Final Technical Report

Site Investigation and Evaluation of Remedial Alternatives for the Vinson Site, Jones County, Texas

(RRC Site: 7B-50212)

by

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1.0 EXECUTIVE SUMMARY

The Bureau of Economic Geology (BEG) conducted an environmental assessment at the Vinson site in Jones County, Texas (RRC Cleanup Code 7B-50212) from March through August of 1997. The Railroad Commission of Texas (RRC) prioritized assessment of the Vinson site because of a complaint of crude-oil impact in the Vinson water-supply wells. Previous RRC investigations included monitoring of the replugging of three former oil wells and pressure testing of a crude-oil pipeline located within 1 mi of the site. At the start of this assessment the source of crude oil and its subsurface extent were undetermined. During the investigation BEG delineated the extent of subsurface crude-oil impact and excluded several potential sources. However, the source of the crude oil at the Vinson site remains unproven.

The principal tasks performed for this investigation included:

(1) review of RRC files and previously compiled site data,

(2) identification of the subsurface horizon(s) in which the crude oil is contained,

(3) delineation of the subsurface extent of crude oil and methane via solid-stem auger drilling and measurement of borehole vapor concentrations,

(4) installation of monitoring wells and sampling of ground water to determine hydraulic gradient and ground-water quality,

(5) evaluation of risk associated with crude-oil-impacted ground water, and

(6) evaluation of options for site remediation.

The Vinson site is located in southwestern Jones County, Texas, approximately 18 mi northwest of Abilene and 5 mi north of Merkel, Texas, adjacent to a tributary of Bitter Creek. On November 6, 1991, Mrs. Vinson reported to the RRC that a windmill on their property had pumped crude oil into a surface tank, which spilled over into the yard and down the hill behind the house. Subsequent work revealed the presence of crude oil in a newly installed water well, which is also in the Vinson's backyard.

Results of this assessment show that free-phase crude oil underlies approximately 76,000 ft^2 of the Vinson property at a depth approximately 20 ft below ground level (bgl). Two domestic water supply wells, WW-1 and WW-2, intersect the crude-oil plume, which is nearly centered beneath the house. Total oil volume is estimated between 125 and 500 barrels (bbl) (5,250 to 21,000 gal); 600 gal has already been produced. Coincident with and surrounding the crude-oil plume is a secondary plume or halo of methane, which underlies an additional approximately 66,000-ft^2 area. BEG measured methane concentrations up to 98 percent in the unsaturated zone at depths of 8 to 12 ft bgl, in open boreholes drilled as deep as 35 ft within and around the perimeter of the crude-oil plume.

Shallow (<35 ft bgl) ground water within the zone of hydrocarbon impact shows elevated concentrations of total petroleum hydrocarbons (TPH); however, results of benzene, toluene, ethylbenzene, and xylene (BTEX) analyses from five down-gradient wells completed in the same water-bearing zone were below detection limits. Minor concentrations of polynuclear aromatic hydrocarbons (PAH's) were detected in (1) one well completed in shallow (<35 ft bgl) ground water and (2) three samples of water from the deeper (50 to 60 ft bgl) water-bearing zone. Not all of the individual PAH compounds were detected in each sample, however, and duplicate analyses did not yield the same results.

The presence of hydrocarbons in shallow sediments (<35 ft bgl), its absence at greater depths (50 to 60 ft bgl), and lack of a trace of lateral plume migration to the mapped position are indicative of a nearby source of crude oil. The oil likely came from either (1) an overflowing surface storage tank located adjacent to an oil well now plugged and abandoned, immediately northwest of the Vinson house (Bennett "A" #2 well) or (2) a shallow, buried, gathering line carrying oil from that well to a nearby tank battery that could have developed a leak. Given an oil-production rate test of 87 bbl in 24 h, an unabated spill lasting at least 2 to 6 d could account for the amount of subsurface crude oil estimated to be present at the Vinson site. Oil from the well could have discharged onto the surface or into the subsurface and seeped into the ground to impact the shallow ground water. We estimated the velocity of oil movement at the Vinson site to be approximately 0.013 to

0.026 ft/d. At this velocity oil might travel 5 to 10 ft/yr, or take 30 to 60 yr to travel 300 ft through the ground at the Vinson site. The present diameter of the crude-oil plume is approximately 300 ft.

Public health and safety issues include use of an oil-impacted domestic water-supply well (WW-2) by site residents, a potential for further impact to deeper water-bearing zones by cross-contamination through a well annulus, and the presence of elevated concentrations of methane in the shallow subsurface.

As remedial actions, we recommend that the free-phase crude oil be removed from the subsurface through the use of product-only extraction devices placed in two fluid-extraction wells. We also recommend installation of five soil-vapor-extraction (SVE) wells to reduce subsurface methane levels. A pilot system is needed to provide data on total emission of petroleum hydrocarbons; if total emission does not exceed 1.0 lb/hr a standard air permitting exemption may be obtained.

2.0 INTRODUCTION

The Railroad Commission of Texas (RRC) has statutory responsibility under S.B. 1103 (72nd Legislature, 1991) for oversight of cleanup of abandoned oil-field sites throughout Texas. Since 1991, RRC personnel have identified and inventoried numerous sites as candidates for cleanup and have given priority to those sites that have had observable releases, occur in ground-water recharge zones with high soil permeability, lie near surface-water bodies or water-supply wells (or both), have high public profile and have received complaints, and are near population centers. Straightforward solutions for cleanup are readily apparent for many of the sites. At some sites, however, outlining cost-effective approaches to cleanup requires more complete information on the surface and subsurface extent of the contamination. For these priority sites, the Bureau of Economic Geology (BEG) is providing more extensive site investigations for the RRC under interagency contract 94-0423. The purpose of these investigations is to provide the required information for planning and executing the appropriate level of remediation.

The site of concern for this investigation is the Vinson site in Jones County (RRC Cleanup Code 7B-50212), where two private water-supply wells were found to be impacted with crude oil in November 1991. On the basis of the potential for risk to human health and the presence of an unknown source of oil, RRC placed the Vinson site high on the priority list of sites in need of remediation. The objectives of this study were to (1) determine extent and, if possible, the source of crude oil in the Vinson wells and (2) make recommendations for cleanup at the site.

The principal tasks performed for this investigation included:

(1) review of RRC files and previously compiled site data,
(2) identification of the subsurface horizon(s) in which the crude oil is contained,
(3) delineation of the subsurface extent of crude oil and methane via solid-stem auger drilling and measurement of borehole vapor concentrations,
(4) installation of monitoring wells and sampling of ground water to determine hydraulic gradient and ground-water quality,
(5) evaluation of risk associated with crude-oil-impacted ground water, and
(6) evaluation of options for site remediation.

2.1 Site Description

The Vinson site is located in southwestern Jones County, Texas, approximately 18 mi northwest of Abilene and 5 mi north of Merkel, Texas, adjacent to a tributary of Bitter Creek (figure 2.1). It lies within a rural area that is used primarily for farming, ranching, and petroleum production.

The site lies within the Mead oil-production field (figure 2.1), where numerous oil wells have been drilled and operated since the 1950's. According to the Abilene Geological Society (1978), production from Mead field between 1951 and 1978 exceeded 1 million bbl (MMbbl) of oil from 28 wells completed in fluvial-deltaic mid-Pennsylvanian Strawn formation sands at depths between 4,000 and 5,000 ft bgl. Three oil wells were in operation on the Vinson property within the last

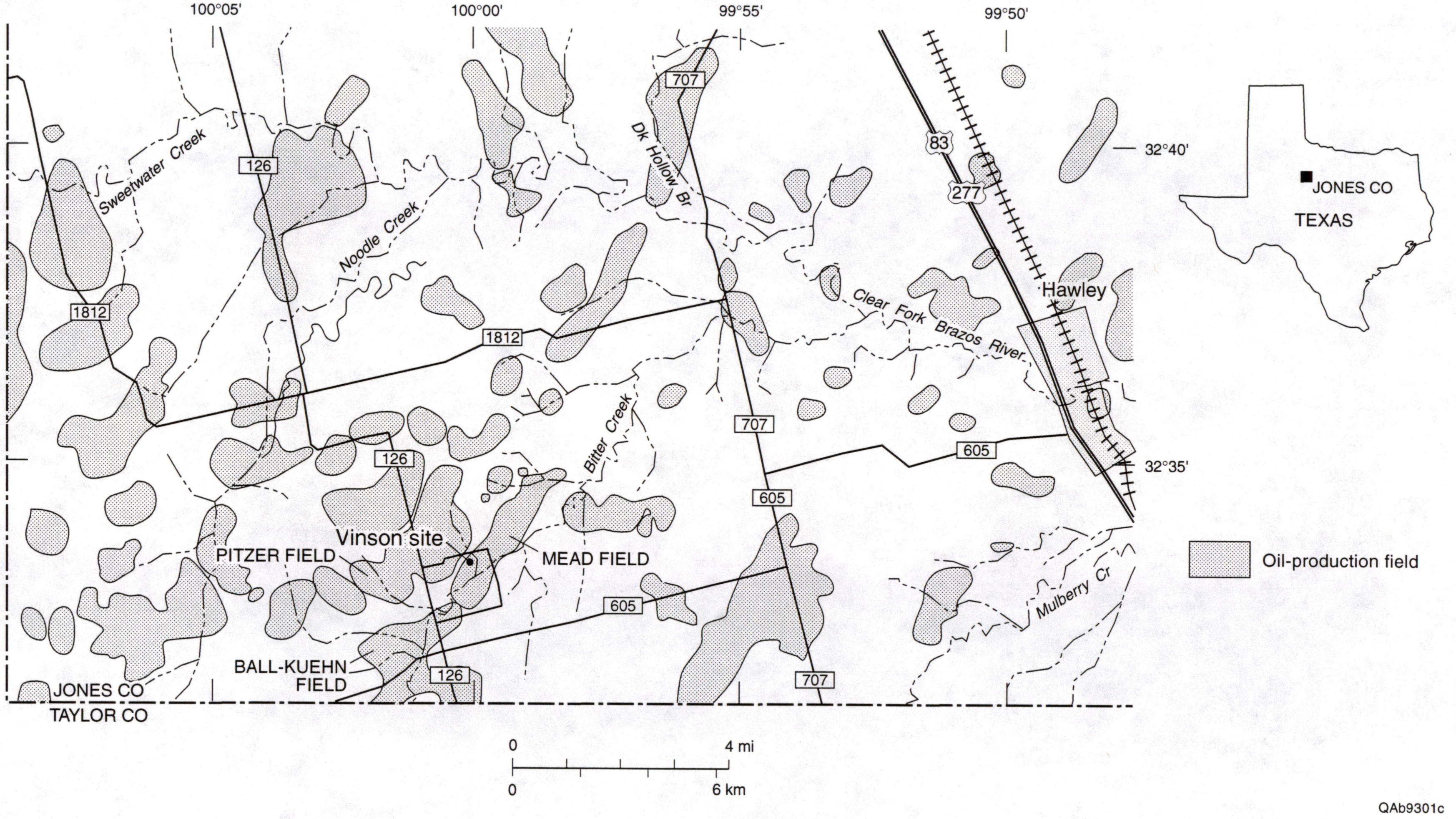


Figure 2.1. Locations of the Vinson site and major oil-production fields in southwestern Jones County.

40 yr; all three were plugged in the 1980's. A crude-oil pipeline, which is now abandoned, parallels County Road 436 along the north edge of the Vinson site.

Approximately 1 acre of the Vinson property is occupied by their home and surrounding yard (fig. 2.2); the remainder of the property is used to grow crops for grazing cattle and horses. The Vinson house and two water wells (WW-1 and WW-2) sit on a hill at an elevation of approximately 1,780 ft above mean sea level (amsl). Both of these wells have contained crude oil since the original complaint in 1991. A third water well (WW-3) on the Vinson site is located off the hill approximately 500 ft to the south of the domestic supply wells at an elevation of approximately 1,767 ft amsl (fig. 2.2). WW-3 is used as an irrigation well and has not shown any evidence of crude-oil contamination.

2.2 Site Geology

The Vinson site is located in the south portion of the West Texas Rolling Prairies Section of the North Central Plains physiographic province of Texas (Duffin and Beynon, 1992). Surface topography slopes to the southeast and is characterized by flat plains to rolling hills. Structurally the area is near the east edge of the Permian Basin (Richter and others, 1990). Outcrops of Permian sediments in Jones County show that strata dip west-northwest at approximately 40 ft/mi. Overlying Quaternary deposits of the Seymour Formation and Recent alluvium dip gently to the east-southeast (Price, 1978). The Pennsylvanian Strawn Formation underlies Jones County at depths of approximately 4,000 to 6,000 ft below land surface. This formation is the major oil-producing zone in the region.

The Vinson site is located near the contact of Quaternary alluvial deposits (Seymour Formation) and the Choza Formation of the Clear Fork Group (fig. 2.3). The Permian-age Clear Fork Group comprises red shale and siltstone with interbeds of limestone, dolomite, gypsum, and occasional lenses of silty sand. The Clear Fork Group is divided, from oldest to youngest, into the Arroyo, Vale, and Choza Formations; these three formations are of similar lithology and often

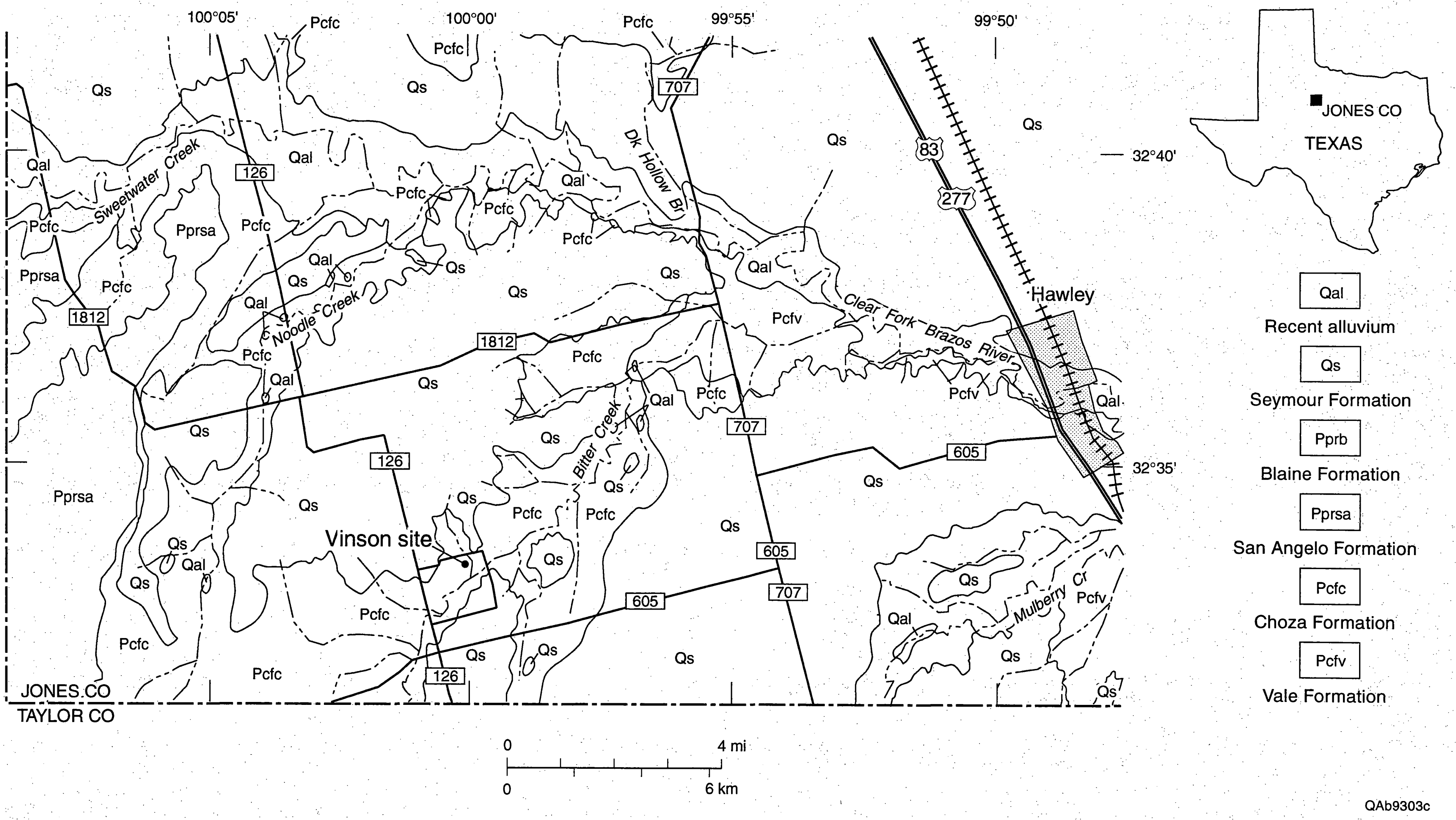


Figure 2.3. Surface geology of southwestern Jones County.

difficult to distinguish (Barnes, 1974). Semiconsolidated and unconsolidated Quaternary deposits of clay, sand, and gravel of the Seymour Formation and Recent alluvium overlie rocks of the Clear Fork Group.

2.3 Site Hydrology

2.3.1 Surface Water

Regional surface drainage is to the southeast. A tributary of Bitter Creek that crosses the Vinson property drains a hilly region to the northwest and joins the main portion of the creek approximately 0.3 mi (~1,600 ft) to the southeast of the site. Bitter Creek flows into the Clear Fork of the Brazos River approximately 7 mi to the northeast (fig. 2.2).

Water in the tributary creek flows to the southeast around the terrace upon which the Vinson house sits. The ephemeral creek was observed to be dry where it crosses under the Vinson driveway in May, June, and August of 1997 but contained water after heavy rains in July. Water movement in the creek is slow to stagnant, and the creekbed can pond water. During our field studies, there was no evidence of crude-oil seeps along the creek.

2.3.2 Ground Water

Both Permian and Quaternary rocks provide fresh to moderately saline waters in small to moderate quantities to wells within the county. In Jones County, water-bearing units of the Clear Fork Group yield enough water to support irrigation and minor industry (Duffin and Benyon, 1992). Water wells on the Vinson property are completed in the Choza Formation, the uppermost member of the Permian-age Clear Fork Group, which throughout western Jones County provides limited amounts of fresh to slightly saline ground water (Price, 1978). Water-supply wells in the immediate vicinity of the Vinson site are completed in the Choza Formation at depths of approximately 60 ft bgl. Six water wells were identified on and in the immediate vicinity of the

Vinson property during previous studies (table 2.1 and fig. 2.2). Data from these wells are also used in this study.

2.4 Site History

In August 1991 the Vinson family moved a house onto the property referred to here as the Vinson site. At that time there was a windmill (WW-1) located just south of the house that was used to pump water from a depth of approximately 40 ft bgl (table 2.1). The Vinsons installed a second water well (WW-2) to a depth of 60 ft bgl in early September 1991. On November 6, 1991, Mrs. Vinson reported to the RRC that the windmill (WW-1) had pumped crude oil into a surface tank, which spilled over into the yard and down the hill behind the house.

Inspections by RRC personnel on November 6 and 22, 1991, found well WW-1 to be pumping slugs of "black, dead oil." WW-2 did not appear impacted at that time. Samples were collected from both wells for chemical analysis. On February 22, 1992, an RRC inspector documented that a 15-ft-thick column of crude oil was present in WW-2.

Other investigations into the source of crude oil at the Vinson site that predate this study include:

(1) RRC, November 1991—collected samples of crude oil from Vinson wells and nearby tank battery for finger-printing analyses using distillation and chromatography; collected ground-water samples from WW-1, -2, and -3 for chemical analysis.

(2) Unocal, February 1992—collected samples of crude oil from Vinson wells and nearby pipeline for chromatographic analysis; collected samples of ground water for chemical analysis from WW-1, -2, -3, -4, -5, -6 (fig. 2.2).

(3) Reynolds Engineering Company, January 1993—supervised removal of approximately 600 gal (14 bbl) of crude oil from WW-2 and concluded that "a considerable quantity of oil remained in the shallow aquifer underlying the Vinson property."

Table 2.1. Wells in the immediate vicinity of the Vinson site.

Well	Approximate depth (ft bgl)	Comments
WW-1	40	Windmill on the Vinson property that is not in use.
WW-2	60	Water supply well for the Vinson house and garden.
WW-3	35	Irrigation well south of the Vinson house.
WW-4	unknown	Hand-dug well in pasture southwest of Vinson property.
WW-5	unknown	Water-supply well northwest of the Vinson property.
WW-6	60	Well next to tank battery on County Road 436.

Possible sources of the oil contamination were investigated and several potential sources were eliminated, but the source of crude-oil contamination was not identified. Suspected sources of the crude oil and the reasons for their elimination as potential sources prior to this study are included in table 2.2.

3.0 METHODOLOGY

BEG personnel reviewed RRC case files for the Vinson site and conducted two reconnaissance visits. BEG began onsite field work by collecting continuous cores in May 1997, delineated the contaminant plume and installed five ground-water monitoring wells in July 1997, and completed site sampling in August 1997. Field methods described later include those used to construct a site map, determine the feasibility of a surface geophysical survey, and conduct a drilling and sampling program to delineate the extent of crude-oil contamination and characterize local ground-water conditions.

3.1 Global Positioning System Survey

BEG prepared site maps shown in figures 2.2 and 3.1 using (1) a Global Positioning System (GPS), (2) measured distances and compass bearings, and (3) aerial photography. On May 14 and 15, we conducted a differential GPS (DGPS) survey. At selected locations, we used our real-time DGPS in a static mode to acquire as many as 180 positions at a rate of about one per second. These data were averaged to yield position coordinates with an accuracy of ±3 ft. Locations included water wells (WW-1, WW-2, WW-3, WW-4, WW-5 and WW-6), two core sites (VCC-1 and VCC-2), one borehole (VBH-1), and sites of past and current oil wells and tank batteries. Road intersections were also surveyed to provide ground-control points for georeferencing vertical aerial photography. BEG also referenced aerial photography with a kinematic (walking) DGPS survey of the Vinson driveway. Positions of the Vinson residence and later borehole locations were

Table 2.2. Possible sources of crude oil.

Source	Location	Finding
Crude-oil pipeline	~1,000 ft north of Vinson house	Tested by RRC and found not to be leaking.
Crude-oil pipeline pumping station	~1,300 ft northwest of Vinson house	Ruled out because of an uncontaminated water well (WW-5) located nearby.
Bennett "A" #1 (Arnot well)	~1,000 ft south of Vinson house (see fig. 2.2)	Reentered and replugged in November 1991 under supervision of RRC with no apparent show of oil.
Bennett "A" #2 (Unocal well)	~150 ft northwest of Vinson house (see fig. 2.2)	Reentered and replugged in June 1992 with no apparent oil show. CURA Inc. witnessed and provided documentation of plugging on behalf of Unocal.
Stroube Operating salt-water disposal well (formerly an oil well)	$^1/4$ mi east across Bitter Creek	RRC witnessed plugging and found no evidence of oil or leakage.
Bennett "A" lease tanks	~500 ft southwest of Vinson house	Removed in 1991; reported in earlier RRC documents to be the most likely source.

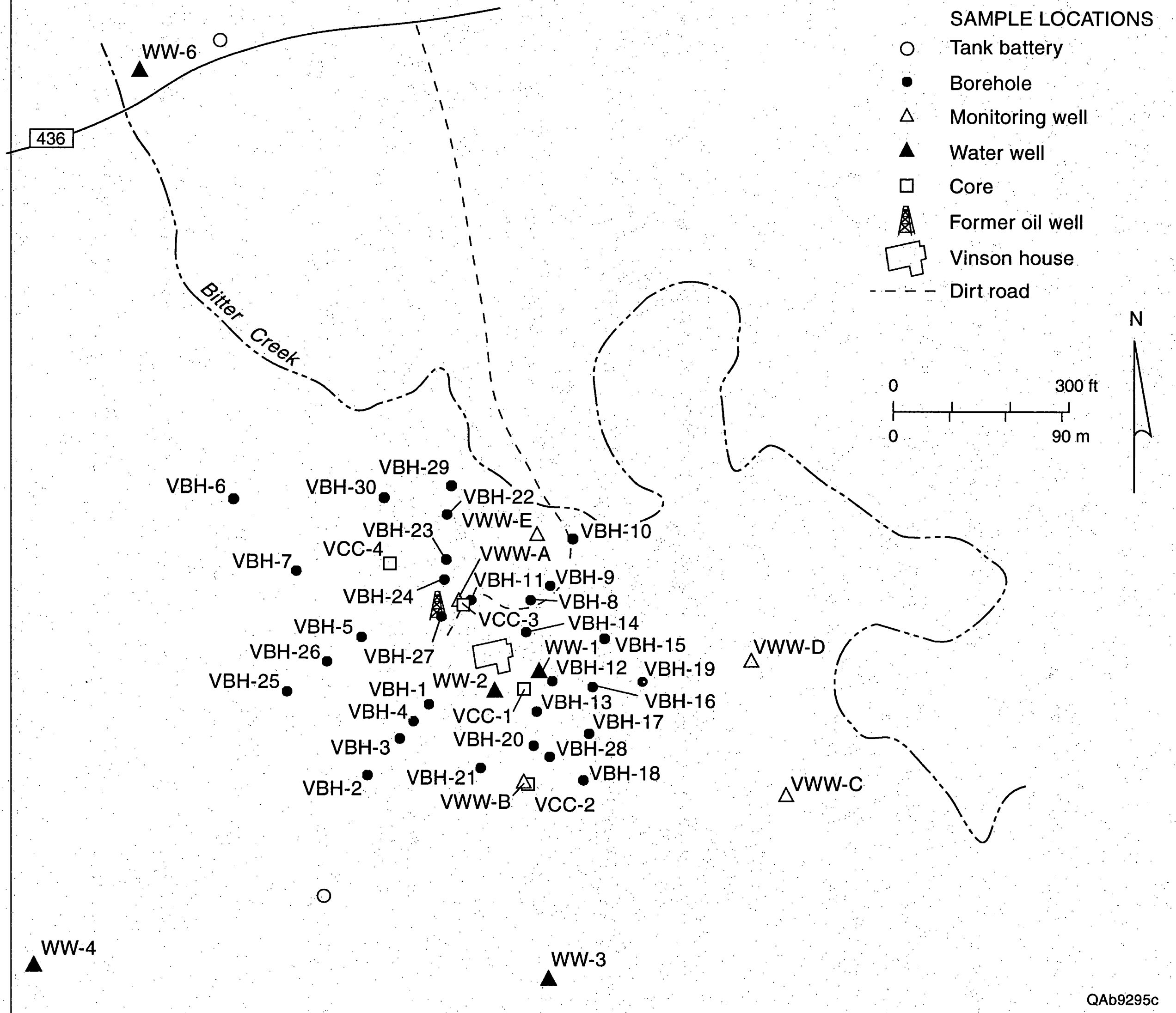


Figure 3.1. Locations of cores, boreholes, and monitoring wells drilled by BEG. Previously existing water wells and tank batteries at the Vinson site also shown.

determined by measuring the distances and directions from DGPS-surveyed locations using a tape, compass, and transit.

Positional data were compiled and transferred to ArcView, a Geographic Information System (GIS) software. We digitally scanned a 1:24,000-scale, black-and-white aerial photograph taken on December 20, 1976. This scanned image was georeferenced, mathematically corrected for distortion, and imported into the GIS. The photograph served as a backdrop to the positional data and allowed the on-screen digitizing of features not surveyed in the field.

3.2 Geophysics

BEG logged conductivity in boreholes using a Geonics EM39 electromagnetic induction probe. The purpose of this test was to determine whether there was sufficient electrical contrast between the crude-oil-impacted zone and unimpacted layers to allow the plume to be mapped by surface geophysics. The EM39 has a 50-cm separation of transmitter and receiver coils, an operating frequency of 39.2 kHz, and a formation-penetration radius of about 1 m. Use of the EM39 in combination with lithologic logging allowed us to attempt to calibrate conductivity readings with the known oil-bearing zone. In comparing the induction log and the cores, we learned that there is only a slight conductivity decrease in the oil-bearing zone and that the contrast probably would not be large enough to be detected accurately using surface geophysical methods. We therefore omitted the planned surface geophysical survey described in the site-investigation plan and relied on drilling to map out the oil plume.

3.3 Field Methods

BEG employed solid- and hollow-stem augering and mud rotary-drilling methods at the Vinson site to collect sediment cores, drill boreholes to collect soil-gas samples, and to install ground-water monitoring wells. We also collected water samples from ground-water monitoring wells and the Vinson kitchen water tap. Figure 3.1 shows the locations of 30 soil-gas borings, 4 continuous cores, and 5 ground-water monitoring wells. We conducted the drilling and sampling in several stages. Stage 1 (May 1–3, 1997) was designed to determine:

(1) at what depth the crude oil occurs in the subsurface,

(2) whether subsurface layers of indurated rock would most likely preclude penetration by a conventional direct-push soil probe for soil and soil-gas sampling,

(3) whether a nonintrusive geophysical method would be feasible for obtaining cost-effective information on the location of the subsurface oil plume, and

(4) whether significant health risk is posed by exposure to ground water from the contaminated well in domestic use.

During Stage 1 drilling we first collected two continuous cores (VCC-1 and VCC-2) using hollow-stem augers. VCC-1, located between existing wells WW-1 and WW-2, was drilled to a depth of 68 ft bgl. We found oil present in the core from a depth of 15 ft bgl to approximately 36 ft bgl; we also found oil floating on ground water at this location. VCC-2 was located 220 ft to the south of VCC-1 and was drilled to a depth of 35 ft bgl. There were no obvious signs of crude oil detected in the core or ground water at this location.

Second, we drilled one borehole (VBH-1) using solid-stem augers at a station approximately 210 ft west of VCC-1, between the contaminated wells and the position of the former tank battery (fig. 3.1). Drill cuttings in VBH-1 had a strong hydrocarbon odor starting at a depth of about 20 ft bgl, and a split-spoon sample of sediments from the same depth contained crude oil. After completing the boring at a depth of 50 ft bgl and removing the augers, we measured ground water at a depth of 17.5 ft bgl; it too contained crude oil.

Third, we put blank 2-inch casing in selected test borings and logged the holes using the downhole electromagnetic logging tool, as previously described.

The stage 1 results indicated a drilling resistance of as much as 16,000 lb of head-feet torque is needed to penetrate the rock layers, which exceeds the capacity of conventional direct-push soil probes, therefore excluding the use of direct-push technology at the Vinson site. However, we found that penetration rate with both hollow-stem and solid-stem augers was good, that we could obtain information from cuttings on the auger flights, and that the resulting boreholes allowed us to take downhole readings of gas concentrations.

Stage 2 (May 20–30, 1997) included drilling and sampling to delineate the extent of the crude-oil plume and conducting an inventory of water wells within 1 mi of the Vinson site. During stage 2 drilling we used solid-stem augers with the Bureau's CME 75 rig to drill 27 additional borings (VBH-2 through VBH-28; fig. 3.1). We measured volatile constituents of soil gas as indirect indicators of crude-oil impacts. Transglobal Environmental Geochemistry (TEG) provided mobile laboratory services for gas chromatography and TPH analyses. At the 27 borings we:

(1) inspected the soil material on the auger flights for evidence of free oil product or oil staining;

(2) measured methane, carbon dioxide, and oxygen content of vapor in the borehole;

(3) analyzed light-end hydrocarbons in vapor samples using gas chromatography;

(4) analyzed total petroleum hydrocarbons (TPH) of soil samples; and

(5) analyzed TPH of ground water.

Objectives of stage 3 (July 10–19, 1997) field work were to bound the hydrocarbon plume on the northwest edge, determine whether the source of crude oil was in the shallow subsurface or at greater depth, collect core samples for laboratory TPH analyses, and install wells to monitor water quality.

Field work completed at the Vinson site during stage 3 included (fig. 3.1):

(1) collection of two additional continuous cores (VCC-3 and VCC-4) from the surface to depths of approximately 35 ft bgl;

(2) drilling of two additional plume-delineation borings (VBH-29 and VBH-30) and measurement of borehole vapors; and

(3) installation, development, and sampling of the five 2-inch-diameter ground-water monitoring wells (VWW-A, VWW-B, VWW-C, VWW-D, and VWW-E) and sampling of preexisting wells WW-3 and WW-6.

BEG planned stage 4 field work (August 18–19, 1997) in order to resample the five ground-water monitoring wells. Drill cuttings from the borings that contained hydrocarbon constituents and water from wells WW-2 and VWW-A were drummed for disposal at an RRC-approved disposal facility.

Samples of the Vinson kitchen tap water (pumped from WW-2) were collected for analysis during stages 1 through 3 of field work. During stage 4 we also collected a sample of water directly from the holding tank that is located next to and supplied by WW-2.

3.3.1 Coring

BEG collected four continuous cores (fig 3.1) from the Vinson site using standard procedures:

(1) A 3-inch-diameter split barrel sampler was attached inside of the lead auger and advanced in 3-ft intervals.

(2) Recovered intervals were measured, described, and sampled for laboratory analysis and then heat-sealed in plastic tubing for transport back to the BEG Core Research Center (CRC).

(3) At the CRC, cores were examined under black light to detect presence or absence of oil contamination.

(4) Additional core descriptions regarding mineralogy, bedding, and fractures were made.

3.3.2 Borehole Vapor Survey

The purpose of vapor sampling is to map the hydrocarbon plume on the basis of gas concentrations of volatile aliphatic molecules coming off the crude oil; we used results of the onsite gas chromatography (GC) analyses of vapor samples from 30 boreholes (fig. 3.1, table 3.1). The soil-gas sampling followed standard methods (ASTM D5314-92, Section 6.2.2.3). Vapor samples were collected by

Table 3.1. Borehole information.

Boring	Date drilled	Date plugged	Approximate elevation (ft amsl)	Total depth (ft bgl)	Depth to water (ft bgl)	Water-level elevation (ft amsl)
VBH-1	05/02/97	05/03/97	1777.23	50	17.50	1759.73
VBH-2	05/20/97	05/21/97	1776.77	35	13.60	1763.17
VBH-3	05/21/97	05/21/97	1778.27	35	14.50	1763.77
VBH-4	05/21/97	05/21/97	1778.25	35	14.50	1763.75
VBH-5	05/21/97	05/21/97	1777.80	35	16.15	1761.65
VBH-6	05/21/97	05/21/97	1779.72	25	0.00	1779.72
VBH-7	05/22/97	05/22/97	1777.81	35	15.40	1762.41
VBH-8	05/22/97	05/22/97	1777.11	35	n/m	n/m
VBH-9	05/22/97	05/22/97	1770.55	25	4.80	1765.75
VBH-10	05/22/97	05/22/97	1770.19	25	3.80	1766.39
VBH-11	05/22/97	05/22/97	n/m	35	12.90	n/m
VBH-12	05/23/97	05/23/97	1778.01	35	14.15	1763.86
VBH-13	05/23/97	05/23/97	1774.89	35	10.00	1764.89
VBH-14	05/28/97	05/28/97	n/m	35	14.10	n/m
VBH-15	05/28/97	05/28/97	1769.79	25	8.50	1761.29
VBH-16	05/28/97	05/28/97	1770.37	25	13.00	1757.37
VBH-17	05/28/97	05/28/97	1769.49	25	9.15	1760.34
VBH-18	05/28/97	05/29/97	1768.33	25	7.65	1760.68
VBH-19	05/29/97	05/29/97	1767.72	25	6.82	1760.90
VBH-20	05/29/97	05/29/97	1772.35	25	10.25	1762.10
VBH-21	05/29/97	05/29/97	1772.49	25	11.20	1761.29
VBH-22	05/29/97	05/29/97	1769.82	25	6.21	1763.61
VBH-23	05/29/97	05/30/97	1773.11	25	6.73	1766.38
VBH-24	05/30/97	05/30/97	1777.11	35	13.93	1763.18
VBH-25	05/30/97	05/30/97	n/m	35	16.52	n/m
VBH-26	05/30/97	05/30/97	n/m	35	17.89	n/m
VBH-27	05/30/97	05/30/97	1779.20	35	17.90 *	1761.30
VBH-27	05/30/97	05/30/97	1779.20	35	18.30	1760.90
VBH-28	05/30/97	05/30/97	1769.65	25	9.30	1760.35
VBH-29	07/16/97	07/16/97	n/m	25	n/m	n/m
VBH-30	07/16/97	07/16/97	n/m	35	n/m	n/m

*Depth to oil; n/m = not measured.

(1) preparing the soil-gas-sampling probe with an appropriate length of 0.25-inch-diameter virgin polyethylene tubing and collecting a vapor sample blank;
(2) drilling the borehole to a depth of 25 or 35 ft bgl;
(3) covering the borehole opening with a piece of high-density polyethylene to trap vapors as soon as the solid-stem augers were withdrawn from the borehole;
(4) measuring the water level by inserting a probe through the plastic;
(5) lowering a soil-vapor probe consistently within 1 to 3 ft of the fluid level;
(6) purging the tubing with a 50-cc plastic, gas-tight syringe;
(7) sampling borehole vapors using a 5-cc glass, gas-tight syringe for GC analysis; and
(8) analyzing vapor samples on the GC for organic (C1–C6) fractions and on a Lantech infrared gas analyzer for methane, carbon dioxide, and oxygen levels.

TEG of Marion, Texas, provided a mobile laboratory to collect and analyze vapor samples for TPH and C1-C6 hydrocarbons using EPA Method 8015 (appendix A-2). Depths shown in appendix A-2 are sample depths. A Shimadzu GC-14A (with FID detector) was used in conjunction with a DB-5 1.5-µm, megabore capillary column for TPH and an Altech alumina-packed column for C1-C6 analyses. The GC was calibrated three times each day using external standard techniques based on a hexane gas standard. A minimum of three gas concentration standards (for example, 110, 440, and 1100 ppmv methane) were run during each calibration; if percent relative standard deviation was less than 20 percent, then the average response factor could be used for calibration. No sample preparation was necessary for analysis of soil vapors. GC analysis duplicates were run after every 10 vapor samples.

BEG drilled and sampled approximately five boreholes per day. Boreholes were plugged with cement–bentonite grout at the end of each day.

3.3.3 Monitoring-Well Installation

BEG constructed five monitoring wells at the Vinson site using a CME-75 drilling rig. Boreholes were drilled using a combination of hollow-stem auger and hydraulic rotary-drilling methods. The rig, augers, and drilling equipment were decontaminated before drilling and between wells. The completed monitoring wells consist of nominal 2-inch, flush-joint threaded (FJT), schedule 40 PVC blank and slotted casing. Slotted casing (0.010-inch) was used to screen targeted water-bearing zones. Clean, 15/40-grade silica sand was placed in the annulus of the well from the total depth (TD) to between 2 and 5 ft above the top of the screened interval. We then sealed off the screened interval from overlying strata by emplacing a 2- to 5-ft-thick layer of bentonite pellets (1/4-inch diameter) and Holeplug brand bentonite chips.

Well VWW-A was completed by first installing a 6-inch-diameter PVC casing from the surface to 32.8 ft bgl to isolate the crude-oil-contaminated zone and then advancing the borehole to 62 ft bgl for installation of a 2-inch-diameter well casing to monitor the deepest water-bearing zone (fig. 3.2). The remaining four monitoring wells were completed in shallow and intermediate water-bearing zones (fig. 3.2; table 3.2). The five monitoring wells have locking caps with keyed-alike locks; keys were provided to the RRC District 7B office in Abilene and RRC Site Remediation Office in Austin, Texas.

3.3.4 Ground-Water Testing and Sampling

Tests to determine transmissivity were conducted at the five BEG monitoring wells and in WW-3 in conjunction with collection of water samples for chemical analysis. The tests consisted of standard unsteady-state pumping and recovery tests using a submersible pump with constant pumping rate and water-level changes measured in the pumping well. Using a 5-gal (18.93-L) bucket and stopwatch, we measured the discharge rate of water from the well regularly, which varied from 1 to 4 gal per minute (gpm) at the various wells. Water levels were measured by hand using an electric sonde for all tests. At completion of the drawdown phase of the test, ground-

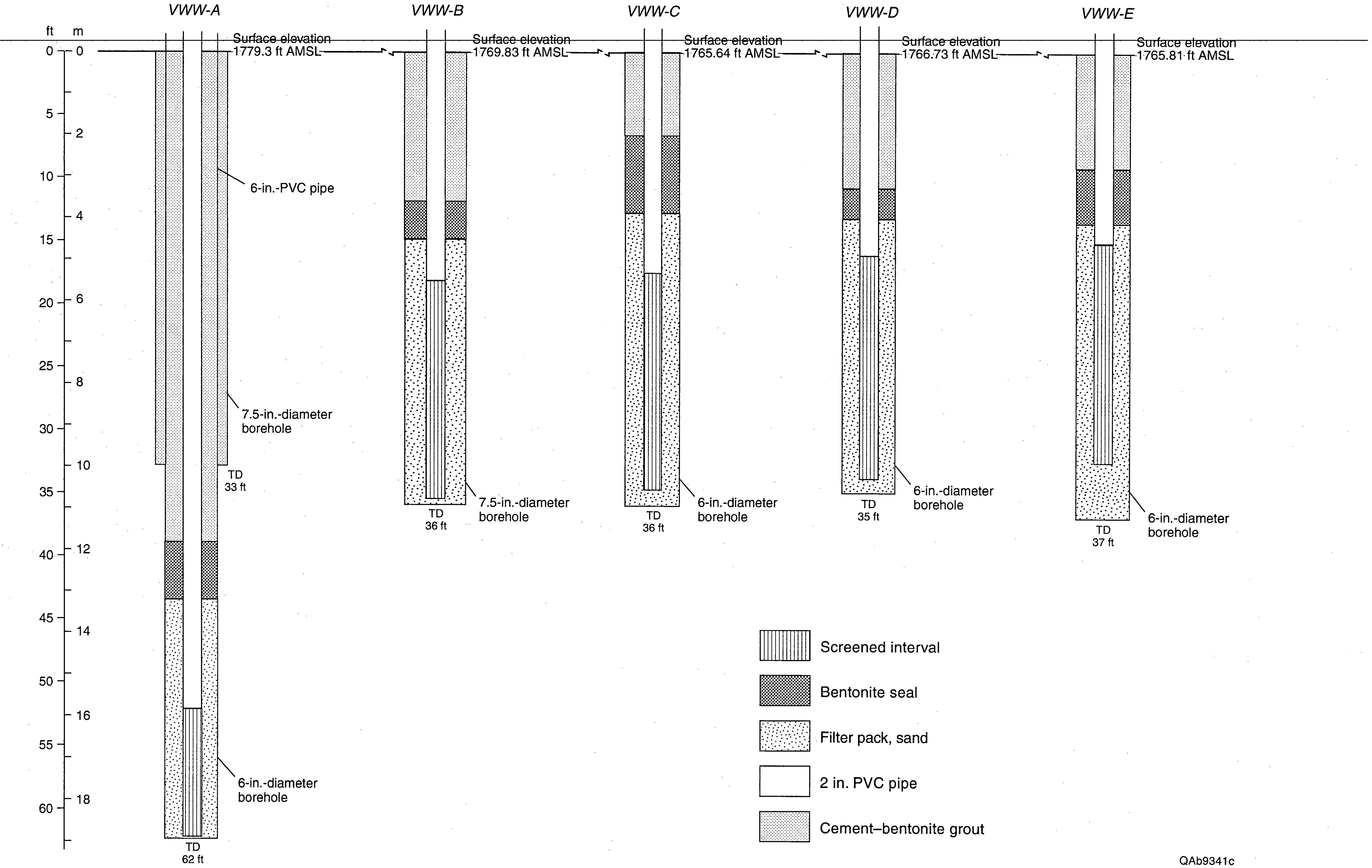


Figure 3.2. As-built diagrams of monitoring wells installed by BEG. See table 3.2 for well-completion specifications.

