', 6-8', 8-10', and 10-12' intervals; however, ERM's split samples were analyzed for TPH fractions (the LDEQ recommended methodology for hydrocarbon risk assessment), and a single fraction was reported above a RECAP screening standard (aliphatic >C8-C10 in the 6-8' interval). TPH mixtures and fractions were not detected above the RECAP screening standards in the 12-14' interval, demonstrating vertical delineation of hydrocarbons at this location. Barium concentrations were reported above the screening standard in some borings, typically limited to the uppermost sample interval (0-2' or 0-4' interval).

ERM's investigation included further evaluation of soil in Area 4, including five resample locations and 22 new boring locations. H-21 was resampled for salt parameters (H-21R) in the 0-1', 1-2', and 2-3' intervals and the results demonstrate that elevated ESP and SAR are not encountered in the effective root zone (i.e., upper one foot of soil). An additional sample was collected at H-21R in the 22-24' interval, and the results were below 29-B standards for salt parameters, demonstrating vertical delineation. H-16 was also resampled to further evaluate 29-B salt parameters (H-16R). The sample collected in the 50-50.5' interval did not exhibit 29-B salt parameter exceedances and demonstrates vertical delineation. Furthermore, geotechnical analysis was performed on the 50.5-51' interval and the sample had a vertical permeability of 1.1×10^{-7} cm/sec, demonstrating that clayey soils underlying the shallow water-bearing zone in Area 4 preclude vertical water migration and protect the Chicot Aquifer below the confining unit. ERM's soil sampling in Area 4 also included analysis of 29-B salt parameters at H-21W, MW-6, and MW-7. Of these locations, only MW-6 exhibited slight exceedances of 29-B standards at depths below the root zone (SAR in 4-6' interval and EC in 18-20' interval). Delineation of 29-B salt parameters in soil in Area 4 is achieved vertically by borings H-16, H-21, MW-6, and MW-7, and horizontally by H-2, H-8, H-10, H-20, H-22, H-23, H-21W, and MW-7.

Additional sampling was conducted in the vicinity of H-15 for further evaluation of hydrocarbons. H-15 was resampled (H-15R) in the 6-8' interval for analysis of polycyclic aromatic hydrocarbons (PAHs) in accordance with RECAP Appendix D, and reported concentrations were below RECAP screening standards. Stepout borings were advanced to the north (H-15N), east (H-15E), south (H-15S), and west (H-15W). Evidence of hydrocarbon impacts (e.g., visual or olfactory observations or elevated PID readings) were not observed in these borings, and samples were collected for TPH fractions in the 6-8' interval. TPH fractions were below RECAP screening standards in these samples, demonstrating horizontal delineation of hydrocarbons (see Figure 112).

Barium in soil was further evaluated at locations in the 0-2' interval (H-8E, H-8N, H-8N2, H-8S, H-8W, H-15E, H-15N, H-15S, H-15W, H-16R, H-16E, H-16N, H-16S, H-16W, H-22E, H-22N, H-22S, H-22S2, and H-22W). Concentrations were reported above the RECAP screening standard in some boring locations, and in many of these, the split sample result did not confirm the concentration (see Figure 108). Boring locations H-8, H-16 and H-22 were resampled (H-8R, H-16R, and H-22R, respectively) in the 0-2' interval for analysis of SPLP barium. Results at these locations were below the RECAP screening standard for leachate, demonstrating that barium concentrations at these locations are protective of groundwater. Barium speciation was performed on sample H-8R 0-2', and the results indicate that barium in the area is characterized as barite. Barium is further evaluated under RECAP in Section 8.

Based on the RECAP evaluation, additional delineation is proposed for barium, and the concentrations are screened in Figure 108 relative to the default limiting screening standard (550 mg/kg) and an updated RECAP screening value of 1,600 mg/kg. A proposed sampling program to further delineate barium in soil, with discussion of the rationale for locations in Area 4, is presented in Section 10.

7.1.2.2 Groundwater

ICON installed and sampled monitoring wells at six locations (H-2, H-10, H-16, H-20, H-22, and H-23), and ERM installed and sampled two additional wells (MW-6 and MW-7) in and around Area 4. Where elevated constituents were detected in Area 4, they were highest near the former operational area (e.g., H-16) and decreased rapidly with distance. Strontium was detected above the RECAP screening standard (2.2 mg/L) in H-16 (28.4 mg/L), MW-6 (2.88 mg/L), and MW-7 (3.76 mg/L). Cadmium was detected in H-16 slightly above the RECAP screening standard, and was not detected in the dissolved analysis. TPH-D and TPH-O were reported by ICON above the RECAP screening standard in H-16; however, ERM's split sample was analyzed for TPH fractions (the LDEQ-recommended methodology for hydrocarbon risk assessment), which were not detected. Combined radium-226 and -228 were reported slightly above the EPA MCL, which is not an applicable standard, in ICON's sample of H-16 (5.387 pCi/L) but was not confirmed in ERM's split sample (0.0771 pCi/L). Chloride in groundwater was highest at H-16 (up to 13,000 mg/L) and was also elevated at H-2 (1,340 mg/L), H-10 (1,290 mg/L), MW-6 (1,940 mg/L), and MW-7 (2,580 mg/L). The distribution of chloride concentrations indicates a rapid decrease with distance from the operational area (e.g., approximately 7 times lower over 185-foot distance from H-16 to MW-6; approximately 5 times lower over 310-foot distance from H-16 to MW-7). Horizontal delineation of groundwater parameters is provided by H-20 to the east, H-22 to the south, and H-23 to the north, which exhibit water quality similar to natural conditions and within expected natural variability, as shown on the Piper and Stiff diagrams (Figures 121 and 122). Elevated concentrations of chloride, sulfate, iron, and manganese in these samples demonstrate the naturally poor quality of the shallow water-bearing zone. Delineation is achieved to the west by H-2 and H-10, except for chloride, which shows decreasing concentrations in this direction and is delineated further west by wells in Area 2 (see Section 7.1.1.2).

7.1.3 Limited Admission Area 5

7.1.3.1 Soil

ICON's investigation in Area 5 included the collection of soil samples from four borings in and around the former operational area (H-1, H-17, H-18, and H-19). Elevated 29-B salt parameters were observed in each of ICON's borings in Area 5, with exceedances at multiple depths in H-17 and H-18, but only slight EC exceedances in H-1 (4.79 mmhos/cm at 6-8') and H-19 (4.27 mmhos/cm at 4-6' [not confirmed in ICON split]). Samples collected at each of these locations decline to levels below the 29-B salt parameter standards with depth. Elevated 29-B salt parameters were primarily below the root zone, with only one sample exhibiting slight exceedances of standards in the root zone (ESP of 17.6% and SAR of 14.6 at H-18 0-4' [no split sample provided by ICON]). Barium was reported above the RECAP screening standard by ICON in the uppermost sample interval (i.e., 0-2' or 0-4' interval) at each of the ICON borings in Area 5; however, ICON did not provide ERM with split samples of these intervals.

ERM's investigation included further evaluation of soil in and around Area 5, including three resample locations and eleven new boring locations. H-18 was resampled for salt parameters (H-18R) in the 0-1', 1-2', and 2-3' intervals, and results demonstrate that elevated ESP and SAR are not encountered in the effective root zone (i.e., upper one foot of soil). Although ICON's original H-18 sample provided vertical delineation of salt parameters, there was a large interval between 16 and 42 feet bgs where no laboratory data were collected. To further refine vertical delineation at the H-18 location, H-18R also included sampling of EC in the 18-20' and 26-28' intervals. The horizontal extent of 29-B salt parameter exceedances was evaluated in stepout borings H-1SE, H-17SW, H-18NW, MW-8, MW-9, MW-10, and MW-11. Of these stepout borings, 29-B salt parameter exceedances were detected in only H-18NW, which had EC and SAR exceedances beneath the root zone at depths similar to those encountered in H-18/H-18R. Geotechnical analysis was performed at MW-8 on the 50-52' interval and the sample had a

vertical permeability of 3.2 x 10^{-9} cm/sec, demonstrating that clayey soils underlying the shallow water-bearing zone in Area 5 preclude vertical water migration and protect the Chicot Aquifer below the confining unit. Delineation of 29-B salt parameters in soil in Area 5 is achieved vertically by borings H-1, H-17, H-18, H-18NW, and H-19, and horizontally by H-1SE, H-17SW, MW-8, MW-9, MW-10, and MW-11.

Barium in soil was further evaluated at locations in the 0-2' interval (H-1R, H-1E, H-1SE, H-17SW, H-18R [0-4'], H-18NW, H-18SW, H-19R, H-19NE, H-19SW, MW-8, MW-9, MW-10, and MW-11). Concentrations were reported above the RECAP screening standard in some boring locations, and in many of these, the split sample result did not confirm the concentration (see Figure 109). Samples H-1R 0-2', H-18R 0-4', H-19R 0-2', and H-19NE 0-2' were analyzed for SPLP barium. Results at these locations were below the RECAP screening standard for leachate, demonstrating that barium concentrations at these locations are protective of groundwater. Barium is further evaluated under RECAP in Section 8.

Based on the RECAP evaluation, additional delineation is proposed for barium, and the concentrations are screened in Figure 109 relative to the default limiting screening standard (550 mg/kg) and an updated RECAP screening value of 1,600 mg/kg. A proposed sampling program to further delineate barium in soil, with discussion of the rationale for locations in Area 5, is presented in Section 10.

