Technical Report

Site Investigation and Preliminary Assessment of the Colorado River Seep site in Wharton County, Texas
(RRC CU# 03-51041)

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SUMMARY

The University of Texas at Austin, Bureau of Economic Geology (BEG), investigated the Colorado River Seep site near the border of Wharton and Matagorda Counties for the Railroad Commission of Texas (RRC) in July and August 1999. The area of concern occupies 0.03 mi^2 (0.07 km^2) on the H. C. Cockburn lease adjacent to the east bank of the Colorado River. The RRC and Magnet-Withers field operators have attempted to identify possible sources of the crude-oil seep since 1992; however, there have been no conclusive findings. The objectives of this study were to (1) characterize the extent of hydrocarbon impacts, (2) determine whether further work is needed to eliminate possible hydrocarbon sources, and (3) produce a summary report containing results of the field investigation.

The scope of work consisted of collecting continuous cores and installing ground-water monitoring wells in 12 boreholes, located as to assess each of several possible sources of the crude oil:

- a plugged and abandoned oil well,
- two tank batteries, and
- as many as four former surface pits that are reported to have been used for oil storage, salt-water storage, or drilling-mud containment.

Data from both this and previous studies indicate that crude oil impacts several locations within the study area, but not all of them are related to the currently observed crude-oil seep.

The most likely source of crude oil now seeping into the Colorado River is one or more of the former surface pits. We base this conclusion primarily on the presence of free-phase crude oil in two wells adjacent to two of the former pits and on results of photoionization detector (PID) screening and laboratory analysis of sediment samples. The

finding is consistent with previous data. The probable pathway for crude-oil discharge to the river is (a) migration from the pit(s) downward through fractured clays to a confined water-bearing sand at a depth of approximately 50 ft and (b) lateral movement in the sand to the river.

Although free-phase crude oil is present in only two of the BEG monitoring wells located between the active seep and the former surface pits, there are other hydrocarbon impacts present at the site. The areal extent and volume of oil discharging to the river have changed over time. Previously reported seeps were located upstream from the seepage area we observed. Hydrocarbon-impacted soil adjacent to an abandoned oil-storage tank battery and a plugged and abandoned oil well suggests that other releases of oil could account for earlier reported seeps.

INTRODUCTION

Purpose and Scope

The University of Texas at Austin, Bureau of Economic Geology (BEG), investigated the Colorado River Seep site near the Wharton and Matagorda county line for the Railroad Commission of Texas (RRC) to help identify the source or sources of crude oil seeping into the river (fig. 1). Previous efforts by RRC and Magnet-Withers field operators to identify the source of the crude-oil seep and a responsible party have not been successful. The objectives of this study were to (1) characterize the extent of hydrocarbon impacts, (2) determine whether further work is needed to eliminate possible hydrocarbon sources, and (3) produce a summary report containing results of our field investigation.

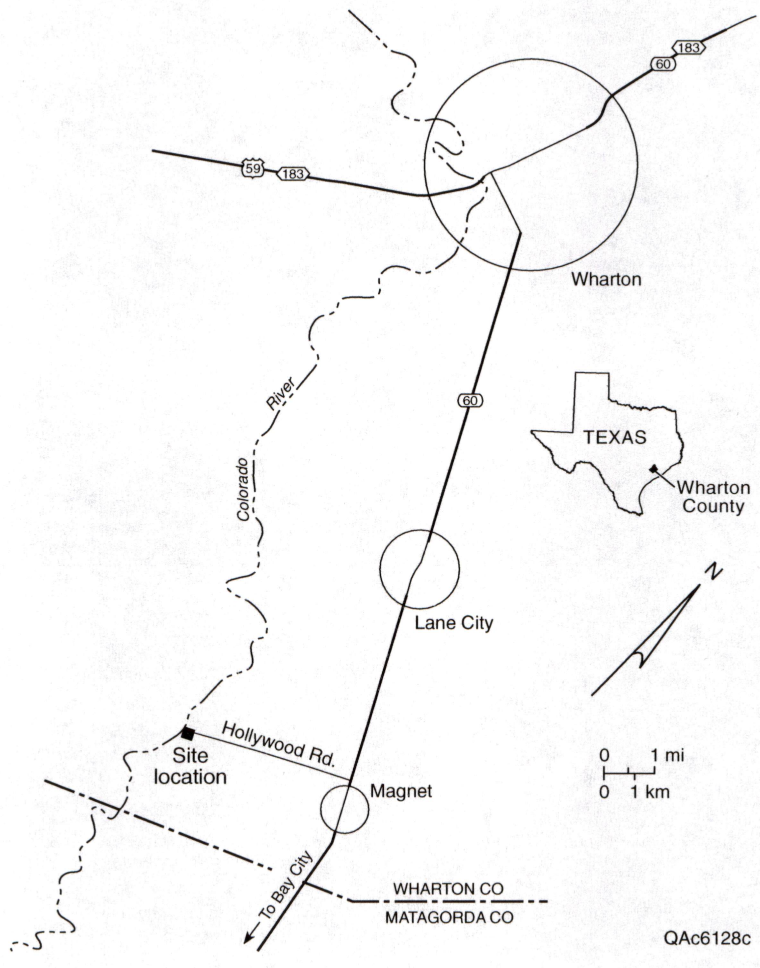

Figure 1. Location of RRC Colorado River Seep site in Wharton County, Texas.

Site History

The area of concern for this study occupies 0.03 mi^2 (0.07 km^2) on the east side of the Colorado River (fig. 2). Most of the site is located on the Brock Ranch (H. C. Cockburn lease, state tract 8B), which is located to the south of Hollywood Road (also known as County Road 106). A small part of the site lies to the north of Hollywood Road on the Tribig property (H. C. Cockburn lease, state tract 7). The Brock Ranch foreman, Mr. Kenneth Roper, has lived on or near the ranch for most of his life and provided information on site history. According to Mr. Roper, crude oil has been seeping into the Colorado River at the site since as early as 1950. Oil exploration and production have been active on lands adjacent to both sides of the river since the late 1930's.

Oil wells on the site are part of the Magnet-Withers oil field, which was discovered in 1936. The production zone is the Frio Formation Barrier/Strandplain sandstone at 5,600 ft. Oil with API gravity of 26 was produced via gas-cap expansion and water drive (Galloway and others, 1983). One of the oil wells, the H. C. Cockburn lease, state tract 8B, well no. 1 (Wolfe and Gray well), blew out in January 1959; this well was plugged and abandoned in 1971 (February 10, 1959, letter from C. F. Gray to RRC District 3). Most other oil wells on the site have also been either plugged or shut-in. Aerial photographs from 1956, 1962, 1971, 1972, and 1989 show that as many as four surface pits have been within the study area (fig. 2). The 1956, 1971, and 1989 photographs are contained in the AEPT (1993) report. Photocopies of the 1962 and 1972 aerial photographs are contained in appendix A.

The Colorado River Seep was reported by RRC District 3 personnel in October 1991. In April 1992, RRC excavated a trench adjacent to the Colorado River, between the river and Pit A, approximately 125 ft from the river (fig. 2). Workers found hydrocarbon-soaked dirt and sludge at 10 ft. On April 30, 1992, the RRC District 3 Director, Guy Grossman, notified the Atlantic Richfield Company (ARCO) of violation of RRC Statewide

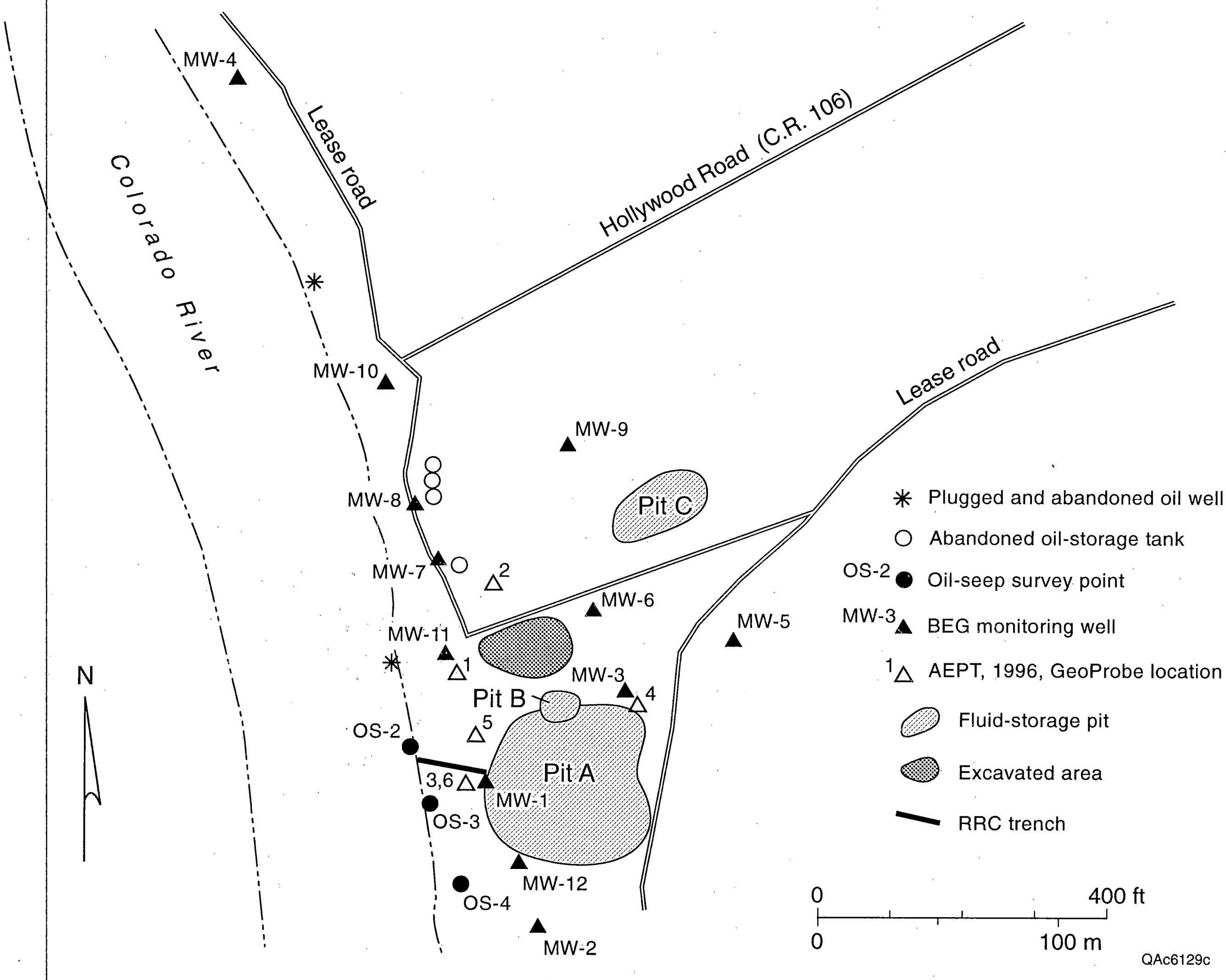

Figure 2. Site map showing locations of BEG monitoring wells, former surface pits, former and existing storage tanks, pertinent plugged and abandoned oil wells, GeoProbe locations from a previous study, and oil-seep survey points.

Rule 8. ARCO Oil and Gas and ARCO Exploration and Production Technology, Environmental Technology Group (AEPT), then began conducting contaminant-source investigations:

- On July 13, 1992, ARCO representatives visited the site and reported results to RRC on July 20, 1992. On the basis of (1) conductivity measurements of water samples taken from ponded water in Pit A (fig. 2) and from the Colorado River and (2) an analysis of oil emanating from the seep, ARCO concluded that the pits were not the source of oil seeping into the river. At that time ARCO noted an additional oil seep in the river approximately 75 yd upstream, adjacent to an existing tank battery.
- On October 2, 1992, RRC requested that ARCO further investigate the source of the Colorado River oil seep. ARCO contracted AEPT to perform fieldwork from October 4 through 14, 1992, using a Giddings soil-boring rig. They drilled 13 holes to depths of from 6.5 to 15 ft and measured borehole vapors using a photoionization detector (PID). In the center of what AEPT called pond no. 1 (Pit A on fig. 2) at a depth of 10 ft, they found gleyed (reduced), clayey sand containing brown liquid with a distinct hydrocarbon odor.

AEPT concluded that Pit A was not the original source of the crude-oil seep into the Colorado River on the basis of results from (1) 13 PID measurements in boreholes completed at depths of between 6.5 and 15 ft; (2) gas chromatograms of soil samples from three borings and two samples of oil, one from the river seep and one from sump of the adjacent tank battery; and (3) two analyses of metals contained in soil samples collected from unreported depths. However, Pit A (their pit no. 1) was the one place AEPT found crude-oil-impacted sediments. AEPT hypothesized that the original source of crude oil was an abandoned pit noted on a 1956 aerial photograph (excavated area in fig. 2). No oil was found in that pit, but AEPT proposed that it might have been filled by "oil-emulsion drilling mud" or may have contained oil because of the dark reflectance observed on the 1956 aerial photo. According to AEPT, crude oil migrated south from the excavated area to Pit A and then moved west to the Colorado River (AEPT, 1993).

- Following a further RRC directive (February 5, 1993, meeting between ARCO and RRC District 3), AEPT contracted Burlington Environmental, Inc., of Houston, Texas, to remediate the old surface pits. Between March 28 and April 7, 1994, workers excavated Pit A down to "clean" soil, mixed the excavated material with clean soil, and placed it all back into the excavation. They removed the soil from what AEPT identified as Pit G (Pit B in fig. 2), mixed it with clean soil and fly ash, and placed it all back into the excavation. Pits A and B were covered with purchased topsoil and seeded with native grasses. No free-phase hydrocarbons were reported in either of the pits during the excavations.

- AEPT then contracted Phillip Environmental (PE) to conduct a GeoProbe investigation of the site from July 8 through 10, 1996 (AEPT, 1996). PE pushed and cored six borings at five locations to depths of 30 to 52 ft. Workers found four of the six borings to be impacted by hydrocarbons: (1) free-phase product in a saturated sand at depths of 50 to 52 ft in a boring (AEPT no. 6) located between Pit A and the river, (2) total petroleum hydrocarbon (TPH) results of 10 to 386 ppm in soil collected from depths of between 46 and 52 ft in AEPT no. 6, (3) TPH results of between 222 and 1,109 ppm in ground water in samples collected from depths of 50 ft in two borings (PE nos. 3 and 5) located between Pit A and the river, and (4) the presence of hydrocarbon odor in core collected from a depth of 24 to 26 ft in a boring (AEPT no. 4) located to the east (upgradient) of Pit A.

A local fisherman reported to RRC District 3 that the seep was still active on February 15, 1998; he described the impacted area to be 15 ft × 100 yd. The Lower Colorado River Authority (LCRA) sampled water in Colorado River on January 19, 1999, and found it to be impacted by crude oil. (Results of EPA method 413.2 showed 43.0 mg/L oil and gas).

APPROACH

Before beginning field-data collection, we reviewed results of previous Colorado River Seep site investigations and conducted site reconnaissance. As requested by RRC, our work plan called for a traditional approach of collecting continuous core and installing ground-water monitoring wells. Reports by AEPT indicate that the clay layers will negatively affect the productivity of a direct-push soil survey. RRC volunteered to retain responsibility for laboratory analysis of core samples and collection and analysis of samples from ground-water monitoring wells.

BEG collected and sampled 12 continuous cores and installed 12 monitoring wells between July 19 and 28, 1999. We returned on August 19, 1999, to survey well locations and measure water levels in the monitoring wells.

Coring and Sampling

We followed the same procedure for continuous core collection, sediment sampling, and monitoring-well installation at all 12 locations. The BEG CME-75 drilling rig used 7-5/8-inch O. D. hollow-stem augers. The core barrel was a 5-ft-long, 3-inch-diameter split barrel sampler that advanced down the borehole, inside of the lead auger, taking an intact core as the auger advanced. The length of the first core run varied between holes as a result of surface roughness around the drill hole; the first core run in each hole was about 4 ft long. Subsequent core runs were 5 ft long. In most core runs, BEG drillers recovered the full 5 ft of core.

After extraction of the core barrel from inside the auger flights, the site geologist measured core recovery and depths to major lithologic breaks. The core was then transferred to PVC trays for preliminary description and sampling. The sampling procedure entailed

1. quartering the core along the entire length and sealing the removed material in a ziplock baggie,
2. setting the baggie in direct sunlight for 15 min to allow volatilization of possible hydrocarbon constituents, and
3. measuring parts per million (ppm) volatile organic constituents (VOC) of headspace gas collected in the baggie using a photoionization detector (PID).