Table 3.2. Well-completion specifications.

Well	Date completed	Drilling method*	Total depth (ft bgl)	Pipe diameter (inches)	Stick-up (ft)	Screened interval (ft bgl)	Filter pack (ft bgl)	Bentonite seal (ft bgl)	Cement/ bentonite grout (ft bgl)	Comments
VWW-A	07/11/97	hsa	32.8	6	1.3	n/m	n/m	n/m	0.0-32.8	Installed by BEG
VWW-A	07/12/97	mr	62.2	2	1.7	52.0-62.0	43.5-62.2	38.8-43.5	0.0-38.8	Installed by BEG
VWW-B	07/13/97	hsa	35.8	2	1.6	18.2-35.6	15.0-35.8	12.0-15.0	0.0-12.0	Installed by BEG
VWW-C	07/14/97	mr	35.1	2	1.8	17.5-34.9	12.8-35.1	5.7-12.8	0.0-5.7	Installed by BEG
VWW-D	07/15/97	mr	33.8	2	2.1	16.2-33.8	13.3-32.8	10.9-13.3	0.0-10.9	Installed by BEG
VWW-E	07/16/97	mr	32.8	2	1.6	15.2-32.6	13.6-32.8	9.2-13.6	0.0-9.2	Installed by BEG
WW-2	05/06/91	ct	60.0	5	n/m	33.0-58.0	16.0-60.0	n/m	0-16	Vinson domestic well
WW-3	n/m	ct	31.5	13	1.1	n/m	n/m	n/m	n/m	Vinson irrigation well
WW-6	07/02/80	ct	60.0	6	1.8	20.0-60.0	gravel	n/m	0.0-20	State well #: 29-32-6D

*Drilling methods: mr: mud rotary; hsa: hollow-stem auger; ct: cable tool.
n/m: not measured

water samples were collected and then the pump was turned off and water-level recovery was monitored.

BEG analyzed the ground-water testing data by graphically plotting changes in water level versus time. One way to estimate transmissivity, the ability of an aquifer of specified thickness to transmit water, is by graphical comparison of the testing data to "type"-curves. The type curves are widely used solutions of the partial differential equation for nonequilibrium (unsteady state) radial flow of ground water to a well having a variety of boundary conditions. We analyzed test data from wells VWW-A, VWW-B, VWW-D, and WW-3 by type-curve matching following the Walton method for semiconfined aquifers (Kruseman and De Ridder, 1983). At VWW-C and VWW-E discharge was not held constant; transmissivity at these wells was estimated only from specific capacity (amount of discharge per unit amount of drawdown). Drawdown periods lasted from 40 to 150 min for the analyzed tests from wells VWW-B, VWW-D, and WW-3. Recovery data were analyzed from well VWW-A; the recovery period lasted for 39 min.

Ground-water samples were collected at the end of the drawdown periods of the hydrologic tests. Prior to collection of water samples, 27 to 123 well-bore volumes of water were removed from the various wells. Temperature and pH were measured at the well sites. We measured alkalinity at well sites by titrating unfiltered samples with a standard dilute (approximately 0.16 N H_2SO_4) solution using a Hach digital titrator. Samples for analysis of ionic constituents and dissolved metals were filtered through an inline 0.45-µm cartridge filter attached at a tee to the discharge line. Samples for cations and metals were acidified using 1 mL of 6N HNO_3 per 125-mL sample.

After completing pumping, we sampled the wells for organic constituents by using disposable polyethylene bailers. In July 1997 we sampled all BEG monitoring wells (VWW-A through VWW-E) and the Vinson irrigation well (WW-3) for benzene, toluene, ethylbenzene, and xylene (BTEX) analysis and sampled VWW-A for polyaromatic hydrocarbon (PAH) analysis. In August 1997 we sampled well VWW-E and the holding tank next to WW-2 and resampled well VWW-A for PAH analysis. We also collected water samples from the kitchen tap in the Vinson residence during repeated site visits and had them analyzed for volatile organic compounds (VOC), PAH, and TPH.

3.4 Well Inventory

The purpose of the water-well inventory was to:

(1) identify possible receptors of ground water in the vicinity of the Vinson site,

(2) select existing wells that might be sampled for ground-water quality, and

(3) determine the ground-water zones in which local wells are completed.

BEG personnel inventoried water wells on May 28 and 29, 1997; Mr. Santos Gonzales (RRC District 7B Field Coordinator) coordinated access to the individual properties. Fifteen water wells were identified and located within about 1 mi of the site (fig. 3.3 and table 3.3). We did not have access to wells labeled S and T (fig. 3.3) to make water-level and other measurements.

Prior to the water-well inventory and as part of the survey we reviewed State well records and verified water-well locations in the vicinity of the site. Two of the inventoried wells were part of the data base of located wells (wells for which locations have been verified in the field by Texas Water Development Board personnel), and three were in the State data base of plotted wells (wells that have been reported but locations for which have not been verified in the field). We verified both types of wells in the field.

Most wells are used for domestic and irrigation purposes. Some are used for watering gardens and cattle. Several windmills have been abandoned after caving in and one windmill (J) to the south of the Vinson site was reported as being dry. Some of these wells have unknown dates of construction; however, most were drilled prior to the 1980's.

Once we realized the limited extent of contamination at the Vinson site, and upon consultation with the RRC, we decided that it was unnecessary to sample offsite wells. However, we did use water levels from WW-6 (fig. 2.2; Q in fig. 3.3) to help define the direction of ground-water flow at the Vinson site.

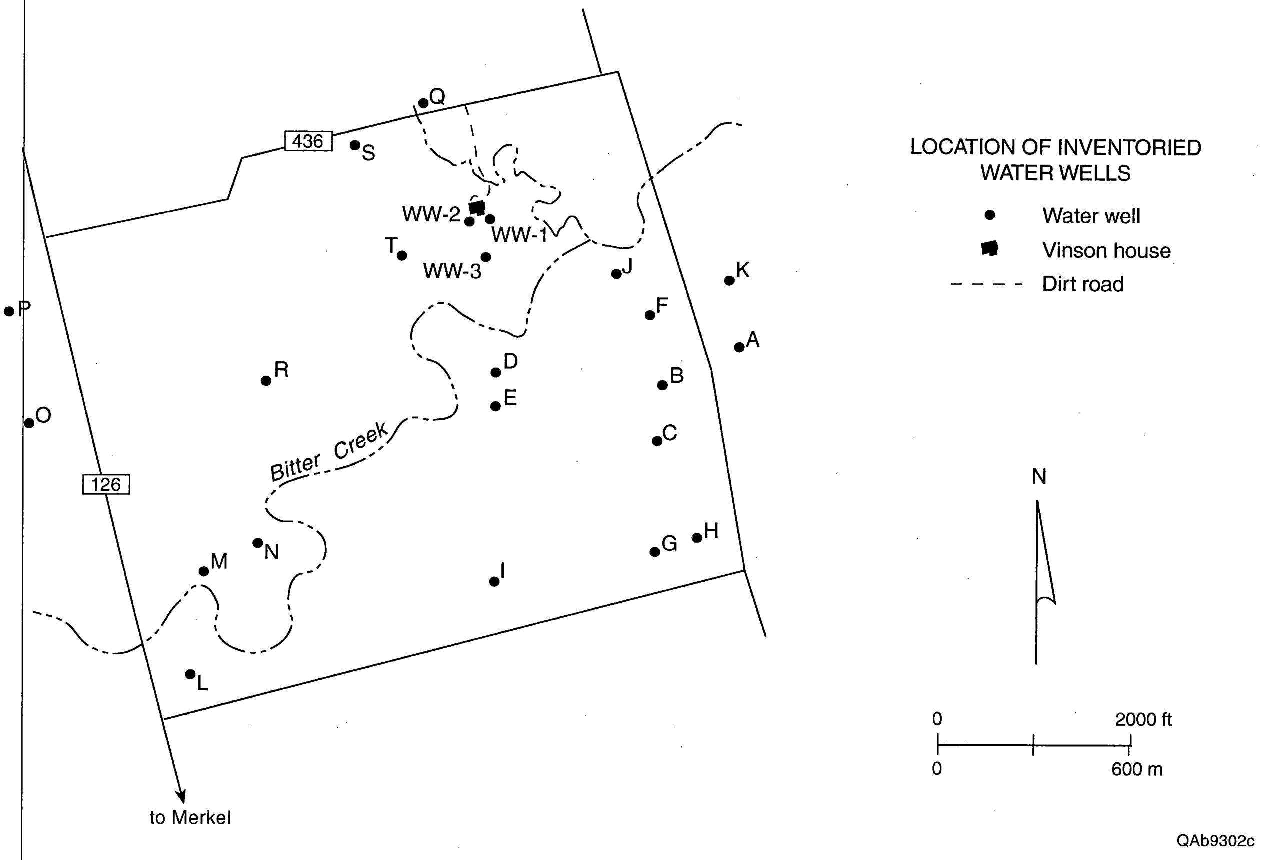


Figure 3.3. Locations of inventoried water wells within 1 mi of the Vinson site. See table 3.3 for information on inventoried wells.

Table 3.3. Water-well inventory.

Well	Date completed	Drilling method	Total depth (ft bgl)	Pipe diameter (inches)	Stickup (ft)	Screened interval (ft bgl)	Filter pack (ft bgl)	Bentonite seal (ft bgl)	Cement/ bentonite grout (ft bgl)	Comments
A	11/12/80	ct	60	5	n/m	40-60	gravel	12	8 - 12	State well # 30-25-4J
B	early 70's	n/a	55-60	5	n/m	n/m	n/m	n/m	n/m	hard water
C	unknown	n/a	25-30	5	n/m	n/m	n/m	n/m	n/m	will pump dry
D	70's	n/a	55	7	n/m	n/m	n/m	n/m	n/m	irrigation well
E	unknown	n/a	n/m	n/m	n/m	n/m	n/m	n/m	n/m	close to well D, irrigation well
F	09/24/82	ct	65	5	n/m	35-62	6-65	1-6	n/m	State well # 30-25-4J (duplicate)
G	1978	n/a	50	5	n/m	n/m	n/m	n/m	n/m	water tables at 19, 36, 42 ft
H	before 1973	n/a	25	1.1	1.7	n/m	n/m	n/m	n/m	stopped in 1978: caved in
I	before 1978 (60's or 70's)	n/a	27	5	n/m	n/m	n/m	n/m	n/m	
J	unknown	n/a	n/m	4	n/m	n/m	n/m	n/m	n/m	dry windmill
K	before 1975	n/a	~40	7	0.6	n/m	n/m	n/m	n/m	
L	before 1978 (60's or 70's)	n/a	35	6	0.6	n/m	n/m	n/m	n/m	
M	05/23/83	ar	60	8	2.3	n/m	n/m	n/m	n/m	State well # 29-32-6M, irrigation well
N	05/24/83	ar	60	8	0.7	n/m	n/m	n/m	n/m	State well # 29-32-6G, irrigation well
O	before 1993	n/a	n/m	5	1.5	n/m	n/m	n/m	n/m	
P	before 1993	n/a	~75	n/m	0.8	n/m	n/m	n/m	n/m	water between 10-15 ft
Q	07/02/80	ct	60	6	1.8	20-60	gravel	n/m	0-2	State well # 29-32-6D
R	unknown	n/a	n/m	n/m	n/m	n/m	n/m	n/m	n/m	hand-dug well, caved in
S	n/a	n/a								
T	n/a	n/a								

*Drilling methods: ct: cable tool; ar: air rotary; n/m: not measured; n/a: not available

3.5 Risk-Evaluation Modeling

BEG used software developed by Groundwater Services Inc. for the Petroleum Storage Tank (PST) Division of the Texas Natural Resource Conservation Commission (TNRCC) for risk-evaluation modeling of conditions at the Vinson site. This software is based on guidance provided in "Risk-Based Corrective Action (RBCA) for Leaking Storage Tank Sites (RG-36)" (TNRCC, 1994). This model was selected because of the similarity between constituents found at the Vinson site and many PST sites.

4.0 RESULTS

The following sections document our hydrogeological investigation and delineation of subsurface contamination at the Vinson site. The information presented provides a basis for inferring the source of the oil, assessing risk, and recommending remedial solutions.

4.1 Waste Package

4.1.1 Crude Oil

BEG found hydrocarbons concentrated in a layer of silty sand at a depth of 17.7 to 18.0 ft and 18.4 to 19.0 ft bgl in cores VCC-1 and VCC-3, respectively, and in small quantities along fractures in both cores as deep as approximately 35 ft bgl. There was no evidence of hydrocarbon contamination in deeper sediments obtained during coring. We found free-phase crude oil floating on ground water in eight boreholes (VBH-1, -5, -11, -12, -13, -14, -24, and -27) and two core holes (VCC-1 and VCC-3) within the vicinity of the Vinson house and the former Bennett "A" No. 2 well. The inner shaded zone in figure 4.1 represents our best estimate of the extent of free-phase crude oil present in the subsurface.

The crude-oil plume shown in figure 4.1 covers approximately 76,000 ft^2. Thickness of the column of crude oil floating on the water surface in WW-2 has ranged from "at least five feet"

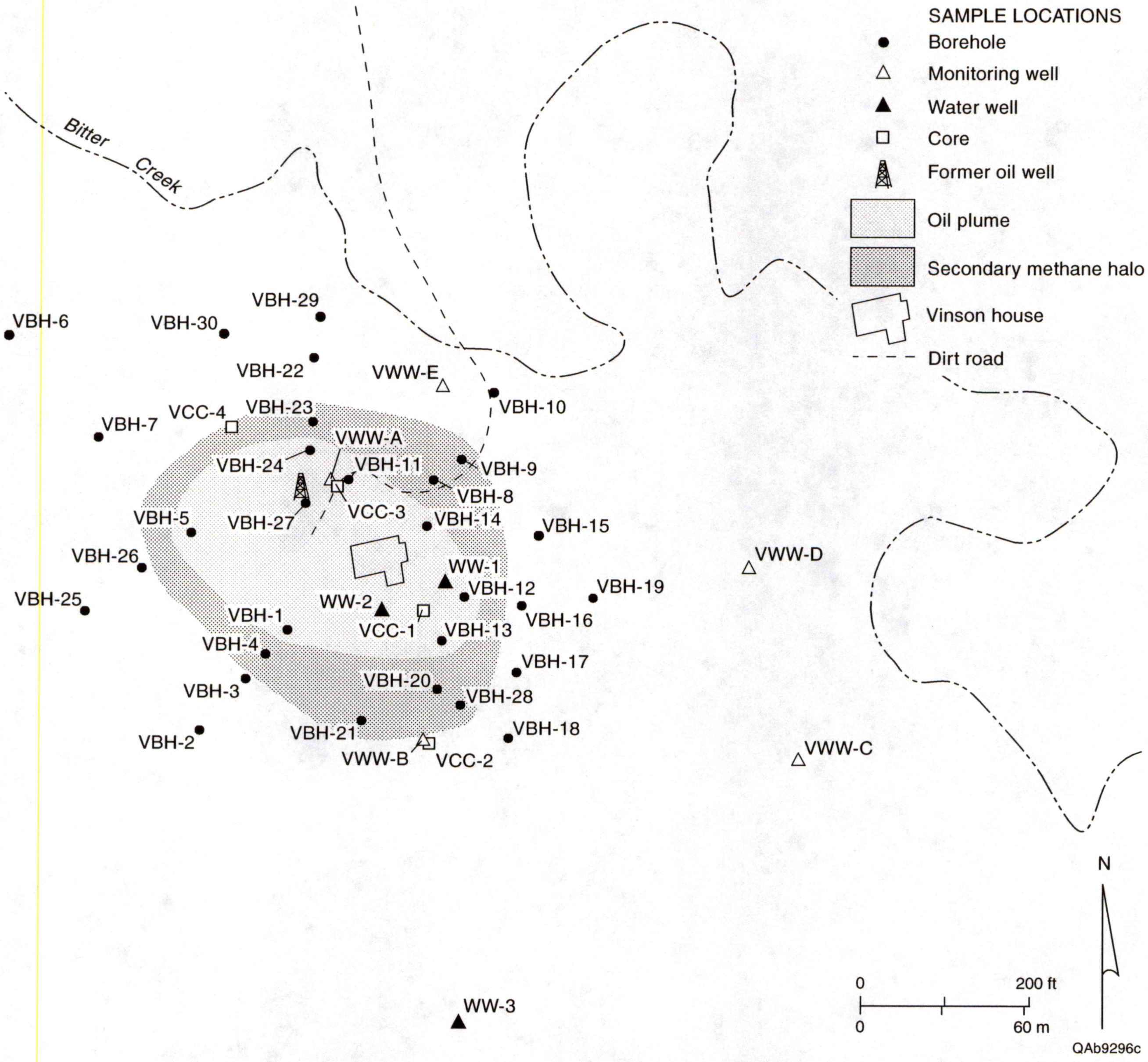


Figure 4.1. Locations of continuous cores, boreholes, wells and inferred extent of oil and methane.

(Reynolds Engineering Co., 1993) in December 1992 to approximately 17 ft in May 1997. On the basis of observations of the thickness of the oil-bearing zone (approximately 0.5 ft thick) and distribution of crude oil in continuous cores, the area covered by the crude-oil plume (as much as 76,000 ft^2), assumed porosity of sediments between 10 and 15 percent, and assumed oil saturation between 25 and 50 percent, we estimate that the total volume of crude-oil present in the subsurface is between approximately 125 and 500 bbl (approximately 5,000 and 21,000 gal).

4.1.2 Methane and Associated Gas Concentrations in Soil

BEG detected methane concentrations of as much as 98 percent by volume of air during the borehole vapor survey (VBH-11); the values range from 0 to 98 percent (table 4.1). A map of methane concentration (fig. 4.2) shows that the highest methane values were measured in borings in which we encountered free-phase crude oil. Data contained in table 4.1 are transcribed from the laboratory results of analyses contained in appendices A and B.

Zones of elevated carbon dioxide (fig. 4.3) and decreased oxygen (fig. 4.4) concentrations are coincident with the zone of increased methane (fig. 4.2) measured in the unsaturated-zone (~10 ft bgl) borehole vapor. Carbon dioxide commonly occurs in the vadose zone because of microbial degradation of organic material. Concentrations of carbon dioxide in clayey soils, however, rarely reach more than 0.5 percent (Jury and others, 1991). Carbon dioxide values within the contaminated zones at the Vinson site range from 0.7 to 10 percent (fig. 4.3 and table 4.2). Atmospheric oxygen concentrations were approximately 21 percent during the Vinson field studies but ranged as low as 1.9 percent in borehole vapor measurements taken in VBH-11 (table 4.2). The lowest values of percent oxygen (fig. 4.4) overlie the inferred center of the crude-oil plume.

Table 4.1. Analytical results of borehole sampling.

		Vapor				Soil		Water
Boring	**Borehole depth (ft)**	**Methane (EPA 8015) (ppmv)**	**Methane* (%)**	**TPH (EPA 8015) (ppmv)**	**Collection depth (ft)**	**TPH (EPA 418.1) (mg/kg)**	**Collection depth (ft)**	**TPH (EPA 418.1) (ppb)**
VBH-1	50	n/a	n/m	n/a	n/m	n/a	n/m	n/a
VBH-2	35	4	0.0	n/d	10	n/d	30	n/a
VBH-3	35	n/d	n/d	n/d	10	n/d	35	n/a
VBH-4	35	40,000	4.0	n/d	10	n/d	35	n/d
VBH-5	35	33,000	3.3	13,400	10	43	35	50,000
VBH-6	25	3	0.0	n/d	10	n/a	n/a	n/d
VBH-7	35	44	0.0	n/d	10	n/a	n/a	n/a
VBH-8	35	51,000	5.1	500	10	n/d	20/35	n/d
VBH-9	25	419	0.04	16	4	n/d	5/10/25	n/d
VBH-10	25	21	0.0	n/d	2	n/d	10/20	n/d
VBH-11	35	980,000	98.0	15,000	10	140	15	150,000
VBH-11	35	n/m	n/m	n/m	n/m	700	35	n/m
VBH-12	35	700,000	70.0	10,000	10	52	20	22,000
VBH-12	35	n/m	n/m	n/m	n/m	200	35	n/m
VBH-13	35	37,000	3.7	730	8	n/d	20/35	2,000
VBH-14	35	73,000	7.3	8,600	10	n/d	20	12,600
VBH-14	35	n/m	n/m	n/m	n/m	107	35	n/m
VBH-15	25	2	0.0	n/d	8	n/d	10/25	n/d
VBH-16	25	9	0.0	n/d	10	n/d	10/25	n/d
VBH-17	25	8	0.0	n/d	8	n/d	10/25	n/d
VBH-18	25	n/d	n/d	n/d	6	n/d	10/25	n/d
VBH-19	25	19	0.0	n/d	6	n/d	10/25	n/d
VBH-20	25	93,000	9.3	1,800	10	n/d	10/25	1,500
VBH-21	25	600	0.06	n/d	10	n/d	10/25	n/d
VBH-22	25	20	0.0	n/d	10	n/d	10/25	n/d
VBH-23	25	87	0.01	n/d	10	n/d	10/25	n/d
VBH-24	35	46,000	4.6	1,300	10	n/d	20/35	14,300
VBH-25	35	4	0.0	n/d	10	n/d	20	n/d
VBH-26	35	3	0.0	n/d	10	n/d	20	n/d
VBH-27	35	830,000	83.0	18,300	12	n/d	20	28,600
VBH-27	35	n/m	n/m	n/m	n/m	200	35	n/m
VBH-28	25	8,000	0.8	100	7	n/d	25	n/d
VBH-29	25	n/a	n/m	n/a	n/m	n/a	n/m	n/a
VBH-30	35	n/a	n/m	n/a	n/m	n/a	n/m	n/a
detection limits	—	1	—	10	—	10	—	1,000

n/a: not analyzed
n/d: not detected
n/m: not measured
*Explosive limits for methane range from 5 to 15 percent; % = ppmv * 0.0001.

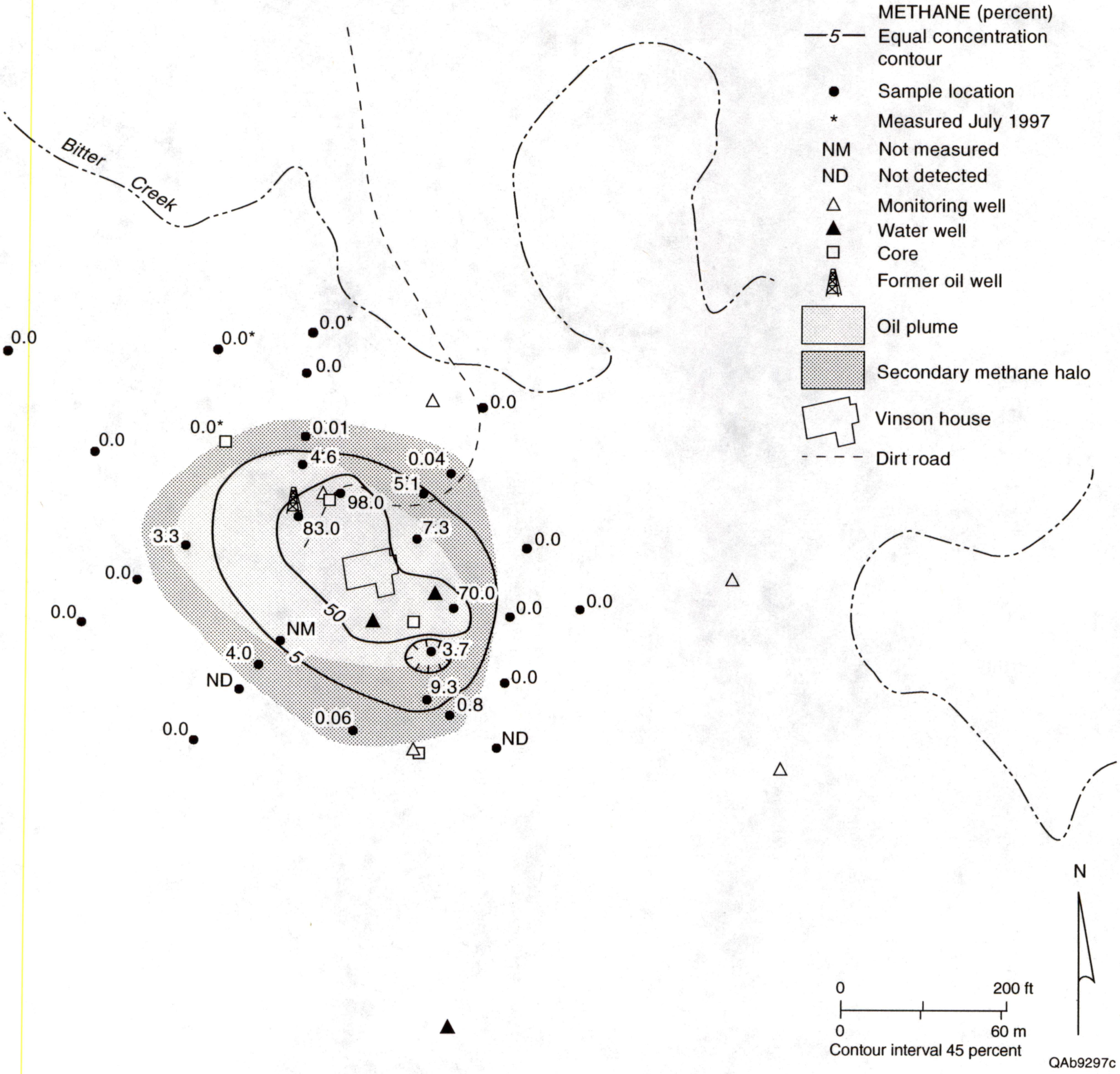


Figure 4.2. Percent methane measured by GC in borehole vapor samples from the unsaturated zone in May 1997. Concentrations of more than 1 percent were measured at depths of 8 to 12 ft below ground surface in 25- to 35-ft-deep boreholes. Analytical results also listed in column 2 of table 4.1.

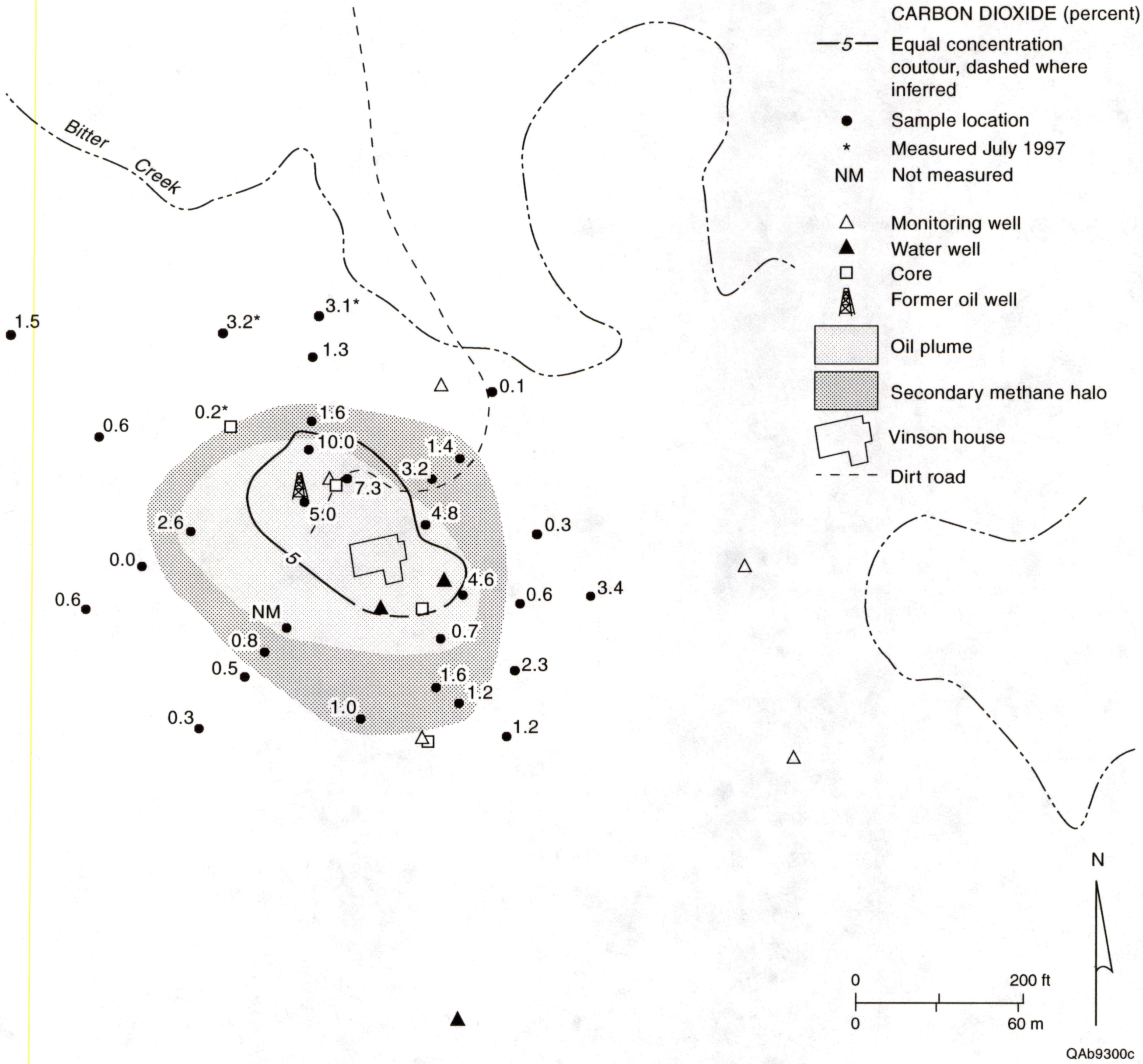


Figure 4.3. Percent carbon dioxide measured in borehole vapor samples from the unsaturated zone in May 1997. Concentrations were measured at depths of 2 to 12 ft in 25- to 35-ft-deep boreholes. Results also listed in table 4.2.

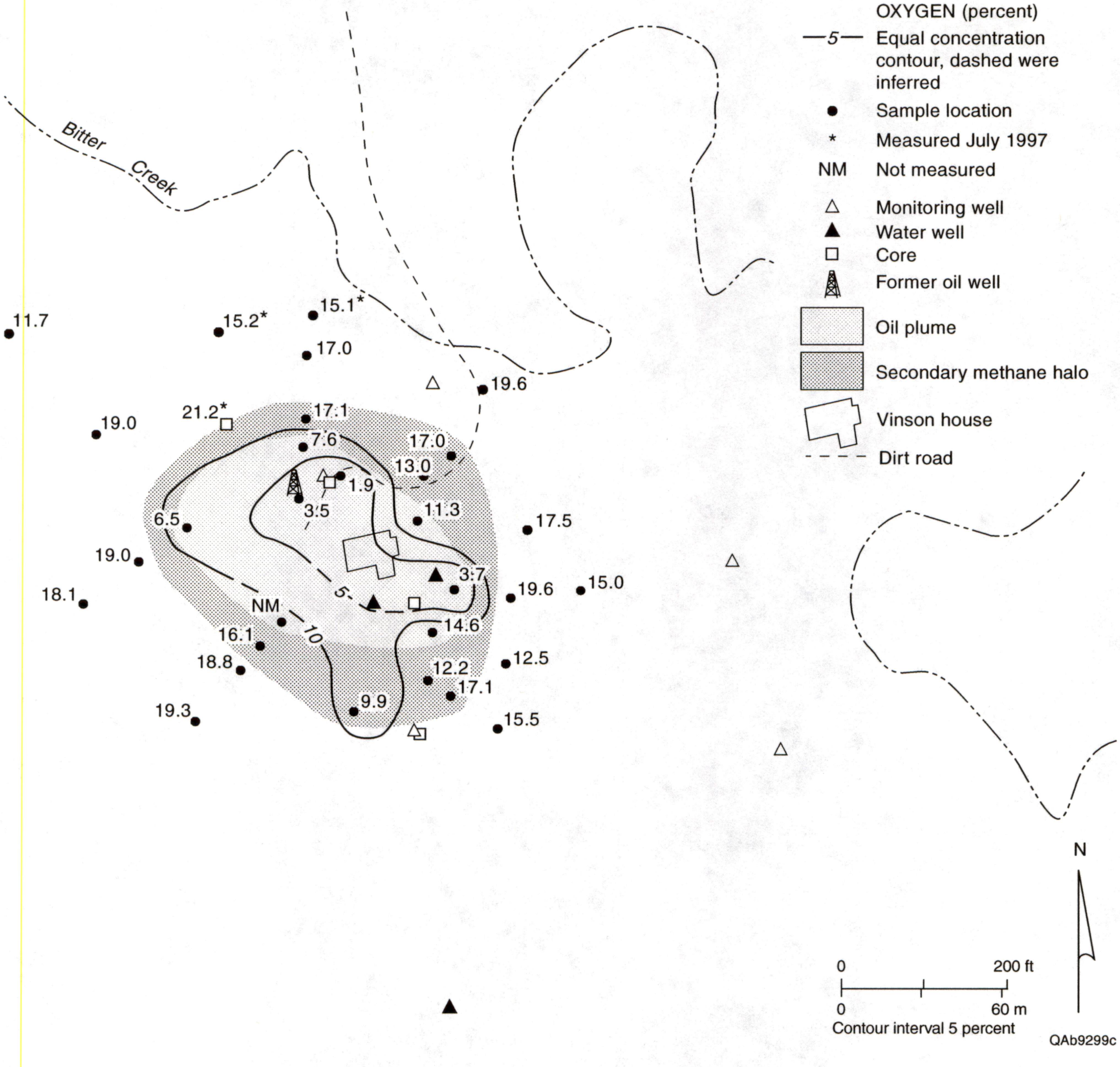


Figure 4.4. Percent oxygen measured in borehole vapor samples from the unsaturated zone in May 1997. Concentrations were measured at depths of 2 to 12 ft in 25- to 35-ft-deep boreholes. Results also listed in table 4.2.

Table 4.2. Meter data collected during borehole drilling.

Boring	Date	Time	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Atmospheric pressure (inches Hg)	Flame ionization detector (ppm methane)
VBH-1	n/m	n/m	n/m	n/m	n/m	n/m	n/m
VBH-2	05/21/97	820	0.0	0.3	19.3	28.2	2
VBH-3	05/21/97	928	0.0	0.5	18.8	28.3	2
VBH-4	05/21/97	1048	3.4	0.8	16.1	28.2	400
VBH-4	05/21/97	n/m	n/m	n/m	n/m	n/m	>10,000 @ 10 ft
VBH-5	05/21/97	1321	offscale	2.6	6.5	28.2	>10,000
VBH-6	05/21/97	1519	0.0	1.5	11.7	28.4	0
VBH-7	05/22/97	900	0.0	0.6	19.0	28.4	0
VBH-8	05/22/97	1027	20.4	3.2	13.0	28.4	n/m
VBH-9	05/22/97	1151	0.0	1.4	17.0	28.4	15
VBH-10	05/22/97	1422	0.0	0.1	19.6	28.2	3
VBH-11	05/22/97	1550	offscale	7.3	1.9	28.1	>10,000
VBH-12	05/23/97	900	offscale	4.6	3.7	28.3	>10,000
VBH-13	05/23/97	1045	40.0	0.7	14.6	28.3	70
VBH-14	05/28/97	1030	offscale	4.8	11.3	28.3	8 @ 5 ft
VBH-14	05/28/97	n/m	n/m	n/m	n/m	n/m	2 @ 10 ft
VBH-14	05/28/97	n/m	n/m	n/m	n/m	n/m	1.5 @ 15 ft
VBH-14	05/28/97	n/m	n/m	n/m	n/m	n/m	700 @ 20 ft
VBH-14	05/28/97	n/m	n/m	n/m	n/m	n/m	200 @ 25 ft
VBH-14	05/28/97	n/m	n/m	n/m	n/m	n/m	900 @ 30 ft
VBH-15	05/28/97	1218	0.0	0.3	17.5	28.3	20
VBH-16	05/28/97	1407	0.0	0.6	19.6	28.1	2
VBH-16	05/28/97	n/m	n/m	n/m	n/m	n/m	15 @ 10 ft
VBH-17	05/28/97	1516	0.0	2.3	12.5	28.2	5
VBH-17	05/28/97	n/m	n/m	n/m	n/m	n/m	7 @ 8 ft
VBH-18	05/28/97	1624	0.0	1.2	15.5	28.1	1
VBH-18	05/28/97	n/m	n/m	n/m	n/m	n/m	3 @ 6 ft
VBH-19	05/29/97	855	0.0	3.4	15.0	28.4	2
VBH-19	05/29/97	n/m	n/m	n/m	n/m	n/m	25 @ 6 ft
VBH-20	05/29/97	956	62.6	1.6	12.2	28.4	>10,000
VBH-21	05/29/97	1128	0.1	1.0	9.9	28.3	200
VBH-21	05/29/97	n/m	n/m	n/m	n/m	n/m	650 @ 10 ft
VBH-22	05/29/97	1410	0.0	1.3	17.0	28.1	2
VBH-22	05/29/97	n/m	n/m	n/m	n/m	n/m	1 @ 10 ft
VBH-23	05/29/97	1530	0.0	1.6	17.1	n/m	25
VBH-23	05/29/97	n/m	n/m	n/m	n/m	n/m	35 @ 15 ft
VBH-24	05/30/97	911	27.1	10.0	7.6	28.1	>10,000
VBH-25	05/30/97	1029	0.0	0.6	18.1	28.1	0
VBH-25	05/30/97	n/m	n/m	n/m	n/m	n/m	5 @ 10 ft
VBH-26	05/30/97	n/m	0.0	0.0	19.0	28.0	0
VBH-26	05/30/97	n/m	n/m	n/m	n/m	n/m	5 @ 10 ft
VBH-27	05/30/97	1405	offscale	5.0	3.5	28.0	>10,000
VBH-28	05/30/97	1609	0.9	1.2	17.1	28.0	9
VBH-28	05/30/97	n/m	n/m	n/m	n/m	n/m	4000 @ 7.5 ft
VBH-29	07/16/97	1449	0.0	3.1	15.1	0380 H_2O	n/m
VBH-30	07/16/97	1624	0.0	3.2	15.2	0378 H_2O	n/m

n/m: not measured

4.2 Sediments

During continuous coring we encountered redbeds (fine-grained clastic rocks) typical of the Permian Choza Formation (appendix B). The strata are composed of poorly bedded clayey silts and silty clays interbedded with lesser amounts of silty sand (0.5 to 1.5 ft thick) and greenish-gray dolomitic mudstone in thin (approximately 0.25- to 1.0-ft) beds. The dolomitic muds and silty sands are cyclic and are therefore traceable across the site. Antiaxial fibrous gypsum occurs in veins and as fracture fillings that were probably deposited as secondary precipitates and are not part of the original stratigraphy (Gustavson and others, 1994).

Most of the intervals were fractured either by discrete, high-angle (45° to 60°) fractures or fractures parallel to bedding planes or they consisted of zones of finely brecciated material. Most breccias and fractures are uncemented matrix except for the sparse gypsum veins. Fractures are commonly slickensided.

One way of detecting hydrocarbons in sediments is by noting fluorescence under a black light. Generally the method is used to detect fluorescence in the actual sediments. Cores VCC-2 and VCC-4 showed no fluorescence at all, which implies absence of hydrocarbons. In two of the Vinson cores (VCC-1 and VCC-3) we saw fluorescence on the plastic that was used to wrap the core as well as in the core itself, indicating that much of the oil had adsorbed onto the plastic. For core VCC-1, most of the fluorescence was on the plastic at depths of 16.6 to 19.7 and 20.45 to 20.65 ft bgl and also along fractures at approximately 32.5 and 40 ft bgl. Much of the VCC-3 core between approximately 15 and 30 ft bgl fluoresces.

4.3 Ground Water

4.3.1 Ground-Water Movement

BEG found three water-bearing zones in the subsurface at the Vinson site: a shallow (approximately 18 to 20 ft bgl) zone that is contaminated with crude oil (zone I), an intermediate zone at approximately 28 to 35 ft bgl (zone II), and a deeper zone between approximately 50 to 60 ft bgl (zone III) that is the main source of drinking water in the area. Casing in the Vinson well, VWW-2, is perforated from 38 to 58 ft bgl, and the annulus is only grouted from the surface to 15 ft bgl (appendix C). Because of this well construction, ground water is being supplied from all three water-bearing zones. Most water-supply wells in the vicinity of the Vinson site are screened across all three zones or are open from the surface to total depth. As a result, specific data on ground-water flow and quality in zones I and II are limited. All of the 30 borings drilled during this study (VBH-1 through VBH-30) penetrated zones I and II but did not extend into zone III. The boundary between water-bearing zones I and II was difficult to determine during borehole drilling.

BEG installed one ground-water monitoring well VWW-A in zone III and wells VWW-B through VWW-E across zones I and II together. Our drilling procedures for VWW-A were designed to minimize movement of contaminants from zones I and II to the deeper zone III.

