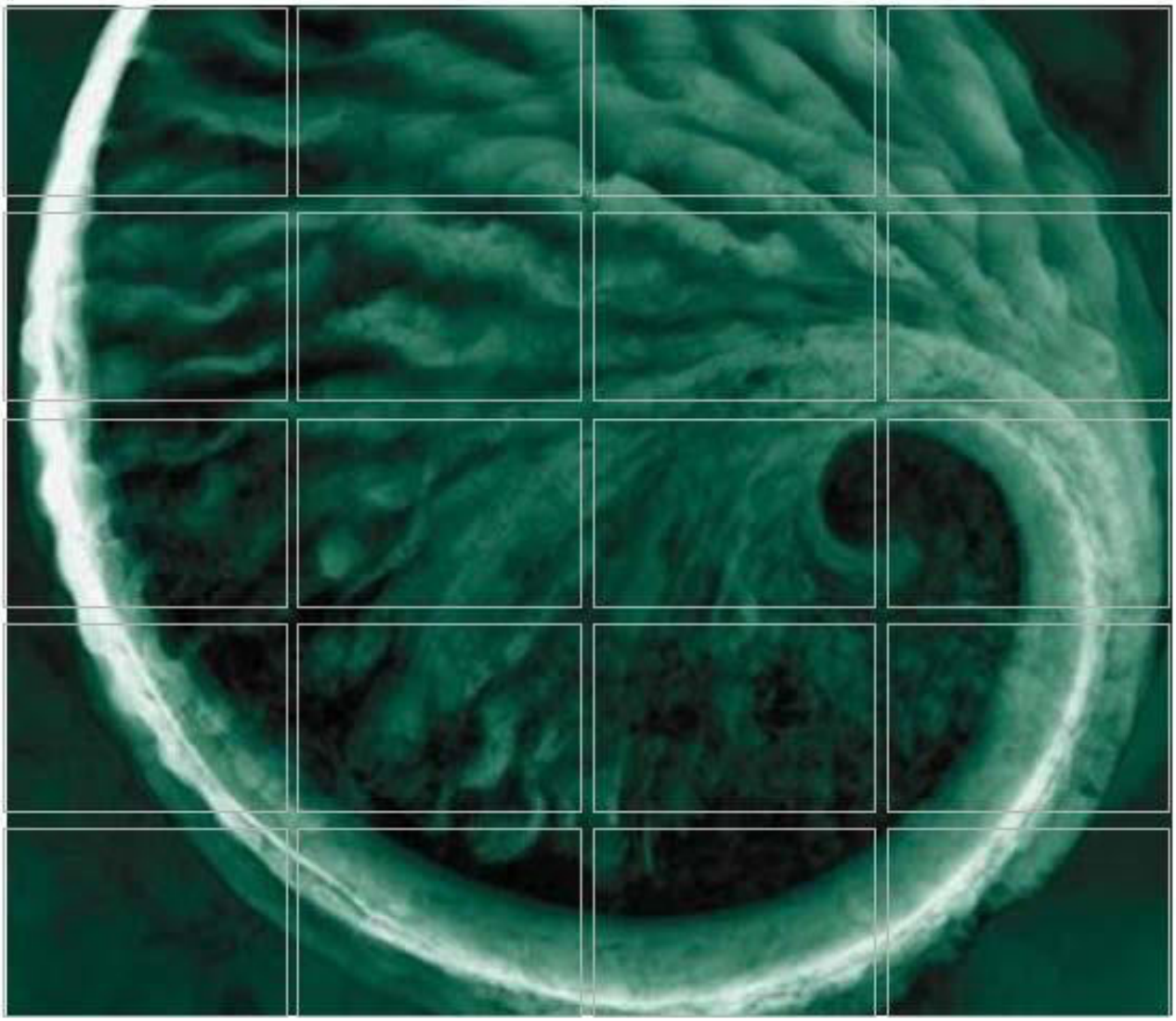

Prepared for:
Louisiana Department of Natural Resources
Office of Conservation on Behalf of Southern Natural Gas Company, L.L.C.

Site Investigation Report and Remediation Work Plan – SNG Limited Admission

Louisiana Wetlands, LLC and New 90, LLC vs Energen Resources Corporation, et al.
OC Legacy Project No. 016-054-002
Franklin Oil and Gas Field
St. Mary Parish, Louisiana

11 September 2020

Project No.: 0557801

The business of sustainability

ERM

Signature Page

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1. INTRODUCTION

On behalf of Southern Natural Gas Company, L.L.C. (SNG), Environmental Resources Management (ERM) [formerly Michael Pisani and Associates, Inc. (MP&A)] is pleased to submit this Site Investigation Report and Remediation Work Plan (Plan) for the three former SNG well locations, SN 62456, SN 64701, and SN 114167, to the Louisiana Department of Natural Resources (LDNR) Office of Conservation. This Plan is submitted to the LDNR in support of SNG's July 31, 2020 limited admission submittal to the court and in further response to the following request to SNG from LDNR and comments from LDNR:

- March 9, 2020 LDNR letter to SNG re SN 64701 requesting that SNG provide written notice of SNG's efforts to assess/address soil and groundwater conditions at the site or SNG's intention to implement such plans.

On April 6, 2020, ERM provided a response to the March 9, 2020 LDNR letter to SNG that included a discussion of the soil and groundwater sample results in the vicinity of SN 64701 and presented a proposed sampling plan to address the results. The sampling plan has been implemented and the results are presented herein.

- July 1, 2020 LDNR email from Ms. Jamie Love to Mr. David Angle with three comments listed below on ERM's April 6, 2020 submittal below.
  1. *No landowner consent for use of RECAP in lieu of 29-B.*
  2. *Only proposing to resample Arsenic at EN-17 0-8 ft bgs. One sample exceeded, one was compliant for Barium at 0-2 feet. At EN-18 proposing SPLP at 0-2 ft bgs.*
  3. *You note using the background COC data from Sterling Sugars for this site. Do you have any documentation noting hydraulic connection to this system? Or do you have other reasoning for using the Sterling Sugars COC data?*

In response to LDNR comment No. 1 above, this plan is being submitted as part of an Act 312 limited admission; therefore, use of any state regulation, including Louisiana Department of Environmental Quality's (LDEQ) Risk Evaluation/Corrective Action Program (RECAP) is appropriate. Data and information related to LDNR comments No. 2 and 3 are provided within this document.

The focus of this Plan is the three former SNG well locations identified above on the property at issue in the lawsuit (Property), located in the Franklin oil and gas field in St. Mary Parish, Louisiana. The Property was the subject of a lawsuit filed in December 2016, in which Energen Resources Corporation (Energen), Chevron U.S.A. Inc. (Chevron), SNG, Brammer Engineering, Inc. (Brammer), and BP America Production Company (BP) are being sued for alleged soil and groundwater contamination that the plaintiffs, James J Bailey III, individually and as representative of successions of Fairfax Foster Bailey and Willie Palfrey Foster, assert has been caused by historical oil and gas exploration and production (E&P) operations.

A separate investigation report and remediation plan is being prepared by ERM for the former Chevron and Energen well locations.