A "hydrocarbon sheen" was reported near the H-1 boring location by the plaintiff's expert Walker Wilson in his June 3, 2021 report. Additionally, HLP samples B1, B2, and B3 to the east of Area 5 had exceedances of the 29-B Oil & Grease standard and/or the RECAP screening standards for TPH-D and TPH-O. Both the hydrocarbon sheen area and the HLP sample locations are located east of Area 5 and outside of the Chevron Limited Admission area. ERM analyzed samples collected in this vicinity (H-1R 0-2', H-1E 0-2', and H-1SE 0-2') for TPH fractions, and results were below RECAP screening standards (see Figure 113).

7.1.3.2 Groundwater

ICON installed and sampled monitoring wells at two locations (H-1 and H-18), and ERM installed and sampled five additional wells (MW-8, MW-9, MW-9D, MW-10, and MW-11) in and around Area 5. Where elevated constituents were detected in Area 5, they were highest near the former operational area (e.g., H-18) and decreased rapidly with distance. Strontium was detected above the RECAP screening standard (2.2 mg/L) in H-18 (4.5 mg/L) and H-1 (2.22 mg/L [not confirmed in either ERM total or dissolved split analysis]). Cadmium was detected in H-18 slightly above the RECAP screening standard, and was not detected in the dissolved analysis. TPH-D and TPH-O were reported by ICON above the RECAP screening standard in MW-9D; however, ERM's split sample was analyzed for TPH fractions (the LDEQ-recommended methodology for hydrocarbon risk assessment), which were not detected. Chloride in groundwater was highest at H-18 (up to 3,960 mg/L) and was also elevated at H-1 (1,830 mg/L) and MW-11 (1,610 mg/L) The distribution of chloride concentrations indicates a rapid decrease with distance from the operational area (e.g., approximately 17 times lower over 250-foot distance from H-18 to MW-9D). Horizontal delineation of groundwater parameters is provided by MW-9 and MW-9D to the north, MW-10 to the west, and MW-8 to the south, which exhibit water quality similar to natural conditions and within expected natural variability, as shown on the Piper and Stiff diagrams (Figures 121 and 122). Elevated concentrations of chloride, sulfate, iron, and manganese in these samples demonstrate the naturally poor quality of the shallow water-bearing zone. Delineation is achieved to the east by H-1 and MW-11, except for chloride, which shows declining concentrations in this direction and is delineated further east by H-24 in Area 6 (see Section 7.1.4.2).

7.1.4 Limited Admission Area 6

7.1.4.1 Soil

ICON's investigation in Area 6 included the collection of soil samples from two borings (H-24 and H-28). The 29-B salt parameters were not elevated in either of these borings. Barium was detected above the RECAP screening standard in H-24 (not confirmed in ERM split) and H-28 in the 0-2' interval.

HLP samples A1 through A5 were collected from the 0.5-1' interval and were located east of Area 6 (outside of the limited admission area). Barium, TPH-D, and/or TPH-O were detected above the RECAP screening standard in these samples.

ERM's investigation in and around Area 6 consisted of further evaluation of barium in the 0-2' interval including two resamples (H-24R and H-28R) and twelve stepout samples (H-24E, H-24N, H-24S, H-24W, H-24NW, H-24NE, H-24SW, H-28E, H-28N, H-28S, H-28W, and H-28SE). Concentrations were reported above the RECAP screening standards (see Figure 110), and samples H-24R, H-24S, and H-28R were analyzed for SPLP barium in the 0-2' interval. Results at these locations were below the RECAP screening standard for leachate, demonstrating that barium concentrations at these locations are protective of groundwater. Barium is further evaluated under RECAP in Section 8.

Based on the RECAP evaluation, additional delineation is proposed for barium, and the concentrations are screened in Figure 110 relative to the default limiting screening standard (550 mg/kg) and an updated RECAP screening value of 1,600 mg/kg. A proposed sampling program to further delineate barium in soil, with discussion of the rationale for locations in Area 6, is presented in Section 10.

7.1.4.2 Groundwater

ICON installed one monitoring well in Area 6 (H-24). Groundwater in H-24 exhibits water quality similar to natural conditions and within expected natural variability, as shown on the Piper and Stiff diagrams (Figures 121 and 122). Elevated concentrations of chloride, sulfate, iron and manganese in these samples demonstrate the naturally poor quality of the shallow water-bearing zone.

7.1.5 Limited Admission Area 8

7.1.5.1 Soil

ICON's investigation in and around Area 8 included the collection of soil samples from two borings (H-3 and H-4). The 29-B salt parameters were not elevated in either of these borings. Barium was detected above the RECAP screening standard in ICON's samples at H-3 and H-4 in the 0-2' interval; however, ICON did not provide ERM with split samples of these intervals.

ERM's investigation in and around Area 8 consisted of further evaluation of barium in the 0-2' interval in the vicinity of former oilfield operations (i.e., H-4 area; the H-3 location is located over 700 feet south of the nearest former operational area and is outside the Chevron limited admission area). A resample was collected at H-4 (H-4R), and stepout samples were collected (H-4S, H-4E, H-4E2, H-4N, H-4N2, H-4W, and H-4W2). Concentrations were reported above the RECAP screening standard in some boring locations, and for some of these, the split sample result did not confirm the concentration (see Figure 111). Samples H-4R and H-4E2 were analyzed for SPLP barium in the 0-2' interval. Results at these locations were below the RECAP screening standard for leachate, demonstrating that barium concentrations at these locations are protective of groundwater. Barium is further evaluated under RECAP in Section 8.

Based on the RECAP evaluation, additional delineation is proposed for barium, and the concentrations are screened in Figure 111 relative to the default limiting screening standard (550 mg/kg) and an updated RECAP screening value of 1,600 mg/kg. A proposed sampling program to further delineate barium in soil, with discussion of the rationale for locations in Area 8, is presented in Section 10.

7.1.5.2 Groundwater

No groundwater wells were installed in Area 8; however, ICON installed one monitoring well south of Area 8 (H-3), located over 700 feet south of the nearest former operational area. Groundwater in H-3 exhibits water quality consistent with surface water samples collected on the Property, as shown on the Piper and Stiff diagrams (Figures 121 and 122). High concentrations of sulfate, iron, and manganese in these samples demonstrate the naturally poor quality of the shallow water-bearing zone. TPH-D was reported by ICON above the RECAP screening standard in H-3; however, ERM's split sample was analyzed for TPH fractions (the LDEQ recommended methodology for hydrocarbon risk assessment), which were not detected.

7.2 Other Sampling Areas

7.2.1 Sampling Area 1

7.2.1.1 Soil

Soil samples were collected in Area 1 from ICON borings H-25 through H-27. No exceedances of RECAP or 29-B standards in soil were detected in this area.

7.2.1.2 Groundwater

ICON installed and sampled monitoring wells at each of the three boring locations in Area 1. Each of these wells went dry during sampling, and the yield at H-26 was not sufficient to fill all of ICON's sample containers or to provide ERM with a split sample. ICON's H-25 and H-27 samples contained TPH-D (0.359 mg/L and 0.248 mg/L, respectively) above the RECAP screening standard (0.15 mg/L); however, ERM's split samples were analyzed for TPH fractions (the LDEQ-recommended methodology for hydrocarbon risk assessment), which were not detected. Water quality at H-25, H-26, and H-27 is similar to natural conditions and within expected natural variability, as shown on the Piper and Stiff diagrams (Figures 121 and 122). Elevated concentrations of chloride, sulfate, iron, and manganese demonstrate the naturally poor quality of the shallow water-bearing zone.

7.2.2 Sampling Area 3

Chevron and its predecessors did not operate in Area 3. Sampling results for this area are presented on tables and figures, but a detailed evaluation is not included as part of this report.

7.2.3 Sampling Area 7

Chevron and its predecessors did not operate in Area 7. Sampling results for this area are presented on tables and figures, but a detailed evaluation is not included as part of this report.

7.2.4 Sampling Area 9

Samples collected in Area 9 are located near Bayou Lacassine and are distant from any former oilfield operations (i.e., sample locations are approximately 3,500 to 5,000 feet from the nearest former operational area in Area 8).

7.2.4.1 Soil

ICON's investigation in Area 9 included the collection of soil samples from three borings (H-32, H-33, and H-34). Results were below the RECAP and 29-B standards in the soil samples collected in Area 9.

7.2.4.2 Groundwater

ICON installed four monitoring wells in Area 9 (H-32A, H-32B, H-33, and H-34). TPH-D was reported by ICON above the RECAP screening standard in H-32A and H-33; however, ERM's split samples were analyzed for TPH fractions (the LDEQ recommended methodology for hydrocarbon risk assessment), which were not detected. Based on the laboratory results, along with the distance from former oilfield operations, groundwater in Area 9 is believed to be representative of natural conditions (see Piper and Stiff diagrams on Figures 121 and 122). Elevated concentrations of chloride, sulfate, iron, and manganese in these samples demonstrate the naturally poor quality of the shallow water-bearing zone. Chloride concentrations detected in Area 9 indicate that natural chloride in the shallow water-bearing zone ranged up to 629 mg/L.

8. RECAP EVALUATION

The results of the soil and groundwater investigations were evaluated in accordance with RECAP, which provides LDEQ-recommended methods for identifying standards protective of human health and the environment. The Conceptual Site Model is provided in Section 8.1 to identify the exposure pathways and scenarios that warrant risk evaluation. Quantitative RECAP assessment is then provided for soil (Section 8.2.1) and groundwater (Section 8.2.2) in a step-wise process, using a screening step to first identify potential constituents of concern, followed by site-specific assessment.

8.1 Conceptual Site Model

A Conceptual Site Model (CSM) was developed based on the results of site investigations and a site-specific exposure pathway analysis. The CSM describes the potential exposures and the default scenarios used to evaluate the property under RECAP. The CSM (Figure 123) confirms that screening and Management Option (MO) RECAP standards (including their default exposure pathways/scenarios) applied to the site are appropriate and protective for the current and potential future exposure conditions.