Analysis of water-level changes during the hydrologic tests (fig. 4.5) and information about subsurface stratigraphy and hydrologic setting suggest that the deeper water-bearing zones at the Vinson site are semiconfined. A confined or semiconfined aquifer can be defined as a saturated permeable zone in which water is under pressure so that a potentiometric surface is above the top of the permeable aquifer or the base of the overlying confining layer. Addition to or loss of water from storage in a confined or semiconfined aquifer occurs with a change in fluid pressure while pore space remains saturated. The amount of fluid-pressure or water-level change caused by addition to or loss of water from storage is controlled by compressibility of water and elasticity of the aquifer material. The difference between a confined or semiconfined aquifer is largely determined by the permeability of the overlying confining layer. A confined aquifer is defined as being overlain by an impermeable confining layer that exchanges no water with the aquifer. Because completely impermeable layers rarely exist in nature, a true confined aquifer is rare. A semiconfined aquifer, on the other hand, is overlain by a semipermeable confining layer in which horizontal flow of ground water is negligible but through which shallower water can exchange

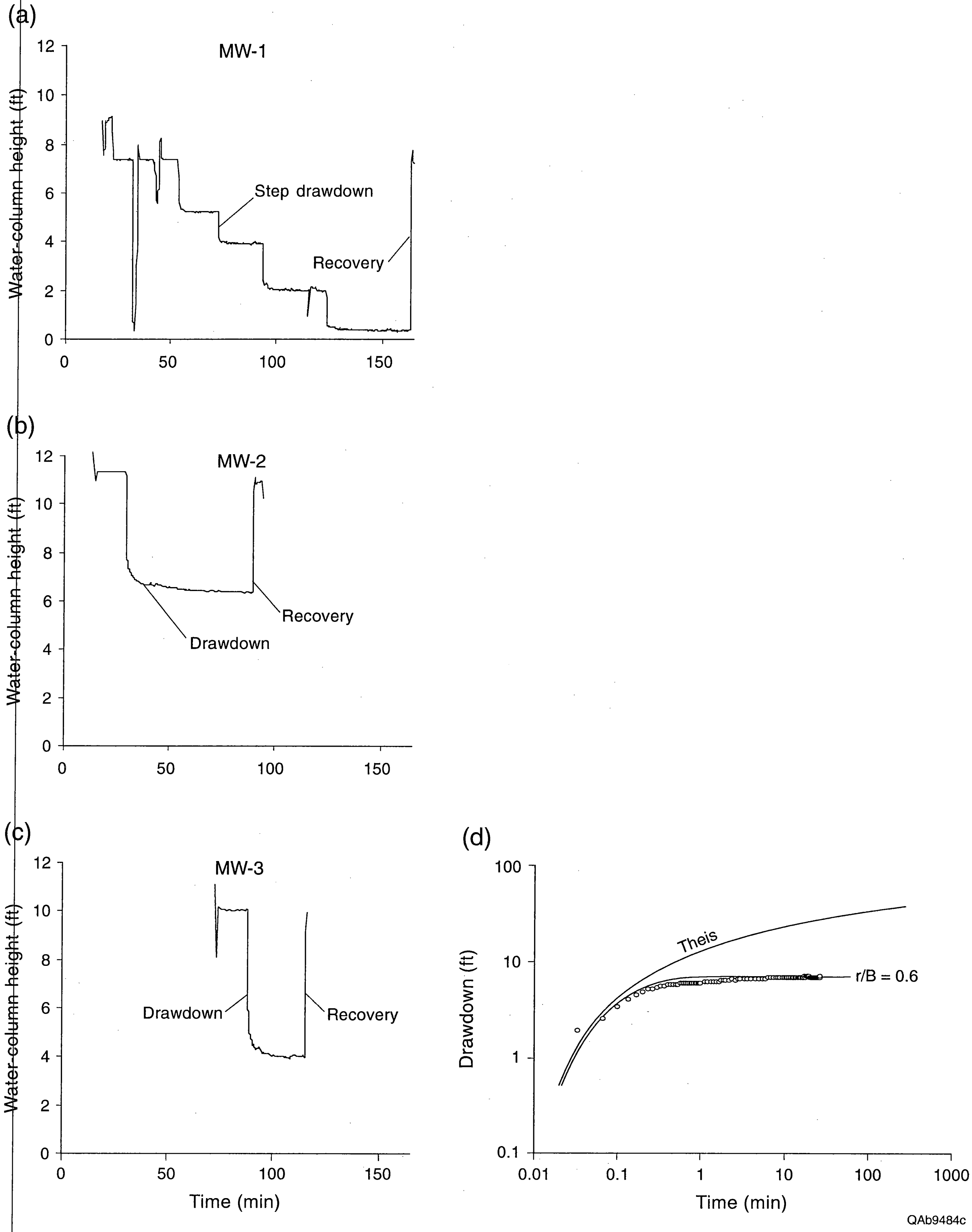


Figure 4.5. Water-level changes in monitoring wells during hydrologic testing.

with deeper water in the aquifer. A semiconfined aquifer also is commonly called a leaky confined aquifer.

The August 1997 potentiometric surface of the aquifer composed of zones I and II (table 4.3) is inclined toward the east at a gradient of 0.002 to 0.005 (dimensionless) (fig. 4.6). Water levels measured in wells VWW-A and WW-2 were not used in mapping the potentiometric contours because (1) VWW-A is screened in zone III and is isolated from zones I and II by surface casing, (2) WW-2 is producing ground water from zones I, II, and III, and (3) the water level in WW-2 is depressed by the weight of a 13-ft-thick layer of crude oil (table 4.3). On the basis of the potentiometric surface contours, we infer that ground water in zones I and II has the potential to move to the east.

Leakage of water from low-permeability layers appears to affect the results of hydrologic tests at the Vinson site, with drawdown less than that predicted by the Theis equation (fig. 4.7). It is that effect that makes the semiconfined nature of the hydrologic setting at the test wells so apparent.

Transmissivity estimates made by type-curve matching for data from the VWW-A, VWW-B, VWW-D, and WW-3 wells ranged from 1 to 2,473 ft^2/d (table 4.4). Transmissivity derived from specific capacity (amount of discharge obtained per unit amount of drawdown) for these wells ranged from 6 to 4,191 ft^2/d. This latter approach, however, overestimates transmissivities because of the delayed yield from leakage. The geometric mean transmissivity (60 ft^2/d) calculated from the tests at VWW-A, VWW-B, VWW-D, and WW-3 monitoring wells is the best estimate of average transmissivity at the Vinson site.

BEG estimated specific discharge to be 0.01 ft/d and average linear velocity of ground-water to be 0.07 ft/d, assuming a geometric mean transmissivity of 60 ft^2/d (hydraulic conductivity of 3 ft/d), an average gradient of 0.0033, and porosity of 15 percent. Specific discharge, also known as apparent velocity, is the volumetric flow rate per unit area and, for example, is what is measured when water is flowing from an open pipe. Average linear velocity (v), however, is calculated by dividing the specific discharge (q) by porosity of the aquifer material. Ground water moves along circuitous pathways as it passes through pore spaces around individual grains so the actual velocity

Table 4.3. Water levels in the vicinity of the Vinson site.

Well	Surface elevation (ft amsl)	Total depth (ft bgl)	Stickup (ft)	Date measured	Depth to oil (ft btoc)	Thickness of oil column (ft)	Depth to water (ft btoc)	Water-level elevation (ft amsl)
WW-2	1778.33	54.61	0.85	03/11/97	16.34	10.14	26.48	1751.00
				05/23/97	16.93	11.57	28.50	1748.98
				05/30/97	12.52	16.98	29.50	1747.98
				07/18/97	17.19	12.44	29.63	1748.70
				08/19/97	22.63	13.08	35.71	1741.77
WW-3	1765.54	31.52	1.13	03/11/97	n/a	n/a	6.52	1757.89
				05/30/97	n/a	n/a	6.21	1758.2
				07/19/97	n/a	n/a	8.53	1755.88
				08/18/97	n/a	n/a	9.43	1754.98
WW-6	1767.00	60.00	1.72	03/11/97	n/a	n/a	8.54	1756.74
				08/19/97	n/a	n/a	9.58	1755.70
VWW-A	1779.30	62.24	2.70	07/17/97	n/a	n/a	21.48	1755.12
			1.65	08/01/97	n/a	n/a	n/a	n/a
		61.95		08/18/97	n/a	n/a	26.19	1751.46
VWW-B	1769.83	35.80	1.95	07/18/97	n/a	n/a	11.79	1756.09
			1.65	08/01/97	n/a	n/a	n/a	n/a
		36.00		08/18/97	n/a	n/a	13.88	1754.30
VWW-C	1765.64	35.13	2.52	07/18/97	n/a	n/a	9.15	1753.97
			1.85	08/01/97	n/a	n/a	n/a	n/a
		34.22		08/18/97	n/a	n/a	10.32	1753.47
VWW-D	1766.73	33.80	2.95	07/19/97	n/a	n/a	10.21	1753.57
			2.10	08/01/97	n/a	n/a	n/a	n/a
		33.45		08/18/97	n/a	n/a	11.58	1753.05
VWW-E	1765.81	32.80	2.50	07/18/97	n/a	n/a	8.53	1754.78
			1.61	08/01/97	n/a	n/a	n/a	n/a
		31.99		08/18/97	n/a	n/a	9.29	1754.91

n/a: not applicable

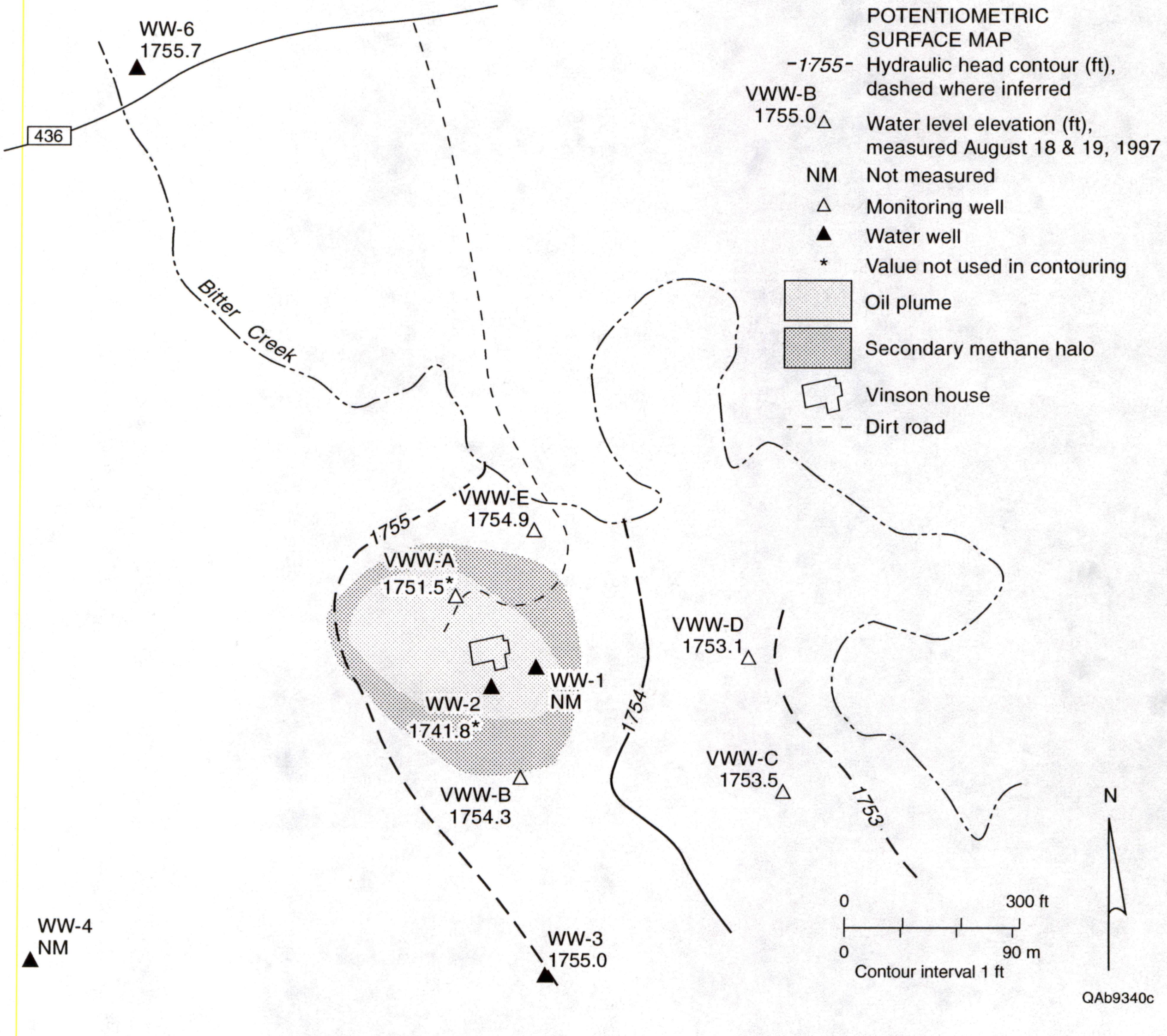


Figure 4.6. Potentiometric surface of ground water in zones I and II. Measurements from wells VWW-A and WW-2 not used, as explained in text.

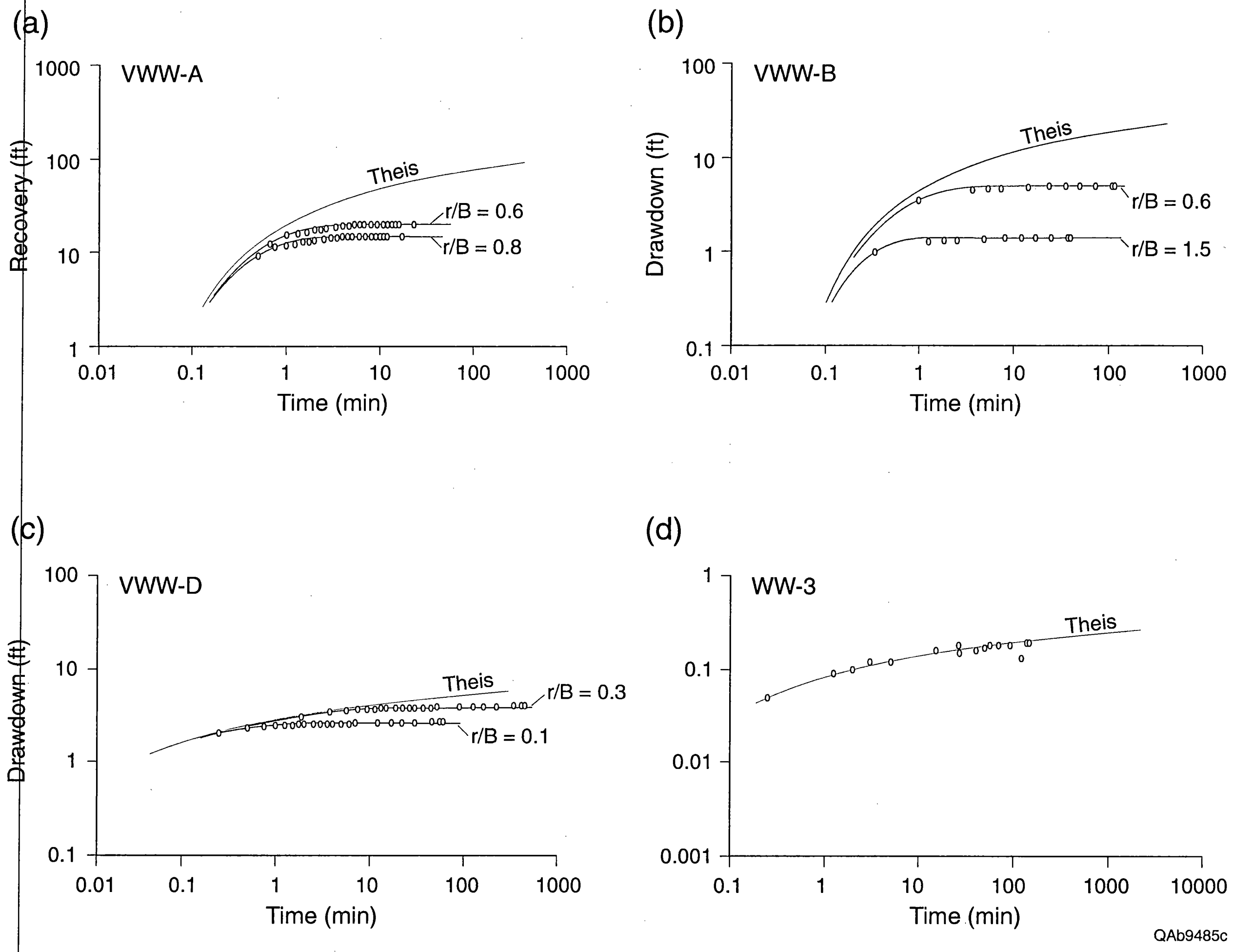


Figure 4.7. Curves used for estimating hydrologic properties of (a) zone III and (b, c, and d) zones I and II water-bearing units in Vinson site monitoring wells.

Table 4.4. Hydrologic properties estimated from tests at Vinson site wells.

Well	Test period	Discharge (ft^3/d)	Walton r/B value	Specific capacity (ft^2/d)	T^1 (ft^2/d)	T^2 (ft^2/d)	T^3 (ft^2/d)
VWW-A	Recovery	220	0.6 to 0.8	17.6	1 to 2	10	6
VWW-B	Drawdown	780	0.6 to 1.5	558	19 to 66	457	342
VWW-C	Drawdown	629*	n/d	1,078	n/d	847	622
VWW-D	Drawdown	586	0.03 to 0.1	220	83 to 124	172	126
VWW-E	Drawdown	595	n/d	187	n/d	135	97
WW-3	Drawdown	781	0.0	4,327	2,473	4,191	3,318

[1] Transmissivity determined from type-curve matching.
[2] Transmissivity determined from specific capacity assuming storativity of 0.001.
[3] Transmissivity determined from specific capacity assuming storativity of 0.01.
* Weighted average of multiple-rate discharge.
n/d: not determined

of water molecules and dissolved constituents is greater than the average rate across a given distance.

The permeability ratio of oil and water-bearing media (K_o/K_w) depends on the relative saturation of each fluid phase, as well as the environmental conditions controlling fluid properties, but we assume a K_o/K_w value of 0.2 to 0.4. Using this range of K_o/K_w, we estimate the average linear velocity of oil at the Vinson site to be approximately 0.013 to 0.026 ft/d. At this net velocity, oil might travel 5 to 10 ft/yr or take 30 to 60 yr to travel 300 ft through the subsurface at the Vinson site. These estimates do not take into account natural attenuation of the crude oil.

4.3.2 Ground-Water Quality

Analyses of major cations, anions, and selected organic constituents in ground water define the type of ground water and the extent of impacts present at the Vinson site. Ground-water samples from the Vinson wells and regional water wells have similar chemical compositions; both show distinctly different compositions from nearby brine or brine-contaminated water wells. TPH, BTEX, and PAH analyses of samples from Vinson wells show that although there are impacts to ground water in the immediate vicinity of the crude-oil plume, they do not appear to extend to down-gradient wells.

Results of the cation and anion analyses of Vinson ground-water samples show that most wells contain calcium-sulfate- or mixed-cation-sulfate-type ground water (table 4.5). Exceptions are duplicate samples taken from well VWW-C, which plot as magnesium-chloride-type ground water (fig. 4.8). Results of ground-water samples reported for seven water wells located within 4 mi of the site (table 4.6) (Price, 1978) show that regional wells are also completed in calcium-sulfate- or mixed-cation-sulfate-type ground-water zones (fig. 4.8). Aquifer units represented by the regional wells are the Choza Formation of the Permian Clear Fork Group (Pcfc) and Quaternary-age Seymour Formation (Qs). We think that the Vinson wells are all completed in the Choza Formation water-bearing unit because

Table 4.5. Results of general chemical analyses at Vinson site wells.

Sample	Date analyzed	Lab	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Li (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	Cl (mg/L)	Br (mg/L)	F (mg/L)	Charge balance error (%)
VWW-A	8/19/97	RRC	537.0	140.0	197.0	5.0	0.0	12.0	0.0	0.0	182.0	1,574.0	25.0	273.0	1.0	3.0	3.76
VWW-A (dup.)	8/19/97	RRC	534.0	141.0	193.0	0.0	0.0	12.0	0.0	0.0	182.0	1,595.0	31.0	281.0	1.0	3.0	2.51
VWW-A	8/19/97	CHEMSOLVE	430.0	93.0	170.0	4.8	0.2	14.0	0.0	0.0	182.0	1,600.0	3.2	210.0	0.0	n/a	-6.69
VWW-B	8/18/97	RRC	301.0	107.0	159.0	0.0	0.0	12.0	0.0	0.0	187.0	1,243.0	26.0	250.0	0.0	2.0	-7.78
VWW-B	8/18/97	CHEMSOLVE	410.0	90.0	150.0	5.8	0.1	12.0	0.0	0.0	187.0	1,400.0	8.7	260.0	0.0	n/a	-6.74
VWW-C	8/19/97	RRC	706.0	1,167.0	1,363.0	0.0	1.2	12.0	0.0	0.4	453.0	3,654.0	4.0	3,216.0	6.0	18.0	4.57
VWW-C (dup.)	8/19/97	RRC	740.0	1,240.0	1,399.0	0.0	1.10	12.0	0.0	0.310	453.0	3,507.0	4.0	3,221.0	6.0	4.0	7.77
VWW-C	8/19/97	CHEMSOLVE	550.0	790.0	1,600.0	17.0	0.7	12.0	0.0	0.3	453.0	3,800.0	0.0	2,200.0	0.0	n/a	4.57
VWW-D	8/19/97	RRC	505.0	137.0	225.0	0.0	0.0	13.0	0.0	0.0	189.0	1,484.0	39.0	386.0	1.0	3.0	-3.16
VWW-D	8/19/97	CHEMSOLVE	470.0	110.0	190.0	5.3	0.1	13.0	0.0	0.0	189.0	1,400.0	5.8	310.0	0.0	n/a	-4.25
VWW-E	8/19/97	RRC	459.0	122.0	166.0	0.0	0.0	12.0	0.0	0.0	196.0	1,375.0	26.0	246.0	1.0	3.0	1.55
VWW-E	8/19/97	CHEMSOLVE	390.0	68.0	140.0	4.6	0.1	12.0	0.0	0.0	196.0	1,400.0	4.6	180.0	0.0	3.0	-8.63
WW-1	12/19/91		451.0	118.0	181.0	0.0	n/a	n/a	n/a	n/a	228.0	1,331.0	21.0	259.0	n/a	n/a	1.25
WW-1	2/26/92		318.0	103.0	142.0	3.0	n/a	n/a	n/a	n/a	309.0	899.0	n/a	262.0	n/a	n/a	-0.94
WW-2	12/19/91		520.0	123.0	204.0	0.0	n/a	n/a	n/a	n/a	192.0	1,584.0	21.0	276.0	n/a	n/a	0.77
WW-2	2/26/92		98.0	33.0	65.0	2.0	n/a	n/a	n/a	n/a	283.0	148.0		99.0	n/a	n/a	-0.14
WW-2	8/19/97	RRC	508.0	127.0	192.0	0.0	0.0	11.0	0.0	0.0	164.0	1,570.0	22.0	258.0	1.0	3.0	1.59
WW-2	8/19/97	CHEMSOLVE	420.0	94.0	230.0	6.3	0.2	11.0	0.0	0.0	164.0	1,900.0	22.0	270.0	0.0	3.0	-6.69
WW-3	12/19/91		254.0	78.0	391.0	0.0	n/a	n/a	n/a	n/a	157.0	840.0	20.0	381.0	n/a	n/a	7.39
WW-3	2/26/92		347.0	107.0	560.0	7.0	n/a	n/a	n/a	n/a	145.0	1,523.0	n/a	638.0	n/a	n/a	-1.39
WW-3	8/19/97	RRC	547.0	231.0	500.0	0.0	0.0	11.0	0.0	0.0	221.0	1,852.0	16.0	815.0	2.0	4.0	2.14
WW-3	8/19/97	CHEMSOLVE	440.0	180.0	420.0	6.1	0.3	11.0	0.0	0.0	221.0	1,800.0	0.0	640.0	0.0	n/a	-3.24
WW-4	2/26/92		21.0	3.0	27.0	3.0	n/a	n/a	n/a	n/a	16.0	37.0	n/a	50.0	n/a	n/a	-3.04
WW-6	8/19/97	RRC	200.0	83.0	102.0	0.0	0.0	6.0	0.0	0.0	127.0	719.0	3.0	173.0	1.0	2.0	8.03
WW-6	8/19/97	CHEMSOLVE	240.0	62.0	120.0	3.2	0.1	7.9	0.0	0.0	127.0	820.0	0.8	940.0	0.0	n/a	-24.36

n/a = not analyzed

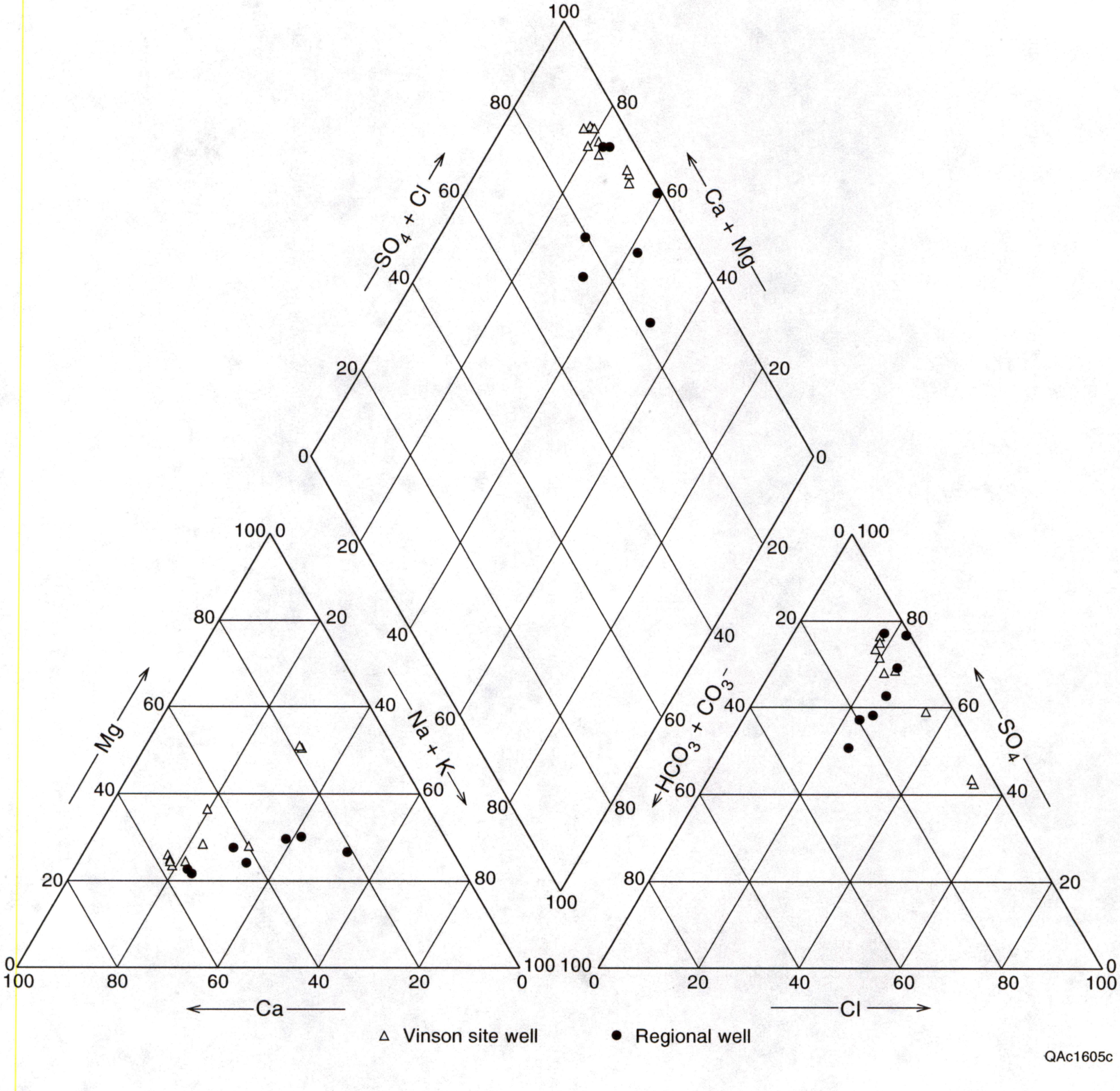


Figure 4.8. Piper plot of ground-water samples from Vinson site (•) and regional water wells (+).

Table 4.6. Results of general chemical analyses from regional wells.

State well number	Date analyzed	Water-bearing unit	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	Cl (mg/L)	Charge balance error (%)
Regional water wells										
29-32-601	12/19/67	Pcfc	590	153	276	203	1,760	17	454	0.92
29-32-904	-----	Pcfc	180	71	140	245	560	9	164	1.13
30-25-109	9/25/67	Pcfc	570	141	288	154	1,980	6	330	–0.55
30-25-209	3/18/68	Qs	366	237	610	447	1,970	13	580	–0.48
29-32-905	12/19/67	Pcfc	340	199	478	24	1,990	0	426	0.26
30-25-701	12/19/67	Pcfc	199	156	570	438	1,220	189	383	1.20
30-25-113	12/21/67	Qs,Pcfc	215	76	194	338	550	168	189	0.77
Brine wells										
Strawn brine	-----	Pitzer field	16,200	1,940	46,000	n/a	330	n/a	105,000	0.00
29-32-604	1/5/67	Pco	1,880	659	19,182	232	3,750	n/a	32,000	–0.11

n/a: not analyzed
Pcfc = Permian Clear Fork Group, Choza Formation
Qs = Quaternary Seymore Formation

(1) similarities in major ion chemistry between samples taken from site wells and analyses reported for regional water wells that are completed in the Choza Formation,

(2) our interpretation of continuous cores collected onsite, and

(3) published geologic maps of the area (Barnes, 1974; Price, 1978).

Investigators from the RRC previously thought that if the source of crude oil had been nearby plugged and abandoned oil wells, there would be evidence of brine contamination in ground water at the Vinson site. It was later noted in an RRC memorandum (September 10, 1993, memorandum from Joe Cress to Felix Dailey) that very little salt water was produced from either the Bennett "A" No. 1 or No. 2 oil wells. For example, between 1965 and 1990 the two wells cumulatively produced 111,375 bbl of crude oil and only 98 bbl of salt water. Even if a leaking oil well were the source of currently observed impacts, the ground water might not show elevated chloride concentrations.

Results of TPH analyses run on grab samples taken during borehole drilling indicate local hydrocarbon impact to shallow (Zones I/II) ground water (table 4.1). A contour plot (fig. 4.9) shows that measurable concentrations of TPH were detected only within the area where crude oil and methane were found. TPH measurements in ground water ranged from 2 to 150 ppm within the crude-oil plume. We used these results to screen water-quality conditions and predict ground-water flow conditions in the shallow water-bearing zones before installing the site-monitoring wells.

Results of BTEX analyses of samples taken from the five Zone I/II, down-gradient wells (VWW-A through VWW-E) were all below the 1 μg/L detection limits (table 4.7) at the July 1997 sampling. BTEX analyses are generally used as a screening parameter to determine whether it is necessary to sample for PAH's. Because of the degraded nature of crude oil found at the Vinson site and the likelihood that the BTEX constituents had been attenuated, we decided that it was necessary nonetheless to sample ground water at the Vinson site for PAH's. Results of the PAH analyses are, however, inconsistent or equivocal. For example, analytical results of a sample taken from VWW-E in August 1997 showed presence of some U.S. EPA method 8310 PAH's

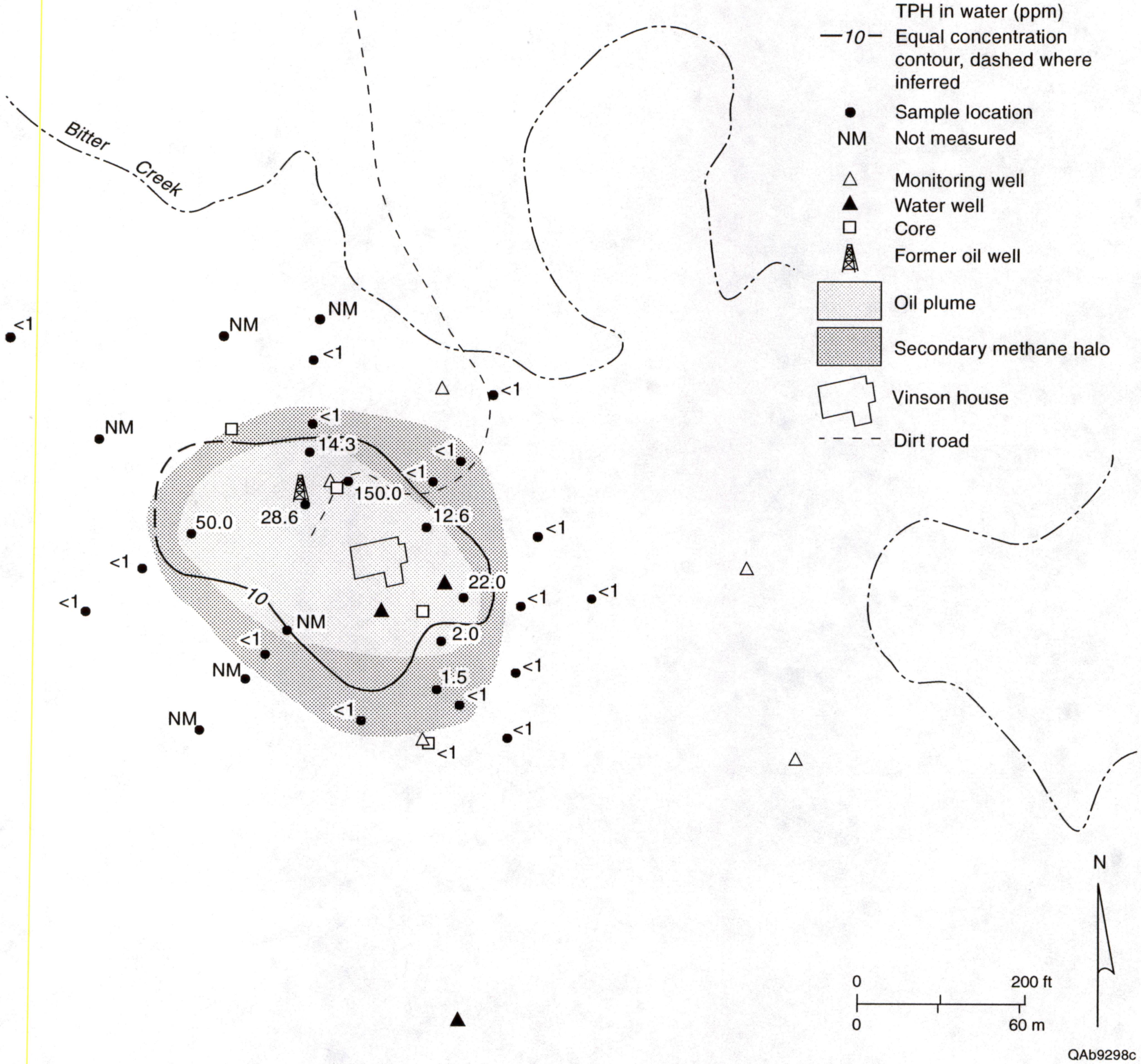


Figure 4.9. Total petroleum hydrocarbons measured by GC in borehole ground-water samples in May 1997. Analytical results also listed in table 4.1. Results in table 4.1 are reported in ppb but are posted on this map in ppm.

Table 4.7. BTEX analytical results of Vinson ground-water samples.

BEG well number	Date sampled	Total depth (ft bgl)	Elevation (ft above msl)	Analyte	Result (µg/L)	U.S. EPA method
VWW-A	7/17/97	62.2		Benzene	<1	8020
				Ethylbenzene	<1	8020
				m,p-Xylenes	<1	8020
				MTBE	<10	8020
				o-Xylene	<1	8020
				Toluene	<1	8020
VWW-A (dup.)	7/17/97	62.2		Benzene	<1	8020
				Ethylbenzene	<1	8020
				m,p-Xylenes	<1	8020
				MTBE	<10	8020
				o-Xylene	<1	8020
				Toluene	<1	8020
VWW-B	7/18/97	35.8		Benzene	<1	8020
				Ethylbenzene	<1	8020
				m,p-Xylenes	<1	8020
				MTBE	<10	8020
				o-Xylene	<1	8020
				Toluene	<1	8020
VWW-C	7/18/97	35.1		Benzene	<1	8020
				Ethylbenzene	<1	8020
				m,p-Xylenes	<1	8020
				MTBE	<10	8020
				o-Xylene	<1	8020
				Toluene	<1	8020
VWW-D	7/18/97	33.8		Benzene	<1	8020
				Ethylbenzene	<1	8020
				m,p-Xylenes	<1	8020
				MTBE	<10	8020
				o-Xylene	<1	8020
				Toluene	<1	8020
VWW-E	7/17/97	32.8		Benzene	<1	8020
				Ethylbenzene	<1	8020
				m,p-Xylenes	<1	8020
				MTBE	<10	8020
				o-Xylene	<1	8020
				Toluene	<1	8020
WW-3	7/18/97	31.5		Benzene	<1	8020
				Ethylbenzene	<1	8020
				m,p-Xylenes	<1	8020
				MTBE	<10	8020
				o-Xylene	<1	8020
				Toluene	<1	8020

(table 4.8). Anthracene, fluoranthene, phenanthrene, and pyrene concentrations were measured between 1.9 and 6.9 µg/L in VWW-E.

PAH constituents anthracene, fluoranthene, phenanthrene, and pyrene ranged between 9.5 and 14 µg/L in a July 1997 sample from VWW-A. All PAH constituents are below detection limits in the August 1997 sample from the same well. Results of duplicate samples collected in August 1997 from the holding tank next to WW-2 are also inconsistent (table 4.8). PAH constituents anthracene, fluoranthene, phenanthrene, and pyrene concentrations are reported between 2.1 and 4.0 µg/L in one sample. All four of these constituents are below detection limits in the duplicate sample taken from the same source on the same date. The PAH naphthalene measured 9.1 µg/L in the duplicate sample, but it was not present in the other WW-2 sample.

A sample taken from the Vinson kitchen water tap on May 3, 1997, contained 0.61 µg/L of the PAH naphthalene (table 4.9). Another PAH, fluorene, and selected volatile and semivolatile organic compounds were also indicated in the same kitchen tap sample. The later results, however, were reported as "J" values. In other words, although enough of a peak was present to tentatively identify the compound, the calculated concentration was below the method quantitation limit. No BTEX constituents were identified in the July 18, 1997, sample collected from the Vinson kitchen water tap.

5.0 RISK EVALUATION

Our evaluation of risk associated with crude-oil-impacted ground water includes calculation of carcinogenic and toxic risks associated with specific exposure pathways, as well as a general recognition that crude-oil contamination of an underground source of drinking water is unacceptable. Results of the RBCA risk model indicate that levels of carcinogenic and toxic risks associated with modeled exposure pathways are acceptable, even with the conservative input assumptions used (highest detected PAH concentrations and inclusion of undetected BTEX constituents).

Table 4.8. PAH (EPA Method 8310) analytical results of Vinson ground-water samples.

Well		**VWW-A**[1]	**VWW-A**[2]	**VWW-B**[1]	**VWW-E**[2]	**WW-2**[2]	**WW-2**[2] **(dup.)**
Date		**7/17/97**	**8/19/97**	**7/18/97**	**8/19/97**	**8/19/97**	**8/19/97**
Unit		**(μg/L)**	**(μg/L)**	**(μg/L)**	**(μg/L)**	**(μg/L)**	**(μg/L)**
Analyte	1-methylnaphthalene	<2	n/a	<2	n/a	n/a	n/a
	Acenaphthene	<2	<2	<2	<2	<2	<2
	Acenaphthylene	<2	<2	<2	<2	<2	<2
	Anthracene	11	<1	<1	1.9	2.6	<1
	Benz(a)anthracene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Benzo(a)pyrene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Benzo(b)fluoranthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Benzo(ghi)perylene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Benzo(k,j)fluoranthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Chrysene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Dibenz(a,h)anthracene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Fluoranthene	12	<0.4	<0.4	2.3	3.5	<0.4
	Fluorene	<1	<1	<1	<1	<1	<1
	Indeno(1,2,3-cd)pyrene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	Naphthalene	<2	<2	<2	<2	<2	9.1
	Phenanthrene	9.5	<1	<1	4.2	2.1	<1
	Pyrene	14	<0.4	<0.4	6.9	4	<0.4
U.S. EPA Method		8310	8310	8310	8310	8310	8310

[1] Sample analyzed by DHL laboratory

[2] Sample analyzed by ChemSolve

n/a = not analyzed

Table 4.9. Organic analyte results of samples from Vinson kitchen tap.

BEG well number	Date sampled	Analyte	Result (µg/L)	U.S. EPA method
KTAP-1	5/3/97	TPH	<1,100	418.1
KTAP-1	5/3/97	Acenaphthene	<0.17	8310
		Acenaphthylene	<0.85	8310
		Anthracene	<1.78	8310
		Benzo[a]anthracene	<0.08	8310
		Benzo[b]fluoranthene	<0.06	8310
		Benzo[k]fluoranthene	<0.06	8310
		Benzo[g,h,i]perylene	<0.17	8310
		Benzo[a]pyrene	<0.08	8310
		Chrysene	<0.06	8310
		Dibenzo[a,h]anthracene	<0.29	8310
		Fluoranthrene	<0.14	8310
		Fluorene	0.09 J	8310
		Indeno[1,2,3-cd]pyrene	<1.12	8310
		Naphthalene	0.61	8310
		Phenanthrene	<0.29	8310
		Pyrene	<0.19	8310
KTAP-1	5/3/97	Acetone	<100	8260A
		Benzene	1.4 J	8260A
		Bromobenzene	<5	8260A
		Brochloromethane	<5	8260A
		Bromodichloromethane	<5	8260A
		Bromoform	<5	8260A
		Bromomethane	<5	8260A
		2-Butanone (MEK)	<100	8260A
		n-Butylbenzene	<5	8260A
		sec-Butylbenzene	<5	8260A
		tert-Butylbenzene	<5	8260A
		Carbon Disulfide	<100	8260A
		Carbon tetrachloride	<5	8260A
		Chlorobenzene	<5	8260A
		Chloroethane	<5	8260A
		2-Chloroethylvinyl ether	<20	8260A
		Chloroform	<5	8260A
		Chloromethane	<5	8260A
		2-Chlorotoluene	<5	8260A
		4-Chlorotoluene	<5	8260A
		Dibromochloromethane	<5	8260A
		1,2-Dibromo-3-chloropropane	<5	8260A
		1,2-Dibromoethane	<5	8260A
		Dibromomethane	<5	8260A
		1,2-Dichlorobenzene	<5	8260A
		1,3-Dichlorobenzene	<5	8260A
		1,4-Dichlorobenzene	<5	8260A
		1,1-Dichloroethane	<5	8260A
		1,2-Dichloroethane	<5	8260A
		1,1-Dichloroethene	<5	8260A
		Dichlorodifluoromethane	<5	8260A
		cins-1,2-Dichloroethene	<5	8260A
		trans-1,2-Dichloroethene	<5	8260A

Table 4.9. (cont.)

BEG well number	Date sampled	Analyte	Result (µg/L)	U.S. EPA method
		1,2-Dichloropropane	<5	8260A
		1,3-Dichloropropane	<5	8260A
		2,2-Dichloropropane	<5	8260A
		1,1-Dichloropropene	<5	8260A
		cis-1,3-Dichloropropene	<5	8260A
		trans-1,3-Dichloropropene	<5	8260A
KTAP-1 (cont.)		Ethylbenzene	<5	8260A
		2-Hexanone	<20	8260A
		Hexachlorobutadiene	<5	8260A
		Iodomethane	<5	8260A
		Isopropylbenzene	<5	8260A
		p-Isopropyltoluene	<5	8260A
		4-Methyl-2-pentanone (MIBK)	<50	8260A
		Methylene chloride	<5	8260A
		Naphthalene	<5	8260A
		n-Propylbenzene	<5	8260A
		Styrene	<5	8260A
		1,1,1,2-Tetrachloroethane	<5	8260A
		1,1,2,2-Tetrachloroethane	<5	8260A
		Tetrachloroethene	<5	8260A
		Toluene	<5	8260A
		1,2,3-Trichlorobenzene	<5	8260A
		1,2,4-Trichlorobenzene	<5	8260A
		1,1,1-Trichloroethane	<5	8260A
		1,1,2-Trichloroethane	<5	8260A
		Trichloroethene	<5	8260A
		Trichlorofluoromethane	<5	8260A
		1,2,3-Trichloropropane	<5	8260A
		1,2,4-Trimethylbenzene	1.9 J	8260A
		1,3,5-Trimethylbenzene	1.9 J	8260A
		Vinyl acetate	<50	8260A
		Vinyl chloride	<5	8260A
		Xylenes	4.8 J	8260A
KTAP-2	5/22/97	TPH	<1,000	418.1
KTAP-3	7/18/97	1-methylnaphthalene	<2	8310
		Acenaphthene	<2	8310
		Acenaphthylene	<2	8310
		Anthracene	<1	8310
		Benz(a)anthracene	<0.2	8310
		Benzo(a)pyrene	<0.02	8310
		Benzo(b)fluoranthene	<0.02	8310
		Benzo(ghi)perylene	<0.02	8310
		Benzo(k,j)fluoranthene	<0.02	8310
		Chrysene	<0.2	8310
		Dibenz(a,h)anthracene	<0.02	8310
		Fluoranthene	<0.4	8310
		Fluorene	<1	8310
		Indeno(1,2,3-cd)pyrene	<0.04	8310
		Naphthalene	<2	8310
		Phenanthrene	<1	8310
		Pyrene	<0.4	8310

Table 4.9. (cont.)