We used this method to screen for presence of crude-oil impacts and to select sample intervals in all 12 cores. When we encountered strong hydrocarbon odors in the core or the breathing zone around the drilling rig, we monitored gas concentrations using an Intek methane detector. No readings exceeded safety limits. RRC personnel transferred samples to the RRC and AnalySys Inc. laboratories in Austin, Texas, for TPH analyses by methods 418.1 and TX1006, respectively. We completed more detailed core descriptions at the BEG headquarters in Austin, Texas.

Well Installation

Immediately after reaching total depth and removing auger flights from the borehole, we lowered flush-joint threaded, 2-inch-diameter, schedule-40 PVC casing to the maximum depth possible. It was imperative that we install the casing quickly because, in most borings, the targeted water-bearing sand was under pressure and migrated up the borehole (for example, sand came up approximately 7 ft in borehole no. 7). The flowing sand prevented us from being able to place the bottom of the PVC string at total depth in each borehole. In some cases, we were able to push the PVC into the sand using the center rod head on the drilling rig.

PVC strings consisted of a threaded end cap at the base of a 10-ft section of slotted pipe (0.010-inch slots) and additional 10-ft sections of blank pipe to bring the well casing to as much as 4 to 5 ft above ground surface. Even though we were not always able to place the screened interval of the well adjacent to the targeted water-bearing zone, we maintained hydraulic connection with the fluid-saturated native sand. This sand acts as a good filter-pack material where it is in contact with the well screen.

We then added enough Olgebay Norton Industrial, 20-40-sorted silica sand to bring the filter pack above the top of the screened interval. On top of the sand, we added approximately 25 lb of 1/4-inch bentonite pellets and allowed them to swell overnight. Above the bentonite we tremmied in annular grout, a mixture of 80-percent bentonite powder, and 20-percent type I Portland cement. This type of grout mixture will most appropriately bond with the Beaumont Clay and prevent migration of fluids from the surface or shallow subsurface down to the filter-packed interval. All wells were capped by a PVC slip-cap and completed at the surface with a locking steel protective cover fixed in a 2 ft × 2 ft concrete surface pad. We provided sets of keys to the 12 keyed-alike locks to District 3 field and Austin office RRC personnel.

Surveying

We determined the positions of all monitoring wells using a combination of conventional and global positioning system (GPS) surveying techniques. Using a Sokkia SET5W total station, we measured the local x, y, and z positions of each well relative to well no. 9. This conventional surveying method required line-of-site contact between each surveyed point and well no. 9. After finishing the monitoring-well survey, we tied into a point on the river bluff (OS-1) to survey positions along the edge of the river (OS-2 through OS-4).

Next we surveyed locations of wells no. 9, 2, and 5 using a Trimble 4000 SSi geodetic GPS receiver and collected 20 min of dual-frequency phase observations at each station at a 5-s data rate. In order to postprocess the GPS data and estimate elevations, we obtained GPS base-station data for August 19, 1999, the date of our survey, from the Houston Regional Reference Point (RRP). This was the closest High-Accuracy Reference

Network (HARN) GPS station. We computed double-differenced, ionospherically corrected phase solutions for the position of monitoring wells MW-2, MW-5, and MW-9 with respect to the Houston RRP using the National Geodetic Survey's Kinematic and Rapid-Static (KARS) processing software.

We then used the GPS solutions to adjust and transform the local x, y, and z coordinates into geographic coordinates and heights above the WGS-84 reference ellipsoid. An ellipsoid is an estimate of the shape of the Earth's sphere at a point in time, in this case 1984. We transformed ellipsoid heights to NAVD88 elevations (that is, elevations relative to mean sea level) using the National Geodetic Survey's GEOID96 gravity model.

RESULTS

Surface Features

Present at the study area are (1) numerous plugged and abandoned or shut-in oil-production and salt-water injection wells, (2) numerous surface tanks formerly used for oil and salt-water storage, and (3) as many as three former surface pits (fig. 2). Locations of shut-in wells are visible at the surface, whereas locations of plugged and abandoned wells are inferred from remnants of old wooden drilling platforms. Two empty tanks are still on site, but only the concrete pads remain from what we assume were another four or five fluid-holding tanks.

Locations of the former pits were not readily apparent on the surface because of remediation efforts, but we could see differences in vegetation patterns in areas where pits are located on aerial photographs and on the site maps produced by previous workers. The pit outlines shown in figure 2 are taken from a series of aerial photographs dated 1956, 1962, 1971, 1972, and 1989. The size and location of pits have changed over time. For example, Pit A was largest in the 1956 photograph and appeared successively smaller in aerial photographs dated 1962 and 1972. For the purpose of evaluating potential site impacts, Pit A is shown as it appeared in the 1956 photo.

Pit B, located immediately north of Pit A, is present in the 1962 photo, but it had apparently been filled in by 1971. Pits A and B appear contiguous in the 1962 photo but contained fluids of highly contrasting reflectance; the pits were most likely separated by a berm. Pit C shows up in the 1971 and 1972 photos but was absent in early and later photos. Like Pit B, Pit C contained a fluid of very low reflectance (that is, both pits looked dark- instead of light-colored like Pit A).

Drill sites approved by the RRC were located within the study area so as to evaluate potential sources of crude oil seeping into the river and to establish background conditions. BEG monitoring wells MW-1 and -12 lie between the river and Pits A and B. MW-2 is downgradient from Pit A. MW-3 is upgradient from Pits A and B. MW-6 is upgradient from the excavated area. MW-7 and -8 are between two sets of tanks and the river. MW-4, -5, and, -9 are the background wells (fig. 2). MW-10 was originally supposed to be a background well but it showed evidence of hydrocarbon impacts. As a result, we moved MW-4 from its original location south of MW-11 to try again to establish background conditions. Unfortunately, core samples from MW-4 and MW-9 also showed evidence of hydrocarbon impacts.

BEG observed discrete blebs of crude oil bubbling up from the riverbed the entire time we were on site. The crude oil was rapidly dispersed downstream. Points on the river bank that correspond to the northern and southern extents of where we observed oil in the river are marked as OS-2 and OS-4, respectively (fig. 2). Oil staining is present along the riverbank between those two points and is concentrated at location OS-3. The cutbank of the river is migrating eastward relative to its position in the 1962 aerial photo, so that point OS-4 appears to be up the side of the river bank, when in fact it was located at the water's edge at the time of the August 1999 measurement. OS-3 was measured approximately 1.5 ft up the side of the bank to show the position of the oil staining in August 1999. We were not able to observe whether there was another active seepage area farther upstream at the time of our investigation (fig. 2).

Subsurface Sediments

Stratigraphy

Two geologic units are present in the vicinity of the site: (1) the Pleistocene-age Beaumont Formation and (2) younger Pleistocene to Recent terrace deposits from the Colorado River and its tributaries. The Beaumont Formation crops out approximately 1 mi east and underlies a thin layer of terrace deposits at the site (Proctor and others, 1974), and the more clay-rich facies of the Beaumont Formation is mapped in the vicinity of the site. We found Beaumont Formation clay in the continuous cores taken from ground surface to a depth of approximately 45 ft. Figure 3 shows a typical stratigraphic column of sediments seen in the 12 cores. Thicknesses of units I through IV (fig 3; app. B) represent what we found in cores CC-1 through CC-3 and CC-5 through CC-12. CC-4 was located farther north, where, during a recent flooding event, the Colorado River eroded clay beds (units III and IV) and deposited sandy fluvial sediments (unit I) directly on top of what we define as Beaumont Formation sand unit V (figs. 3, 4). Other indications of this flooding event came from the 1956 aerial photograph and from conversations with Mr. Roper.

Stratigraphic cross sections A–A′ and B–B′ are parallel and perpendicular, respectively, to the Colorado River (fig. 4). They show representative stratigraphic units I through III grouped together and units IV and V separately. Fractured zones occur primarily within clay-rich parts of the Beaumont Formation (unit IV) but also sometimes in the overlying unit III (for example, in core CC-12 taken at the location of MW-12 on cross section A–A′).

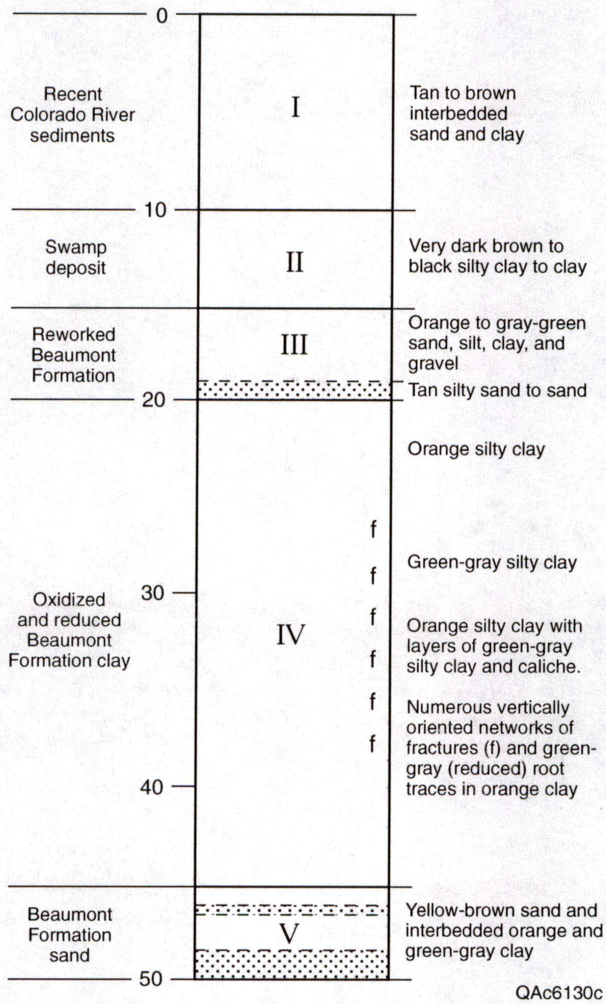

Figure 3. Schematic stratigraphic section of subsurface units found in cores at the Colorado River Seep site.

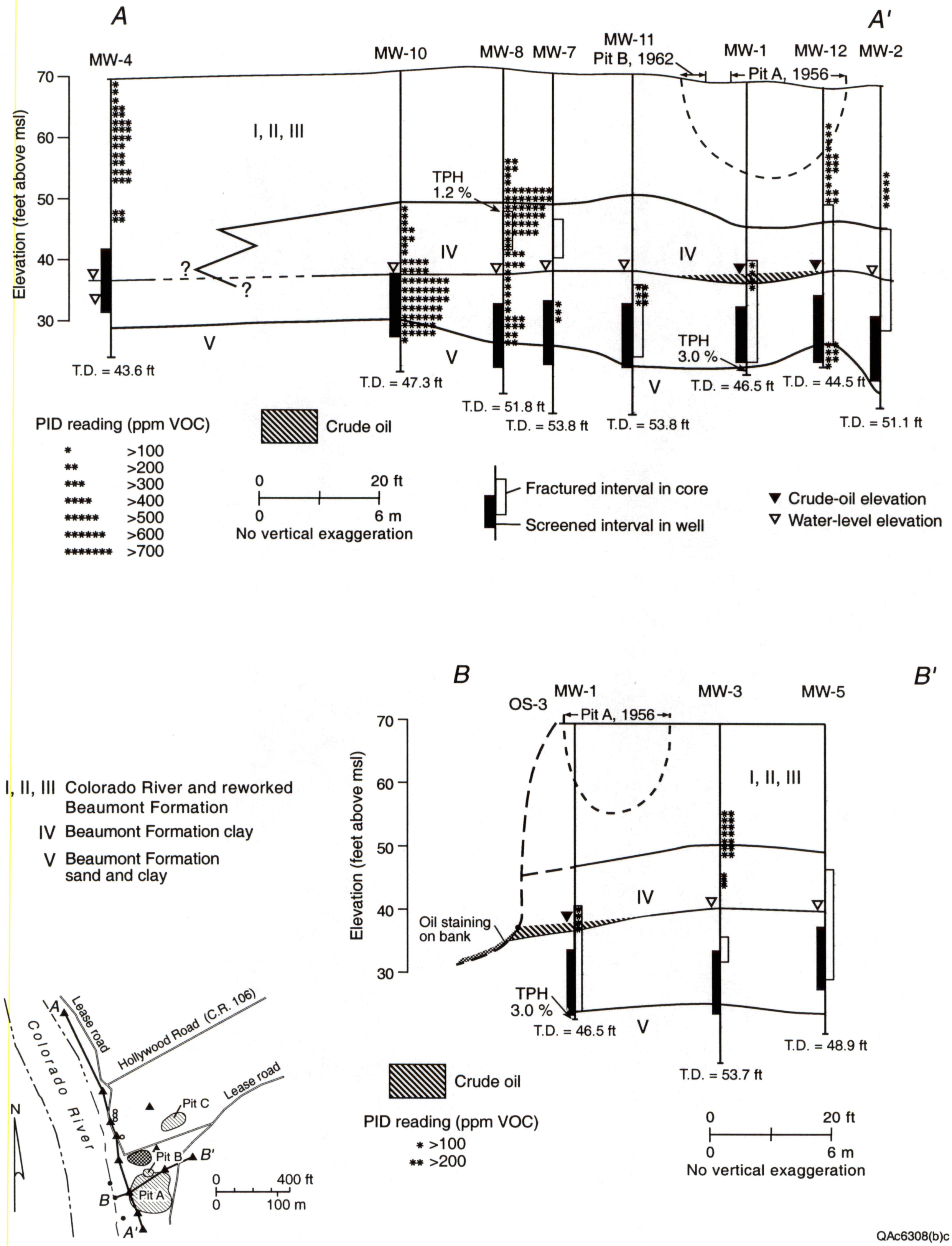

Figure 4. Cross sections A–A′ and B–B′

Stratigraphic unit IV is a clay-rich facies of the Beaumont Formation (fig. 3). Oxidation and reduction reactions have altered the color of the unit IV sediments. Where oxidized, the sediments are red, yellow, brown, or some combination of these colors. The prevalent valence state of the abundant iron in Beaumont Formation sediments is oxidized (Fe^{3+}). Prolonged exposure to reducing conditions causes iron to become reduced (Fe^{2+}). Sediments containing compounds with reduced iron are gray, green, and in the most extreme case, black. Iron is commonly reduced in the presence of abundant organic material such as vegetation roots or hydrocarbons (Tedesco, 1995).

Some unit IV sediments have been reduced in elongate patterns that correspond with preserved roots. The presence of hydrocarbons also causes sediments to become reduced. Surfaces of many of the high-angle fractures in unit IV clay are green. This pattern of discoloration almost certainly is not accounted for by vegetation but by movement of a reducing fluid, such as crude oil or ground water that has been in contact with crude oil, through the fractures.

Chemical Analysis of Sediment Samples

Asterisks on the cross sections (fig. 4) denote cored intervals having elevated PID measurements. One asterisk denotes a PID reading of more than 100 ppm VOC, two asterisks denote a reading of more than 200 ppm VOC, and so on. Cores having the highest PID readings were taken from CC-8, CC-9, and CC-10 (app. C; fig. 4). We used PID readings, visual observations, and presence of hydrocarbon odor to decide where to collect samples for TPH analysis by RRC (app. D; table 1) and AnalySys (app. D; table 2) laboratories. The two samples that contained TPH concentrations of more than 1 percent (10,000 mg/kg) came from CC-1 and CC-8 at depths of 46.5 and 21.5 ft, respectively (table 1).

Table 1. Colorado River Seep:
results of TPH analyses performed at RRC laboratory.