8.1.1 Land and Groundwater Use

A discussion of property and groundwater characteristics was provided in Section 2, and the information is used in this section in the context of an exposure assessment. The majority of the Property has been used for agriculture, oil and gas E&P operations, high pressure gas pipeline ROWs, hunting leases, and undeveloped wetlands along Bayou Lacassine since the 1940s. The former E&P operational areas were located on an approximate 29-acre portion of the approximate 1,262-acre Property. A small portion of the Property outside of the E&P operational areas appears to have been used for residential purposes around 1940 through the late 1950s. The surrounding properties in this rural setting have similar uses including E&P activity, agriculture, and some rural residential use. Future use of the subject Property can reasonably be assumed to include this same range of potential uses. There are no sensitive receptors such as schools, hospitals, or nursing homes within a 500-foot radius of the Chevron investigation areas.

Groundwater beneath the Property is not currently used for any purpose. Chicot Aquifer groundwater was used historically to provide rig supply from screened intervals to 160 feet bgs and greater, and the wells were subsequently plugged. A water well in the Chicot Aquifer was identified in deposition testimony by Mr. Paul Roussel (representative of the former landowner), which is not currently in use. There is no indication that the shallow groundwater (encountered at various depths between approximately 20 and 62 feet bgs) has ever been used for water supply on the Property, and future use is not reasonably anticipated due the natural limitations of low yield and poor quality. There is no registered use of shallow groundwater within a mile radius of the Property based on the water well survey. This finding is consistent with ERM's identification of Class 3 for the groundwater beneath the Property based upon slug tests performed on seventeen monitoring wells, with an estimated mean sustainable yield of less than 800 gallons per day. Active wells within a mile surrounding the Property are screened in the Chicot Aquifer at total depths ranging from 125 to 370 feet bgs and are registered for rig supply, domestic supply, and irrigation. Beyond the mile radius, there is limited use of shallow groundwater, and the Property and the surrounding area are served by the Jefferson Davis Water and Sewer Commission #1 public water supply.

8.1.2 Exposure and Source Media

Surface soil is an exposure medium under current and future land use and was evaluated under RECAP as a direct contact exposure point. RECAP defines the upper 15 feet bgs as surface soil. Soil from all depths is evaluated as a potential source medium for transfer of constituents to groundwater.

Because there are no water supply wells completed in the affected shallow groundwater on the Property, there is no exposure and no risk or potential health effects resulting from direct exposure to constituents in groundwater. The water well depths in the vicinity of the Property indicate it is not routine practice to complete wells in the shallow, finer-grained water-bearing layers within the confining unit. The well survey information indicates the coarser-grained soil of the Chicot Aquifer, along with the Jefferson Davis Water and Sewer Commission #1 public water supply, provide productive water supply for the Property and surrounding area. Direct contact with shallow groundwater is not identified as a complete pathway.

In accordance with RECAP requirements, Class 3 groundwater is considered a potential source medium for surface water that could potentially receive discharge from the groundwater zone. Evaluation of the groundwater to surface water pathway is theoretical at this site because there is no indication that discharge of shallow groundwater to surface water features is occurring. A potential connection between groundwater and surface water was not identified on or near the Property. Shallow groundwater occurs below approximately 20 feet bgs, and often considerably deeper, while surface water bodies do not extend that deep. The shallow groundwater flow direction is variable, but on the portion of the Property west of Highway 14, flow is generally to the north. Groundwater flow east of Highway 14 appears to be generally to the northeast; however, groundwater flows away from the bayou to the southwest near Bayou Lacassine.

The Lacassine Bayou subsegment is designated for primary and secondary contact recreation, fish and wildlife propagation, and agriculture (Subsegment 050601 Lacassine Bayou, LAC 33:IX.1123). Because Lacassine Bayou is not a drinking water resource, GW3NDW is the appropriate groundwater classification for evaluation of the shallow water bearing zone in accordance with RECAP.

The volatile constituent benzene was detected in shallow groundwater in Area 2 of the Property, and potential release to outdoor air from the uppermost groundwater zone is evaluated as a potential pathway for benzene (GWairni). In addition, release of benzene from groundwater to an enclosed structure is evaluated as a hypothetical pathway (GWesni).

8.1.3 Summary of Exposure Pathway Analysis and Exposure Scenarios

Consistent with RECAP guidance, the land use of the study area as discussed above was considered in the evaluation of risk to human health from direct contact. The default RECAP standards relevant to potential soil contact under the current agricultural land use are the standards based on the industrial exposure scenario (for agricultural and pastureland, NAICS codes 111 and 112 in RECAP Appendix E). However, to address potential future use of the property (or portions of the property) as residential, the risk evaluation was performed using the default non-industrial (residential) exposure scenario of RECAP. A non-industrial assessment provides the most conservative assessment under RECAP, with greater exposure assumed relative to industrial and periodic recreational scenarios, and demonstration of compliance with non-industrial standards eliminates the potential requirement for conveyance notice for site soil.

Based on the analysis of potential exposure pathways for the site, the human exposure scenarios that are quantitatively evaluated under the Screening and Management Options for current and potential future conditions in accordance with RECAP include:

- *Non-industrial exposure to soil ($Soil_{ni}$):* exposure pathways include ingestion, dermal contact, and inhalation.
- *Soil-to-groundwater protection ($Soil_{GW3NDW}$):* transfer of constituents to the upper water bearing zone is evaluated, considering subsequent migration of constituents to surface water.
- *Class 3 groundwater (GW3NDW), shallow zone:* hypothetical groundwater discharge from the shallow groundwater zone to surface water (Lacassine Bayou), with use of surface water assumed to include recreation, fishing, and fish ingestion.
- *Groundwater-to-ambient air (GW_{airni}):* release of volatile constituents from the upper zone to ambient (outdoor) air, assuming inhalation can occur during non-industrial land use.
- *Groundwater-to-indoor air (GW_{esni}):* hypothetical release of volatile constituents from the upper zone to enclosed structure air, assuming inhalation can occur during non-industrial land use.

The default exposure assumptions provided in RECAP for these scenarios are utilized in the following assessment of soil and groundwater.

8.2 DEVELOPMENT AND COMPARISON TO RECAP STANDARDS

RECAP provides a tiered framework consisting of a Screening Option (SO) and three Management Options (MO-1, MO-2, and MO-3) to evaluate risks to human health and the environment posed by releases of chemical constituents to environmental media. The higher tiers of assessment offer the flexibility to derive standards more reflective of site-specific conditions.

The SO, for which generic criteria are provided by LDEQ, was used to identify preliminary constituents of concern (COCs) in soil and groundwater. Further evaluation was performed under MO-1 for groundwater and MO-2 for soil, as described in the subsections below. Supporting data and calculations for the risk assessment are provided in Appendix M.

8.2.1 Soil

The soil samples collected by ICON and ERM were used in the RECAP evaluation to assess human health risk. Chemical analytical results useful for RECAP risk assessment and consistent with Appendix D of RECAP are available for over 250 soil samples (including splits) collected from within Areas 2, 4, 5, 6, and 8 during 2019 through 2022 (Table 6). The soil samples at most boring locations included at least two depth intervals, with analysis for metals and/or hydrocarbon compounds useful for human health risk evaluation to a maximum depth of 16 feet bgs. Samples were also collected within this interval and additional, deeper depths for analysis of Statewide Order 29-B indicators of salinity and sodicity associated with agronomic objectives, but unrelated to human health risk (e.g., EC, SAR) as discussed in Section 7 for each area. Salt compounds in soil (e.g., sodium chloride) are not a concern for adverse effects to human health and therefore are not included in quantitative risk assessment for soil direct contact per RECAP.

Laboratory analyses for soil were performed using EPA- and LDEQ-recommended methods supported by Quality Assurance/Quality Control (QA/QC) data, with one deviation for ICON metals analysis noted below. Analytes in soil useful for risk assessment included metals, hydrocarbons, and PAHs. Field screening observations (e.g., staining or hydrocarbon odor) were used by investigators to guide the selection of samples for hydrocarbon analysis as documented in the boring logs. A review of the field and laboratory QA/QC results was performed in accordance with RECAP. Through data comparability review in consistent units (mg/kg-wet), ERM identified that ICON-reported results for barium were higher than the corresponding ERM-reported result in 80% of the split soil samples collected site-wide. The ICON results

were more than five times higher on average for barium, and while other metals were also higher in a similar percentage of the samples, no other metals demonstrated this degree of disparity. Based on the observation of differences, ERM performed a detailed data validation on ERM-reported metals results in soil. The data quality review and data usability report for the ERM data is provided in Appendix N. The ERM results for metals were confirmed to be valid, definitive data in accordance with RECAP requirements.[2] The same laboratory (Element) was used by ERM and ICON to perform the metals analyses, and the difference identified in the analytical procedures was a dry and grind preparation of the samples performed for ICON. The ERM-requested analyses adhered to EPA SW-846 preparation and analysis methods recommended by LDEQ for risk assessment. Despite the deviation, the ICON metals results for soil were included in the following RECAP evaluation to provide complete information, however, the impact of the bias in ICON's sample results is discussed in Section 10 in relation to delineation objectives for barium in soil.