BEG well number	Date sampled	Analyte	Result (µg/L)	U.S. EPA method
KTAP-3	7/18/97	Benzene	<1	8020
		Ethylbenzene	<1	8020
		m,p-Xylenes	<1	8020
		MTBE	<10	8020
		o-Xylene	<1	8020
		Toluene	<1	8020

Although potential for migration of subsurface methane is identified as a site concern, it is not a risk considered by the RBCA model. In this report we do not quantify health or public-safety risks associated with elevated methane concentrations measured at depths of 8 to 12 ft below ground surface (fig. 4.2).

5.1 Site Summary

Current land use at the Vinson site is residential and agricultural. Surrounding land use is agricultural, along with some oil wells and accompanying tank batteries and pipelines. We expect that future land use will remain residential and agricultural, with nearby oil production.

The oil-contaminated ground water and associated methane-rich substrate are the media of concern at the Vinson site. Our site investigation did not reveal the presence of oil-field waste materials, such as drilling muds or basic sediment. Because no surface-exposed contaminated soils were noted at the site, direct surface-water runoff from the site is not of concern. However, the potential exists for discharge of oil-contaminated ground water to the Bitter Creek tributary if the crude oil is not removed. During the site investigation, no oily surface sheen was noted on the stream. Addressing the subsurface oil contamination will alleviate concerns regarding the potential for future surface-water contamination.

Crude oil overlies and is in contact with an underground source of drinking water at the Vinson site. The TPH data show that there is some impact on water quality in the shallow water-bearing zones (zones I and II) in association with the crude-oil and methane plumes. Zone III ground water may have been affected by the crude-oil plume because of the presence of PAH constituents in VWW-A and WW-2. Water well WW-2 provides a pathway for oil contamination to move from the shallow subsurface into zone III.

There are two possible explanations for the apparent absence of BTEX in ground water found to contain PAH's. First, the subsurface crude oil has been degraded and has probably lost a significant part of its BTEX and other light hydrocarbon fractions. Little ongoing solubilization of

BTEX from the oil into the water would therefore be taking place. Second, BTEX that dissolved into ground water has probably been attenuated. The heavier, PAH constituents would remain in the oil and dissolve slowly into ground water.

Because of well construction, the annulus of the Vinson's domestic water-supply well is open to the oil-bearing strata. An oil column has accumulated in the well bore and can be pulled into the house's plumbing when water levels in the well fall below the pump intake.

5.2 Constituents of Concern

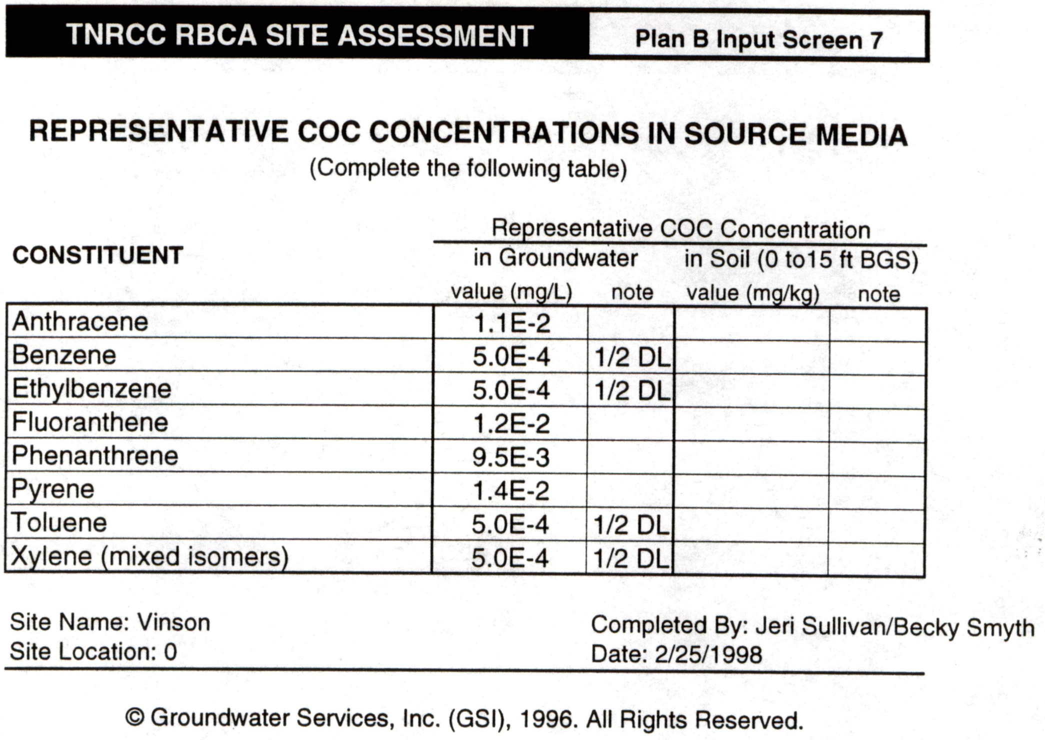
The constituents of concern (COC's) that we input to the RBCA model include those organic and inorganic compounds detected at any time in any analysis of samples from the Vinson site. These include four PAH compounds: anthracene, fluoranthene, phenanthrene, and pyrene. Representative COC concentrations (table 5.1) are required as input for the RBCA model. Physical properties of these constituents are given in appendix D. In order to be conservative, we defined the representative COC's for PAH's as the maximum concentration detected in any analysis.

We also included BTEX compounds in the RBCA model as a conservative measure for protecting human health. Although BTEX compounds are known constituents in hydrocarbons, they were not detected in ground water at the Vinson site. We used one-half the detection limit (for example, 0.5 μg/L for benzene) for the BTEX representative COC concentrations.

5.3 Potential Receptors and Migration Pathways

Potential receptors are located within the immediate vicinity of the crude-oil plume (the Vinson residence) and outside of the plume (referred to as offsite for purposes of the RBCA model). We included the offsite receptor as a measure for evaluating impacts to a hypothetical water-supply well relocated at a distance of 600 ft (180 m) (table 5.2) away from the plume. This distance corresponds to the farthest point up gradient (northwest) of the oil plume that is still on the Vinson property.

Table 5.1. Representative concentrations for constituents of concern at Vinson site.



TNRCC RBCA SITE ASSESSMENT | **Plan B Input Screen 7**

REPRESENTATIVE COC CONCENTRATIONS IN SOURCE MEDIA

(Complete the following table)

CONSTITUENT	Representative COC Concentration in Groundwater value (mg/L)	in Groundwater note	in Soil (0 to15 ft BGS) value (mg/kg)	in Soil (0 to15 ft BGS) note
Anthracene	1.1E-2			
Benzene	5.0E-4	1/2 DL		
Ethylbenzene	5.0E-4	1/2 DL		
Fluoranthene	1.2E-2			
Phenanthrene	9.5E-3			
Pyrene	1.4E-2			
Toluene	5.0E-4	1/2 DL		
Xylene (mixed isomers)	5.0E-4	1/2 DL		

Site Name: Vinson
Site Location: 0

Completed By: Jeri Sullivan/Becky Smyth
Date: 2/25/1998

Table 5.2. Exposure parameters, exposure pathways, and target risks at the Vinson site.

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT | **Plan B Output Table 1**

Site Name: Vinson
Site Location:

Job Identification: RRC Vinson
Date Completed: 2/25/98
Completed By: Jeri Sullivan/Becky Smyth

Software: Texas RBCA
Version: 1.0

NOTE: values which differ from default values are shown in bold italics and underlined.

Exposure Parameter	Definition (Units)	RME (Current Exposure) Res.	RME Child	RME Comm.	MLE (Future Exposure) Res.	MLE Child	MLE Comm.	Const.
ATc	Averaging time for carcinogens (yr)	70			70			
ATn	Aver. time for non-carcin. - soil/air exp. (yr)	30	6	25	9	6	25	0.25
ATn.GW	Aver. time for non-carcin. - GW ing. (yr)	30		25	9		25	
ATn.GWd	Aver. time for non-carcin. - GW dermal (yr)	33			33			0.25
BW	Body weight (kg)	70	15	70	70	15	70	70
ED	Soil/Air exposure duration (yr)	30	6	25	9	6	25	0.25
t	Exposure interval (s)	9.5E+8		7.9E+8	--		--	7.9E+6
ED.GW	Groundwater ing. exposure duration (yr)	30		25	9		25	
ED.GWd	Groundwater dermal exposure duration (yr)	33			33			0.25
EF	Soil/Air exposure frequency (d/yr)	350		250	235		250	250
EF.D	Soil dermal exposure frequency (d/yr)	350		250	40		40	40
EF.GW	Groundwater ing. exposure frequency (d/yr)	350		250	235		250	
EF.GWd	Groundwater dermal exposure freq. (d/yr)	5			5			250
IRw	Ingestion Rate of Water (L/day)	2		1	1.4		1	
IRs	Ingestion Rate of Soil (mg/day)	100	200	50	100	200	50	480
AAFs	Use age adjustment on soil ingestion?	TRUE			TRUE			
IRadj	Age adjusted soil ing. rate (mg•yr/kg•d)	114			84			
IRa.I	Inhalation rate indoor (m^3/day)	15		20	15		20	
IRa.O	Inhalation rate outdoor (m^3/day)	15		20	15		20	20
SA	Skin surface area (soil dermal) (cm^2)	5.8E+3		5.8E+3	5.0E+3		5.0E+3	5.0E+3
M	Soil to skin adherence factor	1			0.2			0.12
SA.GWd	Skin surface area (GW dermal) (cm^2)	6.2E+3			6.2E+3			6.2E+3
ET.GWd	Duration of GW dermal exposure (hr/day)	3			3			4

Matrix of Exposed Persons to Complete Exposure Pathways		On-Site Current	On-Site Future	Off-Site Current	Const. Future
Groundwater Pathways:					
GW.i	Groundwater Ingestion	TRUE	FALSE	TRUE	--
GW.d	Groundwater Dermal Contact	TRUE	FALSE	TRUE	TRUE
Soil Pathways:					
S.i	Direct Ingestion and Dermal Contact	FALSE	TRUE	--	TRUE
Outdoor Air Pathways:					
S.v	Volatilization and Particulates from Soil	FALSE	TRUE	TRUE	TRUE
GW.v	Volatilization from Groundwater	FALSE	TRUE	TRUE	TRUE
Indoor Air Pathways:					
S.b	Vapor Intrusion to Buildings from Soil	FALSE	TRUE	--	--
GW.b	Vapor Intrusion to Buildings from GW	TRUE	FALSE	--	--

Distance to Off-Site Receptor		
GWdist	Distance to groundwater receptor (m)	1.8E+02
Sdist	Distance to inhalation receptor (m)	

Target Risks		On-Site Current All Off-Site Individual Soil/Air	Individual GW	Cum.	On-Site Future Individual Soil/Air	Individual GW	Cum.
TRab	Target Risk (class A&B carcinogens)	1.0E-6	1.0E-6	1.0E-4	1.0E-4	1.0E-4	1.0E-4
TRc	Target Risk (class C carcinogens)	1.0E-5	1.0E-5		1.0E-4	1.0E-4	
THQ	Target Hazard Quotient	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0

Calculation Options		
LU_opt	On-site land use	Residential
LU_opt.off	Off-site land use	Residential
tox	Use PEL as industrial exposure limit in air?	FALSE
gwMCL?	Use MCL as exposure limit in groundwater?	TRUE
SPLP_opt	Use site-specific soil to leachate partitioning	FALSE

Surface Parameters	Definition (Units)	Res.	Const.
A	Contaminated soil area (m^2)	1.5E+2	1.5E+2
W	Width of affected soil perpendicular to wind (m)	2.1E+1	2.1E+1
W.gw	Length of affected soil parallel to GW flow (m)		
Uair	Ambient air velocity in mixing zone (m/s)	2.3E+0	
delta	Air mixing zone height (m)	2.0E+0	
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-12	

Groundwater Parameters	Definition (Units)	Value
Ugw	Groundwater Darcy velocity (cm/yr)	2.1E+1
Ugw.tr	Groundwater seepage velocity (cm/yr)	2.1E+2
Ks	Saturated Hydraulic Conductivity(cm/s)	2.0E-4
grad	Groundwater Gradient (cm/cm)	3.3E-3
phi.eff	Effective Porosity in Water-Bearing Unit	1.0E-1
foc.sat	Fraction organic carbon in water-bearing unit	2.0E-3
Sw	Width of groundwater source zone (m)	6.1E+1
Sd	Depth of groundwater source zone (m)	1.5E-1
LDF	Leachate dilution factor (unitless)	1.0E+2
delta.gw	Groundwater mixing zone depth (m)	
I	Groundwater infiltration rate (cm/yr)	
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE

Soil	Definition (Units)	Value
hc	Capillary zone thickness (cm)	5.0E+0
hv	Vadose zone thickness (cm)	***<u>1.2E+3</u>***
Lgw	Depth to groundwater (cm)	***<u>1.2E+3</u>***
Ls	Depth to top of affected soil (cm)	6.0E+1
ds	Thickness of affected soil zone (cm)	6.0E+1
rho	Soil density (g/cm^3)	1.8E+0
phi	Soil porosity in vadose zone	3.2E-1
foc	Fraction of organic carbon in vadose zone	2.0E-3
pH	Soil/groundwater pH	7.0E+0

		cap.	vadose	fndtn.
phi.w	Volumetric water content	2.9E-1	1.0E-1	1.2E-1
phi.a	Volumetric air content	3.2E-2	2.2E-1	2.6E-1

Building	Definition (Units)	Res.	Comm.
Lb	Building volume/area ratio (cm)	2.0E+2	3.0E+2
ER	Building air exchange rate (s^-1)	1.4E-4	2.3E-4
Lcrk	Foundation crack thickness (cm)	1.5E+1	
eta	Foundation crack fraction	1.0E-2	

Dispersive Transport Parameters	Definition (Units)	
Groundwater		
ax	Longitudinal dispersion coefficient (m)	5.9E+00
ay	Transverse dispersion coefficient (m)	5.9E-01
az	Vertical dispersion coefficient (m)	5.9E-02
Vapor		
dcy	Transverse dispersion coefficient (m)	
dcz	Vertical dispersion coefficient (m)	

Exposure pathways we identified for use in the RBCA model include:

(1) ground-water ingestion,
(2) ground-water dermal contact, and
(3) inhalation of volatiles from ground water during bathing.

It was necessary for us to use a limited Plan B assessment because we included dermal-contact and offsite ground-water-ingestion pathways. These pathways are detailed in table 5.2, along with exposure parameters and target risks. We considered ingestion of soil and inhalation of hydrocarbon vapors that could volatilize from soil (the construction-worker scenario) to be incomplete exposure pathways because depth to contaminated soil is greater than 10 ft.

5.4 RBCA Plan B Assessment Assumptions

The RBCA Plan B process involves comparison of risk-based exposure limits (RBEL's) with (a) known onsite or (b) calculated offsite constituent concentrations at selected points of exposure. Target concentrations are generated by the software in accordance with the TNRCC RBCA guidance. Exposure points are located at some stated distance from the site for the various applicable pathways. For ground water, onsite exposure was evaluated, and a hypothetical distance to a replacement well was chosen as a potential offsite point of exposure. The onsite land use was input as residential. The ground-water use category was classified as category I (beneficial use and TDS <3,000 µg/L). Depth to ground water was input as 12 m (40 ft). This depth automatically removes the ground-water dermal contact pathway from the model. This pathway most likely produces a negligible contribution to the total risk when compared with ground-water inhalation and ingestion pathway risks. Default soil and ground-water transport parameters were used. No soil pathways were evaluated because surface soils are not impacted. Table 5.2 lists the assumptions and input parameters used in the RBCA modeling of the Vinson site.

Calculations are based on standard exposure factors, such as 3 h/d of ground-water exposure for residents and standard intake values for ground-water consumption (TNRCC, 1996a). These factors are listed in table 5.2 and appendix C. Target health risk values are also shown in table 5.2. Individual values are for an individual exposure route, whereas cumulative values are for the combined routes. The cumulative cancer risks and hazard indices for various exposure pathways should be summed when the same individual or subpopulation is subject to the exposure over the same period of time (TNRCC, 1996a). Typically if cumulative values fall below the target values for a site, the exposure limits may be assumed to be protective of human health. A cumulative hazard index less than 1 or a cumulative carcinogenic risk less than 1 × 10^{-4} is acceptable and does not necessitate remediation or appropriate control measures, or both, according to the TNRCC (1996a). However, if individual values simultaneously fall above the target values, then these particular pathways may still be of concern and may still need to be addressed if it is concluded to be necessary or appropriate.

5.5 Assessment Results

The decision on whether to remediate a site should be based on the reasonable maximum exposure expected under current and future land-use situations (TNRCC, 1996). We used the RBCA model, which considers constituents dissolved in ground water, to determine the measurable maximum exposure. No cumulative COC risk levels were exceeded for on- or offsite receptors, according to our RBCA model results and the assumptions outlined in previous sections. In addition, no individual carcinogenic or toxicity risk levels were exceeded. Risks were not exceeded for carcinogens (benzene) because of low input concentrations to the model. Risks were not exceeded for toxins (PAH's) because only low levels were measured in onsite ground water and input to the model. Table 5.3 is a summary of the risk-calculation results. Printouts of the individual pathway risk spreadsheets are given in appendix D.

Table 5.3. Plan B baseline risk summary for the Vinson site.

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT | **Plan B Output Table 4**

Site Name: Vinson
Site Location: 0
Completed By: Jeri Sullivan/Becky Smyth
Date Completed: 2/25/1998
1 of 1

PLAN B BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk Limit(s) Exceeded?	Hazard Quotient		Hazard Index		Toxicity Limit(s) Exceeded?
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk		Maximum Value	Applicable Limit	Total Value	Applicable Limit	
OUTDOOR AIR EXPOSURE PATHWAYS										
On-Site:	1.9E-12	1.0E-4	1.9E-12	1.0E-4	☐	3.0E-7	1.0E+0	3.1E-7	1.0E+0	☐
Off-Site:	9.5E-12	1.0E-6	9.5E-12	1.0E-4	☐	4.5E-7	1.0E+0	4.6E-7	1.0E+0	☐
INDOOR AIR EXPOSURE PATHWAYS										
On-Site:	1.5E-8	1.0E-6	1.5E-8	1.0E-4	☐	4.8E-4	1.0E+0	4.9E-4	1.0E+0	☐
SOIL EXPOSURE PATHWAYS										
On-Site:	0.0E+0	1.0E-4	0.0E+0	1.0E-4	☐	0.0E+0	1.0E+0	0.0E+0	1.0E+0	☐
COMBINED SOIL/AIR EXPOSURE PATHWAY										
On-Site:	1.9E-12	1.0E-4	1.9E-12	1.0E-4	☐	3.0E-7	1.0E+0	3.1E-7	1.0E+0	☐
GROUNDWATER EXPOSURE PATHWAYS										
On-Site:	1.7E-7	1.0E-6	1.7E-7	1.0E-4	☐	6.5E-2	1.0E+0	8.7E-2	1.0E+0	☐
Off-Site:	4.3E-9	1.0E-6	4.3E-9	1.0E-4	☐	1.6E-3	1.0E+0	2.2E-3	1.0E+0	☐

CRITICAL EXPOSURE PATHWAY (Select Maximum Values From Applicable Pathways)										
On-Site:	1.7E-7	1.0E-6	1.7E-7	1.0E-4	☐	6.5E-2	1.0E+0	8.7E-2	1.0E+0	☐
Off-Site:	4.3E-9	1.0E-6	4.3E-9	1.0E-4	☐	1.6E-3	1.0E+0	2.2E-3	1.0E+0	☐

Software: Texas RBCA
Version: 1.0
Serial: G-437-SNX-750

6.0 REMEDIAL EVALUATION

The scope of work for this project included evaluation of feasible remediation alternatives and recommendation of an appropriate approach for remediation of the Vinson site. Site-specific conditions considered in evaluating remedial alternatives included mitigation of potential environmental impacts and cost effectiveness of different methods.

As remedial actions, we recommend that the free-phase crude oil be removed from the subsurface through the use of product-only extraction devices placed in two fluid-extraction wells. In addition, we recommend that five soil-vapor-extraction wells be installed to reduce subsurface methane levels and to encourage air infiltration into the subsurface. Naturally occurring biodegradation should be encouraged through oxygen supplementation to the subsurface. Target locations for the fluid-extraction wells and soil-vapor-extraction wells are shown on figure 6.1. The basis for these recommendations is given in the following sections.

6.1 Source Identification

The first step in any remedial activity is to identify and address the contaminant source. The RRC initially suspected the former Bennett "A" No. 2 well as a possible source of crude oil at the Vinson site; but it was reentered and replugged in June 1992 without any evidence of oil in the well bore or mud pit (table 2.2). Circumstantial evidence, however, continues to suggest that the plugged and abandoned well was somehow involved as the source of existing subsurface crude oil:

(1) the crude oil surrounds the location of the former Bennett "A" No. 2 well,

(2) there is no evidence of migration of the oil to its present position from some source other than the Bennett "A" No. 2 well, and

(3) the Bennett "A" No. 2 well is the only known oil-field activity within the footprint of the oil plume.

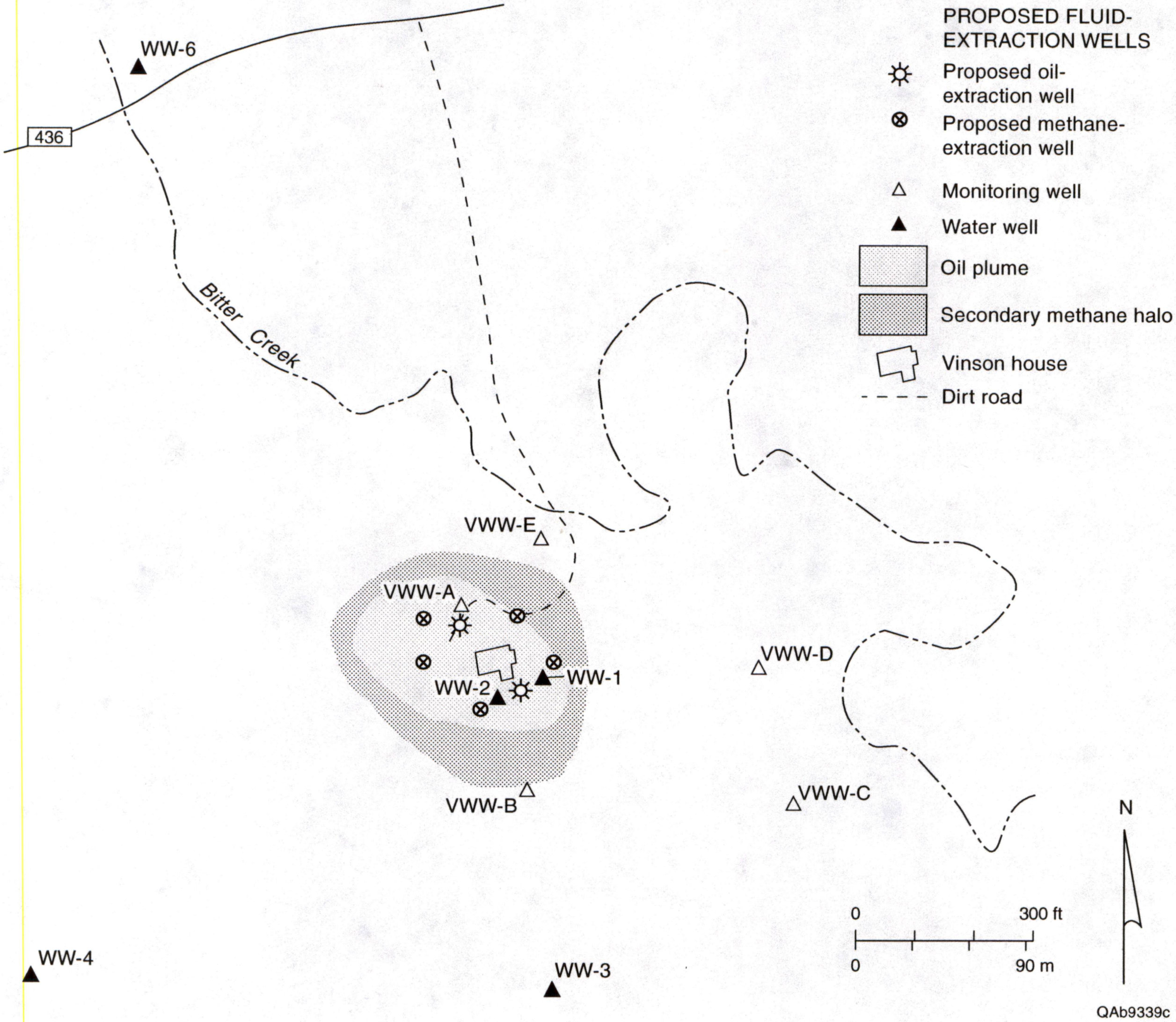


Figure 6.1. Location of recommended oil- and methane-extraction wells at the Vinson site. Number of fluid-extraction wells will depend on design of the fluid-recovery period and radius of influence to be determined from pilot-test data.

An earlier RRC report on the Vinson site discusses crude-oil fingerprinting. RRC investigators concluded that samples from WW-2 and a nearby pipeline do not exactly match but could be from the same subsurface reservoir (February 5, 1992, memorandum to Joe Cress from RRC Surface Mining and Reclamation Laboratory). Two chromatograms from oil-fingerprinting analyses run by the RRC lab are reproduced in figure 6.2. The chromatograms differ in that the sample from WW-2 (fig. 6.2a) is more degraded relative to the pipeline sample (fig. 6.2b). We base this observation on the increase of heavier and the slight loss of lighter hydrocarbon components shown by the chromatogram in figure 6.2a relative to the one in figure 6.2b. For example, the peaks including and to the right of C18 are higher in figure 6.2a than in figure 6.2b. Also, the shortest retention time peak in figure 6.2b is absent in figure 6.2a. The flatter base line in figure 6.2a means that there is a lower overall concentration of hydrocarbon constituents in the sample from WW-2 than in the pipeline sample.

Indications of a probable surface or near-surface source of hydrocarbon contamination include

(1) presence of hydrocarbon contamination in shallow sediments (<35 ft bgl),

(2) absence of crude oil at greater depths,

(3) concentration of the crude-oil plume near the former Bennett “A” No. 2 well with no obvious subsurface source of crude oil found when the well was reentered.

BEG suspects that if a leak in an oil-gathering line, buried in the shallow subsurface, went unnoticed for some period of time, then the oil would have infiltrated down to the lower permeability layer upon which water-bearing zone I is perched and spread laterally. Alternatively, oil from the well could have discharged onto the surface and seeped into the ground to contaminate shallow ground water. The oil could have come from (1) a surface storage pit, (2) a storage tank overflow or (3) a leak at the wellhead. The Bennett “A” No. 2 well was operational from October 1964 to November 1980. A review of aerial photographs and regional oil-field practices in the early 1960’s shows that large bermed areas were used for surface drilling-mud pits.

A report of an oil-production test performed on the Bennett “A” No. 2 well in 1964 shows that the well produced 87 bbl in 24 h; oil was flowing at the surface and did not have to be pumped. If

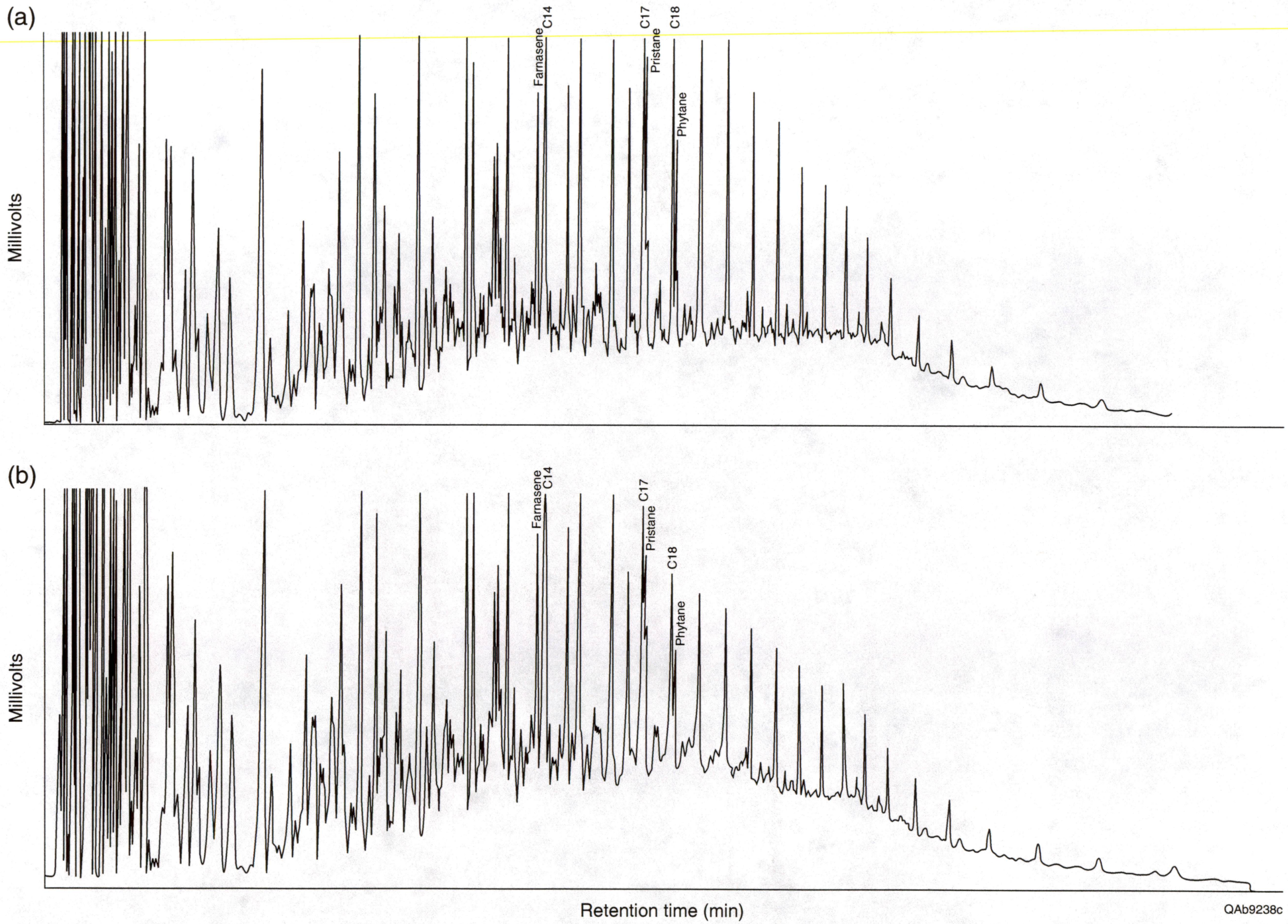


Figure 6.2. Chromatograms of crude oil from (a) water well WW-2 and (b) crude-oil pipeline. From RRC files (memorandum to Joe Cress, February 5, 1992).

oil leaked from a pipeline or spilled at the wellhead or from an oil-storage tank, as much as 87 bbl (3,654 gal) could have been discharged daily onto the ground or into the shallow subsurface. The spill or leak would have had to continue unabated for at least 1.5 to 6 d in order to accumulate the amount of subsurface crude-oil contamination estimated at the Vinson site. If the oil source was a prolonged spill some time when the Bennett "A" No. 2 well was active, then it follows that there is no ongoing source of contamination.

The source of the methane plume is most likely degradation of the crude oil. Crude-oil degradation can occur by both inorganic and organic processes. Volatilization is an inorganic process whereby components of a liquid phase are transformed to a gaseous phase according to pressure being exerted at the liquid–gas interface. At near-surface temperatures and pressures, crude oil can exsolve methane and other light-end gasses.

Methane is also generated biogenically during microbial degradation of crude oil. Breakdown of organic material is an oxygen-consuming process that results in the formation of a reducing environment. Carbon dioxide is also generated during the degradation of organic material. The reactions are catalyzed by microbes that occur naturally in the subsurface (Drever, 1988). Bacterial oxidation and bacterial fermentation, two processes typical of microbial degradation of crude oil, are represented by the following two generalized reactions:

Bacterial oxidation: $CH_2O + O_2 \longrightarrow CO2 + H_2O$

Bacterial fermentation: $2C_{organic} + 2H_2O \longrightarrow CH_4 + CO_2$.

6.2 Remediation Options

The issues of concern at the Vinson site include the crude-oil contamination of ground water and the elevated methane levels in the subsurface. Available technologies exist to address these concerns. Methods for addressing contaminant sources and types of remedial activities may fall into one of three categories: extraction, destruction, or immobilization. Extraction techniques remove the contamination from its location. Once extracted, the contaminated media may be managed onsite or offsite. Disposal, treatment or destruction processes may be used to remediate the contaminated media. Common extraction and remediation techniques include wells for fluid-phase contaminant removal and excavation and removal of contaminated solids.

Destruction techniques are used to degrade the contamination to an acceptable level and include technologies such as bioremediation, soil flushing with fluid removal, and vacuum extraction and treatment systems. Immobilization techniques seek to reduce the potential threat by containing or isolating or fixing contamination. These techniques include containment systems such as capping, stabilization and/or solidification, grout curtains, and slurry or cutoff walls.

There are common technologies appropriate for implementation at the Vinson site; other technologies are inappropriate. In general, immobilization techniques, such as slurry walls and cutoff walls, are less favorable options for the Vinson site. Whereas these immobilization systems restrict contaminant migration, they do not address the existing contaminant itself. Other immobilization systems such as stabilization and solidification are used to address contaminants in semisolids or sludges but are inefficient in addressing free-product contamination.

The current site use and associated risks require that the contaminant itself be addressed. Because extraction or destruction techniques or both are required to address the contaminant itself, immobilization techniques are not recommended for the RRC Vinson site. Individual immobilization techniques were therefore not evaluated as remedial alternatives.

The remedial options considered for the Vinson site include

(1) no action,

(2) free product extraction,

(3) ground-water extraction,

(4) gas venting,

(5) gas extraction,

(6) bioremediation, and

(7) enhanced bioremediation.

6.2.1 No Action

The no-action alternative means taking no action to remediate the site and leaving it in its present condition with natural processes controlling contaminant fate and rate of remediation. Natural biodegradation, volatilization, and solubilization would over time (>10 yr) reduce the crude-oil plume and ground-water contamination. Under a no-action alternative, the existing oil-contaminated ground water and elevated methane levels would remain and the potential for environmental impact would continue.

The no-action alternative is not appropriate for the Vinson site because of the risks presented by usage and potential consumption of the oil-contaminated ground water, the potential explosive risks due to the elevated methane levels in the subsurface, and the risk of spreading ground-water contamination. Furthermore, State regulatory requirements for protection of ground water (Texas Water Code, Title 2, Subtitle D, Chapter 26, Sections 26.003, 26.131, and 26.401) state that ground water shall not be degraded. Conditions present at the Vinson site—(1) free product is present in the subsurface and must be removed and (2) TPH concentrations exceed 5 μg/L, violate this rule.

6.2.2 Extraction Techniques

A conventional method of addressing subsurface fluid contamination is an extraction system utilizing vertical wells, horizontal wells, French (trench) drains, or a combination of these methods. Once extracted, the fluid is used, treated, or disposed of. Offsite use, treatment, or disposal requires the additional costs of transportation. Onsite fluid treatment or disposal requires discharge permits for effluent; an onsite treatment process may be required prior to discharge.

Free-Product-Extraction System

In a free-product-extraction system, crude oil would be extracted from the subsurface with minimal ground-water extraction. In ground-water-extraction systems, a large volume of ground water is removed from the subsurface and requires subsequent management by treatment or disposal. The costs of subsequent ground-water management are usually high. Product-only removal systems are an accepted technology.

Extraction of the oil alone may be accomplished through at least two different methods. One method is to target well locations and depths to extract mostly oil and minimal amounts of ground water. Using this method, wells would be placed at locations where the oil layer is distinct and wells would be screened only across those depths where oil would be encountered (17 to 20 ft bgl). Locating and designing wells require a high level of certainty as to hydrogeologic characterization and some stability in the depth and thickness of the oil layer. The design must allow for fluctuations in water level while still minimizing ground-water production. Furthermore, we believe that the oil layer is influencing the hydrogeologic behavior of water, depressing the water level in certain locations. As the oil layer is removed, it is anticipated that the hydrogeologic behavior of the water will be altered. Wells screened to particular depths on the basis of the depressed water-level behavior may then become less effective in oil removal.

Another method, which allows some flexibility, is considered more appropriate for the RRC Vinson site. In this method, wells would be screened across the entire fluid interface in the target zone (ground-water zones I and II) and only the oil fluid would be pumped from the wells. Using this method, the wells would be constructed as typical ground-water-extraction wells but specialized pumps would be installed. Different pump or skimmer mechanisms may be used to extract the oil fluids. Skimmer or floater pumps have inlets placed near the top of the pumps to generally restrict inflow into the pumps to floating free-phase contaminants. Monitoring of this system is required because, as the thickness of floating contaminant decreases during the remediation, the possibility of inflow of ground water into the inlet increases and adjustments in the intake level may be necessary. Whereas skimmer or floater pumps primarily extract free product, a limited amount of ground water will be removed and would require subsequent separation, as well as treatment and/or disposal. Several well-pump manufacturers offer types of skimmer or floater pumps. A model with a phase-level sensor is preferred.

A more innovative type of pump is an in-well separator. This type of pump intakes both free product and water, separates the product out and pumps the product to the surface, returning the water to the well bore. This pump offers the advantage of only extracting product, removing the need for a subsequent separation step. The disadvantage is that in-well separators are available from a limited number of suppliers and, often, some implementation hurdles are encountered in the use of new technology. In addition, small belt skimmers are available that are designed for well applications. Similar to belt skimmers used in surface tanks and ponds, these small belt skimmers pass a continuous belt in the well bore, attracting oil to the belt, and elevate the oil to the surface where it is scraped from the belt and collected. Belt skimmers remove a minimal amount of ground water.

Ground-Water-Extraction System

Another type of fluid-extraction system is a ground-water-extraction system. These systems are a conventional method of addressing ground-water contamination and may use vertical wells, horizontal wells, French (trench) drains, or a combination of these methods to accomplish fluid removal. Once extracted, the contaminated ground water is treated or disposed of. The advantage to this type of system is that ground-water contamination is addressed. The disadvantage is that large volumes of ground water are generally extracted and require subsequent management. Because of large fluid volumes, significant transportation costs may be incurred with offsite treatment or disposal. Onsite fluid treatment or disposal requires discharge permits for effluent, and generally onsite treatment processes are required prior to discharge.

Design of a ground-water-extraction system requires consideration of the depth of the ground water and ground water flow rate, as well as the influence of the extraction system on the ground-water flow regime.

The use of vertical wells to extract ground water is a well-established and conventional technology that provides considerable flexibility as to well depth, well spacing, and extraction rate (U.S. EPA, August 1991). It is important to target locations of the pumping wells on the basis of contaminant distribution and the presence of permeable units; both of these may be heterogeneous across the contaminated area. A major disadvantage to a vertical well system is the cost of the numerous vertical wells that may be required to intercept the horizontal extent of a contaminant plume. A second disadvantage is that a long period of time may be required for ground-water pumping.

A more innovative technology in recent site-remediation practices is the use of horizontal wells for contaminant recovery. In horizontally dispersed contaminant plumes, horizontal wells offer an advantage in that the wells may be placed within and extend along the plume, allowing greater recovery with fewer wells. Horizontal wells are also useful in situations where surface access directly above the contaminant plume is restricted, precluding the use of vertical wells. The need for relatively specialized equipment and installation, higher cost, and the need for sufficient surface access and offset to achieve horizontal drilling at the desired depth are all disadvantages to horizontal drilling (U.S. EPA, August 1991).

French drains are commonly used to intercept and collect shallow ground water by excavating a trench, installing a perforated pipe in the bottom of the trench, and backfilling the trench with permeable material. The trench may be gravity drained or pumped (U.S. EPA, August 1991). The greater surface area provided by a French drain often allows more rapid recovery of contaminated ground water. A large volume of soil is excavated during the installation of the French drains, however, that may require treatment or disposal if contaminated. A French drain system may also result in a large volume of coproduced ground water that will need to be disposed of.

Extraction, treatment, and disposal of oil-contaminated ground water are technically feasible options for the Vinson site. The technology is well established and has been shown to be effective in mitigating adverse environmental impacts by removing the contaminated media. Contaminated ground-water-extraction systems, however, are very costly to install and operate. The additional costs in treating or disposing of large quantities of extracted ground water are frequently the major cost factor when considering ground-water-extraction systems.

Oil-field waters may be disposed of by surface discharge or by injection. Surface discharge of oil-field waters requires a discharge permit (RRC Rule 3.75); a national pollutant discharge elimination system (NPDES) permit is currently also required (Brookshire, 1996). RRC Rule 3.75(b)(3) prohibits the introduction of any pollutant other than sewage into a publicly owned treatment works (POTW). Under Rule 3.75, a pollutant is defined as "any waste or other substance or material, including salt water, other mineralized water, sludge, drilling fluids, and oil, that is associated with any operation subject to regulation by the RRC under the Texas Natural Resources Code § 91.101 or § 141.012." Therefore, discharge to a POTW of oil-contaminated ground water from the Vinson site is not considered a viable option.

Gas-Venting System

The presence of elevated levels of subsurface methane at the RRC Vinson site dictates the need for remedial activities to address the methane. A passive gas-venting system may be used to reduce subsurface methane level by discharge of soil gas. Disadvantages of a passive gas-venting system are lack of drive for venting, the required relatively close spacing of the vents, and slow progress in reaching closure criteria. Passive drive is rarely sufficient to decrease subsurface gas concentrations in a timely manner, particularly when an air-treatment apparatus is used. Environmental regulations may restrict venting of hydrocarbon pollutants into the atmosphere.

Gas-Extraction System

Soil-gas or soil-vapor extraction systems (SVE's) are a technology frequently used for in situ remediation of fuel hydrocarbon spills from leaking petroleum storage tank sites. In soil-gas-extraction systems, clean air is drawn through a zone of contaminated soil; contaminants desorb from the soil and are removed in the exhausted air. Continued flushing with clean air can significantly reduce methane concentration in soil (U.S. EPA, August 1991).