Location no.	Soil-sample depth (ft bgl)	RRC lab TPH (%)	RRC lab TPH (ppm)	RRC lab oil & grease (% dry solids)	PID sample interval (ft bgl)	PID field reading (ppmv)	Sample date	Analysis date
CC-1	46.5	3.00	30,000	2.00	NA	NA	7/26/99	9/7/99
CC-1	31.6 - 32.8	0.05	500	0.05	31.6-32.8	149.5	7/26/99	9/7/99
CC-1	44.1 - 45.8	0.20	2,000	0.20	44.1-45.8	77.0	7/26/99	9/7/99
CC-2	13.5 - 15.0	0.17	1,700	0.15	13.5-15.0	126.6	7/26/99	9/7/99
CC-2	22.4 - 22.7	0.07	700	0.07	21.0-23.5	57.8	7/26/99	9/7/99
CC-2	50.8 - 51.1	<0.05	---	<0.05	48.5-51.1	2.4	7/26/99	9/7/99
CC-3	13.5 - 15.2	0.26	2,600	0.33	13.7-15.2	200.0	7/22/99	7/29/99
CC-3	18.7 - 21.2	0.10	1,000	0.12	18.7-21.2	205.0	7/22/99	7/29/99
CC-4	18.6 - 21.1	<0.05	---	<0.05	18.6-21.1	10.3	7/27/99	9/9/99
CC-4	38.6 - 40.7	<0.05	---	<0.05	38.6-40.7	0.0	7/27/99	9/9/99
CC-5	18.9 - 21.4	<0.05	---	<0.05	18.9-21.4	0.0	7/22/99	7/29/99
CC-6	19.3 - 19.6	<0.05	---	<0.05	19.2-21.7	0.0	7/22/99	7/29/99
CC-7	18.8 - 21. 3	<0.05	---	<0.05	18.8-21.3	0.0	7/22/99	9/9/99
CC-7	48.2 - 48.5	<0.05	---	<0.05	46.3-48.8	0.0	7/22/99	9/9/99
CC-7	53.6 - 53.8	<0.05	---	<0.05	51.3-53.8	0.1	7/22/99	9/9/99
CC-8	21.5 - 21. 7	1.20	12,000	0.75	21.3-23.8	604.2	7/24/99	9/9/99
CC-8	23.8 - 26.3	0.07	700	<0.05	23.8-26.3	505.8	7/24/99	9/9/99
CC-8	28.2 - 31.3	0.07	700	<0.05	28.8-31.3	387.0	7/24/99	9/9/99
CC-8	31.3 - 33.6	0.27	2,700	0.18	31.3-33.6	502.4	7/24/99	9/9/99
CC-8	38.8 - 41.3	0.20	2,000	0.18	38.8-41.3	352.8	7/24/99	9/9/99
CC-9	18.1 - 18.4	<0.05	---	<0.05	16.3-18.8	0.0	7/24/99	9/9/99
CC-9	36.9 - 37.2	<0.05	---	<0.05	36.9-37.2	90.0	7/24/99	9/9/99
CC-10	41.3 - 42.2	<0.05	---	<0.05	41.3-42.2	121.8	7/22/99	9/9/99
CC-11	18.35 - 19.0	<0.05	---	<0.05	16.3-18.8	0.0	7/23/99	9/9/99
CC-11	36.3 - 36.7	<0.05	---	<0.05	36.3-37.5	22.5	7/23/99	9/9/99
CC-12	8.8 - 9.2	0.73	7,300	0.55	8.8-11.3	109.6	7/25/99	9/9/99
CC-12	16.3 - 18.8	0.21	2,100	0.15	16.3-18.8	274.9	7/25/99	9/9/99
CC-12	21.5 - 21.7	0.25	2,500	0.19	21.3-23.8	69.3	7/25/99	9/9/99

Table 2. Colorado River Seep:
TPH (TX1006) analyses from AnalySys laboratory.

Location no.	Depth (ft bgl)	Aliphatic >C5 - C8 (mg/kg)	Aliphatic C9 - C19 (mg/kg)	Aliphatic C19 - C32 (mg/kg)	Aromatic C9 - C32 (mg/kg)	TPH (mg/kg)	PID sample interval (ft bgl)	PID field reading (ppmv)	Comments
C-1	44.1–45.8	<500	2,610	1,420	<500	4,030	44.1–45.8	77.0	Free product in deep sand
C-3	19.5	<500	<500	<500	<500	<500	18.7–21.2	205.0	Clean, shallow sand
C-4	6.1–8.4	1,070	2,020	<500	533	3,623	6.1–8.4	353.8	Shallow, oil-impacted sand
C-8	18.8–21.3	<500	860	<500	<500	860	18.8–21.3	751.3	Shallow, oil-impacted sand
C-10	33.3–33.8	<500	<500	<500	<500	<500	31.3–33.8	760.0	Intermediate, oil-impacted sandy clay

Ground Water

Water-bearing sands of the Beaumont Formation are generally considered part of the Chicot aquifer in Wharton County (Baker, 1979; Dutton, 1994). The Chicot aquifer is composed of geologic units from the surface to a depth of approximately 900 ft in the vicinity of the site. Nearby irrigation wells tap ground water at depths of approximately 200 to 500 ft, whereas local stock wells are typically completed at depths of 30 to 50 ft (Loskot and others, 1982). According to Mr. Roper, stock wells in the immediate vicinity of the site, which were not recorded in Loskot and others (1982), are completed in sand at a depth of 50 ft.

At this site we encountered two water-bearing zones between ground surface and 50-ft depth. There is a thin (0.5-ft maximum thickness) water-bearing sand at the base of unit III at a depth of approximately 20 ft (fig. 3). Dry intervals beneath this sand suggest that it represents a zone of perched ground water. Unit V contained the main water-bearing sand. All 12 BEG monitoring wells were completed so as to be in hydraulic connection with unit V (table 3; app. E). The unit V saturated sand is nonindurated and flowed into the open boreholes.

Hydraulic head of unit V ground water lies at a depth of approximately 35 ft in all wells except MW-1 and MW-12 (table 3; figs. 4, 5). The hydraulic head is above the top of the unit V sand, reflecting confined conditions. The water levels measured in wells MW-1 and MW-12 are depressed by free-phase crude oil (table 3; fig. 4). Thickness of the crude oil measured as much as 1.3 ft in MW-1 on July 27, 1999, immediately after the wells were installed. We therefore excluded water levels in wells MW-1 and MW-12 from our estimation of potentiometric surface contours. The inferred gradient of approximately 0.005 of the potentiometric surface for unit V is toward the Colorado River (fig. 5).

Table 3. RRC Colorado River Seep: well information.

Well	Date drilled	Latitude (degrees N)	Longitude (degrees W)	Ground elevation (ft amsl)	Top of casing elevation (ft amsl)	Depth drilled (ft bgl)	Depth well (ft bgl)	Stickup (ft)	Screen interval (ft bgl)	Filter sand pack[1] (ft bgl)	Depth to fluid[2] (ft btoc)	Fluid-level elevation (ft amsl)
MW-1	26-Jul-99	29.1346	96.0427	71.9	75.0	46.5	46.5	3.1	36.2–46.2	32.1–46.5	37.0 oil 38.3	38.0 oil 36.7
MW-2	26-Jul-99	29.134	96.0425	71.5	74.4	51.1	47.5	3.0	37.2–47.2	34.8–51.1	36.8	37.6
MW-3	20-Jul-99	29.1349	96.0421	71.6	74.6	53.7	46.5	3.0	36.2–46.2	31.6–46.5	34.3	40.3
MW-4	27-Jul-99	29.1372	96.0437	71.8	74.9	43.6	38.0	3.1	27.7–37.7	25.1–43.6	38.1	36.8
MW-5	21-Jul-99	29.1351	96.0416	71.8	74.8	48.9	42.0	3.0	31.7–41.7	29.5–48.9	35.1	39.7
MW-6	21-Jul-99	29.1352	96.0422	72.2	74.9	49.2	48.7	2.7	38.7–48.7	35.0–49.2	35.8	39.1
MW-7	22-Jul-99	29.1354	96.0428	73.0	76.1	53.8	46.5	3.1	36.2–46.2	33.6–53.8	38.0	38.1
MW-8	24-Jul-99	29.1356	96.0429	74.3	77.4	51.8	48.3	3.1	38.0–48.0	34.9–51.8	39.6	37.8
MW-9	24-Jul-99	29.1358	96.0423	71.4	74.3	43.8	37.5	2.9	27.2–37.2	20.0–43.8	35.4	38.9
MW-10	22-Jul-99	29.1361	96.0431	73.6	76.8	47.3	42.5	3.2	32.2–42.2	31.0–47.3	39.2	37.6
MW-11	23-Jul-99	29.135	96.0428	72.8	75.6	53.8	47.0	2.9	36.7–46.7	36.1–53.8	37.5	38.1
MW-12	25-Jul-99	29.1342	96.0425	71.1	74.0	44.5	44.0	2.9	33.7–43.7	31.5–44.5	35.3 oil 35.7	38.7 oil 38.3

Notes:
[1]Pressurized sand filled the boreholes before well casing could be installed in all wells except MW-3. Bentonite plug placed below sand in MW-3.
[2]Fluid is water unless noted as oil. All fluid-level depths measured.

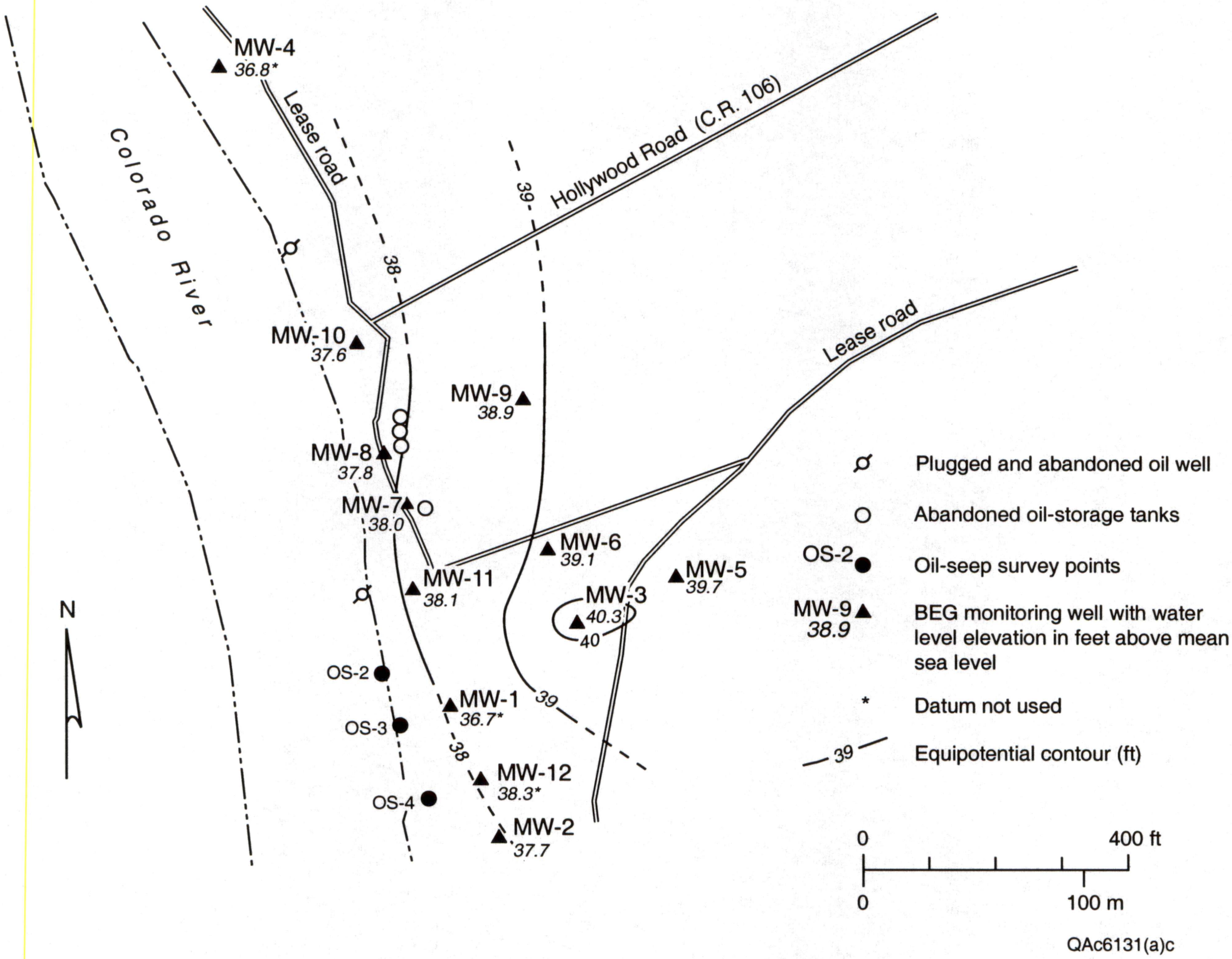

Figure 5. Potentiometric surface map of ground water in stratigraphic unit V.

PRELIMINARY SITE ASSESSMENT

The objectives of this study were to characterize the extent of hydrocarbon impacts and determine whether further work is needed to eliminate possible hydrocarbon sources. After review of previous site studies and completion of our own investigation, it became apparent that both the areal extent and volume of crude oil discharging to the river have changed over time, thus indicating the possibility of multiple hydrocarbon sources on or near the site. The primary conclusions presented here pertain to the crude-oil seep that we observed in July and August of 1999. We also evaluate new evidence related to an additional seep reported farther upstream from the one we observed.

The possible sources of crude oil considered in this study include:

1. Plugged and abandoned oil well (H. C. Cockburn lease, state tract 8B, well no. 1). This well, also known as the Wolfe and Gray well, was located directly west of BEG MW-11 in the river channel (fig. 6). Remnants of the old wooden drilling platform were all we could see of this well from the riverbank. It blew out in 1959 and was reportedly plugged and abandoned in 1971 (RRC 1996 document of chronology of site).

2. Tank batteries. Two tanks are still on site: one adjacent to MW-7 and one adjacent to MW-8 (fig. 6). We do not know what was stored in the tank next to MW-7, although local residents said it was sometimes used to store salt water. The tank next to MW-8 was used for oil storage and was formerly accompanied by two other tanks. According to Mr. Roper, two of the three oil-storage tanks adjacent to MW-8 were found to be leaking upon removal. Both of the remaining tanks were empty at the time of the BEG site investigation.

3. Old surface pits. As many as four surface pits have been at the site at least since 1956 that have been used for oil-reserve, salt-water, or drilling-mud storage (AEPT, 1993, 1996). All pits had been filled in or remediated at the time of our site investigation.

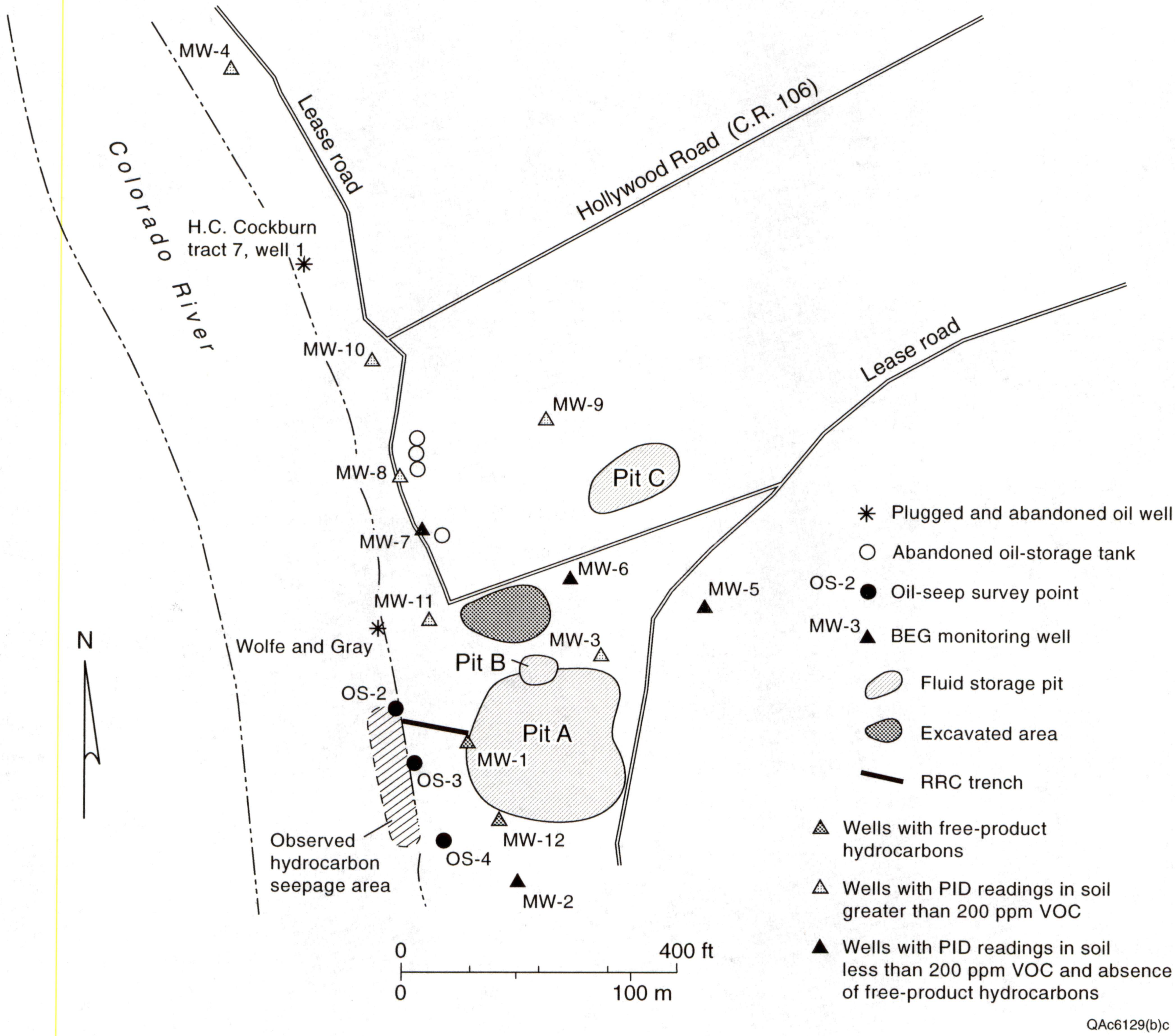

Figure 6. Monitoring wells showing hydrocarbon impacts.