Samples analyzed for total petroleum hydrocarbons by ICON were analyzed using the hydrocarbon mixture method (Method 8015), with the results expressed as total petroleum hydrocarbons in the diesel and oil ranges (TPH-DRO and TPH-ORO). For the ERM samples, hydrocarbon analysis was conducted using the more informative hydrocarbon fractioning method of analysis. Because hydrocarbon fractionation data provide more specific information than TPH mixture data and a more detailed understanding of TPH concentrations, use of fractionation data is recommended instead of TPH mixture data for conducting environmental risk assessments (LDEQ, 2003; TPHCWG 1997 and 1998; EPA, 2009), and fraction results were used in this risk analysis in accordance with RECAP Appendix D.[3]

The soil investigations were focused on sampling primarily within and in the vicinity of former pits and other oil and gas-related operational features that were located on the Property. The focus in former operational areas represents a biased sampling design, intended to characterize areas most likely to be impacted. The investigation completed on behalf of the defendant included collection and analysis of samples to provide additional sample density in potentially affected areas, as well as delineation, hydrocarbon fractionation, and leachate testing for metals of interest in accordance with RECAP. The sampling design is likely to overestimate risk for a typical human exposure scenario that includes movement during the assumed exposure duration (e.g., 25 to 30 years) over a broad area, including some more affected and some less affected locations. EPA and LDEQ recognize this kind of sampling design (i.e., biased or purposive sampling) as supporting conservative (protective) risk evaluation, with recognition of the potential for high bias in the risk estimation.

Screening Evaluation: As the first step in the RECAP risk evaluation, soil concentrations were compared to non-industrial limiting screening standards to identify constituents warranting further site-specific evaluation. Soil from the ground surface to a depth of 15 feet bgs is considered potentially available for direct human contact per RECAP definition ("surface soil"), and all data from 0 to 15 feet bgs (including samples from the 14-16' interval) were included in the comparison to health-protective screening standards for contact including dermal contact, soil ingestion, and inhalation. As a practical matter, repeated contact is limited to the surface material, and evaluation of soil samples collected deeper than the upper sample interval (0-2 feet) represents a hypothetical scenario which, to be relevant, requires that soil be excavated, spread, and left at the surface permanently.

[2] Data validation supports reliance on the ERM metals data for the definitive comparison to the RECAP standards (see LDNR letter of September 2, 2016 to John H. Carmouche Re: VPSB, et al. v. La Land et al Response to Motion for Clarification and/or Reconsideration)

[3] RECAP Appendix D states: "If TPH fractionation data and TPH mixture data have both been collected at an AOI and the two data sets yield different conclusions about management of the AOI, then management decisions shall be based on the fractionation data since the fractionation method yields more specific information regarding the TPH constituents present and thus more accurately characterizes site conditions."

For each of the soil admission areas identified on Figure 92, the maximum concentrations for each constituent reported within the upper 15 feet bgs are compared to the non-industrial limiting screening standards in Table 11. For surface soil, the limiting standards are the lower of the screening standard protective of non-industrial direct contact ($Soil_{SSni}$) and the groundwater protection screening standard ($Soil_{SSGW}$). Barium is the primary constituent identified through screening as warranting further risk evaluation under a Management Option of RECAP, with concentrations above the limiting screening standard in each study area. A single hydrocarbon fraction (aliphatic >C8-C10) was also reported above the limiting screening standard in one location in Area 4.

A site-specific demonstration of groundwater protection was performed for barium by collecting samples for synthetic precipitation leaching procedure (SPLP) analysis in each study area. ERM characterized the high end of the range of concentrations reported for barium through SPLP analysis of samples with maximum concentrations or by replicating the maximum locations, to the extent possible, for SPLP testing. As shown in the table below, all barium SPLP results were less than the RECAP screening standard for leachate, protective of all classes of groundwater.

Area	Sample	Barium (mg/kg) Soilssgw = 2000	Sample	Barium SPLP (mg/L) SPLPss = 40
Area 2	H-11 (0-2')	**2260**	H-11R (0-2')	0.206
Area 4	H-8 (0-2')	**6110**	H-8R (0-2')	1.83
	H-16 (0-2')	3660 / 186	H-16R (0-2')	0.472
	H-22 (0-2')	2700 / 53.1	H-22R (0-2')	1.04
Area 5	H-18 (0-4')	**5210**	H-18R (0-4')	0.885
	H-1 (0-2')	2540	H-1R (0-2')	4.41
	H-19NE (0-2')	1860 / 2070	H-19NE (0-2')	12.4
	H-19 (0-2')	3150	H-19R (0-2')	0.775
Area 6	H-24NE (0-2')	**6030** / 3310	*	*
	H-28 (0-2')	5460 / 902	H-28R (0-2')	11
	H-24 (0-2')	3490 / 294	H-24R (0-2')	1.65
	H-24S (0-2')	4150 / 3350	H-24S (0-2')	9.48
Area 8	H-4E2 (0-2')	**5680** / 3920	H-4E2 (0-2')	0.708
	H-4 (0-2')	3690	H-4R (0-2')	2.41

Bold – maximum reported barium concentration in soil in each area.

/ # - ICON sample result / ERM sample result.

* = sample to be collected (proposed in Section 10).

Barium (for the direct contact pathway) and aliphatic >C8-C10 are the COCs subject to further evaluation under a Management Option of RECAP to provide the appropriate site-specific assessment. For the remaining constituents, maximum reported concentrations (and all concentrations) in soil are below the non-industrial limiting screening standards in Table 11. These concentrations are protective of residential and unrestricted land use, protective of groundwater, and require no further risk assessment beyond screening.

The distribution of barium in soil, including an examination of lateral and vertical delineation relative to screening standards, is identified in Figures 106 through 111. The hydrocarbon fraction distribution is

identified in Figures 112 and 113. Based on the RECAP evaluation, additional delineation sampling is proposed for barium in Section 10.2.3.

Management Option Evaluation: The concentrations of barium and aliphatic >C8-C10 in surface soil were further evaluated under MO-2 in Table 12. The MO-2 RECAP Standard (RS) for barium was developed using the LDEQ-provided spreadsheets (RECAP, 2003, Appendix H) and the current toxicity value (reference dose) provided in the EPA Integrated Risk Information System (IRIS). No other changes to default RECAP parameters for a non-industrial scenario were made. MO-2 was used in accordance with RECAP Section 2.15 which indicates that the use of updated toxicity factors is appropriate and should be performed at the MO-2 (and higher) level.[4]

The Area of Investigation Concentrations (AOICs) for Areas 2, 4, 5, 6 and 8 are compared in Table 12 to the limiting MO-2 RS, which were identified for the COCs as the lowest of the direct contact standard ($Soil_{ni}$), groundwater protection standard ($Soil_{GW3NDW}$), and soil saturation concentration ($Soil_{sat}$). The $Soil_{ni}$ standards were evaluated for additivity to the same target organ in accordance with RECAP requirements as shown in Table 12.

AOICs were identified as the maximum concentrations in each area, and further calculation of exposure concentrations (e.g., 95% confidence limits on the mean) was not required to demonstrate compliance. The maximum reported concentrations in each of the study areas are less than the MO-2 RECAP standards, protective of human health for residential and unrestricted land use and protective of groundwater.

Evaluation of Salt in Soil: In accordance with RECAP guidance for the nontraditional parameter sodium chloride, the presence of salt in soil is not a concern for adverse effects to human health upon direct contact, and the evaluation of this compound is focused on vegetation health (an agronomic standard) and the potential soil-to-groundwater migration pathway. The evaluation related to agronomic health is provided in Section 7.1. To assess the soil-to-groundwater pathway, LDEQ recommends the comparison of SPLP leachate results from salt-affected soil to a standard developed for the appropriate classification of groundwater. All SPLP results for chlorides (as well as leachate concentrations for chlorides reported by ICON using an alternative leachate method) are less than the MO-1 GW_{3NDW} standard that incorporates the appropriate longitudinal DAF (440) under RECAP (GW_{3NDW} x DF3 = 90 mg/L x 440), assuming hypothetically that shallow groundwater could discharge to surface water. The site-specific testing included analysis of the maximum EC location in unsaturated soil, at the H-12 boring location (48-50'), and the leachate results indicate that concentrations of salt in soil do not represent a residual source of contamination to shallow groundwater (and hypothetical receiving surface water bodies) above applicable standards.

Protection of groundwater for salt parameters is further demonstrated by additional lines of evidence detailed in this report, including vertical delineation of 29-B salt parameters in each Chevron limited admission area, field EC data and EC probe logs, and geotechnical [vertical permeability] data. Because the maximum EC detections (average of splits) in Area 4 (H-16 16-18') and Area 5 (H-18 14-16') do not have corresponding SPLP chloride data (although SPLP chloride data is available at other depths in these borings), a contingent sampling program for SPLP chloride at these locations is provided in Section 10.2.2.

[4] Section 2.15 of RECAP states: "If a toxicity value presented in the RECAP document is revised by the EPA: 1) the SS and MO-1 RS shall not be re-calculated using the revised toxicity value; and 2) the MO-2 and MO-3 RS shall be calculated using the revised toxicity value."

8.2.2 Groundwater

The shallow groundwater samples collected by ICON and ERM were used in the RECAP evaluation. The groundwater data supporting human health risk assessment include over 35 samples (including splits) from 18 monitoring wells screened at variable depths generally in the range between 20 and 60 feet bgs in Areas 2, 4, 5, and 6. Groundwater analyses included total and dissolved metals, hydrocarbons, the volatile organic constituents BTEX, chlorides and other water quality indicators (Table 7). EPA and LDEQ-recommended laboratory methods were used with supporting QA/QC. Because of the fine-grained material in the shallow water-bearing zone beneath the Property, and because the sampling method required for small-diameter wells at these depths results in disturbance of sediment in the well (i.e., suspended sediment), analysis of filtered metals was performed by both parties for some samples and by ERM for all samples, as identified by EPA and LDEQ guidance on obtaining representative samples (LDEQ, 2003; EPA, 2002a; Saar, 1997).[5] Both the filtered and unfiltered sample results for metals are shown in the RECAP assessment tables for complete information, however, the results for the filtered samples provide more reliable data for representative groundwater concentrations (i.e., definitive data per RECAP) where turbidity was elevated. Similar to the soil analyses, ICON provided groundwater analyses of hydrocarbon mixtures (TPH-GRO, TPH-DRO, and TPH-ORO), and ERM provided fraction analyses for all groundwater samples. In accordance with RECAP Appendix D, the fraction analyses are used in the quantitative risk assessment.