A basic soil-gas-extraction system consists of extraction well(s) and extraction trench(es), or both, in conjunction with an air blower and/or vacuum pump. Treatment of discharge air, to separate moisture and remove contaminants, may be required. Soil-gas-extraction systems are flexible and can be adapted to changed site conditions or modified on the basis of additional site information. The future effectiveness of a basic system can be enhanced by monitoring and controlling the gas-extraction rates, supplementing the system with air-injection wells, providing an impermeable cover, or conditioning the injection air (U.S. EPA, August 1991). If multiple soil-gas-extraction wells are used, they may be pumped separately by individual pumps or through piping connected to a single pump (U.S. EPA, August 1991).

Soil-gas extraction is most successful when highly volatile compounds are present in high-permeability and high-porosity soils. In particular, the air-phase permeability across the unsaturated zone impacts the performance of soil-vapor extraction and air-sparging systems (Widdowson, 1995). For soils with high permeability and porosity, vacuum extraction is an attractive remediation technique. The process can be implemented in situ with minimal disturbance to surface operations. Therefore, there is limited handling of contaminated materials, and contaminant concentration (and thereby volatile mobility) is reduced. The process introduces only air into the soil and requires only residual controls with respect to the air discharge (U.S. EPA, August 1991).

Designing a soil-gas-extraction system generally requires that a pilot system be installed and operated so that input data can be obtained for assessment of the zone of capture, well spacing, flow rates, chemical concentrations, and discharge-air quality (Sterrett, 1992). Based on these data, a standard exemption from air permitting for new construction for water and soil remediation may likely be claimed (30 TAC 106.533).

6.2.3 Destruction Techniques

General destruction techniques include methods such as incineration, chemical treatment, vitrification, and contaminant degradation. In situ bioremediation is an attractive destruction technique for the Vinson site.

Bioremediation

Bioremediation is a destruction technology that is applied to various contaminated media through different techniques. It involves the use of biological (microbial) activity to destroy most organic wastes through biochemical degradation and is known to be effective technology for destruction of petroleum-compound contamination (Cookson, 1995). For biodegradation of petroleum compounds to occur, temperature, pH, and salinity must be appropriate, degrading microorganisms must be present, target constituents must be accessible, and oxygen (for aerobic degradation) and inorganic nutrients must be available.

Bioremediation may be in situ or ex situ. Generally, if site conditions permit, in situ bioremediation is preferred over ex situ bioremediation. In situ treatment has the advantage of involving neither the cost nor the contaminant-exposure risks associated with removing the contaminated media. Disadvantages of in situ treatment are the difficulties of manipulating the environment to being conducive to bioremediation and monitoring the extent and effectiveness of the bioremediation. The disadvantages to ex situ bioremediation include the significant additional material-handling costs and the increase of site disturbance, with possible additional exposure risks.

Bioremediation of contaminated soil requires a favorable environment for biological activity and may include tasks such as tilling to increase oxygen, adding moisture, adding nutrients such as potassium, or providing supplemental microbes. Bioremediation of surface water frequently includes the addition of supplemental microbes and aeration to increase oxygen content. Bioremediation of ground water may include practices such as air or oxygen injection (air sparging) and hydrogen peroxide or magnesium peroxide supplementation. Biodegradation rate is dependent upon presence of appropriate microorganisms, adequate concentration of essential nutrients, availability and concentration patterns of the compound to be degraded, and contaminant effects on microbial population activity (U.S. EPA, April 1991). The use of bioremediation as a destruction technique requires an analysis of the contaminants present as well as an additional investigation of site conditions.

With respect to in situ application of bioremediation, naturally occurring bioremediation is occasionally sufficient to degrade contamination. In some situations, however, environmental conditions such as the lack of oxygen, unsuitable moisture content or presence of toxic contaminants limit the effectiveness of natural bioremediation (U.S. EPA, August 1991). Stimulation of existing bioremediation and acceleration of the biodegradation rate through supplemental oxygen supply is frequently used.

Enhanced Bioremediation Using Oxygen Supplementation

Often oxygen is the limiting factor in in situ bioremediation, and supplemental oxygen may be required to maintain a desirable bioremediation rate. In situ injection of air is an economic means to supply oxygen. Air-sparging techniques are used to inject supplemental oxygen into the ground water in the saturated zone, whereas bioventing techniques are used to encourage biodegradation of volatile organic compounds in the unsaturated zone. Both air sparging and bioventing are attractive in situ technologies for use at the Vinson site.

6.3 Remediation Recommendations

Remedial actions are recommended to remove the free-phase crude oil, decrease the level of methane in the soil zone, and obtain monitoring data needed to document site closure. The recommended remedial actions and methods take into account site data, results of the risk assessment, land use, available technology, and economic factors. The remediation recommendations are

(1) remove free-phase oil,

(2) reduce methane level,

(3) encourage natural biodegradation, and

(4) monitor effectiveness of remedial actions for site closure.

6.3.1 Remove Free-Phase Oil

Free-phase oil floating on ground water provides a continuing source of ground-water contamination and a source of methane and other volatile gases contaminating the soil zone. Site remediation should include extraction and removal of recoverable free-phase crude oil. We estimated that the volume of crude oil at the Vinson site is 125 to 500 bbl (5,250 to 21,000 gal). It is reasonable to expect that one-third to one-half of this volume can be readily recovered by simple extraction technology. The remainder is expected to become increasingly immobile as the result of natural biodegradation, which can be artificially enhanced (see section 6.3.3). Recovered product is expected to have a refinable value that might be used to offset the cost of remediation.

Commercially available product-only pumps and in-well belt skimmer pumps specify flow rates from 60 gallons per day (60 gpd) to 250 gpd. Considering the maximum crude-oil volume estimate and probable lower pumping rates, time for extraction of the free product at the Vinson site ranges to as much as 1 yr if one extraction well is used. Expected duration of the oil-recovery operation could be shortened with additional wells. Because of site heterogeneity and the areal extent of the crude-oil plume, we recommend two free-product-extraction wells. These shallow wells should extend to 35 ft bgl to allow for fluctuations in water level.

Owing to the methane concentrations at the site, extraction pumps or skimmer motors should be explosion-proof. Explosion-proof equipment and techniques should be used during well installation because of the subsurface methane concentrations present at the site.

6.3.2 Reduce Methane Level

Because the methane level was measured within the explosive range (5 to 15 percent) in the subsurface during the site investigation and because remediation of the oil plume will generate more methane in the short term, steps should be taken to reduce the methane level. Removal of the crude-oil free product will remove most of the source of methane generation. In the near term, however, volatilization and natural biodegradation will continue to generate methane as the crude-oil residuals are degraded.

BEG recommends soil-vapor-extraction wells as opposed to a strictly passive venting system. The passive vapor drive in the subsurface soils at the Vinson site may be insufficient to lower the methane levels. Soil-vapor-extraction wells will also serve to create a gas-pressure flux in the subsurface by encouraging movement of air into the subsurface where oxygen is needed for biodegradation supplementation. We expect that a standard exemption from air permitting may be claimed for this remediation system. The exemption requires that total emission of petroleum hydrocarbons does not exceed 1.0 lb/hr. If abatement equipment is required to satisfy this criterion, burning of the discharge vapors or routing the vapors through a carbon absorption system may be required (30 TAC 106.533). Five soil-vapor-extraction wells (fig. 6.1), each with an assumed radius of influence of 100 ft, are recommended to remediate the area with elevated methane. Pilot testing will indicate the actual radius of influence, so fewer or more soil-vapor-extraction wells might be used.

6.3.3 Encourage Natural Biodegradation

The elevated methane, decreased oxygen, and elevated carbon dioxide levels measured in the subsurface surrounding the oil-impacted area are evidence that volatilization and natural biodegradation of the oil-contamination is ongoing. Even after recoverable free product is removed, immobile crude-oil residuals are anticipated in the subsurface soils, as well as possible residual TPH in the ground water. These residuals can be addressed through in situ biodegradation. Generally oxygen is a limiting factor in bioremediation, and the low oxygen levels encountered during the site investigation indicate that natural biodegradation at the Vinson site is limited by oxygen supply. The rate and extent of the natural biodegradation should be encouraged by supplementing oxygen supply to the subsurface.

The proposed soil-vapor-extraction wells (see section 6.3.2) allow for future flexibility with respect to bioremediation. If necessary, once free-product removal has been completed, the fluid-extraction wells could be converted into air-sparging wells or air-injection wells into the unsaturated zone for bioventing. This flexibility provides a further means to accelerate bioremediation of the crude-oil residuals through direct air or oxygen injection.

6.3.4 Monitor Effectiveness of Remedial Actions for Site Closure

The success of the remediation system in removing crude oil from the subsurface needs to be monitored throughout the operation to ensure that cleanup is achieved in the most cost-effective manner possible. Monitoring would most likely be required on a daily basis during the first week of operation, on a weekly basis during the first month of operation, and on a monthly basis thereafter. Monitoring should consist of adjusting discharge rates of extraction systems, measuring fluid levels in wells, and monitoring gas concentrations. Using two extraction wells, we estimate the time for free-product removal to be at least 6 months. The monitoring results will be evaluated to determine whether additional wells are needed to accelerate the rate of crude-oil and methane extraction.

7.0 CONCLUSIONS

Crude-oil impact at the Vinson site is contained within an area of approximately 76,000 ft^2 surrounded by a methane halo that covers an additional 66,000 ft^2. Indications are that crude oil likely was introduced to the shallow subsurface by a transport pipeline leak or surface spill near the Bennett "A" No. 2 well. We have ruled out potential sources such as plume migration from a distant leaking pipeline (for example, crude-oil pipeline along C.R. 436) or oil storage-tank battery. Replugging of the Bennett "A" No. 2 well in June 1992 with no show of oil makes it unlikely that there is currently crude oil leaking from this well. Although we do not have specific data to rule out natural seepage from a deep-seated fault, we also consider that unlikely because crude-oil discharge is restricted to the topographically high area instead of occurring along the creek and no evidence of soil staining was found beneath the oil plume.

The likely source of weathered crude oil at the Vinson site was a surface spill or a near-surface transport-line leak. This may have occurred during production testing or operation. Reasons supporting this conclusion include:

(1) The presence of hydrocarbons in shallow sediments in cores VCC-1 and VCC-3. The oil was concentrated in silty sand layers approximately 17.7 to 18.0 and 18.4 to 19.0 ft bgl in cores VCC-1 and VCC-3, respectively, and was found in small quantities along fractures in both cores as deep as approximately 35 ft bgl. There was no evidence of hydrocarbons in the deeper sediments obtained during coring.

(2) Free-phase crude oil was found floating on shallow ground water (approximately 10 ft bgl) in borings completed to depths of approximately 35 ft bgl but was absent in well VWW-A, which was completed in the deepest water-bearing zone (zone III).

(3) There is no trace of lateral migration of the oil plume from an offsite source to its present position.

Down gradient from the crude-oil plume neither TPH nor BTEX was detected in samples from monitoring wells completed in zones I and II. Analytical results from one down-gradient well show presence of some PAH constituents. Ground water in the deeper, zone III (50 to 60 ft bgl) water-bearing zone shows possible contamination by PAH's; however, analytical results are inconclusive.

BEG suspects that some natural attenuation of the hydrocarbon contamination has occurred via microbial degradation in the subsurface at the Vinson site. This observation is supported by the presence of decreased oxygen and increased carbon dioxide levels in the unsaturated zone.

We recommend that the free-product crude oil be recovered with two shallow product-only extraction wells. We also recommend that five soil-vapor-extraction wells be installed to reduce the subsurface methane levels and increase subsurface oxygen at the Vinson site.

Once remedial actions have been undertaken, the site should be monitored to ensure the performance of the remedial systems and to confirm that there is no ongoing source of crude oil. These monitoring data are also needed to document total emission of petroleum hydrocarbons for an application for a standard air permitting exemption.

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Appendix A

Vinson Site Laboratory Reports and Chain of Custody Documents

DHL Analytical - May 1997
Vinson kitchen tap sample (KTAP-1)

Transglobal Environmental Geochemistry (TEG)- May 1997
Vinson site soil vapor survey, soil, and water samples (including KTAP-2) from on-site mobil laboratory.

ChemSOLVE - July 1997
Organic (BTEX and PAH) analyses of ground water and KTAP-3.

Railroad Commission (RRC) - July 1997
Cation and anion analyses of ground water

RRC - July 1997
TPH analyses of soils

ChemSOLVE - August 1997
Cation, anion, and organic (PAH) analyses of ground water

RRC - August 1997
Cation and anion analyses of ground water

DHL Analytical - May 1997
Vinson kitchen tap sample (KTAP-1)

DHL
ANALYTICAL

TRPH ANALYTICAL RESULTS

Client: Bureau of Economic Geology
Client Project Number: N/A
Location: Vinson Site Kitchen Tap
DHL Project Number: 9705010

Water samples analyzed on 5/6/97
Analyst: DW
EPA Methods 3510B/418.1 Separatory Funnel Extraction / Total Petroleum Hydrocarbons

SAMPLE ID	**TRPH ppm (mg/L)**
Method Blank	ND
KTAP-1	ND
PQL	1.1 mg/L

Continuing Calibration Verification (CCV) - Percent Recovery

CCV	Measured Conc. (ppm)	Recovery (%)
#1 230 PPM	227	99
#2 230 PPM	229	100

Laboratory Control Sample (LCS) - Percent Recovery

LCS	Measured Conc. (ppm)	Recovery (%)
LCS 2.3 PPM	2.3	100

Matrix Spike (MS) & Matrix Spike Duplicate (MSD) - Percent Recovery and Relative Percent Difference (RPD)

SAMPLE ID	Unspiked Conc. (ppm)	Spiked Conc. (ppm)	Recovered Conc. (ppm)	% Recovery
BATCH MS	ND	23	22.1	96
BATCH MSD	ND	23	22.0	96
			RPD =	0.45

NOTE:
ND - Not Detected, at listed Practical Quantitation Limit (PQL)

Tien-Yu Chang
Data Review

DHL
ANALYTICAL

TENTATIVELY IDENTIFIED COMPOUND (TIC) REPORT

DHL PROJECT #: 9705010
CLIENT: Bureau of Economic Geology
CLIENT PROJECT #: N/A
LOCATION: Vinson Site Kitchen Tap

TIC ID	KTAP-1 ppb (ug/L)
Methyl cyclopentane	16
Dibromofluoromethane	24
Cyclohexane	19
Methyl Cyclohexane	20

NOTES:
These compounds are present in the sample, but they are not target analytes of EPA method 8260. Estimated concentration are for reference only.

Tien-Yu Chang
Data Review

DHL ANALYTICAL

VOLATILE ORGANICS ANALYSIS DATA SHEET

DHL PROJECT #: 9705010
CLIENT: Bureau of Economic Geology
CLIENT PROJECT #: N/A
LOCATION: Vinson Site Kitchen Tap

EXTRACTION METHOD:	**5030A**	**SAMPLE DATE:**	5/3/97
ANALYTICAL METHOD:	**8260A**	**SAMPLE REC'D:**	5/5/97
MATRIX:	WATER	**SAMPLE CONDITION:**	GOOD
REPORT GENERATED BY:	FL	**EXTRACTION DATE:**	5/7/97
ANALYST:	FL	**EXTRACT. HOLD TIME (D**	0
QA REVIEW:	TC	**ANALYSIS DATE:**	5/7/97
BATCH NUMBER:	8260970507-BT1	**HOLDING TIME (DAYS):**	4

TARGET COMPOUND ID	EQL ppb (ug/L)	Method Blank ppb (ug/L)	KTAP-1 ppb (ug/L)	Trip Blank ppb (ug/L)
Acetone	100	ND	ND	ND
Benzene	5	ND	1.4 J	ND
Bromobenzene	5	ND	ND	ND
Brochloromethane	5	ND	ND	ND
Bromodichloromethane	5	ND	ND	ND
Bromoform	5	ND	ND	ND
Bromomethane	5	ND	ND	ND
2-Butanone (MEK)	100	ND	ND	ND
n-Butylbenzene	5	ND	ND	ND
sec-Butylbenzene	5	ND	ND	ND
tert-Butylbenzene	5	ND	ND	ND
Carbon Disulfide	100	ND	ND	ND
Carbon tetrachloride	5	ND	ND	ND
Chlorobenzene	5	ND	ND	ND
Chloroethane	5	ND	ND	ND
2-Chloroethylvinyl ether	20	ND	ND	ND
Chloroform	5	ND	ND	ND
Chloromethane	5	ND	ND	ND
2-Chlorotoluene	5	ND	ND	ND
4-Chlorotoluene	5	ND	ND	ND
Dibromochloromethane	5	ND	ND	ND
1,2-Dibromo-3-chloropropane	5	ND	ND	ND
1,2-Dibromoethane	5	ND	ND	ND
Dibromomethane	5	ND	ND	ND
1,2-Dichlorobenzene	5	ND	ND	ND
1,3-Dichlorobenzene	5	ND	ND	ND
1,4-Dichlorobenzene	5	ND	ND	ND
1,1-Dichloroethane	5	ND	ND	ND
1,2-Dichloroethane	5	ND	ND	ND
1,1-Dichloroethene	5	ND	ND	ND

CONTINUED - PAGE 2

ANALYTICAL METHOD	8260	ANALYSIS DATE:	5/7/97

TARGET COMPOUND ID	EQL ppb (ug/L)	Method Blank ppb (ug/L)	KTAP-1 ppb (ug/L)	Trip Blank ppb (ug/L)
Dichlorodifluoromethane	5	ND	ND	ND
cins-1,2-Dichloroethene	5	ND	ND	ND
trans-1,2-Dichloroethene	5	ND	ND	ND
1,2-Dichloropropane	5	ND	ND	ND
1,3-Dichloropropane	5	ND	ND	ND
2,2-Dichloropropane	5	ND	ND	ND
1,1-Dichloropropene	5	ND	ND	ND
cis-1,3-Dichloropropene	5	ND	ND	ND
trans-1,3-Dichloropropene	5	ND	ND	ND
Ethylbenzene	5	ND	ND	ND
2-Hexanone	20	ND	ND	ND
Hexachlorobutadiene	5	ND	ND	ND
Iodomethane	5	ND	ND	ND
Isopropylbenzene	5	ND	ND	ND
p-Isopropyltoluene	5	ND	ND	ND
4-Methyl-2-pentanone (MIBK)	50	ND	ND	ND
Methylene chloride	5	ND	ND	ND
Naphthalene	5	ND	ND	ND
n-Propylbenzene	5	ND	ND	ND
Styrene	5	ND	ND	ND
1,1,1,2-Tetrachloroethane	5	ND	ND	ND
1,1,2,2-Tetrachloroethane	5	ND	ND	ND
Tetrachloroethene	5	ND	ND	ND
Toluene	5	ND	ND	ND
1,2,3-Trichlorobenzene	5	ND	ND	ND
1,2,4-Trichlorobenzene	5	ND	ND	ND
1,1,1-Trichloroethane	5	ND	ND	ND
1,1,2-Trichloroethane	5	ND	ND	ND
Trichloroethene	5	ND	ND	ND
Trichlorofluoromethane	5	ND	ND	ND
1,2,3-Trichloropropane	5	ND	ND	ND
1,2,4-Trimethylbenzene	5	ND	1.9 J	ND
1,3,5-Trimethylbenzene	5	ND	1.9 J	ND
Vinyl acetate	50	ND	ND	ND
Vinyl chloride	5	ND	ND	ND
Xylenes	5	ND	4.8 J	ND

SURROGATE	CONC. (ug/L)	RECOVER	RECOVER	RECOVERY
Dibromofluoromethane	50	104	108	107
1,2-Dichloroethane-d4	50	81	87	84
Toluene-d8	50	95	97	95
Bromofluorobenzene	50	102	104	102

NOTES:

ND : Not Detected at listed Estimated Quantitation Limit (EQL)

J - detected below EQL but above Method Detection Limit (MDL)

Tien-Yu Chang

Data Review

DHL
ANALYTICAL

QUALITY ASSURANCE REPORT

DHL PROJECT #: 9705010
CLIENT: Bureau of Economic Geology
CLIENT PROJECT #: N/A
ANALYSIS DATE: 5/7/97

RELATIVE RESPONSE FACTOR (RRF) OF SPCC

TARGET COMPOUND	CCV #1	CCV #2	Min. RRF
Chloromethane	0.626	0.612	0.300
1,1-Dichloroethane	1.002	1.006	0.300
Chlorobenzene	1.325	1.301	0.300
Bromoform	0.248	0.242	0.100
1,1,2,2-Tetrachloroethane	0.807	0.779	0.300

PERCENT DIFFERENCE OF RRF FOR CCC

TARGET COMPOUND	CCV #1	CCV #2	Max. % D
Vinyl chloride	15.7	17.7	20
1,1-Dichloroethene	6.3	7.7	20
Chloroform	2.5	4.4	20
1,2-Dichloropropane	3.9	5.7	20
Toluene	10.1	11.8	20
Ethylbenzene	1.3	1.5	20

% RECOVERY AND RPD FOR 50 ppb MATRIX SPIKE

SAMPLE ID	1,1-DCE	Benzene	TCE	Toluene	Chlorobenz.
KTAP-1 MS	91	111	110	113	99
KTAP-1 MSD	88	108	108	112	97
%RPD =	3.35	2.74	1.83	0.89	2.04

NOTES:
SPCC - System Performance Check Compound
CCC - Calibration Check Compound
CCV - Continuing Calibration Verification

Tien-Yu Chang
Data Review

DHL
ANALYTICAL

PAH ANALYSIS DATA SHEET

DHL PROJECT #: 9705010
CLIENT: Bureau of Economic Geology
CLIENT PROJECT #: N/A
LOCATION: Vinson Site Kitchen Tap

EXTRACTION METHOD:	**3510B**	**SAMPLE DATE:**	5/3/97
ANALYTICAL METHOD:	**8310**	**SAMPLE REC'D:**	5/5/97
MATRIX:	WATER	**SAMPLE CONDITION:**	GOOD
REPORTED BY:	FL	**EXTRACTION DATE:**	5/8/97
ANALYST:	FL	**EXTRACT. HOLD TIME (DAYS):**	5
QA REVIEW:	LB	**ANALYSIS DATE:**	5/8/97
BATCH NUMBER:	PA970508-BT1	**HOLDING TIME (DAYS):**	5

TARGET COMPOUND	PQL ppb (ug/L)	Method Blank ppb (ug/L)	KTAP-1 ppb (ug/L)
Acenaphthene	0.17	ND	ND
Acenaphthylene	0.85	ND	ND
Anthracene	1.78	ND	ND
Benzo[a]anthracene	0.08	ND	ND
Benzo[b]fluoranthene	0.06	ND	ND
Benzo[k]fluoranthene	0.06	ND	ND
Benzo[g,h,i]perylene	0.17	ND	ND
Benzo[a]pyrene	0.08	ND	ND
Chrysene	0.06	ND	ND
Dibenzo[a,h]anthracene	0.29	ND	ND
Fluoranthrene	0.14	ND	ND
Fluorene	0.26	ND	0.09 J
Indeno[1,2,3-cd]pyrene	1.12	ND	ND
Naphthalene	0.53	ND	0.61
Phenanthrene	0.29	ND	ND
Pyrene	0.19	ND	ND
SURROGATE	Conc. (mg/L)	% Recovery	% Recovery
2-Fluorobiphenyl	200	79	84

NOTE:
ND: Not Detected at listed Practical Quantitation Limit (PQL)
J: Estimated value, concentration detected below PQL but above Method Detection Limit (MDL)

Lee Barkdull
Data Review

DHL
ANALYTICAL

QUALITY ASSURANCE REPORT

PAH ANALYSIS

DHL PROJECT #: 9705010
CLIENT: Bureau of Economic Geology
CLIENT PROJECT #: N/A
Analysis Date: 5/8/97

CONTINUING CALIBRATION VERIFICATION (CCV) - % Recovery

TARGET COMPOUND	CCV #1	CCV #2
Acenaphthene	104	102
Acenaphthylene	89	87
Anthracene	108	108
Benzo[a]anthracene	102	101
Benzo[b]fluoranthene	106	110
Benzo[k]fluoranthene	100	99
Benzo[g,h,i]perylene	96	99
Benzo[a]pyrene	112	109
Chrysene	103	101
Dibenzo[a,h]anthracene	104	97
Fluoranthrene	101	99
Fluorene	110	109
Indeno[1,2,3-cd]pyrene	105	106
Naphthalene	101	99
Phenanthrene	105	103
Pyrene	85	83

Data Review

DHL
ANALYTICAL

QUALITY ASSURANCE REPORT

PAH ANALYSIS

DHL PROJECT #: 9705010
CLIENT: Bureau of Economic Geology
CLIENT PROJECT #: N/A
Analysis Date: 5/8/97

% RECOVERY AND RELATIVE PERCENT DIFFERENCE (RPD) OF LABORATORY CONTROL SAMPLE / DUPLICATE (LCS/LCSD)

TARGET COMPOUND	LCS	LCSD	RPD=
Benzo[a]pyrene	108	120	10.5
Chrysene	107	118	9.8
Phenanthrene	91	96	5.3
Pyrene	89	96	7.6

Data Review

DHL ANALYTICAL

2300 Double Creek Drive • Round Rock, TX 78664
Phone (512) 388-8222 • FAX (512) 388-8229

CHAIN-OF-CUSTODY

CLIENT: Bureau of Economic Geology
ADDRESS: University Station, Box X
PHONE: (512) 471-0232 FAX: (512) 471-0140
CLIENT PROJECT #:
PROJECT MANAGER: R.C. Smyth

DATE: 5/3/97 PAGE 1 OF 1
DHL PROJECT #: 9705010
LOCATION: Vinson site Kitchen tap
COLLECTOR: Rebecca C. Smyth

Sample I.D.	Depth	Time	Sample Type	Container Type	BTEX	TRPH 418.1	TPH 8015 (gas)	TPH 8015 (diesel)	pH	VOA 601/8010	VOA 602/8020	VOA 624/8240	VOA 8260	SEMI VOL 625/8270	PCBs 608/8080	PAHs 8310	RCI	RCRA 8 METALS	TOTAL LEAD	TOX	TDS	FIELD NOTES	Total Number of Containers	Laboratory Note Number
KTap-1	—	14:00	L	40 ml									X									Kitchen faucet	2	
KTap-1	—	1400	L	1 L		X																"	1	
KTap-1	—	1400	L	1L												X	~~X~~					"	1	
Trip Blank	4.26.97	14.20	Water	40ml									X											

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	DATE/TIME
Rebecca C. Smyth	1300 5/5/97	Lee Bulkdall	1300 5/5/97

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

☐ DHL DISPOSAL @ $4.00 each ☐ Return ☐ Pickup

SAMPLE RECEIPT	
TOTAL NUMBER OF SAMPLES	3
CHAIN OF CUSTODY SEALS Y/[✓ N]/NA	
SEALS INTACT? Y/N/[✓ NA]	
RECEIVED [✓ *GOOD COND*]/[✓ *COLD*]	
NOTES:	

LABORATORY NOTES:
Rec. Temp = 1.4°C

Transglobal Environmental Geochemistry (TEG)- May 1997
Vinson site soil vapor survey, soil, and water samples (including KTAP-2) from
on-site mobil laboratory.

transglobal environmental geochemistry
teg

June 10, 1997

Ms. Rebecca Smyth
Bureau of Economic Geology (BEG)
University Station Box X
Austin, TX 78713-8924

RE: SOIL VAPOR SURVEY, SOIL AND WATER SAMPLES - VINSON PROPERTY – 1147 CO RD 436, MERKEL, TX – PROJECT #RRC VINSON

TEG-Texas project #T2-970520

Ms. Smyth:

Please find enclosed the data report for the soil vapor survey, soil and water samples conducted at the Vinson Property site in Merkel, TX for the BEG. All samples were analyzed in TEG-Texas' mobile environmental laboratory for the following:

- 27 soil vapor samples for Total Petroleum Hydrocarbons, C1-C6 carbon range (EPA Method 8015).
- 45 soil samples for Total Recoverable Petroleum Hydrocarbons (EPA Method 418.1)
- 26 water samples for Total Recoverable Petroleum Hydrocarbons (EPA Method 418.1).

You will also find enclosed appropriate QA/QC data, Chain of Custody Records and copies of the chromatograms for the above mentioned project.

TEG-Texas appreciates the opportunity to work with The Bureau of Economic Geology on this project. If you have any questions regarding these data or need further information, please do not hesitate to call (210)420-3516.

Sincerely,

Julie A. Pieper

Julie A. Pieper
General Manager

Transglobal Environmental Geochemistry ★ Texas
Route 2 Box 54P • Marion, TX 78124
Telephone: 210-420-3516 • Fax: 210-420-3603
Mobile Telephone: 210-602-4002 • Pager: 800-710-6181

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

TEG Project #T2-970520

TPH (DOHS EPA Method 8015 C1-C6) ANALYSES OF VAPORS

SAMPLE NUMBER	DATE ANALYZED	DEPTH (FT)	Methane (ppmv)	Ethane (ppmv)	Propane (ppmv)	Butane (ppmv)	Pentane (ppmv)	Hexane (ppmv)	TPH(8015) (ppmv)
METHOD BLANK	**5/20/97**	—	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-2	5/20/97	10'	4	ND	ND	ND	ND	ND	ND
METHOD BLANK	**5/21/97**	—	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-3	5/21/97	10'	ND	ND	ND	ND	ND	ND	ND
VBH-4	5/21/97	10'	40000	13	ND	1	2	ND	ND
METHOD BLANK	**5/21/97**	—	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-5	5/21/97	10'	33000	ND	155	1800	2100	640	13400
METHOD BLANK	**5/21/97**	—	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-6	5/21/97	10'	3	ND	ND	ND	ND	ND	ND
METHOD BLANK	**5/22/97**	—	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-7	5/22/97	10'	44	ND	ND	ND	ND	ND	ND
VBH-8	5/22/97	10'	51000	6	40	157	74	212	500
METHOD BLANK	**5/22/97**	—	**8**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-9	5/22/97	4'	419	ND	ND	5	4	ND	16
METHOD BLANK	**5/22/97**	—	**4**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-10	5/22/97	2'	21	ND	ND	ND	ND	ND	ND
METHOD BLANK	**5/22/97**	—	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-11	5/22/97	10'	980000	ND	125	2200	3300	1300	15000
METHOD BLANK	**5/23/97**	—	**2**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-12	5/23/97	10'	700000	430	2300	3700	2000	500	10000
METHOD BLANK	**5/23/97**	—	**19**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-13	5/23/97	8'	37000	40	400	600	300	60	730
METHOD BLANK	**5/28/97**	—	**3**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-14	5/28/97	10'	73000	440	520	1700	1500	650	8600
METHOD BLANK	**5/28/97**	—	**2**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-15	5/28/97	8'	2	ND	ND	ND	ND	ND	ND
VBH-16	5/28/97	10'	9	ND	ND	ND	ND	ND	ND
VBH-17	5/28/97	8'	8	ND	ND	ND	ND	ND	ND
VBH-18	5/28/97	6'	ND	ND	ND	ND	ND	ND	ND
METHOD BLANK	**5/29/97**	—	**2**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-19	5/29/97	6'	19	ND	ND	ND	ND	ND	ND
VBH-20	5/29/97	10'	93000	48	640	1130	375	21	1800
METHOD BLANK	**5/29/97**	—	**2**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-21	5/29/97	10'	600	ND	ND	ND	ND	ND	ND
METHOD BLANK	**5/29/97**	—	**7**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-22	5/29/97	10'	20	ND	ND	ND	ND	ND	ND
METHOD BLANK	**5/29/97**	—	**5**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-23	5/29/97	10'	87	ND	ND	ND	ND	ND	[illegible]

teg

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL, TX

TEG Project #T2-970520

TPH (DOHS EPA Method 8015 C1-C6) ANALYSES OF VAPORS

SAMPLE NUMBER	DATE ANALYZED	DEPTH (FT)	Methane (ppmv)	Ethane (ppmv)	Propane (ppmv)	Butane (ppmv)	Pentane (ppmv)	Hexane (ppmv)	TPH(8015) (ppmv)
METHOD BLANK	**5/30/97**	**—**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-24	5/30/97	10'	46000	4	35	93	287	440	1300
METHOD BLANK	**5/30/97**	**—**	**18**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-25	5/30/97	10'	4	ND	ND	ND	ND	ND	ND
VBH-26	5/30/97	10'	3	ND	ND	ND	ND	ND	ND
VBH-27	5/30/97	12'	830000	33	790	7200	7000	1900	18300
METHOD BLANK	**5/30/97**	**—**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
VBH-28	5/30/97	7'	8000	8	82	144	36	5	100
DETECTION LIMITS			1	1	1	1	1	1	10

"**ND**" INDICATES NOT DETECTED AT LISTED DETECTION LIMITS

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

QA/QC Data Report for soil vapors for EPA methods 8015 (C1-C6)

DATE: 5/20/97
TIME: 15:42

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	105	105%
Methane(C1)	1100	1182	107%
Ethane(C2)	1070	1159	108%
Propane(C3)	1050	1131	108%
Butane(C4)	1060	1152	109%
Pentane(C5)	1100	1199	109%
Hexane(C6)	1030	1118	109%

DATE: 5/20/97
TIME: 18:43

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	98	98%
Methane(C1)	1100	1079	98%
Ethane(C2)	1070	1044	98%
Propane(C3)	1050	1024	98%
Butane(C4)	1060	1021	96%
Pentane(C5)	1100	1043	95%
Hexane(C6)	1030	925	90%

% RECOVERY - PERCENT RECOVERY OF ANALTYTE(S) FROM STANDARD
ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LAB
ANALYSES PERFORMED BY : Richard Rodriguez

teg

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

QA/QC Data Report for soil vapors for EPA methods 8015 (C1-C6)

DATE: 5/21/97
TIME: 7:46

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	105	105%
Methane(C1)	1100	1122	102%
Ethane(C2)	1070	1094	102%
Propane(C3)	1050	1063	101%
Butane(C4)	1060	1059	100%
Pentane(C5)	1100	1030	94%
Hexane(C6)	1030	884	86%

DATE: 5/21/97
TIME: 11:51

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	106	106%
Methane(C1)	1100	1219	111%
Ethane(C2)	1070	1085	101%
Propane(C3)	1050	1074	102%
Butane(C4)	1060	1091	103%
Pentane(C5)	1100	1123	102%
Hexane(C6)	1030	1007	98%

DATE:5/21/97
TIME:15:50/16:43

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	97	97%
Methane(C1)	1100	1129	103%
Ethane(C2)	1070	1085	101%
Propane(C3)	1050	1062	101%
Butane(C4)	1060	1072	101%
Pentane(C5)	1100	1101	100%
Hexane(C6)	1030	989	96%

% RECOVERY - PERCENT RECOVERY OF ANALTYTE(S) FROM STANDARD
ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LAB
ANALYSES PERFORMED BY : Richard Rodriguez

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

QA/QC Data Report for soil vapors for EPA methods 8015 (C1-C6)

DATE: 5/22/97
TIME: 7:44 / 8:20

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	95	95%
Methane(C1)	1100	1094	99%
Ethane(C2)	1070	1067	100%
Propane(C3)	1050	1043	99%
Butane(C4)	1060	1040	98%
Pentane(C5)	1100	1023	93%
Hexane(C6)	1030	866	84%

DATE: 5/22/97
TIME: 13:07

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	90	90%
Methane(C1)	1100	1110	101%
Ethane(C2)	1070	1071	100%
Propane(C3)	1050	1038	99%
Butane(C4)	1060	1038	98%
Pentane(C5)	1100	1048	95%
Hexane(C6)	1030	914	89%

DATE:5/22/97
TIME:16:58

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	92	92%
Methane(C1)	1100	948	86%
Ethane(C2)	1070	934	87%
Propane(C3)	1050	973	93%
Butane(C4)	1060	967	91%
Pentane(C5)	1100	1123	102%
Hexane(C6)	1030	981	95%

% RECOVERY - PERCENT RECOVERY OF ANALTYTE(S) FROM STANDARD
ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LAB
ANALYSES PERFORMED BY : Richard Rodriguez

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

QA/QC Data Report for soil vapors for EPA methods 8015 (C1-C6)

DATE: 5/23/97
TIME: 7:31 /7:36

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	87	87%
Methane(C1)	1100	1125	102%
Ethane(C2)	1070	1104	103%
Propane(C3)	1050	1079	103%
Butane(C4)	1060	1095	103%
Pentane(C5)	1100	1135	103%
Hexane(C6)	1030	1047	102%

DATE:5/23/97
TIME:11:16 / 11:39

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	100	89	89%
Methane(C1)	1100	1085	99%
Ethane(C2)	1070	1065	100%
Propane(C3)	1050	1055	100%
Butane(C4)	1060	1070	101%
Pentane(C5)	1100	1120	102%
Hexane(C6)	1030	1019	99%

% RECOVERY - PERCENT RECOVERY OF ANALTYTE(S) FROM STANDARD
ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LAB
ANALYSES PERFORMED BY : Richard Rodriguez

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

QA/QC Data Report for soil vapors for EPA methods 8015 (C1-C6)

DATE: 5/28/97
TIME: 7:35 / 8:26

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1049	102%
Methane(C1)	1100	1123	102%
Ethane(C2)	1070	1081	101%
Propane(C3)	1050	1066	102%
Butane(C4)	1060	1030	97%
Pentane(C5)	1100	1004	91%
Hexane(C6)	1030	893	87%

DATE:5/28/97
TIME: 12:41

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1102	107%
Methane(C1)	1100	1131	103%
Ethane(C2)	1070	1093	102%
Propane(C3)	1050	1072	102%
Butane(C4)	1060	1086	102%
Pentane(C5)	1100	1116	101%
Hexane(C6)	1030	1035	100%

DATE:5/28/97
TIME: 16:00

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1064	103%
Methane(C1)	1100	1120	102%
Ethane(C2)	1070	1110	104%
Propane(C3)	1050	1099	105%
Butane(C4)	1060	1117	105%
Pentane(C5)	1100	1155	105%
Hexane(C6)	1030	1059	103%

% RECOVERY - PERCENT RECOVERY OF ANALTYTE(S) FROM STANDARD
ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LAB
ANALYSES PERFORMED BY : Richard Rodriguez

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

QA/QC Data Report for soil vapors for EPA methods 8015 (C1-C6)

DATE: 5/29/97
TIME: 7:30

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1071	104%
Methane(C1)	1100	1126	102%
Ethane(C2)	1070	1114	104%
Propane(C3)	1050	1100	105%
Butane(C4)	1060	1101	104%
Pentane(C5)	1100	1118	102%
Hexane(C6)	1030	996	97%

DATE:5/29/97
TIME:12:11

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1015	99%
Methane(C1)	1100	1052	96%
Ethane(C2)	1070	1054	99%
Propane(C3)	1050	1042	99%
Butane(C4)	1060	1057	100%
Pentane(C5)	1100	1110	101%
Hexane(C6)	1030	1048	102%

DATE:5/29/97
TIME:15:57

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1038	101%
Methane(C1)	1100	1127	102%
Ethane(C2)	1070	1113	104%
Propane(C3)	1050	1095	104%
Butane(C4)	1060	1110	105%
Pentane(C5)	1100	1148	104%
Hexane(C6)	1030	1062	103%

% RECOVERY - PERCENT RECOVERY OF ANALTYTE(S) FROM STANDARD
ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LAB
ANALYSES PERFORMED BY : Richard Rodriguez

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

QA/QC Data Report for soil vapors for EPA methods 8015 (C1-C6)

DATE: 5/30/97
TIME: 7:48/8:14

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1065	103%
Methane(C1)	1100	1081	98%
Ethane(C2)	1070	1062	99%
Propane(C3)	1050	1050	100%
Butane(C4)	1060	1064	100%
Pentane(C5)	1100	1114	101%
Hexane(C6)	1030	1022	99%

DATE:5/30/97
TIME:12:51

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1032	100%
Methane(C1)	1100	1105	100%
Ethane(C2)	1070	1076	101%
Propane(C3)	1050	1048	100%
Butane(C4)	1060	1061	100%
Pentane(C5)	1100	1112	101%
Hexane(C6)	1030	1025	100%

DATE:5/30/97
TIME:16:38

COMPONENT	CONCENTRATION PPMV	RESULTS PPMV	RECOVERY %
TPH(Hexane)	1030	1080	105%
Methane(C1)	1100	1120	102%
Ethane(C2)	1070	1086	101%
Propane(C3)	1050	1066	102%
Butane(C4)	1060	1086	102%
Pentane(C5)	1100	1124	102%
Hexane(C6)	1030	1057	103%

% RECOVERY - PERCENT RECOVERY OF ANALTYTE(S) FROM STANDARD
ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LAB
ANALYSES PERFORMED BY : Richard Rodriguez

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

TEG Project #T2-970520

TRPH (EPA Method 418.1) ANALYSES OF SOILS

SAMPLE NUMBER	DATE ANALYZED	DEPTH FT	TRPH (mg/kg)
METHOD BLANK	**5/21/97**	—	**ND**
VBH-2	5/21/97	30'	ND
VBH-3	5/21/97	35'	ND
VBH-4	5/21/97	35'	ND
VBH-5	5/21/97	35'	43
METHOD BLANK	**5/22/97**	—	**ND**
VBH-8	5/22/97	20'	ND
VBH-8	5/22/97	35'	ND
VBH-9	5/22/97	5'	ND
VBH-9	5/22/97	10'	ND
VBH-9	5/22/97	25'	ND
VBH-10	5/22/97	10'	ND
VBH-10	5/22/97	20'	ND
VBH-11	5/22/97	15'	140
VBH-11	5/22/97	35'	700
METHOD BLANK	**5/23/97**	—	**ND**
VBH-12	5/23/97	20'	52
VBH-12	5/23/97	35'	200
VBH-13	5/23/97	20'	ND
VBH-13	5/23/97	35'	ND
METHOD BLANK	**5/28/97**	—	**ND**
VBH-14	5/28/97	20'	ND
VBH-14	5/28/97	35'	107
VBH-15	5/28/97	10'	ND
VBH-15	5/28/97	25'	ND
VBH-16	5/28/97	10'	ND
VBH-16	5/28/97	25'	ND
VBH-17	5/28/97	10'	ND
VBH-17	5/28/97	25'	ND
VBH-18	5/28/97	10'	ND
VBH-18	5/28/97	25'	ND

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL, TX

TEG Project #T2-970520

TRPH (EPA Method 418.1) ANALYSES OF SOILS

SAMPLE NUMBER	DATE ANALYZED	DEPTH FT	TRPH (mg/kg)
METHOD BLANK	**5/29/97**	—	**ND**
VBH-19	5/29/97	10'	ND
VBH-19	5/29/97	25'	ND
VBH-20	5/29/97	10'	ND
VBH-20	5/29/97	25'	ND
VBH-21	5/29/97	10'	ND
VBH-21	5/29/97	25'	ND
VBH-22	5/29/97	10'	ND
VBH-22	5/29/97	25'	ND
VBH-23	5/29/97	10'	ND
VBH-23	5/29/97	25'	ND
METHOD BLANK	**5/30/97**	—	**ND**
VBH-24	5/30/97	20'	ND
VBH-24	5/30/97	35'	ND
VBH-25	5/30/97	20'	ND
VBH-26	5/30/97	20'	ND
VBH-27	5/30/97	20'	ND
VBH-27	5/30/97	35'	200
VBH-28	5/30/97	10'	ND
VBH-28	5/30/97	25'	ND
DETECTION LIMITS (mg/kg,ppm)			10