The plaintiffs' expert, ICON Environmental, Inc. (ICON), has conducted investigations of the Property in 2016 through 2020. The data collected by ICON during these investigations as well as the split sample data and field documentation collected by MP&A and ERM 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 three SNG well locations and provide a remediation plan.

2. SITE SETTING

The Property consists of multiple tracts located on both sides of Louisiana Highway 90 within the Franklin Oil and Gas Field in Franklin, St. Mary Parish, Louisiana (Figures 1 and 2). The Property encompasses approximately 240 acres in Section 68 of Township 14 South, Range 9 East and Section 38 of Township 15 South, Range 9 East.

2.1 Land Use and Ground Surface Topography

The majority of the Property is currently and has historically only been used for agricultural purposes (i.e., growing sugarcane) and oil and gas E&P operations. The Property slopes very gently towards the southwest (away from Bayou Teche) with ground surface elevations ranging from approximately ten feet above mean sea level (MSL) to the northeast and zero feet above MSL to the southwest based upon the United States Geological Survey (USGS) topographic and Light Detection and Ranging (LiDAR) maps provided as Figures 2 and 3, respectively.

Adjacent properties are primarily utilized for growing sugar cane and private residences. Franklin Junior High School and Foster W. Prescott Elementary are located to the north/northwest of the Property, and a gun range is located to the southwest. Also adjacent to the southwest portion of the Property is a historical parish dump. Much of the area on and adjacent to the Property south of Highway 90 is identified by the US Fish and Wildlife Service (USFWS) as freshwater wetlands (Figure 4).

The Property is located within a major underground pipeline corridor, with numerous high-pressure natural gas and crude oil pipelines running beneath the Property (Figure 5).

The majority of the Property is located within the Federal Emergency Management Agency (FEMA) 100-year flood zone, with only the most northeastern portion located within the 500-year flood zone (Figure 6) indicating that the Property is subject to flooding.

2.2 Surface Water

The surface water bodies located in the vicinity of the Property are shown on Figure 7. The Property is located within the Bayou Teche-From Charenton Canal to Wax Lake Outlet LDEQ Subsegment #LA060501 (Figure 8). The designated uses of the surface water in this subsegment are primary and secondary contact recreation, fish and wildlife propagation, and drinking water supply. The chloride and total dissolved solids (TDS) numerical criteria for this subsegment are 80 mg/L and 350 mg/L, respectively. Bayou Teche is approximately 1,500 feet northeast of the Property. The Franklin Water System utilizes water from Bayou Teche and the infrastructure for this water system is approximately one mile north of the Property. The direction of groundwater flow in the shallow water-bearing zone is variable beneath the Property, but appears to be generally to the southwest. The nearest downgradient surface water body is the Franklin Canal, which is approximately 4,000 feet west of the Property. The Franklin Canal is located in LDEQ Subsegment # 060907. The designated uses of the surface water in this subsegment are primary and secondary contact recreation and fish and wildlife propagation. The chloride and TDS numerical criteria for this subsegment are 250 mg/L and 500 mg/L, respectively.

LDEQ Subsegment No. 060501 has been designated as impaired by the LDEQ by low dissolved oxygen as a result of municipal point source discharges, on-site treatment systems (septic systems and similar decentralized systems), and package plant or other permitted small flows discharges and fecal coliform by on-site treatment systems (LDEQ, 2019). LDEQ Subsegment No. 060907 has been designated as impaired by the LDEQ by low dissolved oxygen as a result of municipal point source discharges, on-site treatment systems (septic systems and similar decentralized systems), and package plant or other

permitted small flows discharges and fecal coliform by on-site treatment systems and package plant or other permitted small flows discharges (LDEQ, 2019).

2.3 Surface Soils

The composition of surface soils underlying the Property ranges from clay to silty loam 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, 2001 & 2018 USDA Web Soil Survey):

- BdA - Baldwin silty clay loam, 0 to 1 percent slopes, Teche natural levee on delta plain, poorly drained, very high shrink-swell potential, classified as prime farmland, rooting depth of crops may be restricted by high clay content, movement of water into subsurface drains is restricted, not suited to homesite or building site development.
- GaA - Galvez silt loam, 0 to 1 percent slopes, natural levees, somewhat poorly drained, moderate shrink-swell potential, classified as prime farmland.
- ShA - Schriever clay, 0 to 1 percent slopes, backswamps, poorly drained, very high shrink-swell potential, classified as prime farmland, rooting depth of crops is restricted by very high clay content, movement of water into subsurface drains is restricted, not suited to homesite development.
- LoA – Loreauville silt loam, 0 to 1 percent slopes, Teche natural levee on delta plain, somewhat poorly drained, moderate shrink-swell potential, classified as prime farmland, poorly suited to building site development.
- IbA – Iberia clay, 0 to 1 percent slopes, backswamp on delta plain, poorly drained, very high shrink-swell potential, very slow hydraulic conductivity or impermeable, classified as prime farmland, rooting depth of crops may be restricted by high clay content, movement of water into subsurface drains is restricted, not suited to homesite development.
- HSA – Harahan and Allemands soils, drained, Harahan soils are backswamp on delta plain, Allemands soils are protected and artificially drained freshwater marsh on delta plain poorly drained, very slow hydraulic conductivity or impermeable, very high shrink-swell potential, rooting depth of crops is restricted by very high clay content, may be deficient in micronutrients, not suited to homesite or building site development.

2.4 Geology

The shallow geology underlying the Property consists of Quaternary age meander-belt and deltaic deposits as shown on Figure 10. The locations of geologic cross sections A to A', B to B', C to C', and D to D' are provided on Figure 11, and geologic cross sections A to A', B to B', C to C', and D to D' 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. The cross sections document that the subsurface soils down to a depth of approximately 70-feet below the ground surface (bgs) consist primarily of clays and silts. Shallow groundwater is present in the laterally variable and discontinuous silt zones.

2.5 Hydrogeology and Groundwater

The area is underlain by the Atchafalaya Aquifer, which occurs at depths greater than approximately 160 to 200 feet below the ground surface. The clay-confining unit overlying the Atchafalaya Aquifer is reported by Sargent (2004) to range in thickness from approximately 200 to 280 feet as shown on Figure 16. The clay-confining unit restricts infiltration of precipitation into the groundwater system. The Property is located

over an area that has no potential to recharge the Atchafalaya Aquifer based on the Louisiana Geological Survey (LGS) map (LGS, 2000) as shown on Figure 17.

There are no active, registered water wells located on the Property and there are four reportedly active water wells located within a one-mile radius of the Property based upon a search of LDNR's Strategic Online Natural Resources Information System (SONRIS) database (Figure 18). Water well drillers logs obtained from the LDNR are provided in Appendix B. A summary of the four reportedly active water wells within a one-mile radius of the Property is listed below.