Evaluation of Sources

Whatever source is providing crude oil to the active seep in the Colorado River must also be the source of the crude oil found in monitoring wells MW-1 and MW-12. Next we evaluate the three possible sources of crude oil seeping into the Colorado River between survey points OS-2 and OS-4 (fig. 6).

1. Plugged and abandoned oil well (H. C. Cockburn lease, state tract 8B, well no. 1). If the blowout in the Wolfe and Gray well were the source of the free-phase crude oil observed in monitoring wells MW-1 and MW-12, we would expect also to see free-phase crude oil in MW-11 (fig. 6). During the release of pressurized gasses, crude oil could have moved rapidly upward into the unit V water-bearing sand against both vertical and lateral hydraulic gradients. It is unlikely that a blowout in the Wolfe and Gray well can account for the crude oil found in MW-1 and MW-12 because (a) free-phase crude oil is not present in MW-11, (b) the unit V water-bearing sand in the CC-11 core did not contain free-phase crude oil, and (c) TPH analyses of AEPT boring no. 1 ground-water and sediment samples taken from depths between 40 and 45 ft were below detection limits.

2. Tank batteries. If the tank batteries were the source of the present seep, we would expect to see free-phase crude oil in the unit V water-bearing sand in BEG monitoring wells MW-7 or MW-8 (fig. 6). Hydrocarbon impacts we observed in stratigraphic units III and IV in core CC-8 (apps. B, C; fig. 4; table 2) are most likely related to oil that leaked from the adjacent tank battery. Because the unit V water-bearing sand at this location does not contain crude oil, however, the tank battery was probably not the source of crude oil seeping into the river at the time of our site investigation.

3. Old surface pits. The most likely source or sources of the crude-oil seep were one or more of the former surface pits located immediately east of BEG monitoring wells, MW-1 and MW-12 (fig. 6). These are the only two locations where we found free-phase crude oil in unit V water-bearing sand. At these locations, oil accumulations in the well are

sufficient to depress the ground-water potentiometric surface (figs. 4, 5; table 3). A credible pathway for migration of the crude oil is percolation downward from the pit along fractures in the unit IV clay and lateral transport in the unit V sand toward the river along the natural gradient in hydraulic head. The elevation of the river surface is approximately the same as that of the unit V sand potentiometric surface.

Other data from previous studies also support our conclusion that one or more of the surface pits are the most likely source or sources of the observed seep. The pertinent data include:

- Observations of gleyed (reduced) silty sand at a depth of 10 ft in Pit A (AEPT, 1993). The reduced sand indicates presence of a reducing agent such as crude oil in the pit before remediation.
- Elevated TPH in ground water (1,109 ppm) at a depth of 50 ft and free-phase crude oil in unit V sands (depth of 46 to 52 ft) in AEPT boring no. 3, between Pit A and the river (AEPT, 1996) (fig. 6).
- Hydrocarbon odor at a depth of approximately 20 ft in AEPT boring no. 4, which is located near the north edge of Pit A within 10 ft of BEG monitoring well MW-3 (AEPT, 1996) (fig. 6).

BEG found visual hydrocarbons and elevated PID readings in the CC-3 shallow water-bearing sand at the base of unit III (apps. B, C; fig. 4). This observation, along with data from the AEPT studies, supports our hypothesis that crude oil could have migrated from a pit down to the deeper, unit V water-bearing sands.

Remaining Issues

Both RRC personnel (Randy Rodriguez, personal communication, 1999) and ARCO (July 1992 letter to RRC) reported additional crude-oil seeps in the river adjacent to the former oil-storage tanks before the BEG site investigation (fig 6). However, RRC personnel later noted (July 1996 RRC field report) that the seep farther to the north was no longer active. BEG found additional areas having subsurface hydrocarbon impacts other than those related to the crude-oil seep that was active at the time of our investigation (fig. 6).

Cores that BEG originally intended to use to provide background PID measurements at the site were CC-5, CC-9, and CC-10 (fig. 6). Samples from CC-5 were free of hydrocarbon impacts, whereas samples from CC-9 and CC-10 both had elevated PID readings (app. C; fig. 4). Core CC-9 had PID readings as high as 461 ppm VOC in unit IV fractured clay.

PID readings in CC-10 were as high as 768 ppm VOC. Because that location could not be used to establish background conditions, we moved to the north of a plugged and abandoned oil well (H. C. Cockburn lease, state tract 7, well no. 1) to collect core (CC-4) and complete monitoring well MW-4. Our intentions were both to establish background conditions at MW-4 and assess whether the H. C. Cockburn lease, state tract 7, well no. 1, could be the source of hydrocarbons found in CC-10 (fig. 6). Core CC-4 also contained elevated PID readings (as high as 353.8 ppm VOC between depths of 6 and 8 ft), but not in the same stratigraphic zones as where observed the hydrocarbon impacts in CC-10.

BEG monitoring wells MW-4, MW-9, and MW-10, which were all completed in unit V water-bearing sand, did not contain free-phase hydrocarbons at the time of our site investigation. Therefore, we do not think these wells are completed near sources contributing to the active crude-oil seep. However, elevated PID readings show that there are hydrocarbon impacts at these locations. Perhaps the earlier observed areas of seepage in the Colorado River were a result of crude-oil plumes associated with other potential and now inactive sources, such as the former oil-storage tanks or H. C. Cockburn lease, state tract 7, well no. 1. Additional site investigation would be needed to further evaluate these potential sources.

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Appendix A

Photocopies of 1962 and 1972 Aerial Photographs Taken near Site


3-5-62 AWV - 4CC - 184
RSDIS# 000768
Wharton County
N


1-16-72 1440 48481 172-27
RSDIS# 000531
Wharton County
N

Appendix B

Depth Intervals and Description of Stratigraphic Units in BEG Cores

RRC Colorado Seep Core Units

Core	Depth Interval (ft bgl)	Unit
CC-1	0.0-8.0	I
	8.0-14.1	II
	14.1-23.2	III
	23.2-46.2	IV
	46.2-46.5	V
CC-2	0.0-8.5	I
	8.5-13.3	II
	13.3-22.7	III
	22.7-49.1	IV
	49.1-51.1	V
CC-3	0.0-7.7	I
	7.7-11.2	II
	11.2-19.6	III
	19.6-44.5	IV
	44.5-53.7	V
CC-4	0.0-39.4	I
	39.4-43.6	V
CC-5	0.0-7.6	I
	7.6-12.3	II
	12.3-19.9	III
	19.9-45.4	IV
	45.4-48.9	V
CC-6	0.0-9.0	I
	9.0-12.6	II
	12.6-19.8	III
	19.8-45.6	IV
	45.6-49.2	V

Core	Depth Interval (ft bgl)	Unit
CC-7	0.0-13.0	I
	13.0-17.1	II
	17.1-20.9	III
	20.9-42.0	IV
	42.0-53.8	V
CC-8	0.0-13.8	I
	13.8-16.4	II
	16.4-21.7	III
	21.7-43.9	IV
	43.9-51.8	V
CC-9	0.0-8.0	I
	8.0-12.6	II
	12.6-18.4	III
	18.4-36.0	IV
	36.0-43.8	V
CC-10	0.0-12.1	I
	12.1-14.1	II
	14.1-20.8	III
	20.8-39.8	IV
	39.8-47.3	V
CC-11	0.0-10.8	I
	10.8-14.0	II
	14.0-19.0	III
	19.0-45.9	IV
	45.9-53.8	V
CC-12	0.0-8.8	I
	8.8-11.8	II
	11.8-21.7	III
	21.7-41.3	IV
	41.3-44.5	V

Unit Description

Unit I	Tan to brown interbedded sand and clay; Recent Colorado River sediments.
Unit II	Very dark brown to black silty clay to clay;
Unit III	Orange to gray-green gravel, sand, silt, and clay; caliche-rich; Reworked Beaumont Fm.
Unit IV	Orange to green-gray silty to sandy clay; caliche-rich; abundant high-angle fractues; Beaumont Fm. clay.
Unit V	Interbedded orange to green-gray sandy clay and yellow-brown fine to medium grained sand; Beaumont Fm. clay and sand.

Appendix C

Photoionization Detector Measurements in Cored Sediments

Photoionization Detector (PID) Measurements Taken in Cores

Core	Interval (ft bgl)	PID reading (ppm VOC)
CC-4	31.1-33.6	9.4
	33.6-36.1	2.1
	36.1-37.4	3.2
	37.4-38.6	nr
	38.6-40.7	0.0
	40.7-43.6	nr
CC-5	0.0-3.9	0.0
	3.9-6.4	0.0
	6.4-8.4	0.0
	8.4-8.9	nr
	8.9-11.4	0.0
	11.4-13.9	0.0
	13.9-16.4	0.0
	16.4-18.9	0.0
	18.9-21.4	0.0
	21.4-23.9	0.0
	23.9-26.4	0.0
	26.4-28.9	0.0
	28.9-31.4	0.0
	31.4-33.9	0.0
	33.9-36.4	0.0
	36.4-38.9	0.0
	38.9-41.4	0.0
	41.4-43.9	0.0
	43.9-47.2	0.0
	47.2-48.9	nr
CC-6	0.0-2.1	0.0
	2.1-4.2	0.0
	4.2-6.2	0.0
	6.2-8.1	0.0
	8.1-9.2	nr
	9.2-11.7	0.4
	11.7-14.2	0.0
	14.2-16.7	0.0
	16.7-19.2	0.0
	19.2-21.7	0.0
	21.7-24.2	0.0
	24.2-26.7	0.0
CC-6 cont.	26.7-29.2	0.0
	29.2-31.7	0.0
	31.7-34.2	0.6
	34.2-36.7	25.0
	36.7-39.2	19.0
	39.2-41.7	0.0
	41.7-44.2	0.0
	44.2-46.7	0.0
	46.7-49.2	0.0
CC-7	0.0-1.4	0.0
	1.4-3.8	nr
	3.8-6.3	0.0
	6.3-8.45	0.0
	8.45-8.8	nr
	8.8-11.3	0.0
	11.3-13.8	0.0
	13.8-16.3	0.0
	16.3-18.8	0.0
	18.8-21.3	0.0
	21.3-23.5	3.7
	23.8-26.3	1.8
	26.3-28.8	0.0
	28.8-31.3	3.3
	31.3-33.8	39.9
	33.8-36.3	21.1
	36.3-38.8	157.8
	38.8-41.3	23.3
	41.3-43.8	7.6
	43.8-46.3	14.6
	46.3-48.8	0.0
	48.8-51.3	0.0
	51.3-53.8	0.1

Photoionization Detector (PID) Measurements Taken in Cores

Core	Interval (ft bgl)	PID reading (ppm VOC)
CC-8	0.0-3.8	1.9
	3.8-6.3	33.3
	6.3-7.8	48.2
	7.8-8.8	nr
	8.8-11.3	0.3
	11.3-13.0	8.4
	13.0-13.8	nr
	13.8-16.3	200.1
	16.3-18.4	154.6
	18.4-18.8	nr
	18.8-21.3	751.3
	21.3-23.8	604.2
	23.8-26.3	505.8
	26.3-28.8	134.8
	28.8-31.3	387.0
	31.3-33.6	502.4
	33.6-33.8	nr
	33.8-36.3	146.2
	36.3-38.8	148.2
	38.8-41.3	352.8
	41.3-43.8	240.7
	43.8-46.3	39.6
	46.3-48.8	18.7
	48.8-51.8	2.5
CC-9	0.0-3.8	0.0
	3.8-6.3	0.0
	6.3-8.8	0.0
	8.8-11.3	0.0
	11.3-13.8	0.0
	13.8-16.3	0.0
	16.3-18.8	0.0
	18.8-21.3	4.5
	21.3-23.8	0.0
	23.8-26.3	1.3
	26.3-28.8	10.5
	28.8-31.3	169.6
	31.3-33.8	165.9
	33.8-36.3	461.0
	36.3-36.8	165.9
CC-9 cont.	36.8-36.9	nr
	36.9-37.2	90.0
	37.2-38.8	nr
	38.8-41.6	1.7
	41.6-43.8	nr
CC-10	0.0-3.8	0.9
	3.8-6.55	0.9
	6.55-8.8	nr
	8.8-11.3	0.6
	11.3-13.8	1.2
	13.8-16.3	2.0
	16.3-18.8	18.8
	18.8-21.3	49.9
	21.3-23.8	138.4
	23.8-26.3	210.2
	26.3-28.8	152.6
	28.8-31.3	454.5
	31.3-33.8	760.0
	33.8-36.3	768.0
	36.3-38.8	621.4
	38.8-41.3	560.7
	41.3-42.2	121.8
	42.2-43.8	nr
	43.8-46.3	79.8
	46.3-47.3	107.0

Photoionization Detector (PID) Measurements Taken in Cores

Core	Interval (ft bgl)	PID reading (ppm VOC)
CC-11	0.0-3.8	0.0
	3.8-6.2	0.0
	6.2-8.8	0.0
	8.8-11.1	NA
	11.1-11.3	nr
	11.3-12.7	0.0
	12.7-13.8	nr
	13.8-16.3	0.0
	16.3-18.8	0.0
	18.8-21.3	0.0
	21.3-23.8	0.0
	23.8-26.3	0.0
	26.3-28.8	0.0
	28.8-31.3	0.0
	31.3-33.8	59.1
	33.8-36.3	298.4
	36.3-37.5	22.5
	37.5-38.8	nr
	38.8-41.3	0.0
	41.3-43.8	0.0
	43.8-46.3	0.8
	46.3-48.8	0.0
	48.8-51.3	0.0
	51.3-53.8	0.0

Core	Interval (ft bgl)	PID reading (ppm VOC)
CC-12	0.0-3.1	0.0
	3.1-3.8	nr
	3.8-6.3	0.0
	6.3-8.8	108.2
	8.8-11.3	109.6
	11.3-13.8	247.2
	13.8-16.3	165.1
	16.3-18.8	274.9
	18.8-21.3	57.8
	21.3-23.8	69.3
	23.8-26.3	50.2
	26.3-28.8	67.9
	28.8-31.3	38.5
	31.3-33.8	8.6
	33.8-36.3	22.5
	36.3-38.8	16.9
	38.8-41.3	80.5
	41.3-43.8	241.2
	43.8-44.5	139.2

Appendix D
Laboratory Reports of Chemical Analyses of Soil Samples

RAILROAD COMMISSION OF TEXAS

SURFACE MINING AND RECLAMATION DIVISION

MEMORANDUM

RECEIVED
RRC OF TEXAS
SEP 14 1999
OG SR
AUSTIN, TEXAS

TO: Aimee Beveridge
Site Remediation, Oil and Gas Division

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

SUBJECT: Analysis of the samples from the Colorado Seep

DATE: September 13, 1999

I have enclosed the analysis results of the nineteen samples from the above referenced source. These samples were received at the Surface Mining and Reclamation Division Laboratory on July 29, 1999.

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

Carl Nelson

CN/gm

enc.