"**ND**" INDICATES NOT DETECTED AT LISTED DETECTION LIMITS

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

TEG Project #T2-970520

TRPH (EPA Method 418.1) ANALYSES OF WATER

SAMPLE NUMBER	DATE ANALYZED	TPH (ug/L)
METHOD BLANK	**5/21/97**	**ND**
VBH-4	5/21/97	ND
VBH-5	5/21/97	50000
VBH-6	5/21/97	ND
METHOD BLANK	**5/22/97**	**ND**
KTAP-2	5/22/97	ND
VBH-8	5/22/97	ND
VBH-9	5/22/97	ND
VBH-10	5/22/97	ND
VBH-11	5/22/97	150000
METHOD BLANK	**5/23/97**	**ND**
VBH-12	5/23/97	22000
VBH-13	5/23/97	2000
METHOD BLANK	**5/28/97**	**ND**
VBH-14	5/28/97	12600
VBH-15	5/28/97	ND
VBH-16	5/28/97	ND
VBH-17	5/28/97	ND
VBH-18	5/28/97	ND
VCC-2	5/28/97	ND
METHOD BLANK	**5/29/97**	**ND**
VBH-19	5/29/27	ND
VBH-20	5/29/97	1500
VBH-21	5/29/97	ND
VBH-22	5/29/97	ND
VBH-23	5/29/97	ND
METHOD BLANK	**5/30/97**	**ND**
VBH-24	5/30/97	14300
VBH-25	5/30/97	ND
VBH-26	5/30/97	ND
VBH-27	5/30/97	28600
VBH-28	5/30/97	ND
DETECTION LIMITS (ug/L,ppb)		1000

"**ND**" INDICATES NOT DETECTED AT LISTED DETECTION LIMITS

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE LAB
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

BEG
PROJECT # RRC VINSON
1147 CO.RD 436 MERKEL,TX

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR SOILS
ANALYSIS DATE : 5/21/97
TEG Project #T2-970520

COMPOUND	SPK CONC (mg/kg)	MS CONC (mg/kg)	MS %REC	MSD CONC (mg/kg)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	500	517	103%	512	102%	1.0%	15%	65%-135%

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR WATERS
ANALYSIS DATE : 5/21/97
TEG Project #T2-970520

COMPOUND	SPK CONC (ug/L)	MS CONC (ug/L)	MS %REC	MSD CONC (ug/L)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	5000	5580	112%	5720	114%	2.5%	15%	65%-135%

SPK CONC - CONCENTRATION SPIKED INTO MATRIX
MS CONC - ANALYZED CONCENTRATION OF SPIKED SAMPLE
% REC - PERCENT RECOVERY OF SPIKE FROM MATRIX
RPD - RELATIVE PERCENT DIFFERENCE BETWEEN MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERIES

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR SOILS
ANALYSIS DATE : 5/22/97
TEG Project #T2-970520

COMPOUND	SPK CONC (mg/kg)	MS CONC (mg/kg)	MS %REC	MSD CONC (mg/kg)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	500	519	104%	515	103%	0.8%	15%	65%-135%

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR WATERS
ANALYSIS DATE : 5/22/97
TEG Project #T2-970520

COMPOUND	SPK CONC (ug/L)	MS CONC (ug/L)	MS %REC	MSD CONC (ug/L)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	10000	9732	97%	10018	100%	2.9%	15%	65%-135%

SPK CONC - CONCENTRATION SPIKED INTO MATRIX
MS CONC - ANALYZED CONCENTRATION OF SPIKED SAMPLE
% REC - PERCENT RECOVERY OF SPIKE FROM MATRIX
RPD - RELATIVE PERCENT DIFFERENCE BETWEEN MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERIES

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR SOILS

ANALYSIS DATE : 5/23/97
TEG Project #T2-970520

COMPOUND	SPK CONC (mg/kg)	MS CONC (mg/kg)	MS %REC	MSD CONC (mg/kg)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	500	515	103%	519	104%	0.8%	15%	65%-135%

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR WATERS

ANALYSIS DATE : 5/23/97
TEG Project #T2-970520

COMPOUND	SPK CONC (ug/L)	MS CONC (ug/L)	MS %REC	MSD CONC (ug/L)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	10000	9730	97%	9400	94%	3.5%	15%	65%-135%

SPK CONC - CONCENTRATION SPIKED INTO MATRIX
MS CONC - ANALYZED CONCENTRATION OF SPIKED SAMPLE
% REC - PERCENT RECOVERY OF SPIKE FROM MATRIX
RPD - RELATIVE PERCENT DIFFERENCE BETWEEN MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERIES

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

BEG
PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR SOILS
ANALYSIS DATE : 5/28/97
TEG Project #T2-970520

COMPOUND	SPK CONC (mg/kg)	MS CONC (mg/kg)	MS %REC	MSD CONC (mg/kg)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	500	522	104%	526	105%	0.8%	15%	65%-135%

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR WATERS
ANALYSIS DATE : 5/28/97
TEG Project #T2-970520

COMPOUND	SPK CONC (ug/L)	MS CONC (ug/L)	MS %REC	MSD CONC (ug/L)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	10000	10000	100%	9700	97%	3.0%	15%	65%-135%

SPK CONC - CONCENTRATION SPIKED INTO MATRIX
MS CONC - ANALYZED CONCENTRATION OF SPIKED SAMPLE
% REC - PERCENT RECOVERY OF SPIKE FROM MATRIX
RPD - RELATIVE PERCENT DIFFERENCE BETWEEN MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERIES

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR SOILS
ANALYSIS DATE : 5/29/97
TEG Project #T2-970520

COMPOUND	SPK CONC (mg/kg)	MS CONC (mg/kg)	MS %REC	MSD CONC (mg/kg)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	500	447	89%	452	90%	1.1%	15%	65%-135%

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR WATERS
ANALYSIS DATE : 5/29/97
TEG Project #T2-970520

COMPOUND	SPK CONC (ug/L)	MS CONC (ug/L)	MS %REC	MSD CONC (ug/L)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	10000	10200	102%	9600	96%	6.1%	15%	65%-135%

SPK CONC - CONCENTRATION SPIKED INTO MATRIX
MS CONC - ANALYZED CONCENTRATION OF SPIKED SAMPLE
% REC - PERCENT RECOVERY OF SPIKE FROM MATRIX
RPD - RELATIVE PERCENT DIFFERENCE BETWEEN MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERIES

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

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PROJECT # RRC VINSON
1147 CO RD 436 MERKEL,TX

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR SOILS
ANALYSIS DATE : 5/30/97
TEG Project #T2-970520

COMPOUND	SPK CONC (mg/kg)	MS CONC (mg/kg)	MS %REC	MSD CONC (mg/kg)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	500	513	103%	503	101%	2.0%	15%	65%-135%

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD) FOR WATERS
ANALYSIS DATE : 5/30/97
TEG Project #T2-970520

COMPOUND	SPK CONC (ug/L)	MS CONC (ug/L)	MS %REC	MSD CONC (ug/L)	MSD %REC	RPD %	ACCEPTABLE RPD	ACCEPTABLE %RECOVERY
TRPH	10000	10180	102%	10300	103%	1.2%	15%	65%-135%

SPK CONC - CONCENTRATION SPIKED INTO MATRIX
MS CONC - ANALYZED CONCENTRATION OF SPIKED SAMPLE
% REC - PERCENT RECOVERY OF SPIKE FROM MATRIX
RPD - RELATIVE PERCENT DIFFERENCE BETWEEN MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERIES

ANALYSES PERFORMED ON-SITE IN TEG-TEXAS' MOBILE ENVIRONMENTAL LABORATORY
ANALYSES PERFORMED BY: RICHARD RODRIGUEZ

Transglobal Environmental Geochemistry

CHAIN-OF-CUSTODY RECORD

P.O.#

CLIENT: BUREAU OF ECONOMIC GEOLOGY (BEG.	DATE: 5/20/97 — PAGE 1 OF
ADDRESS: UNIVERSITY STATION, BOX X AUSTIN, TX 78713-8924	TEG PROJECT #: T2-970520
PHONE: (512) 471-0232 — FAX: (512) 471 0140	LOCATION: VINSON PROPERTY.
CLIENT PROJECT #: — PROJECT MANAGER: REBECCA C. SMYTH.	COLLECTOR: (BEG). UNIV. OF TEXAS — DATE OF COLLECTION: 5/20/97

ANALYSES

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015(gasoline)	TPH 8015(diesel)	TPH 8015(g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	8015 VAP						FIELD NOTES	Total No. of Containers	Laboratory Note No.
BLANK	—	1648	VAP.	5 cc syn.														✓	✓								
VBH-2	10'	1830	〃	〃 〃														✓	✓								

RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME
Rebecca C Smyth	5/20/97		5/20/97 1630
RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME

SAMPLE RECEIPT

Total No. of Containers	
Seals Intact? Y/N/NA	
Received Good Cond./Cold	
Notes:	

Laboratory Notes:

SAMPLE DISPOSAL INSTRUCTIONS

TEG DISPOSAL/$2.00@ **RETURN** **PICKUP**

Transglobal Environmental Geochemistry

CHAIN-OF-CUSTODY RECORD

P.O.#

CLIENT: BEG

DATE: 5/21/97

PAGE 1 OF

ADDRESS: UNIVERSITY STATION, BOX X AUSTIN, TX 78713-8924

TEG PROJECT #: 72-970520

PHONE: (512) 471-0232

FAX: (512) 471-0140

LOCATION: VINSON PROPERTY

CLIENT PROJECT #:

PROJECT MANAGER: Rebecca C. Smyth.

COLLECTOR: (BEG) UNIV. OF TEXAS BEG.

DATE OF COLLECTION: 5/21/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	8015 VAP	FIELD NOTES	Total No. of Containers	Laboratory Note No.
BLANK	—	8:40	VAPOR	6CC SYR														✓	✓			
VBH-2	30'	8:40	SOIL	2OZ JAR					✓									✓				
VBH-3	10'	930	VAPOR	5CC SYR														✓	✓			
VBH-3	35'	930	SOIL	2OZ JAR					✓													
VBH-4	35'	1050	SOIL	〃 〃					✓													
VDH-4	10'	1050	VAPOR	6CC SYR														✓	✓			
BLANK	—	1240	〃	5CC SYR.														✓	✓			
VDH-5	10'	1325	〃	5CC SYR														✓	✓			
VBH-5	35'	1330	SOIL	2OZ JAR					✓													
VDH-5	—	1340	WATER	40ml VOA														✓	✓			
VBH-4	—	1500	〃	〃 〃					✓									[illegible]				
~~VDH~~ RR BLANK	—	1500	VAPOR	6CC SYR														✓	✓			
VDH-6	10'	1520	VAPOR	6CC SYR														✓	✓			
VDH-6	25'	1520	SOIL	2OZ JAR					✓													

RELINQUISHED BY (*Signature*) Rebecca C. Smyth DATE/TIME 5/21/97

RECEIVED BY (SIGNATURE) DATE/TIME 5/21/97 1520

RELINQUISHED BY (*Signature*) DATE/TIME

RECEIVED BY (SIGNATURE) DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

TEG DISPOSAL/$2.00@ **RETURN** **PICKUP**

SAMPLE RECEIPT

Total No. of Containers

Seals Intact? Y/N/NA

Received Good Cond./Cold

Notes:

Laboratory Notes:

MMP 11/95

Transglobal Environmental Geochemistry

CHAIN-OF-CUSTODY RECORD

P.O.# ______________

CLIENT: BEG	DATE: 5/22/97 PAGE 2 OF
ADDRESS: UNIVERSITY STATION, BOX X AUSTIN, TX 78713-8924	TEG PROJECT #: T2-970520
PHONE: (512) 471-0232 FAX: (512) 471 0140	LOCATION: VINSON PROPERTY 1142 436 CO. Rd.
CLIENT PROJECT #: PROJECT MANAGER:	COLLECTOR: BEG DATE OF COLLECTION: 5/22/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015(gasoline)	TPH 8015(diesel)	TPH 8015(g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	•8015-vapor.	FIELD NOTES	Total No. of Containers	Laboratory Note No.
BLANK	—	8:30	VAPOR	5CC SYR														✓	✓			
VDH-7	10'	9:00	"	" "														✓	✓			
KTAP-2	—	10:0	WATER	40 ml VOA					✓													
VBH-8	10'	1030	VAPOR	5CC SYR														✓	✓			
VBH-8	20'	1045	SOIL	2 OZ JAR					✓													
VDH-8	35'	1045	"	" "					✓													
VBH-9	5'	1115	"	" "					✓													
VDH-9	10'	1115	"	" "					✓													
BLANK	—	1130	VAP	5CC SYR														✓	✓			
VDH-8	–	1125	WATER	40 ml VOA					✓													
VDH-9	3'	1155	VAP	5CC SYR														✓	✓			
VPH-9	—	1300	WATER	40ml VOA					✓													
VBH-9	25'	1330	SOIL	2OZ JAR					✓													
BLANK	—	1350	VAPOR	5CC SYR														✓	✓			
VBH-10	10'	1415	SOIL	2OZ JAR					✓													
VDH-10	25'	1415	SOIL	" "					✓													
VDH-10	2'	1415	VAP	5CC SYR.														✓	✓			

RELINQUISHED BY (*Signature*)	DATE/TIME	RECEIVED BY (SIGNATURE)	1415 5/22/97 DATE/TIME
RELINQUISHED BY (*Signature*)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

☐ TEG DISPOSAL/$2.00@ ☐ RETURN ☐ PICKUP

SAMPLE RECEIPT

Total No. of Containers	
Seals Intact? Y/N/NA	
Received Good Cond./Cold	
Notes:	

Laboratory Notes:

Transglobal Environmental Geochemistry
CHAIN-OF-CUSTODY RECORD

teg

P.O.# ____________

CLIENT: BEG

DATE: 5/22/97

PAGE 2 OF

ADDRESS: UNIVERSITY STATION, BOX X AUSTIN 78713-8924

TEG PROJECT #: T2-9705 20

PHONE: (512) 471 0232

FAX: (512) 471-0140

LOCATION: VINSON PROPERTY

CLIENT PROJECT #:

PROJECT MANAGER: Rebecca C Smyth.

COLLECTOR: BEG

DATE OF COLLECTION: 5/22/97.

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	8015 VAP.						FIELD NOTES	Total No. of Containers	Laboratory Note No.
VDH-10	-	1410	H_2O	40ml VOA					✓																		
BLANK	—	1330	vapor	5cc SYR														✓	✓								
VBH-11	10'	1600	vapor	5cc SYR														✓	✓								
VDH-11	15'	1600	soil	2oz JAR					✓																		
VBH-11	35'	1600	〃	〃 〃					✓																		
VDH-11	—	1605	H_2O	40ml VOA					✓																		

RELINQUISHED BY (Signature) Rebecca C. Smyth DATE/TIME 5/22/97 1605 RECEIVED BY (SIGNATURE) DATE/TIME 5/22/97 1605

RELINQUISHED BY (Signature) DATE/TIME RECEIVED BY (SIGNATURE) DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

TEG DISPOSAL/$2.00@ RETURN ☐ PICKUP

SAMPLE RECEIPT

Total No. of Containers

Seals Intact? Y/N/NA

Received Good Cond./Cold

Notes:

Laboratory Notes:

MMP 11/95

Transglobal Environmental Geochemistry
CHAIN-OF-CUSTODY RECORD

P.O.#

CLIENT: BEG

DATE: 5/23/97

PAGE 1 OF

ADDRESS: UNIVERSITY STATION, BOX X AUSTIN 78713-8924

TEG PROJECT #: T2-970520

PHONE: (512) 471-0232

FAX: (512) 471-0140

LOCATION: VINSON PROPERTY

CLIENT PROJECT #:

PROJECT MANAGER: Rebbeca. C Smyth.

COLLECTOR: BEG

DATE OF COLLECTION: 5/23/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	2015 VAP	FIELD NOTES	Total No. of Containers	Laboratory Note No.
BLANK	—	8:35	VAP	5cc SYR														✓	✓			
VBH-12	20'	855	soil	2oz JAR					✓													
VDH-12	35	855	〃	〃					✓													
VDH-12	10'	9:05	VAP	5cc SYR														✓	✓			
VDH-12	–	925	H2O	40mL VOA					✓													
BLANK	—	1010	VAP	5cc SYR														✓	✓			
VBH-13	8'	1050	〃	〃														✓	✓			
VBH-13	20'	1100	soil	2oz JAR					✓													
VDH-13	35	1100	〃	〃 〃					✓													
VDH-13	—	1105	H2O	40ml VOA					✓													

RELINQUISHED BY (Signature) Rebecca C. Smyth	DATE/TIME 5/23/97 1105	RECEIVED BY (SIGNATURE)	DATE/TIME 5/23/97 11:05
RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

☐ TEG DISPOSAL/$2.00@ ☐ RETURN ☐ PICKUP

SAMPLE RECEIPT

Total No. of Containers	
Seals Intact? Y/N/NA	
Received Good Cond./Cold	
Notes:	

Laboratory Notes:

Transglobal Environmental Geochemistry

CHAIN-OF-CUSTODY RECORD

P.O.#

CLIENT: BEG
DATE: 5/28/97
PAGE 1 OF
ADDRESS: UNIVERSITY STATION, BOX X AUSTIN, TX 78713-8924
TEG PROJECT #: T2-970520
PHONE: (512) 471-0232
FAX: (512) 471-0140
LOCATION: VINSON PROPERTY
CLIENT PROJECT #:
PROJECT MANAGER: REBECCA SMYTH.
COLLECTOR: BEG
DATE OF COLLECTION: 5/28/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015(gasoline)	TPH 8015(diesel)	TPH 8015(g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	8015 VAPOR	FIELD NOTES	Total No. of Containers	Laboratory Note No.
BLANK	—	730	VAPOR	5CC SYR.														✓	✓			
VDH-14	10'	1035	VAPOR	〃 〃														✓	✓			
VDH-14	20'	1035	SOIL	2OZ JAR					✓													
VDH-14	35'	1035	SOIL	〃					✓													
VBH-14	—	1015	H2O	40ML VOA					✓													
BLANK	—	1150	VAP	5CC SYR														✓	✓			
VDH-15	8'	1230	VAP.	〃														✓	✓			
VDH-15	10'	1230	SOIL	2OZ JAR					✓													
VBH-15	26'	1230	SOIL	2OZ JAR					✓													
VBH-15	—	1315	H2O	40ML VOA					✓													
VBH-16	—	1415	H2O	〃 〃					✓													
VBH-16	10'	1415	SOIL	2OZ JAR					✓													
VBH-16	25'	1415	SOIL	〃 〃					✓													
VBH-16	—	1415	VAPOR	5CC SYR														✓	✓			
VBH-17	8'	1520	〃	〃														✓	✓			
VBH-17	10'	1520	SOIL	2OZ JAR					✓													
VBH-17	25'	1520	SOIL	〃					✓													

RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME
Rebecca C. Smyth	5/28/97 1520		5/28/97 1520

RELINQUISHED BY (Signature) DATE/TIME RECEIVED BY (SIGNATURE) DATE/TIME

SAMPLE RECEIPT

Total No. of Containers
Seals Intact? Y/N/NA
Received Good Cond./Cold
Notes:

Laboratory Notes:

SAMPLE DISPOSAL INSTRUCTIONS

☐ TEG DISPOSAL/$2.00@ ☐ RETURN ☐ PICKUP

Transglobal Environmental Geochemistry
CHAIN-OF-CUSTODY RECORD

P.O.#

CLIENT: BEG

DATE: 5/28/97

PAGE 2 OF

ADDRESS: UNIVERSITY STATION, BOX X AUSTIN, TX 78713-8924

TEG PROJECT #: TX-970520

PHONE: (512) 471-0232

FAX: (512) 471-0140

LOCATION: VINSON PROPERTY

CLIENT PROJECT #:

PROJECT MANAGER: REBBECA SMYTH

COLLECTOR: BEG

DATE OF COLLECTION: 5/28/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	2015 V.						FIELD NOTES	Total No. of Containers	Laboratory Note No.
VBH-17	—	1530	H_2O	40mL VOA					✓																		
VBH-18	10'	1640	soil	2 OZ JAR					✓																		
VBH-18	25'	1640	〃	〃					✓																		
VBH-18	—	1640	H_2O	40mL VOA					✓																		
VBH-RR18	—	1640	VAPOR	5cc SYR.														✓	✓								
VCC-2	—	1640	H_2O	40mL VOA					✓																		

RELINQUISHED BY (Signature): Rebecca C. Smyth

DATE/TIME: 5/28/97 1640

RECEIVED BY (SIGNATURE):

DATE/TIME: 5/28/97 1640

RELINQUISHED BY (Signature):

DATE/TIME:

RECEIVED BY (SIGNATURE):

DATE/TIME:

SAMPLE DISPOSAL INSTRUCTIONS

☐ TEG DISPOSAL/$2.00@ ☐ RETURN ☐ PICKUP

SAMPLE RECEIPT

Total No. of Containers	
Seals Intact? Y/N/NA	
Received Good Cond./Cold	
Notes:	

Laboratory Notes:

Transglobal Environmental Geochemistry
CHAIN-OF-CUSTODY RECORD

P.O.#

CLIENT: BEG.	DATE: 5/29/97 PAGE 1 OF
ADDRESS: UNIVERSITY STATION BOX X AUSTIN, TX 78713-8924	TEG PROJECT #: T2-970520
PHONE: (512) 471-0232 FAX: (512) 471-0140	LOCATION: VINSON PROPERTY
CLIENT PROJECT #: PROJECT MANAGER: Rebecca C Smyth	COLLECTOR: BEG. DATE OF COLLECTION: 5/29/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	8015V						FIELD NOTES	Total No. of Containers	Laboratory Note No.
BLANK	—	330	VAPOR	5CC SYR.														✓	✓								
VBH-19	6'	9:00	VAPOR	5CC SYR														✓	✓								
VDH-19	10'	9:00	SOIL	2OZ JAR					✓																		
VDH-19	25'	9:00	″	″					✓																		
VDH-19	–	900	H2O	40ML VOA					✓																		
VDH-20	10'	1005	VAP	5CC SYR														✓	✓								
VDH-20	10'	1005	SOILS	2OZ JAR					✓																		
VBH-20	25'	1005	SOILS	″ ″					✓																		
VDH.20	–	1010	H2O	40ML VOA					✓																		
BLANK	—	1105	VAP	5CC SYR														✓	✓								
VDH-21	10'	1130	″	″ ″														✓	✓								
VDH-21	10'	1130	SOIL	2OZ JAR					✓																		
VDH-21	25'	1130	″	″ ″					✓																		
VDH-21	—	1240	H2O	40ML VOA					✓																		
BLANK		1255	VAP	5CC SYR														✓	✓								
VBH-22	10'	1410	VAP	5CC SYR														✓	✓								
VDH-22	10'	1410	SOILS	2OZ JAR					✓																		

RELINQUISHED BY (Signature) Rebecca C. Smyth	DATE/TIME 5/29/97 1410	RECEIVED BY (SIGNATURE)	DATE/TIME 5/29/97 1410
RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

☐ TEG DISPOSAL/$2.00@ ☐ RETURN ☐ PICKUP

SAMPLE RECEIPT

Total No. of Containers	
Seals Intact? Y/N/NA	
Received Good Cond./Cold	
Notes:	

Laboratory Notes:

MMP 11/95

Transglobal Environmental Geochemistry

CHAIN-OF-CUSTODY RECORD

P.O.# ____________

CLIENT: BEG.
DATE: 5/29/97
PAGE 2 OF

ADDRESS: UNIVERSITY STATION BOX X AUSTIN, TX 78713 8924
TEG PROJECT #: T2-970520

PHONE: (512) 4710232
FAX: (512) 471-0140
LOCATION: VINSON PROPERTY

CLIENT PROJECT #:
PROJECT MANAGER: Rebecca C Smyth.
COLLECTOR: BEG
DATE OF COLLECTION: 5/29/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	8015 VAP.	FIELD NOTES	Total No. of Containers	Laboratory Note No.
VBA-22	25'	1410	SOIL	2OZ JAR					✓													
BLANK	—	1455	VAP	5cc SYR.														✓	✓			
VBH-23	10'	1540	VAP	6cc SYR														✓	✓			
VBH-23	10'	1540 ~~SOIL~~	SOIL	2OZ JAR					✓													
VBA-23	25'	1520	SOIL	〃					✓													
VBH-22	—	1630	H2O	40ML VOA					✓													
VBA-23	—	1630	〃	〃					✓													

RELINQUISHED BY (Signature): Rebecca C. Smyth
DATE/TIME: 5/29/97 1630
RECEIVED BY (SIGNATURE):
DATE/TIME: 5/29/97 1630

RELINQUISHED BY (Signature):
DATE/TIME:
RECEIVED BY (SIGNATURE):
DATE/TIME:

SAMPLE DISPOSAL INSTRUCTIONS

☐ TEG DISPOSAL/$2.00@ ☐ RETURN ☐ PICKUP

SAMPLE RECEIPT

Total No. of Containers
Seals Intact? Y/N/NA
Received Good Cond./Cold
Notes:

Laboratory Notes:

Transglobal Environmental Geochemistry

CHAIN-OF-CUSTODY RECORD

P.O.#

CLIENT: BEG		DATE: 5/30/97	PAGE 1 OF
ADDRESS: UNIVERSIT STATION BOX X AUSTIN, TX 787133924		TEG PROJECT #: T2-970520	
PHONE: (512) 4710232	FAX: (512) 471-0140	LOCATION: VINSON PROPERTY	
CLIENT PROJECT #:	PROJECT MANAGER: Rbbeca C. Smyth	COLLECTOR: BEG	DATE OF COLLECTION: 5/30/97

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	2015 VAP.	FIELD NOTES	Total No. of Containers	Laboratory Note No.
BLANK	—	925	VAP	5CC SYR														✓	✓			
VDH-24	10'	9:15	11	11														✓	✓			
VDH-24	20'	915	SOIL	2OZ JAR					✓													
VDH-24	35'	915	11	11					✓													
VDH-24	—	930	H_2O	40ml VOA					✓													
BLANK	—	10:00	VAP	5CC SYR														✓	✓			
VDH-25	10'	1035	11	11														✓	✓			
VDH-25	20'	1035	SOIL	4OZ JAR					✓													
VDH-25	—	1130	H_2O	40ml VOA					✓													
VDH-26	10'	11:50	VAP	5CC SYR														✓	✓			
VDH-26	20'	1155	SOIL	4OZ JAR					✓													
VDH-26	—	1220	H_2O	40ml VOA					✓													
VDH-27	20'	1355	SOIL	4OZ JAR					✓													
VDH-27	35'	1410	11	11					✓													
VDH-27	12'	1410	VAPOR	5CC SYR														✓	✓			
VDH-27	—	1420	H_2O	40ml VOA					✓													
BLANK	—	1530	VAP	5CC SYR														✓	✓			

RELINQUISHED BY (Signature) Rebecca C Smyth	DATE/TIME 5/30/97 1530	RECEIVED BY (SIGNATURE)	DATE/TIME 5/30/97 1530
RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME

SAMPLE RECEIPT

Total No. of Containers	
Seals Intact? Y/N/NA	
Received Good Cond./Cold	
Notes:	

Laboratory Notes:

SAMPLE DISPOSAL INSTRUCTIONS

TEG DISPOSAL/$2.00@ RETURN PICKUP

teg

Transglobal Environmental Geochemistry
CHAIN-OF-CUSTODY RECORD

P.O.# ____________

CLIENT: BEG

DATE: 5/30/97

PAGE 2 OF

ADDRESS: UNIVERSITY STATION BOX X AUSTIN, TX 787138924

TEG PROJECT #: T2-970520

PHONE: (512) 4710232

FAX: (512) 4710140

LOCATION: VINSON PROPERTY

CLIENT PROJECT #:

PROJECT MANAGER:

COLLECTOR: BEG

DATE OF COLLECTION: 5/30/97

ANALYSES

Sample Number	Depth	Time	Sample Type	Container Type	VOA 601/8010	VOA 602/8020	MTBE	Methane	TPH 418.1	TPH 8015(gasoline)	TPH 8015(diesel)	TPH 8015(g & d)	PNA 610/8100	PEST/PCBs 8080	Oxygen	Nitrogen	Carbon Dioxide	C1-C6	8015 VAP						FIELD NOTES	Total No. of Containers	Laboratory Note No.
VDH-28	10'	1610	SOIL	4OZ JAR					✓																		
VDH-28	25'	1610	SOIL	4OZ JAR					✓																		
VBH-28	7'	1610	VAP.	5CC SYR														/	/								
VDH-28	—	1640	H_2O	40ML VOA					✓																		

RELINQUISHED BY (*Signature*)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME
Rebecca C. Smyth	5/30/97 1640		5/30/97 1646

RELINQUISHED BY (*Signature*)	DATE/TIME	RECEIVED BY (SIGNATURE)	DATE/TIME

SAMPLE RECEIPT

Total No. of Containers	
Seals Intact? Y/N/NA	
Received Good Cond./Cold	
Notes:	

Laboratory Notes:

SAMPLE DISPOSAL INSTRUCTIONS

☐ **TEG DISPOSAL/$2.00@** ☐ **RETURN** ☐ **PICKUP**

MMP 11/95

ChemSOLVE - July 1997
Organic (BTEX and PAH) analyses of ground water and KTAP-3.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27863

Project: RRC-Vinson
Sample: 6003 (VWW-A) **Matrix:** water
Date/Time Taken: 7/17/97 17:21 **Date/Time Rec'd:** 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By
1-methylnaphthalene	<2	µg/L	2	8310	7/31/97	8:16	KLM
Acenaphthene	<2	µg/L	2	8310	7/31/97	8:16	KLM
Acenaphthylene	<2	µg/L	2	8310	7/31/97	8:16	KLM
Anthracene	11	µg/L	1	8310	7/31/97	8:16	KLM
Benz(a)anthracene	<0.2	µg/L	0.2	8310	7/31/97	8:16	KLM
Benzo(a)pyrene	<0.02	µg/L	0.02	8310	7/31/97	8:16	KLM
Benzo(b)fluoranthene	<0.02	µg/L	0.02	8310	7/31/97	8:16	KLM
Benzo(ghi)perylene	<0.02	µg/L	0.02	8310	7/31/97	8:16	KLM
Benzo(k,j)fluoranthene	<0.02	µg/L	0.02	8310	7/31/97	8:16	KLM
Chrysene	<0.2	µg/L	0.2	8310	7/31/97	8:16	KLM
Dibenz(a,h)anthracene	<0.02	µg/L	0.02	8310	7/31/97	8:16	KLM
Fluoranthene	12	µg/L	0.4	8310	7/31/97	8:16	KLM
Fluorene	<1	µg/L	1	8310	7/31/97	8:16	KLM
Indeno(1,2,3-cd)pyrene	<0.04	µg/L	0.04	8310	7/31/97	8:16	KLM
Naphthalene	<2	µg/L	2	8310	7/31/97	8:16	KLM
Phenanthrene	9.5	µg/L	1	8310	7/31/97	8:16	KLM
Pyrene	14	µg/L	0.4	8310	7/31/97	8:16	KLM

Respectfully submitted,

Mark C. Krause

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

Project: RRC-Vinson **Report #:** 27863
Sample: 6003 (VWW-A)

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Terphenyl-d14	8310	36	33-141

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27864

Project: RRC-Vinson
Sample: 6004 (VWW-A)
Matrix: water
Date/Time Taken: 7/17/97 17:24
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By
Benzene	<1	µg/L	1	8020	7/31/97	16:19	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	16:19	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	16:19	KLM
MTBE	<10	µg/L	10	8020	7/31/97	16:19	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	16:19	KLM
Toluene	<1	µg/L	1	8020	7/31/97	16:19	KLM

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Fluorobenzene	8260	92	67-128
Bromofluorobenzene	8260	93	70-130

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27865

Project: RRC-Vinson
Sample: 6005 (VWW-A)
Matrix: water
Date/Time Taken: 7/17/97 18:02
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By
Benzene	<1	µg/L	1	8020	7/31/97	16:36	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	16:36	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	16:36	KLM
MTBE	<10	µg/L	10	8020	7/31/97	16:36	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	16:36	KLM
Toluene	<1	µg/L	1	8020	7/31/97	16:36	KLM

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Fluorobenzene	8260	97	67-128
Bromofluorobenzene	8260	106	70-130

Respectfully submitted,

Mark C. Krause

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27866

Project: RRC-Vinson
Sample: 6008 (VWW-E) **Matrix:** water
Date/Time Taken: 7/17/97 17:20 **Date/Time Rec'd:** 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By
Benzene	<1	µg/L	1	8020	7/31/97	16:52	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	16:52	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	16:52	KLM
MTBE	<10	µg/L	10	8020	7/31/97	16:52	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	16:52	KLM
Toluene	<1	µg/L	1	8020	7/31/97	16:52	KLM

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Fluorobenzene	8260	92	67-128
Bromofluorobenzene	8260	92	70-130

Respectfully submitted,

Mark C. Krause

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27867

Project: RRC-Vinson
Sample: 6012 (VWW-D) **Matrix:** water
Date/Time Taken: 7/18/97 09:55 **Date/Time Rec'd:** 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By
Benzene	<1	µg/L	1	8020	7/31/97	17:07	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	17:07	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	17:07	KLM
MTBE	<10	µg/L	10	8020	7/31/97	17:07	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	17:07	KLM
Toluene	<1	µg/L	1	8020	7/31/97	17:07	KLM

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Fluorobenzene	8260	93	67-128
Bromofluorobenzene	8260	93	70-130

Respectfully submitted,

Mark C. Krause

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27868

Project: RRC-Vinson
Sample: 6015 (VWW-C)
Matrix: water
Date/Time Taken: 7/18/97 11:45
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By
Benzene	<1	µg/L	1	8020	7/31/97	17:24	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	17:24	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	17:24	KLM
MTBE	<10	µg/L	10	8020	7/31/97	17:24	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	17:24	KLM
Toluene	<1	µg/L	1	8020	7/31/97	17:24	KLM

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Fluorobenzene	8260	93	67-128
Bromofluorobenzene	8260	99	70-130

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27869

Project: RRC-Vinson
Sample: 6018 (VWW-B)
Matrix: water
Date/Time Taken: 7/18/97 13:40
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By
1-methylnaphthalene	<2	µg/L	2	8310	7/30/97	17:25	KLM
Acenaphthene	<2	µg/L	2	8310	7/30/97	17:25	KLM
Acenaphthylene	<2	µg/L	2	8310	7/30/97	17:25	KLM
Anthracene	<1	µg/L	1	8310	7/30/97	17:25	KLM
Benz(a)anthracene	<0.2	µg/L	0.2	8310	7/30/97	17:25	KLM
Benzo(a)pyrene	<0.02	µg/L	0.02	8310	7/30/97	17:25	KLM
Benzo(b)fluoranthene	<0.02	µg/L	0.02	8310	7/30/97	17:25	KLM
Benzo(ghi)perylene	<0.02	µg/L	0.02	8310	7/30/97	17:25	KLM
Benzo(k,j)fluoranthene	<0.02	µg/L	0.02	8310	7/30/97	17:25	KLM
Chrysene	<0.2	µg/L	0.2	8310	7/30/97	17:25	KLM
Dibenz(a,h)anthracene	<0.02	µg/L	0.02	8310	7/30/97	17:25	KLM
Fluoranthene	<0.4	µg/L	0.4	8310	7/30/97	17:25	KLM
Fluorene	<1	µg/L	1	8310	7/30/97	17:25	KLM
Indeno(1,2,3-cd)pyrene	<0.04	µg/L	0.04	8310	7/30/97	17:25	KLM
Naphthalene	<2	µg/L	2	8310	7/30/97	17:25	KLM
Phenanthrene	<1	µg/L	1	8310	7/30/97	17:25	KLM
Pyrene	<0.4	µg/L	0.4	8310	7/30/97	17:25	KLM

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

Project: RRC-Vinson **Report #:** 27869
Sample: 6018 (VWW-B)

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Terphenyl-d14	8310	49	33-141

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

141

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27870

Project: RRC-Vinson
Sample: 6019 (VWW-B)
Matrix: water
Date/Time Taken: 7/18/97 13:41
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	**Result**	**Units**	**PQL**	**Method**	**Date/Time Run**		**By**
Benzene	<1	µg/L	1	8020	7/31/97	17:40	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	17:40	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	17:40	KLM
MTBE	<10	µg/L	10	8020	7/31/97	17:40	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	17:40	KLM
Toluene	<1	µg/L	1	8020	7/31/97	17:40	KLM

Quality Assurance Data

Surrogate	**Method**	**Recovery**	**Limits**
Fluorobenzene	8260	95	67-128
Bromofluorobenzene	8260	102	70-130

Respectfully submitted,

Mark C. Krause

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27871

Project: RRC-Vinson
Sample: 6021 (WW-3)
Matrix: water
Date/Time Taken: 7/18/97 17:30
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By
Benzene	<1	µg/L	1	8020	7/31/97	17:56	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	17:56	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	17:56	KLM
MTBE	<10	µg/L	10	8020	7/31/97	17:56	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	17:56	KLM
Toluene	<1	µg/L	1	8020	7/31/97	17:56	KLM

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Fluorobenzene	8260	95	67-128
Bromofluorobenzene	8260	103	70-130

Respectfully submitted,

Mark C. Krause

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27872

Project: RRC-Vinson
Sample: 6026 (KTAP-3)
Matrix: water
Date/Time Taken: 7/18/97 18:30
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By
Benzene	<1	µg/L	1	8020	7/31/97	18:12	KLM
Ethylbenzene	<1	µg/L	1	8020	7/31/97	18:12	KLM
m,p-Xylenes	<1	µg/L	1	8020	7/31/97	18:12	KLM
MTBE	<10	µg/L	10	8020	7/31/97	18:12	KLM
o-Xylene	<1	µg/L	1	8020	7/31/97	18:12	KLM
Toluene	<1	µg/L	1	8020	7/31/97	18:12	KLM

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Fluorobenzene	8260	95	67-128
Bromofluorobenzene	8260	101	70-130

Respectfully submitted,

Mark C. Krause

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 27873

Project: RRC-Vinson
Sample: 6027 (KTAP-3)
Matrix: water
Date/Time Taken: 7/18/97 18:20
Date/Time Rec'd: 7/21/97 14:00

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By
1-methylnaphthalene	<2	µg/L	2	8310	7/30/97	16:56	KLM
Acenaphthene	<2	µg/L	2	8310	7/30/97	16:56	KLM
Acenaphthylene	<2	µg/L	2	8310	7/30/97	16:56	KLM
Anthracene	<1	µg/L	1	8310	7/30/97	16:56	KLM
Benz(a)anthracene	<0.2	µg/L	0.2	8310	7/30/97	16:56	KLM
Benzo(a)pyrene	<0.02	µg/L	0.02	8310	7/30/97	16:56	KLM
Benzo(b)fluoranthene	<0.02	µg/L	0.02	8310	7/30/97	16:56	KLM
Benzo(ghi)perylene	<0.02	µg/L	0.02	8310	7/30/97	16:56	KLM
Benzo(k,j)fluoranthene	<0.02	µg/L	0.02	8310	7/30/97	16:56	KLM
Chrysene	<0.2	µg/L	0.2	8310	7/30/97	16:56	KLM
Dibenz(a,h)anthracene	<0.02	µg/L	0.02	8310	7/30/97	16:56	KLM
Fluoranthene	<0.4	µg/L	0.4	8310	7/30/97	16:56	KLM
Fluorene	<1	µg/L	1	8310	7/30/97	16:56	KLM
Indeno(1,2,3-cd)pyrene	<0.04	µg/L	0.04	8310	7/30/97	16:56	KLM
Naphthalene	<2	µg/L	2	8310	7/30/97	16:56	KLM
Phenanthrene	<1	µg/L	1	8310	7/30/97	16:56	KLM
Pyrene	<0.4	µg/L	0.4	8310	7/30/97	16:56	KLM

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Monday, August 4, 1997

Project: RRC-Vinson
Sample: 6027 (KTAP-3)

Report #: 27873

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Terphenyl-d14	8310	36	33-141

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

to chemsolve

ChemSOLVE
11629 Manchaca Road
Austin, Texas 78748
Phone: 512-280-7680 FAX: 512-280-7651
Email: Chemsolve@aol.com
WWW: http://www.eden.com/~chemsolv/

REPORT TO:	BILL TO:
CONTACT JERI SULLIVAN	
COMPANY BEG UT AUSTIN	
ADDRESS	
PHONE 471 6285 FAX 471-0140	

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD Page ____ of ____

Project Name: ~~RRC - Vernon Briggs~~

Project No.: RRC - Vinson

Turnaround: ASAP

Analytical Request:

Sample ID	Date	Time	No. of Cont.	Matrix	PAH (8310)	BTEX (8020)		Lab Number	Comments
VWW-A	7-17-97	1721	1	H_2O	x		✓27863	6003	
VWW-A	7-17-97	1724	2	"		x	✓27864	6004	HB
VWW-A	7-17-97	1802	2	"		x	✓27865	6005	GF
VWW-E	7-17-97	1720	2	"		x	✓27866	6008	
VWW-D	7-18-97	0955	2	"		x	✓27867	6012	
VWW-C	7-18-97	1145	2	"		x	✓27868	6015	
VWW-B	7-18-97	1340	1	"	x		✓27869	6018 [redacted]	
VWW-B	7-18-97	1341	2	"		x	✓27870	6019 *	
WW-3	7-18-97	1730	2	"		x	✓27871	6021	
KTAP3	7-18-97	1830	2	"		x	✓27872	6026	
KTAP3	7-18-97	1820	2	"	x		✓27873	6027	

Relinquished By	Date	Time	Received By	Carrier	Date	Time
			Angie O'Donnell Rec'd 4°C	Courier	7/21/97	14:00

↓ * one voa had headspace

Railroad Commission (RRC) - July 1997
Cation and anion analyses of ground water

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3915E RRC Custody Tag No.

Sample Identification: Vinson, Sample ID 6001 (VWW-A)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	666.	mg/L
Iron	<0.1	mg/L
Lithium	28.	mg/L
Magnesium	167.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	229.	mg/L
Strontium	11.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3916E RRC Custody Tag No.

Sample Identification: Vinson, Sample ID 6002 (VWW - A)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	163	mg/L
Carbonate	0.	mg/L
Chloride	285.	mg/L
Nitrate	23.	mg/L
pH	7.74	
Specific Conductance at 25C	3480.	umhos/cm
Sulfate	1554.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3917E RRC Custody Tag No.