Screening Evaluation: As a first step of RECAP evaluation, maximum reported concentrations in shallow groundwater were compared to screening standards protective for all classifications of groundwater to identify constituents warranting further site-specific evaluation (Table 13). The screening standards include MCLs, if available, and risk-based levels protective of a residential drinking scenario. RECAP identifies that SMCLs may be considered for groundwater assessment on a site-specific basis, and the SMCLs for chlorides, iron, TDS, and manganese were compared to the site groundwater concentrations for screening purposes. Following screening, the site-specific assessment under a Management Option of RECAP incorporates the appropriate classification of the groundwater. Both total and dissolved metals data are summarized on the screening table for complete information.

Constituents reported above screening standards or SMCLs in shallow groundwater and subject to further evaluation include benzene, the metals barium and strontium, and salt indicators chloride and TDS. In Areas 4 and 5, cadmium was reported just above the screening standard in the total metals analysis and below the standard in the filtered analysis of the same sample, as well as in all other samples collected across the site. Cadmium is not identified as an E&P-related constituent of concern in soil and is suspected to be an artifact of turbidity in groundwater. As discussed in Section 6.3, elevated sulfate in the shallow groundwater appears to be naturally occurring and unrelated to E&P activities. Iron and manganese are highly influenced by sampling-related turbidity and variable natural concentrations, and they are not identified as E&P-related constituents for further risk assessment.

Benzene, barium, and chlorides concentrations reported in groundwater samples are shown in Figures 118, 114, and 115, respectively. Benzene was reported above the screening standard in Area 2 in the vicinity of the known well blowout location, and benzene was analyzed and not detected in surrounding wells. The highest concentrations of barium, strontium, chlorides, and TDS were also observed in the same location as benzene in Area 2 (i.e., H-12). As discussed in Section 7.1., the constituents are delineated to below screening standards or background range for chlorides in this area (and all other limited admission areas) with the exception of chlorides/TDS north of Area 2. Based on the RECAP

[5] Incomplete removal of solids from groundwater samples is a data quality concern because acidification of suspended solids during sample collection causes dissolution of the natural matrix metals, resulting in metals present in the samples due to the mineral aquifer matrix and not groundwater constituents.

evaluation, additional delineation sampling is proposed for chlorides in Area 2, as further discussed in Section 10.

MO-1 Evaluation: In accordance with RECAP requirements, the shallow Class 3 groundwater concentrations were evaluated for protection of the surface water body that could potentially receive discharge from the groundwater zone. Because the shallow water bearing zone is discontinuous and occurs at a depth well below the elevation of any surface water bodies on or downgradient of the Property, the groundwater to surface water discharge pathway is incomplete. Groundwater flows generally north, and near Bayou Lacassine in Area 9, groundwater flows away from the Bayou. The evaluation of groundwater to surface water discharge is provided as a hypothetical and conservative (protective) assessment, consistent with the default pathway analysis for Class 3 groundwater.

Table 14 provides the development of MO-1 RS for groundwater and comparison to Compliance Concentrations for the constituents that exceeded screening standards or SMCLs in shallow groundwater. Although cadmium was not identified as an E&P-related constituent of concern, it is included in Table 14 for informational purposes. The limiting RS for groundwater is the lower of the groundwater Class 3 standard (GW_{3NDW}) protective of receiving surface water and solubility. The development of the GW_{3NDW} standard includes the estimation of attenuation from the Point of Compliance (POC) to the Point of Exposure (POE) at the potential receiving surface water body. The MO-1 longitudinal dilution-attenuation factors (DF3) provided in RECAP are a function of migration distance (x) and affected saturated zone thickness (Sd). The factors are derived by LDEQ using the Domenico analytical solute transport model conservatively assuming a retardation factor of one. A distance (x) of over 2000 feet is identified between all locations within the study areas subject to this evaluation and Lacassine Bayou, the POE. The POC is identified as the location of the maximum concentration of COCs reported within each area, and therefore may differ for individual COCs within an area. However, the distance to the POE remains over 2000 feet from all sample locations. The average thickness of the shallow zone (Sd) beneath the Property is identified as less than 5 feet based upon the average shallow zone thickness across the site, and the resulting DF3 values are provided in Table 14 with the final GW_{3NDW} standards. The maximum concentration of each COC was identified as the Compliance Concentration in each of the study areas.

The assessment provided in Table 14 demonstrates that groundwater concentrations in the shallow zone in each area are less than standards protective of surface water quality considering all designated uses, with one exception. One of two split samples collected at monitor well H-12 in Area 2 included chloride reported above the example MO-1 RS. The concentration in the split sample and all remaining concentrations surrounding H-12, as well as all other areas of the Property, were below the example MO-1 value. Examination of the empirical data in Area 2 demonstrates that the chloride concentration declines over an order of magnitude in 400 feet downgradient (north). No adverse impact to receiving surface water is estimated based on the following factors: depth to groundwater, absence of connection to surface water, distance to a downgradient surface water body, and recognized concentration gradient with distance. The assessment supports the conclusion that groundwater beneath the site does not pose a risk of adverse effects to surface waters or people who may use them for their designated recreational uses. An additional downgradient sampling location in Area 2 is proposed for groundwater sample collection to confirm further decline in chloride concentration.

To address the potential placement of a non-industrial enclosed structure in the location of groundwater containing the volatile constituent benzene above the screening standard, Table 15 provides a comparison of the Compliance Concentration for benzene in Area 2 to the MO-1 standard (GW_{esni}) from Table 3 of RECAP. The maximum reported benzene concentration is below the standard protective of

hypothetical overlying structures, including residential, and below the standard protective of ambient air in a residential setting.

8.2.3 Surface Water

The surface water feature in Area 2 was sampled by ERM and analyzed for the same constituents as groundwater, including the constituents identified in site groundwater as potential E&P-related constituents (e.g., chlorides, barium, benzene) (see Table 16). The analyses were performed using EPA and LDEQ-recommended methods with appropriate detection limits for risk evaluation. Reported concentrations in the surface water samples were compared in Table 16 to available promulgated surface water quality standards applicable to a non-drinking water supply (LAC 33:IX.1113), and where unavailable, to RECAP standards for water that is not a drinking water supply (i.e., GW_{3NDW} with no DAF applied). There were no hydrocarbon fractions or BTEX detected in the surface water samples. Reported concentrations of inorganic constituents in the surface water are less than RECAP risk-based values protective of the designated uses of water features in the Bayou Lacassine subsegment. There is no adverse impact to the surface water feature as a result of potential E&P-related constituents in site soil or ground water.

8.3 RECAP EVALUATION CONCLUSIONS

The RECAP evaluation for soil included a comparison to non-industrial limiting screening standards followed by site-specific evaluation under Management Option 2. Barium was the primary constituent that warranted risk evaluation beyond the screening level, and the remaining concentrations of barium (inclusive of ICON-reported results) and all other constituents in soil are less than the non-industrial standards protective of residential and unrestricted land use. Additionally, the remaining soil concentrations do not provide a residual source of constituents above applicable health-based standards to the uppermost groundwater.

Based on the GW3 classification of the shallow groundwater, the potential to discharge to surface water was evaluated for the groundwater as required by RECAP. The study of site-specific hydrogeology completed by ERM demonstrates that groundwater to surface water discharge is an incomplete pathway, and constituents reported above screening standards in groundwater do not pose a risk to human health or the environment. Corrective action is not required for soil or groundwater to protect human health or comply with RECAP standards.

9. SUMMARY OF FINDINGS BY OTHER EXPERTS

A summary of the additional evaluations conducted by other experts is contained in this section. The full reports prepared by these experts are included as appendices.

9.1 Ecological Risk Assessment

An ecological risk assessment (ERA) was performed by Dr. Helen Connelly for sampling areas 1, 2, 4, 5, 6, and 8 (site) within the Henning property (property), located in the Hayes Oil and Gas Field. These sampling areas are inclusive of samples within and outside the Chevron limited admission areas 2, 4, 5, 6, and 8, and the ERA and its conclusions are applicable to both the Chevron limited admission areas and other sampling areas assessed on the property. Key highlights are summarized below and the complete ERA is provided as Appendix O.

This ERA has been prepared in accordance with U.S. Environmental Protection Agency (USEPA) and Louisiana Department of Environmental Quality (LDEQ) guidance (e.g. USEPA, 1997, 1998; LDEQ, 2003). The ERA evaluates whether oilfield exploration and production (E&P) operations within the site have damaged the ecology (flora and fauna) on the site. The ERA demonstrates that there are no unacceptable risks to ecological receptors on the site from E&P operations and that remedial action based on ecological risk is not warranted. This conclusion is supported by the following information and evidence:

- Site inspections and evaluations performed in 2019, 2021, and 2022 by Connelly (2022), Angle/Levert/Purdom (2019, 2021, 2022), Holloway/Ritchie (2021), ICON (2019, 2021, 2022), and Coastal Environments, Inc. (CEI; 2021);
- Data from investigations in 2019, 2021, and 2022 of soil and groundwater samples (chemical concentrations), vegetation, and wildlife (ERM, Holloway/Ritchie, ICON, and CEI);
- A Screening-Level Ecological Risk Assessment (SLERA); and
- A site-specific Baseline Ecological Risk Assessment (BERA).