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9163E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-4 (18.6-21.1)

Submitted by: Special Response

Date Collected: 07/27/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification Carl Nelson

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9164E   RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-4 (38.6-40.7)

Submitted by: Special Response

Date Collected: 07/27/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification ______________________

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9165E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-7 (18.8-21.3)

Submitted by: Special Response

Date Collected: 07/22/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification Carl Nelson

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9166E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-7 (48.2-48.5)

Submitted by: Special Response

Date Collected: 07/22/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification [signature]

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9167E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-7 (53.6-53.8)

Submitted by: Special Response

Date Collected: 07/22/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification [signature]

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9168E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-8 (31.3-33.6)

Submitted by: Special Response

Date Collected: 07/24/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.27	%
Total Petroleum Hydrocarbons	0.18	%

Comments:

Data Verification ____________

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9169E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-8 (21.5-21.7)

Submitted by: Special Response

Date Collected: 07/24/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	1.2	%
Total Petroleum Hydrocarbons	0.75	%

Comments:

Data Verification ____________

54

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9170E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-8 (23.8-26.3)

Submitted by: Special Response

Date Collected: 07/24/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.07	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification ____________

55

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9171E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-8 (28.2-31.3)

Submitted by: Special Response

Date Collected: 07/24/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.07	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification Carl Nelson

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9172E   RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-8 (38.8-41.3)

Submitted by: Special Response

Date Collected: 07/24/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.20	%
Total Petroleum Hydrocarbons	0.18	%

Comments:

Data Verification Carl Nelson

57

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9173E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-9 (18.1-18.4)

Submitted by: Special Response

Date Collected: 07/24/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification Carl Nelson

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9174E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-9 (36.9-37.2)

Submitted by: Special Response

Date Collected: 07/24/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification Carl Nelson

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9175E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-10 (41.3-42.2)

Submitted by: Special Response

Date Collected: 07/22/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification Carl Nelson

60

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9176E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-11 (18.35-19.0)

Submitted by: Special Response

Date Collected: 07/23/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification Carl Nelson

61

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9177E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-12 (21.5-21.7)

Submitted by: Special Response

Date Collected: 07/25/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.25	%
Total Petroleum Hydrocarbons	0.19	%

Comments:

Data Verification ____________

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9178E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-12 (16.3-18.8)

Submitted by: Special Response

Date Collected: 07/25/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.21	%
Total Petroleum Hydrocarbons	0.15	%

Comments:

Data Verification Carl Nelson

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9179E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-12 (8.8-9.2)

Submitted by: Special Response

Date Collected: 07/25/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.73	%
Total Petroleum Hydrocarbons	0.55	%

Comments:

Data Verification ____________

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9180E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-11 (36.3-36.7)

Submitted by: Special Response

Date Collected: 07/23/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification C. Carl Nelson

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9181E RRC Custody Tag No.

Sample Identification: Colorado Seep, CC-1 off Augers

Submitted by: Special Response

Date Collected: 07/26/1999 Date Received: 07/29/1999 Date Completed: 09/09/1999

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	3.0	%
Total Petroleum Hydrocarbons	2.0	%

Comments:

Data Verification Carl Nelson

RAILROAD COMMISSION OF TEXAS LABORATORY

2801 Wheless, Austin, TX 78723 / Phone 926-3064 / Fax 926-5462

~~Site Name~~ Sample ID Colorado Seep	Custody Tag #	Dist. No.	~~Sample ID~~	Type (soil, liq. sludge)	Lab Test *	Container & Preservation	Time Taken	Date Taken	Lab Rec'd	Date Results Rec'd
CC-1 (22.9-23.2)	NA	3	~~CC-1 (22.9-23.2)~~	Soil	TPH	Ice	930	7/26	7-29	
CC-1 (31.6-32.8)					5c.		1145	7/26		
CC-1 (44.1-45.8)							1135	7/26		
CC-2 (22.4-22.7)							1545	7/26		
CC-2 (13.5-15)							1730	7/26		
CC-2 (50.8-51.1)							1710	7/26		
~~CC-3 (18.7-21.2)~~			Skip	Sent to Lab for TOC			1300	7/20		
CC-3' (13.7-15.2)							1230	7/20		
CC-4 (18.6-21.1)							1045	7/27		
CC-4 (38.6-40.7)							1150	7/27		
~~CC-5 (18.9-21.4)~~			Skip	Sent to	Lab previously		~~1500~~	~~7/21~~		
CC-6 ~~(19.2-21.7)~~	should be		19.3-19.6'	RCS	(Submitted on 7/22/99)		0930	7/21	?	
CC-7 (18.8-21.3)							1500	7/22		
CC-7 (48.2-48.5)							1556	7/22		

AEB OK. ABC

Relinquished by Rebecca C. Smyth	Time 1545	Date 7/29/99 /	Received by Aimee Beveridge	Time 1545	Date 7/29/99
Relinquished by Aimee B.	Time 1750	Date 7-29-99 /	Received by Carl Nelson	Time 1750	Date 07-29-99
Relinquished by	Time	Date /	Received by	Time	Date
Relinquished by	Time	Date /	Received by	Time	Date

*1. Full constitutent 1:1 extract; TPH, oil & grease; TCLP metals
*2. Oliensis spot test (only if oil is present); TCLP metals; full constituent 1:1 extract; TPH oil and grease
*3. Full constituent
*4. Metals
*5. TPH oil and grease
*6. Oliensis spot test; API gravity; TPH/oil and grease; finger printing

SPECIAL INSTRUCTIONS

RAILROAD COMMISSION OF TEXAS LABORATORY

2801 Wheless, Austin, TX 78723 / Phone 926-3064 / Fax 926-5462

Site Name Sample	Custody Tag #	Dist. No.	Sample ID	Type (soil, liq. sludge)	Lab Test	Container & Preservation	Time Taken	Date Taken	Lab Rec'd	Date Results Rec'd
CC-7 (53.6-53.8)	NA	3		Soil	TPH/O&G	Ice	1630	7-22		
CC-8 (31.3-33.6							1545	7/24		
CC-8 (21.5-21.7)							1530			
CC-8 (23.8-26.3)							1930			
CC-8 (28.2-31.3)							1945			
CC-8 (38.8-41.3)							1940			
CC-9 (18.1-18.4)							0951			
CC-9 (36.9-37.2)							1050	7/24		
~~CC-10 (33.3-33.8)~~	Taken for			1006			1030	7-22		
CC-10 (41.3-42.2)							1050	7-22		
CC-11 (18.35-19.0)							1149	7/23		
CC-12 (21.5-21.7)							1045	7/25		
CC-12 (16.3-18.8)								7/25		
CC-12 (8.8-9.2)							1013	7/25		

AE

Relinquished by [signature]	Time 1545	Date 7/29/99	Received by [signature]	Time 1545	Date 7-29-99
Relinquished by [signature]	Time 1750	Date 7/29/99	Received by [signature]	Time 1750	Date 7-29-99
Relinquished by	Time	Date	Received by	Time	Date
Relinquished by	Time	Date	Received by	Time	Date

*1. Full constitutent 1:1 extract; TPH, oil & grease; TCLP metals

*2. Oliensis spot test (only if oil is present); TCLP metals; full constituent 1:1 extract; TPH oil and grease

*3. Full constituent

*4. Metals

*5. TPH oil and grease

*6. Oliensis spot test; API gravity; TPH/oil and grease; finger printing

SPECIAL INSTRUCTIONS

RAILROAD COMMISSION OF TEXAS LABORATORY

2801 Wheless, Austin, TX 78723 / Phone 926-3064 / Fax 926-5462

Site Name	Custody Tag #	Dist. No.	Sample ID	Type (soil, liq. sludge)	Lab Test *	Container & Preservation	Time Taken	Date Taken	Lab Rec'd	Date Results Rec'd
CC-3 (1905-1955)	NA	3	SKIP	Soil	TPH +	Ice	300	7-20		
CC-11 (36-3-36.7)					O+G		1230	7-23		

AB OK

Relinquished by Rebecca C. Smyth Time 1545 Date 7/29/99 / Received by [signature] Time 1545 Date 7-29-99

Relinquished by Aimee Beveridge Time 1750 Date 7-29-99 / Received by Carl Nelson Time 1750 Date 07-29-99

Relinquished by ________ Time ______ Date ______ / Received by ________ Time ______ Date ______

Relinquished by ________ Time ______ Date ______ / Received by ________ Time ______ Date ______

*1. Full constituent 1:1 extract; TPH, oil & grease; TCLP metals

*2. Oliensis spot test (only if oil is present); TCLP metals; full constituent 1:1 extract; TPH oil and grease

*3. Full constituent

*4. Metals

*5. TPH oil and grease

*6. Oliensis spot test; API gravity; TPH/oil and grease; finger printing

SPECIAL INSTRUCTIONS

FILE: EDWARDS\FORMS\LABCUST2.XLS

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9110E RRC Custody Tag No.

Sample Identification: CC-3 (13.5-15.2)

Submitted by: Special Response

Date Collected: Date Received: 07-22-1999 Date Completed: 07-29-199

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.33	%
Total Petroleum Hydrocarbons	0.26	%

Comments:

Data Verification ______________________________

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9111E RRC Custody Tag No.

Sample Identification: CC-3 (18.7-21.2)

Submitted by: Special Response

Date Collected: Date Received: 07-22-1999 Date Completed: 07-29-199

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	0.12	%
Total Petroleum Hydrocarbons	0.10	%

Comments:

Data Verification________________________________

71

RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9112E   RRC Custody Tag No.

Sample Identification: CC-5 (18.9-21.4)

Submitted by: Special Response

Date Collected: Date Received: 07-22-1999 Date Completed: 07-29-199

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification ______________________________

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RAILROAD COMMISSION OF TEXAS
SURFACE MINING AND RECLAMATION DIVISION LABORATORY

Soil Analysis Report

Lab No. 9113E   RRC Custody Tag No.

Sample Identification: CC-6 (19.3-19.6)

Submitted by: Special Response

Date Collected: Date Received: 07-22-1999 Date Completed: 07-29-199

ANALYSIS	VALUE	UNITS
Oil and Grease (as % dry solids)	<0.05	%
Total Petroleum Hydrocarbons	<0.05	%

Comments:

Data Verification ______________________

RAILROAD COMMISSION OF TEXAS LABORATORY

2801 Wheless, Austin, TX 78723 / Phone 926-3064 / Fax 926-5462

Colorado Seep Site Dist. 3

~~Site Name~~ Sample	Custody Tag #	Dist. No.	~~Sample ID~~	Type (soil, liq. sludge)	Lab Test *	Container & Preservation	Time Taken	Date Taken	Lab Rec'd	Date Results Rec'd
CC-3 (13.5-15.2)	None	3		Soil	TPH	ice		7-21	7-22	
CC-3 (18.7-21.2)	↓	↓		↓	↓	↓		7-21	↓	
CC-5 (18.9-21.4)	↓	↓		↓	↓	↓		7-21	↓	
CC-6 (19.3-19.6)	↓	↓		↓	↓	↓		7-21		

Relinquished by Aimee Berdy Time 7-22-99 Date 8:46 / Received by Gigi Mendez Time 8:46 Date 7-22-99

Relinquished by ______ Time ______ Date ______ / Received by ______ Time ______ Date ______

Relinquished by ______ Time ______ Date ______ / Received by ______ Time ______ Date ______

Relinquished by ______ Time ______ Date ______ / Received by ______ Time ______ Date ______

*1. Full constitutent 1:1 extract; TPH, oil & grease; TCLP metals
*2. Oliensis spot test (only if oil is present); TCLP metals; full constituent 1:1 extract; TPH oil and grease
*3. Full constituent
*4. Metals
*5. TPH oil and grease
*6. Oliensis spot test; API gravity; TPH/oil and grease; finger printing

SPECIAL INSTRUCTIONS

AnalySys Inc.

4221 Freidrich Lane, Suite 190, Austin, TX 78744
& 2209 N. Padre Island Dr., Corpus Christi, TX 78408
(512) 444-5896 • FAX (512) 447-4766

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-2967
Phone: 463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100500 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-8 (18.8-21.3)
Sample Matrix: soil
Date Received: 7/29/99 **Time:** 17:30:00
Date Sampled: 7/24/99 **Time:** 17:35:00

REPORT OF ANALYSIS / **QUALITY ASSURANCE DATA**[1]

Parameter	Result	Units	RQL[5]	Blank	Date	Method[6]	Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Aliphatic (>C5-C8)	<500	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	96.6	-NA-
Aliphatic (C9-C18)	860	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	97	-NA-
Aliphatic(C19-C32)	<500	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	102.4	-NA-
Aromatic (C9-C32)	<500	mg/Kg	500	<500	8/4/99	TX 1006				
TPH by GC (1006-ext)	---				7/29/99	TX 1006				
TPH by GC (Aliphatic)	---				8/4/99					
TPH by GC (Aromatic)	---				8/4/99					

RECEIVED
RRC OF TEXAS
AUG 19 1999
OG SR
AUSTIN, TEXAS

This analytical report respectfully submitted by AnalySys, Inc. The enclosed results have been reviewed and to the best of my knowledge the analytical results are consistent with AnalySys, Inc.'s Quality Assurance/Quality Control Program.

Respectfully Submitted,

Richard Laster

Richard Laster

1. Quality assurance data reported is for the lot analyzed which included this sample.
2. Precision (Prec.) is the absolute value of the relative percent (%) difference between duplicate measurements.
3. Recovery (Recov.) is the percent (%) of analyte recovered from a spiked sample.
4. Calibration Verification (CCV) and Lab Control Sample (LCS) results expressed as the percent (%) recovery of analyte from a known standard.
5. Reporting Quantitation Limit. The Practical Quantitation Limit (PQL) or the Method Detection Limit (MDL) reported for the analyte.
6. Method numbers typically denote USEPA procedures. Less than ("<") values reflect nominal quantitation limits, adjusted for any required dilution.

75

AnalySys Inc.

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-296'

Phone: 463-7995 FAX: 463-7328

Report #/Lab ID#: 100500 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-8 (18.8-21.3)
Sample Matrix: soil
Date Received: Jul 29, 19! **Time:** 17:30:0
Date Sampled: 7/24/99 **Time:** 17:35:00

Surrogate Recoveries

Surrogate Compound	Method	Recovery	Recovery Limits
p-Terphenyl	TX 1006	100	50-150

76

AnalySys Inc.

4221 Freidrich Lane, Suite 190, Austin, TX 78744
& 2209 N. Padre Island Dr., Corpus Christi, TX 78408
(512) 444-5896 • FAX (512) 447-4766

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-2967

Phone: 463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100501 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-10 (33.3-33.8)
Sample Matrix: soil
Date Received: 7/29/99 **Time:** 17:30:00
Date Sampled: 7/22/99 **Time:** 10:30:00

REPORT OF ANALYSIS | **QUALITY ASSURANCE DATA**[1]

Parameter	Result	Units	RQL[5]	Blank	Date	Method[6]	Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Aliphatic (>C5-C8)	<500	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	96.6	-NA-
Aliphatic (C9-C18)	<500	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	97	-NA-
Aliphatic(C19-C32)	<500	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	102.4	-NA-
Aromatic (C9-C32)	<500	mg/Kg	500	<500	8/4/99	TX 1006				
TPH by GC (1006-ext)	---				7/29/99	TX 1006				
TPH by GC (Aliphatic)	---				8/4/99					
TPH by GC (Aromatic)	---				8/4/99					

Respectfully Submitted,

Richard Laster

Richard Laster

1. Quality assurance data reported is for the lot analyzed which included this sample.
2. Precision (Prec.) is the absolute value of the relative percent (%) difference between duplicate measurements.
3. Recovery (Recov.) is the percent (%) of analyte recovered from a spiked sample.
4. Calibration Verification (CCV) and Lab Control Sample (LCS) results expressed as the percent (%) recovery of analyte from a known standard.
5. Reporting Quantitation Limit. The Practical Quantitation Limit (PQL) or the Method Detection Limit (MDL) reported for the analyte.
6. **Method numbers typically denote USEPA procedures.** Less than ("<") values reflect nominal quantitation limits, adjusted for any required dilution.

AnalySys Inc.

Client:	Railroad Commission
Attn:	Aimee Beveridge
Address:	P.O. Box 12967
	Austin, Tx 78711-296′
Phone:	463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100501 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-10 (33.3-33.8)
Sample Matrix: soil
Date Received: 07/29/99 **Time:** 17:30:00
Date Sampled: 7/22/99 **Time:** 10:30:00

Surrogate Recoveries

Surrogate Compound	Method	Recovery	Recovery Limits
p-Terphenyl	TX 1006	92.9	50-150

AnalySys Inc.
4221 Freidrich Lane, Suite 190, Austin, TX 78744
& 2209 N. Padre Island Dr., Corpus Christi, TX 78408
(512) 444-5896 • FAX (512) 447-4766

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-2967
Phone: 463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100502 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-4 (6.1-8.4)
Sample Matrix: soil
Date Received: 7/29/99 **Time:** 17:30:00
Date Sampled: 7/27/99 **Time:** 11:50:00

REPORT OF ANALYSIS — **QUALITY ASSURANCE DATA[1]**

Parameter	Result	Units	RQL[5]	Blank	Date	Method[6]	Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Aliphatic (>C5-C8)	1070	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	96.6	-NA-
Aliphatic (C9-C18)	2020	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	97	-NA-
Aliphatic(C19-C32)	<500	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	102.4	-NA-
Aromatic (C9-C32)	533	mg/Kg	500	<500	8/4/99	TX 1006				
TPH by GC (1006-ext)	---				7/29/99	TX 1006				
TPH by GC (Aliphatic)	---				8/4/99					
TPH by GC (Aromatic)	---				8/4/99					

This analytical report respectfully submitted by AnalySys, Inc. The enclosed results have been reviewed and to the best of my knowledge the analytical results are consistent with AnalySys, Inc.'s Quality Assurance/Quality Control Program.