Sample Identification: Vinson, Sample ID 6006 (VWW-E)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	495.	mg/L
Iron	<0.1	mg/L
Lithium	22.	mg/L
Magnesium	137.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	192.	mg/L
Strontium	12.	mg/L

Comments: Results To Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3918E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6007 (VWW-E)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	188	mg/L
Carbonate	0.	mg/L
Chloride	290.	mg/L
Nitrate	23.	mg/L
pH	7.70	
Specific Conductance at 25C	3140.	umhos/cm
Sulfate	1263.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3919E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6010 (VWW - D)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	491.	mg/L
Iron	<0.1	mg/L
Lithium	25.	mg/L
Magnesium	132.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	183.	mg/L
Strontium	12.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3920E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6011 (VWW-D)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	172	mg/L
Carbonate	0.	mg/L
Chloride	557.	mg/L
Nitrate	46.	mg/L
pH	7.71	
Specific Conductance at 25C	3290.	umhos/cm
Sulfate	2909.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3921E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6013 (VWW-C)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	176	mg/L
Carbonate	0.	mg/L
Chloride	618.	mg/L
Nitrate	43.	mg/L
pH	7.74	
Specific Conductance at 25C	3370.	umhos/cm
Sulfate	2878.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3922E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6014 (VWW-C)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	456.	mg/L
Iron	<0.1	mg/L
Lithium	25.	mg/L
Magnesium	122.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	208.	mg/L
Strontium	10.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3923E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6016 (VWW-B, X) duplicate

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	417.	mg/L
Iron	<0.1	mg/L
Lithium	22.	mg/L
Magnesium	116.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	169.	mg/L
Strontium	9.4	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3924E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6017 (VWW-B, X) duplicate

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	194	mg/L
Carbonate	0.	mg/L
Chloride	481.	mg/L
Nitrate	45.	mg/L
pH	7.76	
Specific Conductance at 25C	2880.	umhos/cm
Sulfate	2338.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3925E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6024 (VWW-B)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	403.	mg/L
Iron	<0.1	mg/L
Lithium	22.	mg/L
Magnesium	112.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	167.	mg/L
Strontium	9.6	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson J.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3926E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6025 (VWW-B)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	190	mg/L
Carbonate	0.	mg/L
Chloride	225.	mg/L
Nitrate	24.	mg/L
pH	7.79	
Specific Conductance at 25C	2880.	umhos/cm
Sulfate	1162.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3927E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6020 (WW-3)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	258.	mg/L
Iron	<0.1	mg/L
Lithium	69.	mg/L
Magnesium	117.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	311.	mg/L
Strontium	9.8	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3928E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6022 (WW-3, T)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	562.	mg/L
Iron	<0.1	mg/L
Lithium	68.	mg/L
Magnesium	262.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	719.	mg/L
Strontium	9.4	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3929E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6023 (WW-3)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	241	mg/L
Carbonate	0.	mg/L
Chloride	1292.	mg/L
Nitrate	8.	mg/L
pH	7.68	
Specific Conductance at 25C	6810.	umhos/cm
Sulfate	1812.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3930E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6028 (WW-6)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Calcium	148.	mg/L
Iron	<0.1	mg/L
Lithium	<1	mg/L
Magnesium	50.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	68.	mg/L
Strontium	2.8	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 3931E RRC Custody Tag No.

Sample Identification: Vinson - Sample ID 6029 (WW-6)

Submitted by: Special Response

Date Collected: Date Received: 07-21-1997 Date Completed: 07-23-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	236	mg/L
Carbonate	0.	mg/L
Chloride	92.	mg/L
Nitrate	5.	mg/L
pH	7.83	
Specific Conductance at 25C	236	umhos/cm
Sulfate	357.	mg/L

Comments: Results to Dr. Jeri Sullivan - BEG
Copy to RRC - Site Remediation

Data Verification Carl Nelson Jr.

BUREAU OF ECONOMIC GEOLOGY
SAMPLE CUSTODY AND HISTORY FORM

PROJECT: ~~VERNON BRIGGS~~ VINSON

RC LAB No.	No.	Sample ID	Date	Time	Purpose	Amount left	Date out	Date in	Comments
3915E	1	✓ 6001	7/17/97	1405	Cations				VWW-A
3916E	2	✓ 6002	7/17/97	1404	Anions				VWW-A
* 3917E	3	✓ 6006	7/17/97	1848	Cations				VWW-E
3918E	4	✓ 6007	7/17/97	1848	Anions				VWW-E
* 3919E	5	✓ 6010	7/18/97	0840	Cations				VWW-D
3920E	6	✓ 6011	7/18/97	0845	Anions				VWW-D
3921E	7	✓ 6013	7/18/97	1116	Cations ←	ANIONS = NO ACID CN-RRC SMLAB	7/21/97		VWW-C
* 3922E	8	✓ 6014	7/18/97	1118	Anions ←	CATIONS = ACIDIFIED CN-RRC SMLAB	7/21/97		VWW-C
* 3923E	9	✓ 6016	7/18/97	1318	Cations				VWW-B, X
3924E	10	✓ 6017	7/18/97	1319	Anions				VWW-B, X
* 3925E	11	✓ 6024	7/18/97	1320	Cations				VWW-B
3926E	12	✓ 6025	7/18/97	1321	Anions				VWW-B
* 3927E	13	✓ 6020	7/18/97	1620	Cations				WW-3
* 3928E	14	✓ 6022	7/18/97	1630	Cations~~, Anions~~ AND				WW-3, T
3929E	15	✓ 6023	7/18/97	1621	Anions				WW-3
* 3930E	16	✓ 6028	7/18/97	1910	Cations				WW-6
3931E	17	✓ 6029	7/18/97	1910	Anions				WW-6

JUL 1997
RECEIVED
R.R.C. OF TEXAS
Surface Mining Lab

	Name	Signature	Organization	Date	Time
Relinquished by:	Alan R. Dutton	Alan R Dutton	Bureau of Economic Geology	7/21/97	12:08 pm
Received by:	CARL NELSON	Carl Nelson	RailROAD Comm LAB	07/21/97	1415 HRS
Relinquished by:					
Received by:					
Relinquished by:					
Received by:					

RRC - July 1997
TPH analyses of soils

CHARLES R. MATTHEWS, *CHAIRMAN*
CAROLE KEETON RYLANDER, *COMMISSIONER*
BARRY WILLIAMSON, *COMMISSIONER*

MELVIN B. HODGKISS, P.E., *DIRECTOR*

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION

MEMORANDUM

TO: Becky Smith
Bureau of Economic Geology, University of Texas

FROM: Carl Nelson, Jr., Laboratory Supervisor
Surface Mining and Reclamation Division Laboratory

SUBJECT: Vinson samples collected July 17, 1997

DATE: July 30, 1997

I have enclosed the analysis results of the four samples from the above referenced source. These samples were received at the Surface Mining and Reclamation Division Laboratory on July 24, 1997.

If additional information is needed, please contact me at (512) 926-3064.

Carl Nelson Jr.
Carl Nelson, Jr.

CN/gm

enc.
xc: John Tintera, Deputy Assistant Director
Site Remediation
Oil and Gas Division
Austin, Texas

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 3946E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID VCC-4-(5.5-5.9')

Submitted by: Special Response

Date Collected: 07-17-1997 Date Received: 07-24-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.00	%
Total Petroleum Hydrocarbons	0.00	%

Comments: Results to Becky Smith - BEG
Copy to John Tintera - RRC

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 3947E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID VCC-4-(8.4-8.8')

Submitted by: Special Response

Date Collected: 07-17-1997 Date Received: 07-24-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.00	%
Total Petroleum Hydrocarbons	0.00	%

Comments: Results to Becky Smith - BEG
Copy to John Tintera - RRC

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 3948E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID VCC-4-(13.6-14.0')

Submitted by: Special Response

Date Collected: 07-17-1997 Date Received: 07-24-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.00	%
Total Petroleum Hydrocarbons	0.00	%

Comments: Results to Becky Smith - BEG
Copy to John Tintera - RRC

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 3949E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID VCC-4-(20.0-20.5')

Submitted by: Special Response

Date Collected: 07-17-1997 Date Received: 07-24-1997 Date Completed: 07-29-1997

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.00	%
Total Petroleum Hydrocarbons	0.00	%

Comments: Results to Becky Smith - BEG
Copy to John Tintera - RRC

Data Verification Carl Nelson Jr.

~~ChemSOLVE~~
~~11629 Manchaca Road~~
Austin, ~~Texas 78748~~
~~Phone: 512-280-7600 FAX: 512-2~~ 51
Email: ~~Chemsolve@aol.com~~
WWW: ~~http://www.eden.com/~chemsolv/~~

REPORT TO: Becky Smyth
CONTACT ~~JERI~~ ~~[illegible]~~
COMPANY BF AUSTIN
ADDRESS
0232
PHONE 471 6285 FAX 471-~~8140~~

BILL TO:

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD

Page 1 of 1

Project Name: RRC-Vinson

Project No.: —

Turnaround: ASAP

Analytical Request:

Sample ID	Date	Time	No. of Cont.	Matrix	TPH soil										Lab Number SM	Comments
VCC-4-(5.5-5.9')	7/17/97	1030	1	soil	X										3946E	
VCC-4(8.4-8.8')	7/17/97	1100	1	"	X										3947E	
VCC-4(13.6-14.0)	7/17/97	1130	1	"	X										3948E	
VCC-4(20.0-20.5)	7/17/97	1200	1	"	X										3949E	

JUL 1997
RECEIVED
R.R.C. OF TEXAS
Surface Mining Lab

Relinquished By	Date	Time	Received By	Carrier	Date	Time
Rebecca C. Smyth	7/24/97	4:10 pm	Gigi Mendez		7-24	

ChemSOLVE - August 1997
Cation, anion, and organic (PAH) analyses of ground water

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28200

Project: RRC Vinson
Sample: 6082 (VWW-B) **Matrix:** water
Date/Time Taken: 8/18/97 16:50 **Date/Time Rec'd:** 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	0.043	mg/L	0.005	6010	9/3/97	16:21	LBK	
Calcium	410	mg/L	0.1	6010	9/10/97	18:45	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	16:21	LBK	
Lithium	0.12	mg/L	0.01	6010	9/19/97	10:38	LVK	
Magnesium	90	mg/L	0.01	6010	9/19/97	10:38	LVK	
Manganese	<0.005	mg/L	0.005	6010	9/3/97	16:21	LBK	
Potassium	5.8	mg/L	0.1	6010	9/19/97	10:38	LVK	
Sodium	150	mg/L	0.01	6010	9/19/97	10:38	LVK	
Strontium	12	mg/L	0.05	6010	9/19/97	10:38	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.56	20	100.0	102.6	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	10.91	20	120.8	108.3	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28201

Project: RRC Vinson
Sample: 6083 (VWW-B)
Date/Time Taken: 8/18/97 16:50

Matrix: water
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run	By	Blank
Alkalinity, total	120	mg/L	10	310.1	9/18/97 15:47	LVK	
Bromide	<2.5	mg/L	2.5	300.1	8/26/97 12:18	LBK	
Chloride	260	mg/L	1.25	300.1	8/26/97 12:18	LBK	
Nitrate-N	8.7	mg/L	1.25	300.1	8/26/97 12:18	LBK	
Sulfate	1,400	mg/L	1.25	300.1	8/26/97 12:18	LBK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	1.87	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28202

Project: RRC Vinson
Sample: 6064 (VWW-A)
Matrix: water
Date/Time Taken: 8/19/97 13:40
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By	Blank
Barium	<0.005	mg/L	0.005	6010	9/3/97	16:26	LBK	
Calcium	430	mg/L	0.1	6010	9/10/97	18:48	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	16:26	LBK	
Lithium	0.15	mg/L	0.01	6010	9/19/97	10:44	LVK	
Magnesium	93	mg/L	0.01	6010	9/19/97	10:44	LVK	
Manganese	0.019	mg/L	0.005	6010	9/3/97	16:26	LBK	
Potassium	4.8	mg/L	0.1	6010	9/19/97	10:44	LVK	
Sodium	170	mg/L	0.01	6010	9/19/97	10:44	LVK	
Strontium	14	mg/L	0.05	6010	9/19/97	10:44	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.56	20	100.0	102.6	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	10.91	20	120.8	108.3	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28203

Project: RRC Vinson
Sample: 6065 (VWW-A)
Matrix: water
Date/Time Taken: 8/19/97 13:40
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Alkalinity, total	140	mg/L	10	310.1	9/18/97	15:47	LVK	
Bromide	<2.5	mg/L	2.5	300.1	8/26/97	12:39	LBK	
Chloride	210	mg/L	1.25	300.1	8/26/97	12:39	LBK	
Nitrate-N	3.2	mg/L	1.25	300.1	8/26/97	12:39	LBK	
Sulfate	1,600	mg/L	1.25	300.1	8/26/97	12:39	LBK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	1.87	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
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11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28204

Project: RRC Vinson
Sample: 6061 (VWW-A)
Matrix: water
Date/Time Taken: 8/19/97 13:30
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Acenaphthene	<2	µg/L	2	8310	9/17/97	19:40	KLM	<1
Acenaphthylene	<2	µg/L	2	8310	9/17/97	19:40	KLM	<1
Anthracene	<1	µg/L	1	8310	9/17/97	19:40	KLM	<0.5
Benz(a)anthracene	<0.2	µg/L	0.2	8310	9/17/97	19:40	KLM	<0.1
Benzo(a)pyrene	<0.02	µg/L	0.02	8310	9/17/97	19:40	KLM	<0.01
Benzo(b)fluoranthene	<0.02	µg/L	0.02	8310	9/17/97	19:40	KLM	<0.01
Benzo(ghi)perylene	<0.02	µg/L	0.02	8310	9/17/97	19:40	KLM	<0.01
Benzo(k,j)fluoranthene	<0.02	µg/L	0.02	8310	9/17/97	19:40	KLM	<0.01
Chrysene	<0.2	µg/L	0.2	8310	9/17/97	19:40	KLM	<0.1
Dibenz(a,h)anthracene	<0.02	µg/L	0.02	8310	9/17/97	19:40	KLM	<0.01
Fluoranthene	<0.4	µg/L	0.4	8310	9/17/97	19:40	KLM	<0.2
Fluorene	<1	µg/L	1	8310	9/17/97	19:40	KLM	<0.5
Indeno(1,2,3-cd)pyrene	<0.04	µg/L	0.04	8310	9/17/97	19:40	KLM	<0.02
Naphthalene	<2	µg/L	2	8310	9/17/97	19:40	KLM	<1
Phenanthrene	<1	µg/L	1	8310	9/17/97	19:40	KLM	<0.5
Pyrene	<0.4	µg/L	0.4	8310	9/17/97	19:40	KLM	<0.2

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Terphenyl-d14	8310	86	33-141

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28205

Project: RRC Vinson
Sample: 6084 (VWW-C) **Matrix:** water
Date/Time Taken: 8/19/97 10:00 **Date/Time Rec'd:** 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	0.0072	mg/L	0.005	6010	9/3/97	16:30	LBK	
Calcium	550	mg/L	0.1	6010	9/10/97	18:51	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	16:30	LBK	
Lithium	0.68	mg/L	0.01	6010	9/19/97	10:49	LVK	
Magnesium	790	mg/L	0.1	6010	9/10/97	18:51	LBK	
Manganese	0.28	mg/L	0.005	6010	9/3/97	16:30	LBK	
Potassium	17	mg/L	0.1	6010	9/19/97	10:49	LVK	
Sodium	1,600	mg/L	0.05	6010	9/10/97	15:66	LBK	
Strontium	12	mg/L	0.05	6010	9/19/97	10:49	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.56	20	100.0	102.6	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	1.50	20	98.9	100.4	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.05	10.88	20	94.9	85.1	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28206

Project: RRC Vinson
Sample: 6085 (VWW-C)
Matrix: water
Date/Time Taken: 8/19/97 10:00
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Alkalinity, total	220	mg/L	10	310.1	9/18/97	15:47	LVK	
Bromide	<2.5	mg/L	2.5	300.1	8/26/97	12:58	LBK	
Chloride	2,200	mg/L	1.25	300.1	8/26/97	12:58	LBK	
Nitrate-N	<1.25	mg/L	1.25	300.1	8/26/97	12:58	LBK	
Sulfate	3,800	mg/L	1.25	300.1	8/26/97	12:58	LBK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	1.87	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28207

Project: RRC Vinson
Sample: 6064 (VWW-D)
Matrix: water
Date/Time Taken: 8/19/97 10:45
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	0.0090	mg/L	0.005	6010	9/3/97	16:35	LBK	
Calcium	470	mg/L	0.1	6010	9/10/97	18:55	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	16:35	LBK	
Lithium	0.13	mg/L	0.01	6010	9/19/97	10:55	LVK	
Magnesium	110	mg/L	0.01	6010	9/19/97	10:55	LVK	
Manganese	<0.005	mg/L	0.005	6010	9/3/97	16:35	LBK	
Potassium	5.3	mg/L	0.1	6010	9/19/97	10:55	LVK	
Sodium	190	mg/L	0.01	6010	9/19/97	10:55	LVK	
Strontium	13	mg/L	0.05	6010	9/19/97	10:55	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.56	20	100.0	102.6	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	10.91	20	120.8	108.3	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

Report #: 28208

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Project: RRC Vinson
Sample: 6063 (VWW-D)
Matrix: water
Date/Time Taken: 8/19/97 10:45
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run		By	Blank
Alkalinity, total	160	mg/L	10	310.1	9/18/97	15:47	LVK	
Bromide	<2.5	mg/L	2.5	300.1	8/26/97	13:05	LBK	
Chloride	310	mg/L	1.25	300.1	8/26/97	13:05	LBK	
Nitrate-N	5.8	mg/L	1.25	300.1	8/26/97	13:05	LBK	
Sulfate	1,400	mg/L	1.25	300.1	8/26/97	13:05	LBK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	1.87	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28209

Project: RRC Vinson
Sample: 6059 (WW-3)
Matrix: water
Date/Time Taken: 8/19/97 12:30
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	<0.005	mg/L	0.005	6010	9/3/97	16:39	LBK	
Calcium	440	mg/L	0.1	6010	9/10/97	18:58	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	16:39	LBK	
Lithium	0.26	mg/L	0.01	6010	9/19/97	11:00	LVK	
Magnesium	180	mg/L	0.1	6010	9/10/97	18:58	LBK	
Manganese	<0.005	mg/L	0.005	6010	9/3/97	16:39	LBK	
Potassium	6.1	mg/L	0.1	6010	9/19/97	11:00	LVK	
Sodium	420	mg/L	0.01	6010	9/19/97	11:00	LVK	
Strontium	11	mg/L	0.05	6010	9/19/97	11:00	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.56	20	100.0	102.6	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	1.50	20	98.9	100.4	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28210

Project: RRC Vinson
Sample: 6060 (WW-3)
Matrix: water
Date/Time Taken: 8/19/97 12:30
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Alkalinity, total	220	mg/L	10	310.1	9/18/97	15:47	LVK	
Bromide	<2.5	mg/L	2.5	300.1	8/26/97	13:15	LBK	
Chloride	640	mg/L	1.25	300.1	8/26/97	13:15	LBK	
Nitrate-N	<1.25	mg/L	1.25	300.1	8/26/97	13:15	LBK	
Sulfate	1,800	mg/L	1.25	300.1	8/26/97	13:15	LBK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	1.87	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28211

Project: RRC Vinson
Sample: 6050 (VWW-E)
Matrix: water
Date/Time Taken: 8/19/97 08:20
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Acenaphthene	<2	µg/L	2	8310	9/10/97	12:10	MCK	<1
Acenaphthylene	<2	µg/L	2	8310	9/10/97	12:10	MCK	<1
Anthracene	1.9	µg/L	1	8310	9/10/97	12:10	MCK	<0.5
Benz(a)anthracene	<0.2	µg/L	0.2	8310	9/10/97	12:10	MCK	<0.1
Benzo(a)pyrene	<0.02	µg/L	0.02	8310	9/10/97	12:10	MCK	<0.01
Benzo(b)fluoranthene	<0.02	µg/L	0.02	8310	9/10/97	12:10	MCK	<0.01
Benzo(ghi)perylene	<0.02	µg/L	0.02	8310	9/10/97	12:10	MCK	<0.01
Benzo(k,j)fluoranthene	<0.02	µg/L	0.02	8310	9/10/97	12:10	MCK	<0.01
Chrysene	<0.2	µg/L	0.2	8310	9/10/97	12:10	MCK	<0.1
Dibenz(a,h)anthracene	<0.02	µg/L	0.02	8310	9/10/97	12:10	MCK	<0.01
Fluoranthene	2.3	µg/L	0.4	8310	9/10/97	12:10	MCK	<0.2
Fluorene	<1	µg/L	1	8310	9/10/97	12:10	MCK	<0.5
Indeno(1,2,3-cd)pyrene	<0.04	µg/L	0.04	8310	9/10/97	12:10	MCK	<0.02
Naphthalene	<2	µg/L	2	8310	9/10/97	12:10	MCK	<1
Phenanthrene	4.2	µg/L	1	8310	9/10/97	12:10	MCK	<0.5
Pyrene	6.9	µg/L	0.4	8310	9/10/97	12:10	MCK	<0.2

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Terphenyl-d14	8310	128	33-141

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28212

Project: RRC Vinson
Sample: 6051 (VWW-E)
Matrix: water
Date/Time Taken: 8/19/97 08:20
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	0.010	mg/L	0.005	6010	9/3/97	17:09	LBK	
Calcium	390	mg/L	0.1	6010	9/10/97	19:01	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	17:09	LBK	
Lithium	0.11	mg/L	0.01	6010	9/19/97	11:06	LVK	
Magnesium	68	mg/L	0.01	6010	9/19/97	11:06	LVK	
Manganese	<0.005	mg/L	0.005	6010	9/3/97	17:09	LBK	
Potassium	4.6	mg/L	0.1	6010	9/19/97	11:06	LVK	
Sodium	140	mg/L	0.01	6010	9/19/97	11:06	LVK	
Strontium	12	mg/L	0.05	6010	9/19/97	11:06	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.56	20	100.0	102.6	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	10.91	20	120.8	108.3	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28213

Project: RRC Vinson
Sample: 6052 (VWW - E)
Matrix: water
Date/Time Taken: 8/19/97 08:20
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	**Result**	**Units**	**PQL**	**Method**	**Date/Time**	**Run**	**By**	**Blank**
Alkalinity, total	190	mg/L	10	310.1	9/18/97	15:47	LVK	
Bromide	<2.5	mg/L	2.5	300.1	8/26/97	13:23	LBK	
Chloride	180	mg/L	1.25	300.1	8/26/97	13:23	LBK	
Nitrate-N	4.6	mg/L	1.25	300.1	8/26/97	13:23	LBK	
Sulfate	1,400	mg/L	1.25	300.1	8/26/97	13:23	LBK	

Quality Assurance Data

Parameter	**Blank**	**%RSD**	**Limit**	**M.S.**	**M.S.D.**	**Limits**
Alkalinity, total	<10	1.87	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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Wednesday, November 19, 1997

Report #: 28214

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Project: RRC Vinson
Sample: 6068 (WW-2) **Matrix:** water
Date/Time Taken: 8/19/97 15:00 **Date/Time Rec'd:** 8/20/97 17:15

Report of Laboratory Analysis

Parameter	**Result**	**Units**	**PQL**	**Method**	**Date/Time**	**Run**	**By**	**Blank**
Acenaphthene	<2	µg/L	2	8310	9/10/97	12:37	MCK	<1
Acenaphthylene	<2	µg/L	2	8310	9/10/97	12:37	MCK	<1
Anthracene	2.6	µg/L	1	8310	9/10/97	12:37	MCK	<0.5
Benz(a)anthracene	<0.2	µg/L	0.2	8310	9/10/97	12:37	MCK	<0.1
Benzo(a)pyrene	<0.02	µg/L	0.02	8310	9/10/97	12:37	MCK	<0.01
Benzo(b)fluoranthene	<0.02	µg/L	0.02	8310	9/10/97	12:37	MCK	<0.01
Benzo(ghi)perylene	<0.02	µg/L	0.02	8310	9/10/97	12:37	MCK	<0.01
Benzo(k,j)fluoranthene	<0.02	µg/L	0.02	8310	9/10/97	12:37	MCK	<0.01
Chrysene	<0.2	µg/L	0.2	8310	9/10/97	12:37	MCK	<0.1
Dibenz(a,h)anthracene	<0.02	µg/L	0.02	8310	9/10/97	12:37	MCK	<0.01
Fluoranthene	3.5	µg/L	0.4	8310	9/10/97	12:37	MCK	<0.2
Fluorene	<1	µg/L	1	8310	9/10/97	12:37	MCK	<0.5
Indeno(1,2,3-cd)pyrene	<0.04	µg/L	0.04	8310	9/10/97	12:37	MCK	<0.02
Naphthalene	<2	µg/L	2	8310	9/10/97	12:37	MCK	<1
Phenanthrene	2.1	µg/L	1	8310	9/10/97	12:37	MCK	<0.5
Pyrene	4.0	µg/L	0.4	8310	9/10/97	12:37	MCK	<0.2

Quality Assurance Data

Surrogate	**Method**	**Recovery**	**Limits**
Terphenyl-d14	8310	63	33-141

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28215

Project: RRC Vinson
Sample: 6069 (WW-2) duplicate
Matrix: water
Date/Time Taken: 8/19/97 15:00
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Acenaphthene	<2	µg/L	2	8310	9/10/97	13:06	MCK	<1
Acenaphthylene	<2	µg/L	2	8310	9/10/97	13:06	MCK	<1
Anthracene	<1	µg/L	1	8310	9/10/97	13:06	MCK	<0.5
Benz(a)anthracene	<0.2	µg/L	0.2	8310	9/10/97	13:06	MCK	<0.1
Benzo(a)pyrene	<0.02	µg/L	0.02	8310	9/10/97	13:06	MCK	<0.01
Benzo(b)fluoranthene	<0.02	µg/L	0.02	8310	9/10/97	13:06	MCK	<0.01
Benzo(ghi)perylene	<0.02	µg/L	0.02	8310	9/10/97	13:06	MCK	<0.01
Benzo(k,j)fluoranthene	<0.02	µg/L	0.02	8310	9/10/97	13:06	MCK	<0.01
Chrysene	<0.2	µg/L	0.2	8310	9/10/97	13:06	MCK	<0.1
Dibenz(a,h)anthracene	<0.02	µg/L	0.02	8310	9/10/97	13:06	MCK	<0.01
Fluoranthene	<0.4	µg/L	0.4	8310	9/10/97	13:06	MCK	<0.2
Fluorene	<1	µg/L	1	8310	9/10/97	13:06	MCK	<0.5
Indeno(1,2,3-cd)pyrene	<0.04	µg/L	0.04	8310	9/10/97	13:06	MCK	<0.02
Naphthalene	9.1	µg/L	2	8310	9/10/97	13:06	MCK	<1
Phenanthrene	<1	µg/L	1	8310	9/10/97	13:06	MCK	<0.5
Pyrene	<0.4	µg/L	0.4	8310	9/10/97	13:06	MCK	<0.2

Quality Assurance Data

Surrogate	Method	Recovery	Limits
Terphenyl-d14	8310	81	33-141

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28216

Project: RRC Vinson
Sample: 6073 (WW-2)
Matrix: water
Date/Time Taken: 8/19/97 15:00
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	0.0079	mg/L	0.005	6010	9/3/97	17:13	LBK	
Calcium	510	mg/L	0.1	6010	9/10/97	19:18	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	17:13	LBK	
Lithium	0.13	mg/L	0.01	6010	9/19/97	11:12	LVK	
Magnesium	89	mg/L	0.01	6010	9/19/97	11:12	LVK	
Manganese	<0.005	mg/L	0.005	6010	9/3/97	17:13	LBK	
Potassium	17	mg/L	0.1	6010	9/19/97	11:12	LVK	
Sodium	880	mg/L	0.01	6010	9/19/97	11:12	LVK	
Strontium	13	mg/L	0.05	6010	9/19/97	11:12	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.32	20	100.0	97.7	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	10.91	20	120.8	108.3	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28217

Project: RRC Vinson
Sample: 6072 (WW-2)
Matrix: water
Date/Time Taken: 8/19/97 15:00
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Alkalinity, total	190	mg/L	10	310.1	9/18/97	15:47	LVK	
Bromide	<0.1	mg/L	0.1	300.1	8/26/97	13:36	LBK	
Chloride	1,200	mg/L	0.05	300.1	8/26/97	13:36	LBK	
Nitrate-N	16	mg/L	0.05	300.1	8/26/97	13:36	LBK	
Sulfate	2,400	mg/L	0.05	300.1	8/26/97	13:36	LBK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	10.00	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28218

Project: RRC Vinson
Sample: 6075 (WW-2) duplicate
Matrix: water
Date/Time Taken: 8/19/97 15:00
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	<0.005	mg/L	0.005	6010	9/3/97	17:18	LBK	
Calcium	420	mg/L	0.1	6010	9/10/97	19:22	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	17:18	LBK	
Lithium	0.16	mg/L	0.01	6010	9/19/97	11:17	LVK	
Magnesium	94	mg/L	0.01	6010	9/19/97	11:17	LVK	
Manganese	<0.005	mg/L	0.005	6010	9/3/97	17:18	LBK	
Potassium	6.3	mg/L	0.1	6010	9/19/97	11:17	LVK	
Sodium	230	mg/L	0.01	6010	9/19/97	11:17	LVK	
Strontium	11	mg/L	0.05	6010	9/19/97	11:17	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.32	20	100.0	97.7	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	10.91	20	120.8	108.3	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	1.37	20	95.4	94.1	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28219

Project: RRC Vinson
Sample: 6074 (WW-2) duplicate
Matrix: water
Date/Time Taken: 8/19/97 15:00
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time Run	By	Blank
Alkalinity, total	140	mg/L	10	310.1	9/18/97 15:47	LVK	
Bromide	<2.5	mg/L	2.5	300.1	8/26/97 13:57	LBK	
Chloride	270	mg/L	1.25	300.1	8/26/97 13:57	LBK	
Nitrate-N	22	mg/L	1.25	300.1	8/26/97 13:57	LBK	
Sulfate	1,900	mg/L	1.25	300.1	8/26/97 13:57	LBK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	10.00	10			
Bromide	<0.1	9.24	20	93.3	102.4	75 - 125
Chloride	<0.05	10.52	20	97.4	87.6	75 - 125
Nitrate-N	<0.05	0.32	20	99.6	99.9	75 - 125
Sulfate	<0.05	0.16	20	84.0	84.2	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

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11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

Report #: 28220

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Project: RRC Vinson
Sample: 6079 (WW-6)
Matrix: water
Date/Time Taken: 8/19/97 16:30
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Barium	<0.005	mg/L	0.005	6010	9/3/97	17:23	LBK	
Calcium	240	mg/L	0.1	6010	9/10/97	19:26	LBK	
Iron	<0.005	mg/L	0.005	6010	9/3/97	17:23	LBK	
Lithium	0.074	mg/L	0.01	6010	9/19/97	11:23	LVK	
Magnesium	62	mg/L	0.01	6010	9/19/97	11:23	LVK	
Manganese	<0.005	mg/L	0.005	6010	9/3/97	17:23	LBK	
Potassium	3.2	mg/L	0.1	6010	9/19/97	11:23	LVK	
Sodium	120	mg/L	0.01	6010	9/19/97	11:23	LVK	
Strontium	7.9	mg/L	0.05	6010	9/19/97	11:23	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Barium	<0.005	1.98	20	111.9	109.7	75 - 125
Calcium	<0.01	2.32	20	100.0	97.7	75 - 125
Iron	<0.005	4.87	20	82.0	78.1	75 - 125
Lithium	<0.01	4.82	20	97.7	93.1	75 - 125
Magnesium	<0.01	10.91	20	120.8	108.3	75 - 125
Manganese	<0.005	5.14	20	91.7	87.1	75 - 125
Potassium	<0.1	3.86	20	101.4	105.4	75 - 125
Sodium	<0.01	1.21	20	99.5	98.3	75 - 125
Strontium	<0.05	6.77	20	103.7	96.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
chemistry for a changing environment
11629 Manchaca Road • Austin, TX 78748• (512) 280-7680

Wednesday, November 19, 1997

To: Dr. Jeri Sullivan
Bureau of Economic Geology
10100 Burnet Road, Bldg. 130
Austin, TX 78759 FAX: 512-471-0140

Report #: 28221

Project: RRC Vinson
Sample: 6078 (WW-6)
Matrix: water
Date/Time Taken: 8/19/97 16:30
Date/Time Rec'd: 8/20/97 17:15

Report of Laboratory Analysis

Parameter	Result	Units	PQL	Method	Date/Time	Run	By	Blank
Alkalinity, total	270	mg/L	10	310.1	9/18/97	15:47	LVK	
Bromide	<0.1	mg/L	0.1	300.1	9/4/97	14:49	LVK	
Chloride	940	mg/L	0.05	300.1	9/4/97	14:49	LVK	
Nitrate-N	0.81	mg/L	0.05	300.1	9/4/97	14:49	LVK	
Sulfate	820	mg/L	0.05	300.1	9/4/97	14:49	LVK	

Quality Assurance Data

Parameter	Blank	%RSD	Limit	M.S.	M.S.D.	Limits
Alkalinity, total	<10	10.00	10			
Chloride	<0.05	0.18	20	99.2	99	75 - 125
Nitrate-N	<0.05	0.10	20	96.0	95.9	75 - 125
Sulfate	<0.05	0.02	20	98.9	98.9	75 - 125

Respectfully submitted,

Mark C. Krause, FAIC

PQL - Reporting Limit. %RSD - Sample Precision.
M.S. - Matrix Spike. M.S.D. - Matrix spike duplicate.

ChemSOLVE
11629 Manchaca Road
Austin, Texas 78748
Phone: 512-280-7680 FAX: 512-280-7651
Email: Chemsolve@aol.com
WWW: http://www.eden.com/~chemsolv/

REPORT TO:		BILL TO:
CONTACT	JERI SULLIVAN	
COMPANY	BEG UT AUSTIN	
ADDRESS		
	Becky 471 0232	
PHONE	471 6285 FAX 471-0140	

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD

Page 1 of 2

Project Name: RRC-Vinson

Project No.:

Turnaround: ASAP

Analytical Request:

Sample ID	Date	Time	No. of Cont.	Matrix	cations	anions	PAH (8013)									Lab Number	Comments
6082	8/18	1650	1	H_2O	✓											28200	VWW-B
6083	8/18	1650	1	H_2O		✓										28201	VWW-B
6064	8/19	1340	1	H_2O	✓											28202	VWW-A
6065	8/19	1340	1	H_2O		✓										28203	VWW-A
6061	8/19	1330	2	H_2O			✓									28204	VWW-A
6084	8/19	1000	1	H_2O	✓											28205	VWW-C
6085	8/19	1000	1	H_2O		✓										28206	VWW-C
6064	8/19	1045	1	H_2O	✓											28207	VWW-D
6063	8/19	1045	1	H_2O		✓										28208	VWW-D
6059	8/19	1230	1	H_2O	✓											28209	WW-3
6060	8/19	1230	1	H_2O		✓										28210	WW-3

Relinquished By	Date	Time	Received By	Carrier	Date	Time
Rebecca C Smyth	8/20/97	3:12		PRIORITY	8-20	3:12
			Angie O'Donnell	Pridel	8/20	5:15

ChemSOLVE
11629 Manchaca Road
Austin, Texas 78748
Phone: 512-280-7680 FAX: 512-280-7651
Email: Chemsolve@aol.com
WWW: http://www.eden.com/~chemsolv/

REPORT TO:	BILL TO:
CONTACT JERI SULLIVAN	
COMPANY BEG UT AUSTIN	
ADDRESS	
PHONE 471 6285 FAX 471-0140	

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD Page 2 of 2

Project Name: RRC-Vinson

Project No.:

Turnaround: ASAP

Analytical Request:

Sample ID	Date	Time	No. of Cont.	Matrix	cations	anions	PAH (8013)	Lab Number	Comments
6050	8/19	0820	2	H_2O			✓	28211	VWW-E
6051	8/19	0820	1	H_2O	✓			28212	VWW-E
6052	8/19	0820	1	H_2O		✓		28213	VWW-E
6068	8/19	1500	2	H_2O			✓	28214	WW-2
6069	8/19	1500	2	H_2O			✓	28215	WW-2
6073	8/19	1500	1	H_2O	✓			28216	WW-2
6072	8/19	1500	1	H_2O		✓		28217	WW-2
6075	8/19	1500	1	H_2O	✓			28218	WW-2
6074	8/19	1500	1	H_2O		✓		28219	WW-2
6079*	8/19	1630	1	H_2O	✓			28220	WW-6
6078**	8/19	1630	1	H_2O		✓		28221	WW-6

Relinquished By	Date	Time	Received By	Carrier	Date	Time
Rebecca C Smyth	8/20/97	3:12		PRIORITY	8-20	3:12
					8/20	5:15

* NEEDS TO BE FILTERED; WAS NOT ACIDIFIED IN FIELD.
** NEEDS TO BE FILTERED.

RRC - August 1997
Cation and anion analyses of ground water

CHARLES R. MATTHEWS, *CHAIRMAN*
CAROLE KEETON RYLANDER, *COMMISSIONER*
BARRY WILLIAMSON, *COMMISSIONER*

MELVIN B. HODGKISS, P.E., *DIRECTOR*

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION

MEMORANDUM

TO: Rebecca Smyth
Bureau of Economic Geology, University of Texas

FROM: Carl Nelson, Jr., Laboratory Supervisor
Surface Mining and Reclamation Division Laboratory

SUBJECT: Vinson water samples

DATE: September 5, 1997

I have enclosed the analysis results of the twenty samples from the above referenced source. These samples were received at the Surface Mining and Reclamation Division Laboratory on August 21, 1997.

If additional information is needed, please contact me at (512) 926-3064.

Carl Nelson, Jr.
Carl Nelson, Jr.

CN/gm

enc.
xc: John Tintera, Deputy Assistant Director
Site Remediation
Oil and Gas Division
Austin, Texas

1701 NORTH CONGRESS AVENUE ★ POST OFFICE BOX 12967 ★ AUSTIN, TEXAS 78711-2967 ★ PHONE:512/463-6900 FAX:512/463-6709

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4236E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6066 - VWW-D

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	505.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	137.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	225.	mg/L
Strontium	13.	mg/L

Comments: For Lab Nos. 4236E - 4255E:
Send results to Rebeca C. Smyth - BEG
Copy of results John Tintera - RRC

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4237E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6065 - VWW-D

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	183	mg/L
Bromide	1	mg/L
Chloride	386	mg/L
Fluoride	3	mg/L
Nitrate	39	mg/L
Sulfate	1484	mg/L

Comments:

Data Verification Carl Nelson, Jr.

507

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4238E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6053 - VWW-E

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	459.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	122.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	166.	mg/L
Strontium	12.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4239E   RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6054 - VWW-E

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	179	mg/L
Bromide	1	mg/L
Chloride	246	mg/L
Fluoride	3	mg/L
Nitrate	26	mg/L
Sulfate	1375	mg/L

Comments:

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4240E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6070 - WW-Z

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	166	mg/L
Bromide	1	mg/L
Chloride	258	mg/L
Fluoride	3	mg/L
Nitrate	22	mg/L
Sulfate	1570	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4241E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6071 - WW-Z

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	508.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	127.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	192.	mg/L
Strontium	11.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4242E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6057 - WW-3

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	547.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	231.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	500.	mg/L
Strontium	11.	mg/L

Comments:

Data Verification Carl Nelson Jr.

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RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4243E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6058 - WW-3

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	219	mg/L
Bromide	2	mg/L
Chloride	815	mg/L
Fluoride	4	mg/L
Nitrate	16	mg/L
Sulfate	1852	mg/L

Comments:

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4244E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6077 - WW-6

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	200.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	83.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	102.	mg/L
Strontium	6.	mg/L

Comments:

Data Verification Carl Nelson, Jr.

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RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4245E   RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6076 - WW-6

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	128	mg/L
Bromide	1	mg/L
Chloride	173	mg/L
Fluoride	2	mg/L
Nitrate	3	mg/L
Sulfate	719	mg/L

Comments:

Data Verification Carl Nelson Jr.

5/5

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4246E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6062 - VWW-A

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	537.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	140.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	197.	mg/L
Strontium	12.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4247E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6063 - VWW-A

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	171	mg/L
Bromide	1	mg/L
Chloride	273	mg/L
Fluoride	3	mg/L
Nitrate	25	mg/L
Sulfate	1574	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4248E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6066 - VWW-A

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	534.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	141.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	193.	mg/L
Strontium	12.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4249E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6067 - VWW-A

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	169	mg/L
Bromide	1	mg/L
Chloride	281	mg/L
Fluoride	3	mg/L
Nitrate	31	mg/L
Sulfate	1595	mg/L

Comments:

Data Verification Carl Nelson, Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4250E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6080 - VWW-B

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	301.	mg/L
Iron	<0.1	mg/L
Lithium	<0.1	mg/L
Magnesium	107.	mg/L
Manganese	<0.05	mg/L
Potassium	<5	mg/L
Sodium	159.	mg/L
Strontium	12.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4251E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6081 - VWW-B

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	191	mg/L
Bromide	<1	mg/L
Chloride	250.	mg/L
Fluoride	2.	mg/L
Nitrate	26.	mg/L
Sulfate	1243.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4252E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6086 - VWW-C

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	706.	mg/L
Iron	<0.1	mg/L
Lithium	1.2	mg/L
Magnesium	1167.	mg/L
Manganese	0.35	mg/L
Potassium	<5	mg/L
Sodium	1363.	mg/L
Strontium	12.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4253E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6087 - VWW-C

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	436	mg/L
Bromide	6.	mg/L
Chloride	3216.	mg/L
Fluoride	18.	mg/L
Nitrate	4.	mg/L
Sulfate	3654.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4254E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6088 - VWW-C

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 08-26-1997

ANALYSIS	VALUE	UNITS
Barium	<0.05	mg/L
Calcium	740.	mg/L
Iron	<0.1	mg/L
Lithium	1.1	mg/L
Magnesium	1240.	mg/L
Manganese	0.31	mg/L
Potassium	<5	mg/L
Sodium	1399.	mg/L
Strontium	12.	mg/L

Comments:

Data Verification Carl Nelson Jr.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Water Analysis Report

Lab No. 4255E RRC Custody Tag No.

Sample Identification: RRC - Vinson, Sample ID 6089 - VWW-C

Submitted by: Special Response

Date Collected: 08-19-1997 Date Received: 08-21-1997 Date Completed: 09-02-1997

ANALYSIS	VALUE	UNITS
Bicarbonate	429	mg/L
Bromide	6.	mg/L
Chloride	3221.	mg/L
Fluoride	18.	mg/L
Nitrate	4.	mg/L
Sulfate	3507.	mg/L

Comments:

Data Verification Carl Nelson Jr.