- 101-20: Domestic well drilled in 1939 and located approximately 2,600 feet east of the Property. This well is screened from 396 to 400 feet bgs.
- 101-21: Unknown well type drilled in 1946 for Gulf Public Service and located approximately 2,300 feet northeast of the Property. The LDNR well file lists the use as "cooling purposes" and lists the quality as "too salty for ice". The depth of this well is listed as 225 feet.
- 101-22: Well with incomplete well file with poor legibility. Appears to have been drilled sometime prior to 1948 for "working seafood". No well depth is specified. Located approximately 2,900 feet north of the Property.
- 101-5737Z: Domestic well drilled in 1996 and located approximately 3,300 feet north of the Property. This well is screened from 236 to 246 feet bgs.

The Atchafalaya Aquifer water quality is variable, and in places naturally poor, based on the available USGS chloride concentration data shown on Figure 19. The Property and adjacent properties are served by the City of Franklin public water supply system (PWS1101003) which does not obtain water from the Atchafalaya Aquifer.

Shallow groundwater is encountered underlying the Property in silty-clay to silt zones that are discontinuous and laterally variable in grain size and thickness (Figures 12 through 15). The thickness of the discontinuous shallow water-bearing zone is highly variable, ranging from zero to 24.5 feet, with an average thickness of approximately 5.4 feet. The average thickness of this zone beneath Areas 1 and 3 is approximately 7.2 feet. A deeper, variable thickness water-bearing zone consisting of silt and fine sand was encountered at depths below approximately 50 feet below the ground surface. This zone is separated from the shallow water-bearing zone by variable thickness silty clay and clay layers. The shallow water-bearing zones have never been used as a water source on the Property and do not represent a viable future source of potable or irrigation water due to their low yield and naturally poor water quality [i.e. concentrations of iron, manganese and arsenic naturally exceed EPA drinking water and LDEQ Risk Evaluation/ Corrective Action Program (RECAP) screening 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 zones (Figure 18).

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. These results document that the shallow water-bearing zone is not able to sustain a yield of greater than 800 gallons per day. The slug test results are summarized on Table 1, and the individual slug test evaluation reports are provided in Appendix C. In addition, multiple monitoring wells installed by both ICON and ERM in the shallow water-bearing zone (EN-20, EN-31, MW-1, MW-2, and MW-8) 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 are shown on Figure 20. The deeper water bearing zone, occurring at depths below approximately 50 feet below the ground surface, is RECAP Class 2 groundwater based on slug test results.

2.5.2 Groundwater Flow

Groundwater level data were collected on February 7, 2019, March 9, 2020, June 18, 2020, and August 10, 2020, 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 21 through 24. The shallow groundwater flow direction on the northern portion of the Property generally follows the ground surface topography, flowing to the southwest, away from Bayou Teche. Based on the available data, the shallow groundwater on the southern portion of the Property has a variable flow direction, which was generally to the northeast in March 2020, and generally to the south in June and August 2020. Based on the potentiometric maps, the southwestern component of groundwater flow has an average gradient of approximately 0.0026 in the shallow water-bearing zone. The northeastern component of groundwater flow in March 2020 had a gradient of 0.0021.

2.5.3 Arsenic in Soils and Groundwater

Arsenic is a naturally occurring element that is present in soils and minerals throughout the world (ATSDR, 2007). Arsenic is naturally present in the soils and shallow groundwater underlying the Property and in soils as well as the waters that come into contact with these soils throughout Louisiana (Ori, et al., 1993). Ori, et al. (1993) has reported arsenic concentrations ranging from near zero to 73 mg/kg with a mean concentration of 23.2 mg/kg in over 450 alluvial and other soil samples from across Louisiana. In general, finer grained soils (i.e. clays and silts) and groundwater in contact with finer grained soils tend to exhibit higher arsenic concentrations than coarser grained soils (i.e. sands) and associated groundwater.

Because arsenic occurs naturally in soils at much higher concentrations (i.e. mg/kg or part per million) than in groundwater (i.e. µg/L or parts per billion), elevated arsenic concentrations detected in groundwater cannot always be attributed to some type of contamination. According to Smedley and Kinniburgh (2002), strongly reducing aquifers often derived from alluvium tend to exhibit elevated arsenic concentrations. These aquifers also tend to contain geologically young sediments and are located in flat, low-lying areas where groundwater flow is sluggish. Smedley and Kinniburgh (2002) further state the following:

> “A characteristic feature of high groundwater arsenic areas is the large degree of spatial variability in arsenic concentrations in the groundwater. This means that it may be difficult, or impossible, to predict reliably the likely concentration of arsenic in a particular well from the results of neighboring wells, and means that there is little alternative but to analyze each well.”

Yang, et al. (2014) reports that:

> “Aquifers with elevated groundwater As (arsenic) concentrations commonly consist of Holocene riverine and deltaic sediments that are under reducing conditions, poorly drained, and associated with high levels of organic matter content.”

As shown on Figure 25, the shallow water-bearing zones underlying the area are susceptible to contamination from arsenic containing minerals in the alluvial soils as documented by Yang, et al. (2014).

The Atchafalaya Aquifer contains geologically young sediments and exhibits reducing conditions and naturally elevated arsenic concentrations consistent with both the Smedley and Kinniburgh (2002) and Yang, et al. (2014) references.

In 2010, the LDNR issued a Memorandum and a Louisiana alluvial aquifer water quality summary to Louisiana Licensed Water Well Contractors that stated the following regarding the presence of arsenic in alluvial aquifers:

> "Louisiana alluvial aquifer groundwater quality is reported by the USGS to be primarily limited to use for industrial and agricultural purposes due to excessive concentrations of dissolved solids, hardness, iron, or localized salinity. The natural groundwater quality of these aquifer systems is generally considered not suitable for drinking water supply purposes without first undergoing appropriate water treatment. Furthermore, it is reported that other dissolved metals such as arsenic have been, and are expected to be, detected in groundwater in localized areas of these aquifers."

Groundwater monitoring conducted on the Property has confirmed that locations unimpacted by E&P-related constituents contain naturally elevated concentrations of arsenic that range to over 0.2 mg/L.

3. HISTORICAL E&P OPERATIONS

The discovery well for the Franklin oil and gas field was drilled in 1953 (Eby, 1967). Based on available data from LDNR's SONRIS database, seventeen wells have been drilled on the Property (Figure 26). Drilling on the Property began in 1940, with the first productive well drilled in 1956. Numerous companies operated on the Property between approximately 1940 and 2000, when the remaining wells on the Property were plugged and abandoned. SNG operated the following three wells on the Property:

- SN 62456 (Operator)
- SN 64701 (Operator)
- SN 114167 (Operator)

An oil and gas well history for the three SNG wells on the Property is provided in Table 3 and LDNR oil and gas well files are provided in Appendix D.

Historical aerial photographs from 1956 through 2019 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 27-51.

SN 62456, which was a dry hole, was drilled and temporarily plugged and abandoned in 1956 and permanently plugged and abandoned in 1970. This area is currently used for agricultural purposes (sugar cane farming) and no testing has been conducted around this area.

A pit-like feature is visible in the 1967 through 1973 aerial photos near the SN 114167 location. The pit appears to have been closed by 1978, well before the 1986 promulgation of Statewide Order 29-B.

Two pit-like features are visible in the 1957 aerial photo near SN 64701. These pits appear to have been closed by 1962, well before the 1986 promulgation of Statewide Order 29-B. This area is currently used for agricultural purposes (sugar cane farming).