The site supports a variety of aquatic and terrestrial habitats important to the Western Gulf Coastal Plain Ecoregion in which the site is located, including emergent and forested wetlands, croplands, early successional grasslands and scrub-shrub, drainage ditches, ponds, and Bayou Lacassine. The habitats on site are exceptionally diverse, supporting 193 vegetative taxa, with 108 forb/herbs, 40 grasses, and 35 species of woody plants (trees, shrubs) observed. The vegetation present on site is commonly associated with freshwater marsh, bottomland forest, and early successional communities throughout Louisiana.

Site vegetative diversity was compared to a reference location, Management Units A and B of Lacassine National Wildlife Refuge (NWR), 3 miles south of the site. The comparison shows that the site has a community structure of grasses, forbs/herbs, trees and shrubs similar to the NWR, and that the species present on site are typical and representative of the region. This favorable comparison to a protected area is a line of evidence that the ecosystem is healthy and as expected for the region.

The site supports an intact food web, 70 species of birds, and 62 non-avian taxa, including insects, aquatic invertebrates, reptiles, amphibians, fish, and mammals. The site bird population compares favorably to the avian trophic structure at the NWR, and includes 10 birds listed as Species of Greatest Conservation Need (SGCN) by the Louisiana Department of Wildlife and Fisheries (LDWF). Species of all levels of the terrestrial and aquatic food webs are represented on site.

The site is providing services that are expected for mixed habitats in the Western Gulf Coastal Plain Ecoregion. The forested and scrub-shrub area provide ecosystem services including the dissipation of storms, soil stabilization, erosion and flood control, water purification, biological productivity and diversity, carbon sequestration, and provision of habitat. The services provided by the grassy and cropland areas include habitat and diet for wildlife, protection of soil from erosion, sequestration of carbon, nutrient recycling, preservation of genetic diversity, and water purification. Based on observed vegetation and wildlife, and the site's ecological connectivity to the nearby NWR, the site is providing exceptionally diverse, functioning habitat for flora and fauna, and is a valuable ecosystem within the larger landscape and ecoregion.

Based on the results of the Screening Level Ecological Risk Assessment (SLERA), barium, lead, and mercury were retained as Constituents of Potential Ecological Concern (COPECs) for a more in-depth assessment in a site-specific Baseline Ecological Risk Assessment (BERA). The BERA was completed using site-specific data and receptor factors for the ecological populations observed and expected on site. The BERA quantitatively confirms that historical E&P activities on this site do not pose an unacceptable risk to wildlife and the environment.

The following lines of evidence support the conclusion of no adverse effects to site ecology: vegetative habitat is as expected for the region and comparable to references, avian populations are structured and balanced as expected for the region, intact food webs including vertebrates and invertebrates were observed, evidence of functioning ecosystem services was observed, and risk calculated per EPA guidance demonstrates no adverse effects to mammals and birds. Based on these data, the conclusion of the ERA is that E&P operations have not adversely affected site ecology, and that remediation is not required for ecological reasons.

9.1.1 Effects of Remediation on Ecology and Land Use

If soil remediation were to occur on an excessive and intrusive scale, even though there is no ecological need for soil remediation, the result would be that areas that are vegetated, productive, and supporting wildlife would be clear cut, excavated, and removed. Removing large areas and volumes of soil from habitats that are diversely populated and thriving would result in the destruction of habitat and the excavation and removal of productive farming soils, without associated improvement in crop production, wildlife numbers, or ecological services. Similarly, if large volumes of soil are treated with amendments the soils would be excavated and returned, which requires clear cutting and removes habitats and wildlife from soils that do not require treatment for growing vegetation or supporting wildlife.

Soil remediation that is excessive would have a negative effect on the ecosystem and current land use. For example, excavation and disturbance of wetland soils and species disrupts habitat, hunting, and mating grounds for numerous birds, reptiles, and fish. Removal of grasslands destroys existing habitat for game animals such as rabbits and doves and removes soils of good moisture and CEC that are productive for rice farming. The removal of forest eliminates habitat for game animals documented on the site such as hogs, raccoons, deer, and coyotes. Excavation of woody shrub habitat removes documented site habitat for birds of Greatest Conservation Need (habitats or populations that are threatened) such as the Sedge Wren and Northern Bobwhite, as well as removing productive farming soils of good moisture and CEC.

Rice farming has been the historic use of soils in this region, and excavation of soils that are excellent for growing grasses and rice and replacing them with non-native soils of lesser quality would have a negative impact to farm production and to the native ecology. Soils in this region are specifically well-suited to growing grasses and rice, and there is no ecological benefit to massive excavation and replacement of soils on site available for productive farming.

If groundwater remediation, such as groundwater extraction, were performed, the effects to soils, vegetation, and wildlife would be negative. The installation of groundwater treatment wells, flowlines, storage tanks, pumps, piping, and electrical systems would be destructive to plant and wildlife populations that are currently using site vegetation and existing soils as habitat. Agricultural activities would be impeded due to the fact that useful surface soils would become unavailable in areas of water extraction wells and areas of activity associated with removing groundwater. Groundwater remediation activities would negatively affect both the site acreage available for farming and the habitat that is currently supporting wetland species, game animals, and numerous birds.

The ecosystem on site is functioning and thriving, and there is no ecological justification for large scale remediation, excavation, and destruction of farming soils, vegetation, habitat, and wildlife.

9.2 Effective Root Zone Study

In December 2021, Holloway Environmental and ERM conducted an Effective Root Zone study of the Henning Management, LLC property. The parameter effective rooting zone (ERZ), or the depth of the effective root zone, is defined as the potential depth down to which, in dry years, plant roots can take up the maximum amount of plant-available water and nutrients from the soil. The zone between the surface and the effective rooting depth is the interval from which plants obtain their supply of water and nutrients to complete all phases of their life cycle, including germination, growth, and reproduction. The scope of this study was to document and ascertain, in accordance with scientifically-accepted principles and methodology, the depth of the ERZ for vegetation occurring on the property. The study showed that the vegetation within the Henning Property exhibit healthy stands of vegetation that are not experiencing observed impacts from the historical oil and gas E&P activity. Observations made from five rice, four herbaceous, and three tree specimens show shallow rooting depths.

Observations were made during climatic conditions typical of the region for this time of the year. Even in times of drought, vegetation does not efficiently access subsoil moisture due to soil structural constraints that induce a sub-optimal exploration of the soil volume, limited transport of soil water to the root due to low unsaturated soil hydraulic conductivities, and development of large hydraulic resistance at the root–soil interface as roots shrink and loose contact with the soil when the soil is drying. The ERZ accounts for these limiting factors and when climatic conditions may be suboptimal.

The study of rice growing on the property demonstrated typical structure with very shallow ERZ for that of soils on the prairie terraces of Louisiana. These root zones were commensurate with other rice stands from surrounding study areas. Many of the soils on the Henning property exhibited natural saturation at shallow depths typical of the soils with shallow clay pans that are excellent for growing rice. At the time of sampling, the rice fields had been drained and were dry with no surface water present. The rice had been harvested with only rice stubble, cut stem, and leaf parts remaining. Due to the timing of the field observation, it is possible the second crop had been harvested, meaning the plant had completed its life cycle and the root system observed is indicative of mature vegetation. The ERZ for rice ranged from 5.0 to 7.0 inches.

Portions of the subject property were comprised of a mixed herbaceous-shrub successional stand that has established following oil field and agricultural activities. The species sampled, bushy bluestem, sand spikerush, common rush, and sugarcane plumegrass, are commonly found in wet grazed coastal prairies and low, wet pastures in Calcasieu and Jefferson Davis Parish like the property at issue. The ERZ for the unmanaged, uncultivated portions of the property range from 5.0 to 9.0 inches.

The forested portions of the property are limited to the periphery of the agriculture fields, roadsides, and along Bayou Lacassine. Three tree specimens were sampled from representatives of the dominant species on the property. The stand was showing some evidence of stress from the water and hurricane

damage, such as adventitious branching along the trunks, crown dieback, and topping. The tree species observed do not have taproot systems, but an extensive lateral system of roots. The trees investigated, red maple, sweetgum, and Chinese tallow, all showed very shallow root systems with the ERZ ranging from 6 to 10 inches in depth with the overwhelming majority of the roots occurring within the first 4 to 5 inches of the soil.

Based on the results of this ERZ study, a soil remediation depth of 12 inches would be appropriate for the potential future use of the property, if required. Any proposed remediation beyond 12 inches is unnecessary to support the establishment, growth, and reproductive ability of these vegetative communities and would cause undesirable and unneeded additional impacts to this property. Dr. Holloway and Mr. Ritchie's report is provided as Appendix P.

9.3 Human Health Risk Assessment

Dr. John Kind and Dr. Shawn Wnek with CTEH have conducted a toxicological review and Human Health Risk Assessment (HHRA) utilizing the soil and groundwater data gathered from the Property, which is provided as Appendix Q.

9.4 NORM Evaluation

Dr. John Frazier has conducted an evaluation of the Naturally Occurring Radioactive Material (NORM) data gathered from the Property and this evaluation is presented in a separate report authored by Dr. Frazier in Appendix R.

9.5 Oil and Gas Operations Evaluation

Mr. Richard Kennedy with Northstar Exploration Company conducted an evaluation of the E&P operations conducted on the Property and this evaluation is presented in a separate report in Appendix S.