Respectfully Submitted,

Richard Laster

Richard Laster

1. Quality assurance data reported is for the lot analyzed which included this sample.
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6. Method numbers typically denote USEPA procedures. Less than ("<") values reflect nominal quantitation limits, adjusted for any required dilution.

Analysys Inc.

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-296'

Phone: 463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100502 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-4 (6.1-8.4)
Sample Matrix: soil
Date Received: 07/29/99 **Time:** 17:30:00
Date Sampled: 7/27/99 **Time:** 11:50:00

Surrogate Recoveries

Surrogate Compound	Method	Recovery	Recovery Limits
p-Terphenyl	TX 1006	108	50-150

80

AnalySys Inc.

4221 Freidrich Lane, Suite 190, Austin, TX 78744
& 2209 N. Padre Island Dr., Corpus Christi, TX 78408
(512) 444-5896 • FAX (512) 447-4766

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-2967

Phone: 463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100503 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-1 (44.1-45.8)
Sample Matrix: soil
Date Received: 7/29/99 **Time:** 17:30:00
Date Sampled: 7/26/99 **Time:** 11:35:00

REPORT OF ANALYSIS / **QUALITY ASSURANCE DATA**[1]

Parameter	Result	Units	RQL[5]	Blank	Date	Method[6]	Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Aliphatic (>C5-C8)	<500	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	96.6	-NA-
Aliphatic (C9-C18)	2610	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	97	-NA-
Aliphatic(C19-C32)	1420	mg/Kg	500	<500	8/4/99	TX 1005	-NA-	-NA-	102.4	-NA-
Aromatic (C9-C32)	<500	mg/Kg	500	<500	8/4/99	TX 1006				
TPH by GC (1006-ext)	---				7/29/99	TX 1006				
TPH by GC (Aliphatic)	---				8/4/99					
TPH by GC (Aromatic)	---				8/4/99					

This analytical report respectfully submitted by AnalySys, Inc. The enclosed results have been reviewed and to the best of my knowledge the analytical results are consistent with AnalySys, Inc.'s Quality Assurance/Quality Control Program.

Respectfully Submitted,

Richard Laster

Richard Laster

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3. Recovery (Recov.) is the percent (%) of analyte recovered from a spiked sample.
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AnalySys Inc.

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-296'

Phone: 463-7995 FAX: 463-7328

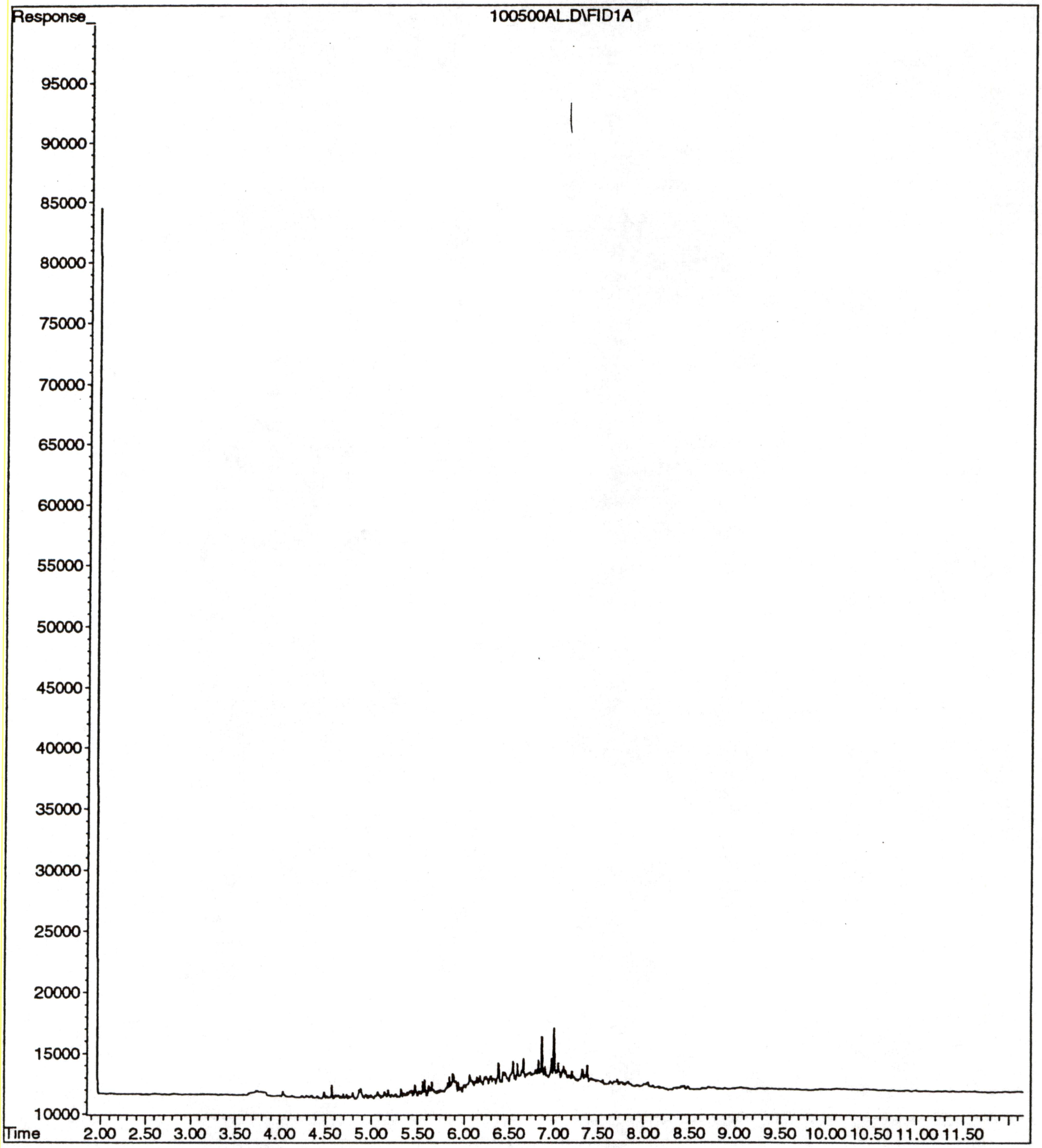
Report #/Lab ID#: 100503 **Report Date:** 8/11/99
Project ID:
Sample Name: CC-1 (44.1-45.8)
Sample Matrix: soil
Date Received: 07/29/99 **Time:** 17:30:00
Date Sampled: 7/26/99 **Time:** 11:35:00

Surrogate Recoveries

Surrogate Compound	Method	Recovery	Recovery Limits
p-Terphenyl	TX 1006	119	50-150

82

File   : C:\HPCHEM\1\DATA\9218MAS\100500AL.D
Operator   : JRO
Acquired   : 4 Aug 99 16:00   using AcqMethod TPH.M
Instrument :   FID/PID
Sample Name: 100500
Misc Info   : S10
Vial Number: 12



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File        : C:\HPCHEM\1\DATA\9218MAS\100500AR.D
Operator    : JRO
Acquired    :  4 Aug 99  18:49     using AcqMethod TPH.M
Instrument  :   FID/PID
Sample Name: 100500
Misc Info   : S10
Vial Number: 20
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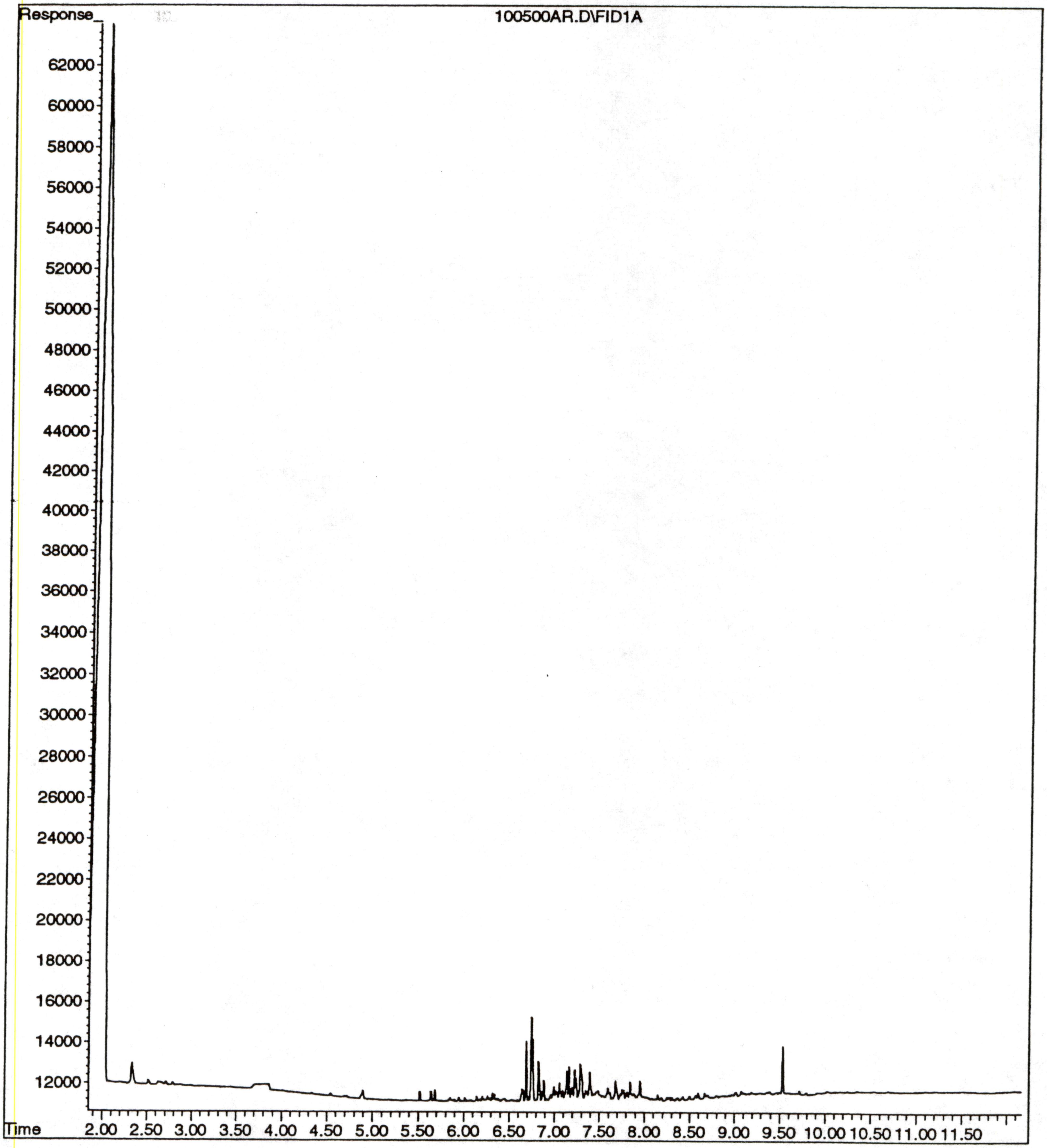