As early as 1952, there is a road southwest of the southern Property boundary that appears to lead to dry and plugged well SN 35270 (not an SNG well location). By 1963, an apparent trash dump is visible at the end of this road, which expands in size until sometime in the 1980's, until a small portion of the dump appears to extend to the Property boundary. Based on historical aerial photos, the dump material is still present, but the dump has been inactive since sometime in the 1980's. Field observations confirm that dump material is still present. The raised elevation of the dump is also visible in the LIDAR elevation data (Figure 3).

4. 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. The three former SNG wells and any associated former pits or other operational features on the Property were plugged and abandoned and/or closed well before Statewide Order 29-B was amended.

4.1 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 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).

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
  - 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)

Based on a root study performed by Dr. Luther Holloway on the Property, the effective root zone is approximately 12 to 14 inches. Statewide Order 29-B salt parameters in soil are agronomic standards and therefore only apply to the effective root zone. Because farmers use deep chisel plowing to remove hard pans in their fields, it is assumed that the remediation zone for 29-B salt parameters is up to 24 inches below ground surface; therefore, soils within the upper two feet were 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 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: PartXV Chapter 14 and the NORM data have been evaluated in accordance with LDEQ’s NORM regulations.

4.2 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 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.

LAC 43.XIX.303.C identifies that “Contamination of a groundwater aquifer or a USDW with E&P Waste is strictly prohibited.” However, 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.

Groundwater within the shallow water-bearing zone is RECAP Class 3A and naturally poor quality. The shallow water-bearing zone is not currently being used, has never been used, and cannot be used as a drinking water or irrigation source due to its naturally poor water quality and low yield. The shallow water-bearing zone is also susceptible to fecal coliform contamination from residential septic systems.

4.2.1 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 E]. 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 E):

> "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 very 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.

4.2.2 Louisiana Title 51 Public Health-Sanitary Code and LAC Title 56 Regulations

In addition to the natural limitations on use of the shallow groundwater due to low yield and 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 regulations 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."
>
> The Part XII. Water Supply §327.A regulations further specify the following regarding all potable water supplies:

- "Every potable water well, and the immediate appurtenances thereto that comprise the well, shall be located at a safe distance from all possible sources of contamination, including but not limited to, privies, cesspools, septic tanks, subsurface tile systems, sewers, drains, barnyards and pits below the ground surface." (No. 2)
- "The earth formations above the water-bearing stratum shall be of such character and depth as to exclude contamination of the source of supply by seepage from the surface of the ground." (No. 5)
- "private supply wells shall be cemented from a minimum depth of 10 feet to the ground surface." (No.8)

Furthermore, Louisiana Administrative Code (LAC) Title 56 Part I. Section 319 regulations pertinent to small diameter (<4-inches) water wells located in coastal areas prone to flooding as a result of direct impact of storm surge events shall be constructed with:

> "5. grouting down to a depth of at least 50 feet below ground surface."

The top of the shallow groundwater-bearing zone is as shallow as ten feet below the ground surface on the Property. Potable water could not be obtained from this zone based upon the Sanitary Code and LAC Title 56 regulations cited above.

5. INVESTIGATION ACTIVITIES AND RESULTS

The following sections discuss the results of the 2016 to 2020 investigations conducted on the Property. The soil and groundwater analytical data are summarized on Tables 4 and 5, respectively. The field parameters recorded during the groundwater sampling events are provided on Table 6. Sample location maps are provided as Figures 52 and 53. Soil boring logs and monitor well construction diagrams are provided in Appendix A. Laboratory reports are provided in Appendix F. Field notes and photographs and photo logs recorded by ERM during site investigation activities on the Property are provided in Appendices G and H. LDNR well registration documents for the monitoring wells installed by ERM are included in Appendix I. A summary of work performed and materials relied upon by ERM is included in Appendix J. Although results are presented for the entirety of the Property, the SNG areas that are the focus of this report are limited to Area 1 and Area 3, as shown on Figures 52 and 53, and Table 4.

5.1 Soil

On December 19, 2016, ICON collected soil samples from hand auger borings HA-2 through HA-6. Samples from HA-2 and HA-3 were analyzed for 29-B salt parameters, total petroleum hydrocarbon (TPH) mixtures, and HEM Oil and Grease. Samples from HA-4 through HA-6 were not analyzed by the laboratory. ERM was not notified of this sampling event, was not present during this sampling event, and did not have the opportunity to collect split samples.

ICON conducted additional fieldwork between January 2019 and March 2020, which included the installation of 31 soil borings advanced with a Geoprobe® drill rig and/or hand auger. 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 26 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 54. 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 May and August 2020, which included advancing soil borings at 55 locations (27 new soil boring locations, 20 soil resample locations, and 9 monitoring wells at 8 locations). Soil boring/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, except some shallow hand auger borings were backfilled with soil cuttings.

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 in Lafayette, Louisiana and Pace Analytical in Baton Rouge Louisiana for analysis. Both 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 various depths ranging from 18 to 68 feet bgs in ERM's deep soil boring DMW-1 were sent to Ardaman & Associates, Inc. for geotechnical analyses including laboratory

classification, grain size, and vertical permeability. The geotechnical results, presented on Table 7, document the clayey and fine-grained nature of the majority of the soils underlying the Property. The vertical permeability of the clay layer encountered at a depth of 67 to 68 feet below the ground surface is 4.0 x 10^{-9} cm/sec (Table 7). The clay layer meets the Statewide Order 29-B definition of a "Natural liner – having a hydraulic conductivity no greater than 1 x 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 Atchafalaya Aquifer below the confining unit.

During ICON and ERM's investigations, a total of approximately 562 soil samples from 61 locations on the Property were submitted for laboratory analysis. Of these samples, a total of 76 soil samples from 7 locations were collected in the SNG Areas.

Laboratory results indicate some soil samples exceed RECAP screening standards in the SNG areas. Exceedances of metals and hydrocarbon screening standards in the SNG areas are shown on Figure 55. A discussion of the soil results at each SNG Area is included in Section 6 of this report.

Dr. Luther Holloway performed a root study on the Property concurrently with ERM's investigation. Based on Dr. Holloway's results, effective root zones are shallow across the Property, ranging from 12 to 14 inches in depth.

5.2 Hydrogeology

An ERM scientist 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 are shown on Figures 12 through 15. The shallow soils underlying the Property down to a depth of at least approximately 70 feet below the ground surface consist primarily of clay and silty clay with discontinuous shallow water-bearing zones that consist primarily of clayey silt and silt. Shallow groundwater is present in the laterally variable and discontinuous silt zone above approximately 40 feet below ground surface, which ranges in thickness from zero to 24.5 feet, with an average thickness of approximately 5.4 feet. A deeper water-bearing zone is present below approximately 50 feet below ground surface and is separated from the shallow zone by approximately 10 to 40 feet of clay. Where borings were advanced to sufficient depth, the deeper zone ranges in thickness from approximately 0.3 to 10 feet. Both of these water-bearing zones are present within shallow soils underlying the Property, which are part of the confining unit overlying the Atchafalaya Aquifer that is reported to range in thickness from approximately 200 to 280 feet. The confining unit restricts infiltration of precipitation into the Atchafalaya Aquifer groundwater system.