~~ChemSOLVE~~
~~11629 Manchaca Road~~
~~Austin, Texas 78748~~
~~Phone: 512-280-7600 FAX: 512-280-7651~~
~~Email: Chemsolve@aol.com~~
~~WWW: http://www.cdcn.com/~chemsolv/~~

REPORT TO: Rebecca C. Smyth
CONTACT ~~TERI SULLIVAN~~
COMPANY BEG UT AUSTIN
ADDRESS
0232
PHONE 471-~~[illegible]~~ FAX 471-0140

BILL TO:

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD Page 2 of 2

Project Name: RRC-Vinson
Project No.:
Turnaround: ASAP

Analytical Request:

Sample ID	Date	Time	No. of Cont.	Matrix	cations*	anions**										RRC Lab Number	Comments
6066 ✓	8/19	1045	1	H2O	✓											4236E	VWW-D
6065 ✓	8/19	1045	1	H2O		✓										4237E	VWW-D
6053 ✓	8/19	0820	1	H2O	✓											4238E	VWW-E
6054 ✓	8/19	0820	1	H2O		✓										4239E	VWW-E
6070 ✓	8/19	1500	1	H2O	X CN	X										4240E	WW-2
6071 ✓	8/19	1500	1	H2O	X	✓ CN										4241E	WW-2
6057 ✓	8/19	1230	1	H2O	✓											4242E	WW-3
6058 ✓	8/19	1230	1	H2O		✓										4243E	WW-3
6077+ ✓	8/19	1630	1	H2O	✓											4244E	WW-6
6076++ ✓	8/19	1630	1	H2O		✓										4245E	WW-6

Relinquished By	Date	Time	Received By	Carrier	Date	Time
Rebecca C. Smyth	8/21/97		Marisela Delgado		8/21	1:50 pm

* Ca, Mg, Na, K, Mn, Fe, Li, Sr, Ba { 6077 6076 + NEEDS TO BE FILTERED, NOT ACIDIFIED IN FIELD. — 6077 Needs acidified
** Cl, SO4, HCO3, Br, F, NO3 ++ NEEDS TO BE FILTERED 6076. Needs filtering 0.45

~~ChemSOLVE~~
1~~1629 Manchaca Road~~
~~Austin, Texas 78748~~
~~Phone: 512-280-7680 FAX: 512-280-7651~~
~~Email: Chemsolve@aol.com~~
~~WWW: http://www.eden.com/~chemsolv/~~

REPORT TO: Rebecca C. Smyth
CONTACT ~~TERI SULLIVAN~~
COMPANY BEG UT AUSTIN
ADDRESS
0232
PHONE 471 ~~[illegible]~~ FAX 471-0140

BILL TO:

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD

Page 1 of 2

Project Name: RRC-Vinson

Project No.:

Turnaround: ASAP

Analytical Request:

Sample ID	Date	Time	No. of Cont.	Matrix	cations*	anions**										RRC Lab Number	Comments
6062 ✓	8/19	1340	1	H_2O	✓											4246E	VWW-A
6063 ✓	8/19	1340	1	H_2O		✓										4247E	VWW-A
6066 ✓	8/19	1340	1	H_2O	✓											4248E	VWW-A
6067 ✓	8/19	1340	1	H_2O		✓										4249E	VWW-A
6080 ✓	8/18	1650	1	H_2O	✓											4250E	VWW-B
6081 ✓	8/18	1650	1	H_2O		✓										4251E	VWW-B
6086 ✓	8/19	1000	1	H_2O	✓											4252E	VWW-C
6087 ✓	8/19	1000	1	H_2O		✓										4253E	VWW-C
6088 ✓	8/19	1000	1	H_2O	✓											4254E	VWW-C
6089 ✓	8/19	1000	1	H_2O		✓										4255E	VWW-C
			$														

Relinquished By	Date	Time	Received By	Carrier	Date	Time
Rebecca C. Smyth	8/21/97		Maricela Delgado		8/21	1:50pm

* Ca, Mg, Na, K, Mn, Fe, Li, Sr, Ba

Appendix B

Core Descriptions

Appendix B. RRC Vinson site core description for VCC-1.

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
0.0 to 2.0	Sandy clayey soil with trace rounded quartz gravel (up to 2 cm diameter) and caliche; sand: fine- to med.-grained, angular; abundant plant roots; loose; dry; no hydrocarbon odor.	SW	dark red (2.5Y 3/6)	none
2.0 to 9.0	Silty clay with green reduction spots;1 to 5% plant roots; caliche zones up to 10 cm thick; low plasticity; dry; no hydrocarbon odor.	CL	dark red 2.5Y (3/6); green-gray (5GY 5/1)	none
9.0 to 11.5	Clayey sand; sand: angular; green reduction spots from 1 mm to 1 cm diameter with associated dark staining; very loose; damp; no hydrocarbon odor.	SC	dark red (2.5YR 3/6)	none
11.5 to 14.0	Silty clay with caliche gravel and caliche-cemented or dolomitized zones up to 0.2 ft thick (looks like green reduction spots concentrated into continuous zone); stiff; damp; no hydrocarbon odor.	CL	dark red (2.5YR 3/6)	none
14.0 to 19.0	Clayey silt with 1 to 5% angular quartz sand and 5 to 10% reduction spots; 0.2 ft thick carbonate cemented zone; med. stiffness; very loose; damp; very strong hydrocarbon odor at 14 ft; strong hydrocarbon odor at 17 ft.	ML	red (2.5YR 4/6); reddish-brown (2.5YR 4/4)	16.6 to 19.0

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
19.0 to 24.0	Clayey silt with 1 to 5% sand in pockets up to 5 cm diameter and occasional thin laminae; 10 to 15% reduction spots; fractured: 20.5 to 21 ft - core separated along bedding planes with 30° fracture lined with dark staining; 21.6 to 21.8 ft - solid core with 45° fracture lined with dark staining. Medium stiffness; core wet at 22 ft; slight hydrocarbon odor.	ML	reddish brown (2.5YR 5/4) and (2.5YR 3/6); lt. Greenish gray (5GY 7/1)	19.0 to 19.7 and 20.5 to 20.7
	23.5 to 25 ft - hard, carbonate cemented zone.		light gray (5Y 7/1)	none
24.0 to 29.0	Clayey silt with 1 to 5% very. fn.-grained to med.-grained quartz sand in pockets up to 3 cm diameter; silt layers very thinly laminated; 10 to 15% green reduction spots; stiff; damp to dry; no hydrocarbon odor.	ML	Greenish gray (5Y 7/1) dark red (2.5Y 3/6)	none
29.0 to 34.0	Sandy clay with silt; sand: very fn.- to fn.-grained, poorly sorted quartz; fracture from 32.4 to 32.6 ft with dark staining and hydrocarbon odor; hard cemented zone from 33 to 33.5 ft; moist; slight hydrocarbon odor.	SC	red (2.5YR 4/6); greenish gray (5GY 6/1)	trace
34.0 to 39.0	Sandy clayey silt; very finely laminated; euhedral dolomite crystals from 36.6 to 36.95; stiff; wet; strong hydrocarbon odor.	SC	Dark red (2.5Y 3/6)	none

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
39.0 to 44.0	Sandy clayey silt; very finely laminated; 5 to 10% reduction spots that coalesce into thin layers up to 0.2 ft thick; stiff; wet; no hydrocarbon odor.	SC	Dark red (2.5Y 3/6)	trace
44.0 to 47.0	same as above	SC	dark red (2.5Y 3/6)	none
47.0 to 49.0	Shale; fissile; very finely laminated; 10 to 15% reduction spots; gypsum layers up to 2 mm thick; hard; no hydrocarbon odor.	ML	dark red (2.5Y 3/6)	none
49.0 to 54.0	same as above	ML	dark red (2.5Y 3/6)	none
54.0 to 55.0	Shale; fissile; very finely laminated; 10 to 15% reduction spots; gypsum layers up to 0.3 ft thick; hard; wet; no hydrocarbon odor.	ML	Dark red (2.5Y 3/6)	none
55.0 to 59.0	no recovery			
59.0 to 60.5	same as above	ML	Dark red (2.5Y 3/6)	none
60.5 to 64.9	no recovery			
64.9 to 68.2	Silty shale; gypsum layers (2 mm to 1 cm thick) every 0.2 to 1 ft; 10 to 15% small (mm-scale) reduction spots and large (up to 5 cm) reduction spots; wet; no hydrocarbon odor.	ML	Dark red (2.5Y 3/6)	none

VCC-2

Appendix B. RRC Vinson site core description for VCC-2.

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
0.0 to 3.9	Top soil: disturbed or tilled sandy clay; caliche starting to form at 2.5ft; dry; no hydrocarbon odor.	SC	dark red (2.5Y 3/6)	none
3.9 to 4.8	Sandy clay soil; dry; no hydrocarbon odor.	CL	dark red 2.5Y (3/6);	none
4.8 to 8.9	Silty clay; thinly laminated; fractures and plant roots throughout, angles are 30 to 45º, some have what looks like fertilizer staining; hard; dry; no hydrocarbon odor.	CL	dark red (2.5YR 3/6)	none
8.9 to 13.9	Silty clay with interbedded clayey sand; clay has 10 to 15% green reduction spots, many subvertical fractures, and is thinly laminated; sand has 5 to 10% gray green reduction spots; layers vary in thickness from 0.05 to 0.8 ft; thickest sand layer from 12.9 to 13.7 ft; dry; no hydrocarbon odor.	CL	dark red (2.5YR 3/6) and lt. greenish gray (5GY 7/1)	none
13.9 to 18.9	Silty clay with greenish carbonate layer from 15.7 to 17.9 ft; carbonate layer is fractured; silty clay has green reduction spots up to 3 cm diam.; wet; no hydrocarbon odor.	CL	red (2.5YR 4/6); lt. gray (5Y 7/1) and greenish gray (5GY 6/1)	none

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
18.9 to 21.4	Silty clay; 1 to 5% green reduction spots; fracture at base filled with dolomite rhombs; occasional interbeds of sandy clay from 0.05 to 0.2 ft thick; no hydrocarbon odor.	CL	greenish gray (5Y 7/1) dark red (2.5Y 3/6)	none
21.4 to 23.9	Silty clay with occasional sandy clay layers up to 0.4 ft thick; low angle fracture at 22.25 ft with fertilizer(?) staining; 23.7 to 23.9 ft is greenish gray clay; no hydrocarbon odor.	CL	red (2.5YR 4/6); greenish gray (5GY 6/1)	none
23.9 to 25.4	Sandy clay with reduction spots; green gray clay in top 0.1 ft; red sandy clay below; wet; no hydrocarbon odor.	SC	dark red (2.5Y 3/6); greenish gray (5GY 6/1)	none
25.4 to 28.9	Sandy clay with reduction spots; wet; no hydrocarbon odor.	SC	dark red (2.5Y 3/6)	none
28.9 to 30.0	Silty clay with green reduction spots; damp; no hydrocarbon odor.	CL	dark red (2.5Y 3/6)	none

Appendix B. RRC Vinson site core description for VCC-3.

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
0.0 to 3.4	Clayey silt with gravel; caliche from 1.7 ft to base of interval; dry; no hydrocarbon odor.	SW	dark red (2.5Y 3/6)	none
3.4 to 5.0	Silty clay with gravel; 1 to 5% green reduction spots; fractured; dark staining on fracture surfaces; dry; no hydrocarbon odor.	CL	dark red (2.5YR 3/6);	none
5.0 to 8.4	Silty clay with gravel; 1 to 5% green reduction spots; fractured; dark staining on fracture surfaces; dry; no hydrocarbon odor.	CL	dark red (2.5YR 3/6)	none
8.4 to 13.4	Silty clay; 1 to 5% green reduction spots; fractured; dark staining on fracture surfaces; carbonate cemented, fractured layer from 13.1 to 13.4 ft; dry; hydrocarbon odor on cuttings.	CL	reddish brown (2.5YR 5/4); greenish gray (5GY 6/1)	none
13.4 to 18.4	Silty clay with interbedded clayey sand; clay has 5 to 10% green reduction spots and is thinly laminated; angular, poorly sorted sand from 13.4 to 15 ft; many small fractures; dry; hydrocarbon odor from 14.8 to 15.4 and 18.2 to 18.4 ft.	SC	red (2.5YR 4/6)	14.9 to 15.4 ft; 16.6 to 17.3 ft
18.4 to 23.4	Clayey silt; 1 to 5% reduction spots; carbonate cemented layer from 23.2 to 23.4 ft; wet from 18.4 to 19 ft, dry to base of interval; very strong hydrocarbon odor from 18.4 to 20 ft.	ML	red (2.5YR 4/6); greenish gray (5GY 6/1)	18.4 to 19.5 ft; 19.8 to 20.9 ft

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
23.4 to 28.4	Clayey silt; 1 to 5% reduction spots; carbonate cemented layer from 26.4 to 27 ft; high angle fracture from 23.4 to 23.8; moist to 26.4, wet from 26.4 to 28.4 ft; no hydrocarbon odor.	ML	red (2.5YR 4/6); greenish gray (5GY 6/1)	23.4 to 24 ft; 26.6 to 28.4
28.4 to 32.8	Sandy clayey silt; 5 to 10% green reduction spots in clay; interbeds of sandy clay from 29.4 to 30.3 and 32.2 to 32.9 ft; wet; no hydrocarbon odor.	SC	dark red (2.5Y 3/6)	28.4 to 32.2 ft

Appendix B. RRC Vinson site core description for VCC-4.

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
0.0 to 3.0	Sandy clay with gravel; caliche throughout; gravel to 3 ft; moist from 2 to 3 ft; no hydrocarbon odor.	SW	dark red (2.5Y 3/6)	none
3.0 to 8.0	Silty clay with gravel; 1 to 5% green reduction spots; fractured; carbonate cemented zone from 3.6 to 4.2 ft; sampled from 5.5 to 5.9 ft for TPH analysis; fractured with dark staining on fracture surfaces; dolomite rhombs in layer at 7.8 ft; dry; no hydrocarbon odor.	CL	dark red (2.5YR 3/6); greenish gray (5GY 7/1)	none
8.0 to 13.0	Silty clay; 1 to 5% green reduction spots; fractured with dark staining on fracture surfaces; high angle fracture from 9.5 to 9.8 ft; sampled for TPH analysis from 8.4 to 8.8 ft; dry; no hydrocarbon odor.	CL	reddish brown (2.5YR 5/4);	none
13.0 to 18.0	Silty clay; 5 to 10% green reduction spots; thinly laminated; fractured, carbonate cemented zone from 13.5 to 13.7 ft with abundant dark staining along fracture surface; high angle fracture in clay from 14.6 to 15 ft; sampled for TPH analysis from 13.6 to 14 ft; moist from 13.0 to 13.65 and 16 to 18 ft;	CL	red (2.5YR 4/6); greenish gray (5GY 6/1)	none

Depth (ft)	Description	USCS class.	Color	Fluorescence (interval noted)
18.0 to 23.0	Clayey silt; 1 to 5% reduction spots; carbonate cemented layer from 18.9 to 19 ft; sampled for TPH analysis from 20 to 20.5 ft; wet; no hydrocarbon odor.	ML	red (2.5YR 4/6); greenish gray (5GY 6/1)	none
23.0 to 28.0	Clayey silt; 1 to 5% reduction spots; carbonate cemented layer from 26.2 to 27.5 ft; wet; no hydrocarbon odor.	ML	red (2.5YR 4/6); greenish gray (5GY 6/1)	none
28.0 to 33.0	Clayey silt; 1 to 5% reduction spots; dry; no hydrocarbon odor.	ML	dark red (2.5Y 3/6)	
33.0 to 38.0	Clayey silt with carbonate cemented layer from 34.9 to 35.2 ft; moist; no hydrocarbon odor.	ML	dark red (2.5Y 3/6)	none

Appendix C

Vinson Water-Well Report

Send original copy by certified mail to: Texas Water Commis. P.O. Box 13087, Austin, Texas 78711   Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas
WELL REPORT

Texas Water Well Drillers Board
P.O. Box 13087
Austin, Texas 78711

1) **OWNER** E. T. WINSON (Name) **ADDRESS** RT 1 BOX 126 MERKEL TX 79536 (Street or RFD) (City) (State) (Zip)

2) **LOCATION OF WELL:** County JONES , 7½ miles in NE (NE, SW, etc.) direction from MERKEL TX (Town)

Driller must complete the legal description below with distance and direction from two intersecting section or survey lines, or he must locate and identify the well on an official Quarter- or Half-Scale Texas County General Highway Map and attach the map to this form.

☐ **LEGAL DESCRIPTION:**

Section No. ______ Block No. ______ Township ______ Abstract No. ______ Survey Name ______

Distance and direction from two intersecting section or survey lines ______

☒ **SEE ATTACHED MAP**

3) **TYPE OF WORK (Check):** ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) **PROPOSED USE (Check):** ☒ Domestic ☐ Industrial ☐ Monitor ☐ Public Supply ☐ Irrigation ☐ Test Well ☐ Injection ☐ De-Watering

5) **DRILLING METHOD (Check):** ☐ Driven ☐ Mud Rotary ☐ Air Hammer ☐ Jetted ☐ Bored ☐ Air Rotary ☒ Cable Tool ☐ Other ______

6) **WELL LOG:**
Date Drilling:
Started 5-1 19 91
Completed 5-7 19 91

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
8	Surface	60

7) **BOREHOLE COMPLETION:** ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other ______

If Gravel Packed give interval . . . from 16 ft. to 60 ft.

From (ft.)	To (ft.)	Description and color of formation material
0	1	SOIL
1	16	RED CLAY
16	31	RED SHALE
31	32	WATER 1/4 GPM
32	43	RED SHALE
43	47	RED CLAY
47	53	SAND & RED CLAY
53	55	WATER 22 GPM
55	60	RED CLAY

(Use reverse side if necessary)

8) **CASING, BLANK PIPE, AND WELL SCREEN DATA:**

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
5	N	PVC	+18"	60	
		PERFS	33	59	

9) **CEMENTING DATA** [Rule 287.44(1)]
Cemented from +1 ft. to 15 ft. No. of Sacks Used 3
______ ft. to ______ ft. No. of Sacks Used ______
Method used BUCKET
Cemented by J. E. McGUIRE

13) **TYPE PUMP:** ☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other ______
Depth to pump bowls, cylinder, jet, etc., ______ ft.

10) **SURFACE COMPLETION**
☐ Specified Surface Slab Installed [Rule 287.44(2)(A)]
☐ Pitless Adapter Used [Rule 287.44(3)(B)]
☒ Approved Alternative Procedure Used [Rule 287.71]

14) **WELL TESTS:**
Type Test: ☐ Pump ☒ Bailer ☐ Jetted ☐ Estimated
Yield: 40 gpm with 5 ft. drawdown after 1 hrs.

11) **WATER LEVEL:**
Static level 19 ft. below land surface Date 7-7-91
Artesian flow ______ gpm. Date ______

15) **WATER QUALITY:**
Did the drilling penetrate any strata which contained undesirable constituents?
☐ Yes ☒ No If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? FRESH Depth of strata ______
Was a chemical analysis made? ☐ Yes ☒ No

12) **PACKERS:**

Type	Depth
CEM	15 FT

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME J. E. McGUIRE DRLG (Type or print) WELL DRILLER'S LICENSE NO. 2329

ADDRESS BOX 54 (Street or RFD) MERKEL (City) TX (State) 79536 (Zip)

(Signed) ______ (Licensed Well Driller) (Signed) ______ (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

For TWC use only: Well No. ______ Located on map ______

WWD-012 (Rev. 09/21/88)

WELL OWNER'S COPY

Appendix D

Risk-Modeling Data

TEXAS RBCA CHEMICAL DATABASE

Physical Property Data

CAS Number	Constituent	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients in air (cm2/s) Dair	ref	Diffusion Coefficients in water (cm2/s) Dwat	ref	log (Koc) or log(Kd) (@ 20 - 25 C) (L/kg) log Koc	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (@ 20 - 25 C) (unitless)	ref	Vapor Pressure (@ 20 - 25 C) Pure Comp. (mm Hg) Pvap.PC	ref	Solubility (@ 20 - 25 C) Pure Comp. (mg/L) Sol.PC	ref	acid pKa	base pKb	ref
120-12-7	Anthracene	PAH	178.23	4	5.68E-02	TX	7.74E-06	4	4.15	TX	1.02E-03	4.24E-02	TX	1.30E-06	4	4.50E-02	TX			
71-43-2	Benzene	A	78.1	5	9.33E-02	TX	1.10E-05	A	1.92	TX	5.59E-03	2.32E-01	TX	9.52E+01	4	1.75E+03	TX			
100-41-4	Ethylbenzene	A	106.2	5	7.48E-02	TX	8.50E-06	A	3.04	TX	6.43E-03	2.67E-01	TX	1.00E+01	4	1.52E+02	TX			
206-44-0	Fluoranthene	PAH	202	4	3.02E-02	4	6.35E-06	4	4.58	TX	6.46E-06	2.69E-04	TX	1.77E-02	4	2.06E-01	TX			
85-01-8	Phenanthrene	PAH	178.22	4	5.40E-03	TX	7.47E-06	4	4.15	TX	1.59E-04	6.63E-03	TX	2.10E-04	4	1.00E+00	TX			
129-00-0	Pyrene	PAH	202.3	4	2.72E-02	4	7.24E-06	4	4.58	TX	5.11E-06	2.13E-04	TX	4.20E-08	4	1.30E-01	TX			
108-88-3	Toluene	A	92.4	5	8.38E-02	TX	9.40E-06	A	2.48	TX	6.37E-03	2.65E-01	TX	3.00E+01	4	5.35E+02	TX			
1330-20-7	Xylene (mixed isomers)	A	106.2	5	7.40E-02	TX	8.50E-06	A	2.38	TX	7.04E-03	2.93E-01	TX	7.00E+00	4	1.98E+02	TX			

Site Name: Vinson Site Location: 0 Completed By: Jeri Sullivan/Becky Smy Date Completed: 2/25/1998

Software version: Texas RBCA, v. 1.0

TEXAS RBCA CHEMICAL DATABASE

Toxicity Data

		Reference Dose (mg/kg/day)						Slope Factors 1/(mg/kg/day)							
CAS Number	Constituent	Oral RfD_oral	ref	Dermal RfD_derm	ref	Inhalation RfD_inhal	ref	Oral SF_oral	ref	Dermal SF_derm	ref	Inhalation SF_inhal	ref	EPA Weight of Evidence	Is Constituent Carcinogenic ?
120-12-7	Anthracene	3.00E-01	TX	2.28E-01	TX	-	TX	-	R	-		-	R	D	FALSE
71-43-2	Benzene	-	R	-		1.70E-03	R	2.90E-02	TX	2.99E-02	TX	2.91E-02	TX	A	TRUE
100-41-4	Ethylbenzene	1.00E-01	TX	9.70E-02	TX	1.00E+00	TX	-	R	-		-	R	D	FALSE
206-44-0	Fluoranthene	4.00E-02	TX	1.24E-02	TX	-	R	-	R	-		-	R	D	FALSE
85-01-8	Phenanthrene	4.00E-03		2.19E-02	TX	4.00E-03		-	R	-		-	R	D	FALSE
129-00-0	Pyrene	3.00E-02	TX	9.30E-03	TX	-	R	-	R	-		-	R	D	FALSE
108-88-3	Toluene	2.00E-01	TX	1.60E-01	TX	4.00E-01	TX	-	R	-		-	R	D	FALSE
1330-20-7	Xylene (mixed isomers)	2.00E+00	TX	1.84E+00	TX	-	TX	-	R	-		-	R	D	FALSE

Site Name: Vinson Site Location: 0 Completed By: Jeri Sullivan/Becky Smyth Date Completed: 2/25/1998

Software version: Texas RBCA, v. 1.0

TEXAS RBCA CHEMICAL DATABASE

Miscellaneous Chemical Data

CAS Number	Constituent	MCL (mg/L)	Permissible Exposure Limit PEL/TLV (mg/m3)	ref	Lower Explosive Limit (ppm)	ref	Relative Absorption Factors		Water Dermal Permeability Data					Half Life (First-Order Decay) (days)		
							Oral	Dermal	Kp (cm/hr)	tau (hr)	t* (hr)	B	ref	Saturated	Unsaturated	ref
120-12-7	Anthracene				6.00E+03	26	1	0.05						920	920	H
71-43-2	Benzene	5.00E-03	3.20E+00	OSHA	1.30E+04	TX	1	0.5	2.10E-02	2.60E-01	6.30E-01	1.30E-02	D	720	720	H
100-41-4	Ethylbenzene	7.00E-01	4.34E+02	ACGIH	1.00E+04	TX	1	0.5	7.40E-02	3.90E-01	1.30E+00	1.40E-01	D	228	228	H
206-44-0	Fluoranthene				-		1	0.05	3.60E-01	1.50E+00	7.30E+00	8.90E+00	D	880	880	H
85-01-8	Phenanthrene				-		1	0.05	2.30E-01	1.10E+00	5.60E+00	2.90E+00	D	400	400	H
129-00-0	Pyrene				-		1	0.05						3800	3800	H
108-88-3	Toluene	1.00E+00	1.47E+02	ACGIH	1.20E+04	TX	1	0.5	4.50E-02	3.20E-01	7.70E-01	5.40E-02	D	28	28	H
1330-20-7	Xylene (mixed isomers)	1.00E+01	4.34E+02	ACGIH	1.00E+04	TX	1	0.5	8.00E-02	3.90E-01	1.40E+00	1.60E-01	D	360	360	H

Site Name: Vinson   Site Location: 0   Completed By: Jeri Sullivan/Becky Smyth   Date Completed: 2/25/1998

Software version: Texas RBCA, v. 1.0

RBCA SITE ASSESSMENT **Input Screen 9.4**

GROUNDWATER DAF VALUES

(Enter DAF values in the following table)

CONSTITUENT	Groundwater DAF Off-Site Residential Receptor
Anthracene	4.0E+1
Benzene	4.0E+1
Ethylbenzene	4.0E+1
Fluoranthene	4.0E+1
Phenanthrene	4.0E+1
Pyrene	4.0E+1
Toluene	4.0E+1
Xylene (mixed isomers)	4.0E+1

Site Name: Vinson	Completed By: Jeri Sullivan/Becky Smyth
Site Location: 0	Date: 2/25/1998

TNRCC RBCA SITE ASSESSMENT

EXPOSURE LIMITS IN GROUNDWATER AND AIR

CONSTITUENT	Exposure Limits Applied to Receptors	
	Groundwater (MCL) (mg/L)	Air (Comm. only) (PEL/TLV) (mg/m^3)
Anthracene		
Benzene	5.0E-3	
Ethylbenzene	7.0E-1	
Fluoranthene		
Phenanthrene		
Pyrene		
Toluene	1.0E+0	
Xylene (mixed isomers)	1.0E+1	

Site Name: Vinson
Site Location: 0

Completed By: Jeri Sullivan/Becky Smyth
Date: 2/25/1998

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT **Plan B Output Table 2**

Site Name: Vinson
Site Location: 0
Completed By: Jeri Sullivan/Becky Smyth
Date Completed: 2/25/1998

PLAN B EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

VOLATILIZATION FROM GW: VAPOR INHALATION	Exposure Concentration 1) Source Medium	2) NAF Value (m^3/L) Receptor		3) Exposure Medium Air: POE Conc. (mg/m^3) (1) / (2)		4) Exposure Multiplier (IRxEFxED)/(BWxAT) (m^3/kg-day)		5) Average Daily Intake Rate (mg/kg-day) (3) X (4)		TOTAL PATHWAY INTAKE (mg/kg-day) *(Sum intake values from soil and groundwater routes.)*	
Constituents of Concern	Groundwater Conc. (mg/L)	On-Site: Future Residential	Off-Site: Current Residential	On-Site: Future Residential	Off-Site: Current Residential	On-Site: Future Residential	Off-Site: Current Residential	On-Site: Future Residential	Off-Site: Current Residential	On-Site: Future Residential	Off-Site: Current Residential
Anthracene	1.1E-2	7.1E+5	7.1E+5	1.5E-8	1.5E-8	1.4E-1	2.1E-1	2.1E-9	3.2E-9	2.1E-9	3.2E-9
Benzene	5.0E-4	1.4E+5	1.4E+5	3.7E-9	3.7E-9	1.8E-2	8.8E-2	6.6E-11	3.3E-10	6.6E-11	3.3E-10
Ethylbenzene	5.0E-4	1.5E+5	1.5E+5	3.3E-9	3.3E-9	1.4E-1	2.1E-1	4.5E-10	6.7E-10	4.5E-10	6.7E-10
Fluoranthene	1.2E-2	1.4E+8	1.4E+8	8.6E-11	8.6E-11	1.4E-1	2.1E-1	1.2E-11	1.8E-11	1.2E-11	1.8E-11
Phenanthrene	9.5E-3	3.3E+7	3.3E+7	2.9E-10	2.9E-10	1.4E-1	2.1E-1	4.0E-11	5.9E-11	4.0E-11	5.9E-11
Pyrene	1.4E-2	1.9E+8	1.9E+8	7.4E-11	7.4E-11	1.4E-1	2.1E-1	1.0E-11	1.5E-11	1.0E-11	1.5E-11
Toluene	5.0E-4	1.4E+5	1.4E+5	3.6E-9	3.6E-9	1.4E-1	2.1E-1	5.0E-10	7.4E-10	5.0E-10	7.4E-10
Xylene (mixed isomers)	5.0E-4	1.4E+5	1.4E+5	3.5E-9	3.5E-9	1.4E-1	2.1E-1	4.8E-10	7.1E-10	4.8E-10	7.1E-10

NOTE:
ABS = Dermal absorption factor (dim)
AF = Adherance factor (mg/cm^2)
AT = Averaging time (days)
BW = Body Weight (kg)
CF = Units conversion factor
ED = Exp. duration (yrs)
EF = Exposure frequencey (days/yr)
ET = Exposure time (hrs/day)
IR = Intake rate (m^3/day)
POE = Point of exposure
SA = Skin surface area (cm^2)

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT

Plan B Output Table 2

Site Name: Vinson | Site Location: 0 | Completed By: Jeri Sullivan/Becky Smyth | Date Completed: 2/25/1998

PLAN B EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

VOLATILIZATION FROM GW:
INDOOR VAPOR INHALATION

Constituents of Concern	Exposure Concentration 1) Source Medium Groundwater Conc. (mg/L)	2) NAF Value (m^3/L) Receptor On-Site: Current Residential		3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2) On-Site: Current Residential		4) Exposure Multiplier (IRxEFxED)/(BWxAT) (m^3/kg-day) On-Site: Current Residential		5) Average Daily Intake Rate (mg/kg-day) (3) X (4) On-Site: Current Residential		TOTAL PATHWAY INTAKE (mg/kg-day) *(Sum intake values from soil and groundwater routes.)* On-Site: Current Residential	
Anthracene	1.1E-2	5.4E+2		2.0E-5		2.1E-1		4.2E-6		4.2E-6	
Benzene	5.0E-4	8.5E+1		5.9E-6		8.8E-2		5.2E-7		5.2E-7	
Ethylbenzene	5.0E-4	9.5E+1		5.3E-6		2.1E-1		1.1E-6		1.1E-6	
Fluoranthene	1.2E-2	1.2E+5		9.6E-8		2.1E-1		2.0E-8		2.0E-8	
Phenanthrene	9.5E-3	3.0E+4		3.2E-7		2.1E-1		6.6E-8		6.6E-8	
Pyrene	1.4E-2	1.7E+5		8.3E-8		2.1E-1		1.7E-8		1.7E-8	
Toluene	5.0E-4	8.6E+1		5.8E-6		2.1E-1		1.2E-6		1.2E-6	
Xylene (mixed isomers)	5.0E-4	8.9E+1		5.6E-6		2.1E-1		1.2E-6		1.2E-6	

NOTE:
ABS = Dermal absorption factor (dim)
AF = Adherance factor (mg/cm^2)
AT = Averaging time (days)
BW = Body Weight (kg)
CF = Units conversion factor
ED = Exp. duration (yrs)
EF = Exposure frequency (days/yr)
ET = Exposure time (hrs/day)
IR = Intake rate (m^3/day)
POE = Point of exposure
SA = Skin surface area (cm^2)

Software: Texas RBCA
Version: 1.0

Serial: G-437-SNX-750

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT | **Plan B Output Table 2**

Site Name: Vinson
Site Location: 0
Completed By: Jeri Sullivan/Be Date Completed: 2/25/1998

PLAN B EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: INGESTION

	Exposure Concentration								
	1) Source Medium	2) NAF Value (dim) Receptor		3) Exposure Medium Groundwater: POE Conc. (mg/L) (1)/(2)		4) Exposure Multiplier (IRxEFxED)/(BWxAT) (L/kg-day)		5) Average Daily Intake Rate (mg/kg-day) (3) X (4)	
Constituents of Concern	Groundwater Conc. (mg/L)	On-Site: Current Residential	Off-Site: Current Residential	On-Site: Current Residential	Off-Site: Current Residential	On-Site: Current Residential	Off-Site: Current Residential	On-Site: Current Residential	Off-Site: Current Residential
Anthracene	1.1E-2	1.0E+0	4.0E+1	1.1E-2	2.7E-4	2.7E-2	2.7E-2	3.0E-4	7.5E-6
Benzene	5.0E-4	1.0E+0	4.0E+1	5.0E-4	1.2E-5	1.2E-2	1.2E-2	5.9E-6	1.5E-7
Ethylbenzene	5.0E-4	1.0E+0	4.0E+1	5.0E-4	1.2E-5	2.7E-2	2.7E-2	1.4E-5	3.4E-7
Fluoranthene	1.2E-2	1.0E+0	4.0E+1	1.2E-2	3.0E-4	2.7E-2	2.7E-2	3.3E-4	8.2E-6
Phenanthrene	9.5E-3	1.0E+0	4.0E+1	9.5E-3	2.4E-4	2.7E-2	2.7E-2	2.6E-4	6.5E-6
Pyrene	1.4E-2	1.0E+0	4.0E+1	1.4E-2	3.5E-4	2.7E-2	2.7E-2	3.8E-4	9.6E-6
Toluene	5.0E-4	1.0E+0	4.0E+1	5.0E-4	1.2E-5	2.7E-2	2.7E-2	1.4E-5	3.4E-7
Xylene (mixed isomers)	5.0E-4	1.0E+0	4.0E+1	5.0E-4	1.2E-5	2.7E-2	2.7E-2	1.4E-5	3.4E-7

Groundwater DAF Option: Domenico - No Decay

NOTE:
AT = Averaging time (days)
BW = Body Weight (kg)
CF = Units conversion factor
ED = Exp. duration (yrs)
EF = Exposure frequencey (days/yr)
EV = Event frequency (events/day)
IR = Intake rate (L/day or mg/day)
POE = Point of exposure
SA = Skin surface area (cm^2)
Z = Adsorption factor (cm/event)

Software: Texas RBCA
Version: 1.0
Serial: G-437-SNX-750

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT **Plan B Output Table 2**

Site Name: Vinson Site Location: 0 Completed By: Jeri Sullivan/Becky Smyth Date Completed: 2/25/1998

PLAN B EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ☐ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: DERMAL CONTACT	Exposure Concentration									TOTAL PATHWAY INTAKE (mg/kg-day) *(Sum intake values from maximum of ingestion and dermal routes.)*	
	1) Source Medium	2) NAF Value (dim) Receptor		3) Exposure Medium Groundwater: POE Conc. (mg/L) (1)/(2)		4) Exposure Multiplier (SAxZxCFxEFxED*EV)/(BWxAT) (L/kg-day)		5) Average Daily Intake Rate (mg/kg-day) (3) X (4)			
Constituents of Concern	Groundwater Conc. (mg/L)	On-Site:	Off-Site:	On-Site:	Off-Site:	On-Site:	Off-Site:	On-Site:	Off-Site:	On-Site: Current Residential	Off-Site: Current Residential
Anthracene	1.1E-2									3.0E-4	7.5E-6
Benzene	5.0E-4									5.9E-6	1.5E-7
Ethylbenzene	5.0E-4									1.4E-5	3.4E-7
Fluoranthene	1.2E-2									3.3E-4	8.2E-6
Phenanthrene	9.5E-3									2.6E-4	6.5E-6
Pyrene	1.4E-2									3.8E-4	9.6E-6
Toluene	5.0E-4									1.4E-5	3.4E-7
Xylene (mixed isomers)	5.0E-4									1.4E-5	3.4E-7

Groundwater DAF Option: Domenico - No Decay

NOTE:
AT = Averaging time (days)
BW = Body Weight (kg)
CF = Units conversion factor
ED = Exp. duration (yrs)
EF = Exposure frequencey (days/yr)
EV = Event frequency (events/day)
IR = Intake rate (L/day or mg/day)
POE = Point of exposure
SA = Skin surface area (cm^2)
Z = Adsorption factor (cm/event)

Software: Texas RBCA
Version: 1.0
Serial: G-437-SNX-750

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT **Plan B Output Table 3**

Site Name: Vinson Site Location: 0 Completed By: Jeri Sullivan/Becky Smyth Date Completed: 2/25/1998

PLAN B PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAYS ARE ACTIVE)

	CARCINOGENIC RISK						TOXIC EFFECTS				
Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Intake Rate (mg/kg/day) On-Site: Future Residential	(2) Total Carcinogenic Intake Rate (mg/kg/day) Off-Site: Current Residential	(3) Inhalation Slope Factor (mg/kg-day)^-1	(4) Individual COC Risk (2) x (3) On-Site: Future Residential	(4) Individual COC Risk (2) x (3) Off-Site: Current Residential	(5) Total Toxicant Intake Rate (mg/kg/day) On-Site: Future Residential	(5) Total Toxicant Intake Rate (mg/kg/day) Off-Site: Current Residential	(6) Inhalation Reference Dose (mg/kg-day)	(7) Individual COC Hazard Quotient (5) / (6) On-Site: Future Residential	(7) Individual COC Hazard Quotient (5) / (6) Off-Site: Current Residential
Anthracene	D										
Benzene	A	6.6E-11	3.3E-10	2.9E-2	1.9E-12	9.5E-12	5.1E-10	7.6E-10	1.7E-3	3.0E-7	4.5E-7
Ethylbenzene	D						4.5E-10	6.7E-10	1.0E+0	4.5E-10	6.7E-10
Fluoranthene	D										
Phenanthrene	D						4.0E-11	5.9E-11	4.0E-3	9.9E-9	1.5E-8
Pyrene	D										
Toluene	D						5.0E-10	7.4E-10	4.0E-1	1.2E-9	1.9E-9
Xylene (mixed isomers)	D										

Total Pathway Carcinogenic Risk = **1.9E-12** **9.5E-12**

Total Pathway Hazard Index = **3.1E-7** **4.6E-7**

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT | **Plan B Output Table 3**

Site Name: Vinson　Site Location: 0　Completed By: Jeri Sullivan/Becky Smyth　Date Completed: 2/25/1998

PLAN B PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS　■ (CHECKED IF PATHWAYS ARE ACTIVE)

	CARCINOGENIC RISK						TOXIC EFFECTS				
Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Intake Rate (mg/kg/day) On-Site: Current Residential		(3) Inhalation Slope Factor (mg/kg-day)^-1	(4) Individual COC Risk (2) x (3) On-Site: Current Residential		(5) Total Toxicant Intake Rate (mg/kg/day) On-Site: Current Residential		(6) Inhalation Reference Dose (mg/kg-day)	(7) Individual COC Hazard Quotient (5) / (6) On-Site: Current Residential	
Anthracene	D										
Benzene	A	5.2E-7		2.9E-2	1.5E-8		8.1E-7		1.7E-3	4.8E-4	
Ethylbenzene	D						7.3E-7		1.0E+0	7.3E-7	
Fluoranthene	D										
Phenanthrene	D						4.4E-8		4.0E-3	1.1E-5	
Pyrene	D										
Toluene	D						8.1E-7		4.0E-1	2.0E-6	
Xylene (mixed isomers)	D										

Total Pathway Carcinogenic Risk = **1.5E-8**

Total Pathway Hazard Index = **4.9E-4**

Software: Texas RBCA
Version: 1.0

Serial: G-437-SNX-750

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT | **Plan B Output Table 3**

Site Name: Vinson
Site Location: 0
Completed By: Jeri Sullivan/Becky
Date Completed: 2/25/1998

PLAN B PATHWAY RISK CALCULATION

COMBINED SOIL/AIR EXPOSURE PATHWAY ■ (CHECKED IF PATHWAYS ARE ACTIVE)

		CARCINOGENIC RISK							TOXIC EFFECTS						
Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Intake Rate (mg/kg/day) On-Site: Future Residential		(3a) Oral Slope Factor (mg/kg-day)^-1	(3b) Inhalation Slope Factor (mg/kg-day)^-1	(3c) Dermal Slope Factor (mg/kg-day)^-1	(4) Individual COC Risk (2) x (3) On-Site: Future Residential		(5) Total Toxicant Intake Rate (mg/kg/day) On-Site: Future Residential		(6a) Oral Ref. Dose (mg/kg-day)	(6b) Inhalation Ref. Dose (mg/kg-day)	(6c) Dermal Ref. Dose (mg/kg-day)	(7) Individual COC Hazard Quotient (5) / (6) On-Site: Future Residential	
Anthracene	D								0.0E+0		3.0E-1		2.3E-1	0.0E+0	
Benzene	A	6.6E-11		2.9E-2	2.9E-2	3.0E-2	1.9E-12		5.1E-10			1.7E-3		3.0E-7	
Ethylbenzene	D								4.5E-10		1.0E-1	1.0E+0	9.7E-2	4.5E-10	
Fluoranthene	D								0.0E+0		4.0E-2		1.2E-2	0.0E+0	
Phenanthrene	D								4.0E-11		4.0E-3	4.0E-3	2.2E-2	9.9E-9	
Pyrene	D								0.0E+0		3.0E-2		9.3E-3	0.0E+0	
Toluene	D								5.0E-10		2.0E-1	4.0E-1	1.6E-1	1.2E-9	
Xylene (mixed isomers)	D								0.0E+0		2.0E+0		1.8E+0	0.0E+0	

Total Pathway Carcinogenic Risk = **1.9E-12**

Total Pathway Hazard Index = **3.1E-7**

Software: Texas RBCA
Version: 1.0

Serial: G-437-SNX-750

STATE OF TEXAS - TNRCC RBCA SITE ASSESSMENT | **Plan B Output Table 3**

Site Name: Vinson
Site Location: 0
Completed By: Jeri Sullivan/Becky Smyth
Date Completed: 2/25/1998

PLAN B PATHWAY RISK CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAYS ARE ACTIVE)

		CARCINOGENIC RISK						TOXIC EFFECTS					
	(1) EPA	(2) Total Carcinogenic Intake Rate (mg/kg/day)		(3a) Oral Slope Factor	(3b) Dermal Slope Factor	(4) Individual COC Risk (2) x (3)		(5) Total Toxicant Intake Rate (mg/kg/day)		(6a) Oral Ref. Dose	(6b) Dermal Ref. Dose	(7) Individual COC Hazard Quotient (5) / (6)	
Constituents of Concern	Carcinogenic Classification	On-Site: Current Residential	Off-Site: Current Residential	(mg/kg-day)^-1	(mg/kg-day)^-1	On-Site: Current Residential	Off-Site: Current Residential	On-Site: Current Residential	Off-Site: Current Residential	(mg/kg-day)	(mg/kg-day)	On-Site: Current Residential	Off-Site: Current Residential
Anthracene	D							3.0E-4	7.5E-6	3.0E-1	2.3E-1	1.0E-3	2.5E-5
Benzene	A	5.9E-6	1.5E-7	2.9E-2	3.0E-2	1.7E-7	4.3E-9						
Ethylbenzene	D							1.4E-5	3.4E-7	1.0E-1	9.7E-2	1.4E-4	3.4E-6
Fluoranthene	D							3.3E-4	8.2E-6	4.0E-2	1.2E-2	8.2E-3	2.1E-4
Phenanthrene	D							2.6E-4	6.5E-6	4.0E-3	2.2E-2	6.5E-2	1.6E-3
Pyrene	D							3.8E-4	9.6E-6	3.0E-2	9.3E-3	1.3E-2	3.2E-4
Toluene	D							1.4E-5	3.4E-7	2.0E-1	1.6E-1	6.8E-5	1.7E-6
Xylene (mixed isomers)	D							1.4E-5	3.4E-7	2.0E+0	1.8E+0	6.8E-6	1.7E-7

Total Pathway Carcinogenic Risk = **1.7E-7** | **4.3E-9**

Total Pathway Hazard Index = **8.7E-2** | **2.2E-3**

Software: Texas RBCA
Version: 1.0

Serial: G-437-SNX-750

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