10. REMEDIATION PLAN

The remediation plan proposed in this section complies with Statewide Order 29-B and RECAP, which is the State's risk-based regulatory standard for environmental evaluation and remediation. A remediation plan that fully complies with Statewide Order 29-B without exceptions (referred to as a "Hypothetical 29-B Plan" hereafter), along with a detailed discussion on why such a plan is unreasonable, infeasible, and unnecessary, is included in Appendix T.

The need for and extent of remediation will ultimately be dependent upon LDNR review of the site investigation data and the proposed plan presented below. Based upon the soil and groundwater data presented herein, the following sections outline the proposed remediation plan.

10.1 Demonstration of Proof of Good Cause for Statewide Order 29-B Exceptions

This Plan relies on the application of RECAP and additional lines of evidence regarding groundwater protection to address salt in soil below the effective root zone. Additionally, RECAP is used as the applicable regulatory standard for constituents in soil that do not have promulgated standards within 29-B and for constituents reported in groundwater. As stated in Section 319 of the 29-B regulations:

> *"The commissioner may grant an exception to any provision of this amendment upon proof of good cause. The operator must show proof that such an exception will not endanger USDWs."*

Upon demonstration of good cause, LDNR is authorized to issue exceptions to 29-B, and landowner consent is not required in the context of an Act 312 public hearing. The December 12, 2018, Memorandum from John W. Adams to Richard P. Ieyoub (Appendix U) states:

> *"Landowner consent has not been required by Louisiana Department of Natural Resources, Office of Conservation (hereinafter 'LDNR/OC' or 'Agency') when a case goes through an Act 312 public hearing and a Most Feasible Plan including exceptions to LAC 43:XIX.Subpart 1(29-B) is approved or developed as a result of evidence at an Act 312 public hearing."*

This application of the exception provision was further confirmed recently in the June 29, 2022 MFP issued by LDNR in the H.C. Drew Estate vs. Neumin Production Company matter (Appendix U), which states:

> *"Landowner consent is not required for a Most Feasible Plan with exceptions to Statewide Order 29-B when the plan is based on evidence at an Act 312 public hearing."*

Proof of good cause for the exceptions to Statewide Order 29-B requested in this Plan is demonstrated by the following lines of scientific evidence and application of additional regulatory standards that are protective of public health and the environment:

- An effective root zone study performed by Dr. Luther Holloway and Mr. Patrick Ritchie established the minimum depth (1 foot) below ground surface necessary for soil conditions to meet 29-B soil salt parameter regulatory limits providing for healthy plant and tree growth consistent with the surrounding area and current and future use of the Property.
- In the three locations where initial sampling in the 0-2' or 0-4' interval indicated exceedances of 29-B salt parameters, additional samples were collected in the 0-1', 1-2', and 2-3' intervals, which confirmed that exceedances of 29-B salt parameters were not detected within the effective root zone.

- Exceedances of 29-B salt parameters in soil have been vertically and horizontally delineated in each of the Chevron limited admission areas where they were detected using laboratory analytical data, SPLP data, EC probe logs, field EC data, and soil boring logs. In two areas where maximum EC levels in the unsaturated zone were not tested for salt mobility, resampling with SPLP testing for chlorides is proposed to further support this conclusion.
- Soil samples were collected and analyzed for TPH fractions at each location where evidence of hydrocarbons was observed in the field. Only one RECAP screening standard exceedance of a single TPH fraction was detected in soil. This location is delineated both vertically and horizontally and was further evaluated for PAHs, which were below RECAP screening standards.
- The shallow water-bearing zone has been determined to be RECAP Class 3 groundwater based on slug tests performed at 17 monitoring wells appropriately distributed across the Property. Slug testing is an approved method of direct measurement of aquifer properties for groundwater classification under RECAP and has been routinely used to determine groundwater classification throughout the state of Louisiana since the inception of RECAP regulations. Slug test results demonstrate the variability of the hydraulic conductivity of the shallow water bearing zone as confirmed by the soil descriptions on the soil boring logs and cross-sections and by the well-purging/sampling records. In addition, numerous monitoring wells purged dry or exhibited low yields during the well purging and sampling process.
- Soil-to-groundwater protection has been demonstrated through laboratory analytical data, SPLP results for barium and chlorides, soil boring logs, geotechnical data, and an evaluation of the local and regional geology and hydrogeology.
- Impacts to groundwater have been horizontally and vertically delineated in and around the Chevron limited admission areas, with the exception of chloride to the north of Area 2. The proposed sampling in this Plan includes a monitoring well to complete the delineation of chloride in Area 2.
- The shallow water-bearing zone has been demonstrated to be naturally poor quality and non-potable, with chloride, sulfate, iron, and manganese naturally higher than the corresponding EPA SMCLs. The shallow water-bearing zone is naturally not potable and could not be remediated to meet potable water quality objectives.
- There is no laterally continuous sand or gravel aquifer underlying the Property except the Chicot Aquifer at depths greater than 120 to 200 feet below the ground surface. The Chicot Aquifer is protected by an over 120-foot thick predominantly clay confining unit. The water elevation of the Chicot Aquifer potentiometric surface is approximately 30 to 40-feet different than the shallow water bearing zone, demonstrating hydraulic separation and lack of hydraulic connection. Furthermore, laboratory results for 29-B salt parameters in soil, and vertical permeability and SPLP chloride data collected beneath the shallow water-bearing zone demonstrate that the clay confining unit is protective of vertical migration beneath the shallow water-bearing zone.
- No water wells have ever been installed in the shallow water-bearing silt zones underlying the Property, and no shallow wells are identified within a one-mile radius of the groundwater AOIs. This finding documents that water well drillers do not target these silt zones for water supplies.
- Based on the highly variable and discontinuous nature of the shallow water-bearing zone, there is a low likelihood that a water well driller could ever encounter a thick and permeable enough portion of the discontinuous, water-bearing silt zone to consider use as a potential future water supply. Further, it is not reasonably anticipated that a water well driller would ever target such a zone instead of the first viable sand and gravel aquifer underlying the Property [i.e. the Chicot Aquifer]. Finally, the

shallow water-bearing zone does not meet the definition of an Underground Source of Drinking Water (USDW) as defined in Statewide Order 29-B Section 403.

- Elevated barium in soil is limited to the uppermost sampled intervals and delineation has been achieved or is proposed in Section 10 of this plan for the Chevron limited admission areas. Barium concentrations detected on the Property to date do not pose a risk to human health and the environment, and results of barium speciation indicate that barium is present as barite.
- Where delineation is yet to be completed (i.e., chloride in groundwater and barium in soil), this Plan contains proposed sampling to complete the delineation. If requested by LDNR, additional sampling will be completed until constituents have been delineated to the satisfaction of LDNR.

10.2 Soil and Groundwater Remediation

Based on the evaluation of sampling results, including the RECAP analysis presented in Section 8 and site characterization conclusions presented in Section 10.1, no active remediation of soil or groundwater is required at the Property. However, the following sections outline proposed additional work to remove oilfield NORM/debris, further delineate barium in soil, and further evaluate delineation and long-term stability of shallow groundwater quality.

10.2.1 Contingent NORM/Debris Removal

During the course of site assessment activities, Dr. Frazier identified a pile of what appears to be oilfield debris north of SN206334 and identified two lengths of pipe with elevated NORM readings. This area is on the north end of the well pad for SN206334, a well which was never operated or under lease to Chevron. Since this area is outside the area operated/attributed to Chevron, and is outside Chevron's limited admission areas, it is recommended that this potential NORM-pipe be addressed by others who are responsible for oil and gas operations in that area. In the event that LDNR determines that Chevron is responsible for this area, ERM obtained an estimate for removal and proper disposal of the pipe and clearance of the area for unrestricted use. We have prepared a contingent cost estimate for this activity. The estimated cost to remove this debris and clear the area is approximately $18,000 (Table 17). Contractor cost estimates are provided in Appendix V.

10.2.2 Contingent SPLP Chloride Sampling

During ERM's investigation, numerous samples across the Property were analyzed for SPLP chloride to demonstrate protection of groundwater. This included the analysis of SPLP chloride at H-12 48-50' in Area 2, the interval with the maximum detected EC in an unsaturated zone beneath the Property, which demonstrates protection of groundwater in this area. Protection of groundwater is further demonstrated by additional lines of evidence detailed in this report (e.g., vertical delineation of 29-B salt parameters in each Chevron limited admission area by laboratory data, field EC data, and EC probe logs; geotechnical [vertical permeability] data; soil boring logs; evaluation of local and regional geology and hydrogeology; groundwater monitoring results; etc.). The existing dataset and evaluation demonstrate protection of groundwater. However, the maximum EC detections (average of splits) in Area 4 (H-16 16-18') and Area 5 (H-18 14-16') do not have corresponding SPLP chloride data (although SPLP chloride data is available at other depths in these borings). If requested by LDNR, a contingent sampling program to resample H-16 16-18' and H-18 14-16' for SPLP chloride has been provided. The cost to collect these samples is approximately $5,400 (Table 18), and assumes that the work, if required, would be performed concurrently with the installation of the proposed monitoring well detailed in Section 10.2.4. The contingent SPLP chloride sample locations are shown on Figures 125 and 126.

10.2.3 Proposed Delineation of Barium in Soil

Based on an evaluation of the barium sampling results and concentration distribution shown in Figures 107 through 111, an objective of delineating barium to below the default limiting screening standard of 550 mg/kg is confounded by the disparity in ICON and ERM split sample results. The following proposal for additional delineation adopts a delineation standard of 1,600 mg/kg, is compliant with RECAP requirements for delineation, and continues to incorporate the ICON results (despite the recognized bias) in the sample location selection. ERM recommends additional sampling of soil to further delineate barium as described below. The proposed sample locations are shown on Figures 124 through 128. The estimated cost to complete this sampling is approximately $11,000 (Table 18).