5.3 Groundwater

From January 2019 through March 2020, ICON installed and sampled 26 groundwater monitoring wells at 23 locations and ERM collected split samples. ICON conducted slug tests at wells EN-1A, EN-1B, EN-4B, EN-12, EN-24, EN-27, EN-28, and EN-30. ICON plugged and abandoned 18 of their wells after groundwater sampling was completed. At the time of ERM's field investigation, only ICON wells EN-13, EN-23, EN-24, EN-25, and EN-26 remained on the Property.

S. J. Langlinais & Associates, Inc., a Louisiana-licensed professional land surveyor based in Abbevile, Louisiana surveyed the location, top of casing (TOC) and ground surface elevation of ICON's wells on February 7, 2019 and March 9, 2020. ICON conducted a round of water level measurements in the surveyed monitoring wells on February 7, 2019 and March 9, 2020.

ERM's May to August 2020 investigation activities included the installation and sampling of 9 monitoring wells at 8 locations. Monitoring well installation was performed by 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. Upon completion of each soil boring, a 1-inch diameter Schedule 40 polyvinylchloride (PVC) monitoring well equipped with a prepacked screen (0.01-inch slot) was installed in the borehole. 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/LDOTD specifications. A locking cap was installed on each monitoring well.

Each permanent 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 the monitoring wells installed in and around the sugar cane field. 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, SC, dissolved oxygen, 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 purge dry multiple times prior to sampling. The field parameters recorded during the groundwater sampling events are provided on Table 6.

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.

Samples were placed on ice immediately following collection and submitted under proper chain-of-custody to Pace Analytical, a LELAP accredited laboratory for analysis.

During ICON and ERM's investigations, a total of 73 groundwater samples from 35 monitoring wells on the Property were submitted for laboratory analysis. Of these samples, a total of 10 groundwater samples from 5 monitoring wells were collected in the SNG Areas.

M. P. Mayeux Surveying and Boundary Consulting, L.L.C., a Louisiana-licensed professional land surveyor based in Lafayette, Louisiana surveyed the location, TOC, and ground surface elevation of ERM's wells on June 16, 2020. ERM conducted water level measurements in the surveyed monitoring wells, along with the remaining ICON monitoring wells, on June 18, 2020 and August 10, 2020. 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 and groundwater elevation measurements from both ICON and ERM's investigations are presented in Table 2. Potentiometric surface maps are provided on Figures 21 through 24.

Slug tests were performed on five of ERM's monitoring wells (DMW-1, MW-1, MW-2, MW-6, and MW-7). The slug tests were performed with a solid stainless steel slug. Water levels in the wells were continuously recorded using an In-Situ Level Troll 700. 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 each water-bearing zone was calculated as specified by RECAP by taking the geometric mean of all wells screened in each water-bearing zone. The overall yield of the discontinuous shallow water-bearing zone (above approximately 40 feet bgs) is 136 gallons per day and falls within the range specified by LDEQ as a Class 3 aquifer (less than 800 gpd). The overall yield of the variable thickness deep water-bearing zone (below approximately 50 feet bgs) is approximately 1,736 gallons per day and falls within the range specified by LDEQ as a Class 2 aquifer (greater than 800 gpd and less than 4,800 gpd). The slug test results are presented in Table 1. Slug test reports are presented in Appendix C.

The arsenic, barium, and chloride groundwater results in the SNG areas are shown on Figures 56, 57, and 58 respectively. Hydrocarbons and benzene in groundwater results in the SNG areas are shown on Figure 59. A discussion of the groundwater results at each SNG area is included in Section 6 of this report.

Various monitoring wells on the Property exhibit concentrations of arsenic that exceed the RECAP GW_{3NDW} standard. The arsenic detections on the Property do not appear to follow any spatial relationship and appear to be naturally occurring (see Section 2.5.3). If the arsenic present in the shallow groundwater was the result of oilfield activities, a correlation between chloride and arsenic concentrations would be expected. However, as shown on Figure 60, the highest detected arsenic concentrations do not correlate with the highest chloride concentrations. The lack of any correlation is consistent with a natural source of arsenic. The reducing conditions observed during groundwater sampling on the Property support the regional data documenting naturally elevated arsenic in groundwater.

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 61 and 62). 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 helps identify the individual water types and evaluate differences between various water types. Water samples that plot in the same general location on a Piper diagram indicate similar water quality. Groundwater samples collected on the Property, along with samples previously collected from the Sterling Sugars property located east of Bayou Teche that were identified as background by ICON, and a typical produced water sample collected approximately 4,200 feet northeast of the Property, are shown on the piper diagram on Figure 61. ICON identified samples EN-23, ST-26, and MW-5U as background samples. ERM also identified samples EN-1B, EN-10, EN-19, EN-28, EN-29, EN-30, DMW-1, MW-3, MW-4, and MW-5 as background samples. ICON and ERM's identified background samples plot within the same region on the Piper diagram, demonstrating similar groundwater quality. The arsenic concentrations reported in some of these background samples demonstrate that the presence of arsenic in the shallow groundwater is natural, highly variable, and results range up to over 0.2 mg/L (over four times higher than the RECAP GW_{3NDW} standard of 0.05 mg/L).

The Stiff diagrams shown on Figure 62 demonstrate the presence of groundwater samples consistent with background water quality on the Property. Within the SNG areas, EN-13 shows indications of a produced water signature, and water quality improves rapidly with distance from the former operational

area. The only groundwater location in Area 1 (EN-18) is consistent with background groundwater quality. This demonstrates that groundwater migration has been very 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 0.0013 to 0.0022, yielding an estimated groundwater flow velocity of approximately one ft/yr in the shallow water-bearing zone. The historical closure of any former open pits on the Property has removed the potential for a downward hydraulic gradient and potential migration. 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.

6. EVALUATION OF SAMPLING RESULTS

An evaluation of the soil and groundwater sampling results in the SNG areas is provided in this section.

6.1 SN 64701 Area (Area 1)

Soil samples collected in the vicinity of SN 64701 included samples collected from the two soil borings during ICON's investigation (EN-17 and EN-18) and resampling at those two locations during ERM's investigation (EN-17R and EN-18R). Arsenic concentrations were detected above the 29-B and RECAP screening standards in ERM's split sample of EN-17 in the 8-10' interval; however, ICON's sample did not exceed standards. This interval was resampled during ERM's investigation and both the ERM and ICON splits did not exceed the 29-B and RECAP standards for arsenic. Arsenic was slightly above the 29-B standard in ICON's sample of EN-18 in the 0-2' interval, but was below the 29-B standard in ERM's split sample. Barium exceeded the RECAP screening standard in both the ICON and ERM splits of this interval. This interval was resampled during ERM's investigation and both the ICON and ERM split samples did not exceed 29-B or RECAP standards. ICON analyzed the resample for barium, which was consistent with previous sampling results, while ERM analyzed the resample for SPLP barium, which was well below the RECAP standard.