94

```
File         : C:\HPCHEM\1\DATA\9218MAS\100501AL.D
Operator     : JRO
Acquired     :  4 Aug 99  16:21     using AcqMethod TPH.M
Instrument   :   FID/PID
Sample Name: 100501
Misc Info    : S10
Vial Number: 13
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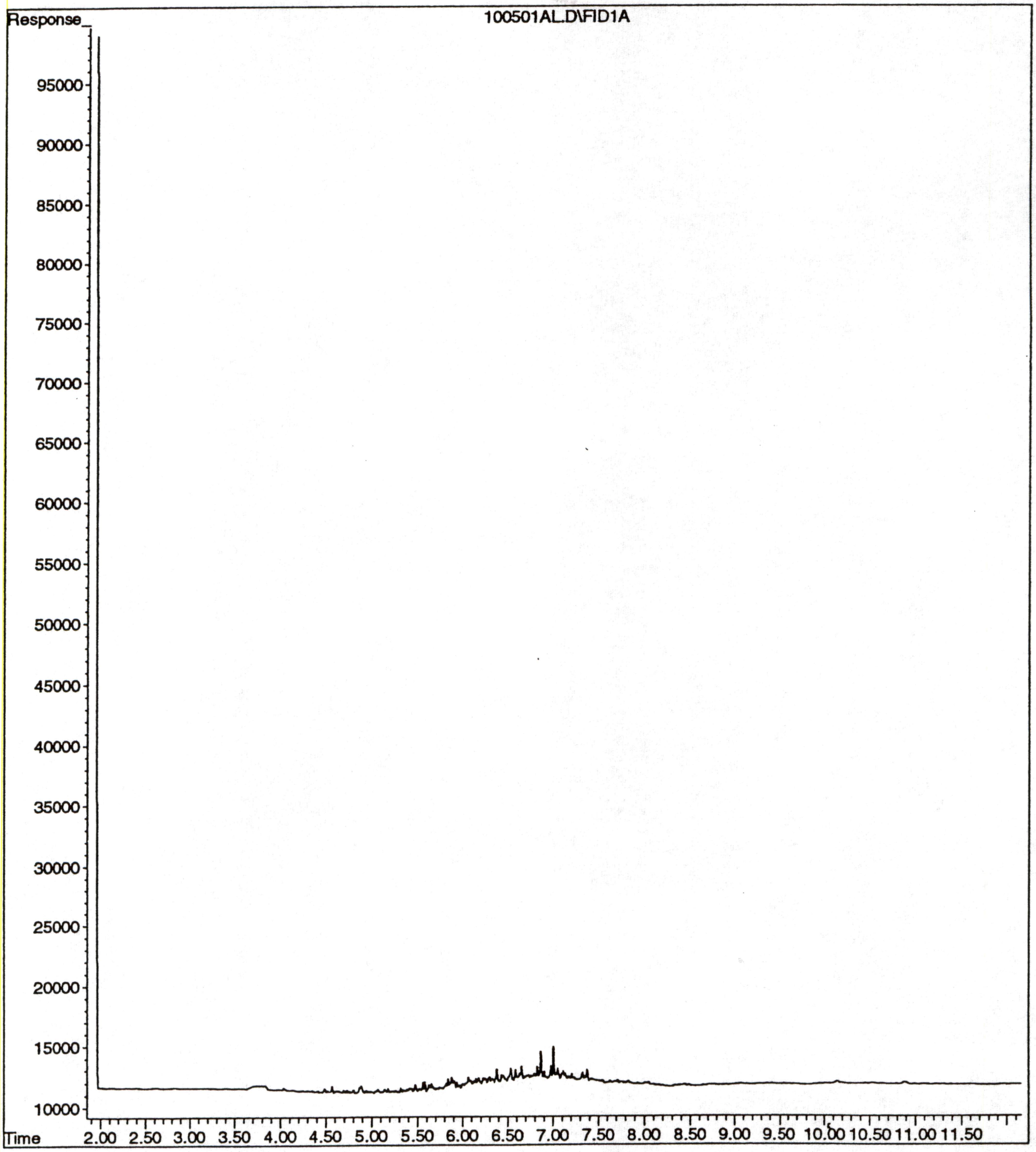
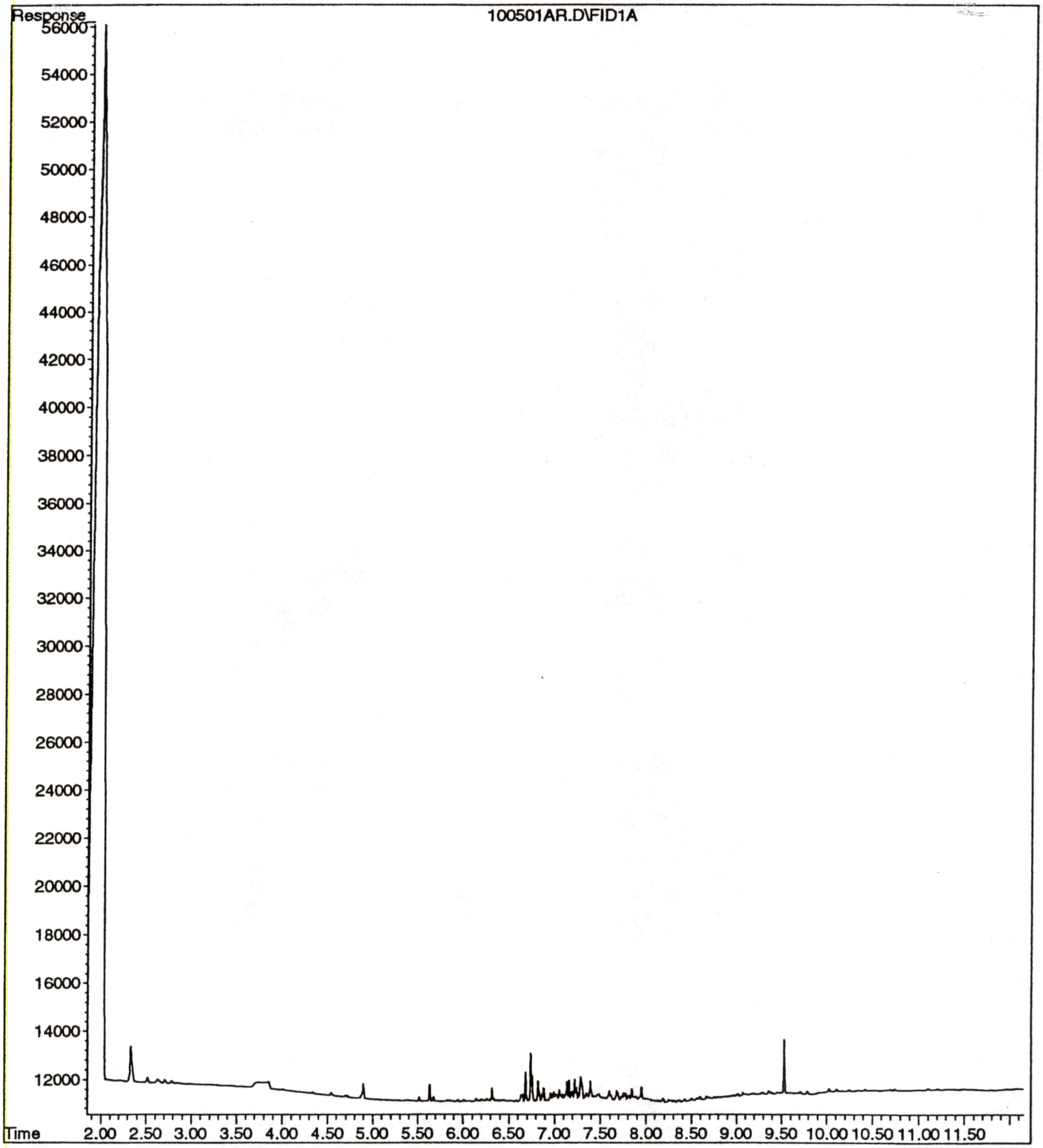
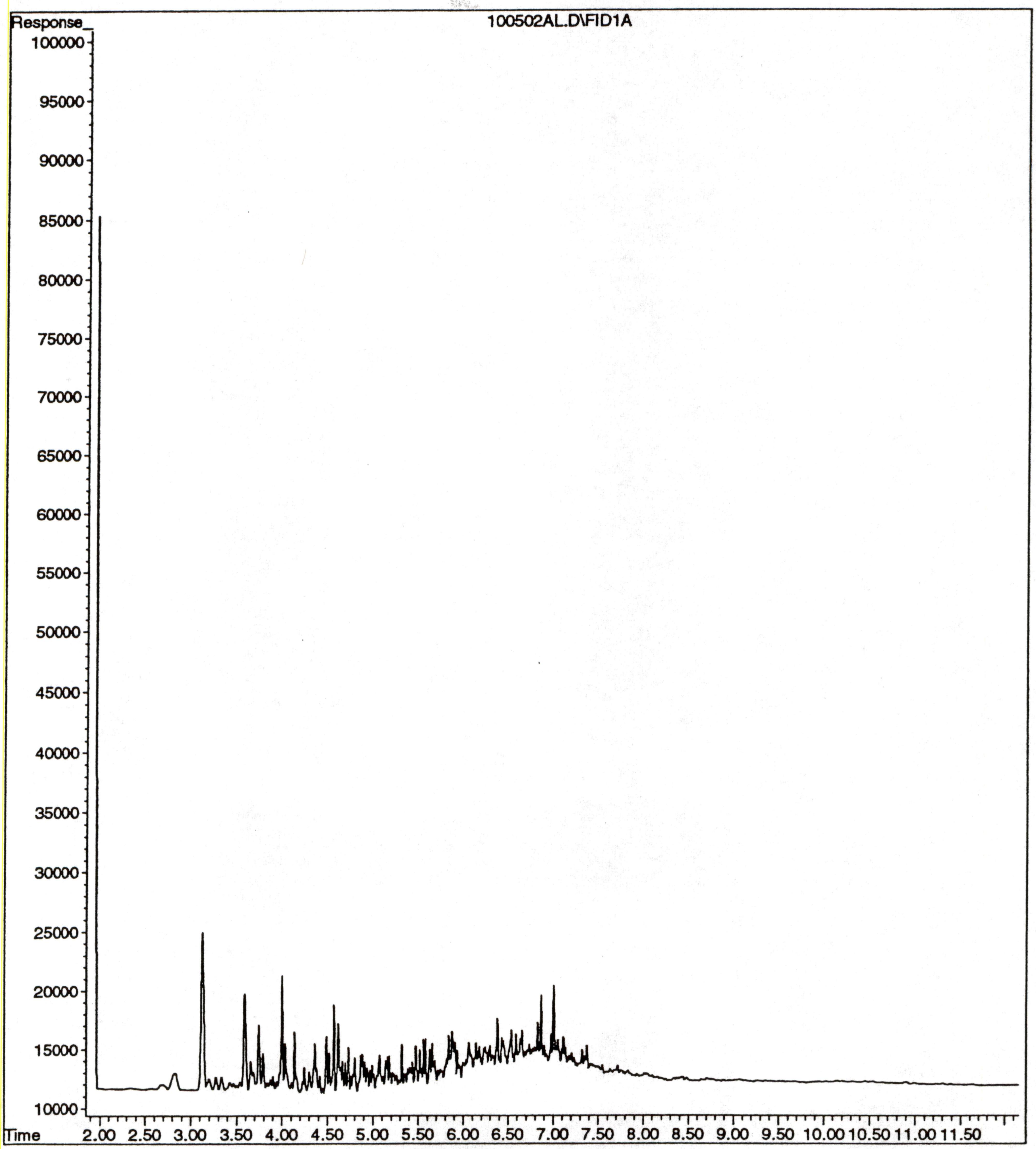


95

File : C:\HPCHEM\1\DATA\9218MAS\100501AR.D
Operator : JRO
Acquired : 4 Aug 99 19:11 using AcqMethod TPH.M
Instrument : FID/PID
Sample Name: 100501
Misc Info : S10
Vial Number: 21



File   : C:\HPCHEM\1\DATA\9218MAS\100502AL.D
Operator   : JRO
Acquired   : 4 Aug 99 16:42   using AcqMethod TPH.M
Instrument :   FID/PID
Sample Name: 100502
Misc Info   : S10
Vial Number: 14



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File        : C:\HPCHEM\1\DATA\9218MAS\100502AR.D
Operator    : JRO
Acquired    :  4 Aug 99   19:32     using AcqMethod TPH.M
Instrument  :   FID/PID
Sample Name: 100502
Misc Info   : S10
Vial Number: 22
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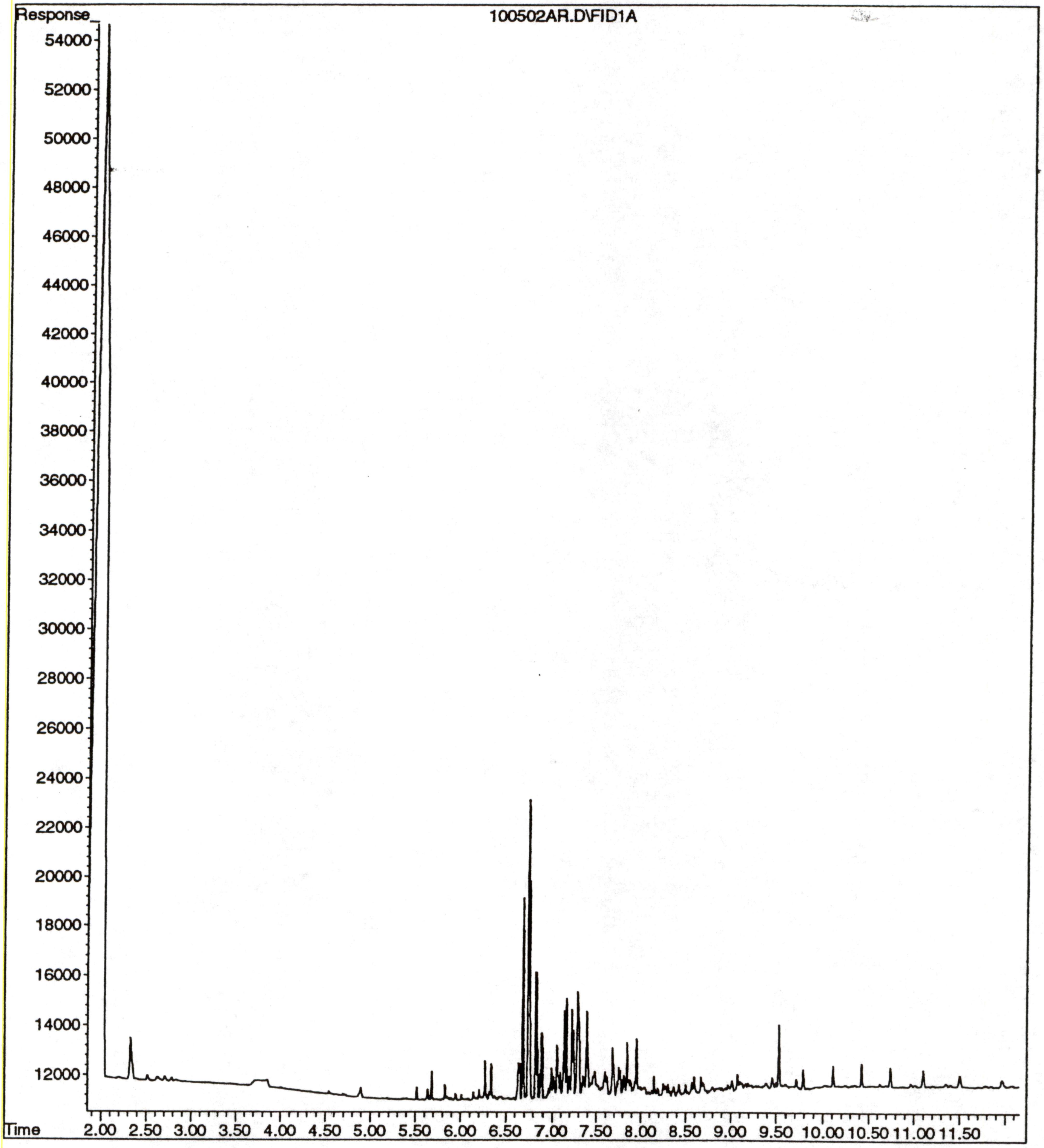
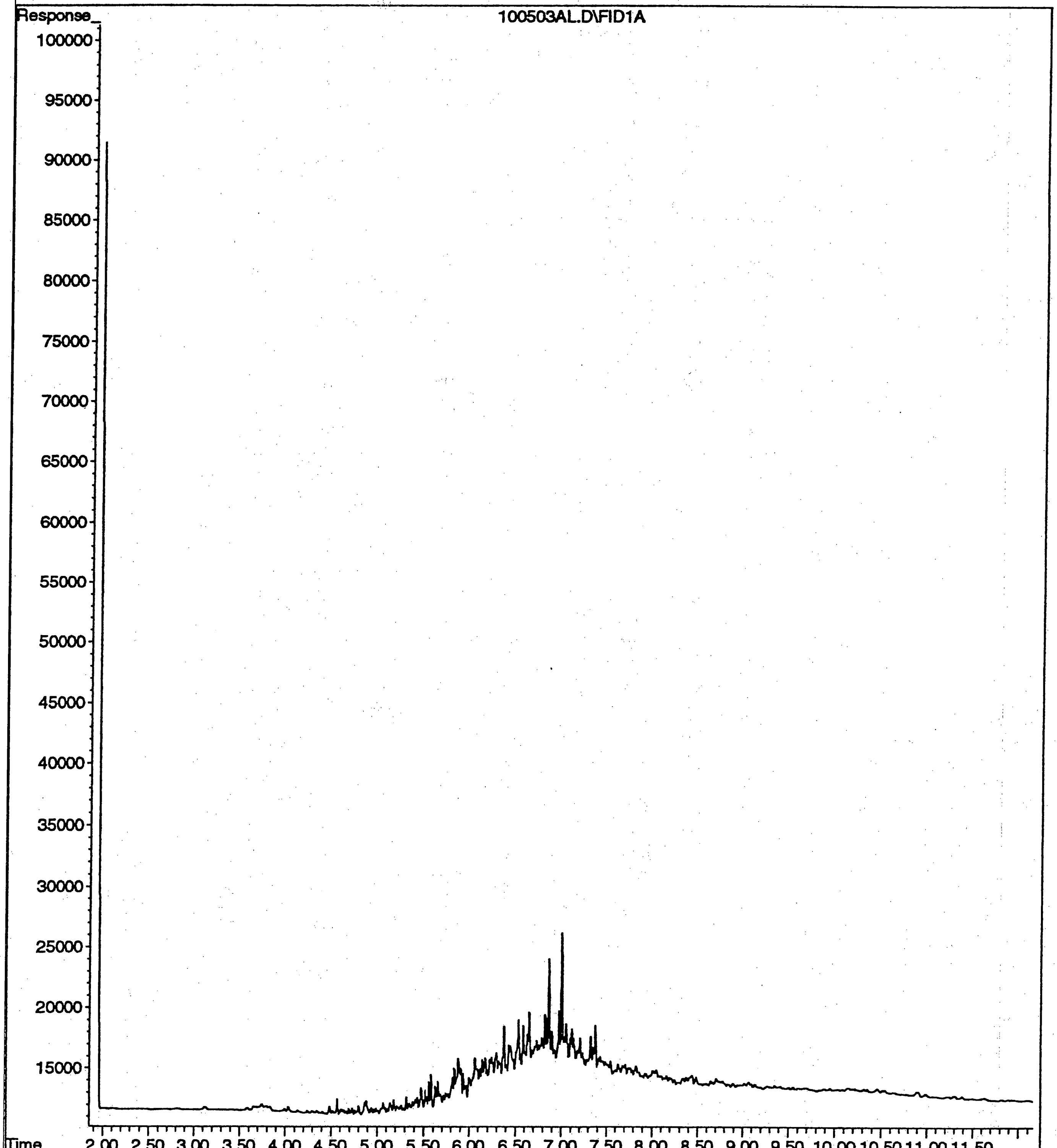
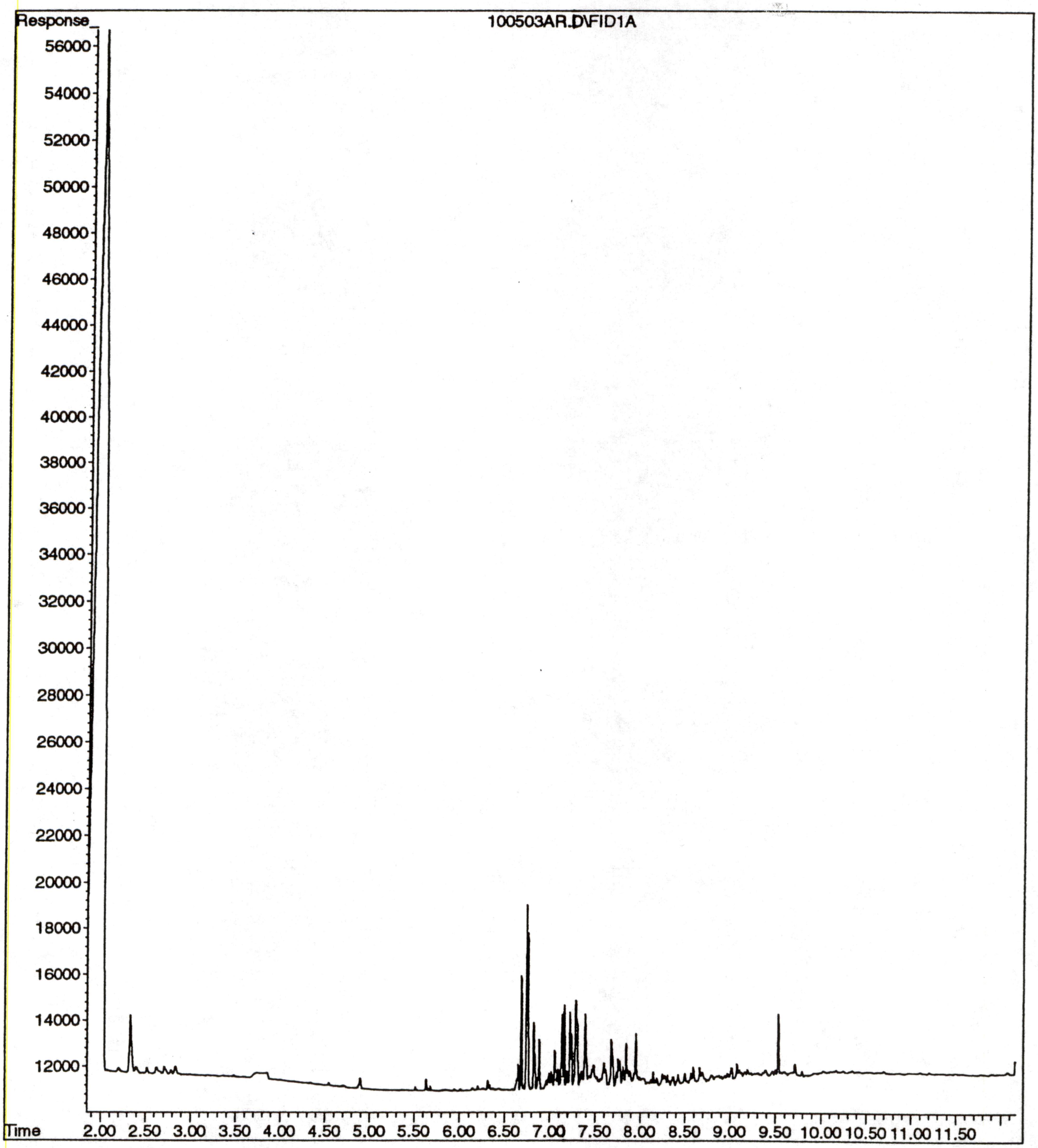


88