Barium is the primary constituent with concentrations reported in soil above default RECAP screening standards. The concentrations reported above screening are primarily limited to the surface soil interval (i.e.,0-2', 0-4')[6] and concentrations decrease with depth, indicating that the barium at the site has limited mobility. This observation is supported by site-specific leachate testing (SPLP) and site-specific barium speciation data, which indicate that the barium is in the form of barite. Barite has been characterized as sparingly soluble and effectively nontoxic to human or ecological receptors, as barite is not bioaccessible and has limited bioaccumulation potential (USGS, 2017). It is notable that the toxicity values used for barium in human health risk assessments and the RECAP regulation are based on soluble forms of barium and are not applicable to barite. This default approach to barium evaluation was retained for this human health risk assessment as a simplified approach under RECAP and to demonstrate protectiveness.

An MO-2 evaluation was performed for soil and demonstrated that barium concentrations in all Chevron limited admission areas are below the MO-2 RS protective of human health for residential and unrestricted land use (16,000 mg/kg). As such, delineation to the default non-industrial MO-1 RECAP direct contact standard (5500 mg/kg) would satisfy the requirements of RECAP, consistent with property closures in the vicinity[7]. However, in recognition that there are some locations where barium concentrations in soil are not declining with lateral distance, and recognizing LDNR's past practice of using screening levels for delineation objectives in certain circumstances, an updated screening level of 1,600 mg/kg was calculated using the current EPA toxicity value for barium[8] and is proposed to guide further delineation sampling at this site. The updated screening level was calculated using the default RECAP algorithm for non-industrial direct contact with soil (Soilssni) and the default Hazard Quotient of 0.1 for the Screening Option. This proposed delineation standard is a conservative, health-protective concentration appropriate for identifying locations for additional barium delineation sampling in soil.

Based on the existing soil concentration results for barium within and surrounding former operational features, additional sampling of barium is not expected to identify levels associated with unacceptable risk to human health (i.e., above the MO-2 SoilIni of 16,000 mg/kg). However, ERM proposes the following sampling to supplement existing lateral delineation samples, and to provide further vertical delineation of soil where vertical characterization is limited.

[6] Out of 91 soil samples collected below the surface interval and analyzed for barium in the Chevron areas, only three (3) samples had reported concentrations of barium above the default screening standard of 550 mg/kg: H-15 (4-6') in Area 4 (642 mg/kg), MW-10 (4-6') in Area 5 (670 mg/kg), and H-28 (6-8') in Area 6 (716 mg/kg), all from ICON's laboratory reports, and the ERM splits of these samples do not confirm the exceedances (ERM results were below 550 mg/kg).

[7] January 4, 2021 *Site Closure Report, Henning Management LLC, v. Anadarko OGC Company, et al.* and subsequent LDNR NFA-ATT letter dated April 30, 2021. OC Legacy No. 031-013-004.

[8] Current EPA toxicity value (RfDo) for barium is 0.2 mg/kg-day, based on repeated ingestion of soluble barium salts (EPA, 2005).

Area	Delineation Review	Additional Sampling Proposed
Area 2 (Fig. 107, Fig. 124)	Barium was detected above the delineation value of 1,600 mg/kg in samples H-11, H-11N, MW-1, MW-2, and MW-3 and was either not confirmed in the split sample or no split sample was provided. These locations are delineated to below 1,600 mg/kg laterally by available surrounding data except for locations MW-3 (not delineated to the north and west) and MW-2 (not delineated to the west and south).	Install four (4) additional step-out soil borings for lateral delineation near the MW-2 and MW-3 borings: MW-2W, MW-2S, MW-3W, and MW-3N.
Area 4 (Fig. 108, Fig. 125)	Barium was detected above the delineation value of 1,600 mg/kg in both split samples at locations H-8N, H-8N2, H-8S, H-22N, and H-22S and these locations are delineated to below 1,600 mg/kg. Barium was detected above 1,600 mg/kg and was either not confirmed in the split sample or no split sample was provided at locations H-8, H-8W, H8S2, H-16/16R, and H-22. These locations are delineated to below 1,600 mg/kg except for H-8W (not delineated to the west).	Install one (1) additional step-out soil boring for lateral delineation to the west of H-8W: H-8W2.
Area 5 (Fig. 109, Fig. 126)	Barium was detected above the delineation value of 1,600 mg/kg in both split samples at location H-19NE. Barium was detected above 1,600 mg/kg and was either not confirmed in the split sample or no split sample was provided at locations H-1/1R, H-18, H-18SW, H-19/19R, and H-19SW. The locations are delineated to below 1,600 mg/kg except for H-19NE (not delineated to the northeast).	Install one (1) additional step-out soil boring for lateral delineation to the northeast of H-19NE: H-19NE2.
Area 6 (Fig. 110, Fig. 127)	Barium was detected above the delineation value of 1,600 mg/kg in both split samples at locations H-24N, H-24S, H-24E, H-24W, H-24NW, and H-24NE. Barium was detected above 1,600 mg/kg and was either not confirmed in the split sample or no split sample was provided at locations H-24, H-28, and H-28S. Additional sampling is recommended to achieve delineation.	Install seven (7) additional step-out soil borings where lateral delineation is limited in the H-24 and H-28 sampling areas: H-24SW2, H-24SW3, H-24W2, H-24NW2, H-24NE2, H-24E2, and H-28S2. Additionally, resample the H-24NE location for analysis of SPLP barium in the 0-2' interval, and barium and percent moisture in the 2-4' and 4-6' intervals to further evaluate vertical delineation. Because this area is enclosed by a berm which generally impounds the surface features, the sampling locations are identified at the perimeter of the impounded area based on the likelihood that E&P-related constituents are contained within the berms.
Area 8 (Fig. 111, Fig. 128)	Barium was detected above the delineation value of 1,600 mg/kg in both split samples at locations H-4E, H-4E2, H-4N, and H-4N2. Barium was detected above 1,600 mg/kg and was either not confirmed in the split sample or no split sample was provided at locations H-4, H-4W, and H-4W2. Additional sampling is recommended to achieve delineation.	Install six (6) additional step-out soil borings where lateral delineation is limited in the H-4 sampling area: H-4SE, H-4E3, H-4SW, H-24NW, H-24N3, and H-4NE. Additionally, resample H-4E2 in the 2-4' and 4-6' intervals to further evaluate vertical delineation. The surface grading of the former E&P operational area to prepare for farming this location appears to have affected the barium concentration distribution. The broad footprint of sampling is proposed to address this likely mechanism of constituent distribution.

For each proposed delineation location and interval, the sample will be collected for analysis of barium and percent moisture. Samples will be analyzed for SPLP barium as indicated above and in the event that highest concentrations are identified in the newly collected samples.

10.2.4 Proposed Shallow Groundwater Delineation Plan

Chloride and other site-related constituents of concern in groundwater are generally delineated across the Property to reference standards or to declining indicator concentrations with distance from source areas. In order to further evaluate delineation of chlorides down-gradient (north) of MW-4 and the former blowout area, ERM recommends the installation and sampling of a monitoring well north of MW-4 at an estimated cost of approximately $18,000 (Table 19). The proposed monitoring well location is shown on Figure 129. Contractor cost estimates are provided in Appendix V.

10.2.5 Shallow Groundwater Monitoring Plan

No active remediation of groundwater in the shallow, RECAP Class 3 water-bearing zone is necessary. ERM recommends a monitoring plan that includes up to three years of quarterly monitoring. Four monitoring wells located downgradient and in the vicinity of the blowout area will be sampled for benzene, barium, chloride, and TDS and water levels will be measured during each monitoring event. Additionally, ERM intends to resample ICON monitoring wells H-9 and H-12 to evaluate the presence and natural attenuation of benzene and chloride/TDS. If the presence of benzene is confirmed, H-9 and H-12 will be added to the monitoring well network for the duration of quarterly monitoring activities. The estimated cost of up to three years of monitoring and reporting to the LDNR, and plugging and abandoning ERM monitoring wells is approximately $158,000 (Table 20). The proposed ERM groundwater monitoring well network is shown on Figure 129. Contractor cost estimates are provided in Appendix V.

11. SCHEDULE AND REPORTING

The implementation schedule for this Plan is dependent upon LDNR OOC approvals. The following summary identifies milestones for the implementation schedule:

11.1 Soil and Groundwater Assessment

- Within 30 days of LDNR approval, initiate field activities;
- 30 days after receipt of final laboratory reports, submit sample location maps and laboratory reports to LDNR;
- 90 days after receipt of final laboratory reports, submit Site Assessment/Remediation Plan report to LDNR.

The Site Assessment report will include a summary of findings along with recommendations for additional phases of investigation, if necessary, and a remediation plan, if necessary, based upon the findings of the additional assessment. The Site Assessment/Remediation Plan report will be submitted upon completion of the assessment activities outlined herein. The report will include:

- Sample location maps;
- Detailed description of sampling methodology;
- Summary tables of analytical, water level, and other data collected;
- Figures presenting the soil and groundwater results;
- Potentiometric surface map;
- Soil boring logs and monitoring well construction diagrams;
- Remediation plan, if necessary, based on assessment findings;
- Site photographs and photologs of investigation activities;
- Field notes; and
- Copies of final laboratory reports for analyses performed.

TABLES

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APPENDIX B LDNR WATER WELL DRILLERS LOGS

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APPENDIX T HYPOTHETICAL 29-B PLAN

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APPENDIX U 2018 JOHN ADAMS MEMO AND NEUMIN MOST FEASIBLE PLAN

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APPENDIX V CONTRACTOR COST ESTIMATES

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