Only one monitoring well was installed in Area 1 during ICON's investigation (EN-18). Water quality at EN-18 is consistent with background, as shown on the Piper and Stiff diagrams (Figures 61 and 62). High concentrations of iron and manganese demonstrate the naturally poor quality of the shallow water-bearing zone. Arsenic was detected at a concentration of 0.16 mg/L, above the RECAP GW_{3NDW} standard of 0.05 mg/L. As previously discussed, elevated arsenic concentrations at the Property appear to be naturally occurring and do not appear to be related to former oil and gas operations.

6.2 SN 114167 Area (Area 3)

ICON's investigation in the vicinity of SN 114167 included the collection of soil samples from two soil borings, EN-13 and EN-14. Soil collected at EN-13 exhibited elevated concentrations of barium and hydrocarbon constituents up to 8 feet below ground surface (with fractions providing delineation in the 6-8' interval). An elevated arsenic concentration, which was not confirmed by the split sample, was also detected in the 6-8' interval. During ERM's investigation, EN-13 was resampled (EN-13R). SPLP barium in the 2-4' interval was well below the RECAP standard. Polycyclic aromatic hydrocarbons (PAHs) were not detected in the 4-6' interval. Arsenic was below the 29-B and RECAP standards in the ERM and ICON split samples in the 6-8' interval. Barium was below the RECAP screening standard in the 8-10' interval, providing vertical delineation for barium.

Soil samples from EN-14 (approximately 120 feet northwest of EN-13) did not exhibit exceedances of metals, and indications of hydrocarbons were not observed during sampling. Elevated concentrations detected in EN-13 are delineated to the northwest by EN-14.

ERM advanced three additional soil samples (SB-12 through SB-14) to delineate barium and hydrocarbons to the northwest, southeast, and southwest. Barium concentrations were below the RECAP screening standards and TPH fractions were not detected above the laboratory detection limits at each of these locations, demonstrating horizontal delineation of barium and hydrocarbons in soil.

29-B salt parameter standards in soil are agronomic standards, and therefore apply to the effective root zone. Based on Dr. Luther Holloway's root study on the Property, the effective root zones range from 12

to 14 inches deep. Based on the effective root zone, soils in the upper two feet are being compared against 29-B salt parameters, which do not demonstrate any exceedances in the vicinity of SN 114167.

ICON installed one monitoring well, EN-13 in the vicinity of SN 114167. Groundwater collected from EN-13 exhibited an elevated chloride concentration (5,330 mg/L). ERM installed three additional wells for horizontal delineation of shallow groundwater (MW-6, MW-7, and MW-8). Chloride concentrations detected in these wells were considerably lower than in EN-13 (335 to 577 mg/L) demonstrating that groundwater migration has been very limited. Slightly elevated arsenic was detected in only one monitoring well in this area (MW-7), further demonstrating the high variability in naturally occurring arsenic concentrations, which do not appear to be related to former oil and gas operations.

7. 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 7.1 to identify the exposure pathways and scenarios that warrant risk evaluation. Quantitative RECAP assessment is then provided for soil (Section 7.2.1) and groundwater (Section 7.2.2) in a step-wise process, using a screening step to first identify potential constituents of concern, followed by site-specific assessment.

7.1 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 63) confirms that screening and Management Option (MO) RECAP standards (including their default exposure pathways/scenarios) applied to the site are appropriate or conservative for the actual exposure conditions.

7.1.1 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 property north of Highway 90, on which the SN 64701 well area is located, and much of the surrounding area, has been used for decades for agriculture based on aerial photography, while specific areas were concurrently used for E&P activities. The site remains in agricultural use today for sugar cane production. This specific use of the land is consistent with the definition of a commercial/industrial land use [North American Industrial Classification (NAIC) codes 111 – Agriculture and Crop Production] under RECAP (RECAP Appendix E). No portions of the property are currently used as residential (nonindustrial); however, residential neighborhoods are located north and northwest of the Property. There are no sensitive receptors such as schools, hospitals, or nursing homes within a 500-foot radius of the SNG investigation areas. The area associated with the SN 114167 well is located south of Highway 90 within the area classified by the USFWS as wetlands (Figure 4).

Groundwater beneath the Property is not used for any purpose, and the shallow groundwater sampled in Areas 1 and 3 has low-yield (Class 3A) and naturally poor water quality. Public water supply is readily available from the City of Franklin water system (number LA1101003). The available water well registry information (see Section 2.5) confirms Class 3 for the shallow groundwater zone, with no active registered water supply wells completed less than 225 feet deep within a mile of the Property.

7.1.2 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 within the 0 to 15 foot interval. Release of volatile constituents from soil to outdoor air is evaluated in the direct contact ($Soil_{ni}$) algorithm. Soil from all depths is also evaluated as a potential source medium for transfer of constituents to groundwater.

There is no direct exposure to constituents present in the silty water-bearing zones that overlie the Atchafalaya aquifer, which is separated from the shallow groundwater by the thick clay-confining unit beneath the Site. The shallow water-bearing zones have never been used as a water source on the property. The shallow zone investigated in Areas 1 and 3 does not represent a viable future water supply

source due to low yield and naturally poor water quality [e.g., concentrations of iron, manganese and arsenic naturally exceed EPA drinking water and RECAP screening standards].

The recognition of no current or historical use and low likelihood of future beneficial use is consistent with the regulatory classification (GW3) determined for the groundwater in Areas 1 and 3. 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 under evaluation. 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. The direction of groundwater flow is generally to the southwest, away from Bayou Teche. The nearest downgradient surface water body that could theoretically be a receptor for groundwater discharge is the Franklin Canal approximately 4,000 feet west of the Property.

The Franklin Canal subsegment is designated for primary and secondary contact recreation and fish and wildlife propagation (Subsegment 060907 Franklin Canal, LAC 33:IX.1123). Because Franklin Canal is not a drinking water resource, GW_{3NDW} is the appropriate groundwater classification for evaluation of the shallow water-bearing zone in accordance with RECAP.

The release of volatile constituents to air from the uppermost groundwater zone was evaluated as a potential pathway, and because volatile constituents were not detected in groundwater in the SNG areas, no further evaluation is warranted for the volatilization (GW_{airni}) pathway.

7.1.3 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. These standards apply to the agricultural use of the property [NAIC codes 111 (agriculture, crop production)] as provided 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 nonindustrial (residential) exposure scenario of RECAP. A nonindustrial assessment provides the most conservative assessment under RECAP, and demonstration of compliance with nonindustrial standards eliminates the 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:

- Nonindustrial 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 (GW_{3NDW}): hypothetical groundwater discharge to surface water (Franklin Canal), with use of surface water assumed to include recreation, fishing, and fish ingestion.

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

7.2 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 and MO-2. MO-1 was used for groundwater and MO-2 was used to incorporate EPA-updated toxicity factors for the soil assessment.