```
File        : C:\HPCHEM\1\DATA\9218MAS\100503AL.D
Operator    : JRO
Acquired    :  4 Aug 99  17:03      using AcqMethod TPH.M
Instrument  :   FID/PID
Sample Name: 100503
Misc Info   : S10
Vial Number: 15
```



File   : C:\HPCHEM\1\DATA\9218MAS\100503AR.D
Operator   : JRO
Acquired   : 4 Aug 99   19:53   using AcqMethod TPH.M
Instrument :   FID/PID
Sample Name: 100503
Misc Info   : S10
Vial Number: 23



90

CHAIN OF CUSTODY

AnalySys Inc.
4221 Freidrich Lane, Suite 190, Austin, TX 78744
(512) 444-5896

Send Reports To:
Company Name Same
Address
City State Zip
ATTN:
Phone Fax

Bill to (if different):
Company Name Railroad Commission - Site Remediation
Address 1701 Congress Ave
City Austin State TX Zip 78745
ATTN: Aimee Beveridge
Phone 463-7995 Fax

Rush Status (must be confirmed with lab mgr.):
Project Name/PO#: Sampler:

Analyses Requested (1)
Please attach explanatory information as required

Client Sample No. Description/Identification	Date Sampled	Time Sampled	No. of Containers	Soil	Water	Waste	Lab I.D. # (Lab only)	TX 1006								Comments
CC-8 (18.8-21.3)	7-24	1735	1	✓			100500									Please include
CC-10 (33.3-33.8)	7-22	1030	1	✓			100501									chromatograms
CC-4 (6.1-8.4)	7-27	1150	1	✓			100502									+ QAQC
CC-1 (44.1-45.8)	7-26	1135	1	✓			100503									

Unless specifically requested otherwise on this Chain-of-custody and/or attached documentation, all analyses will be conducted using ASI's method of choice and all data will be reported to ASI's normal reporting limits (MDL/PQL). For GC/MS volatiles and extractables, unless specific analytical parameter lists are specified on this chain-of-custody or attached to this chain-of-custody, ASI will default to Priority Pollutants or EPA's HSL list at ASI's option. Specific compound lists must be supplied for all GC procedures.

Sample Relinquished By				Sample Received By			
Name	Affiliation	Date	Time	Name	Affiliation	Date	Time
[signature]	UTBEG	7/29/99	1530	[signature]	RRC	~~7-29-99~~	1530
[signature]	RRC	7-29-99	1730	Aaron Starnes	ASI	7/29/99	1730

[Tendering of above described samples to AnalySys, Inc. for analytical testing constitutes agreement by buyer/sampler to AnalySys, Inc.'s standard terms.]

AnalySys Inc.

4221 Freidrich Lane, Suite 190, Austin, TX 78744
& 2209 N. Padre Island Dr., Corpus Christi, TX 78408
(512) 444-5896 • FAX (512) 447-4766

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-2967
Phone: 463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100279 **Report Date:** 8/11/99
Project ID: Colorado Seep
Sample Name: CC3-(19.5')
Sample Matrix: soil
Date Received: 7/22/99 **Time:** 08:07:00
Date Sampled: 7/20/99 **Time:** 00:00:00

REPORT OF ANALYSIS / QUALITY ASSURANCE DATA[1]

Parameter	Result	Units	RQL[5]	Blank	Date	Method[6]	Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Aliphatic (>C5-C8)	<500	mg/Kg	500	<500	8/2/99	TX 1005	-NA-	-NA-	96.6	-NA-
Aliphatic (C9-C18)	<500	mg/Kg	500	<500	8/2/99	TX 1005	-NA-	-NA-	97	-NA-
Aliphatic(C19-C32)	<500	mg/Kg	500	<500	8/2/99	TX 1005	-NA-	-NA-	102.4	-NA-
Aromatic (C9-C32)	<500	mg/Kg	500	<500	8/2/99	TX 1006				
TPH by GC (1006-ext)	---				7/29/99	TX 1006				
TPH by GC (Aliphatic)	---				8/2/99					
TPH by GC (Aromatic)	---				8/2/99					

RECEIVED
RRC OF TEXAS
AUG 1 9 1999
OG SR
AUSTIN, TEXAS

This analytical report respectfully submitted by AnalySys, Inc. The enclosed results have been reviewed and to the best of my knowledge the analytical results are consistent with AnalySys, Inc.'s Quality Assurance/Quality Control Program.

Respectfully Submitted,

Richard Laster

Richard Laster

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Analysys Inc.

Client: Railroad Commission
Attn: Aimee Beveridge
Address: P.O. Box 12967
Austin, Tx 78711-296'

Phone: 463-7995 **FAX:** 463-7328

Report #/Lab ID#: 100279 **Report Date:** 8/11/99
Project ID: Colorado Seep
Sample Name: CC3-(19.5')
Sample Matrix: soil
Date Received: 07/22/99 **Time:** 08:07:00
Date Sampled: 7/20/99 **Time:** 00:00:00

Surrogate Recoveries

Surrogate Compound	Method	Recovery	Recovery Limits
p-Terphenyl	TX 1006	96.6	50-150

93

```
File        : C:\HPCHEM\1\DATA\9218MAS\100279AL.D
Operator    : JRO
Acquired    :  4 Aug 99  15:39     using AcqMethod TPH.M
Instrument  :   FID/PID
Sample Name: 100279
Misc Info   : S10
Vial Number: 11
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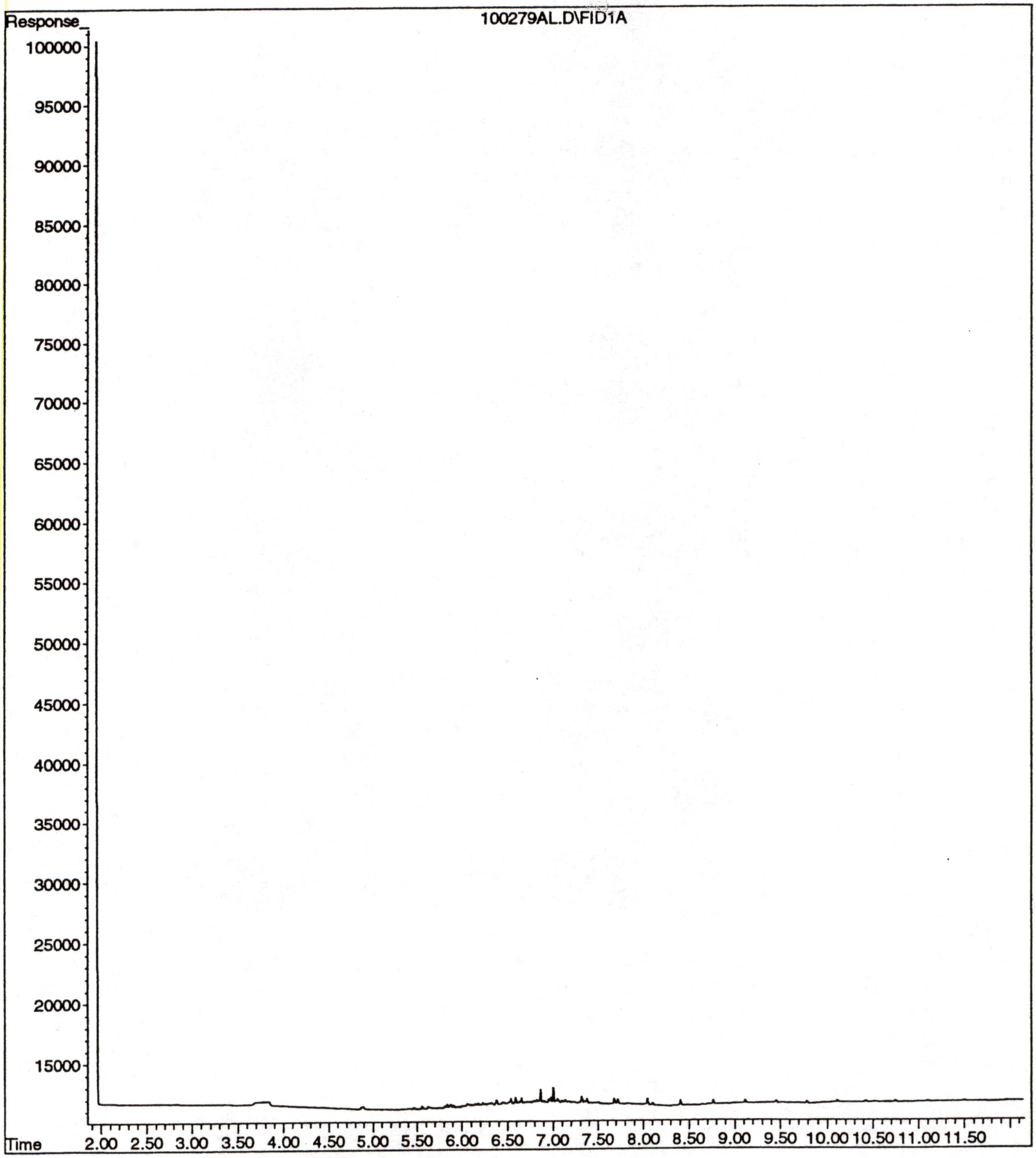

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File          : C:\HPCHEM\1\DATA\9218MAS\100279AR.D
Operator      : JRO
Acquired      :  4 Aug 99   18:28     using AcqMethod TPH.M
Instrument    :   FID/PID
Sample Name: 100279
Misc Info     : S10
Vial Number: 19
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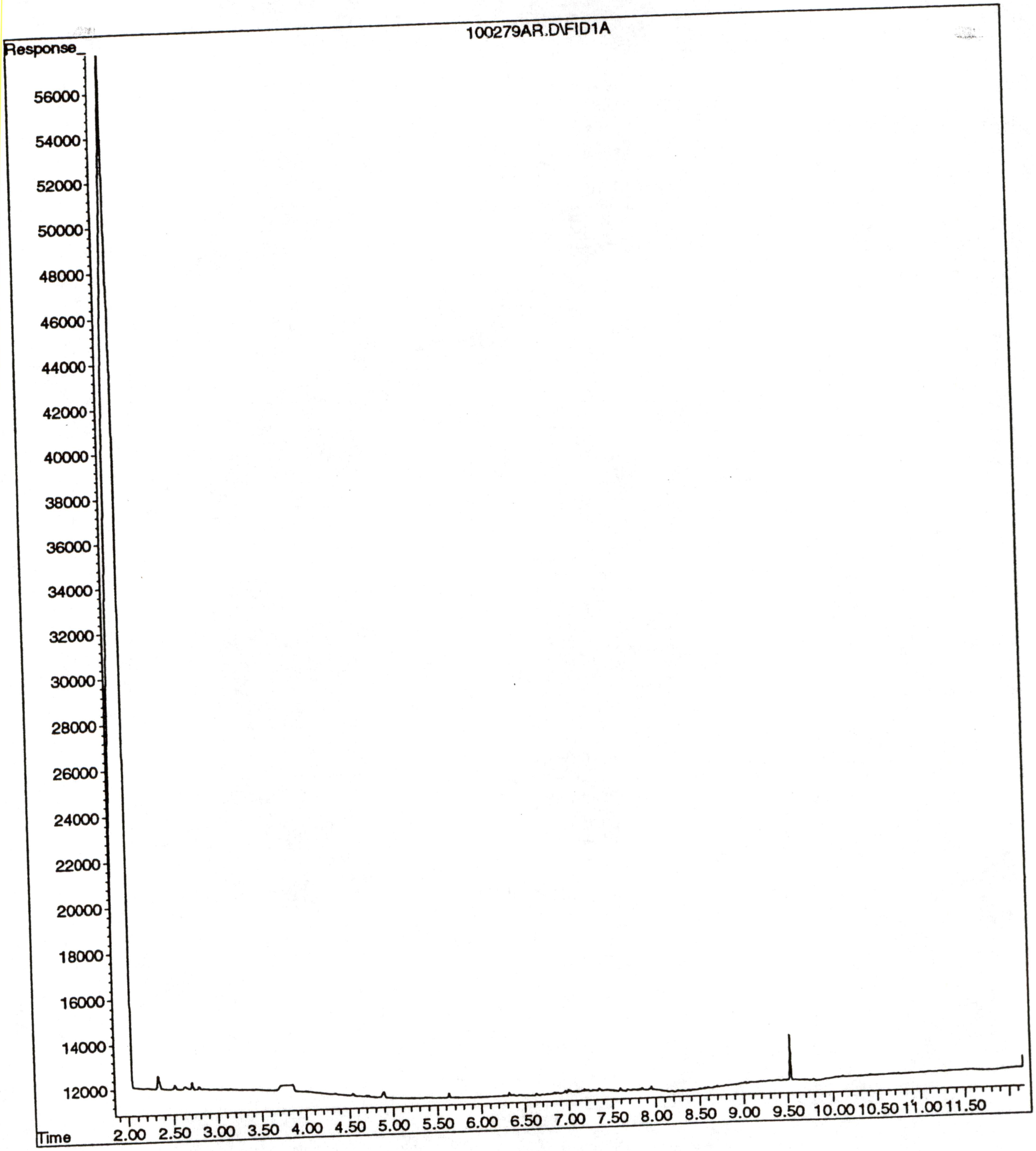

CHAIN F-CUSTODY

AnalySys Inc.
4221 Freidrich Lane, Suite 190, Austin, TX 78744
(512) 444-5896

Send Reports To:
Company Name Railroad Commission
Address P.O. Box 12967
City Austin State TX Zip 78711-2967
ATTN: Aimee Beveridge
Phone 463 Fax 463-7328

Bill to (if different):
Company Name Same
Address
City State Zip
ATTN:
Phone Fax

Rush Status (must be confirmed with lab mgr.): Regular turn
Project Name/PO#: ColoradoSeep Sampler: A. Beveridge

Analyses Requested (1)
Please attach explanatory information as required

Client Sample No. Description/Identification	Date Sampled	Time Sampled	No. of Containers	Soil	Water	Waste	Lab I.D. # (Lab only)	TX 1006								Comments
CC3-(19.5')	7-20		1	X			100279	✓								TX 1006
																Hold until
																three other
																samples arrive
																Please fax

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Sample Relinquished By				Sample Received By			
Name	Affiliation	Date	Time	Name	Affiliation	Date	Time
Aimee Beveridge	RRC	7-22-99	8:04	[signature]	ASI	7-22-99	0807

endering of above described samples to AnalySys, Inc. for analytical testing constitutes agreement by buyer/sampler to AnalySys, Inc.'s standard terms.]