7.2.1 Soil

Soil samples collected by ICON and ERM within Areas 1 and 3 were used in the RECAP evaluation, and included samples from multiple discrete depth intervals at each boring (Table 4). Constituents useful for RECAP risk assessment and consistent with Appendix D of RECAP were analyzed in samples collected to a maximum depth of 10 feet bgs, and analyses were performed using LDEQ-recommended methods supported by Quality Assurance/Quality Control (QA/QC) data. Analytes 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. The sample location with highest total petroleum hydrocarbon concentration was also sampled and analyzed for PAHs in accordance with RECAP requirements. The laboratory QA/QC results indicate that the soil data are definitive data as defined in RECAP, suitable for use in quantitative risk assessment.

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 gasoline, diesel, and oil ranges (TPH-GRO, 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.[1] Fraction data were collected at all locations with hydrocarbon mixture data.

Screening Evaluation: As the first step in the RECAP risk evaluation, soil concentrations were compared to nonindustrial limiting screening standards to identify constituents warranting further site-specific evaluation. Because soil from the ground surface to a depth of 15 feet bgs is considered potentially available for direct human contact per RECAP definition, all data in Areas 1 and 3 were included in the comparison to health-protective screening standards for contact including dermal contact, soil ingestion, and inhalation (as applicable). 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.

A comparison of maximum reported concentrations in soil to limiting screening standards is provided in Table 8. The limiting standards are the lower of the screening standard protective of nonindustrial direct

[1] 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."

contact ($Soil_{SSNI}$) and the groundwater protection screening standard ($Soil_{SSGW}$). Arsenic, barium, and aliphatic >C12-C16 exceeded the limiting screening standard in one or both study areas and were subject to further evaluation under a Management Option of RECAP. Because the maximum barium concentrations exceeded the default groundwater protection screening standard, a site-specific demonstration of groundwater protection was made by collecting samples for synthetic precipitation leaching procedure (SPLP) analysis of barium in each study area.

The reported SPLP concentrations of barium in samples collected from locations with the maximum concentration above the standard in each area are less than the leachate screening standard protective of all classifications of groundwater (see Table 8). These include the resampling of ICON's EN-18 (0-2') location [EN-18R (0-2')] in Area 1 and EN-13 (2-4') in Area 3 [EN-13R (2-4')]. The results indicate that barium concentrations in soil do not represent a residual source of contamination to groundwater above health-based standards.

Management Option 2 Evaluation: The potential COCs were further evaluated under Management Option 2 (MO-2) in Table 9. The MO-2 RECAP Standard (RS) was developed using the LDEQ-provided spreadsheets (RECAP, 2003, Appendix H) and the current toxicity value (reference dose) for barium. No other changes to default RECAP parameters for a nonindustrial 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.[2] The updated toxicological review with derivation of the updated oral reference dose was published for barium in the USEPA's Integrated Risk Information System (IRIS) in June of 2005 following the promulgation of RECAP in 2003. Based upon comparison of reported soil concentrations to the MO-2 RS for the default nonindustrial scenario in Table 9, concentrations of all potential COCs reported in soil are less than the standards protective of human health for unrestricted use of the Property. Although reported barium concentrations are also less than the default MO-1 nonindustrial standard of 5,500 mg/kg, the updated toxicity factor and MO-2 were used to provide a current assessment for soil.

Barium was identified for evaluation beyond screening based on exceedance of the limiting screening standard in two sample locations. A single boring [EN-18 (0-2')] in Area 1 exceeded screening standards for barium. Barium is delineated at EN-18 (0-2') to below the screening standard vertically in sample EN-18 (4-6'). In Area 3, the detection above screening at EN-13 (2-4') is laterally delineated by samples from locations SB-12, SB-13, SB-14, and vertically by sample EN-13R (6-8'). Based on concentrations of barium below both MO-1 and MO-2 standards of RECAP in all borings, no further investigation or action is warranted for the barium in soil.

Arsenic concentrations exceeded screening standards at a single ERM sample in Area 1 [14.1 mg/kg at EN-17 (8-10')]. This exceedance was not confirmed by the ICON split sample (7.21 mg/kg) or resample results for EN-17R (8-10'). In accordance with Section 2.13 of RECAP, the average concentration of arsenic was calculated for the potential AOI at Area 1 and compared to the state-specific background value of 12 mg/kg. The mean arsenic concentration in soil is below the LDEQ-identified state-specific background level, adopted by LDEQ as the RECAP standard protective for unrestricted land use.

Aliphatics >C12-C16 was the only hydrocarbon detection that exceeded screening standards [500 mg/kg at EN-13 (4-6')]. TPH was not detected in delineation borings SB-12, SB-13, and SB-14, and was below screening standards at vertical delineation sample EN-13 (6-8').

[2] 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."

7.2.2 Groundwater

Groundwater data collected by ERM and ICON in Areas 1 and 3 were included in the RECAP evaluation. The samples were collected from two monitor wells installed by ICON and three wells installed by ERM. Groundwater samples were analyzed for the following parameters: total metals, dissolved metals for some samples, hydrocarbons, BTEX (benzene, toluene, ethylbenzene, and xylenes), chlorides, and other water quality indicators. Analyses were performed using LDEQ-recommended methods with supporting QA/QC and appropriate detection limits.

All groundwater samples were analyzed for hydrocarbon mixtures (SW-846 Method 8015) by ICON, with the results expressed as TPH-GRO, TPH-DRO, and TPH-ORO. Split samples were analyzed by ERM using the more informative, RECAP-recommended hydrocarbon fractionation method [Massachusetts Volatile Petroleum Hydrocarbon (VPH)/Extractable Petroleum Hydrocarbon (EPH) Method]. Because LDEQ recommends use of hydrocarbon fraction data when both types of data are available, the fraction results are used in the RECAP assessment.

Screening Evaluation: Groundwater concentrations were compared to screening standards protective for all classifications of groundwater, to identify constituents warranting further site-specific evaluation. Table 10 presents a comparison of maximum reported groundwater concentrations to screening standards (GW_{ss}). SMCLs are available for several constituents with no RECAP Screening Standard, and are used as screening standards in Table 10 for chlorides, iron, TDS, and manganese. Maximum concentrations are summarized for Area 1 including EN-18 and Area 3 including EN-13, MW-6, MW-7, and MW-8.

The screening evaluation provides the following conclusions.

- Iron and manganese are naturally elevated above the SMCL in this region and locally. The occurrence of these constituents is documented in independent regional studies by the USGS and LDEQ and is confirmed in wells on the Property that are unimpacted by E&P activities. They are not considered site-related COCs warranting further evaluation.
- Arsenic is present above the screening standard of 0.01 mg/L in groundwater samples collected throughout the Property (see Figure 56). As discussed in the next section, arsenic has been demonstrated to occur naturally above 0.01 mg/L both regionally (Yang, et al, 2014) and locally (on the Property in unimpacted wells).

Area 1

- Arsenic (total and dissolved) is the only constituent that exceeded the screening standard in Area 1. Arsenic was retained as a COC for further evaluation under MO-1 for demonstration purposes although the concentration is consistent with naturally occurring levels. No delineation wells were required for this area.

Area 3

- Total and dissolved arsenic, barium, and strontium exceeded the RECAP screening standard in Area 3, with barium and strontium delineated below screening standards by monitoring wells MW-6, MW-7, and MW-8. These constituents were further evaluated under MO-1.
- Chlorides and TDS exceeded the SMCL used for screening in Area 3. The concentrations decline significantly in the delineation wells (MW-6, MW-7, and MW-8) completed around the former pit location where the maximum concentration (EN-13) was identified. The SMCLs are not applicable

standards for the Class 3 water-bearing zone, and the maximum concentrations are further evaluated under MO-1.[3]

Arsenic in Groundwater: Arsenic concentrations in groundwater are evaluated under MO-1 to demonstrate protective conditions for the default GW_3 pathway of groundwater to surface water, however, it is noted for delineation purposes that arsenic levels in groundwater in site wells are consistent with naturally occurring levels. Available site-specific background data include samples collected on the Property that show no evidence of produced water (or other) impacts as discussed in Section 5.3 (see discussion of Stiff and Piper diagram analysis). The sample locations identified as unimpacted by oil and gas activities and most representative of natural conditions include EN-1B, EN-10, EN-19, EN-23, EN-28, EN-29, EN-30, DMW-1, MW-3, MW-4, and MW-5. The sample locations and analytical data for these locations are characterized as follows:

- The sample locations are outside of former E&P pit (or other) features;
- There are no confirmed detections of hydrocarbon constituents (TPH or indicator constituents); and
- The water chemistry confirms no signature indicative of brine impact, including low chlorides levels (generally ≤25 mg/L) and cation/anion distribution that is consistent in these samples and has no indication of brine impact (Figures 61 and 62).

Arsenic concentrations in the unimpacted samples range from non-detect to 0.23 mg/L (0.21 mg/L dissolved). The range is notably consistent with the natural range identified for the Sterling Sugars property studied just north of the Property and Bayou Teche within the same hydrogeologic setting. The arsenic concentrations reported in groundwater in Areas 1 and 3 fall within this range with a maximum of 0.16 mg/L. Because samples are available for multiple monitoring wells in Area 3, a two sample t-test was conducted using EPA's PRO-UCL statistical program[4] to confirm no significant difference (5% significance level) in the concentrations for the site-specific background wells and concentrations reported in Area 3. The input data and results are provided in Appendix K, and confirm that no statistically significant difference is identified.

MO-1 Evaluation: In accordance with RECAP requirements, the Class 3 groundwater concentrations were evaluated for protection of the surface water body that could potentially receive discharge from the groundwater zone. For purposes of this assessment, the Franklin Canal approximately 4,000 feet west of the Property was assumed to receive continuous groundwater discharge from the shallow zone beneath the Property although the zone is highly variable and discontinuous. This evaluation is provided as a conservative (protective) assessment, consistent with the default pathway analysis for Class 3 groundwater.

Table 11 provides the development of MO-1 RS and comparison to Compliance Concentrations for the metals, hydrocarbon fractions, and nontraditional parameters (chlorides, TDS) that exceeded screening standards or alternate criteria (SMCLs for chlorides and TDS). The limiting RS for groundwater is the GW_{3NDW} value as the COCs do not have solubility limits (Sol) and are not volatile (therefore these factors are not applicable in identifying the limiting MO-1RS). The development of the GW_{3NDW} standards requires estimation of attenuation from the Point of Compliance (POC) to the Point of Exposure (POE) at the potential receiving surface water body. LDEQ provides longitudinal dilution-attenuation factors (DF3), for use in MO-1 standard development, as a function of migration distance (x) and affected saturated

[3] Appendix D of RECAP references MO-2 for analysis of non-traditional parameters and the RECAP Frequently Asked Questions reference MO-1. The term MO-1 is used herein because the LDEQ-recommended default attenuation factors are used in this assessment as provided in RECAP Appendix H, Section H1.2.2.3.

[4] https://www.epa.gov/land-research/proucl-software

zone thickness (S_d). The factors are derived by LDEQ using the Domenico analytical solute transport model conservatively assuming a retardation factor of one. The average thickness of the shallow zone (S_d) is identified as 6 to 10 feet for Areas 1 and 3, and the resulting DF3 values are provided in Table 11 with the final GW_{3NDW} standards.

The assessment provided in Table 11 demonstrates that maximum groundwater concentrations (Compliance Concentrations in accordance with RECAP) in Areas 1 and 3 are less than standards protective of surface water quality considering all designated uses.

7.3 RECAP EVALUATION CONCLUSIONS

The RECAP evaluation for soil included comparison to screening standards followed by MO-2 evaluation. Three constituents in soil (arsenic, barium, and Aliphatics >C12-C16) were identified above the limiting screening standards and subject to evaluation under MO-2. Based on reported soil concentrations below the MO-2 standards for the default nonindustrial scenario, concentrations are less than the RECAP standards protective of human health for unrestricted use of the Property. Constituent concentrations in soil comply with RECAP standards and do not pose a risk to human health and the environment or provide a residual source of contamination to groundwater above health-based standards.

The evaluation for groundwater included comparison to screening standards followed by MO-1 evaluation. Maximum concentrations (Compliance Concentrations) are below RECAP standards protective of surface water quality, assuming continuous discharge. The arsenic concentrations reported in shallow groundwater in Areas 1 and 3 are within the range of concentrations identified as representative of natural conditions. No further evaluation of groundwater is warranted.

8. PROPOSED REMEDIATION PLAN

The remediation plan proposed in this section complies with Statewide Order 29-B with exceptions and RECAP, which is the State's risk-based protocol 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 and unnecessary, is included in Appendix L.

8.1 SN 64701 Area (Area 1)

Based on the results of the RECAP analysis, no active remediation of soil or groundwater is required in the SN 64701 area. The former operational area is currently being used for agricultural purposes and appears to be supporting healthy sugar cane growth.

8.2 SN 114167 Area (Area 3)

Based on the results of the RECAP analysis, no active remediation of soil or groundwater is required in the SN 114167 area. Based on historical aerial imagery and field observations, there is an unregistered pit in this area that is still present as defined by a bermed, pit-like feature. There is also some debris present, some of which may be related to historical oil and gas operations. The proposed remediation in this area includes registration of the pit with the LDNR using the UIC-15 Form, and closing the pit-like feature by leveling the existing berms and removing any oilfield debris in this area. Mature trees growing on the berms will be left in place. The proposed remediation will allow natural restoration of wetland vegetation and ecology. It is estimated that the cost of these remediation activities will be approximately $28,000 (Table 13). Supporting documentation is provided in Appendix M.

9. SCHEDULE AND REPORTING

The implementation schedule for the proposed remediation activities is provided below. The following milestones for the implementation schedule have been established:

- Submit a Coastal Use Permit (CUP) application – approximately 60 days after adoption of the proposed remediation plan;
- Receipt of the CUP would require at least 3 to 6 months to obtain LDNR Office of Coastal Management and U.S. Army Corps of Engineers approval;
- Begin proposed remediation activities within 60 days of receipt of the CUP; and,
- Submit letter report to LDNR documenting remediation activities completed in SN 114167 area within 60 days of completion.

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APPENDIX K PRO-UCL INPUT DATA AND RESULTS

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APPENDIX L HYPOTHETICAL 29-B PLAN

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APPENDIX M COST ESTIMATE BACKUP

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